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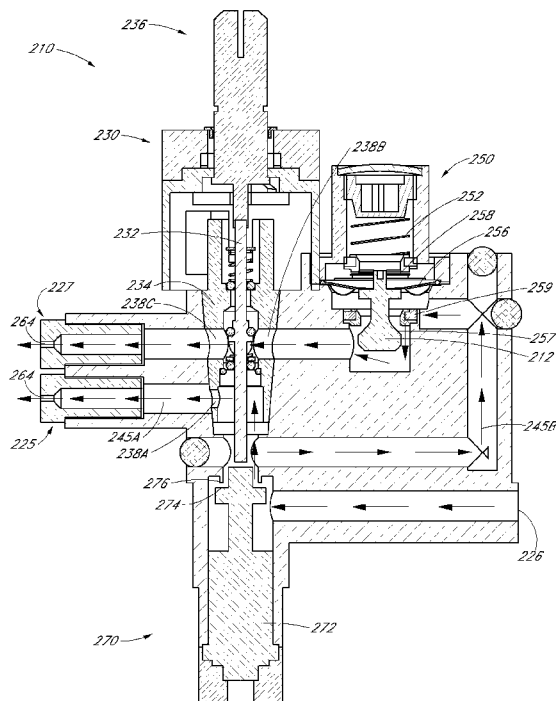


FIG. 46A

(57) Abstract: A heating system can include certain pressure sensitive features. These features can be configured to change from a first position to a second position based on a pressure of a fuel flowing into the feature. These features can include, fuel selector valves, pressure regulators, burner nozzles, and oxygen depletion sensor nozzles, among other features.



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HEATING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese Pat. Appl. Nos. 201210223977.0, 201220314766.3, 201210224414.3, 201220315268.0 all filed July 2, 2012. The entire contents of all of the above applications are hereby incorporated by reference and made a part of this specification.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] Certain embodiments disclosed herein relate generally to a heating source for use in a gas appliance. Aspects of certain embodiments may be particularly adapted for single fuel, dual fuel or multi-fuel use. The gas appliance can include, but is not limited to: heaters, boilers, dryers, washing machines, ovens, fireplaces, stoves, etc.

Description of the Related Art

[0003] Many varieties of heating sources, such as heaters, boilers, dryers, washing machines, ovens, fireplaces, stoves, and other heat-producing devices utilize pressurized, combustible fuels. However, such devices and certain components thereof have various limitations and disadvantages.

SUMMARY OF THE INVENTION

[0004] According to some embodiments a heating system can include any number of different components such as a fuel selector valve, a pressure regulator, a control valve, a burner nozzle, a burner, and/or an oxygen depletion sensor. In addition, a heating system can be a single fuel, dual fuel or multi-fuel heating system. For example, the heating system can be configured to be used with one or more of natural gas, liquid propane, well gas, city gas, and methane.

[0005] In some embodiments, the heating system can comprise a burner and a burner nozzle, the burner nozzle comprising at least one inlet, at least one first outlet, and at least one second outlet. The heating system can also comprise a first flow path from a fuel line to the first outlet and a second flow path from the fuel line to the second outlet. The

second flow path can include a movable body having a first position in which the second flow path is substantially closed, the flow through the second outlet is substantially close to zero, and the flow through the burner nozzle is less than in a second position. The movement of the movable body between the first and second positions can be controlled by the pressure of a fluid flowing through the burner nozzle.

[0006] In some embodiments, the heating system can further include a control valve positioned within the first and/or second flow path, wherein the control valve has a first position configured to allow a first flow of fuel through the first and/or second flow path and a second position configured to allow a second flow of fuel through the first and/or second flow path. The second flow of fuel can be less than the first flow of fluid.

[0007] Certain embodiments of a heating system can comprise a burner and a burner valve, the burner valve comprising at least one inlet, at least one first outlet, and at least one second outlet. The heating system can also comprise a control valve having a first position that allows a first flow of fuel through a control valve body and a second position that allows a second flow of fuel through the control valve body. The heating system can also comprise a first flow path from a fuel line through the at least one inlet, the control valve body, and the at least one first outlet; and a second flow path from the fuel line through the at least one inlet, the control valve body, and the at least one second outlet. The second flow path can include a movable body positioned at least partially within the second flow path and having a first position in which the second flow path is substantially closed, the flow through the second outlet is substantially close to zero, and the flow through the burner valve is less than in a second position. The movement of the movable body between the first and second positions can be controlled by the pressure of a fluid flowing through the burner valve.

[0008] A dual fuel heating system according to some embodiments can include a nozzle comprising at least one inlet, at least one first outlet, and at least one second outlet; a first flow path from a fuel line to the at least one first outlet; a second flow path from the fuel line to the at least one second outlet; and a movable body positioned at least partially within the second flow path. In a first position of the movable body, the second flow path can be substantially closed by the movable body, the amount of flow through the at least one second outlet is substantially close to zero, and the amount of flow through the nozzle is less than in a second position. The movable body can be configured such that movement between the

first and second positions is controlled by a pressure of a fluid flowing through the nozzle and/or system.

[0009] In some embodiments, the dual fuel heating system can also include a control valve positioned within the first flow path. The control valve can have a first position configured to allow a first flow of fuel through the first flow path and a second position configured to allow a second flow of fuel through the first flow path, wherein the second flow of fuel is less than the first flow of fuel. The control valve may also be positioned within the second flow path and the first position is further configured to allow a third flow of fuel through the second flow path and the second position is further configured to allow a fourth flow of fuel through the second flow path, wherein the fourth flow of fuel is less than the third flow of fuel.

[0010] According to some embodiments, a dual fuel heating assembly can comprise a nozzle housing comprising an inlet, at least one first outlet, and at least one second outlet. A first fluid pathway extends between the inlet and the at least one first outlet, and a second fluid pathway extends between the inlet and the at least one second outlet. A pressure controlled valve can be positioned within the second fluid pathway, the valve having an open and a closed position, the valve configured such that the valve position is based on a fluid pressure of fluid flowing through the second fluid pathway to either allow or prevent fluid flow to the at least one second outlet.

[0011] The dual fuel heating assembly may include one or more of the following. The pressure controlled valve can comprise a spring and a diaphragm, wherein the fluid pressure acts on the diaphragm to determine whether the valve is in the open or closed position. A flow control valve can be positioned within at least one of the first and second fluid pathways, wherein the flow control valve is configured to control a size of the fluid pathway. The flow control valve can be a rotatable valve. The flow control valve can be positioned within both the first and second fluid pathways. The pressure controlled valve can be part of the nozzle housing.

[0012] In some embodiments, a dual fuel heating assembly can comprise a nozzle, a control valve and a movable body. The nozzle can include at least one inlet, at least one first outlet, and at least one second outlet. A first flow path can extend from a fuel line through the at least one inlet and the at least one first outlet. A second flow path can

extend from the fuel line through the at least one inlet and the at least one second outlet. The control valve can have a first position that allows a first flow of fuel through a control valve body and a second position that allows a second flow of fuel through the control valve body, the control valve positioned in at least one of the first flow path and the second flow path. The movable body can be positioned at least partially within the second flow path. Wherein in a first position of the movable body, the second flow path is substantially closed by the movable body, the amount of flow through the at least one second outlet is substantially close to zero, and the amount of flow through the burner valve is less than in a second position. Wherein the movable body is configured such that movement between the first and second positions is controlled by a pressure of a fluid flowing to the nozzle. In further embodiments, the control valve is positioned in both the first flow path and the second flow path.

[0013] Certain embodiments of a heating system can comprise a burner and a burner nozzle. The burner nozzle can include a housing defining an inlet, an outlet and an inner chamber between the inlet and the outlet; a movable body within the inner chamber; and a biasing member. The biasing member can be configured to regulate a positional relationship between the body and a wall of the inner chamber in response to a pressure of a fluid flow, flowing through the burner nozzle. According to some embodiments, in a first position of the movable body within the inner chamber, the amount of flow allowed through the burner nozzle is more than in a second position and the movable body can be configured such that movement between the first and second positions is controlled by the pressure of the fluid flow acting on the biasing member.

[0014] According to certain embodiments, the pressure of the flow can act on the biasing member through contact with the movable body. In the second position of some embodiments, the movable body can be configured to sealingly connect to the outlet. The movable body may further comprise a channel passing therethrough. In addition, the burner nozzle may further comprise a second outlet, and when the movable body is in the second position fluid flow can be prevented through the second outlet. In some embodiments, the burner nozzle can further include a second outlet, and when the movable body is in the second position flow of fluid is prevented through either of the outlet or the second outlet.

[0015] In some embodiments, a heating system can include a burner, a nozzle and a biasing member. The nozzle can have a nozzle housing, an inlet, an outlet and a valve body within the nozzle housing and between the inlet and the outlet. The valve body and biasing member can be configured such that fluid flow of a predetermined pressure acts on the valve body to at least one of 1) move, 2) open, and 3) close the valve body within the nozzle housing to control fluid flow through the nozzle.

[0016] In some embodiments, the heating system can also include an end cap within the outlet of the nozzle housing. The end cap can have a first end configured to be manipulated so as to adjust the position of the end cap within the outlet and at least one orifice passing through the end cap. The nozzle housing can be configured such that when the valve body is in an open position, fluid flows through the nozzle entering at the inlet and exiting at the outlet through the at least one orifice. The nozzle can be configured such that adjusting the position of the end cap adjusts at least one of the predetermined pressure required to 1) move, 2) open, and 3) close the valve body within the nozzle housing.

[0017] Many different types of end caps can be used. For example, the biasing member can be between the end cap and the valve body, the end cap configured to calibrate the nozzle to adjust the pressure required to move the valve body to an open position. In some examples, the end cap is a set screw. Also, the end of the end cap can cooperate with a tool to adjust the position of the end cap relative to the valve body. This end of the end cap can include a detent. The end cap can be adjusted from outside of the nozzle. The end cap can also include an orifice and/or the at least one orifice.

[0018] In some embodiments a heating system can comprise an oxygen depletion sensor (ODS). An ODS can include an igniter, an inlet, an outlet, a first injector, a second injector, a first valve body and a first biasing member to control flow of fuel from the inlet to the first injector and a second valve body and a second biasing member to control flow of fuel from the inlet to the second injector. There maybe one or two, or more inlets and outlets. At a first predetermined fluid pressure the first valve can be open and the second valve can be closed and at a second predetermined fluid pressure, greater than the first, the first valve can be closed by the second predetermined fluid pressure acting on the first valve and the second valve can be opened by the second predetermined fluid pressure acting on the second valve.

[0019] The valves can be set such that the first biasing member is configured to open the first valve by the first predetermined fluid pressure acting on the first valve, the first predetermined fluid pressure being insufficient to open the second valve.

[0020] In some embodiments, an ODS can comprise a housing having a single inlet and a single outlet, and having a first fluid flow path and a second fluid flow path through the housing between the inlet and the outlet; a first air intake; a second air intake; a first injector within the housing and defining part of the first fluid flow path, the first injector comprising a first orifice, the first orifice configured to direct a first fuel from the inlet and towards the outlet while drawing air into the housing through the first air intake; a second injector within the housing and defining part of the second fluid flow path, the second injector comprising a second orifice, second first orifice configured to direct a second fuel from the inlet and towards the outlet while drawing air into the housing through the second air intake, wherein the first fuel is at a pressure different from the second fuel; a first valve within the housing and defining part of the first fluid flow path, the first valve configured to control the flow of fuel to the first injector; and a second valve within the housing and defining part of the second fluid flow path, the second valve configured to control the flow of fuel to the second injector.

[0021] According to some embodiments, a heating system can have a burner, a control valve, and a nozzle. The control valve can include a control valve housing, an input, an output and a first valve body within the control valve housing configured such that the position of the first valve body within the control valve housing determines whether the input is in fluid communication with the output and how much fluid can flow therebetween.

[0022] A nozzle in some embodiments can include a nozzle housing, a second valve within the nozzle housing, an inlet, at least two outlets, and a biasing member configured such that the second valve is open during fluid flow of a first predetermined pressure, and fluid flow of a second predetermined pressure causes the second valve to close one of the at least two outlets while one of the at least two outlets remains open.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Various embodiments are depicted in the accompanying drawings for illustrative purposes, and should in no way be interpreted as limiting the scope of the

inventions, in which like reference characters denote corresponding features consistently throughout similar embodiments.

[0024] Figure 1 is a perspective cutaway view of a portion of one embodiment of a heater configured to operate using either a first fuel source or a second fuel source.

[0025] Figure 2 is a perspective cutaway view of the heater of Figure 1.

[0026] Figures 3A-C show some of the various possible combinations of components of a heating assembly 10. Figure 3A illustrates a dual fuel heating assembly. Figure 3B shows another dual fuel heating assembly. Figure 3C illustrates an unregulated heating assembly.

[0027] Figures 4A-B illustrate an embodiment of a heating assembly in schematic, showing a first configuration for liquid propane and a second configuration for natural gas.

[0028] Figure 5 is a chart showing typical gas pressures of different fuels.

[0029] Figure 6 is an exploded view of an embodiment of a fuel selector valve.

[0030] Figures 7A-C are cross-sectional views of the fuel selector valve of Figure 6 in first, second and third positions, respectively.

[0031] Figure 8A is a side view of an embodiment of a fuel selector valve and pressure regulator.

[0032] Figure 8B is a cross-section of the fuel selector valve and pressure regulator of Figure 8A.

[0033] Figures 9A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0034] Figures 10A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0035] Figures 11A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0036] Figures 12A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0037] Figures 13A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0038] Figures 14A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0039] Figures 15A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0040] Figures 16A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0041] Figures 17A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0042] Figures 18A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0043] Figures 19A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0044] Figures 20A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0045] Figures 21A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0046] Figures 22A-B are schematic cross-sectional views of a fuel selector valve in a first position and a second position.

[0047] Figure 23 shows an exploded view of an embodiment of a nozzle.

[0048] Figures 23A-C are sectional views of the nozzle of Figure 23 in first, second and third positions, respectively.

[0049] Figures 24A-B illustrate different configurations for an end of a nozzle.

[0050] Figure 25A shows the nozzle of Figure 23 and a control valve.

[0051] Figure 25B illustrates the nozzle separated from the control valve of Figure 25A, where control valve is shown in an exploded view including two possible internal valve bodies.

[0052] Figure 25C is a cross-sectional view of the nozzle and control valve of Figure 25A.

[0053] Figures 26A-B show perspective and top views respectively of a barbeque grill.

[0054] Figures 27A-B show perspective and bottom views respectively of a stove top.

[0055] Figures 28A-B are sectional views of an embodiment of a nozzle in first and second positions, respectively.

[0056] Figures 29A-B are schematic cross-sectional views of a nozzle in a first position and a second position.

[0057] Figures 30A-B are schematic cross-sectional views of a nozzle in a first position and a second position.

[0058] Figures 31A-B are schematic cross-sectional views of a nozzle in a first position and a second position.

[0059] Figures 32A-B are schematic cross-sectional views of a nozzle in a first position and a second position.

[0060] Figures 33A-D are sectional views of an embodiment of a nozzle in first, second, third and fourth positions, respectively.

[0061] Figures 34A-B show perspective and cross sectional views of a nozzle.

[0062] Figure 35 shows an embodiment of an oxygen depletion sensor.

[0063] Figures 36A-B show perspective and cross sectional views of an oxygen depletion sensor.

[0064] Figures 37A-B show perspective and cross sectional views of an oxygen depletion sensor.

[0065] Figures 38A-B show perspective and cross sectional views of an oxygen depletion sensor.

[0066] Figure 39A illustrates an exploded view of an embodiment of a nozzle.

[0067] Figure 39B shows a partial cross section of the nozzle of Figure 39A.

[0068] Figure 40A illustrates an exploded view of an embodiment of a nozzle.

[0069] Figure 40B is a partial cross section of the nozzle of Figure 40A

[0070] Figure 40C shows the nozzle of Figure 40A in a first position and a second position.

[0071] Figures 41A-B are sectional views of a pressure selectable valve in a first position and a second position.

[0072] Figures 42A-B are sectional views of a nozzle in a first position and a second position.

[0073] Figure 43 is a perspective cutaway view of a heater.

[0074] Figure 44A shows a possible combination of components of a heating assembly.

[0075] Figure 44B shows a possible combination of components of a heating assembly.

[0076] Figure 45 shows a perspective view of a heating assembly.

[0077] Figure 46A shows a sectional view of the heating assembly of Figure 45 taken along line 46A-46A, with a pressure selectable valve in a first position and a control valve in a first position.

[0078] Figure 46B shows a sectional view of the heating assembly of Figure 45 taken along line 46A-46A, with a pressure selectable valve in a second position and a control valve in a first position.

[0079] Figure 47A shows a sectional view of the heating assembly of Figure 45 taken along line 46A-46A, with a pressure selectable valve in a first position and a control valve in a second position.

[0080] Figure 47B shows a sectional view of the heating assembly of Figure 45 taken along line 46A-46A, with a pressure selectable valve in a first position and a control valve in a second position.

[0081] Figure 48A shows a front perspective view of a heating assembly.

[0082] Figure 48B shows a rear perspective view of the heating assembly of Figure 48A.

[0083] Figures 49A and 49B are cross-sectional views of the heating assembly of Figures 48A-48B.

[0084] Figures 50A and 50B are cross-sectional views of the heating assembly of Figures 48A-48B.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0085] Many varieties of space heaters, wall heaters, stoves, fireplaces, fireplace inserts, gas logs, and other heat-producing devices employ combustible fluid fuels, such as liquid propane and natural gas. The term “fluid,” as used herein, is a broad term used in its

ordinary sense, and includes materials or substances capable of fluid flow, such as, for example, one or more gases, one or more liquids, or any combination thereof. Fluid-fueled units, such as those listed above, generally are designed to operate with a single fluid fuel type at a specific pressure or within a range of pressures. For example, some fluid-fueled heaters that are configured to be installed on a wall or a floor operate with natural gas at a pressure in a range from about 3 inches of water column to about 6 inches of water column, while others are configured to operate with liquid propane at a pressure in a range from about 8 inches of water column to about 12 inches of water column. Similarly, some gas fireplaces and gas logs are configured to operate with natural gas at a first pressure, while others are configured to operate with liquid propane at a second pressure that is different from the first pressure. As used herein, the terms “first” and “second” are used for convenience, and do not connote a hierarchical relationship among the items so identified, unless otherwise indicated.

[0086] Certain advantageous embodiments disclosed herein reduce or eliminate various problems associated with devices having heating sources that operate with only a single type of fuel source. Furthermore, although certain of the embodiments described hereafter are presented in a particular context, the apparatus and devices disclosed and enabled herein can benefit a wide variety of other applications and appliances.

[0087] Figure 1 illustrates one embodiment of a heater 100. The heater 100 can be a vent-free infrared heater, a vent-free blue flame heater, or some other variety of heater, such as a direct vent heater. Some embodiments include boilers, stoves, dryers, fireplaces, gas logs, etc. Other configurations are also possible for the heater 100. In many embodiments, the heater 100 is configured to be mounted to a wall or a floor or to otherwise rest in a substantially static position. In other embodiments, the heater 100 is configured to move within a limited range. In still other embodiments, the heater 100 is portable.

[0088] The heater 100 can comprise a housing 200. The housing 200 can include metal or some other suitable material for providing structure to the heater 100 without melting or otherwise deforming in a heated environment. In the illustrated embodiment, the housing 200 comprises a window 220, one or more intake vents 240 and one or more outlet vents 260. Heated air and/or radiant energy can pass through the window 220. Air can flow

into the heater 100 through the one or more intake vents 240 and heated air can flow out of the heater 100 through the outlet vents 260.

[0089] Within the housing 200, the heater 100, or other gas appliance, can include a heating assembly or heating source 10. A heating assembly 10 can include at least one or more of the components described herein.

[0090] With reference to Figure 2, in certain embodiments, the heater 100 includes a regulator 120. The regulator 120 can be coupled with an output line or intake line, conduit, or pipe 122. The intake pipe 122 can be coupled with a main control valve 130, which, in some embodiments, includes a knob 132. As illustrated, the main control valve 130 is coupled to a fuel supply pipe 124 and an oxygen depletion sensor (ODS) pipe 126. The fuel supply pipe 124 can be coupled with a nozzle 160. The oxygen depletion sensor (ODS) pipe 126 can be coupled with an ODS 180. In some embodiments, the ODS comprises a thermocouple 182, which can be coupled with the main control valve 130, and an igniter line 184, which can be coupled with an igniter switch 186. Each of the pipes 122, 124, and 126 can define a fluid passageway or flow channel through which a fluid can move or flow.

[0091] In some embodiments, including the illustrated embodiment, the heater 100 comprises a burner 190. The ODS 180 can be mounted to the burner 190, as shown. The nozzle 160 can be positioned to discharge a fluid, which may be a gas, liquid, or combination thereof into the burner 190. For purposes of brevity, recitation of the term “gas or liquid” hereafter shall also include the possibility of a combination of a gas and a liquid.

[0092] Where the heater 100 is a dual fuel heater, either a first or a second fluid is introduced into the heater 100 through the regulator 120. Still referring to Figure 2, the first or the second fluid proceeds from the regulator 120 through the intake pipe 122 to the main control valve 130. The control valve 130 can permit a portion of the first or the second fluid to flow into the fuel supply pipe 124 and permit another portion of the first or the second fluid to flow into the ODS pipe 126. From the control valve 130, the first or the second fluid can proceed through the fuel supply pipe 124, through the nozzle 160 and is delivered to the burner 190. In addition, a portion of the first or the second fluid can proceed through the ODS pipe 126 to the ODS 180. Other configurations are also possible.

[0093] Figures 3A-C show some of the various possible combinations of components of a heating assembly 10. Such heating assemblies can be made to be single fuel, dual fuel or multi-fuel gas appliances. For example, the heating assembly 10 can be made so that the installer of the gas appliance can connect the assembly to one of two fuels, such as either a supply of natural gas (NG) or a supply of propane (LP) and the assembly will desirably operate in the standard mode (with respect to efficiency and flame size and color) for either gas.

[0094] Figure 3A illustrates a dual fuel system, such as a vent free heater. In some embodiments, a dual fuel heating assembly can include a fuel selector valve 110, a regulator 120, a control valve or gas valve 130, a nozzle 160, a burner 190 and an ODS 180. The arrows indicate the flow of fuel through the assembly. As can be seen in Figure 3B, a dual fuel heating assembly, such as a regulated stove or grill, can have similar components to the heating assembly shown in Figure 3A, but without the ODS. Still further heating assemblies, such as shown in Figure 3C, may not have a fuel selector valve 110 or a regulator 120. This gas system is unregulated and can be an unregulated stove or grill, among other appliances. The unregulated system can be single fuel, dual fuel or multi-fuel. In some embodiments, and as described in more detail below, one or more of the fuel selector valve, ODS and nozzle, in these and in other embodiments can function in a pressure sensitive manner.

[0095] For example, turning to Figures 4A-B, a schematic representation of a heating assembly is shown first in a state for liquid propane (Figure 4A) and second in a state for natural gas (Figure 4B). Looking at the fuel selector valve 110, it can be seen that the pressure of the fluid flow through the valve 110 can cause the gate, valve or door 12, 14 to open or close, thus establishing or denying access to a channel 16, 18 and thereby to a pressure regulator 20, 22. The gate, valve or door 12, 14 can be biased to a particular position, such as being spring loaded to bias the gate 12 to the closed position and the gate 14 to the open position. In Figure 4A, the gate 12 has been forced to open channel 16 and gate 14 has closed channel 18. This can provide access to a pressure regulator 20 configured to regulate liquid propane, for example. Figure 4B shows the fuel selector valve 110 at a rest state where the pressure of the flow is not enough to change to state of the gates 12, 14 and channel 18 is open to provide access to pressure regulator 22, which can be configured to

regulate natural gas, for example. As will be described herein after, the nozzle 160 and the ODS 180 can be configured to function in similar ways so that the pressure of the fluid flow can determine a path through the component. For example, the natural gas state (Figure 4B) can allow more fluid flow than the liquid propane state (Figure 4A) as represented by the arrows.

[0096] Different fuels are generally run at different pressures. Figure 5 shows four different fuels: methane, city gas, natural gas and liquid propane; and the typical pressure range of each particular fuel. The typical pressure range can mean the typical pressure range of the fuel as provided by a container, a gas main, a gas pipe, etc. and for consumer use, such as the gas provided to an appliance. Thus, natural gas may be provided to a home gas oven within the range of 3 to 10 inches of water column. The natural gas can be provided to the oven through piping connected to a gas main. As another example, propane may be provided to a barbeque grill from a propane tank with the range of 8 to 14 inches of water column. The delivery pressure of any fuel may be further regulated to provide a more certain pressure range or may be unregulated. For example, the barbeque grill may have a pressure regulator so that the fuel is delivered to the burner within the range of 10 to 12 inches of water column rather than within the range of 8 to 14 inches of water column.

[0097] As shown in the chart, city gas can be a combination of one or more different gases. As an example, city gas can be the gas typically provided to houses and apartments in China, and certain other countries. At times, and from certain sources, the combination of gases in city gas can be different at any one given instant as compared to the next.

[0098] Because each fuel has a typical range of pressures that it is delivered at, these ranges can advantageously be used in a heating assembly to make certain selections in a pressure sensitive manner. Further, certain embodiments may include one or more pressure regulators and the pressure of the fluid flow downstream of the pressure regulator can be generally known so as to also be able to make certain selections or additional selections in a pressure sensitive manner.

[0099] Figure 6 illustrates the components of an embodiment of a fuel selector valve 110. The fuel selector valve 110 can be for selecting between two different fuels. The

fuel selector valve 110 can have a first mode configured to direct a flow of a first fuel (such as natural gas or NG) in a first path through the fuel selector valve and a second mode configured to direct a flow of a second fuel (such as liquid propane or LP) in a second path through the fuel selector valve. This can be done in many different ways such as the opening and/or closing of one or more valves, gates, or doors 12, 14 to establish various flow paths through the fuel selector valve 110. The opening and/or closing of one or more valves, gates, or doors can be performed in a pressure sensitive manner, as explained below.

[0100] As illustrated, the fuel selector valve 110 of Figures 6-8B includes a main housing 24, a fuel source connection 26, a gasket 28 and valves 12, 14. A heating assembly 10 can connect to a fuel source at the fuel source connection 26. The fuel source connection 26 can be threaded or otherwise configured to securely connect to a fuel source. The main housing 24 can define channels 16, 18 and the valves 12, 14 can reside within the channels 16, 18 in the main housing 24. The housing 24 can be a single piece or a multi-piece housing.

[0101] As will be shown hereafter, in the various embodiments, there can be one or more valves, gates, or doors 12, 14 that can function in different ways, as well as one or more channels 16, 18 within the housing 24. The gates, doors or valves 12, 14 can work in many different ways to open or close and to thereby establish or deny access to a channel 16, 18. The channels 16, 18 can direct fluid flow to an appropriate flow passage, such as to the appropriate pressure regulator 20, 22, if pressure regulators are included in the heating assembly (Figures 8A-B). For example, channel 16 can direct flow to a first inlet 23 on a regulator 120 that connects to pressure regulator 22 and channel 18 can direct flow to a second inlet 21 that connects to pressure regulator 20. Both pressure regulators 20, 22 can direct flow to the outlet 25. Though a regulator 120 is shown that combines the two pressure regulators 20, 22 into one housing other configurations are also possible.

[0102] The shown fuel selector valve 110 of Figures 6-8B further includes, biasing members 32, 34, front portions 30, 40 and rear portions 36, 38. Biasing members 32, 34 can be metal springs, elastic, foam or other features used to bias the valves 12, 14 to a particular position, such as being spring loaded to bias both valves 12, 14 to the closed position. Further, the fuel selector valve 110 can be set such that each valve 12, 14 will open and/or close at different pressures acting on the valve. In this way, the fuel selector valve

110 can use fluid pressure to select a flow pathway through the valve. In some embodiments, this can be a function of the spring force of each individual spring, as well as the interaction of the spring with the valve. In some embodiments, the position of the spring and the valve can be adjusted to further calibrate the pressure required to open the valve 12, 14.

[0103] For example, the front portions 30, 40 can be threadedly received into the channels 16, 18. This can allow a user to adjust the position of the front portions 30, 40 within the channels and thereby adjust the compression on the spring, as can best be seen in Figure 7A. In this illustrated embodiment, the spring 32, 34 is located between the valve 12, 14 and the respective rear portion 36, 38. The spring biases the valve to the closed position where it contacts the front portion 30, 40. Each front portion 30, 40 has holes 42 passing therethrough that are blocked by the valve when the valve is in contact with the front portion. Thus, the adjustment of the position of the front portion with respect to the valve can affect the amount of pressure required to move the valve away from the front portion to open the valve. In some embodiments, the front portions 30, 40 can be adjustable from outside the housing 24. This can allow for the valve 110 to be calibrated without having to disassemble the housing 24. In other embodiments, such as that shown, the front portions 30, 40 can be preset, such as at a factory, and are not accessible from outside the housing 24. This can prevent undesired modification or tampering with the valve 110. Other methods and systems of calibration can also be used.

[0104] Fluid pressure acting on the valve 12, 14, such as through the holes 42 can force the valve to open. Figure 7A shows a first open position where a threshold amount of pressure has been achieved to cause the valve 14 to open, while valve 12 still remains closed. Figure 7B illustrates a second open position where a second threshold pressure has been reached to close valve 14 at the rear end of the valve, and a third threshold pressure has been achieved to open valve 12. In some embodiments, the second and third threshold pressures can be the same. In some embodiments, the third threshold pressure can be greater than the second and the first threshold pressures. Of course, this may change for different configurations, such as where the springs interact and bias the valves in different ways and to different positions.

[0105] In some embodiments, the fuel selector valve 110 can be used in a dual fuel appliance, such as an appliance configured to use with NG or LP. In this situation, the first threshold pressure to open valve 14 may be set to be between about 3 to 8 inches of water column, including all values and sub-ranges therebetween. In some embodiments, the first threshold pressure is about: 3, 4, 5, 6, 7 or 8 inches of water column. The second threshold pressure to close valve 14 may be set to be between about 5 to 10 inches of water column, including all values and sub-ranges therebetween. The third threshold pressure to open valve 12 can be set to be between about 8 to 12 inches of water column, including all values and sub-ranges therebetween. In some embodiments, the third threshold pressure is about: 8, 9, 10, 11 or 12 inches of water column. In a preferred embodiment, the first and second threshold pressures are between about 3 to 8 inches of water column, where the second is greater than the first and the third threshold pressure is between about 10 to 12 inches of water column. In this embodiment, as in most dual fuel embodiments, the ranges do not overlap.

[0106] Returning now to calibration, for certain springs, as the spring is compressed it can require a greater force to further compress the spring. Thus, moving the front portion 30, 40 away from the respective valve 12, 14 would decrease the force required to initially compress the spring, such as to move the valve 14 from a closed position (Figure 7A) to an open position (Figure 7B). The reverse would also be true, moving the front portion closer to the valve would increase the force required to initially compress the spring.

[0107] In some embodiments, a spring can be used that has a linear spring force in the desired range of movement, compression or extension, used in the fuel selection valve. The spring force for a particular use of a particular spring can be based on many different factors such as material, size, range of required movement, etc.

[0108] Turning now to Figure 7C, the valves 12, 14 will now be discussed in more detail. Each valve 12, 14 can form one of more valve seats to prevent fluid flow from passing the valve or to redirect fluid flow in a particular manner. For example, valve 12 has a forward ledge portion 43 and valve 14 has a forward ledge portion 44 and a rearward ledge portion 46, all of which are used to seat the valve 12, 14 against another surface and close the valve. As shown, the forward ledge portions 43, 44 seat with the front portions 30, 40 and the rearward ledge portion 46 seats with a ledge 48 within the outer housing 24. Other

configurations are also possible, such as a valve with a portion that seats in multiple locations within the outer housing, for example to have a first closed position, an open position and a second closed position. A front face and a back face of a ledge on a valve could be used to seat the valve, as one further example.

[0109] The front 30, 40 and rear 36, 38 portions can be used to position the valve 12, 14 within the housing 24. For example, the rear portions 36, 38 can surround a central region of the valve and the valve can move or slide within the rear portion. Further the spring 32, 34 can be between the valve and the rear portion. The front portions 30, 40 can have one or more holes 42 passing therethrough. Fluid pressure acting on the valve 12, 14, such as through the holes 42 can force the valve to open. In some embodiments, the front portions 30, 40 can have a channel 50. The channel 50 can be used to guide movement of the valve. In addition, the channel can direct fluid flow at the valve to open the valve. Because there are no exits in the channel, fluid flow does not pass around the valve but rather remains constantly acting against the valve as long as there is flow through the fuel selector valve 110.

[0110] In other embodiments, the front and/or rear portions can be permanently or integrally attached to the housing 24. Some embodiments do not have either or both of a front or rear portion.

[0111] Figures 9-22 show schematic representations of various other designs for a fuel selector valve 110. Each set of figures “A” & “B” represent the fuel selector valve in a first state (A) and a second state (B) where a fluid flow pressure would preferably be greater in the second state.

[0112] Figures 9A-B show a series of gates 12, 14. In the initial position and at the first fluid flow, gate 14 is open and gate 12 is closed. An increased fluid pressure acts on the gates to close gate 14 and to open gate 12. The gates can be resilient and can act as springs. Thus, once the pressure is decreased, the gates can return to their initial positions.

[0113] Figures 10A-B includes a pressure plate 52 and a spring 32, where fluid pressure can act on the pressure plate 52 to move it from the initial position where one channel 18 is open to the second position where the original channel 18 is closed and a second channel 16 is open. The pressure plate 52 can have one or more holes 42 to allow fluid to flow through the plate 52 in some locations. In some embodiments the plate 52 can

be smaller than the internal chamber so that fluid can flow around the plate instead or in addition to through the plate.

[0114] Figures 11A-B show a series of gates 12, 14 in a teeter-totter configuration and a spring 32. Gate 14 has an increased surface area compared to gate 12 so that more of the fluid flow and pressure will act on gate 14. In the initial position and at the first fluid flow, gate 14 is open and gate 12 is closed. An increased fluid pressure acts on gate 14 to close channel 18 while expanding the spring 32. This also opens gate 12 because the gates are connected by connecting rod 54.

[0115] Figures 12A-B show a series of gates 12, 14 in the form of steel balls connected to magnets 56. The initial fluid flow pressure is not enough to overcome the magnetic attraction between the steel balls 12, 14 and the magnets 56. Thus, gate 14 remains open and gate 12 remains closed. Increased fluid pressure overcomes the attraction and the steel balls move from their initial position to close gate 14 and to open gate 12. Once the pressure is decreased, the magnet 56 will cause the ball to return to the initial position.

[0116] Figures 13A-B is very similar to Figures 12A-B except that only one steel ball and a magnet are used instead of two and the ball blocks one path in the first position and blocks another path in the second. Figures 14A-B show a magnet and sliding gate 12, similar to the single steel ball and magnet in Figures 13A-B. Holes 42 passing through the gate 12 allow fluid to flow through the gate in the initial position but are blocked in the second position.

[0117] Figures 15A-B show a diaphragm that works in a similar manner to the pressure plate of Figures 10A-B. An increased pressure causes the diaphragm to move. In the initial position and at the first fluid flow, channel 18 open and channel 16 is closed. An increased fluid pressure acts on the diaphragm to plug channel 18 with gate 14 and to open gate 12. Gate 12 can be part of a tension rod 60 which may also include a spring 32. The tension rod can have holes 42 therethrough to allow flow past the diaphragm. Moving the diaphragm advances the rod and the gate 12 is moved away from channel 16 to allow flow therethrough. Once the pressure is decreased, the gates can return to their initial positions.

[0118] Each of Figures 9-15 illustrates a fuel selector valve 110 that makes a selection between one of two exits. Figures 16-22 show other embodiments with two or more exits where generally all of the exits can be open, and then one or more of the exits can

be blocked. As will be readily apparent to one skilled in the art, the fuel selector valves of Figures 16-22 function in similar ways to the fuel selector valves shown in Figures 9-15 and described above.

[0119] It will be understood that any of the pressure sensitive valves described herein, whether as part of a fuel selector valve, nozzle, or other component of the heating assembly, can function in one of many different ways, where the valve is controlled by the pressure of the fluid flowing through the valve. For example, many of the embodiments shown herein comprise helical or coil springs. Other types of springs, or devices can also be used in the pressure sensitive valve. Further, the pressure sensitive valves can operate in a single stage or a dual stage manner. Many valves described herein both open and close the valve under the desired circumstances (dual stage), i.e. open at one pressure for a particular fuel and close at another pressure for a different fuel. Single stage valves may also be used in many of these applications. Single stage valves may only open or close the valve, or change the flow path through the valve in response to the flow of fluid. Thus for example, the fuel selector valve 110 shown in Figure 7A is shown with a single stage valve 12 and a dual stage valve 14. The dual stage valve 14 can be modified so that the valve is open in the initial condition and then closes at a set pressure, instead of being closed, opening at a set pressure and then closing at a set pressure. In some instances, it is easier and less expensive to utilize and calibrate a single stage valve as compared to a dual stage valve. In some embodiments, the valve can include an offset. The offset can offset the valve away from the front or rear portion, so that the valve cannot be closed at either the front or back end respectively. Offsets can also be used to ensure the valve does not move beyond a certain position. For example, an offset can be used that allows the valve to close, but that prevents the valve from advancing farther, such as to prevent damage to the valve housing or housing wall.

[0120] As discussed previously, the fuel selector valve 110 can be used to determine a particular fluid flow path for a fluid at a certain pressure or in a pressure range. Some embodiments of heating assembly can include first and second pressure regulators 20, 22. The fuel selector valve 110 can advantageously be used to direct fluid flow to the appropriate pressure regulator without separate adjustment or action by a user.

[0121] In some embodiments, the first and second pressure regulators 20, 22 are separate and in some embodiments, they are connected in a regulator unit 120, as shown in Figures 4A-B & 8A-B. A regulator unit 120 including first and second pressure regulators 20, 22 can advantageously have a two-in, one-out fluid flow configuration, though other fluid flow configurations are also possible including one-in or two-out.

[0122] The pressure regulators 20, 22 can function in a similar manner to those discussed in U.S. Application No. 11/443,484, filed May 30, 2006, now U.S. Patent No. 7,607,426, incorporated herein by reference and made a part of this specification; with particular reference to the discussion on pressure regulators at columns 3-9 and Figures 3-7 of the issued patent.

[0123] The first and second pressure regulators 20, 22 can comprise spring-loaded valves or valve assemblies. The pressure settings can be set by tensioning of a screw that allows for flow control of the fuel at a predetermined pressure or pressure range and selectively maintains an orifice open so that the fuel can flow through spring-loaded valve or valve assembly of the pressure regulator. If the pressure exceeds a threshold pressure, a plunger seat can be pushed towards a seal ring to seal off the orifice, thereby closing the pressure regulator.

[0124] The pressure selected depends at least in part on the particular fuel used, and may desirably provide for safe and efficient fuel combustion and reduce, mitigate, or minimize undesirable emissions and pollution. In some embodiments, the first pressure regulator 20 can be set to provide a pressure in the range from about 3 to 6 inches of water column, including all values and sub-ranges therebetween. In some embodiments, the threshold or flow-terminating pressure is about: 3, 4, 5, or 6 inches of water column. In some embodiments, the second pressure regulator 22 can be configured to provide a second pressure in the range from about 8 to 12 inches of water column, including all values and sub-ranges therebetween. In some embodiments, the second threshold or flow-terminating pressure is about: 8, 9, 10, 11 or 12 inches of water column.

[0125] The pressure regulators 20, 22 can be preset at the manufacturing site, factory, or retailer to operate with selected fuel sources. In many embodiments, the regulator 120 includes one or more caps to prevent consumers from altering the pressure settings selected by the manufacturer. Optionally, the heater 100 and/or the regulator unit 120 can be

configured to allow an installation technician and/or user or customer to adjust the heater 100 and/or the regulator unit 120 to selectively regulate the heater unit for a particular fuel source.

[0126] Returning now to Figures 3A-4B, fuel selector valves 110 and regulators 120 have been discussed above. As can be seen in the Figures, a heating source may or may not include a fuel selector valve 110 and/or a regulator 120. In some embodiments, a fuel source can be connected to a control valve 130, or the fuel selector valve and/or regulator can direct fuel to a control valve 130. The control valve 130 can comprise at least one of a manual valve, a thermostat valve, an AC solenoid, a DC solenoid and a flame adjustment motor. The control valve 130 can direct fuel to the burner 190 through a nozzle 160. The control valve 130 may also direct fuel to an ODS 180.

[0127] The control valve 130 can control the amount of fuel flowing through the control valve to various parts of the heating assembly. The control valve 130 can manually and/or automatically control when and how much fuel is flowing. For example, in some embodiments, the control valve can divide the flow into two or more flows or branches. The different flows or branches can be for different purposes, such as for an oxygen depletion sensor (ODS) 180 and for a burner 190. In some embodiments, the control valve 130 can output and control an amount of fuel for the ODS 180 and an amount of fuel for the burner 190.

[0128] Turning now to the nozzle 160, one embodiment of a nozzle 160 is shown in Figures 23-23C. The nozzle 160 used in a heating assembly can be a pressure sensitive nozzle similar to the fuel selector valves 110 described herein. Figures 23-23C illustrate a nozzle 160 with an internal structure very similar to the fuel selector valve 110 shown in Figures 6-8B. The illustrated nozzle includes a front portion 30', a valve 12', a spring 32', and a rear portion 36'. All of which can be positioned inside a nozzle body 62. The nozzle body 62 can be a single piece or a multi-piece body.

[0129] The nozzle body can include a flange 68 and threads 70. The flange and threads can be used to attach the nozzle to another structure, such as a pipe or line running from the control valve. In some embodiments, the flange 68 is configured to be engaged by a tightening device, such as a wrench, which can aid in securing the nozzle 160 to a nozzle

line. In some embodiments, the flange 68 comprises two or more substantially flat surfaces, and in other embodiments, is substantially hexagonal as shown.

[0130] The nozzle body 62 can define a substantially hollow cavity or pressure chamber 16'. The pressure chamber 16' can be in fluid communication with an inlet and an outlet. In some embodiments, the outlet defines an outlet area that is smaller than the area defined by the inlet. In preferred embodiments, the pressure chamber 16' decreases in cross-sectional area toward a distal end thereof.

[0131] As can be seen, a front ledge 43' on the valve 12' can contact the front portion 30' such that the flow passages or holes 42' are blocked, when the nozzle is in the initial "off" position (Figure 23A). The flow passages or holes 42' can define the inlet. Fluid flow into the nozzle 160 and acting on the valve 12', such as acting on the valve 12' by flowing through the holes 42' and the channel 50', can force the valve to compress the spring 32' and move such that fluid can flow through the nozzle 160. Figure 23B shows the nozzle 160 in a first open position. Fluid is flowing through the nozzle and out the outlet holes or orifices 64, 66. Under certain fluid flows the pressure can cause the valve to advance farther within the nozzle 160 further compressing the spring 32'. In this situation, the valve 12' can reduce or block flow through the nozzle 160. As shown in Figure 23C, flow through orifice 64 can be blocked by the valve 12', while one or more orifices 66 remain open. The orifices 66 can have one of many different configurations, such as comprising two, three, four, or more holes or slots as shown in Figures 23-24B. The orifice 64 can also have many different configurations.

[0132] The nozzle 160 can be used in single fuel, dual fuel or multi-fuel appliances. For example, the nozzle 160 can be used in a dual fuel appliance, such as an appliance configured for use with either of NG or LP. In this situation, the first threshold pressure to open valve 12' may be set to be between about 3 to 8 inches of water column (for NG), including all values and sub-ranges therebetween. In some embodiments, the first threshold pressure is about: 3, 4, 5, 6, 7 or 8 inches of water column. The second threshold pressure to close orifice 64 may be set to be above about 8 inches of water column (for LP). In some embodiments, the second threshold pressure is about: 8, 9, 10, 11 or 12 inches of water column. In this way the nozzle 160 can be used with different fuels and yet provide an amount of fuel to the burner 190 that will create similar size of flames and/or BTU values.

[0133] Similar to the fuel selector valve 110, the front portion 30' of the nozzle 160 can be adjusted to calibrate the threshold pressures. In some embodiments, the spring 32', as well as, other single or dual stage springs discussed herein, can have a spring constant (K) of about 0.0067 N/mm, between about 0.006-0.007 N/mm, or between about 0.005-8.008 N/mm. The spring can be approximately 7 mm, or between approximately 6-8 mm long. The spring can have an outer diameter between approximately 5-9 mm. The spring can be made from wire that is approximately 0.15 mm, 0.2 mm, or between approximately 0.1-0.3 mm in diameter. Other sizes, lengths and spring constants can also be used.

[0134] The nozzle 160 is shown together with a control valve 130 in Figure 25A. Referring back to Figures 3A-C, it was pointed out that a heating assembly can have various different combinations of components and can be made to be single fuel, dual fuel or multi-fuel. The control valve 130, shown in Figure 25A can be used in many different heating assemblies including those discussed with reference to Figures 3B-C. For example, the control valve can be a manual valve such as to adjust a flame height on a grill. The control valve 130 can direct fuel to the burner 190 through the nozzle 160. The control valve 130 could also be modified to control fuel flow to an ODS but such modifications are not shown.

[0135] Two examples are shown in Figures 26A-27B. Figures 26A-B illustrate a barbeque grill 101 having a heating assembly utilizing the nozzle 160 and control valve 130 shown in Figure 25A. The barbeque grill 101 is shown with three different types of burners, namely a side burner, an infrared burner, and a recessed burner. Figures 27A-B similarly show a gas stove top/range having a heating assembly utilizing the nozzle 160 and control valve 130 shown in Figure 25A. The barbeque grill 101 and gas stove top can be dual fuel appliances. For example, they can be used with either propane or natural gas. If using propane, an external pressure regulator may also be used.

[0136] Returning now to Figures 25A-C, a control valve 130 can be connected to a nozzle 160. The nozzle 160 can be one of many different types of nozzles, including those discussed herein. The control valve 130 can have a knob or other control feature 132 to move a valve body 134 within the control valve housing 136 to the desired position. Figure 25B shows two different internal valve bodies 134, 134' that could be used, though other configurations are also possible.

[0137] The first valve body 134 can be used to provide an “OFF” position and two “ON” positions. The two “ON” positions can be a high flow position and a low flow position. The flow of fuel into the control valve can be greater in the high flow position than in the low flow position. The valve body 134 can control the flow by providing two or more different size holes 138 through which the fuel can flow.

[0138] The second valve body 134' can be used to provide an “OFF” position and an “ON” position. The “ON” position can be adjustable to provide different amounts of fuel depending on the position of the valve body within the control valve housing. For example, the valve body 134' can have low and high positions and can be adjustable between those two positions. Thus, the amount of fuel flow can be adjusted to a desired setting that may include, low, high, medium, or something in-between those positions.

[0139] The different “ON” positions in the valve bodies 134, 134' can be facilitated by one or more holes or slots 138. The holes/slots can be different sizes, and/or can change size along their length. Valve body 134 has two different sized holes 138 and valve body 134' has a slot 138 that changes size along its length. The control valve housing 136 can have an inlet 135. The position of the valve body within the housing 136 determines whether the hole or slot 138 is in fluid communication with the inlet 135 and how much fuel can flow through the control valve 130.

[0140] The cross-section in Figure 25C shows the control valve 130 in one of the “ON” positions. As has been discussed, the nozzle 160 shown is a pressure sensitive nozzle. The pressure sensitive nozzle can be single or dual stage. With a dual stage pressure sensitive nozzle, the pressure of the fluid flow opens the internal valve 12'. Independent of whether the pressure sensitive nozzle is dual stage or single stage, the pressure of the fluid flow controls whether the exit orifice 64 is open or closed and thereby controls the amount of flow through the nozzle.

[0141] For example, the nozzle 160 and control valve 130 can be set such that one fuel that flows at a known pressure opens the valve 12' and allows the exit orifice 64 to remain open while a second fuel opens the valve 12' yet closes the exit orifice 64. The second fuel flow would only pass through the exit orifices 66. The nozzle 160 and control valve 130 can be set so that this is the case independent of the position of the control valve 130. In other words, whether the control valve 130 is set to a high “ON” position or a low

“ON” position the nozzle 160 would operate with a predetermined exit orifice configuration based on the type of fuel used (based on the expected pressure range of that fuel).

[0142] Figures 28-34B illustrate various additional embodiments of a nozzle 160. The nozzles are similar to the nozzle described above and illustrate additional ways that one or more orifices can be opened, closed or modified in a pressure sensitive manner.

[0143] Figures 28A-B show a nozzle 160 with one orifice 64 and a channel 72 in the valve 12'. Fluid can flow around the through the valve 12'. As the pressure increases, the valve 12' can contact the orifice 64 and decrease the effective size of the orifice 64. For example, the valve 12 can contact and seal the orifice 64 such that only flow from the channel 72 can leave the nozzle 160 through the orifice. As the channel 72 can have a smaller diameter than the orifice 64, this can decrease the amount of fluid flow through the nozzle 160. In some embodiments, the valve 12' can fit inside the orifice 64 as shown (Figure 28B).

[0144] Figures 29A-32B all show additional nozzles 160 where the fluid flow at a certain pressure can dislodge or move another piece of material to block or close one or more exit orifices 64. Figures 29A-B show a steel ball 12' and a magnet 56'. Figures 30A-B show a force plate 52' and a magnet 56'. Figures 31A-B show a resilient gate 12'. Figures 32A-B show a force plate 52' and a magnet 56'. The arrows illustrate the fuel flow paths through the various nozzles.

[0145] Now looking to Figures 33A-D, another embodiment of a nozzle 160 is shown. The nozzle show can be pressure sensitive such that it can be used interchangeably with different fuels, but can also advantageously be self regulating while in use with a single fuel. This is because the nozzle can be configured such that the volume of fluid flowing through the nozzle can be directly related to the fluid pressure. In other words, the nozzle can be configured to control the flow such that as the pressure increases, the volume of fuel flowing through the nozzle decreases. Thus, for a fuel at a constant temperature, the nozzle can provide a varying volume of fuel as the pressure of the fuel fluctuates while maintaining a constant BTU value.

[0146] This is a result of the ideal gas law:

$$PV=nRT \quad (1)$$

where “P” is the absolute pressure of the gas, “V” is the volume, “n” is the amount of substance; “R” is the gas constant, and “T” is the absolute temperature. Where amount and temperature remain constant, pressure and volume are inversely related. Thus, as the pressure increases, less volume of fuel is needed to provide the same amount of fuel. The amount is typically recorded in number of moles. A set number of moles of fuel will provide a particular BTU value. Therefore, the pressure sensitive nozzle shown in Figures 33A-D can advantageously provide a constant amount of fuel for a constant BTU value for a particular fuel, even as the fuel pressure fluctuates.

[0147] In some embodiments, the valve 12' can have an end 73 that cooperates with the internal chamber 16' to determine the volume of fluid that can flow through the valve 12'. For example, the valve end 73 can be cylindrical while a surface 74 of the internal chamber 16' can be frustoconical. Thus, as the cylinder valve end 73 approaches the frustoconical surface 74 the gap 76 between the two surfaces can slowly decrease, thus a smaller volume of fuel can pass through the gap 76. Figures 33A, B, C, and D illustrate how the gap can change as the pressure increases and the valve moves closer to the surface, until it contacts the surface and prevents flow through the valve 12'. In some embodiments, the valve end 73 includes a gasket 78 to sealingly close the gap 76.

[0148] In some embodiments, the nozzle 160 shown in Figures 33A-D can include one or more additional orifices 66. In some embodiments, the valve 12' can have a channel running through the valve 12' similar to that shown in Figures 28A-B.

[0149] In the various embodiments of valves, including those within a nozzle, adjustments can be made to calibrate the valve. For example, in Figures 33A-D, similar to the discussion with respect to the valve in Figure 7A, the front portion 30' can be threadedly received into the interior of the nozzle. Calibrating the valve adjusts force required to move the valve 12' within the valve body or housing 62. This can be done in many ways, such as by adjusting the position of the valve 12' within the valve body or housing 62 and adjusting the compression or tension on a spring. Here, calibration can adjust the position of the valve body 12' in relation to the front portion 30' while adjusting the amount of force required to act on the spring to move the valve a desired amount. In the example of Figures 33A-D, the spring biases the valve to the closed position and adjusting the position of the front portion

can increase or decrease the amount of pressure required to further compress the spring and open the valve to allow flow therethrough.

[0150] In some embodiments, the position of the rear portion 36', as well as, or in addition to the front portion 30' can be adjusted to calibrate the nozzle. For example, the rear portion 36' can be threadedly received into the interior of the nozzle. Further, the front and rear portions can be adjustable from either or both of inside and outside the housing 62. In some embodiments, the heating assembly can allow for calibration of one or more of the various valves without disassembly of the heating assembly.

[0151] Turning now to Figures 34A-B, an embodiment of a nozzle 160 is shown. In this nozzle 160, the position of both the front 30' and rear 36' portions can be adjusted. Further, at least the position of the rear portion 36' can be adjusted from outside the nozzle body or housing 62. The nozzle 160 can comprise an adjustment feature 88. The adjustment feature 88 can be threadedly received into the housing. The adjustment feature 88 can comprise an end cap. The adjustment feature 88 can comprise a set screw. Adjustment of the position of the set screw can adjust the position of the rear portion 36' and the pressure of the spring 32' acting on the rear portion 36'. The set screw can have a detent 90, for example, to receive the head of a screw driver, Allen wrench or other tool. The tool can be used to adjust the position of the set screw from outside the nozzle housing 62. The set screw can include one or more holes that pass through the set screw. The one or more holes can comprise exit orifices 64, 66. As shown, the exit orifice 64 connects to the detent 90, other configurations are also possible. In some embodiments, the adjustment feature can be a part of the rear portion, or be integrally formed with the rear portion.

[0152] As illustrated, the adjustment feature 88 can have a frustoconical interior surface 74' similar to the valve interior of Figures 33A-D. The valve end 73 can cooperate with the surface 74' to determine the volume of fluid that can flow through the valve 12'. Thus, as the cylinder valve end 73 approaches the frustoconical surface 74' the gap 76 between the two surfaces can slowly decrease, thus a smaller volume of fuel can pass through the gap 76.

[0153] The adjustment feature 88 can also be used with other valves and/or nozzles, for example, the nozzles shown in Figures 23-25C, 28A-B. The adjustment feature

88 can also be used in such a way so as not to be within or form part of the flow path of fuel through the valve or nozzle.

[0154] Figure 34B also illustrates two offsets 91, 93. The offset 91 can be used to prevent the valve 12' from contacting the front portion 30' in such a way as to close the valve completely at the front end. Offsets or similar structures can be used along the valve to prevent closing the valve on either or both of the front and the back sides of the valve. In some embodiments, an offset can be used with a single stage valve. Offsets can be part of the valve, or part of other structures. For example, the front or rear portion can include an offset. Offsets can also be used to ensure the valve does not move beyond a certain position. For example, an offset 93 can be used that allows the valve to close, but that prevents the valve from advancing farther, such as to prevent damage to the valve housing or housing wall.

[0155] Figure 35 shows one embodiment of an oxygen depletion sensor (ODS) 180. An ODS 180 or pilot light (not shown) can include a nozzle similar to the burner nozzles 160 shown and/or described herein and can be used in some heating assemblies.

[0156] The ODS 180 shown includes a thermocouple 182, an electrode 80 and an ODS nozzle 82. The ODS nozzle 82 can include an injector 84 and an air inlet 86. A fuel can flow from the ODS line 143 through the ODS nozzle 82 and toward the thermocouple 182. The fuel flows near the air inlet 86, thus drawing in air for mixing with the fuel.

[0157] In some embodiments, the injector 84 can be a pressure sensitive injector and can include any of the features of the pressure sensitive nozzles described herein. For example, the exit orifices 64 and/or 66 can be located along line A-A of Figure 35 within the ODS nozzle 82. The air inlet 86 can also be adjustable so that the air fuel combination is appropriate for the particular type of fuel used.

[0158] The electrode 80 can be used to ignite fuel exiting the ODS nozzle 82. In some embodiments, a user can activate the electrode 80 by depressing the igniter switch 186 (see Figure 2). The electrode can comprise any suitable device for creating a spark to ignite a combustible fuel. In some embodiments, the electrode is a piezoelectric igniter. Igniting the fluid flowing through the nozzle 82 can create a pilot flame. In preferred embodiments, the nozzle 82 directs the pilot flame toward the thermocouple such that the thermocouple is heated by the flame, which permits fuel to flow through the control valve 130.

[0159] In various embodiments, the ODS 180 provides a steady pilot flame that heats the thermocouple 182 unless the oxygen level in the ambient air drops below a threshold level. In certain embodiments, the threshold oxygen level is between about 18 percent and about 18.5 percent. In some embodiments, when the oxygen level drops below the threshold level, the pilot flame moves away from the thermocouple, the thermocouple cools, and the control valve 130 closes, thereby cutting off the fuel supply to the heater.

[0160] Figures 36A-38B show various additional embodiments of an ODS. The ODS can include or can be connected to a valve. The valve can be user selectable or pressure selectable. For example, Figures 36A-B illustrate an ODS 180' connected to a pressure selectable valve 110' similar to that shown in Figures 6-7C. Any of the pressure selectable valves shown here connected to an ODS can also be used to connect to a pressure regulator or other component of a heating assembly. In addition, other types of user selectable or pressure selectable valves can also be connected to an ODS.

[0161] Referring first to Figures 36A-B, an ODS 180' with pressure selectable valve 110' is shown. The ODS 180' can include a thermocouple 182, an electrode 80, a mounting bracket 92, and an ODS nozzle 82'. The ODS nozzle 82' can include injectors 84A, 84B and air inlets 86A, 86B. The injectors can each have an exit orifice 94A, 94B. The exit orifices 94A, 94B can be the same or different sizes. The air inlets 86A, 86B can also be the same or different sizes, and in some embodiments are adjustable.

[0162] The valve 110' can be similar to those described herein, such as that in Figures 6-7C. The valve 110' can allow for at least two different flow paths through the valve depending on the pressure of the flow. The valve 110' can include a main housing 24, a fuel source connection or inlet 26, valves 12", 14", biasing members 32, 34, front portions 30", 40" and rear portions 36", 38".

[0163] Looking to Figure 36B, a first flow path is shown indicated by the arrows. Fuel at a first pressure can then pass through valve 14" into injector 84B and thereby fuel can flow through the ODS. In a dual stage configuration, the fuel at the first pressure can also cause valve 14" to open, while valve 12" remains closed to allow the fuel to flow through the valve 110'. When fuel at a higher pressure is introduced into the valve 110', the higher pressure fuel can cause the valve 14" to close by contacting the interior surface of the valve 110' at 98. Valve 12" can be opened by the higher pressure fuel which can then direct the

flow to injector 84A and thereby higher pressure fuel can flow through the ODS. The ODS can have one outlet 95 (Figures 36A-B), or two outlets 95 (Figures 37A-38B). The outlets can direct fuel towards the thermocouple.

[0164] In some embodiments with two outlets 95, the outlets can be located the same or different distances away from the thermocouple. Also, the ODS can include one or more thermocouples 182 and igniters 80. In some embodiments, the ODS can have one or more flame directors 97. The flame directors 97 can be used to position the flame in a predetermined relationship to the thermocouple. Further, the embodiments shown in Figures 37A-B and Figures 38A-B including at least some of these features will be understood as functioning in a similar manner to the description of Figures 36A-B.

[0165] A filter 96 can be included anywhere along the fuel flow path within the heating assembly. As shown in Figures 36B, 37B and 38B, a filter 96 is within the injectors 84A, 84B. The filter can filter out impurities in the fuel flow.

[0166] In some embodiments, the valve 110' can allow for calibration of the valves 12", 14" from outside the housing. The front portions 30", 40" can pass through the housing 24 and can include a detent 90'. The detent can be used to adjust the position of the front portion within the valve 110'. For example, the detent 90' can receive the head of a screw driver, Allen wrench or other tool to adjust the position of the front portion.

[0167] Referring now to Figures 41A-B, another embodiment of a pressure selectable valve 110'' is shown which can be used with an ODS, a pressure regulator, or other components of a heating assembly. Except where described as operating in a different manner, the embodiments of Figures 41A-B are understood to function the same as or substantially similar to the embodiments illustrated by Figures 35-38B and to allow for the specific features described with reference to Figures 35-38B. As illustrated, the pressure selectable valve comprises an inlet 26, a chamber 16', a plurality of flow paths 45A, B, a first exit orifice 94A', and a second exit orifice 94B'. Fuel enters the chamber 16' from the inlet 26, passes through the flow paths 45A,B and then passes either through a first channel 50A or a second channel 50B in order to reach the first or second exit orifices 94A',B', respectively.

[0168] The pressure selectable valve 110'' has a first valve 73A and a second valve 73B. The first valve 73A is movable between a first position where the valve body 79A

is a first distance from the valve seat 77A, and a second position where the valve body 79A is a second distance from the valve seat 77A, the second distance being less than the first distance. The second valve 73B is movable between a first position where the valve body 79B is a first distance from the valve seat 77B, and a second position where the valve body 79B is a second distance from the valve seat 77B, the second distance being greater than the first distance.

[0169] In the first position, the valve body 79B is desirably in contact with the valve seat 77B (a closed position), substantially preventing any fluid flow into the second channel 50B, while the valve body 79A is desirably spaced from the valve seat 77A (an open position) so as to allow fluid flow into the first channel 50A. In the second position, the valve body 79B is desirably spaced from the valve seat 77B (an open position) so as to allow fluid flow into the second channel 50B, while the valve body 79A is desirably in contact with the valve seat 77A (a closed position), substantially preventing any flow of fuel into the first channel 50A.

[0170] The valve bodies 79A,B can comprise any structure that can substantially limit the flow of fuel through the channels, such as a gasket, o-ring, rubber stopper, etc. Figure 41A illustrates the first position of valves 73A, B and Figure 41B illustrates the second position of valves 73A, B.

[0171] As illustrated in Figures 41A-B, the first and second valves 73A, B are connected by means of a lever arm 75 that has a first portion extending through a section of the first valve 73A and a second portion extending through a section of the second valve 73B. The lever arm is configured such that when the first valve moves from an open position to a closed position the lever arm will move the second valve from a closed position to an open position. When the first valve returns to an open position the lever arm will move the second valve to a closed position.

[0172] The movement of each valve as illustrated is translation along a single axis, but in other embodiments the valves can move from a closed position to an open position through translation along multiple axes, by rotating, or by some combination of translation and rotation.

[0173] The connection between the valves need not be through a lever arm configured as described above but can desirably occur through any device or connection that

moves the second valve to an open position when the first valve moves to a closed position, and then returns the second valve to a closed position when the first valve returns to an open position. For example, the connection can occur from a lever arm that does not extend through the valves but is instead affixed to the valves. In other embodiments, the valves can be directly connected to each other.

[0174] The pressure selectable valve 110'' further comprises a biasing member 32 that exerts a force designed to keep the first valve 73A in a closed position. When fuel enters the pressure selectable valve 110'' through the inlet 26, the pressure from the fuel applies a force against a diaphragm 146 or other structure directly or indirectly connected to the biasing member 32. In some embodiments, the diaphragm or other structure can act as a spring force and in some embodiments it can serve as the biasing member. If the fuel is at a sufficient, designated pressure, it will keep the biasing member in a compressed state, the first valve 73A open, and the second valve 73B closed. When a fuel that operates at a lower pressure is used, the pressure will be insufficient to compress the biasing member 32, which will exert a closing force on the first valve 73A, thereby opening the second valve 73B. The pressure selectable valve 110'' can be configured to operate at a designated pressure consistent with the fuels and operating pressures described above.

[0175] The pressure selector valve 110'' can be incorporated into the heating assembly as illustrated in Figure 43. Figure 43 is substantially similar to the embodiment of Figure 2, with the exception that the ODS pipe 126 connects to the pressure selectable valve 110'' before reaching the ODS 180. Additionally, the ODS 180 contains two outlets 95, as described in Figures 37A-38B. In some embodiments, the heating assembly can comprise two separate ODSs, one for each fuel line leading from the pressure selectable valve 110''.

[0176] Turning now to Figures 39A-B, 40A-C, and 42A-B, three additional embodiments of a nozzle 160 are shown. The nozzle 160 is a pressure sensitive nozzle similar to that described previously. As has also been mentioned previously, various features (such as the internal valve) of the nozzles 160 shown and described can also be used in other components, such as in fuel selector valves, and ODSs.

[0177] Referring first to Figures 39A-B, the nozzle 160 includes a front portion 30'', a valve 12'', a spring 32', and a rear portion 36', all of which can be positioned inside a

nozzle body 62. The nozzle body 62 can be a single piece or a multi-piece body and can include a flange 68 and threads 70.

[0178] The spring 32' can be a single stage or a dual stage spring. As shown, the spring 32' is a single stage spring and is configured to move from a first position to a second position at a set pressure. In the second position, the valve 12" can reduce or block flow through the nozzle 160. As shown in Figure 39B, flow through orifice 64 can be blocked by the valve 12", while one or more orifices 66 remain open. In this way, the nozzle can function in a manner similar to those previously described.

[0179] The valve 12" can have a passage 140 through which fluid, such as fuel, can pass. The passage 140 can have an inlet 142 and an outlet 144. As shown, there is one inlet 142 and two outlets 144, though any number of inlets and outlets can be used. The passage can be in central region or can direct fluid to or through a central region of the valve 12". The valve 12" can also include a front ledge 43". The front ledge 43" and the passage 140 can be used to direct all, or a substantial portion, of the fluid flow through the valve 12" and can increase the forces acting on the valve to reliably open and/or close the valve.

[0180] Turning now to Figures 40A-C another variation of the nozzle 160 is shown. The valve 12''' also has a passage 140 with an inlet 142 and an outlet 144. The front ledge 43''' of the valve 12''' can be used to connect a diaphragm 146 and a diaphragm retainer 148 to the valve 12'''. The nozzle 160 can also include a washer 150 and a front portion 130'''. The diaphragm retainer can be force fit or otherwise secured onto the valve 12'''. This can allow the diaphragm 146, the diaphragm retainer 148, and the valve 12''' to move together. Other configurations to connect a diaphragm to the valve 12''' can also be used.

[0181] The front portion 130''' can secure the washer 150 and diaphragm 146 in place within the nozzle. For example, in the cross section of Figure 40B the front portion 30''' is not shown, but can be used to secure the washer 150 and diaphragm 146 in place at the location in the nozzle shown.

[0182] The diaphragm 146 can act as a spring force and in some embodiments can replace the spring 32'. In some embodiments, the spring 32' can serve to return the diaphragm 146 to an initial position. In some embodiments, the diaphragm can be set to allow the valve 12''' to move at a set fluid pressure, such as at 8 inches water column, or other

pressures as has been described herein with reference to other valves. In some embodiments, the diaphragm can be made from various materials including silicone and/or rubber.

[0183] Figure 40C shows the valve 12''' in two different positions, such as at an initial position at a lower pressure and the second position at a higher pressure. At the higher pressure the hole 64 can be closed by the valve 12'''.

[0184] The valves 12" and 12''' can advantageously have an increased surface area that is exposed to the fluid flowing through the nozzle. This increased exposure can lead to increased repeatability and reliability of the nozzle under different flow circumstances. The increased surface area can help ensure that the valve sealingly closes the hole 64. Having the fluid flow through the valve and in particular, flow through the central region of the valve can focus the fluid pressure in the center of the valve. As the hole 64 is aligned with the center of the valve focusing the fluid pressure at the center of the valve can increase the reliability of the valve, sealing the hole at increased pressures. In addition, the diaphragm has the added benefit of regulating the gas pressure similar to a typical pressure regulator. This can beneficially provide additional fluid pressure regulation throughout a heater system.

[0185] In some embodiments, a fuel selector valve and/or an ODS can also have a valve with a passage therethrough and/or a diaphragm.

[0186] Figures 42A-B show yet another variation of the nozzle 160. The nozzle has a first flow path 55 through a first channel 51 and out one or more orifices 64. The first flow path 55 remains continuously open. The nozzle also has a second flow path 57 that passes through a second channel 53 and out one or more orifices 66. The first channel 51 and second channel 53 can comprise a tube, pipe, or any structure or combination of structures that define a space in which a fluid can flow.

[0187] The second flow path 57 can be substantially blocked by a valve body 12'''''. The valve body 12''''' can be connected to a diaphragm 146, a diaphragm retainer, and/or a biasing member 32 such that the valve body 12''''' moves with the diaphragm 146, diaphragm retainer, and/or a biasing member 32, as described above. The nozzle comprises a valve seat 48' against which the valve body 12''''' can seat, substantially closing access to the second channel 53. As illustrated, the valve body has a beveled portion 47 that seats against the valve seat 48'. In other embodiments, the valve body 12''''' can be any shape that can mate with a portion of the nozzle to substantially block the second flow path 57. For

example, in some embodiments the valve body 12''' can comprise a ledge portion as in Figures 7A-C.

[0188] Figure 42A illustrates an embodiment where the fuel entering the inlet is at a pressure sufficient to compress the biasing member, seating the valve body 12''' against the valve seat 48' and substantially closing access to the second channel 53. As illustrated, fuel will only be able to exit the nozzle by flowing along the first flow path, through the first channel 51 and out of the orifice 64. The pressure needed to close the second channel 53 can be set at 8 inches water column, or other pressures as has been described herein with reference to other valves.

[0189] Figure 42B illustrates an embodiment where the fuel entering the inlet is at a pressure that fails to compress the biasing member 32 to a point where the beveled portion 47 seats against the valve seat 48' and closes access to the second channel 53. The biasing member at this lower pressure maintains the valve body 12''' open and fuel will flow along both flow paths 55, 57 and out the nozzle 160 through the orifices 64, 66.

[0190] In some embodiments, if the pressure is insufficient to completely close the channel 53, the valve body 12''' can be in a position close enough to the valve seat 48' such that fluid flow along the second flow path 57 is restricted but access to the channel 53 is not substantially closed. In some embodiments, the valve body 12''' can have a first position at a first fluid pressure and a second position at a second, higher fluid pressure such that there is a greater fluid flow along the second flow path 57 in the first position than in the second position.

[0191] The embodiments illustrated in Figures 42A-B are included within a single housing, but in other embodiments the second channel, the first channel, or both can be partially or completely outside of a housing.

[0192] Figure 44A illustrates a schematic representation of the flow of fuel in some embodiments of a dual fuel heating system. In some embodiments, the fuel can travel from the regulator to the control or gas valve, where it splits into two paths. The first path 126 heads toward the pressure selector valve, where a first fuel continues along a first line 99A and a second fuel continues along a second line 99B. The two lines either head to a single ODS or pilot with separate fuel outlets as described with reference to figures 37A-38B, or to two separate ODS or pilots, one for a first fuel and one for a second fuel. The

second path 124 from the control valve heads toward a pressure orifice or nozzle, which adjusts its output to the burner based on the pressure of the fuel as described in other embodiments above.

[0193] In further embodiments, as illustrated in Figure 44B, the fuel can flow from the regulator into multiple gas valves, each of which lead to a pressure orifice or nozzle and then to a burner. This configuration illustrates embodiments where the gas is used to fuel multiple burners, such as ovens, stoves, barbecue grills, etc.

[0194] Figures 45-47B illustrate one embodiment of a heating assembly that can be used with dual fuel (e.g., natural gas and liquid propane) systems as described above. For example, the heating assembly can be used with heating systems and/or systems with burners, such as ovens, stoves, barbecue grills, etc. but, may also be used in other types of heating systems. It will be understood that the heating assembly 210 is similar in some ways to the nozzle assembly 160 described with respect to Figures 42A-B, as well as, certain other embodiments described herein.

[0195] Figure 45 illustrates a perspective view of the heating assembly 210. The heating assembly can include an inlet 226 (better viewed in Figures 46A-47B) adapted to receive a fluid flow, such as from a fuel line. The heating assembly 210 can include a solenoid valve 270, which can be activated to block a fluid from passing further into the heating assembly 210. The heating assembly 210 can also include a pressure selector valve 250, which can be configured to selectively block a fluid flow depending on its pressure. In some embodiments, the heating assembly 210 can also include a control valve 230 with a control valve actuator 236, which can be used to adjust the amount of fluid flowing through the heating assembly 210.

[0196] The illustrated embodiment includes the solenoid valve, the pressure selector valve, and the control valve within a single housing of the heating assembly 210. In some embodiments, the solenoid valve, the pressure selector valve, and/or the control valve can be in one or more independent housings that are in fluid communication with each other. In some embodiments, the heating assembly 210 may lack one or more of the solenoid valve, the pressure selector valve, and the control valve and/or may also include additional components such as an igniter.

[0197] In addition to the inlet 226, the heating assembly 210 can also include nozzle assembly with a first outlet 225 and a second outlet 227. Each outlet can have one or more outlet holes or orifices 264. In some embodiments, as described below, the heating assembly 210 is configured such that when a first fluid is introduced through the inlet 226 the first fluid exits through both the first outlet 225 and the second outlet 227. In some embodiments, a second fluid, flowing at a different pressure, introduced through the inlet 226 can exit through only a single outlet (e.g., first outlet 225). Preferably, the heating assembly 210 is configured to operate with a first fluid being natural gas and a second fluid being liquid propane. The first and second outlets can be the same or different sizes.

[0198] Figures 46A-47B illustrate cross sectional views of the heating assembly 210 taken along line 46A of Figure 45. Figures 47A and 47B illustrate the control valve 230 in a first position in use with a first fluid (Figure 46A) and a second fluid at a different pressure (Figure 46B). Figures 47A and 47B illustrate the control valve 230 in the second position in use with the respective fluids at different pressures.

[0199] With reference to Figure 46A, solenoid valve 270 can include a solenoid valve body 272, shown schematically. The solenoid valve as illustrated is in an open position, allowing fluid entering the inlet 226 to flow past the solenoid valve body. When activated, the solenoid valve body can move to a closed position, wherein a projecting or angled portion 274 of the solenoid valve body can contact a solenoid valve seat, blocking further flow of fluid past the solenoid valve body, and thereby preventing fluid from passing through the first outlet 225 or the second outlet 227. The solenoid valve 270 can be electrically coupled to a thermocouple, thermister, etc., to maintain the valve in an open position when the thermocouple, thermister, etc. is heated.

[0200] As the first fluid flows past the solenoid valve, it can continue along a first flow path 245A, into the control valve body 234, out through a first control valve orifice 238A in the first flow path 245A, and out the first outlet 225. The fluid can also flow along a second flow path 245B, through the pressure selector valve 250, through a second orifice 238B in the second flow path 245B, through a third orifice 238C in the second flow path 245B, and through the second outlet 227. In some embodiments, the order and arrangement of valves can vary from the illustrated arrangement.

[0201] The pressure selector valve 250 generally operates like similar valves described above, such as the valve described with respect to Figures 42A and 42B. For example, the pressure selector valve can have a valve body 212 that can connect to and move with a diaphragm 256, a diaphragm retainer 258, and/or a biasing member 252. The valve body 212 is preferably biased toward an open position, as illustrated, allowing the first fluid at the first pressure to flow through the pressure selector valve 250. Increased fluid pressures will cause the diaphragm to experience a force tending to move the valve body 212 toward a closed position, as illustrated in Figure 46B.

[0202] Figure 46B illustrates the heating assembly 210 when used with a second fluid. The second fluid preferably operates at a pressure greater than the first fluid, and the pressure can be sufficient to move the pressure selector valve body 212 to seat against a valve seat 259, substantially blocking further fluid flow. The pressure selector valve body 212 may include a projection or beveled surface 257 that can seat against the valve seat 259. Preferably, the pressure selector valve is configured such that it is in an open position with a first fuel of natural gas, and in a closed position with a second fuel of liquid propane. With both a first fuel and a second fuel the first flow path 245A can remain open. It will be understood that the heating assembly 210 can also be reversed, such that for example, the pressure selector valve 250 can have an initially closed position.

[0203] Figures 46A and 46B also illustrate the control valve 230 in a first, high flow position, in which at least one of orifices 238A, B, C can be larger than in a second, low flow position. Figures 47A and 47B illustrate the control valve 230 in the second position. The control valve 230 can have a number of set orifice sizes, or it can have continuously variable slots to allow for more adjustable flow. Figure 47A illustrates the control valve in the second position with the pressure selector valve 250 in an open position. Figure 47B illustrates the control valve in the second position with the pressure selector valve 250 in a closed position.

[0204] To move the control valve to the second position, the control valve actuator can be rotated, which can rotate a control valve shaft 232 and the control valve body 234. Different arrangements and connecting elements can be used to translate actuator rotation to valve body rotation. In some embodiments, the control valve actuator 236 can have a knob or other control feature, such as those described with respect to Figures 25A-C.

[0205] In the second position of the control valve, as illustrated, one or more of the orifices 238A, B, C can be smaller than in the first position of the control valve. In some embodiments, the first orifice 238A can be the same size as the second orifice 238B and third orifice 238C, when the control valve is in the first position and/or the second position. In some embodiments, the first orifice 238A can be a different size from the second orifice 238B and/or the third orifice 238C, when the control valve is in the first position and/or the second position. In some embodiments, the second orifice 238B and the third orifice 238C can be approximately the same size when the control valve is in the first position. In some embodiments, the second orifice 238B and the third orifice 238C can be approximately the same size when the control valve is in the second position, in which both the second orifice 238B and the third orifice 238C are smaller than in the first position. In some embodiments, the second orifice 238B can be of a different size than third orifice 238C when the control valve is in the second position. In some embodiments, one or more of the orifices 238A, B, C can be the same size in both the first and second positions of the control valve.

[0206] The control valve body 234 can have various configurations, as described with respect to Figure 25B. Thus, in some embodiments, one or more of the orifices 238A, B, C can be holes of varying sizes. By rotating from the first position to the second position the valve body rotates from a position with larger holes aligned with the flow paths 245A, B to a position with smaller holes aligned with the flow paths. In some embodiments, one or more of the orifices can be a hole or slot that changes in size around the control valve body. In such embodiments, the control valve body can have a first, high flow position; a second, low flow position; and a variety of flow positions between the first and second positions.

[0207] Figures 48A-50B illustrate another embodiment of a heating assembly 210' that can be used with dual fuels. Numerical reference to components is the same as previously described, except that a prime symbol (') has been added to the reference. Where such references occur, it is to be understood that the components are the same or substantially similar to previously-described components. The illustrated heating assembly can have many of the same components of the heating assembly described with respect to Figures 45-47B, and where not described differently those components are understood to operate as previously described. Thus, the heating assembly 210' can have a first outlet 225' and a second outlet 227', each with an outlet hole or orifice 264'. A pressure selector valve

250' can help determine the flow paths of different fluids/fuels, such that a first fluid may exit through the first outlet 225' and second outlet 227', and a second fluid may exit only through the first outlet 225'. The heating assembly 210' can also have a control valve 230'. The illustrated embodiment does not have a solenoid valve, but in some embodiments it may.

[0208] Figures 48A and 48B also illustrate an embodiment of a heating assembly with an additional flow path that leads to a nozzle 282. An electrode 280 can be positioned proximate the nozzle and can be used to ignite fuel exiting from the nozzle. In some embodiments, this arrangement can include a thermocouple (not illustrated) so that the system can act as a pilot or as an ODS, as described above.

[0209] Figures 49A and 49B show the heating assembly 210' in use with the second fluid, such as liquid propane. Figure 49A illustrates the high position and Figure 49B shows the low position. Figures 50A and 50B show the heating assembly 210' in use with the first fluid, such as natural gas. Figure 50A illustrates the high position and Figure 50B shows the low position. As described above, in the high position one or more of the orifices 238A', 238B', 238C' can be larger than it is when the heating assembly is in the low position. Also as described above, in some embodiments one or more of the orifices can be a hole or slot that changes in size around the control valve, and the control valve can have a high position, a low position, and a plurality of flow positions between the high and low positions.

[0210] Advantageously, certain embodiments of the heating assembly as described herein facilitate a single appliance unit being efficaciously used with different fuel sources. This desirably saves on inventory costs, offers a retailer or store to stock and provide a single unit that is usable with more than one fuel source, and permits customers the convenience of readily obtaining a unit which operates with the fuel source of their choice.

[0211] Advantageously, certain embodiments of the heating assembly can transition between the different operating configurations as desired with relative ease and without or with little adjustment by an installer and/or an end user. Preferably, a user does not need to make a fuel selection through any type of control or adjustment. The systems described herein can alleviate many of the different adjustments and changes required to change from one fuel to another in many prior art heating sources.

[0212] It will be understood that the embodiments and components described herein can be used with, without and/or instead of other embodiments and components as described herein or otherwise. For example, the fuel selector valve described herein can be connected to the regulator 120 of the heater 100 shown in Figures 1 and 2.

[0213] Reference throughout this specification to “one embodiment” or “an embodiment” means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, appearances of the phrases “in one embodiment” or “in an embodiment” in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures or characteristics of any embodiment described above may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments.

[0214] Similarly, it should be appreciated that in the above description of embodiments, various features of the inventions are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This method of disclosure, however, is not to be interpreted as reflecting an intention that any claim require more features than are expressly recited in that claim. Rather, as the following claims reflect, inventive aspects lie in a combination of fewer than all features of any single foregoing disclosed embodiment. Thus, the claims following the Detailed Description are hereby expressly incorporated into this Detailed Description, with each claim standing on its own as a separate embodiment.

WHAT IS CLAIMED IS:

1. A dual fuel heating assembly comprising:
 - a nozzle comprising at least one inlet, at least one first outlet, and at least one second outlet;
 - a first flow path from a fuel line through the at least one inlet and the at least one first outlet;
 - a second flow path from the fuel line through the at least one inlet and the at least one second outlet;
 - a control valve having a first position that allows a first flow of fuel through a control valve body and a second position that allows a second flow of fuel through the control valve body, the control valve positioned in at least one of the first flow path and the second flow path; and
 - a movable body positioned at least partially within the second flow path;wherein in a first position of the movable body, the second flow path is substantially closed by the movable body, the amount of flow through the at least one second outlet is substantially close to zero, and the amount of flow through the burner valve is less than in a second position;
- wherein the movable body is configured such that movement between the first and second positions is controlled by a pressure of a fluid flowing to the nozzle.
2. The dual fuel heating assembly of claim 1, further comprising a biasing member configured to regulate the position of the movable body in response to the pressure of the fluid flowing through the nozzle.
3. The dual fuel heating assembly of claim 1, further comprising a spring and a diaphragm, wherein fluid pressure acts on the diaphragm to determine whether the movable body is in the open or closed position.
4. The dual fuel heating assembly of claim 1, wherein the control valve is positioned in both the first flow path and the second flow path.
5. The dual fuel heating assembly of claim 1, wherein the control valve comprises a rotatable valve.
6. The dual fuel heating assembly of claim 1, further comprising a solenoid valve positioned between the fuel line and the first and second flow paths.

7. The dual fuel heating assembly of claim 1, further comprising an oxygen depletion sensor.

8. The dual fuel heating assembly of claim 7, wherein the nozzle comprises part of the oxygen depletion sensor.

9. The dual fuel heating system of claim 1, further comprising a burner, wherein the nozzle is a burner nozzle to direct fuel to the burner to be combusted at the burner.

10. The dual fuel heating assembly of claim 1, wherein the heating assembly is part of a water heater, a fireplace, a gas oven, a BBQ, or a gas dryer.

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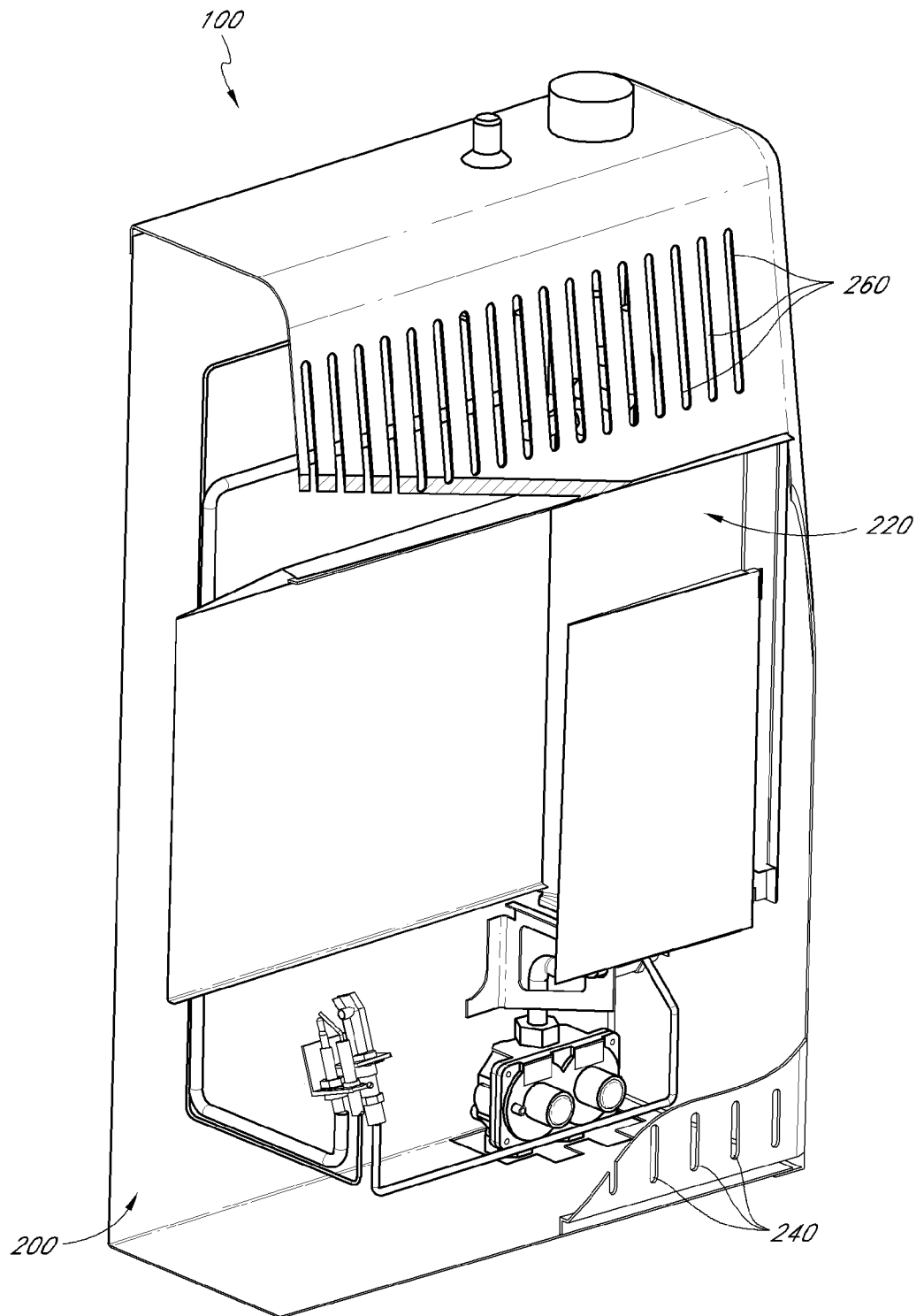


FIG. 1

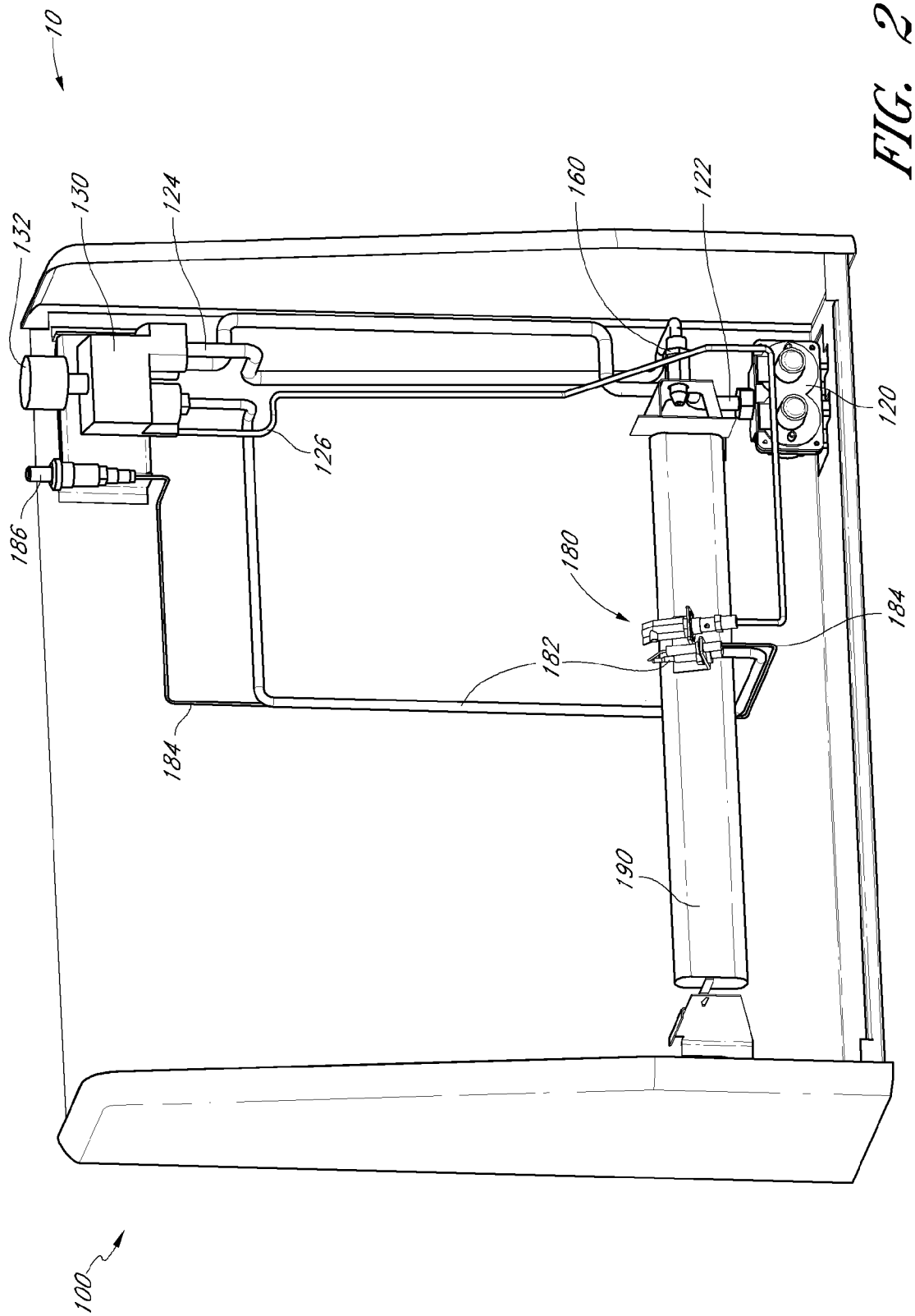


FIG. 2

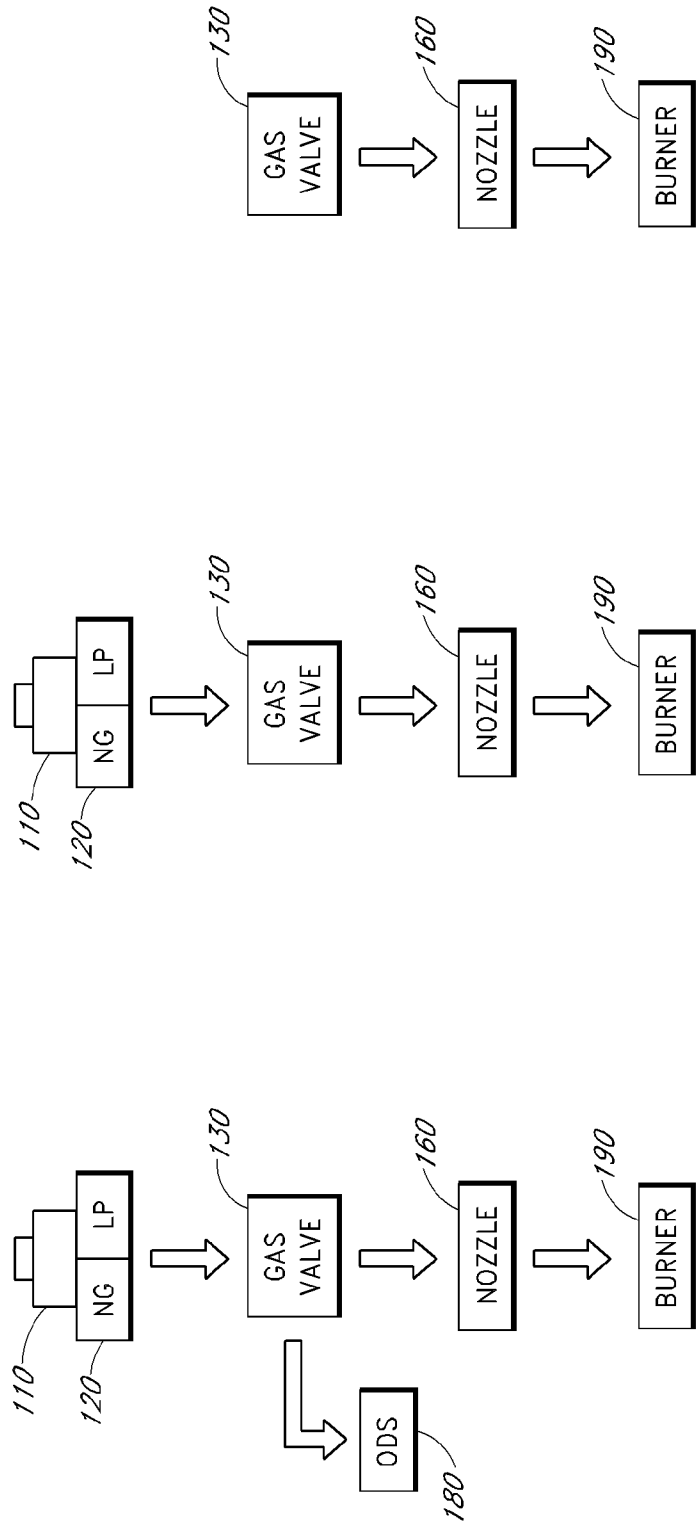


FIG. 3C

FIG. 3B

FIG. 3A

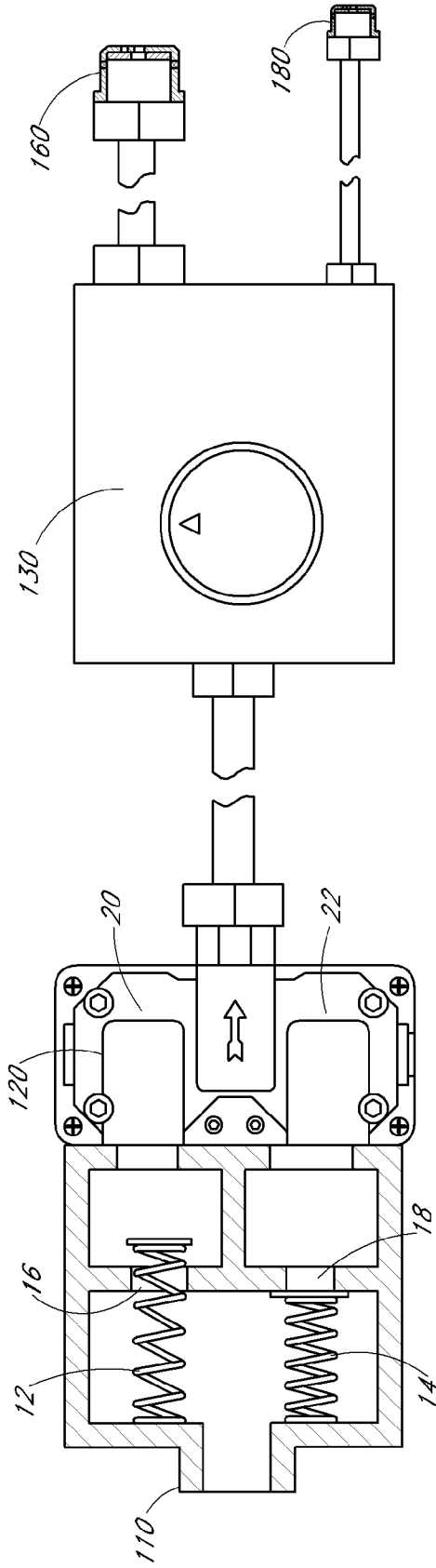


FIG. 4A

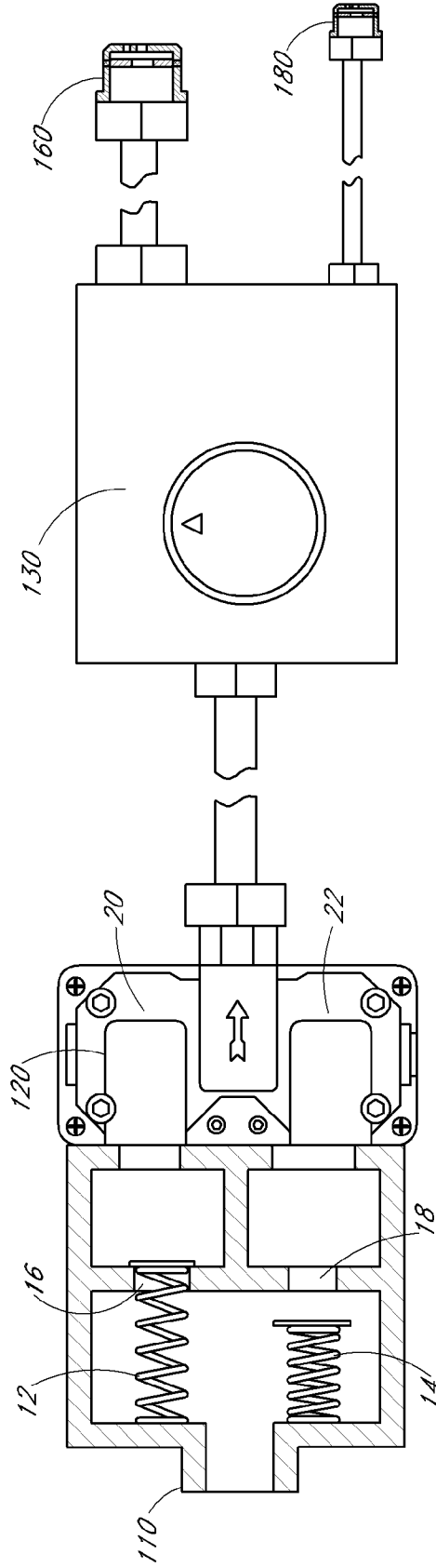


FIG. 4B

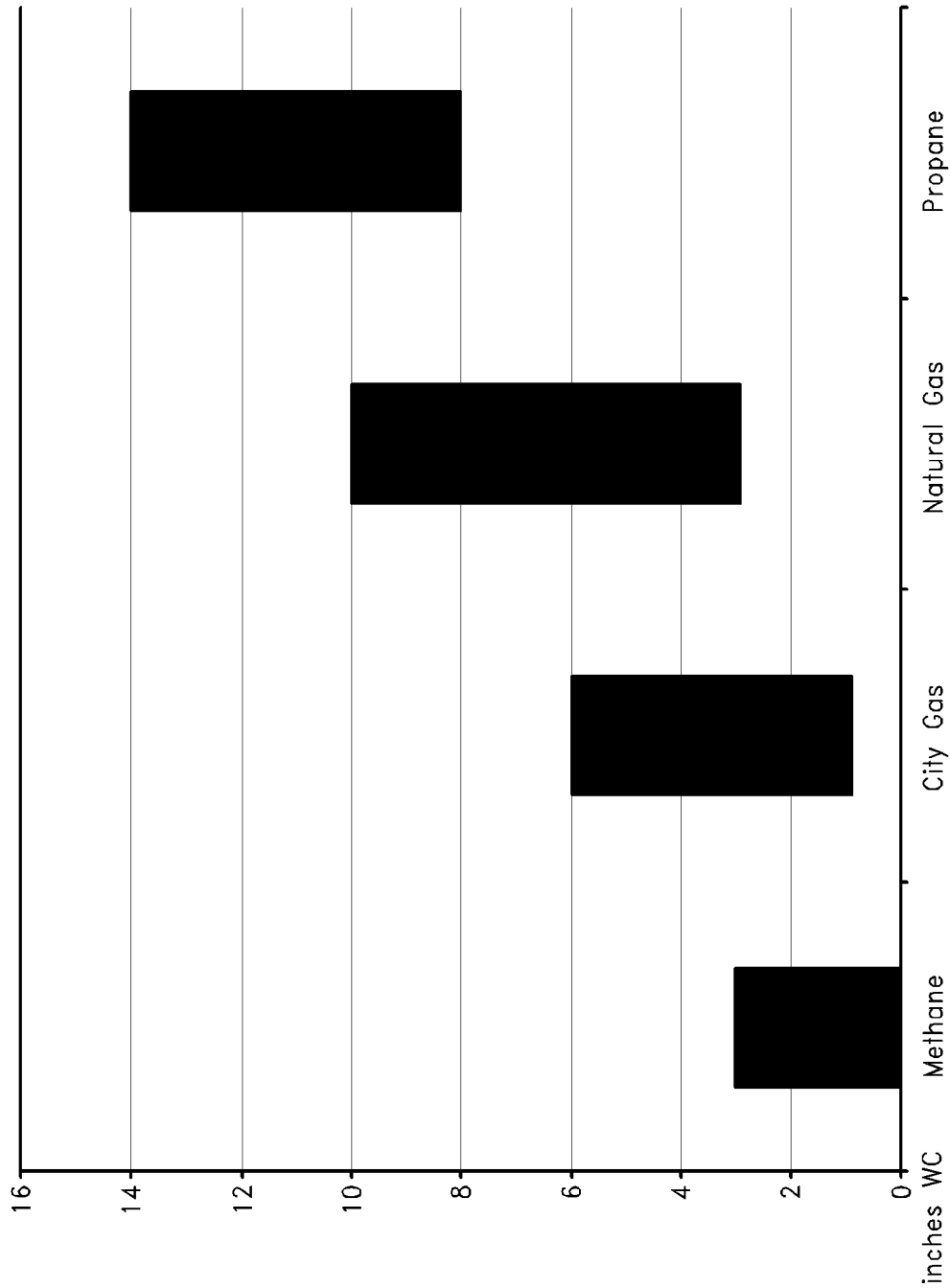


FIG. 5

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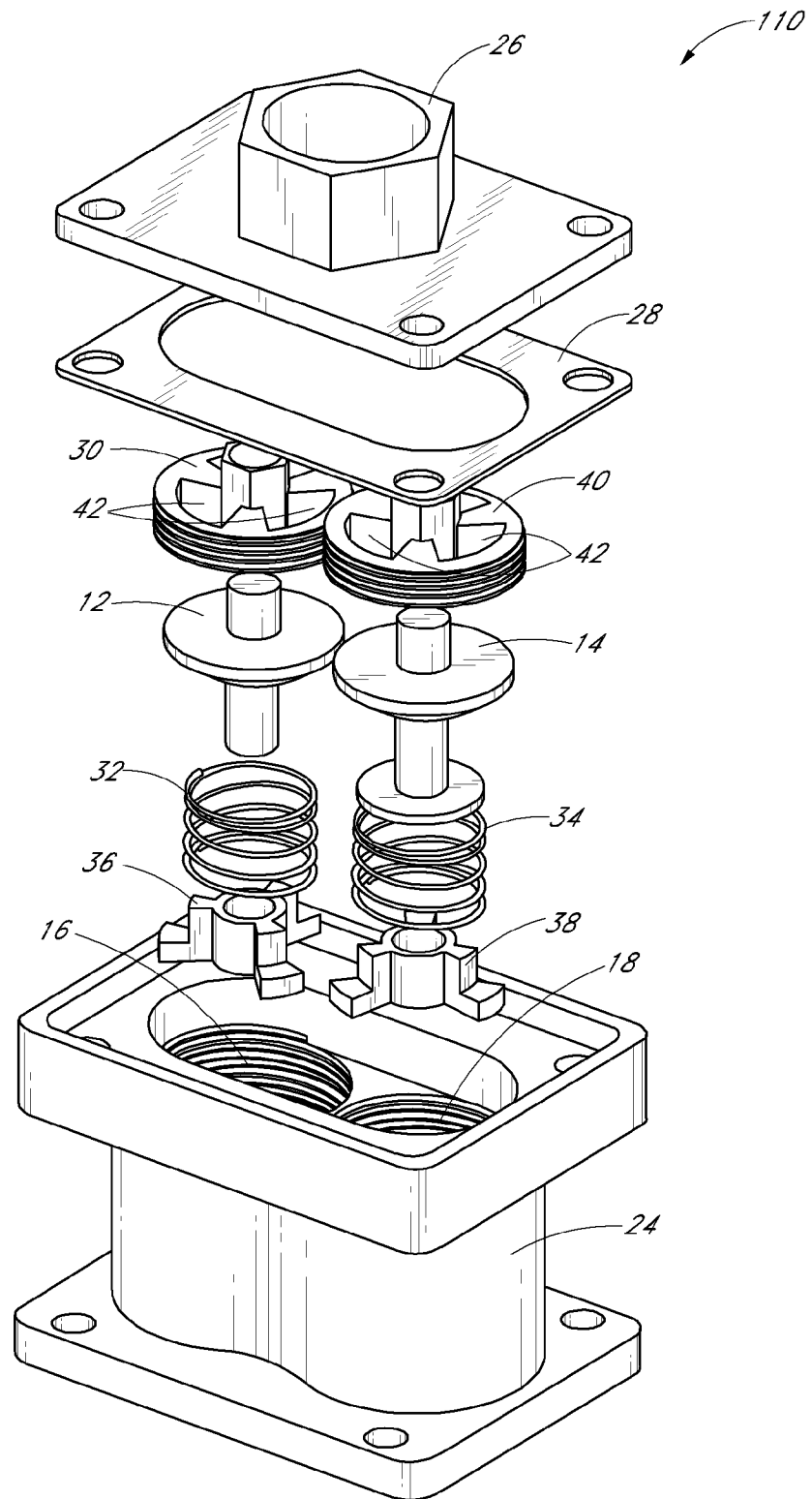


FIG. 6

FIG. 7A

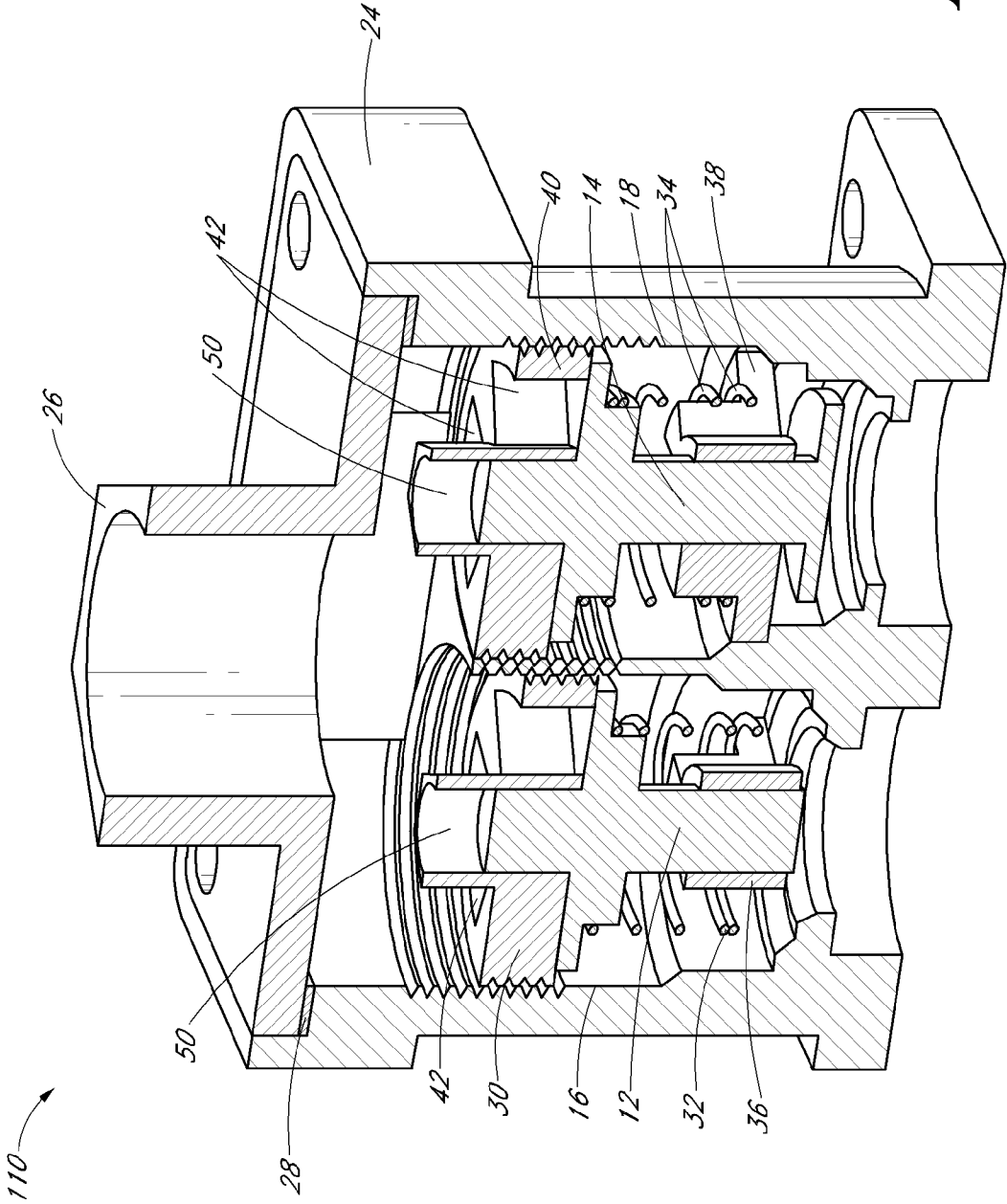


FIG. 7B

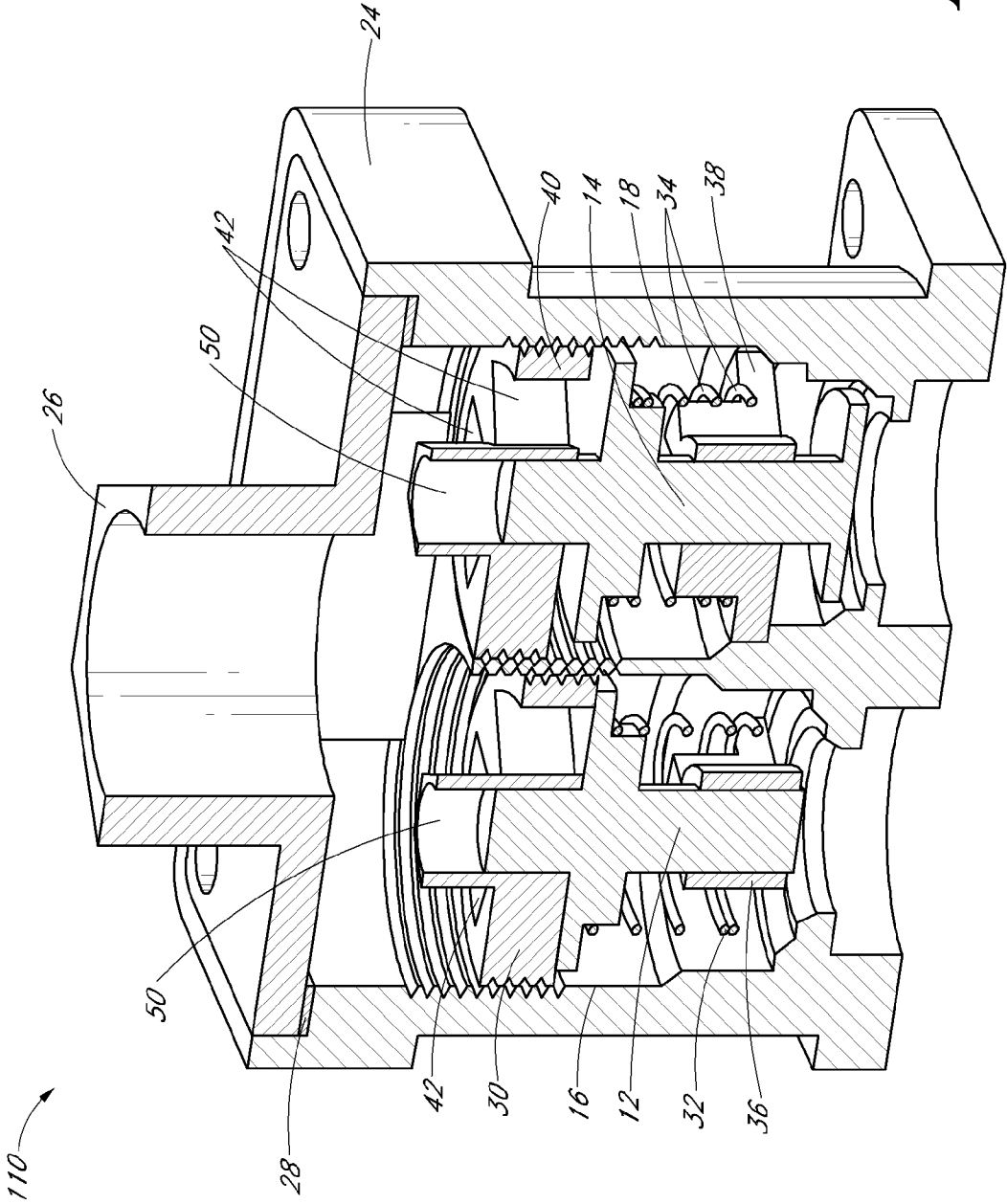
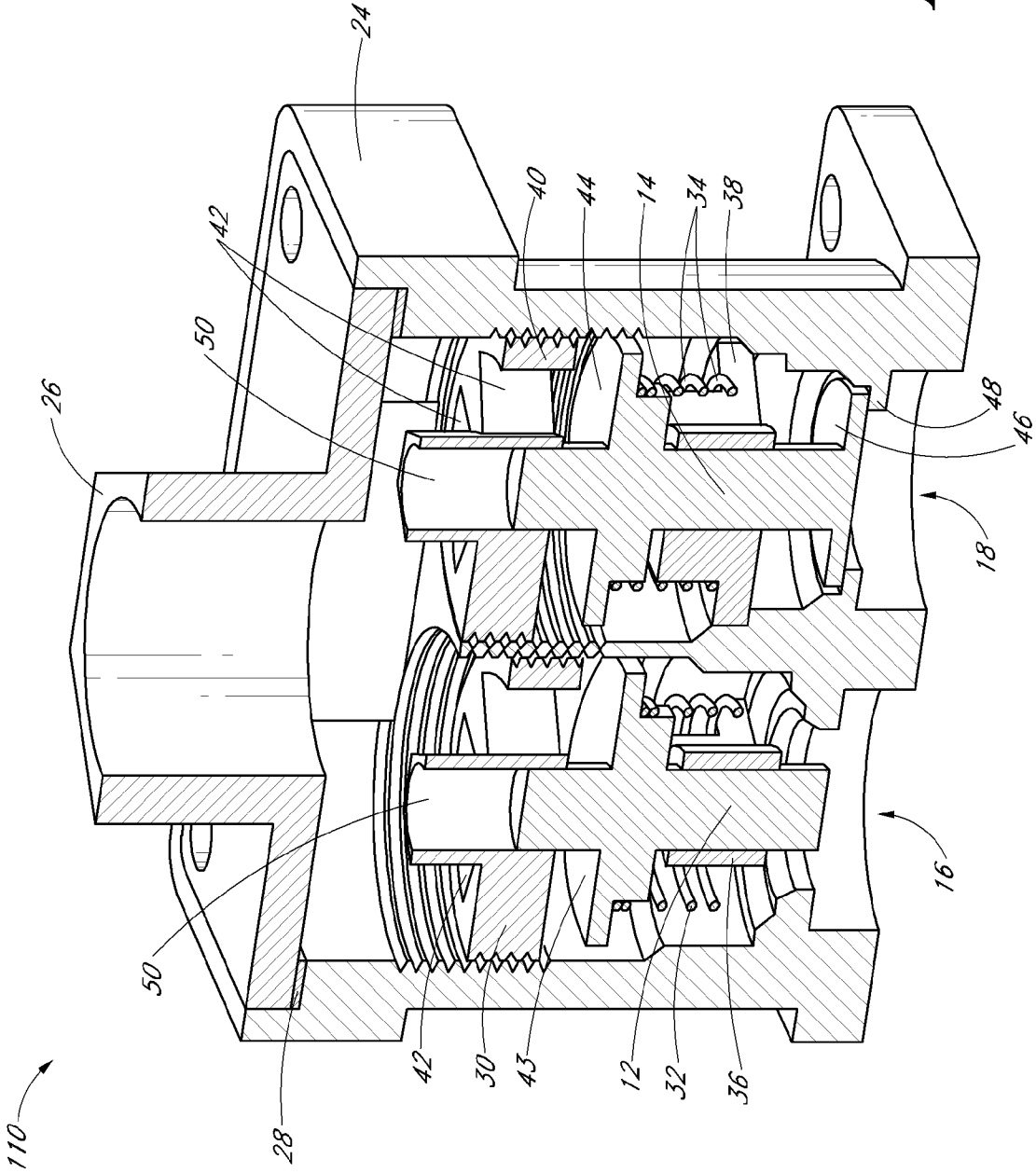


FIG. 7C



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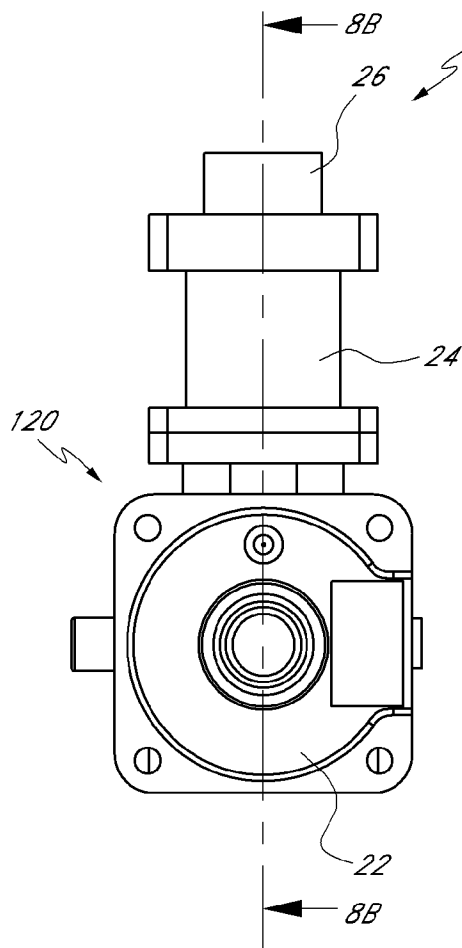


FIG. 8A

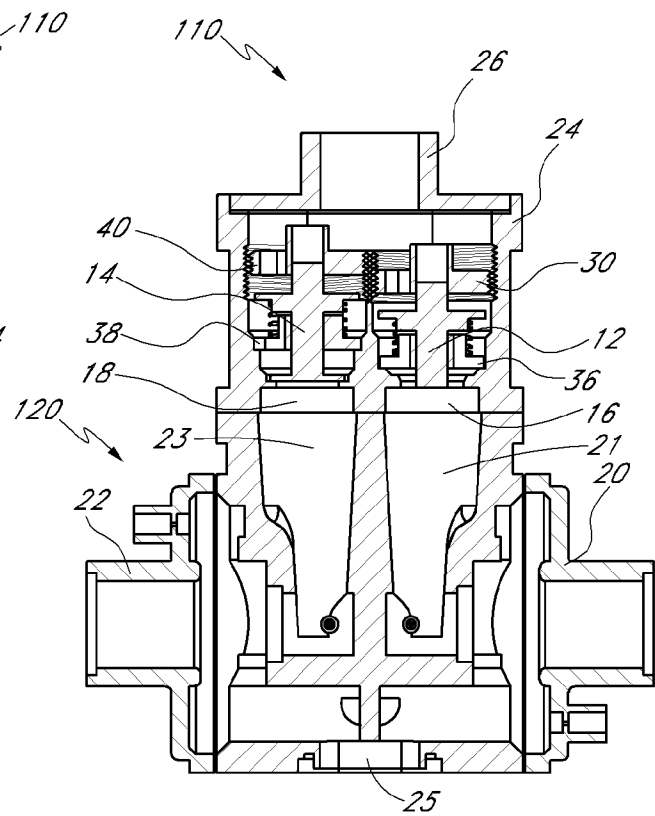


FIG. 8B

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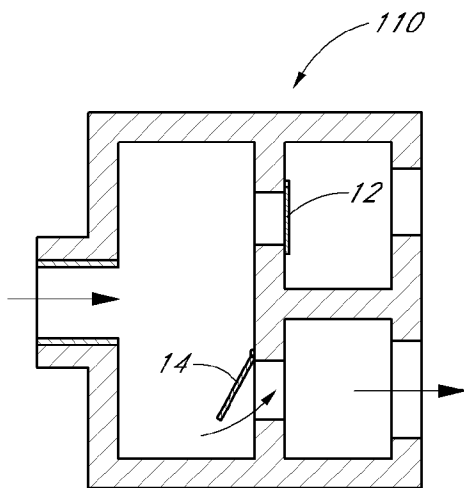


FIG. 9A

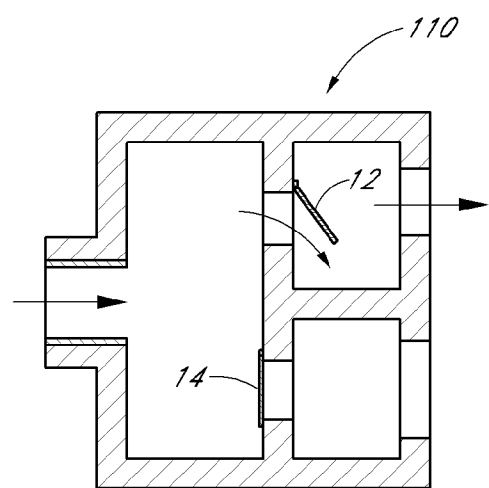


FIG. 9B

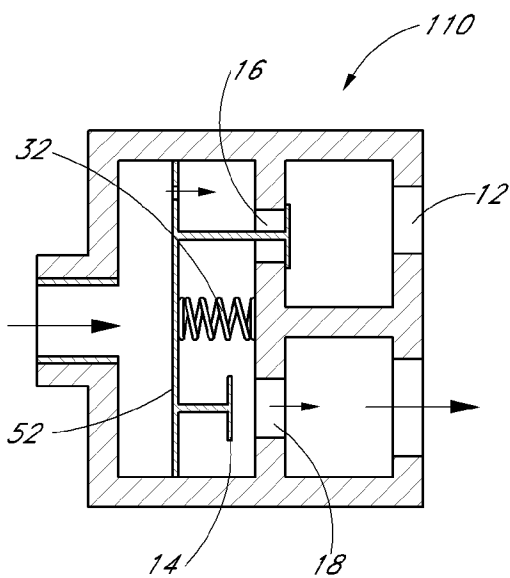


FIG. 10A

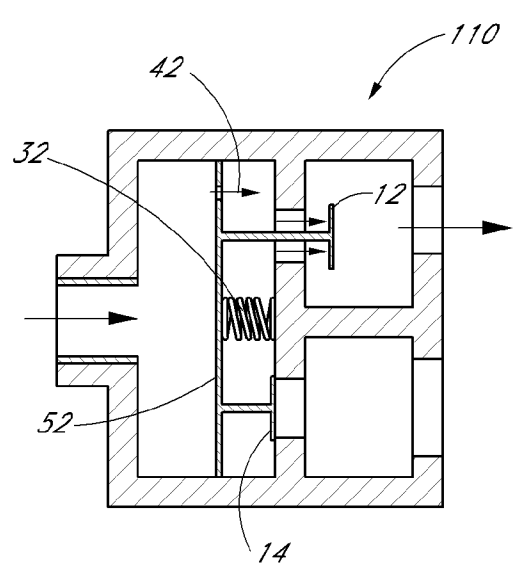


FIG. 10B

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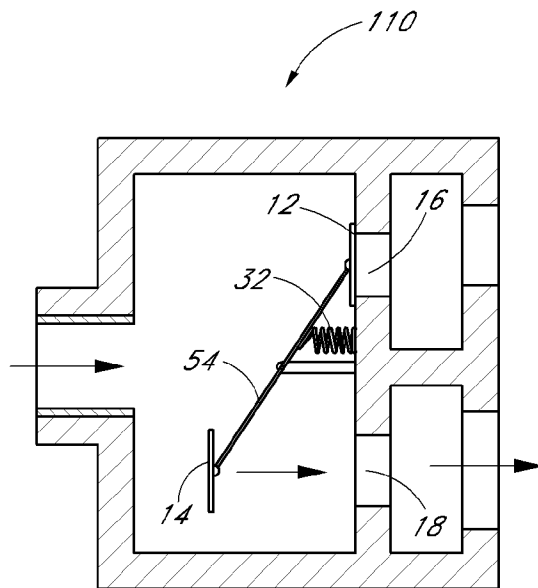


FIG. 11A

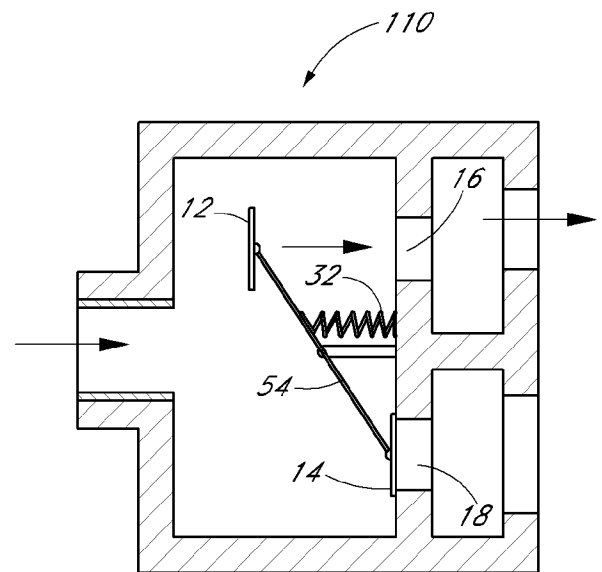


FIG. 11B

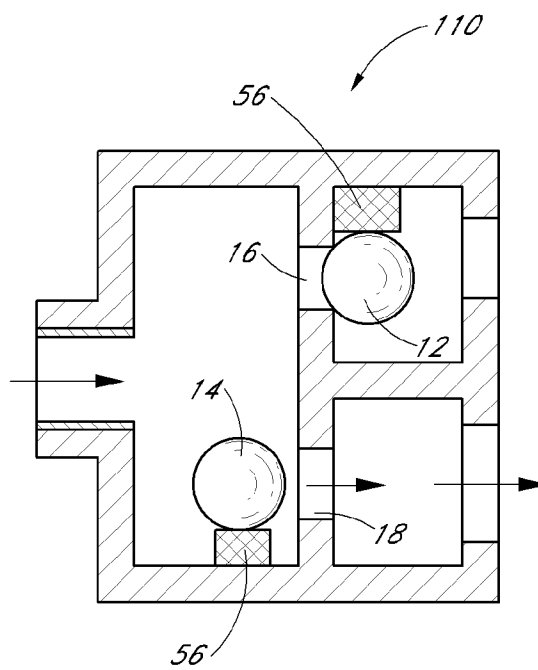


FIG. 12A

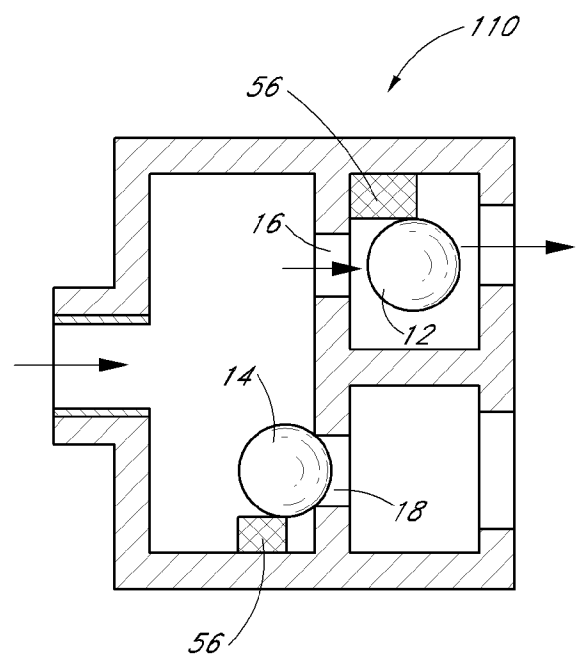


FIG. 12B

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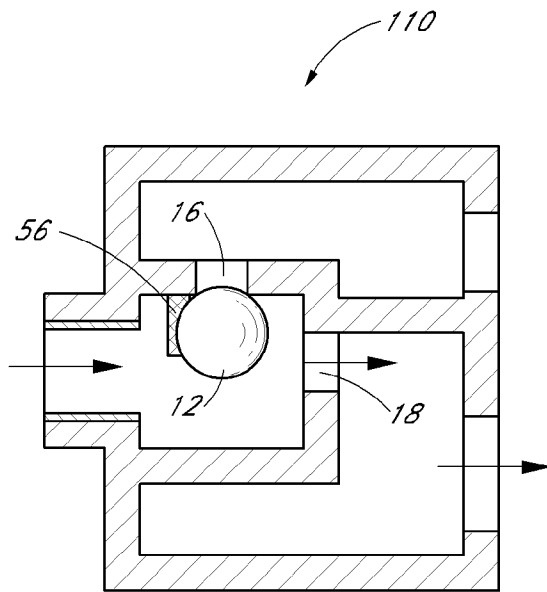


FIG. 13A

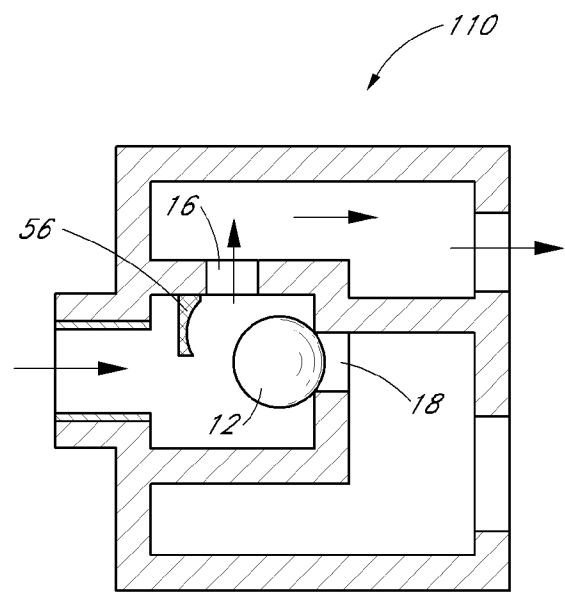


FIG. 13B

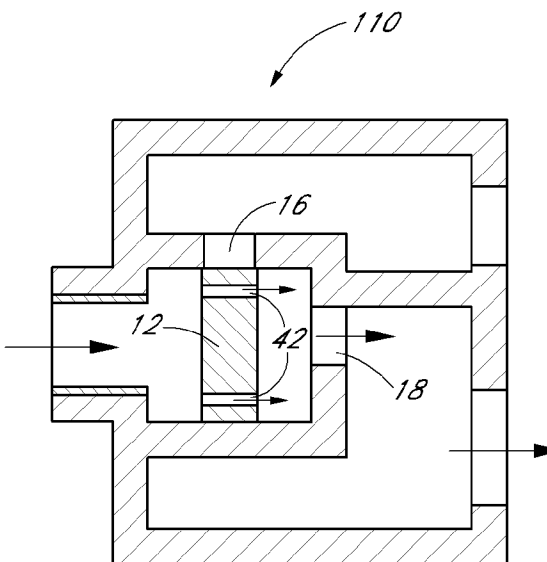


FIG. 14A

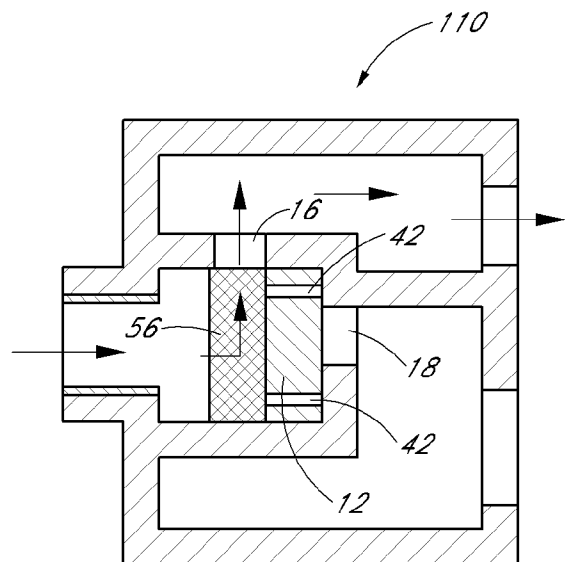


FIG. 14B

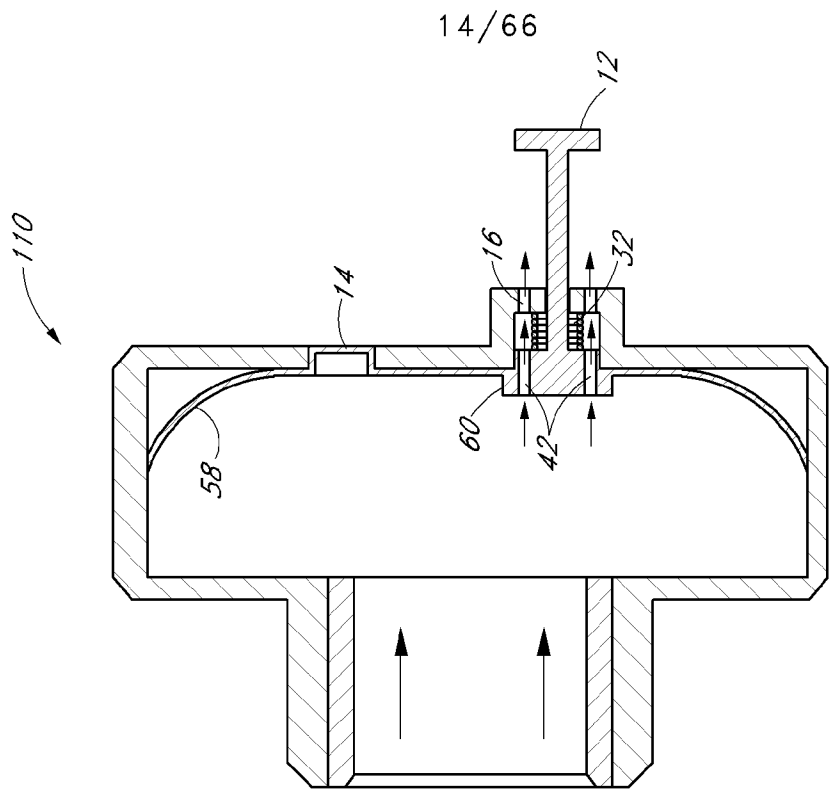


FIG. 15B

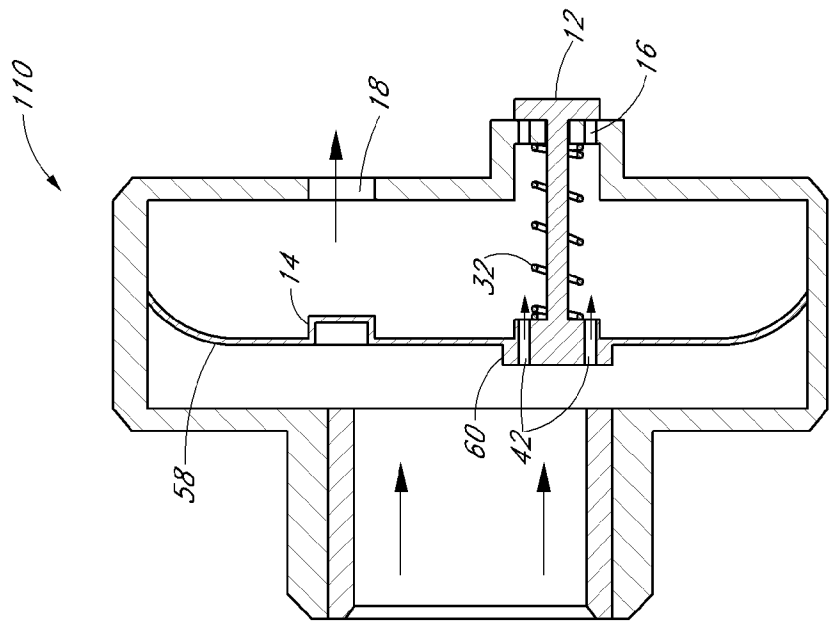


FIG. 15A

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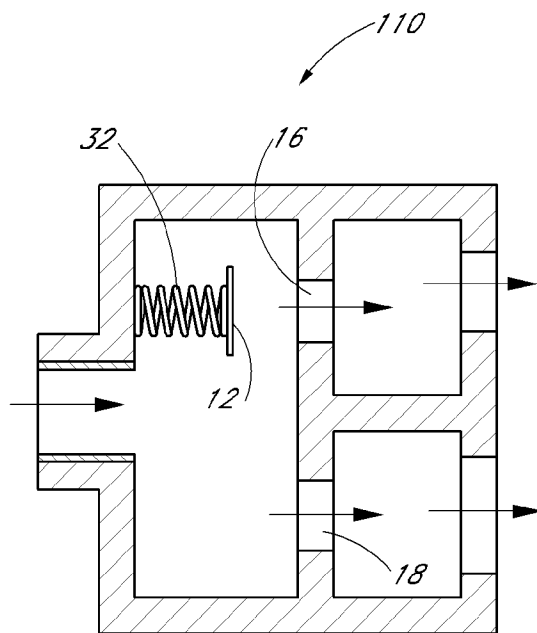


FIG. 16A

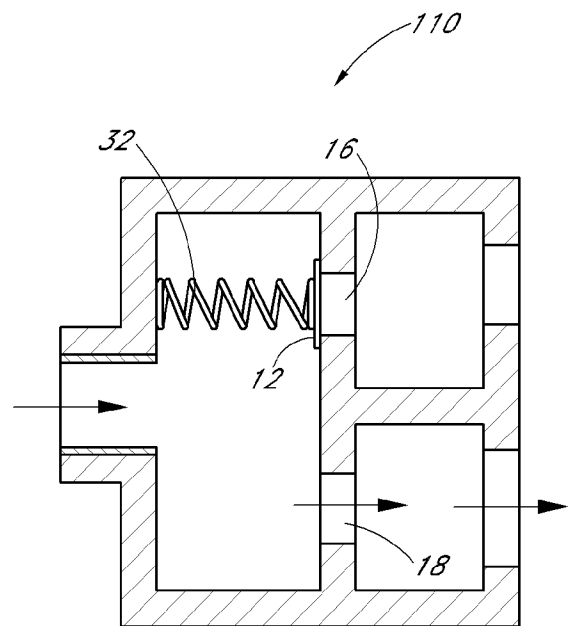


FIG. 16B

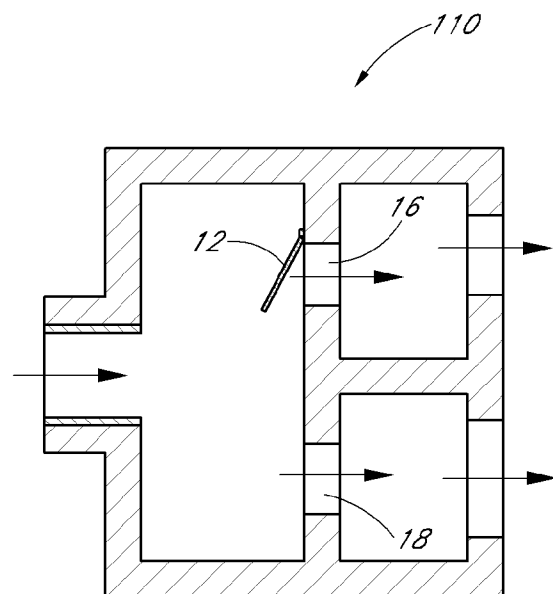


FIG. 17A

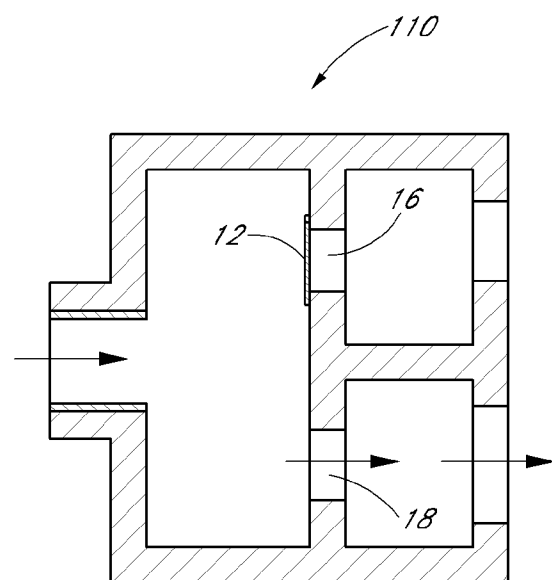


FIG. 17B

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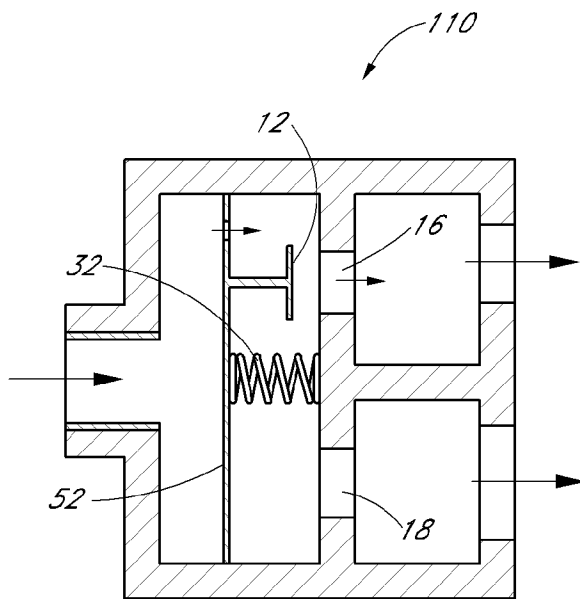


FIG. 18A

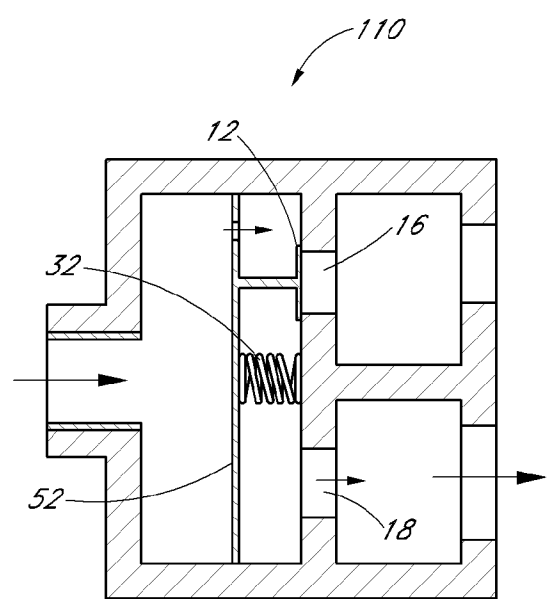


FIG. 18B

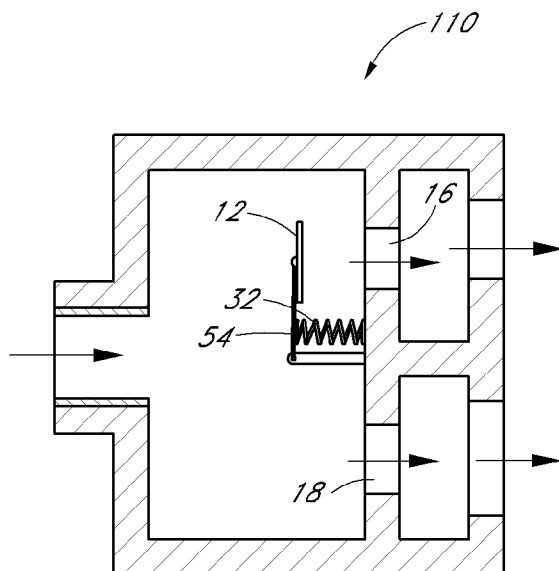


FIG. 19A

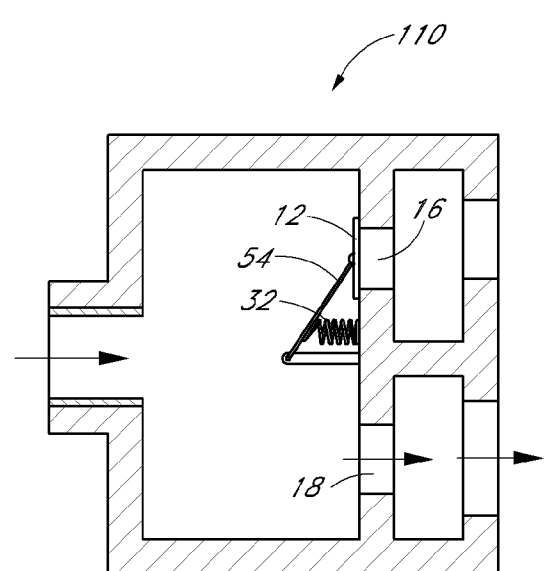


FIG. 19B

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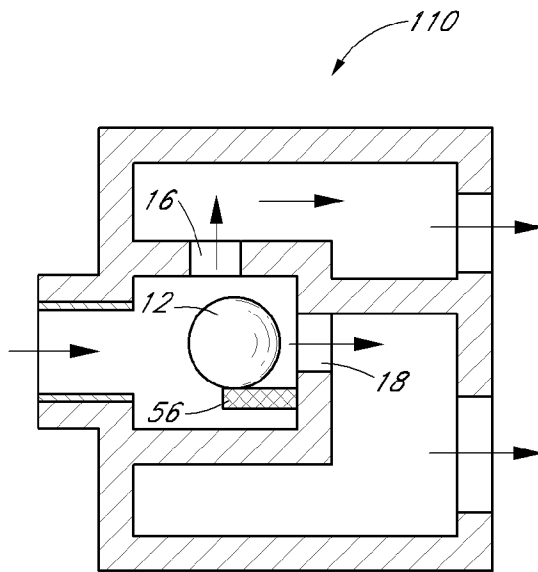


FIG. 20A

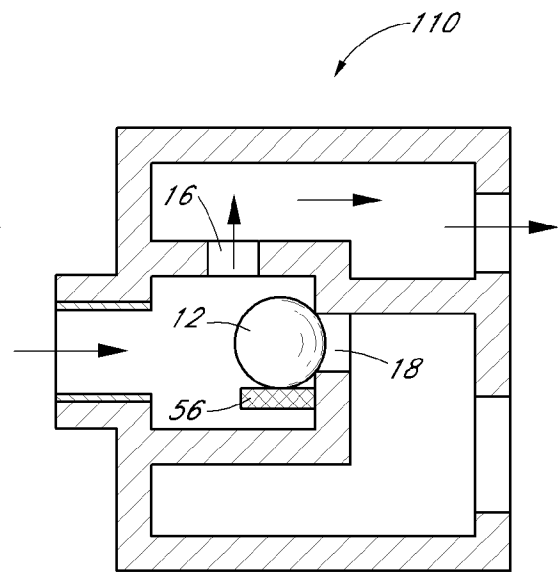


FIG. 20B

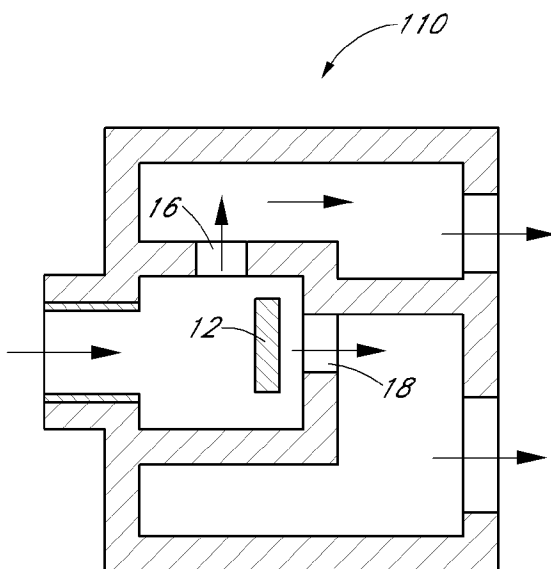


FIG. 21A

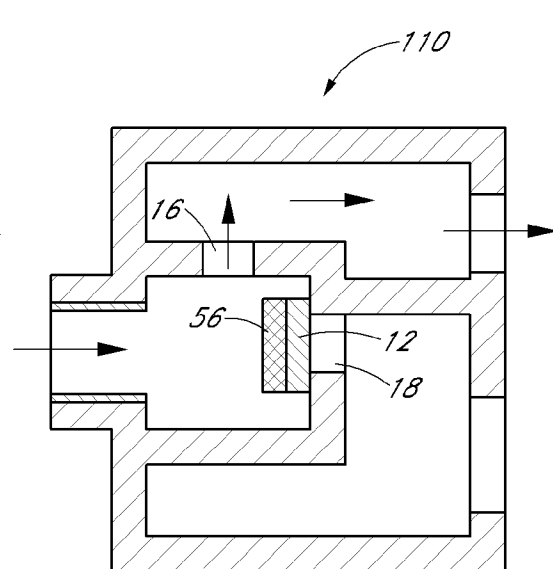


FIG. 21B

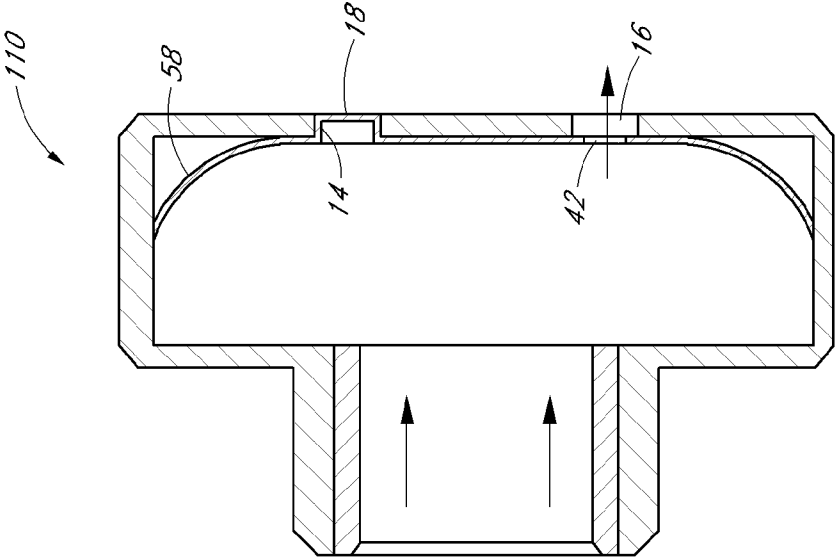


FIG. 22B

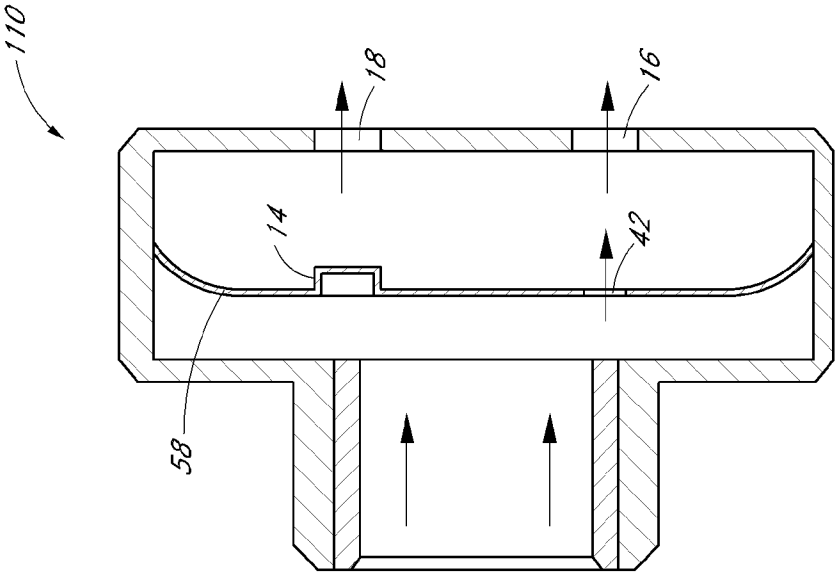


FIG. 22A

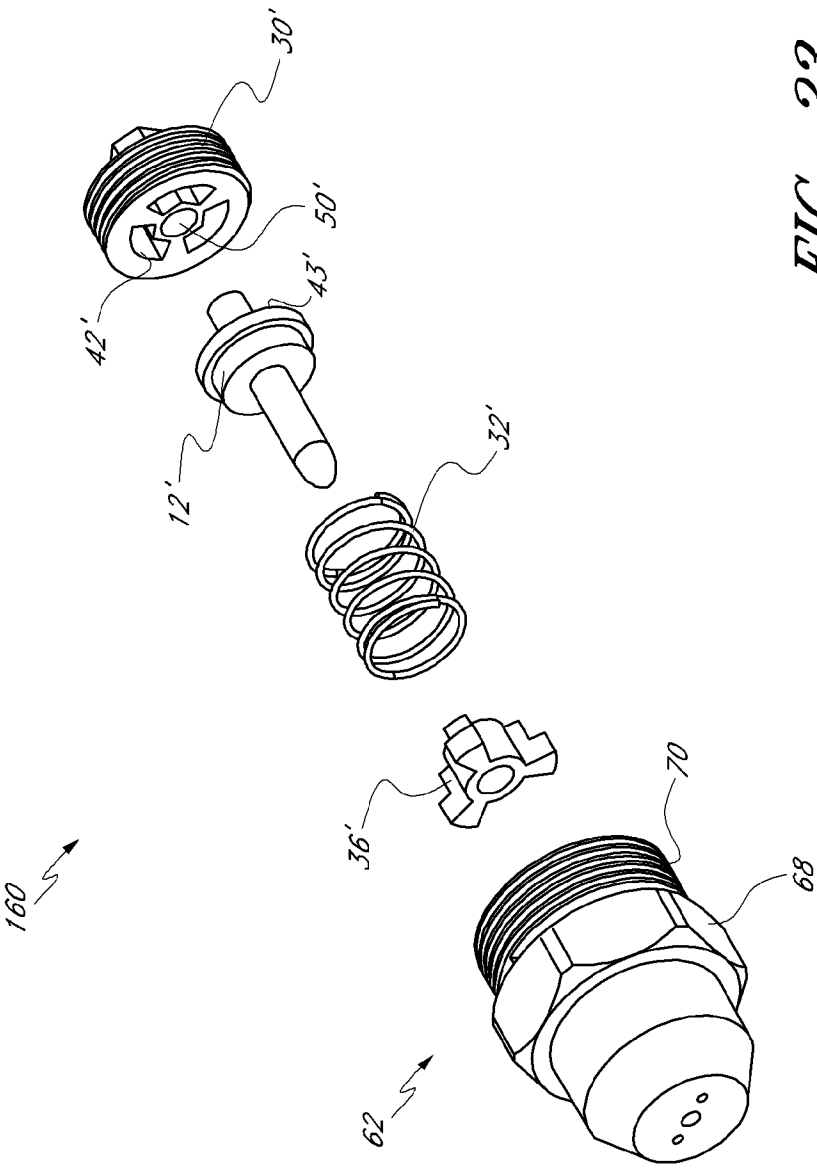


FIG. 23

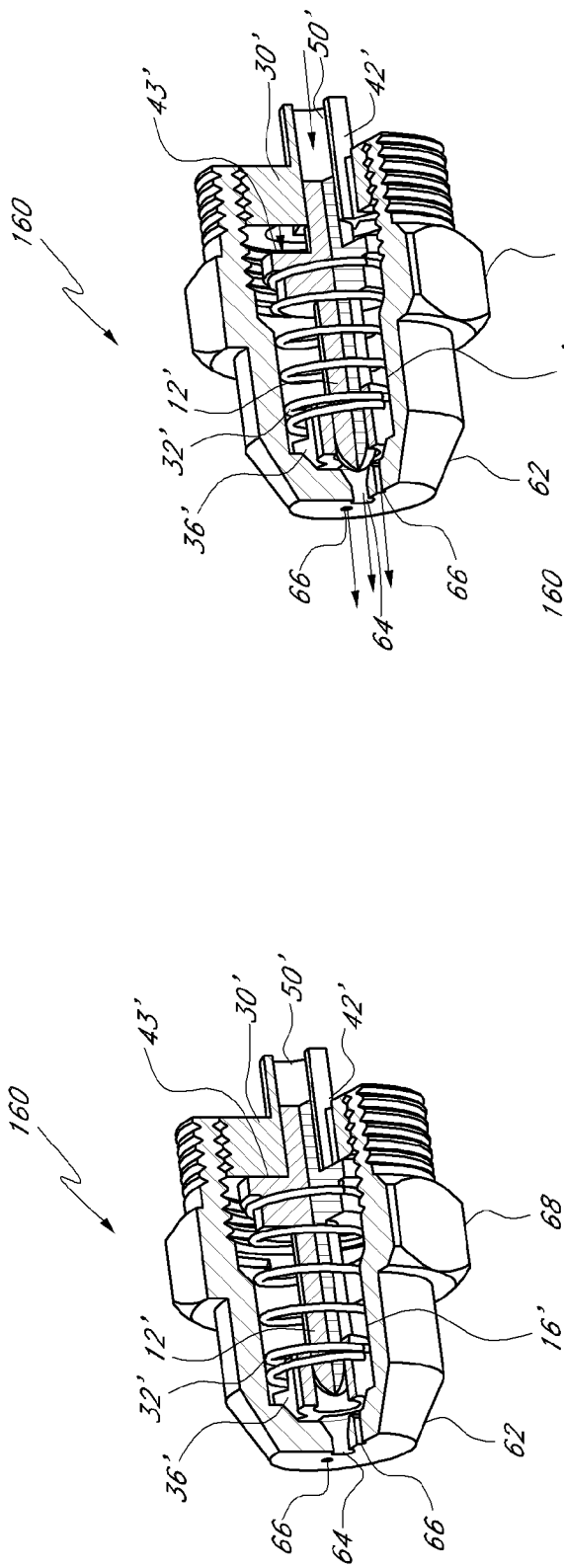


FIG. 23A

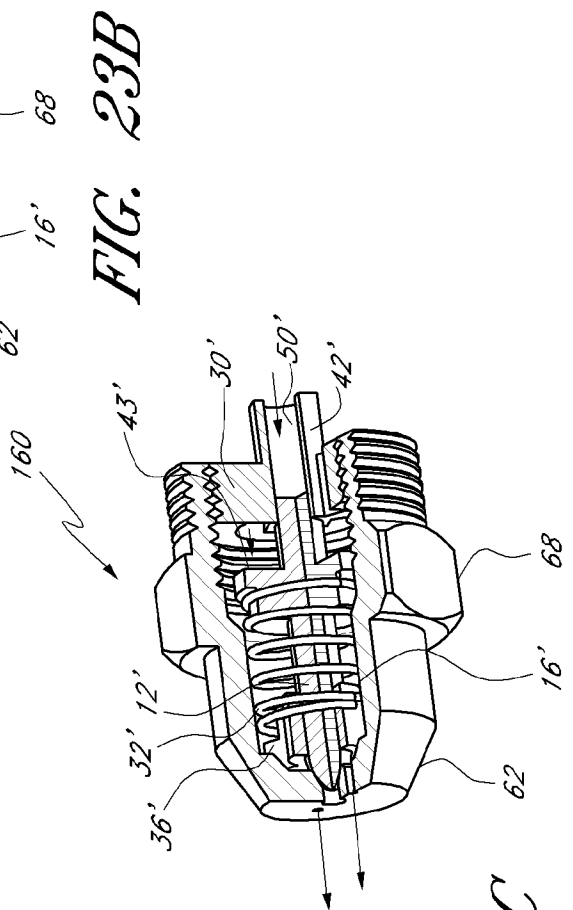


FIG. 23B

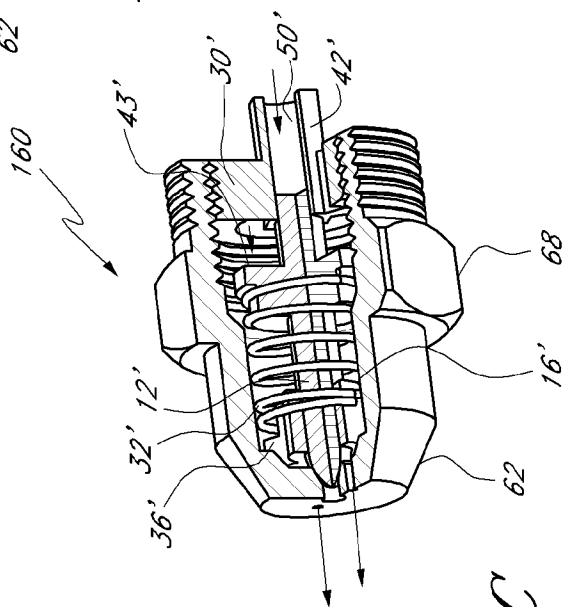


FIG. 23C

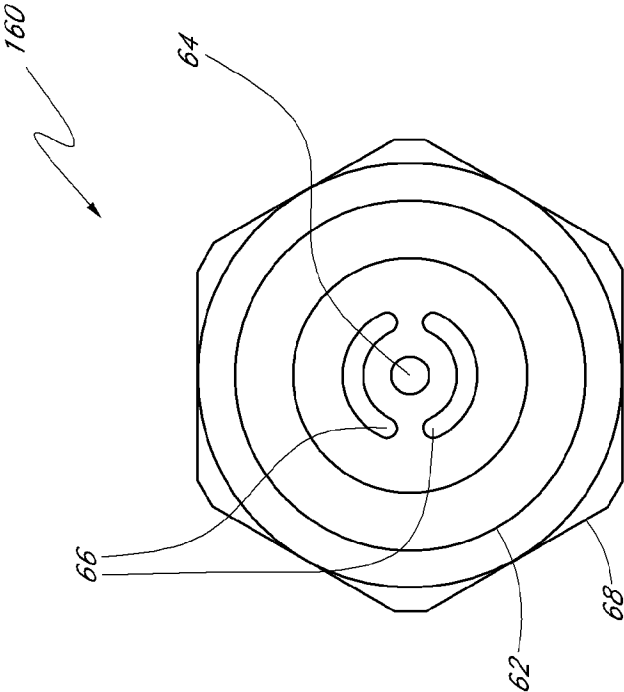


FIG. 24B

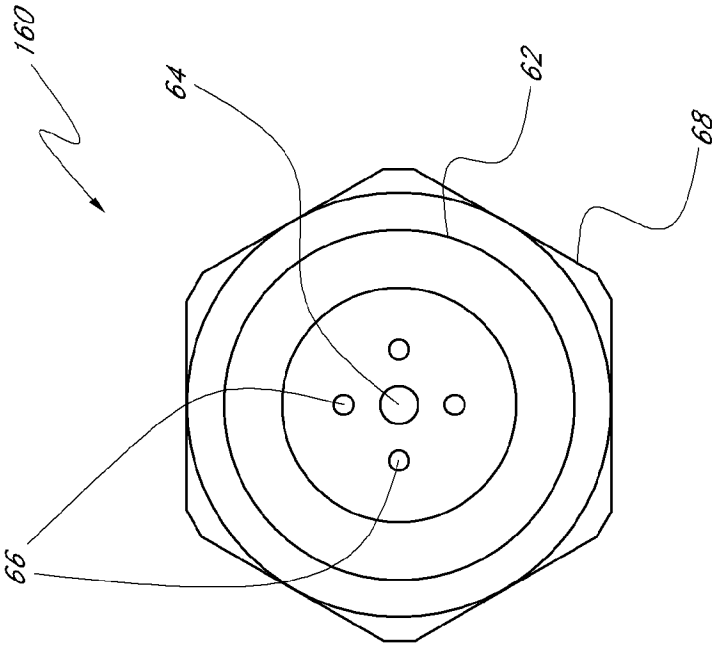
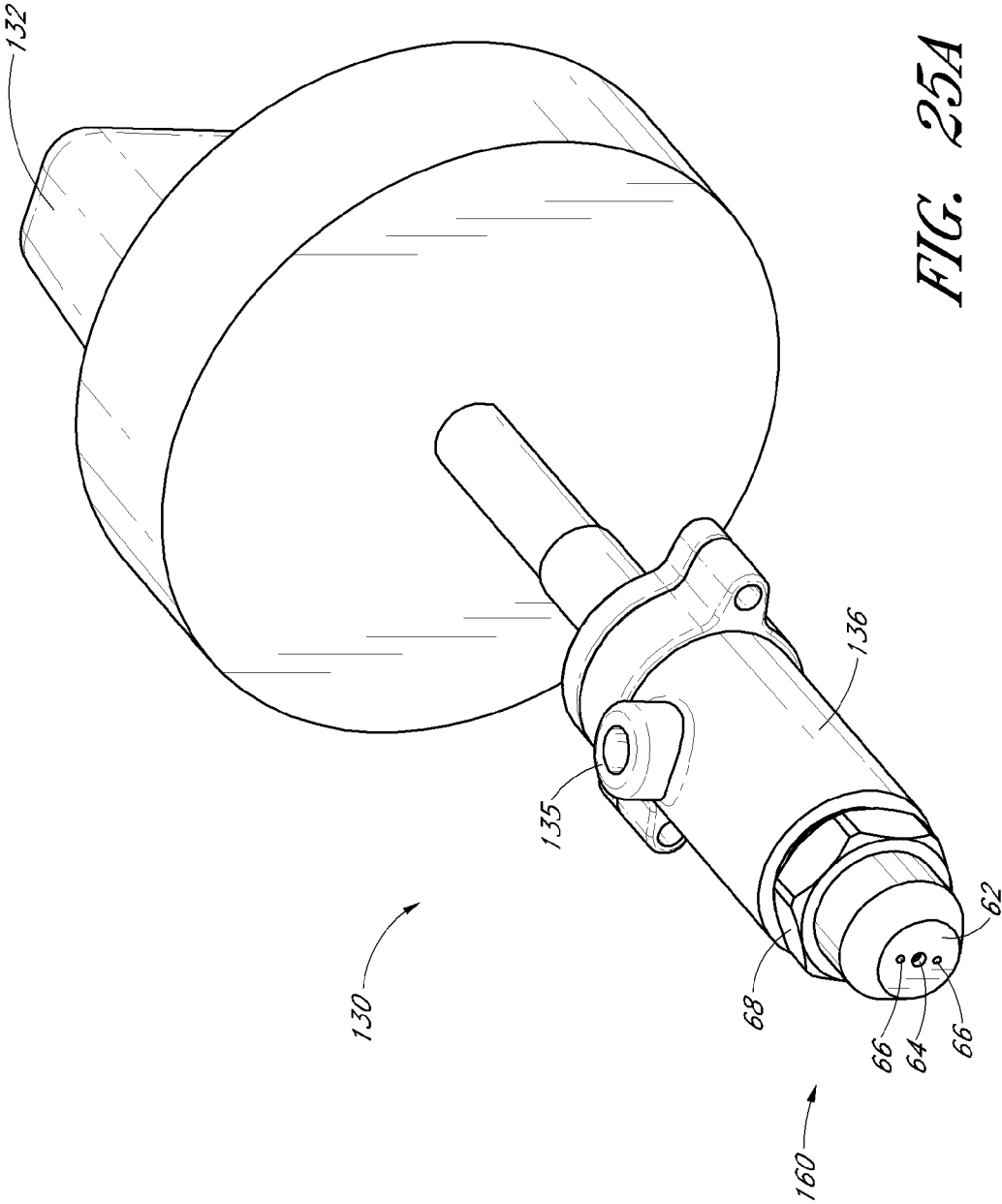
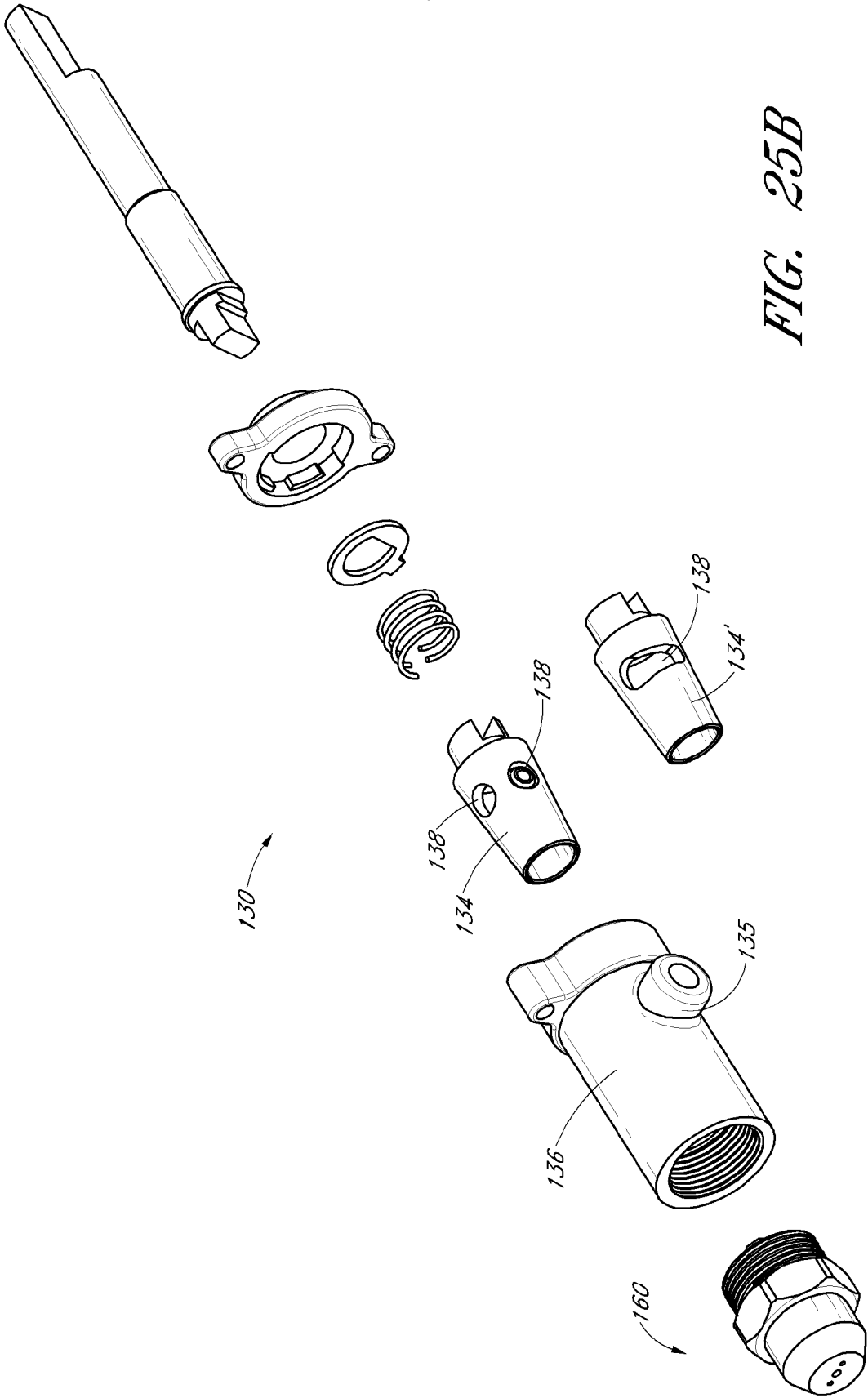


FIG. 24A





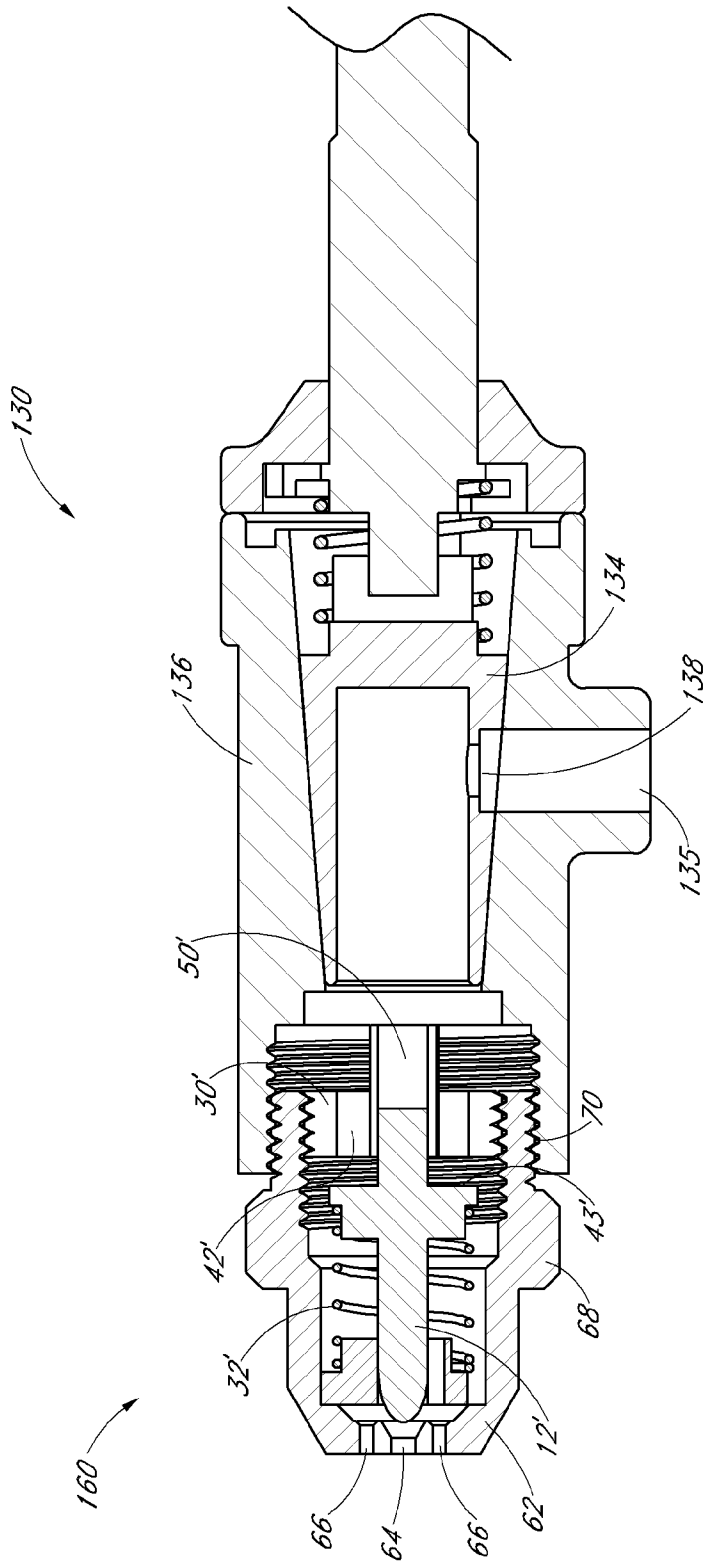


FIG. 25C

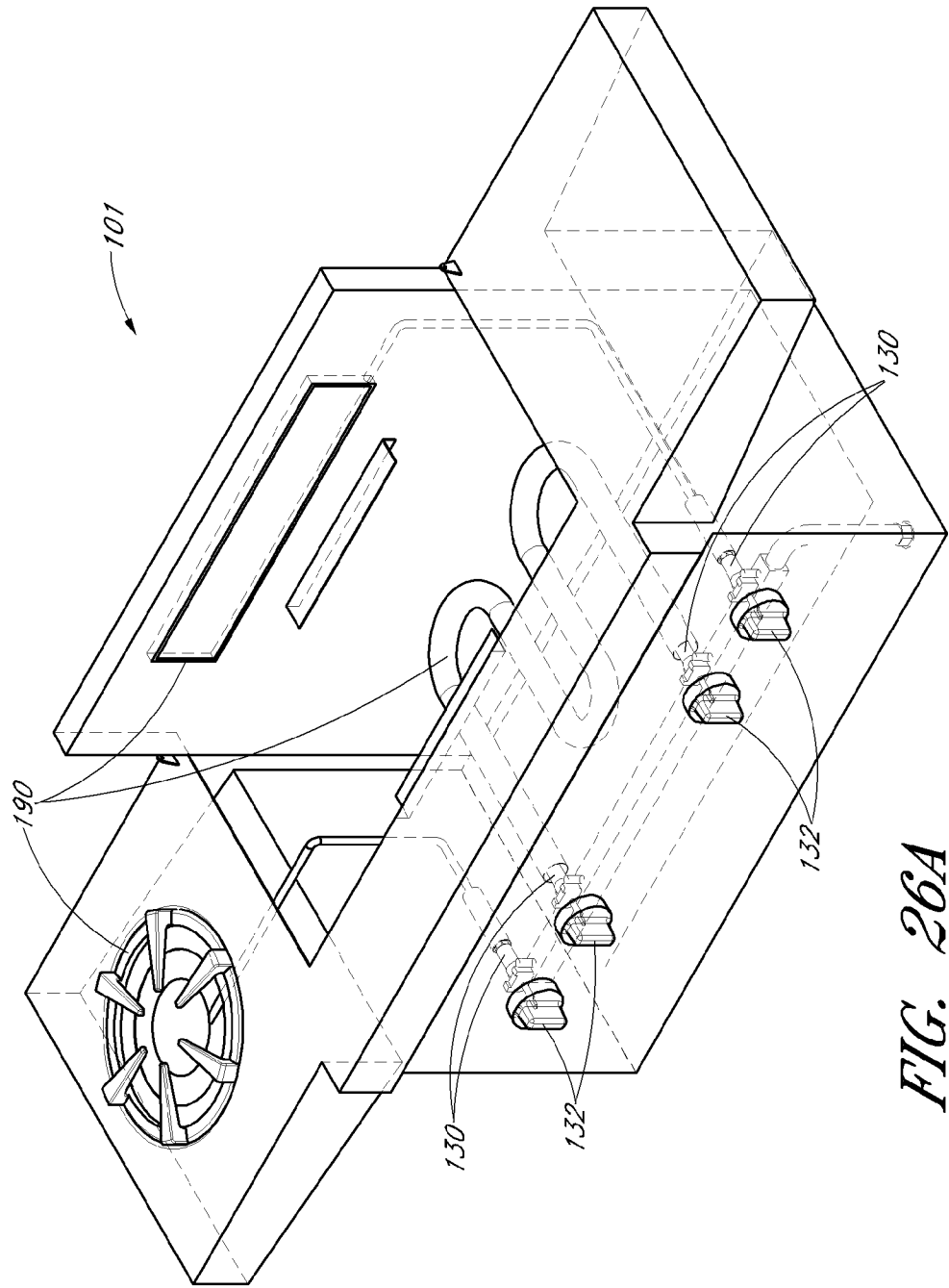


FIG. 26A

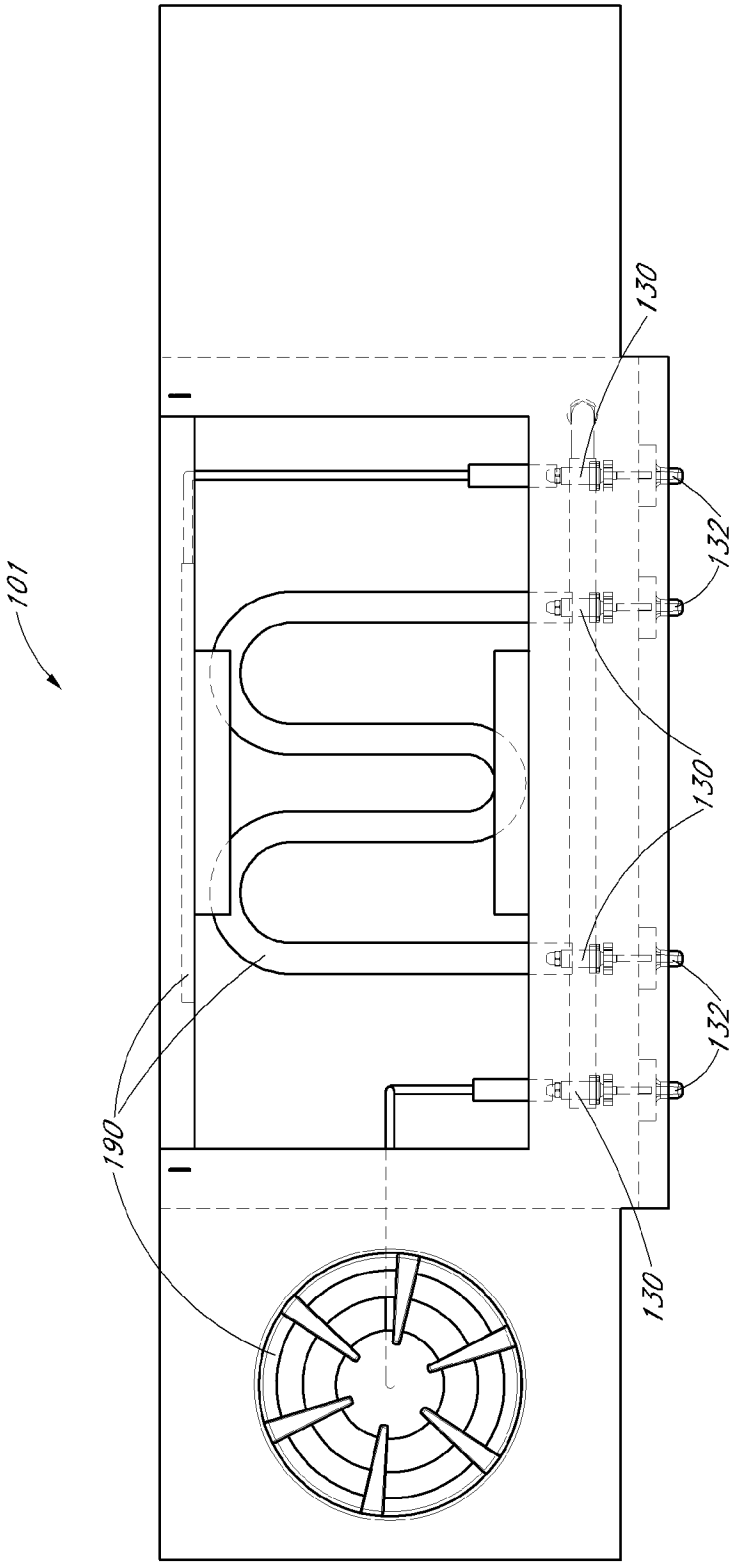


FIG. 26B

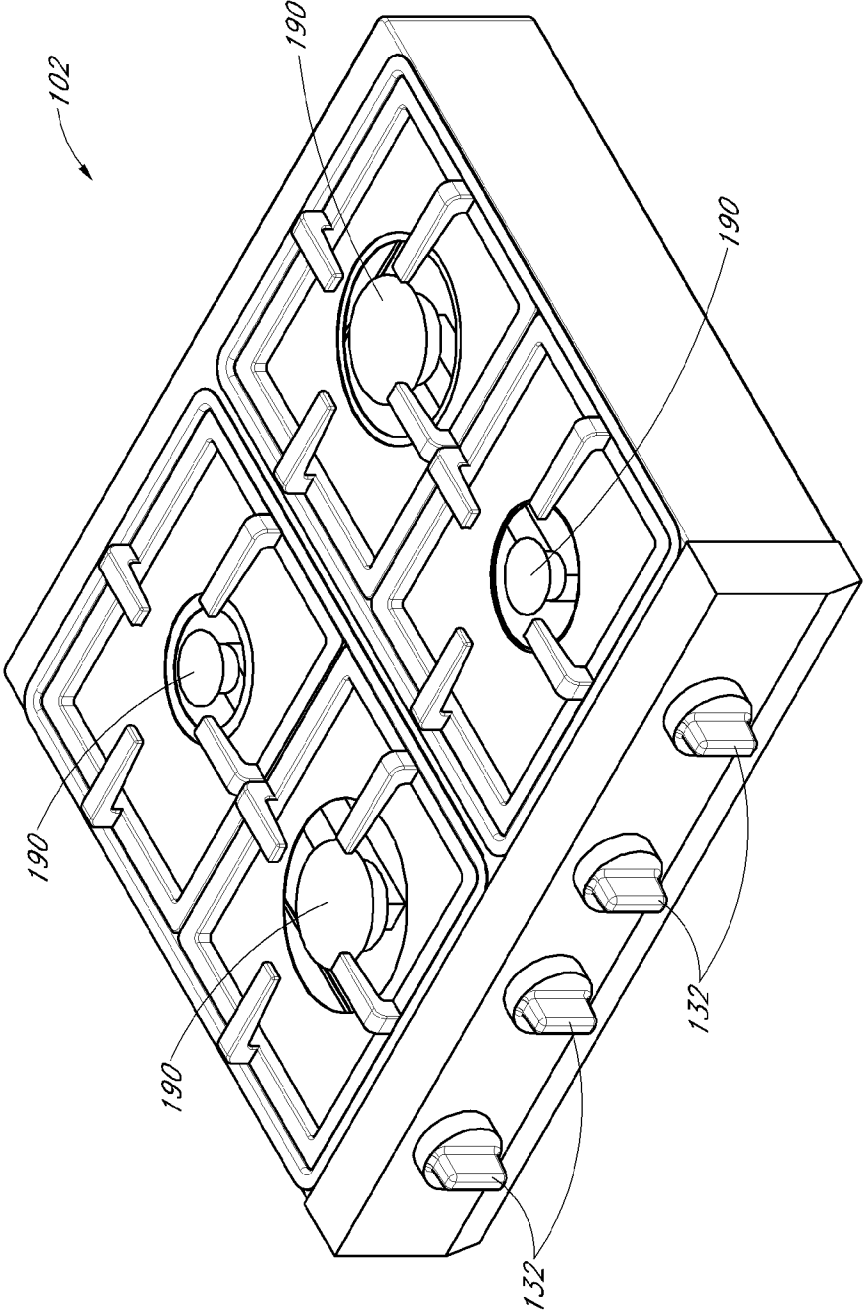


FIG. 27A

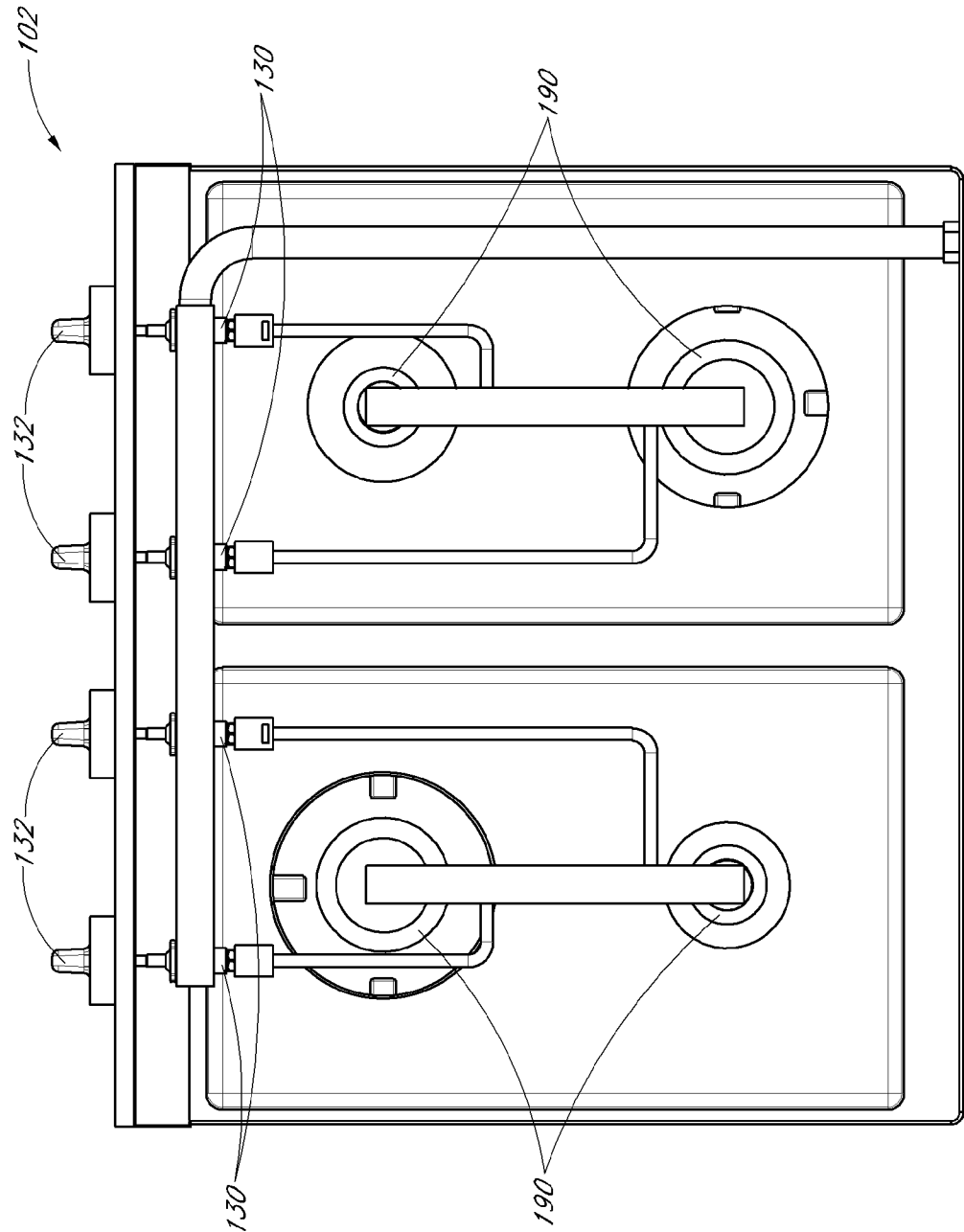


FIG. 27B

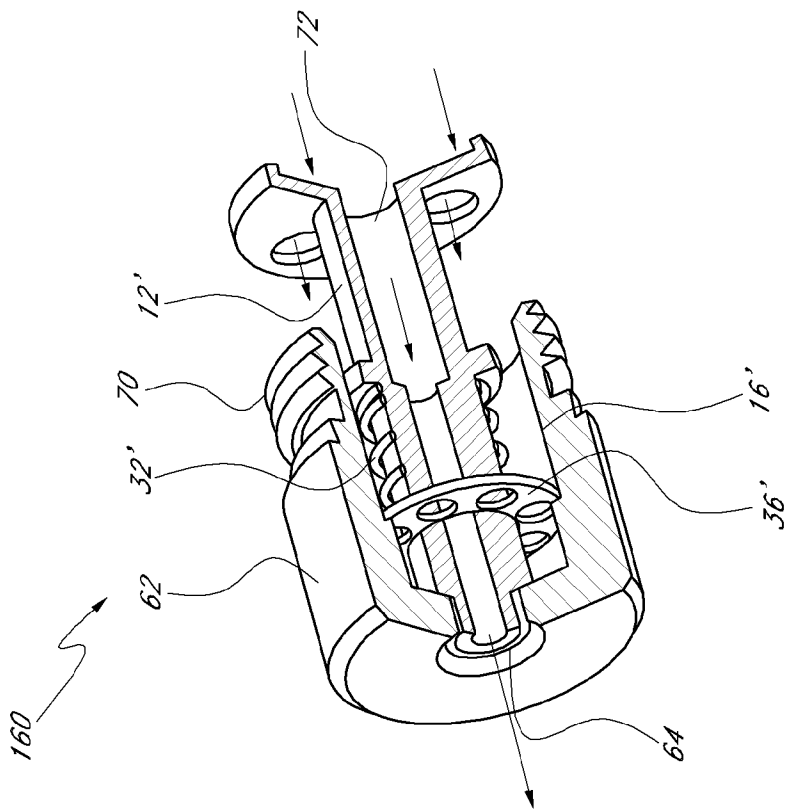


FIG. 28B

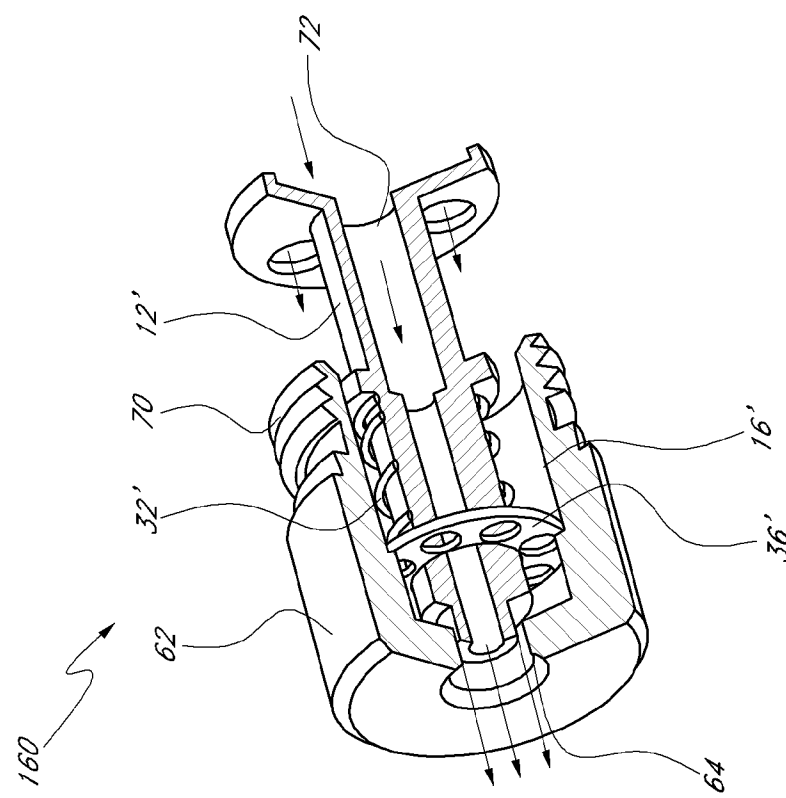


FIG. 28A

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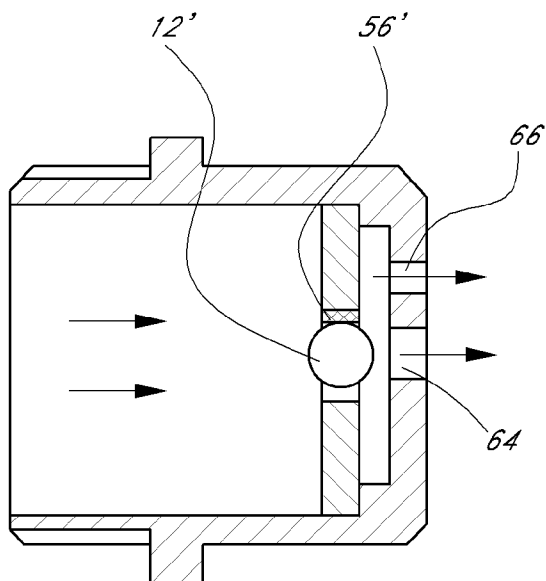


FIG. 29A

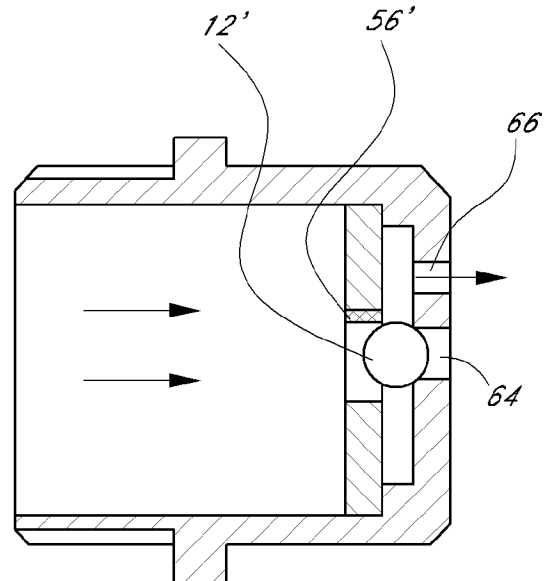


FIG. 29B

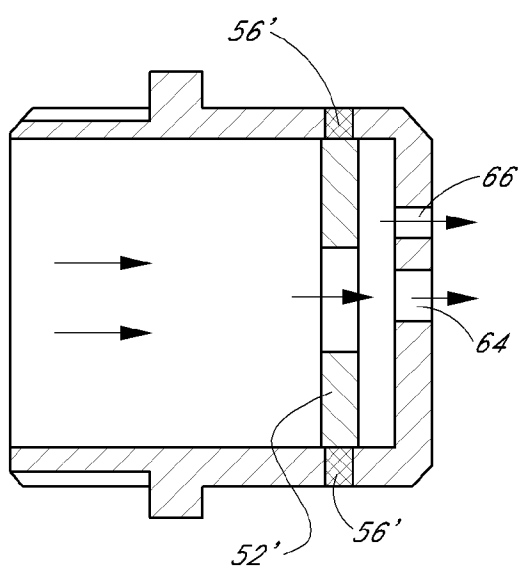


FIG. 30A

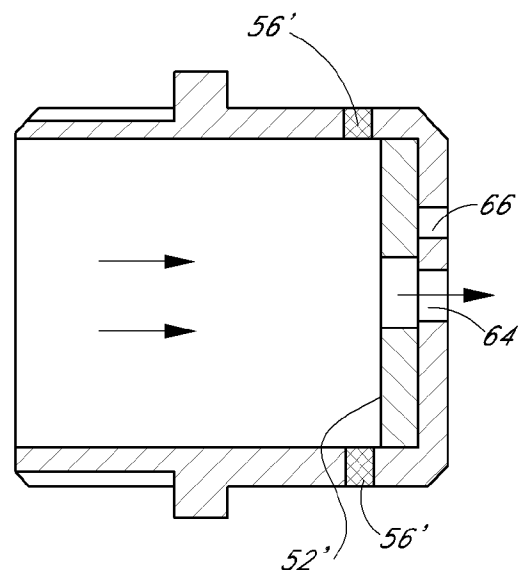


FIG. 30B

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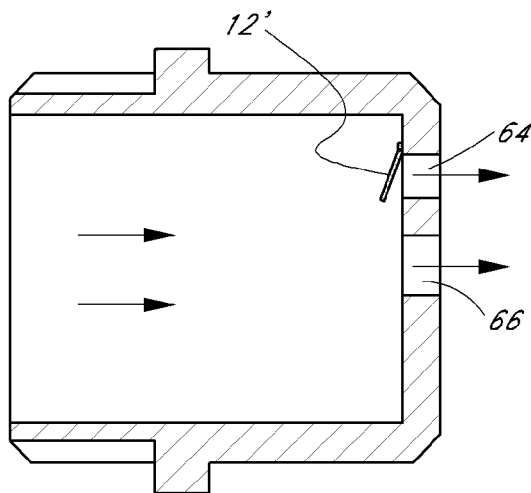


FIG. 31A

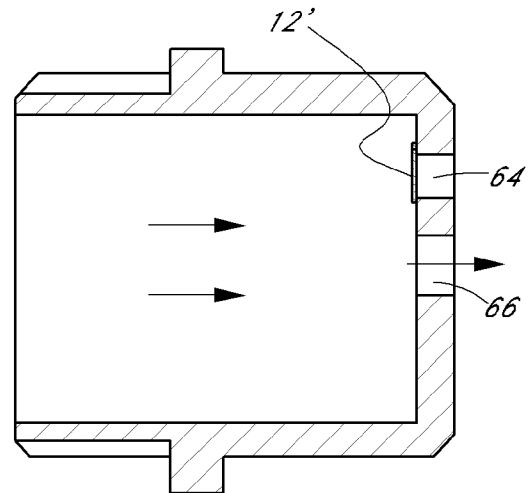


FIG. 31B

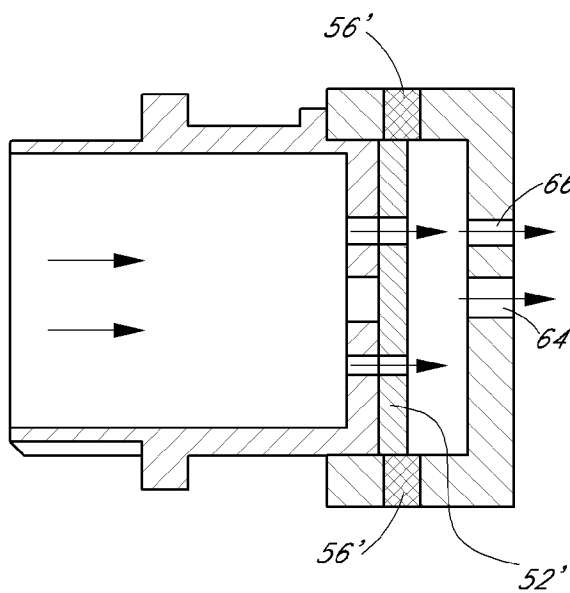


FIG. 32A

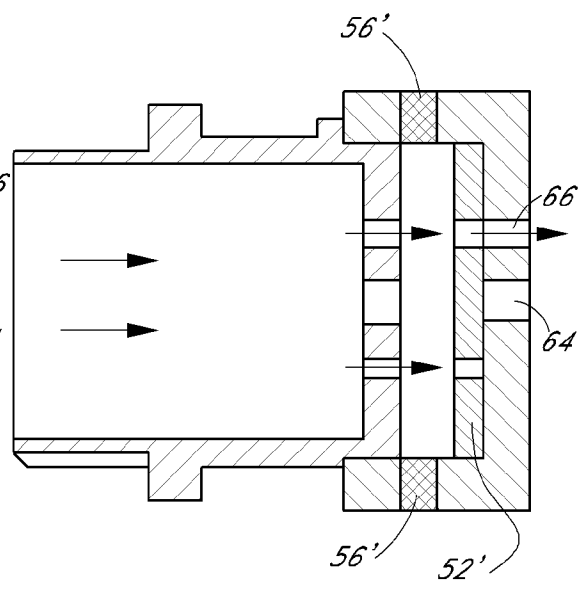


FIG. 32B

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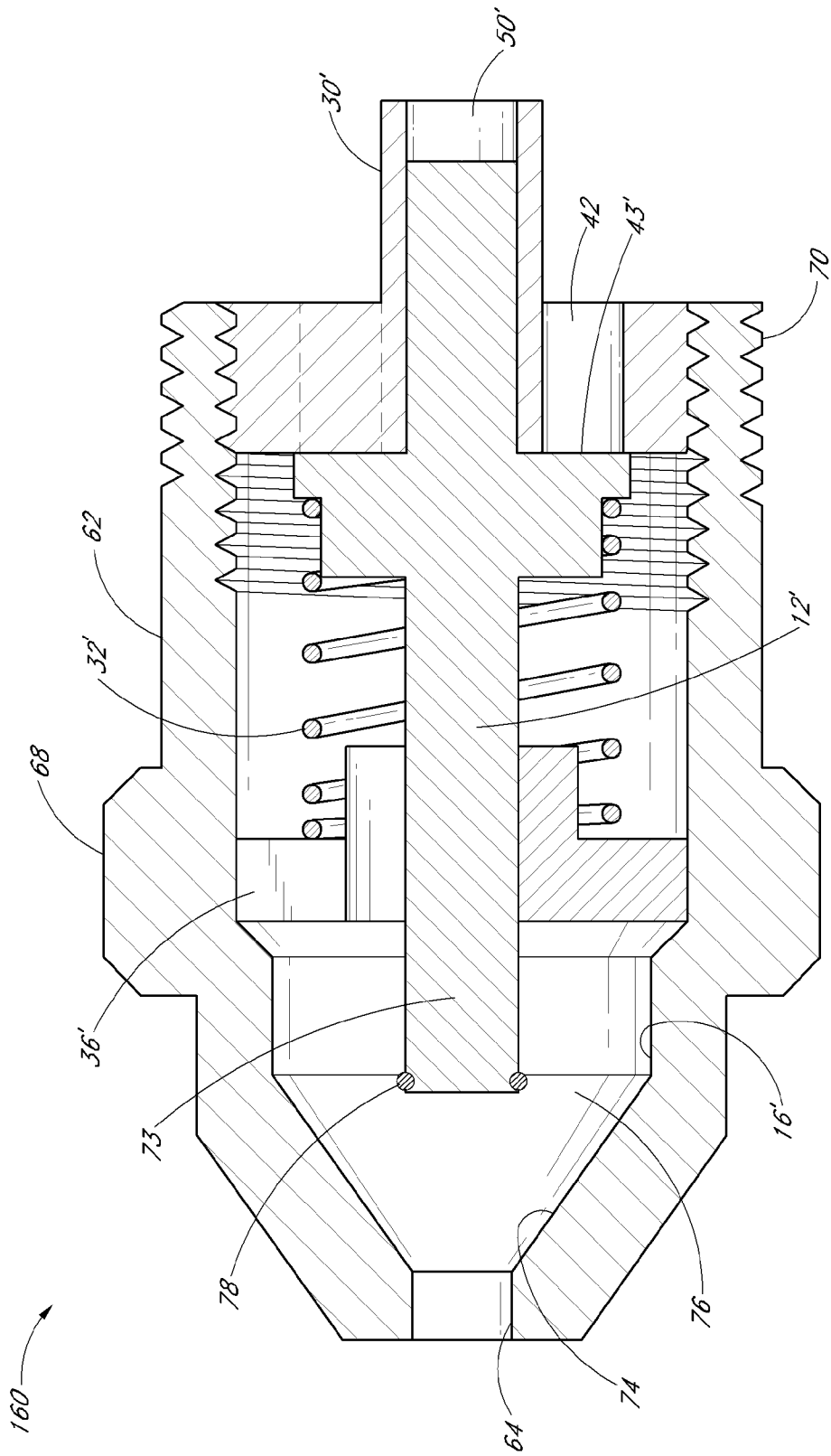


FIG. 33A

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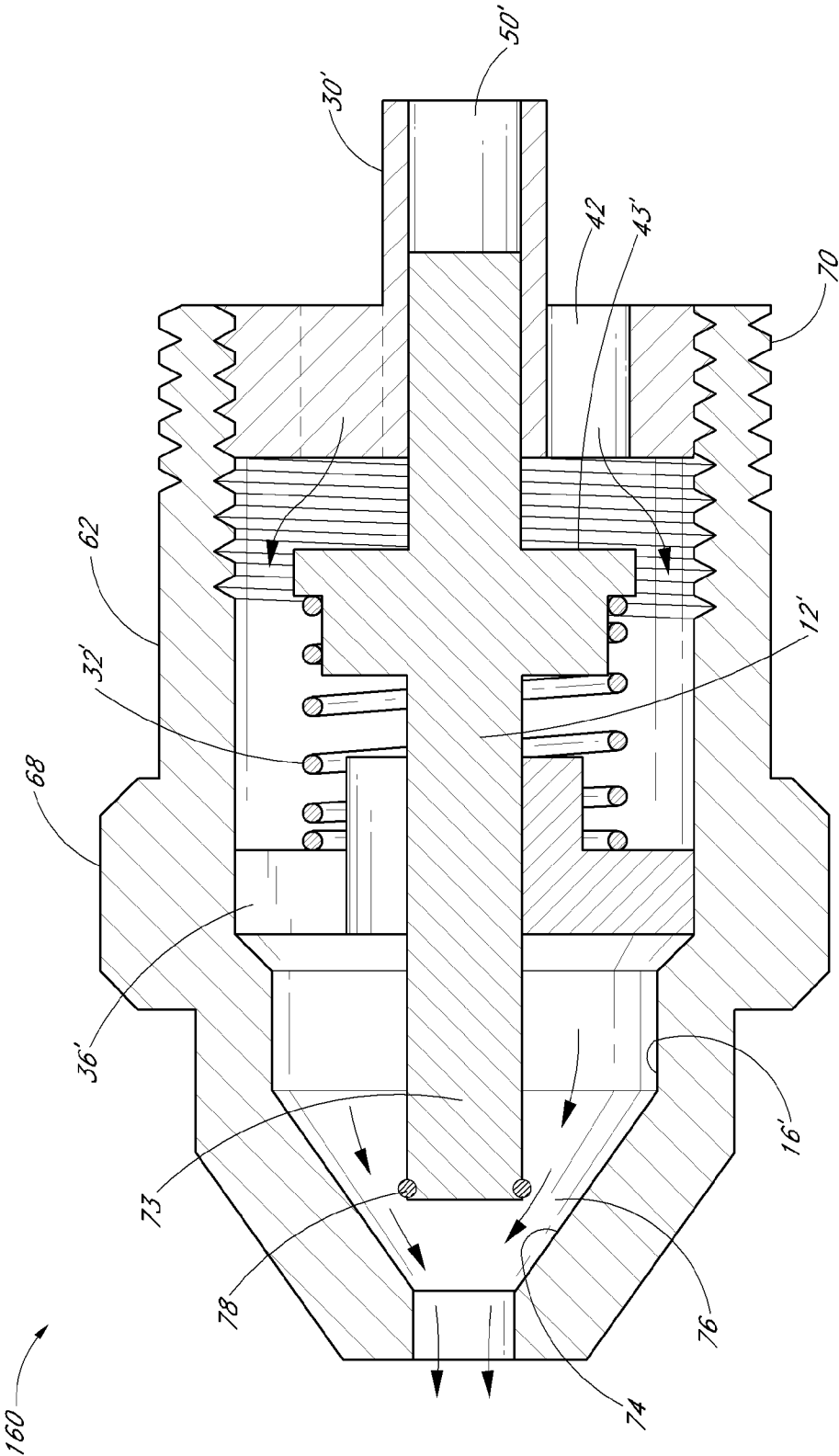


FIG. 33B

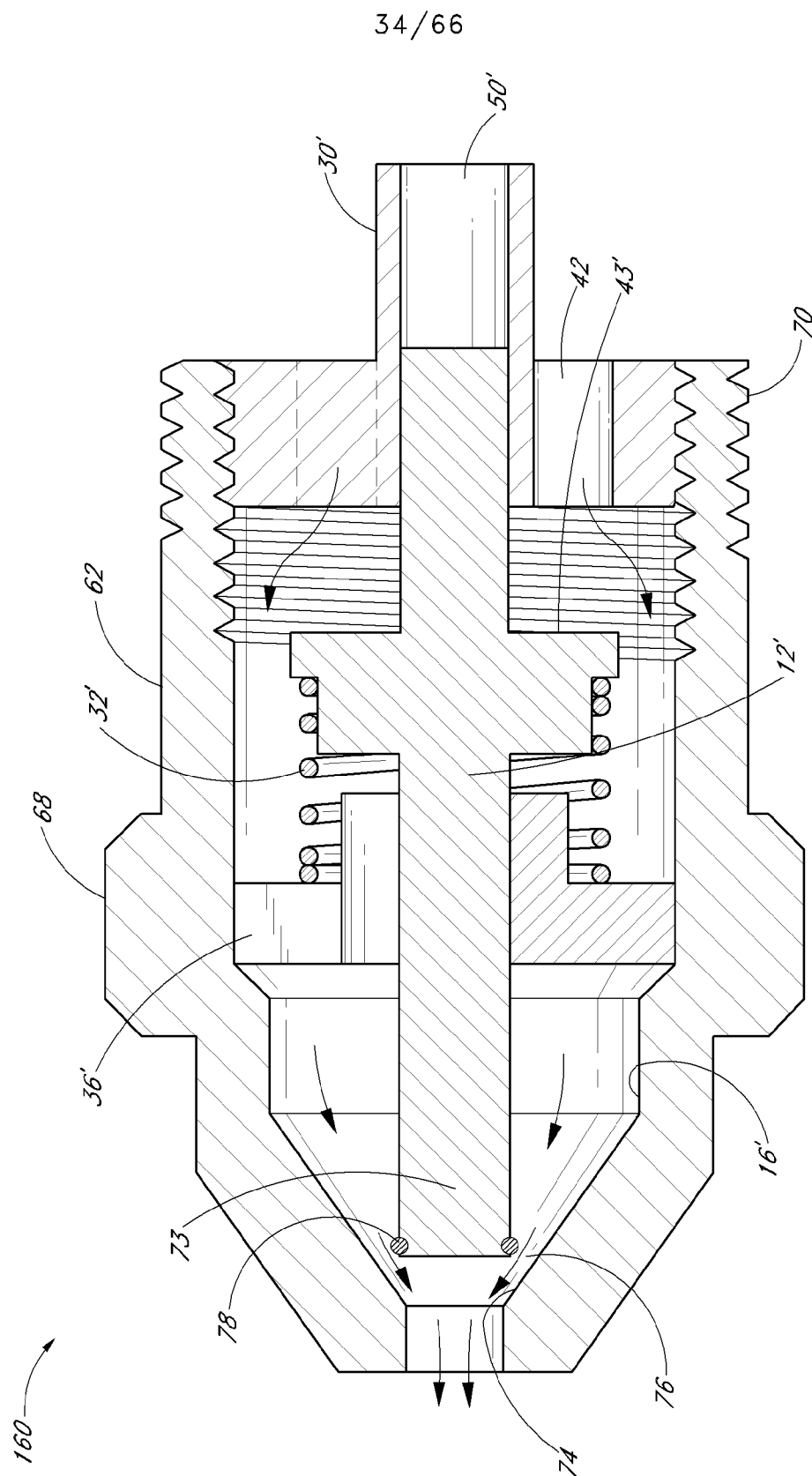


FIG. 33C

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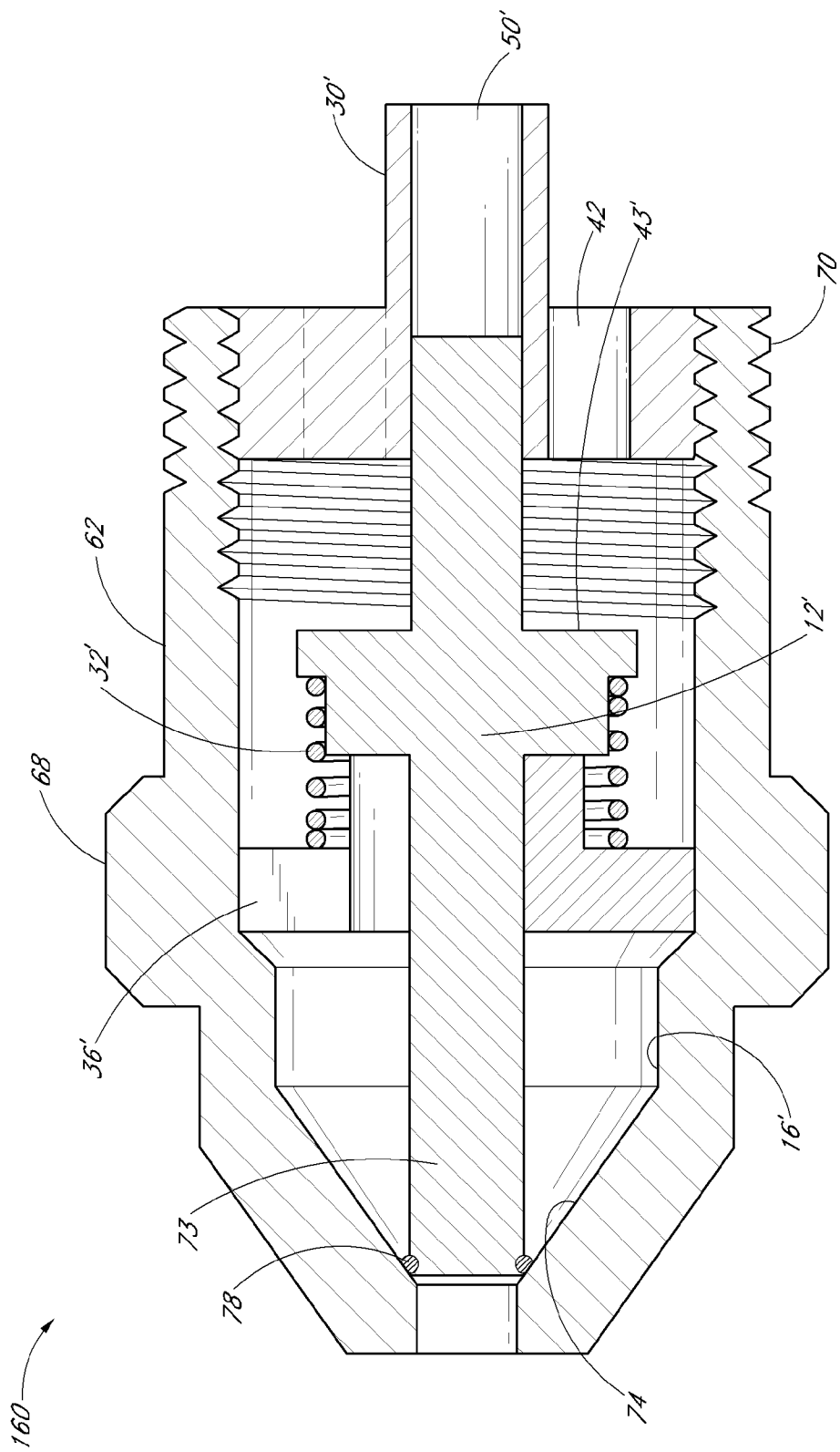


FIG. 33D

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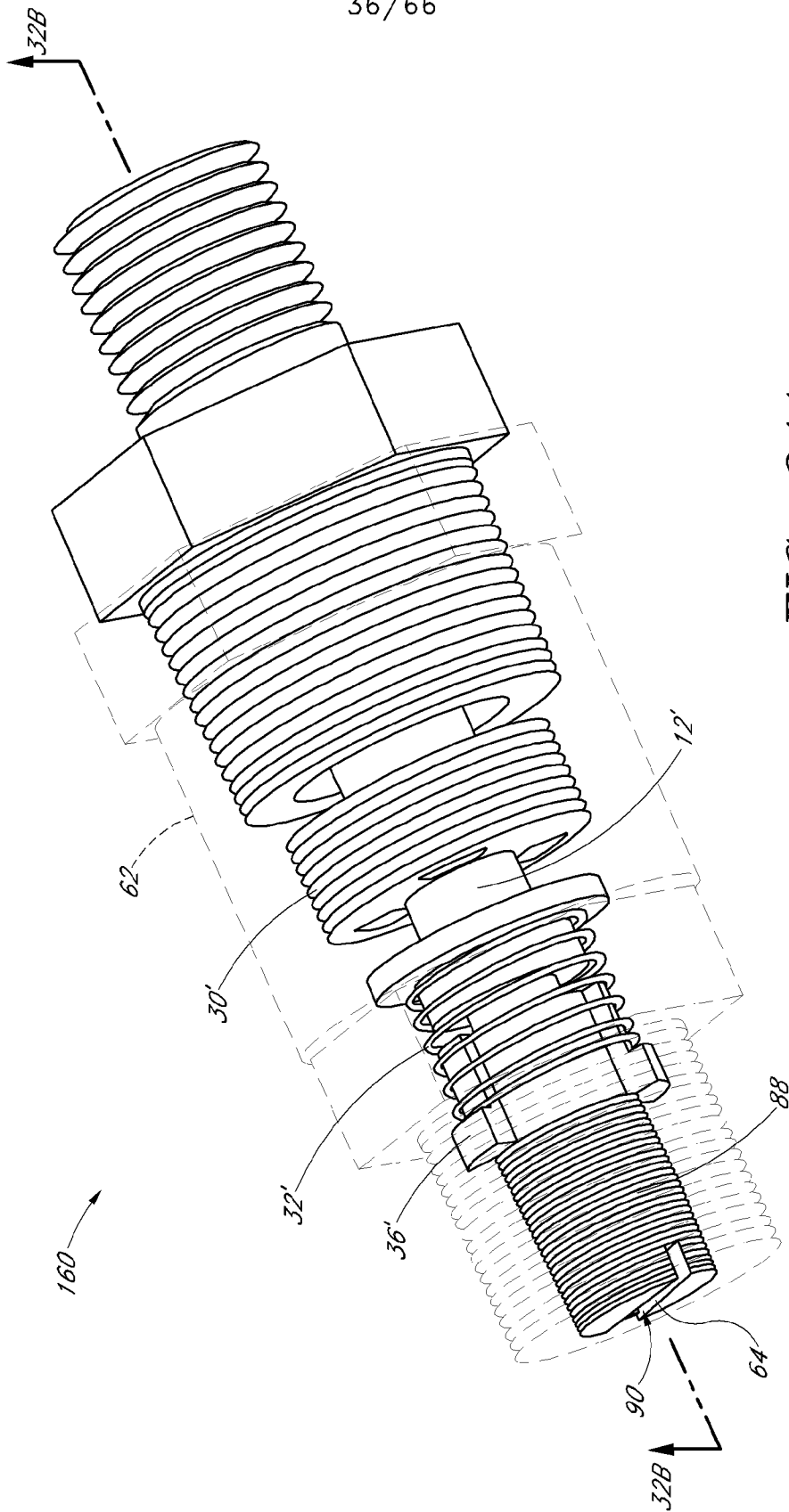


FIG. 34A

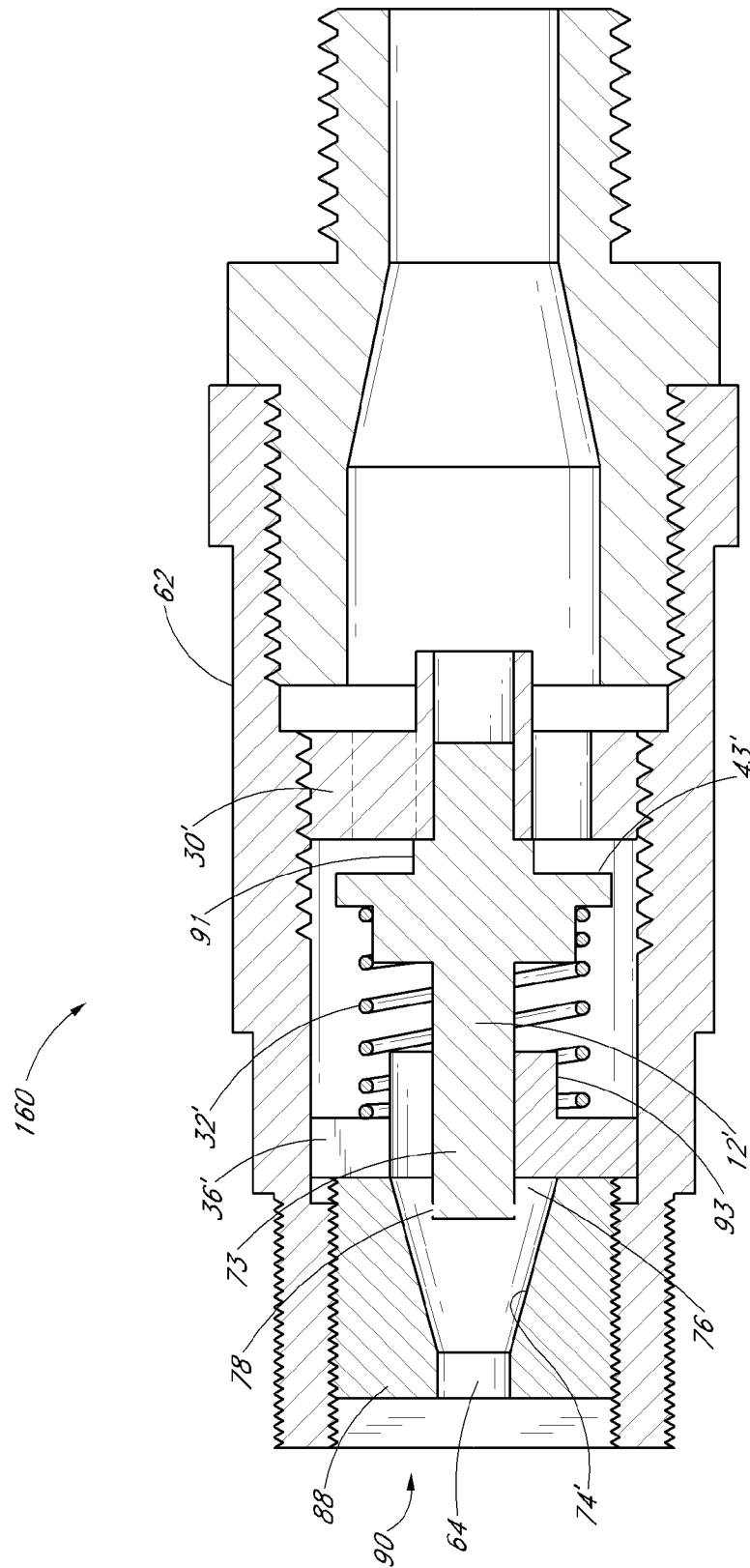


FIG. 34B

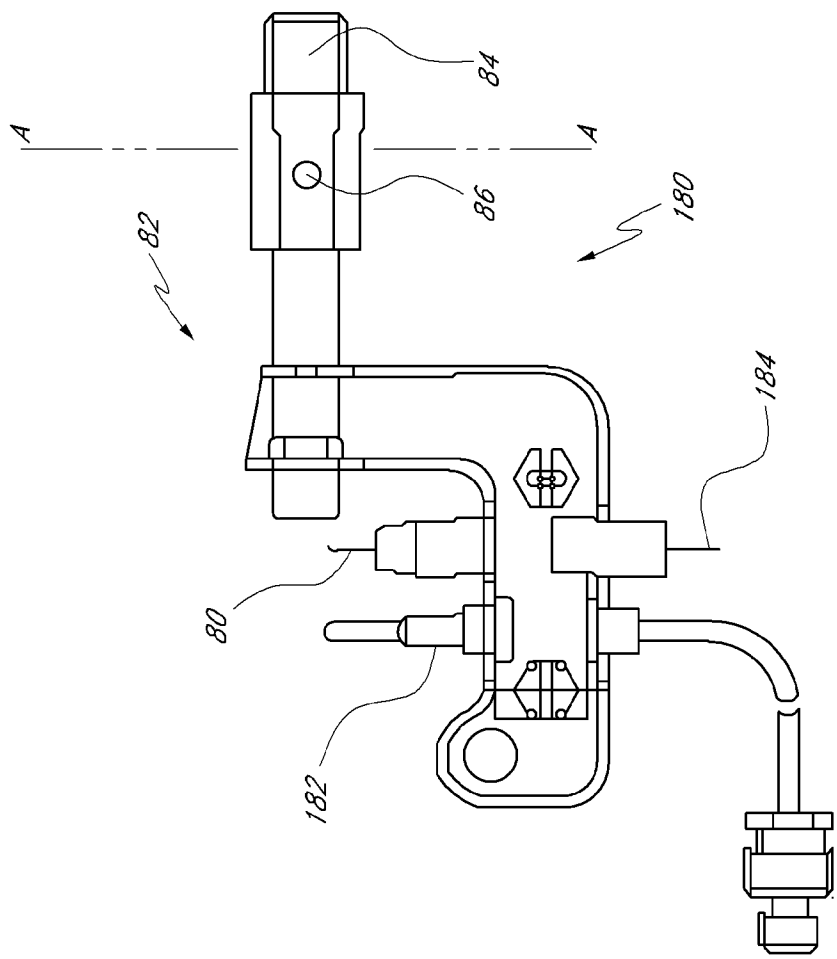


FIG. 35

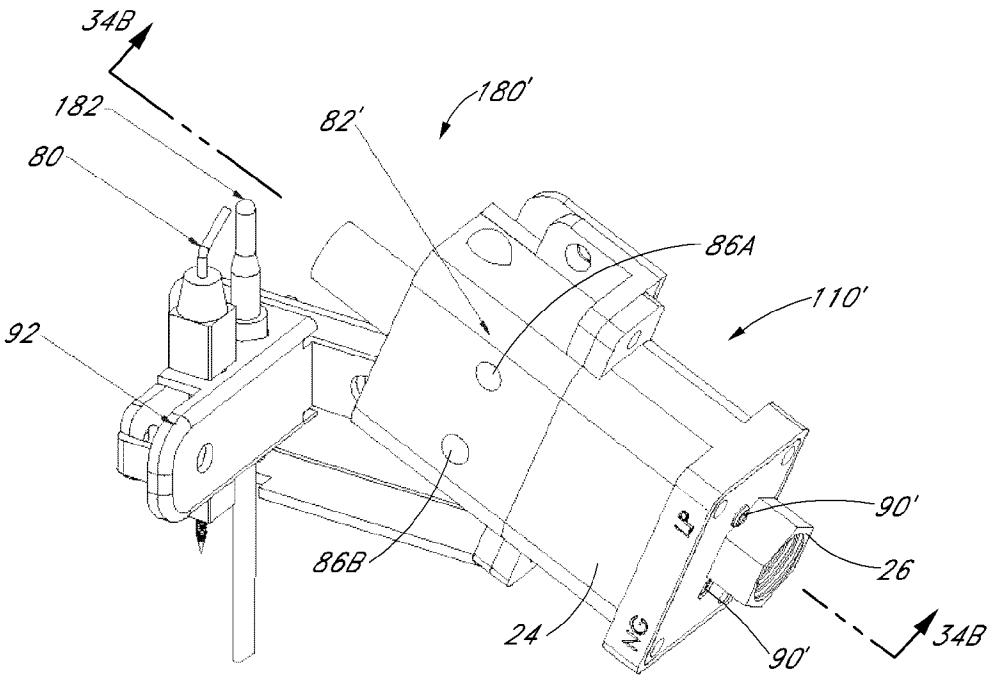
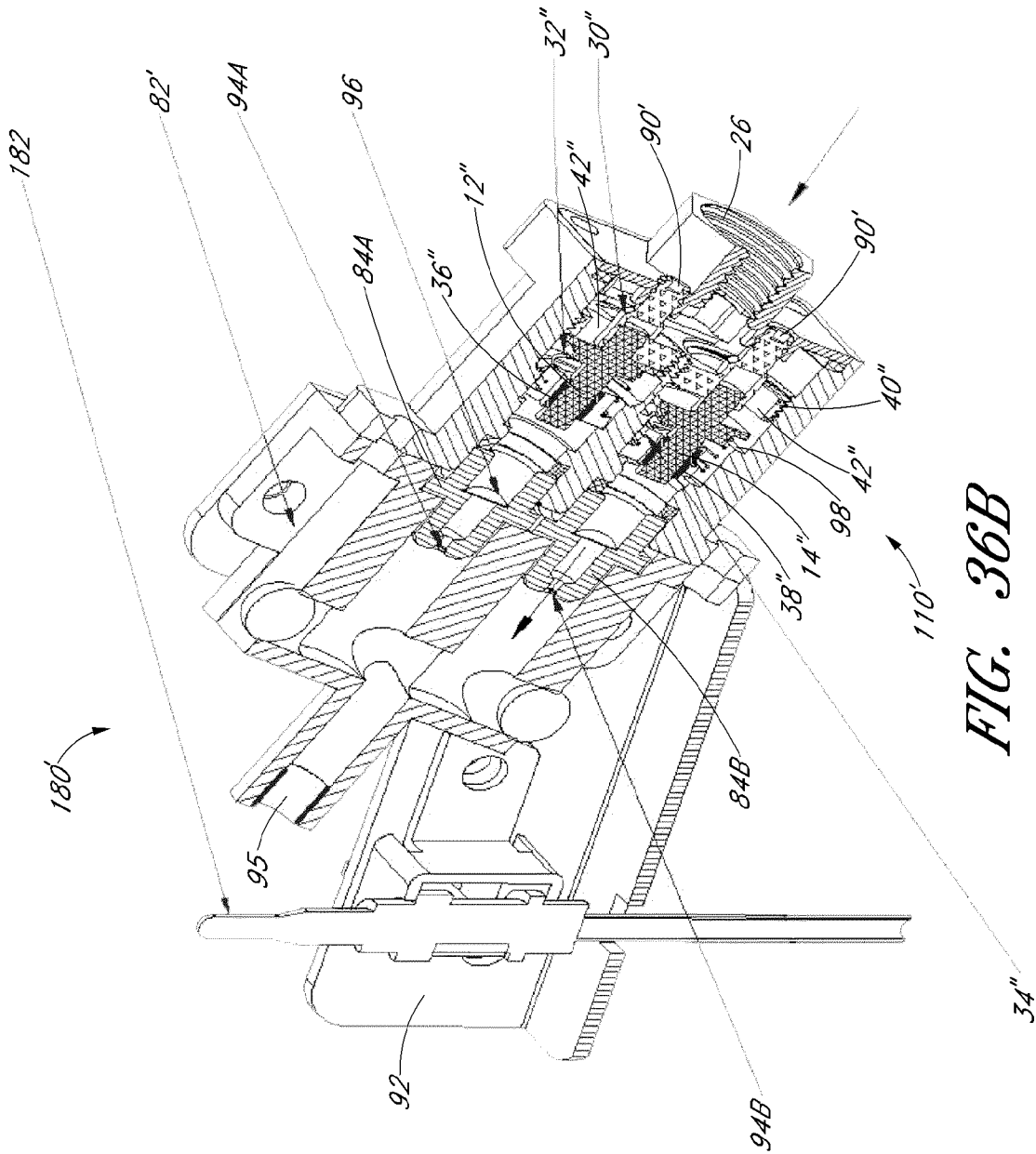


FIG. 36A



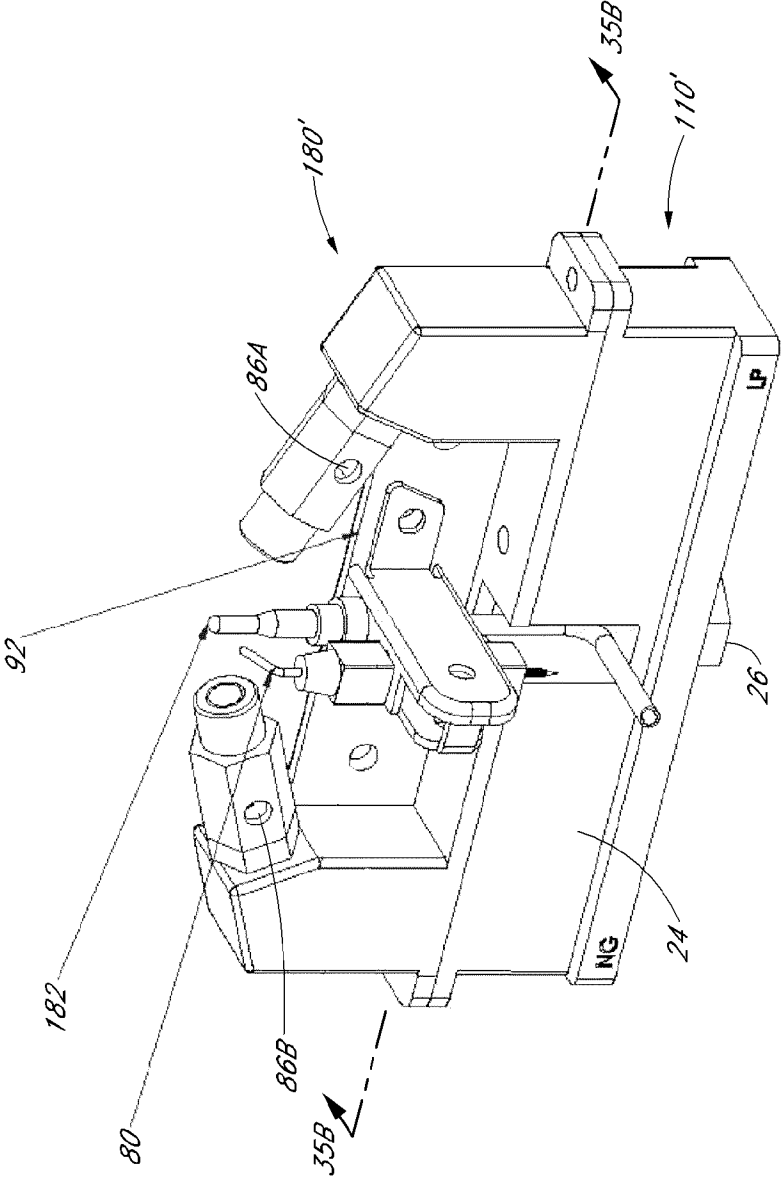


FIG. 37A

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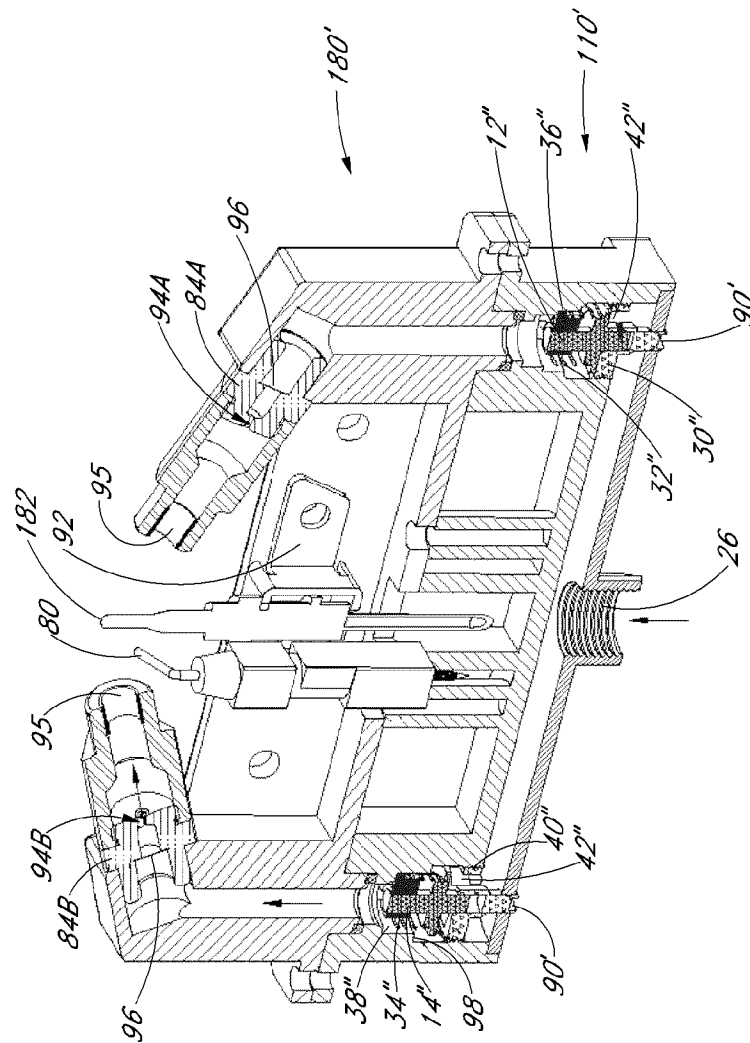


FIG. 37B

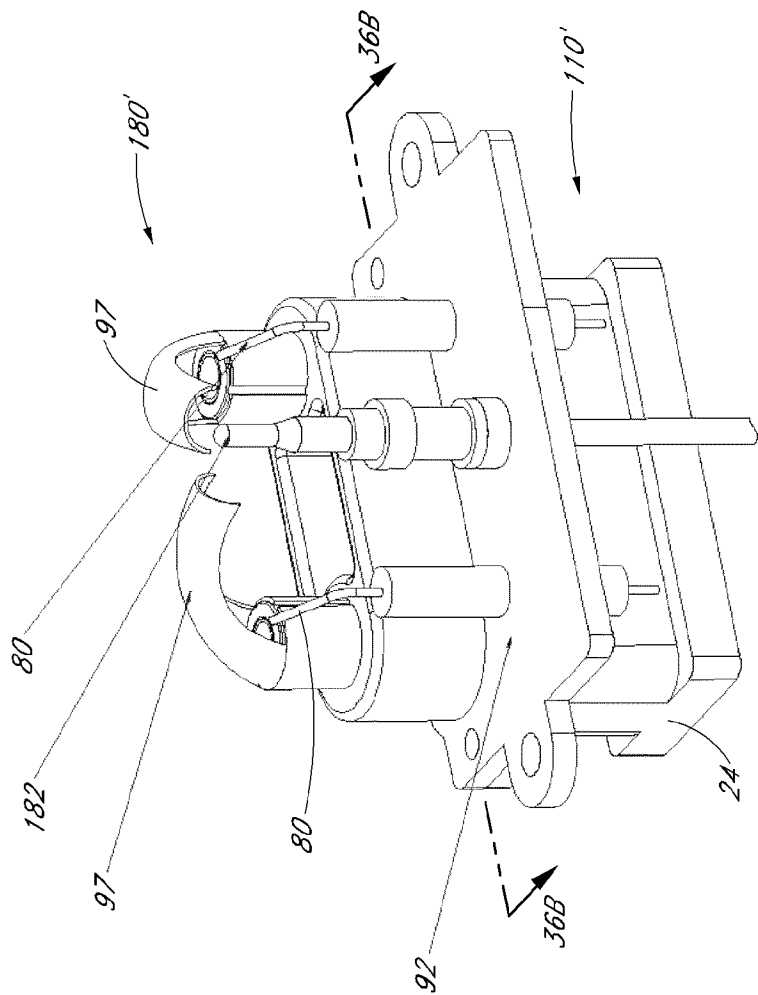


FIG. 38A

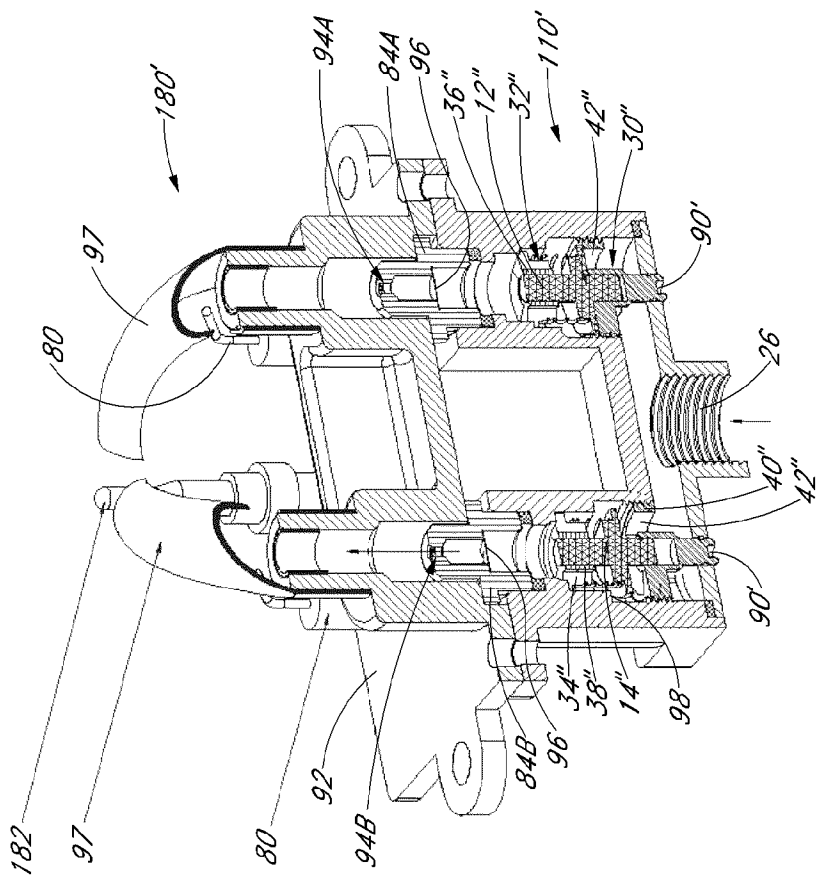


FIG. 38B

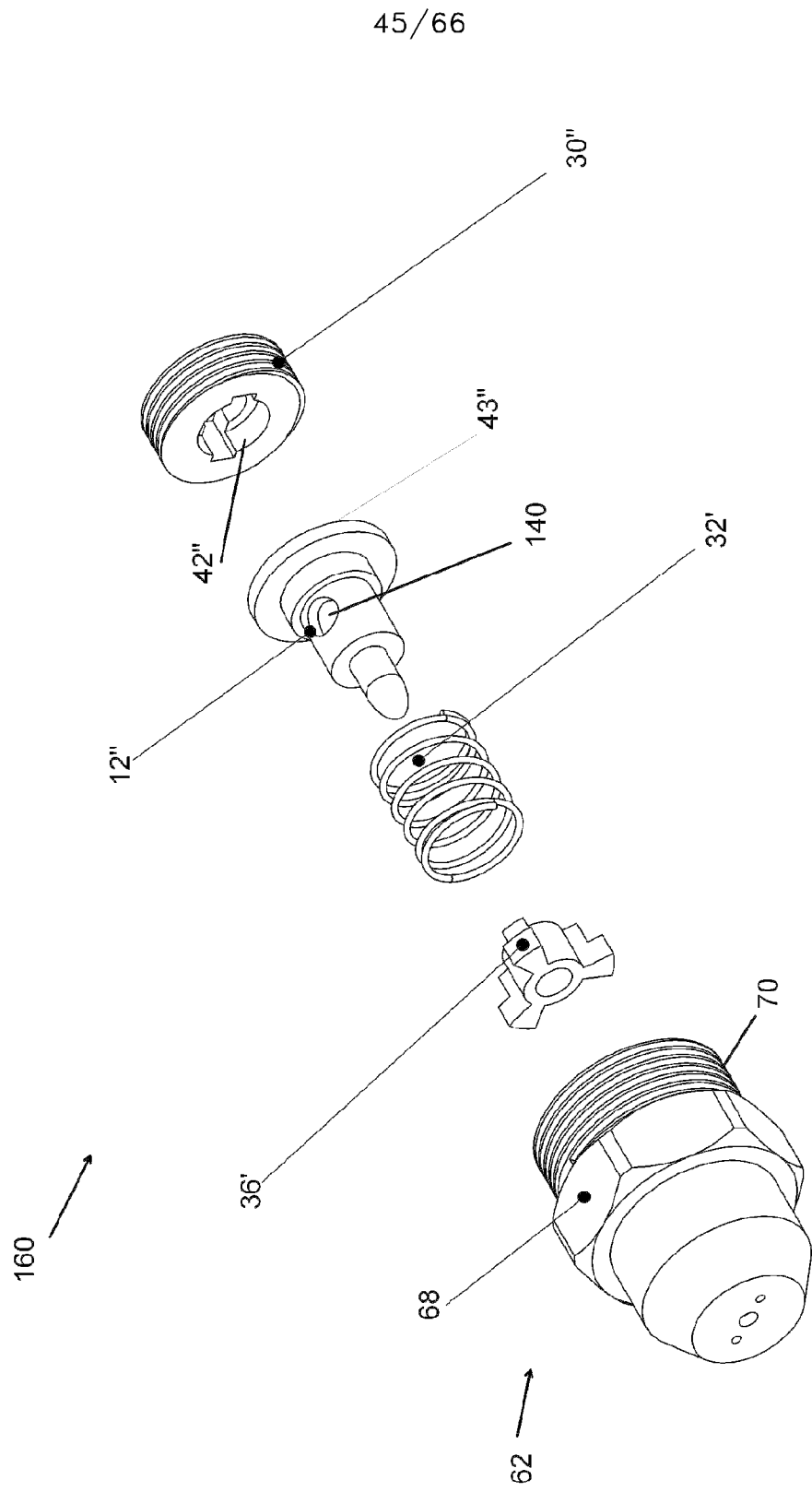


FIG. 39A

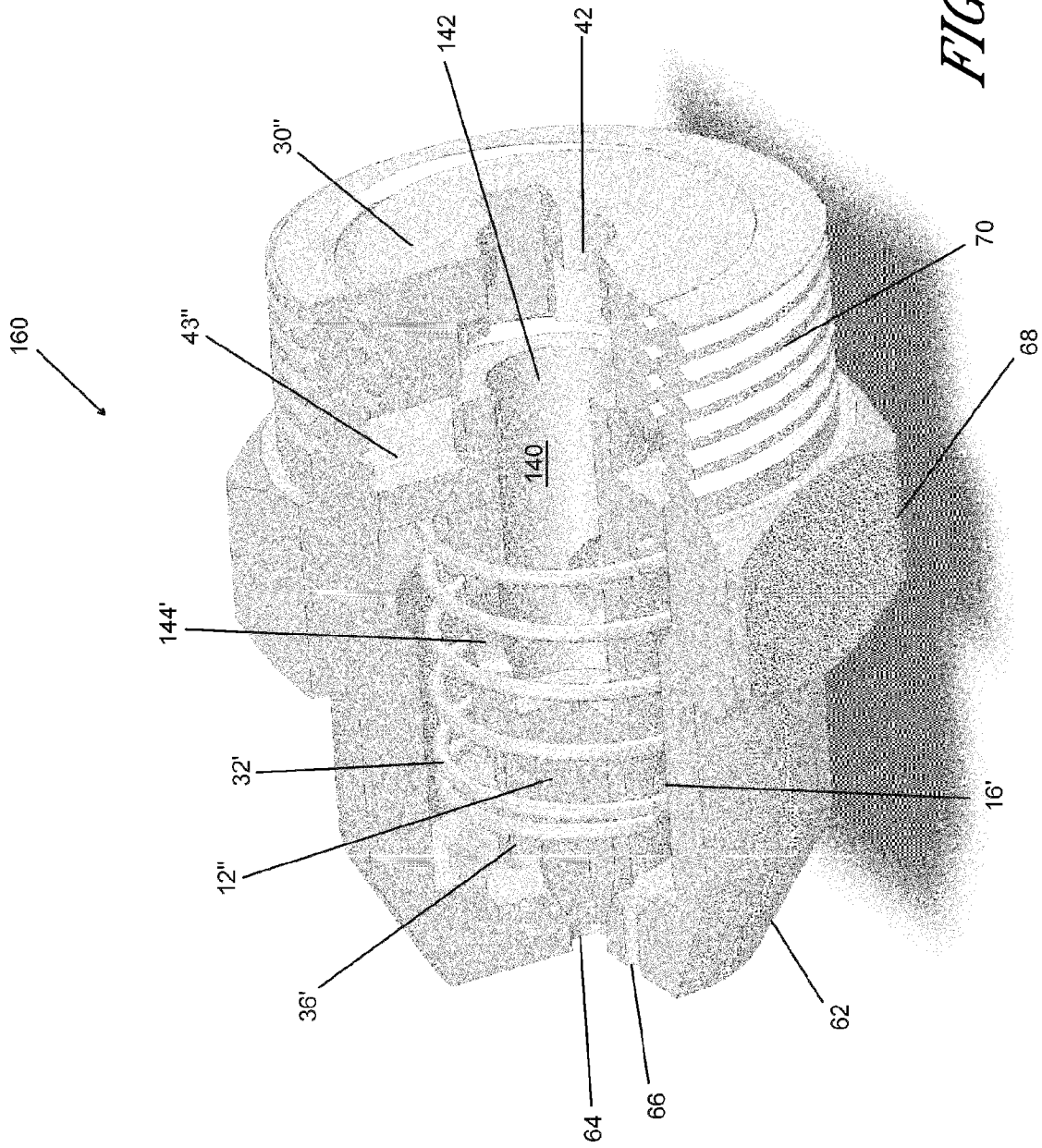
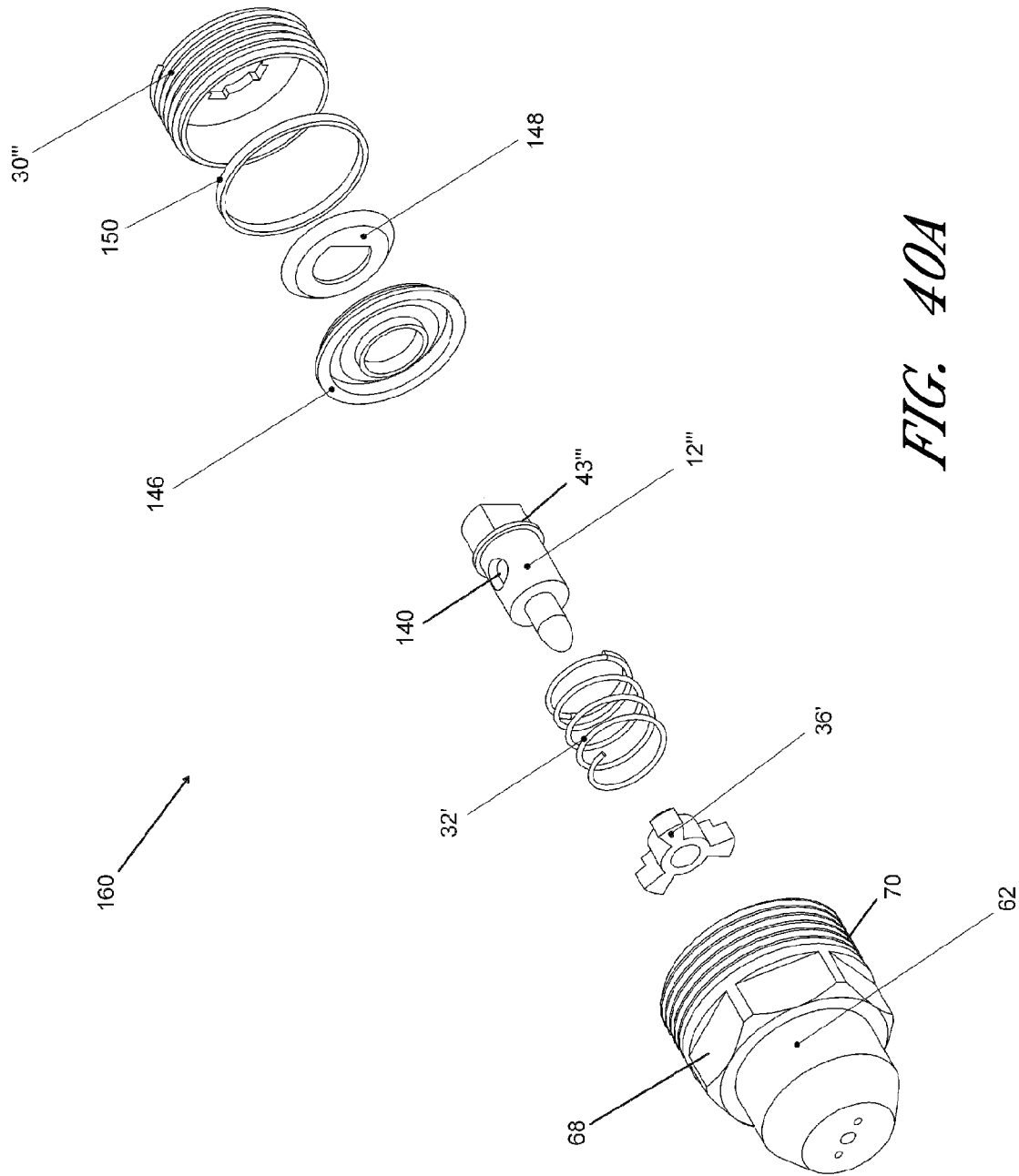


FIG. 39B



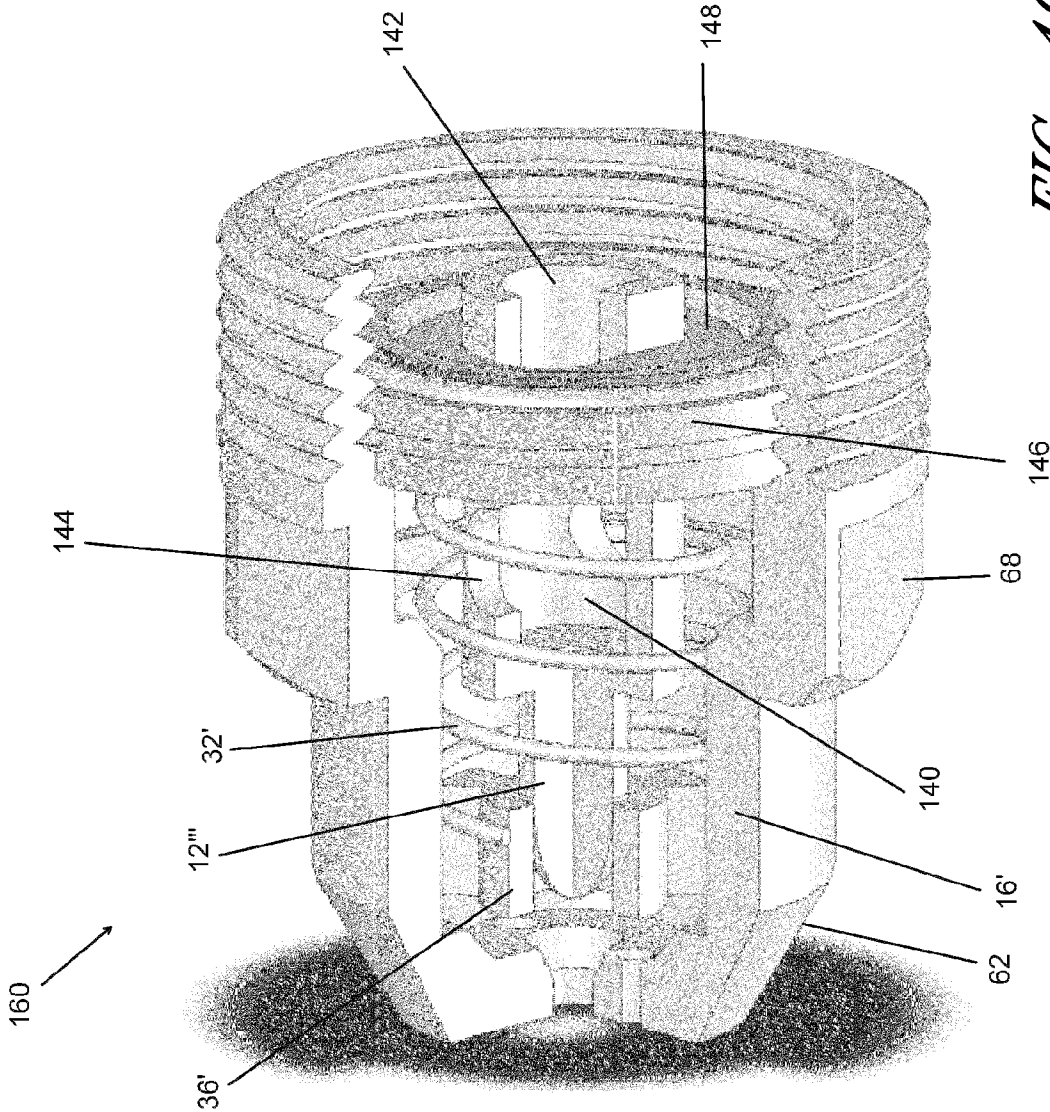
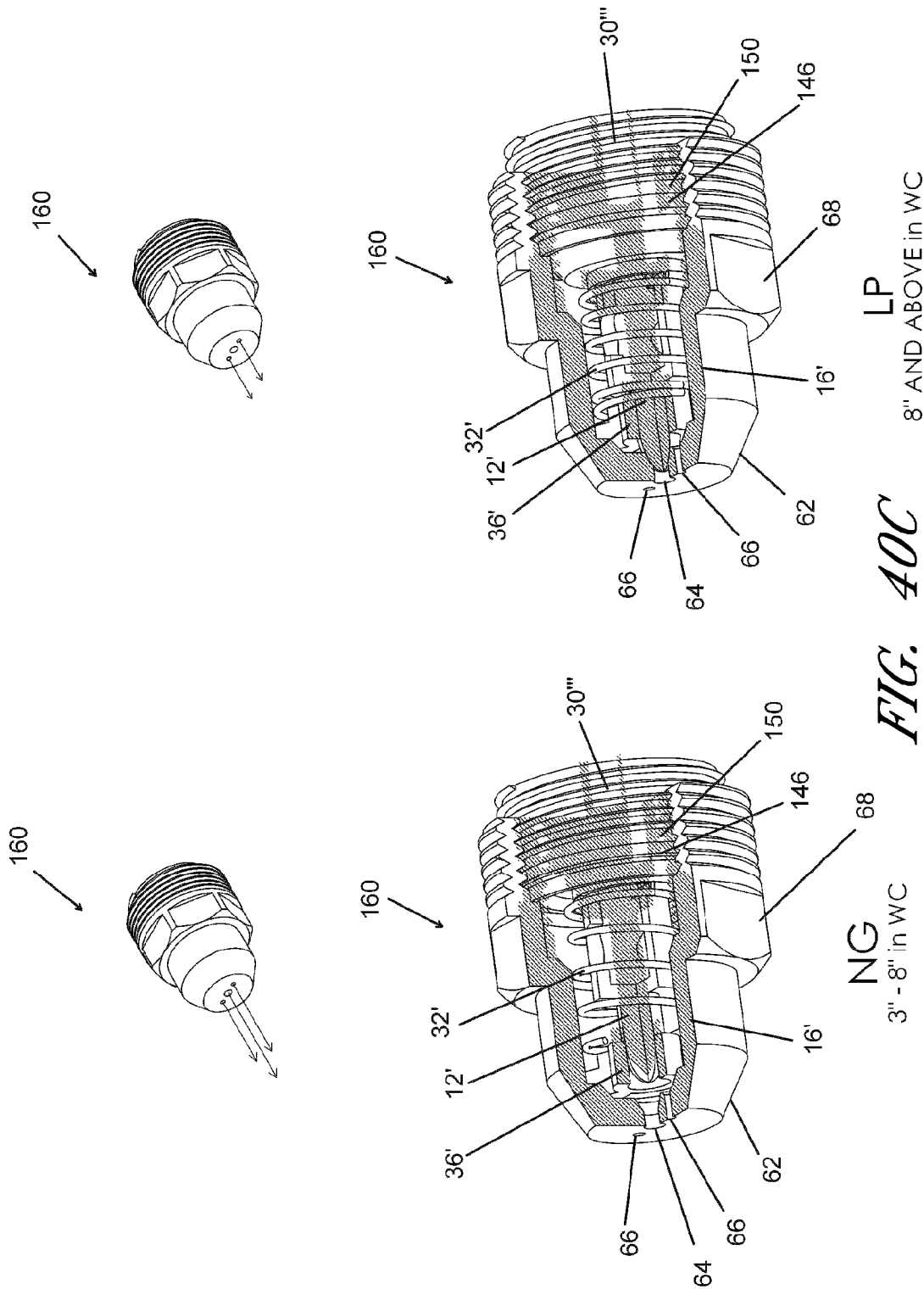
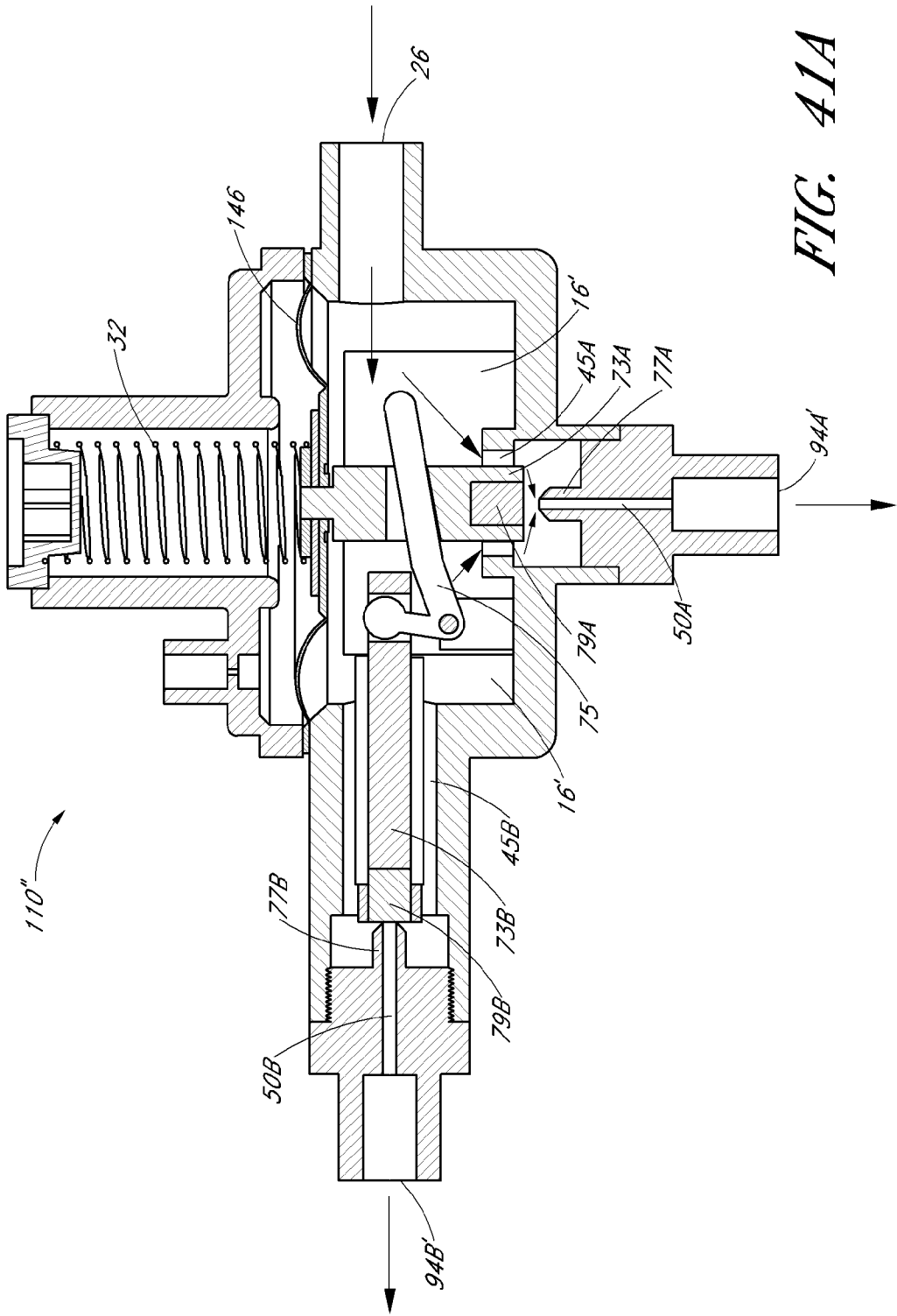


FIG. 40B

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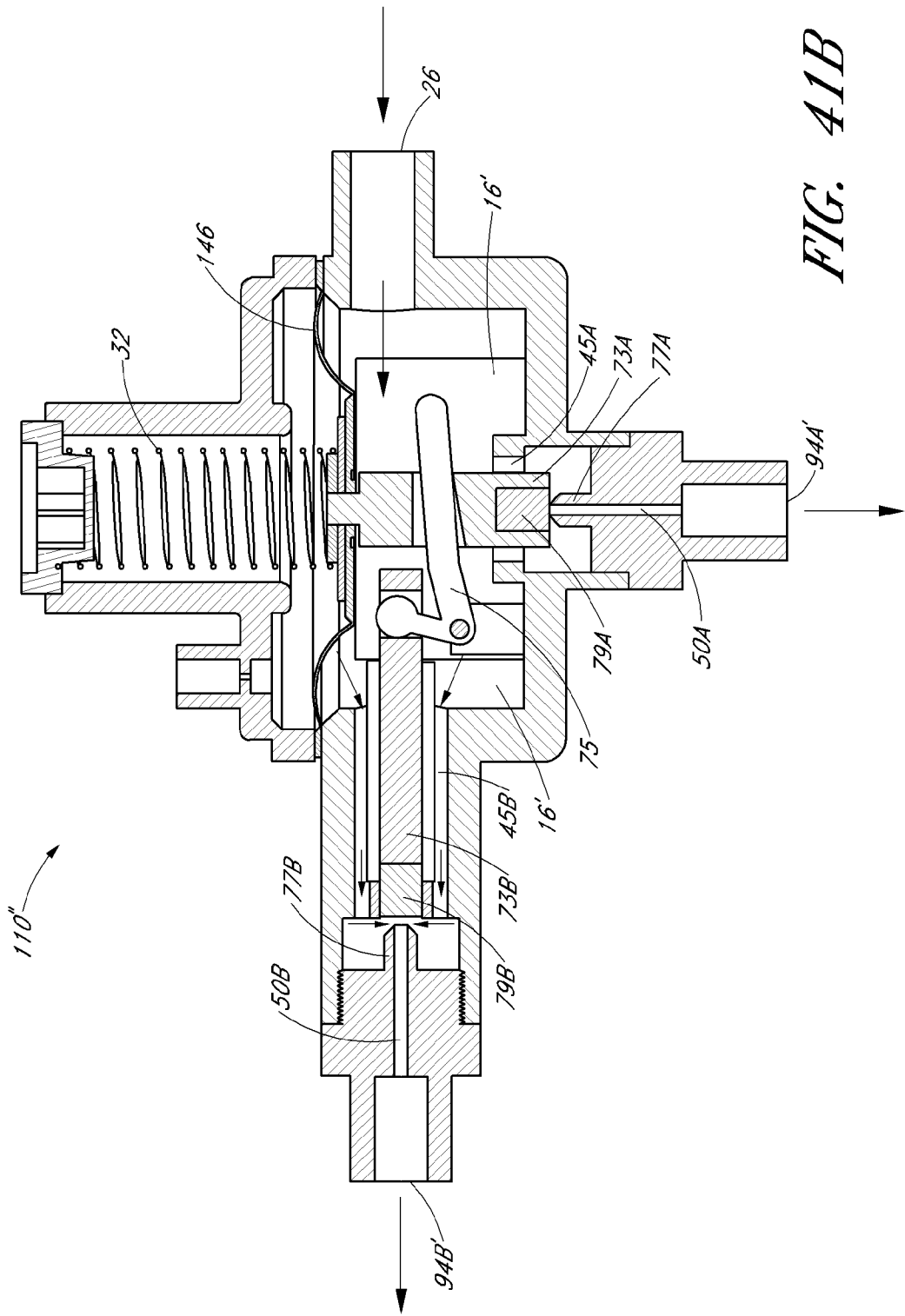


FIG. 41B

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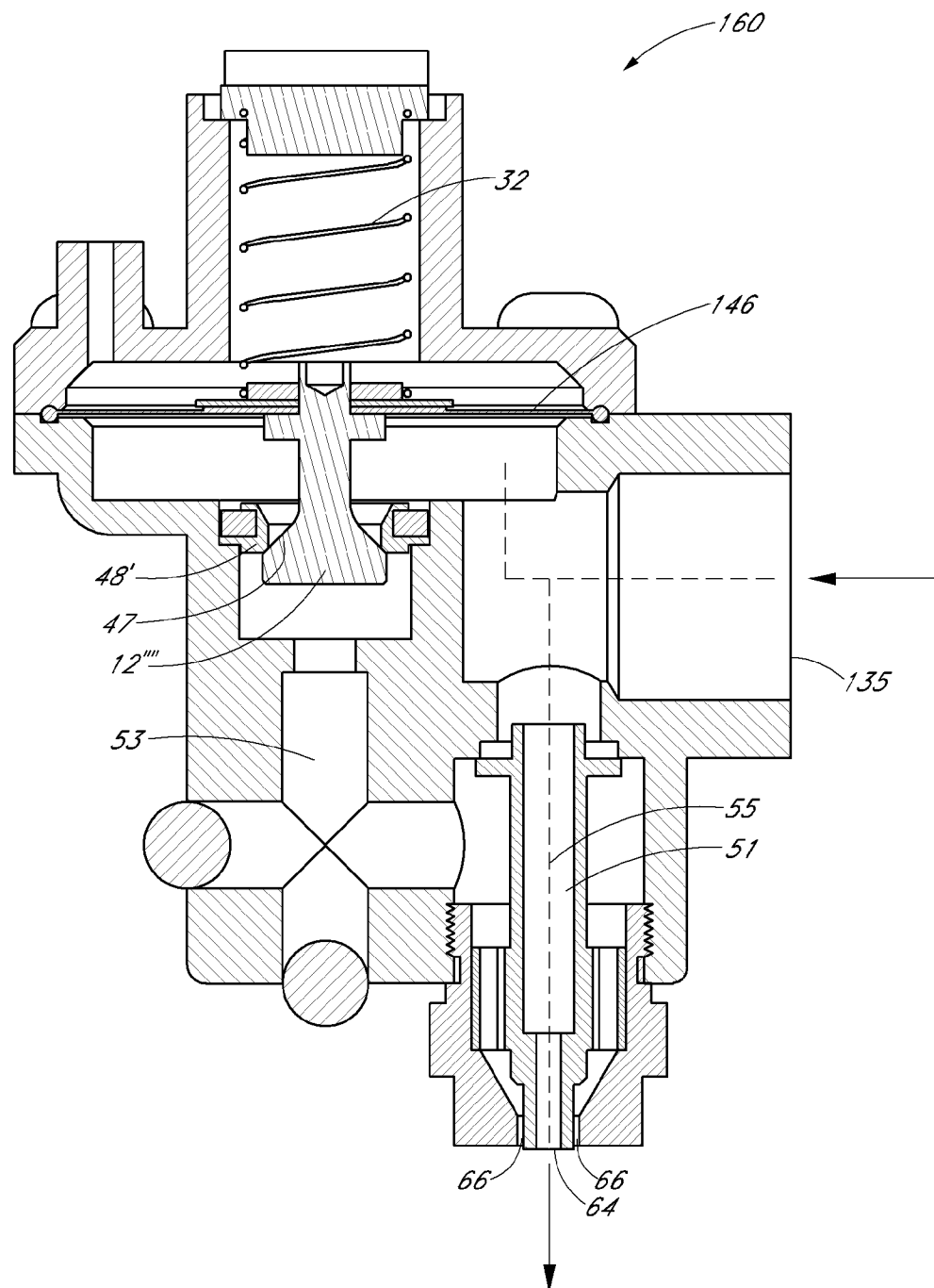


FIG. 42A

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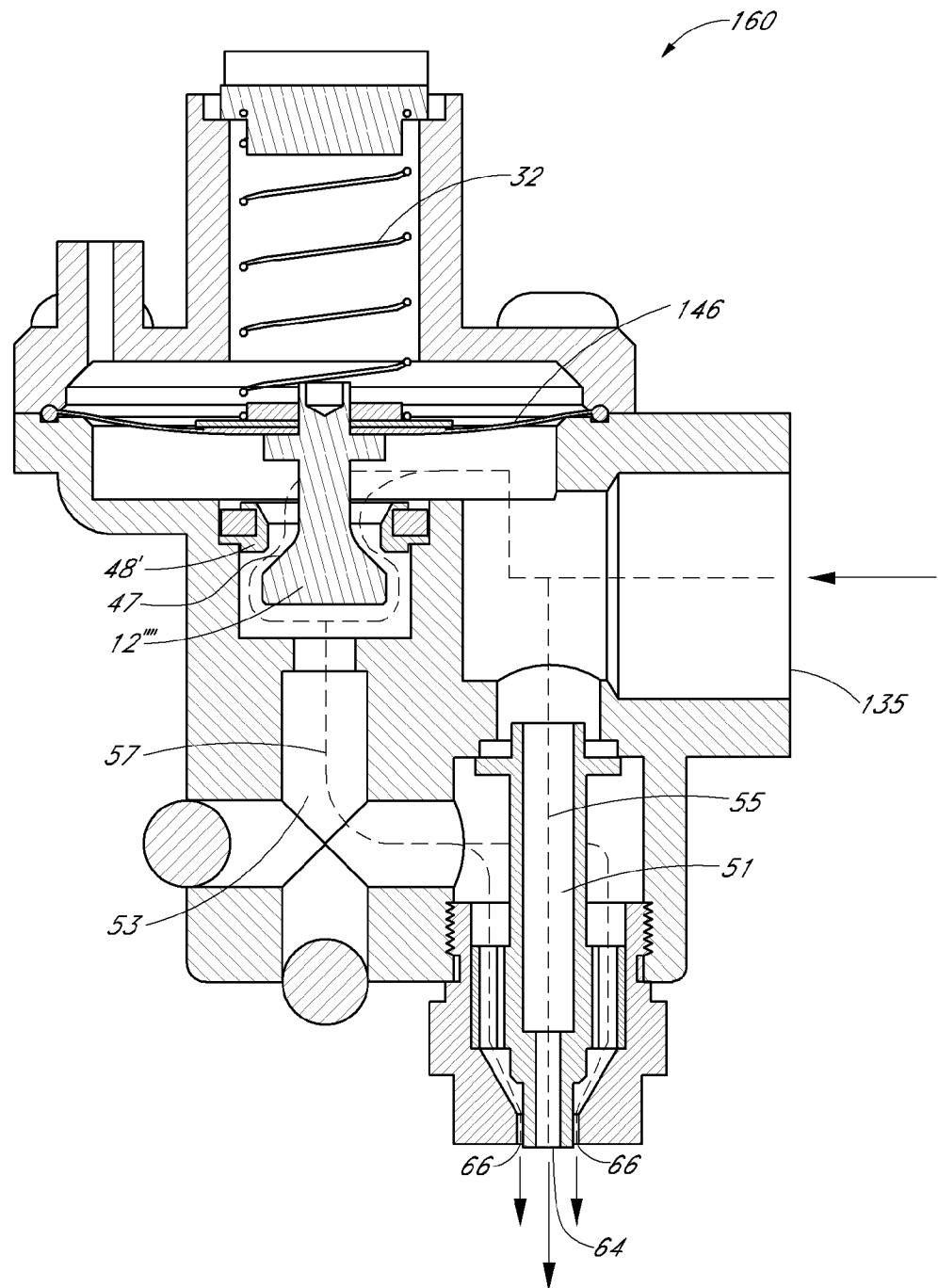


FIG. 42B

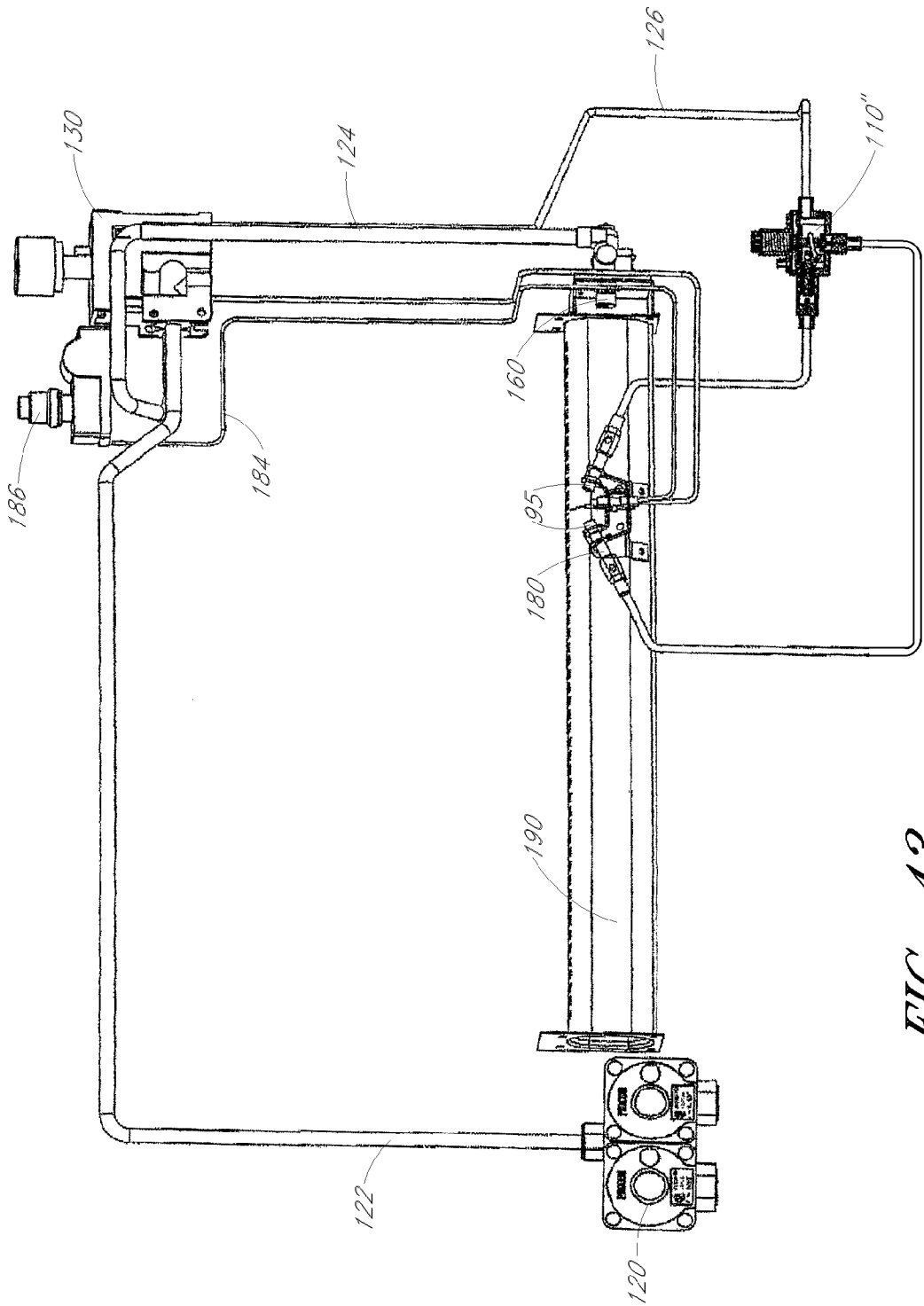


FIG. 43

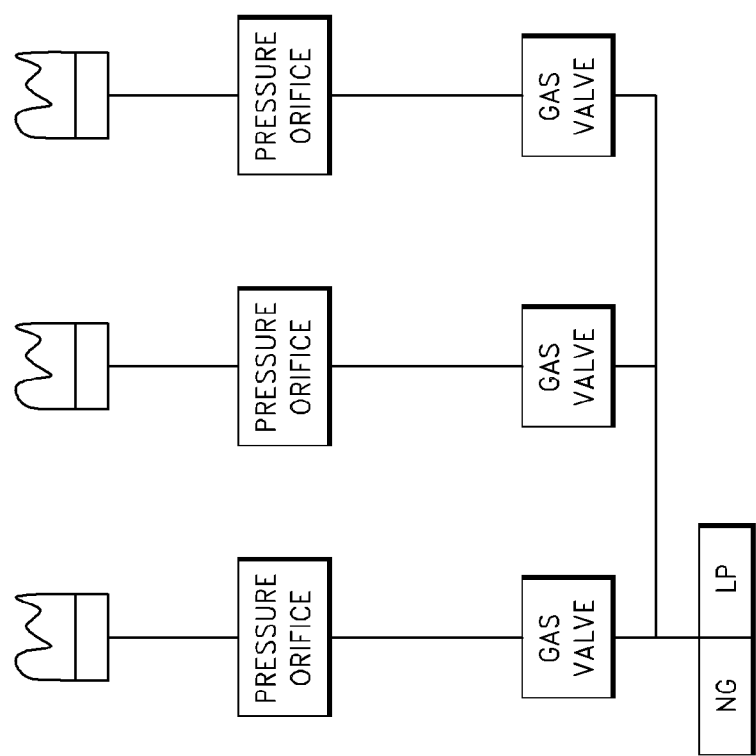


FIG. 44B

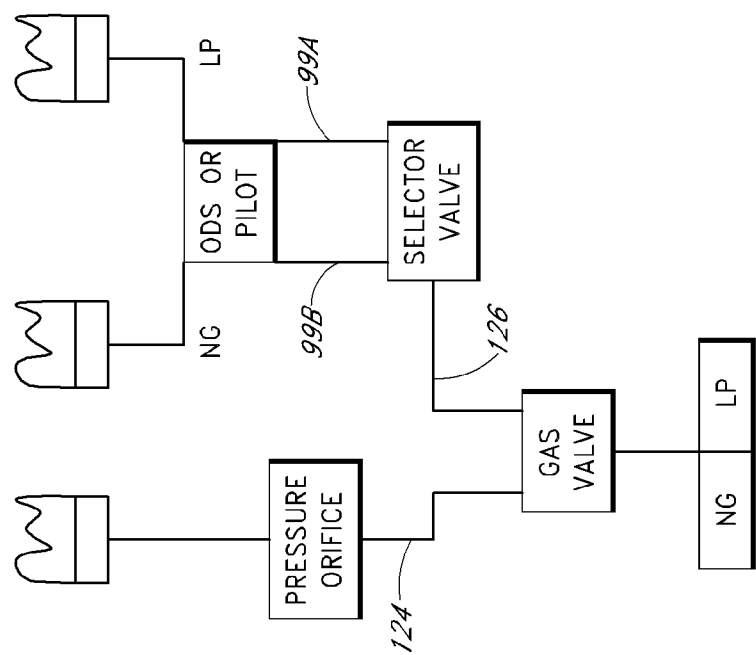
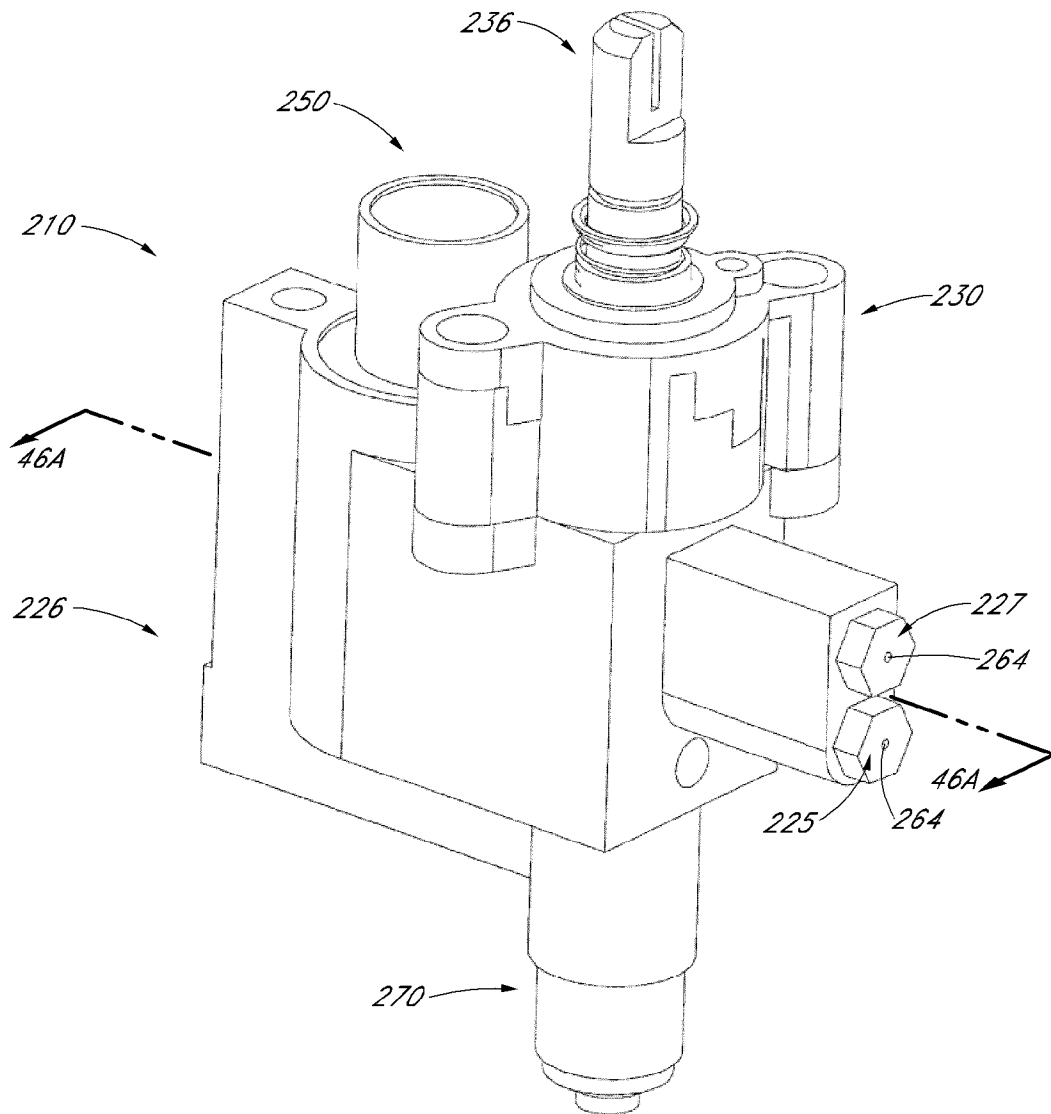
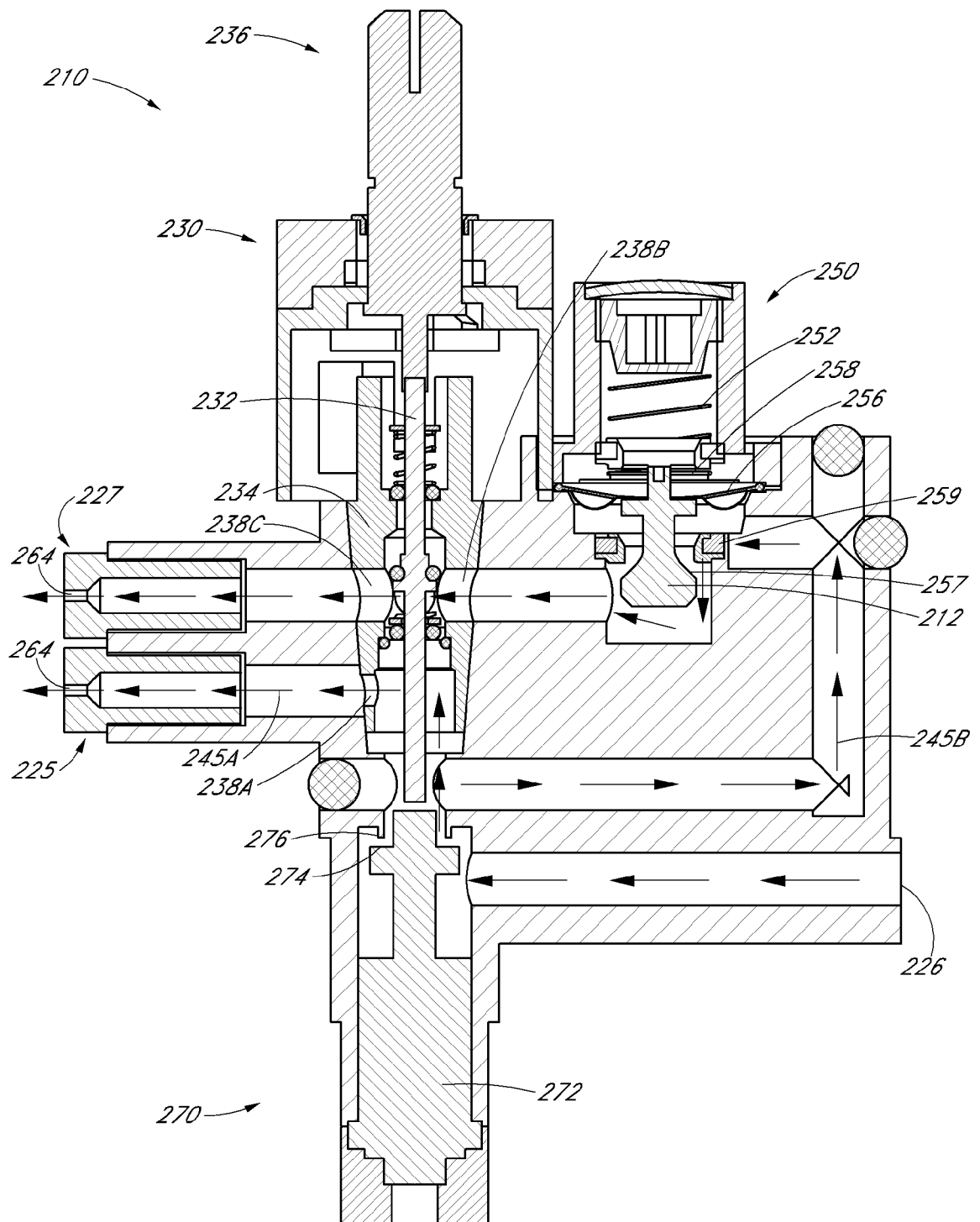


FIG. 44A

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*FIG. 45*

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*FIG. 46A*

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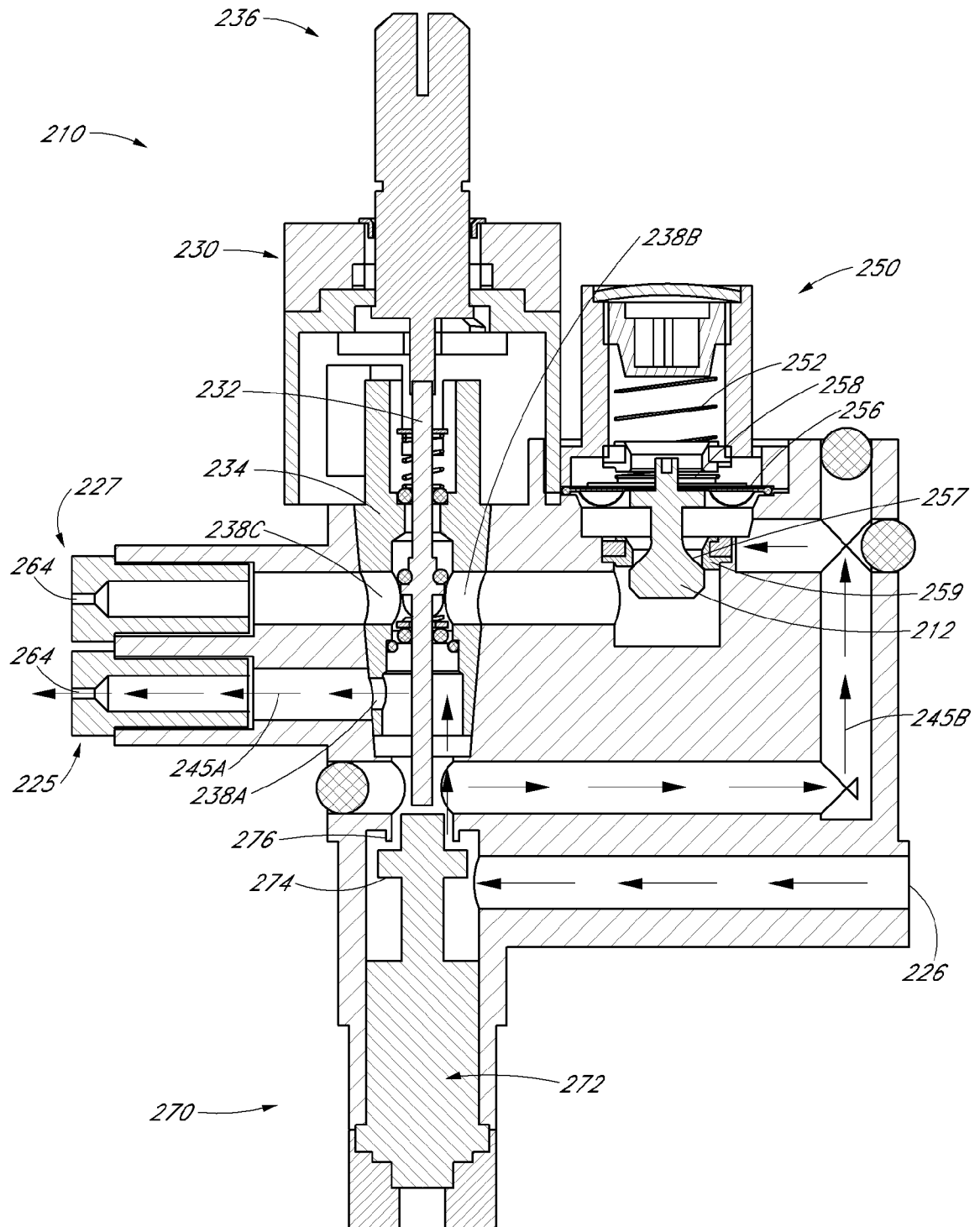
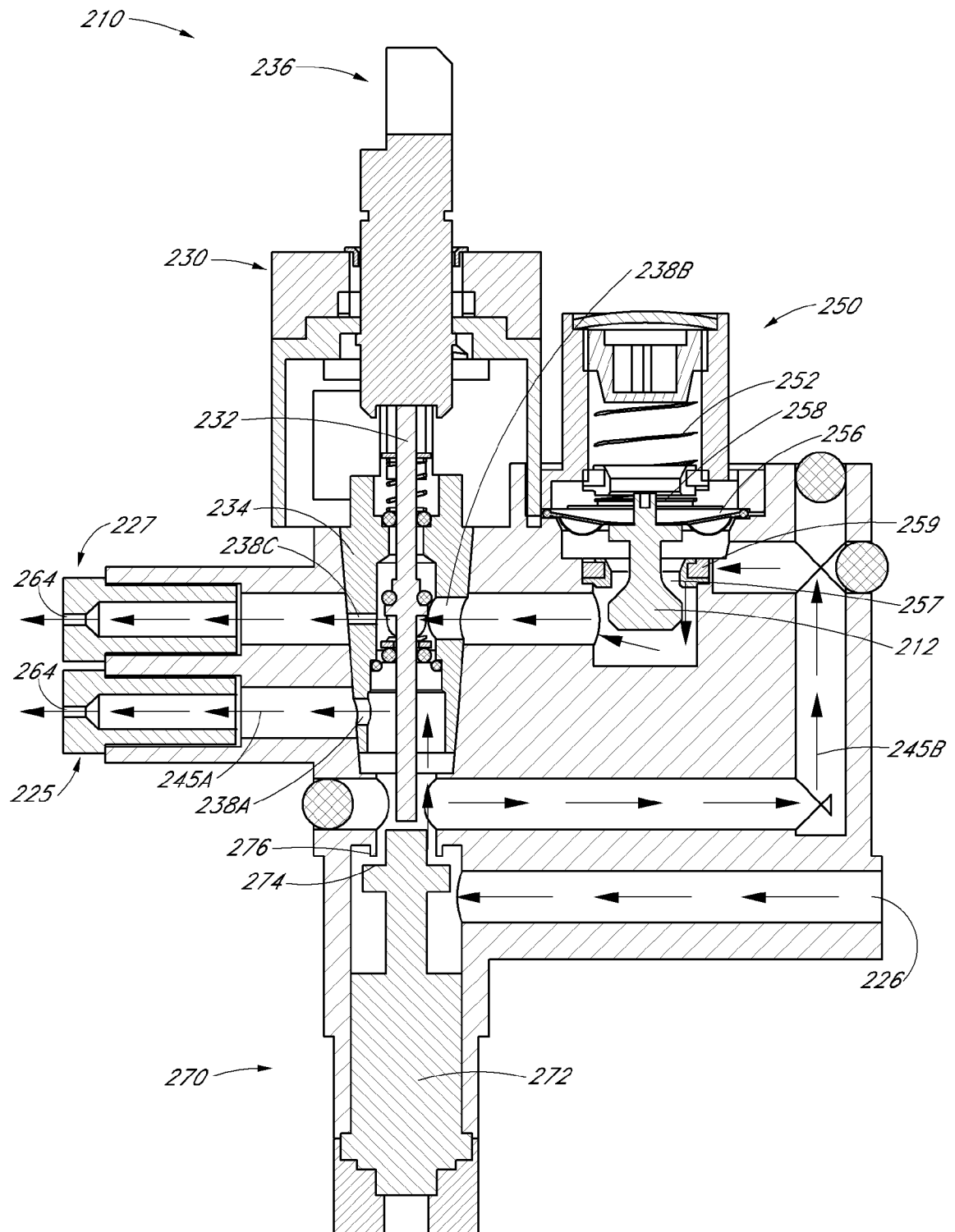
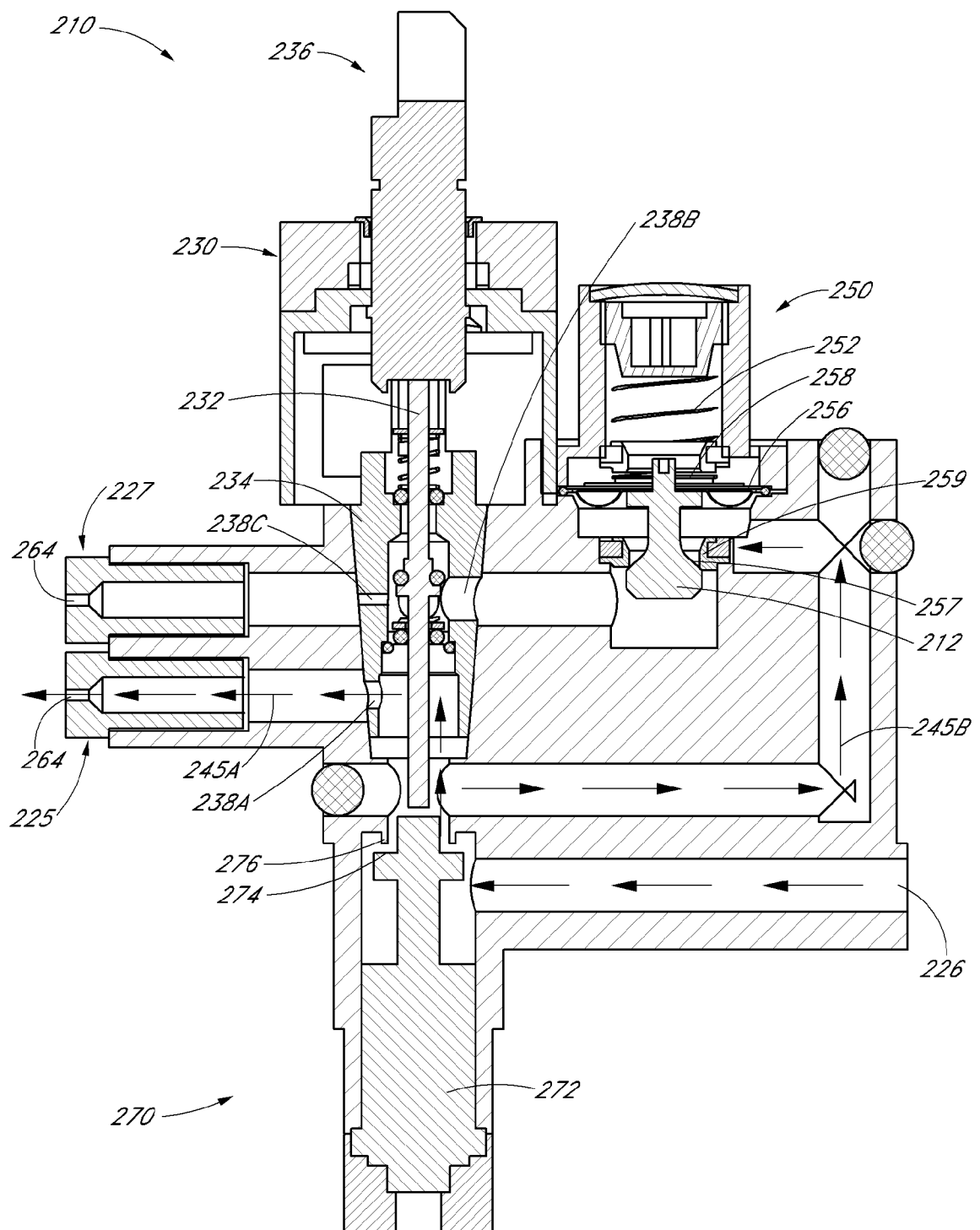


FIG. 46B

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*FIG. 47A*

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*FIG. 47B*

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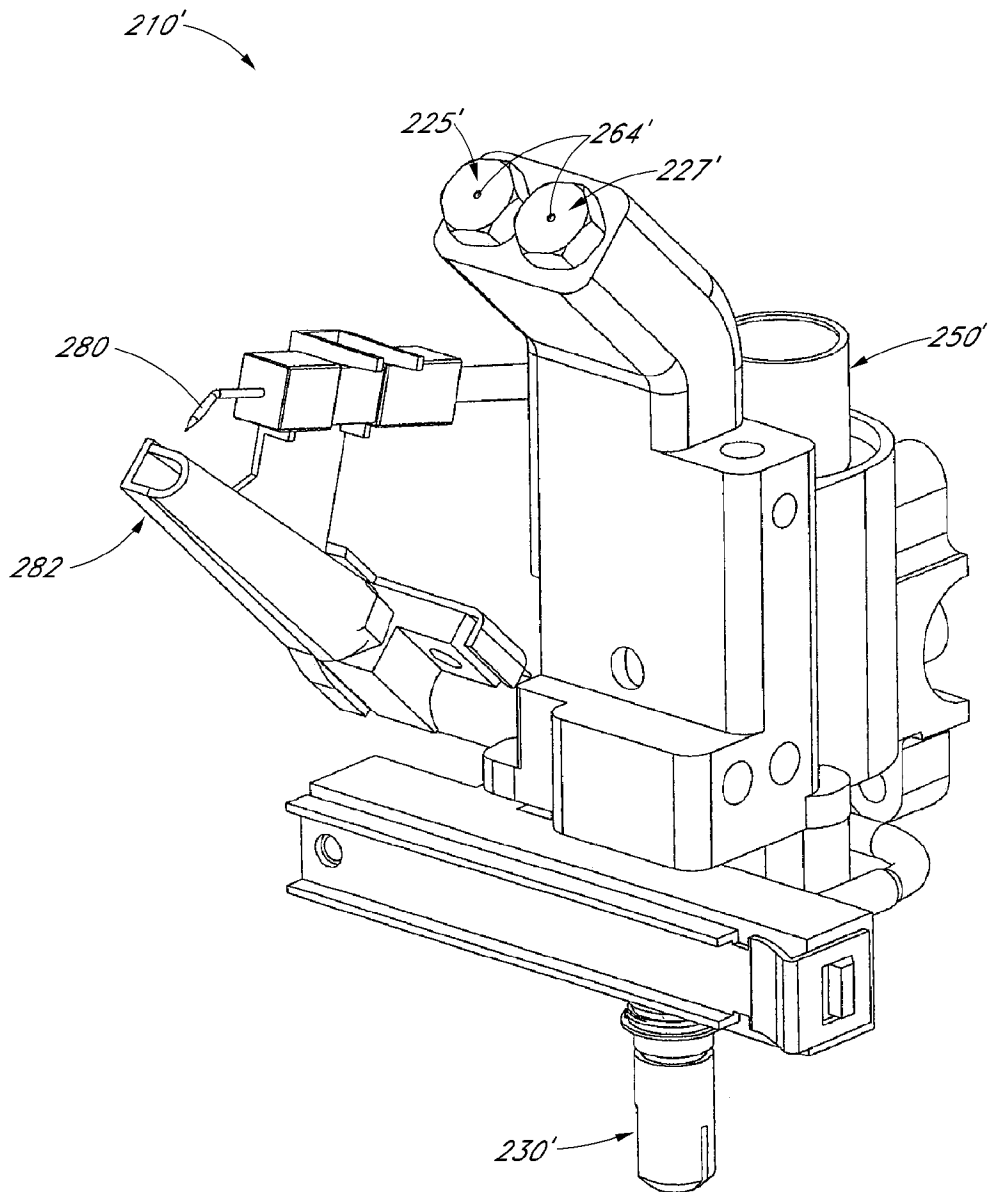


FIG. 48A

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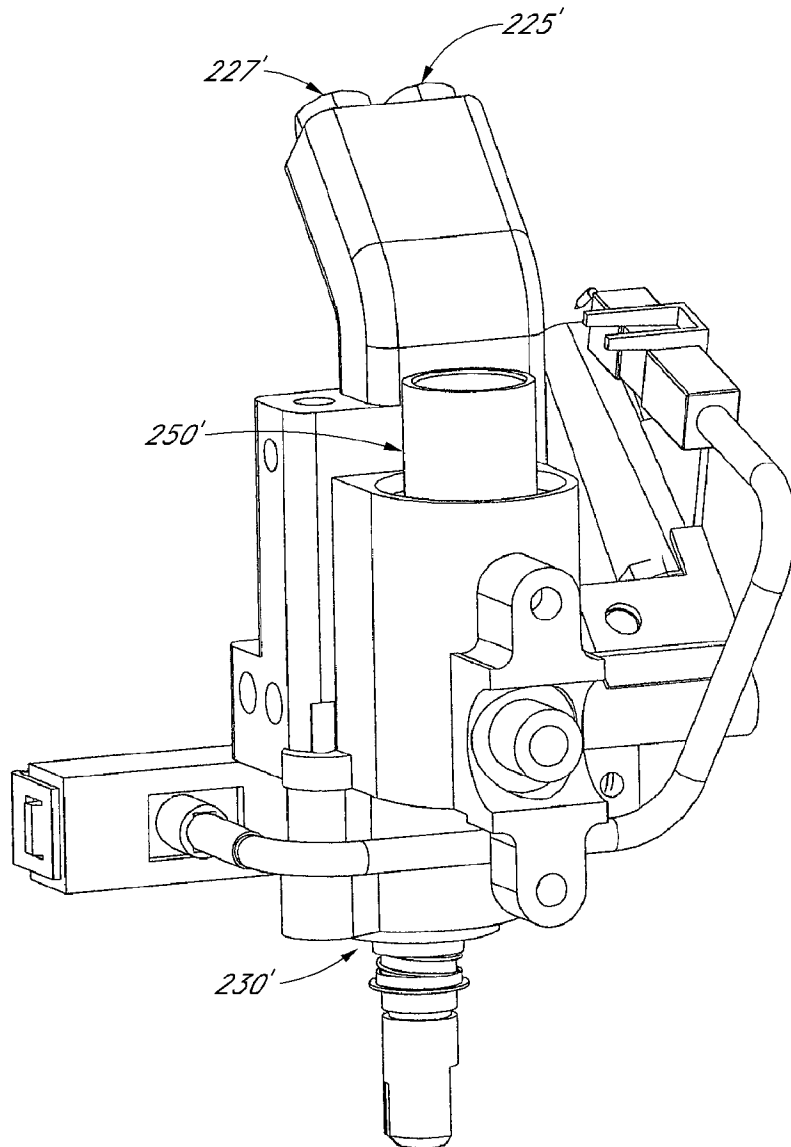


FIG. 48B

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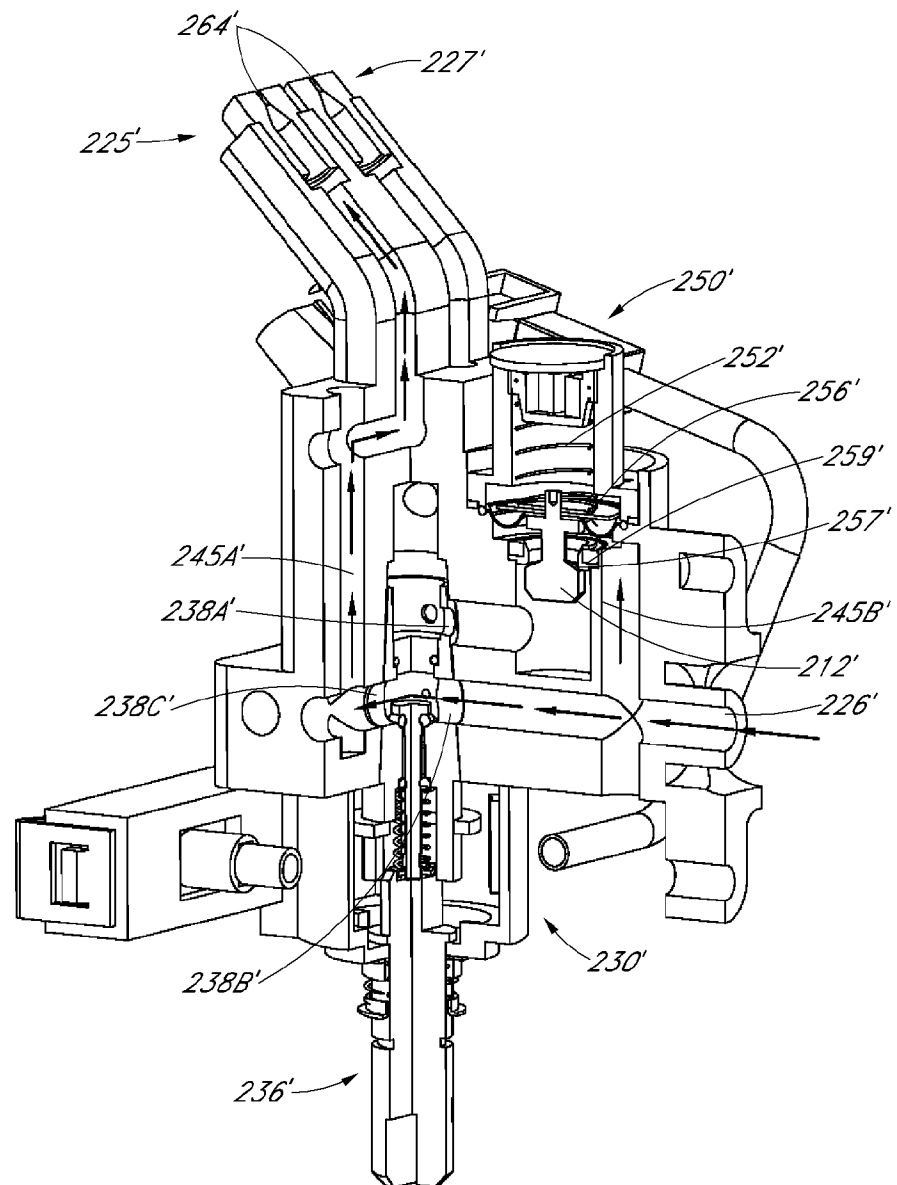
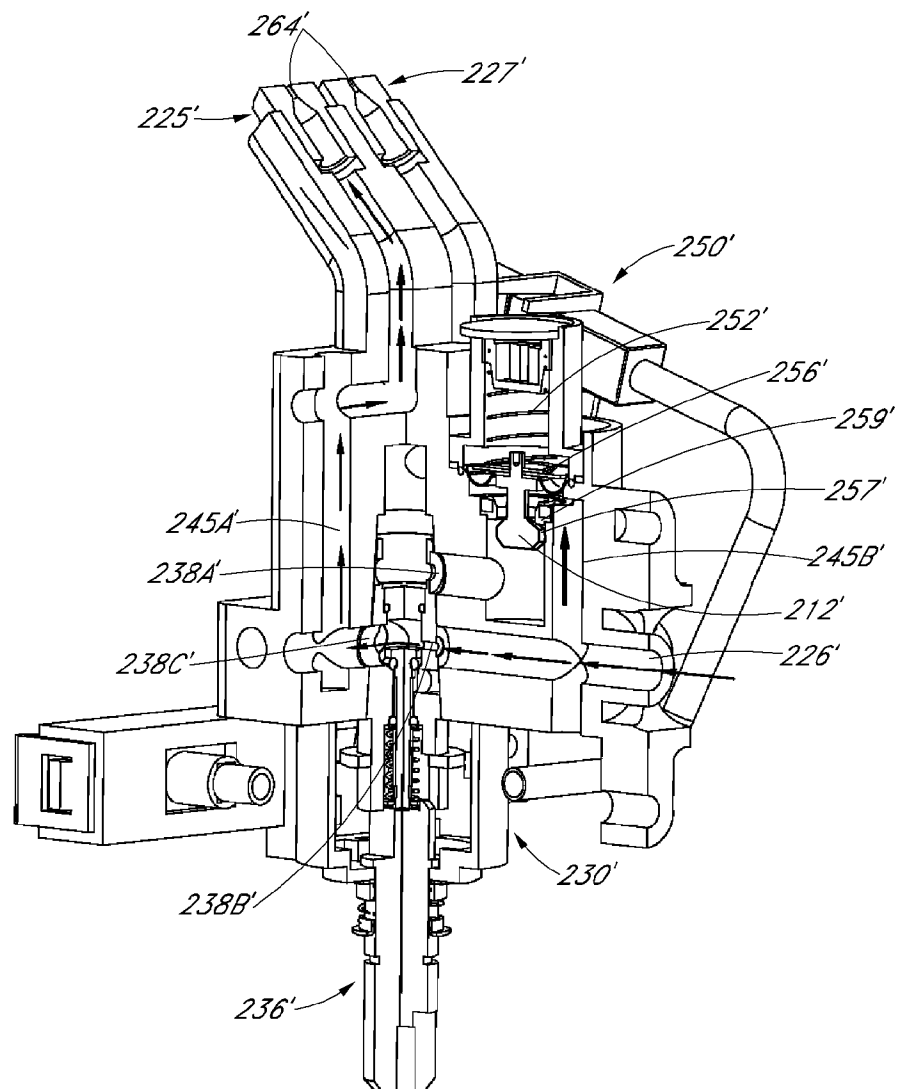


FIG. 49A

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*FIG. 49B*

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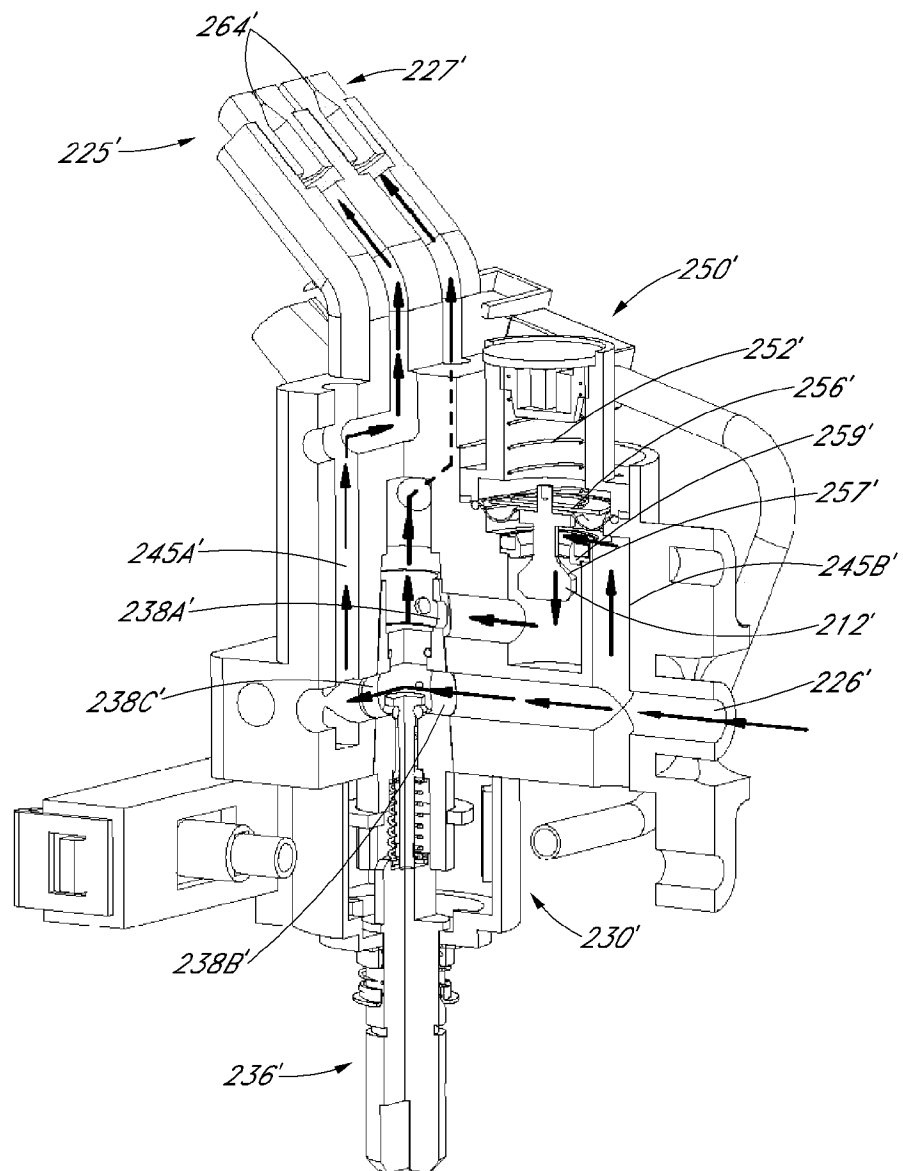
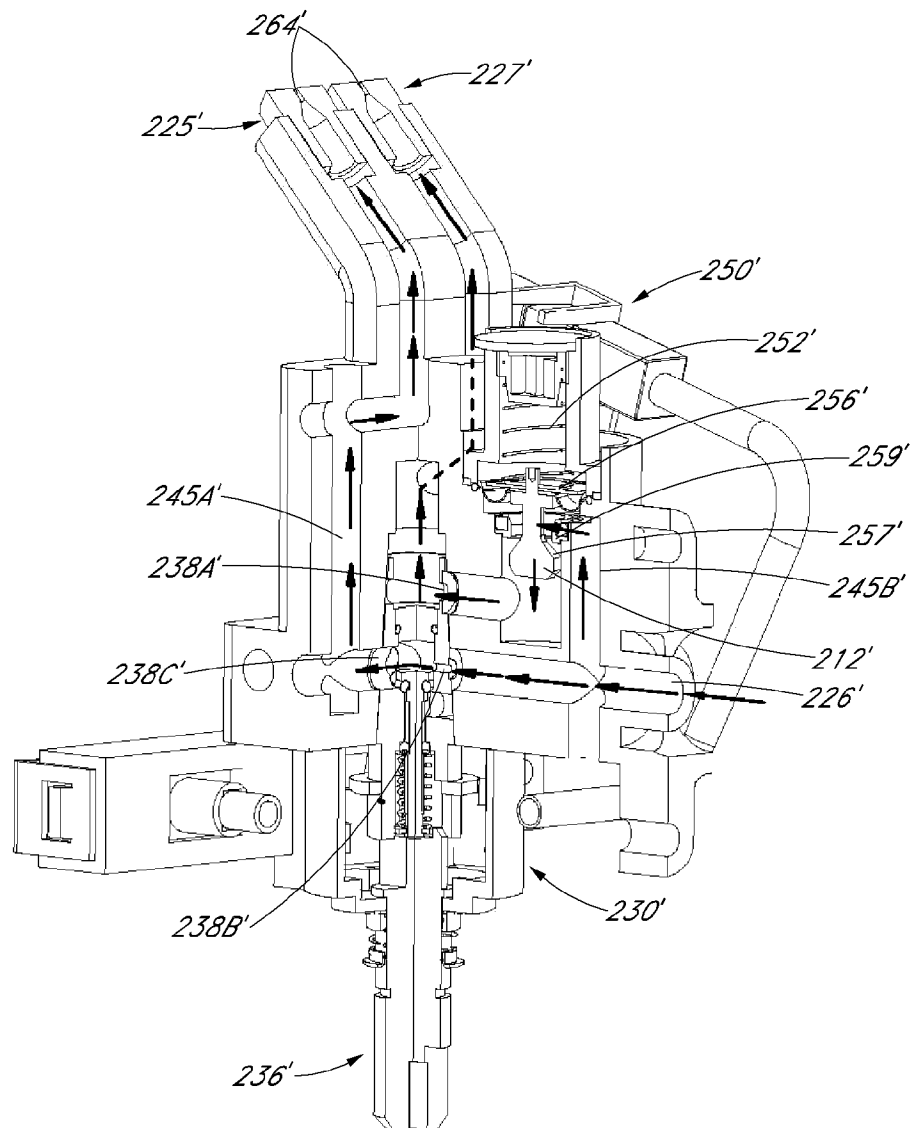


FIG. 50A

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*FIG. 50B*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 13/48769

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F24C 1/02; F23D 17/00 (2013.01)

USPC - 431/280

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)

IPC(8): F24C 1/02; F23D 17/00 (2013.01)

USPC: 431/280

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

IPC(8): F24C 1/02; F23D 17/00 (2013.01) (keyword limited, see terms below)

USPC: 60/39.463; 126/58, 85R, 116A, 116R; 431/278, 280 (keyword limited, see terms below)

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

PatBase, oogle Scholar, Google Patents. Search terms used: dual, pair, second, multi, multiple, first, two, different, separate, twin, diverse, alternate, several, plurality, numerous, fuel, gas, liquid, source, kerosene, diesel, propane, lng, heat, furnace, burn, combustion, fireplace, oven, stove, range, dryer, grill, appliance, bbq, nozzle, inle.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0330518 A1 (DENG) 30 December 2010 (30.12.2010) entire document, especially: Fig 2, 3, para [0002], [0006], [0072]-[0084], [0090], [0091]	1, 4-10
X	US 2012/0006091 A1 (DENG) 12 January 2012 (12.01.2012) entire document, especially: Fig 2, 15A, 15B, 23A, 23B, para [0003], [0015], [0022], [0090], [0093], [0097], [0115], [0129], [0139]	1-3
A	US 2007/0277813 A1 (DENG) 06 December 2007 (06.12.2007) para [0006]	1-10
A	US 2012/0067341 A1 (MATEOS MARTIN) 22 March 2012 (22.03.2012) entire document	1-10

☐ Further documents are listed in the continuation of Box C.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 October 2013 (13.10.2013)

Date of mailing of the international search report

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