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(54) Title: ROTATIONAL FUEL INJECTOR

(57) Abstract: This disclosure relates to a fuel injector (100) having a nozzle chamber (104) with one or more nozzle exits (108), and a plunger (102). The plunger (102) may be configured to move inside the nozzle chamber (104) to engage or disengage with the nozzle chamber (104) to block or allow, respectively, venting of combustible matter out of the nozzle chamber (104) via the one or more nozzle exits (108). A nozzle head (110) having one or more channels (112) may be fluidically coupled to the nozzle chamber (104) via the nozzle exits (108) and the channels (112). The nozzle head (110) may be mechanically coupled with the plunger (102). In response to the downward movement of the plunger (102), the nozzle head (110) may rotate about an axis (114) and simultaneously vent the combustible matter in a cylinder combustion chamber via the one or more channels (112).

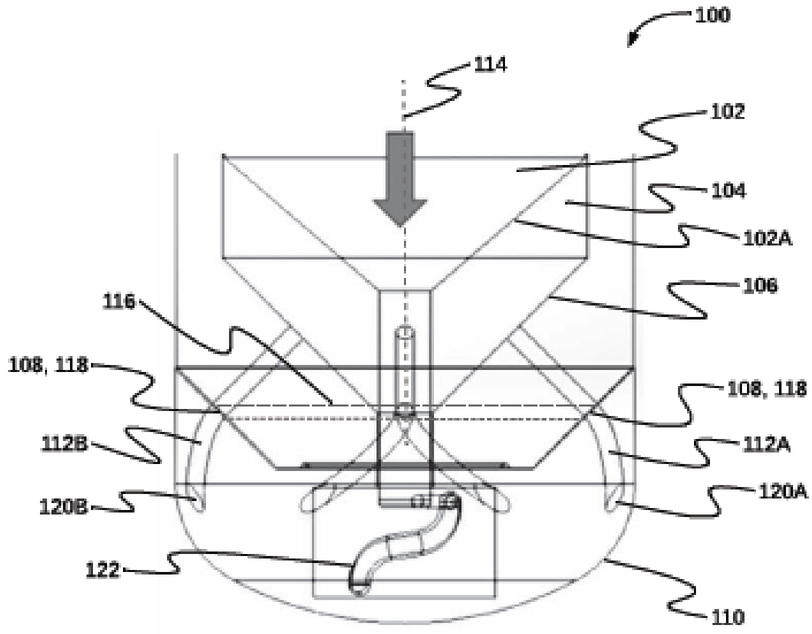

FIG. 1A

FORM 2

THE PATENTS ACT 1970

(39 Of 1970)

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The Patent Rules, 2003

Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

Rotational Fuel Injector

2. APPLICANT(S)

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is performed.

DESCRIPTION

Technical Field

[001] This disclosure relates generally to a fuel injector for an internal combustion (IC) engine, and particularly to a fuel injector with a rotating nozzle head.

Background

[002] A fuel injector may inject combustible matter in a combustion chamber of a cylinder of an internal combustion (IC) engine, for example a spark ignition IC engine (also called petrol engine) or a compression ignition IC engine (also called diesel engine). It may be understood that in the IC engine, the combustible matter may be injected in the combustion chamber during compression stroke (particularly, towards end of the compression stroke) of the engine. Further, in the spark ignition IC engine, the combustible matter may be injected in form of a fuel-air mixture. This fuel-air mixture may include droplets of fuel (for example, petrol) uniformly mixed with air. Once the fuel-air mixture is injected inside the combustion chamber of the cylinder, the fuel-air mixture may be ignited using a spark produced by a spark plug, for example, at the beginning of expansion stroke. Similarly, in the compression ignition engine, the combustible matter may include atomized fuel (diesel). Once the atomized fuel is injected inside the combustion chamber of the cylinder, the atomized fuel may be ignited due to high temperature generated, due to compression of the air and fuel inside the combustion chamber of the cylinder.

[003] As mentioned, the combustible matter may enter the combustion chamber at the end of the compression stroke. The combustible matter may undergo transition from liquid to fragments, to droplets, and finally to gas. It is desirable to make the combustible matter (i.e. the air-fuel mixture, or the atomized fuel) homogeneous (properly mixed). A homogeneous combustible matter may result in better power generation, which may further allow for a smaller engine size. A homogeneous combustible matter may further lead to lesser emissions, for example Nitrogen oxide (NOx) gases, and therefore, lesser pollution.

[004] Some techniques are known in the art which are aimed at obtaining homogeneous combustible matter. For example, these techniques may include introducing curvatures on piston head. However, this makes the piston heavy and adds to the machining cost. Other techniques for obtaining homogeneous combustible matter are based on swirl formation inside the engine (combustion chamber).

BRIEF DESCRIPTION OF THE DRAWINGS

[005] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, serve to explain the disclosed principles.

[006] **FIGS. 1A-1B** illustrate sectional front views of a fuel injector, in accordance with some embodiments of the present disclosure.

[007] **FIG. 1C** illustrates a perspective view of a fuel injector, in accordance with an embodiment of the present disclosure.

[008] **FIGS. 2A-2B** illustrate a sectional front view and a sectional top view, respectively, of a fuel injector already known in the art.

[009] **FIGS. 3A-3B** illustrate a sectional front view and a sectional top view, respectively, of a fuel injector, in accordance with another embodiment of the present disclosure.

[010] **FIG. 4** illustrates a front view of a plunger of a fuel injector, in accordance with an embodiment of the present disclosure.

[011] **FIGS. 5A-5C** are sectional front views and top views of an exemplary fuel injector at different stages of fuel injection, in accordance with some embodiments of the present disclosure.

[012] **FIG. 5D** is a graphical representation of the maximum rotation of a nozzle head of a fuel injector, in accordance with an embodiment of the present disclosure.

[013] **FIG. 6** illustrates a process flow of rotation of a nozzle head during operation of a fuel injector, in accordance with some embodiments of the present disclosure.

[014] **FIG. 7A** illustrates a sectional front view of a fuel injector assembly, in accordance with an embodiment of the present disclosure.

[015] **FIG. 7B** illustrates perspective views of components of a cylinder assembly of an IC engine, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

[016] Exemplary embodiments are described with reference to the accompanying drawings. Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are described herein, modifications, adaptations, and other implementations are possible without departing from the spirit and scope of the disclosed embodiments. It is intended that the following detailed description be considered as exemplary only, with the true scope and spirit being indicated by the following claims.

[017] A fuel injector with a rotating nozzle head is disclosed. By implementing the rotating nozzle head, the fuel injector may spread combustible matter uniformly and evenly throughout the combustion chamber of a cylinder of an internal combustion (IC) engine, thereby generating swirl and covering maximum area. The fuel injector may include a plunger configured to move linearly upwards and downwards. By way of the upwards and downwards movement of the plunger, the venting of combustible matter from the fuel injector is controlled. The plunger may be actuated via a magnetic solenoid and a spring may bring the solenoid actuated plunger back to its rest position. The rotating nozzle head may be mechanically coupled to the plunger, such that the upwards and downwards movement of the plunger causes the nozzle head to rotate.

[018] Referring now to FIG. 1A-1C, a first sectional front view, a second sectional front view, and a front view, respectively, of a fuel injector 100 is illustrated, in accordance with some embodiments of the present disclosure. In some embodiments, the fuel injector 100 may include a nozzle chamber 104. The nozzle chamber 104 may include one or more nozzle exits 108. The fuel injector 100 may further include a plunger 102. The plunger 102 may be configured to slidably move inside the nozzle chamber 104. By way of slidably moving inside the nozzle chamber 104, the plunger 102 may engage with or disengage from the nozzle chamber 104 to block or allow, respectively, venting of combustible matter from the nozzle chamber 104 via the one or more nozzle exits 108. In particular, when the plunger 102 has moved to its bottom-most position, a surface of the plunger 102A may touch a surface 106 of the nozzle chamber 104 to thereby cover a first end of each of the one or more nozzle exits 108. In other words, in this position, the plunger 102 may engage with the nozzle chamber 104 to block venting of combustible matter from the nozzle chamber 104 via the one or more nozzle exits 108. However, as the plunger 102 slidably moves upwards, the surface 102A of the plunger 102 may no longer touch the surface 106 of the nozzle chamber 104, and, therefore, the first end of each of the one or more nozzle exits 108 may be left open (i.e. the plunger 102 disengages from the nozzle chamber 104), to allow venting of the combustible matter form the nozzle chamber 104 via the one or more nozzle exits 108.

[019] The fuel injector 100 may further include a nozzle head 110. The nozzle head 110 may be rotatable with respect to the nozzle chamber 104. The nozzle head may include one or more channels 112 (for example, a first channel 112A and a second channel 112B). The nozzle head 110 may be fluidically coupled to the nozzle chamber 104 via the one or more nozzle exits 108 and the one or more channels 112. Further, the nozzle head 110 may be mechanically coupled with the plunger 102. In response to the downward movement of the plunger 102, the nozzle head 110 may rotate about an axis 114 and simultaneously vent the combustible matter in a combustion chamber of a cylinder of an internal combustion engine via the one or more channels 112.

[020] In some embodiments, the nozzle head 110 may include one or more follower paths 122. Further, the plunger 102 may include a plunger head having one or more projections. It may be noted that each of the one or more projections may engage with one of the one or more follower paths 122 to mechanically couple the nozzle head 110 with the plunger 102. The plunger 102 is further explained in conjunction with FIG. 4.

[021] In some embodiments, each of the one or more nozzle exits 108 may be arc-shaped (i.e. elliptical) extending along the circumference of the nozzle chamber 104. In such embodiments, each of the one or more channels 112 may remain fluidically coupled with the one or more nozzle exits 108, as the nozzle head 110 rotates with respect to the nozzle chamber 104.

[022] In some embodiments, the nozzle head 110 may include one or more first openings 118 and one or more second openings 120 (for example, a first opening 120A and a second opening 120B), such that each of the one or more channels 112 extends between a respective first opening (of the one or more first openings 118) and a respective second opening (of the one or more second openings 120). It may be noted that each of the one or more first openings 118 may be fluidically coupled to one of the one or more nozzle exits 108. Further, each of the one more second openings

120 may open in the combustion chamber of the cylinder of the IC engine. In other words, the nozzle head 110 may be configured to vent the combustible matter from the one or more second openings 120.

[023] It may be noted that once the nozzle chamber 104 has vented the combustible matter via the one or more nozzle exits 108, the combustible matter may flow through the one or more channels 112 of the nozzle head 110, before being vented out from the one or more second openings 120 in the combustion chamber.

[024] In some embodiments, the nozzle head 110 may include a circumferential groove 116. The nozzle head 110 may be fluidically coupled to the nozzle chamber 104 via the one or more channels 112 and the circumferential groove 116. In such embodiments, each of the one or more first openings 118 may open in the circumferential groove 116, and each of the one more second openings 120 may open in the combustion chamber of the cylinder of the internal combustion engine.

[025] In some embodiments, a low-friction coating may be provided between the nozzle chamber 104 and the nozzle head 110, to reduce wearing or high temperature generation due to the relative movement (during rotation of the nozzle head 110) of the nozzle head 110 with respect to the nozzle chamber 104. For example, the low-friction coating may be of a synthetic polymer like Polytetrafluoroethylene (PTFE), or any other polymer, or any other suitable material (friction coefficient of PTFE being low as 0.05). Further, the PTFE coating may provide capability to withstand high temperature and pressure.

[026] Referring now to FIG. 2A-2B, a sectional front view and a sectional top-view of an exemplary IC engine 200 including a fuel injector 202 already known in the art is illustrated. As shown in the FIG. 2, the engine 200 may include a cylinder 208 having a combustion chamber 208A.

As it will be appreciated, the combustion chamber 208A may be a part of the cylinder 208 in which mixing and distribution of the combustible matter and combustion of the combustible matter may occur. The cylinder 208 may include an intake port 204 and an exhaust port 206. The fuel injector 202 may inject combustible matter in the combustion chamber 208A. It may be understood that the fuel injector 202 may inject the combustible matter in the combustion chamber 208A during a compression stroke i.e. when a piston (not shown in the FIG. 2) moves from a bottom dead center (BDC) to a top dead center (TDC) of the cylinder 208. The fuel injector 202 may inject the combustible matter via one or more one or more nozzle exits 210. It may be noted that the fuel injector 202 may inject the combustible matter via the one or more one or more nozzle exits 210 in a straight-line orientation 212. As such, the fuel injector 202 may not be able to impart enough swirl to the injected combustible matter, for homogenous mixing of the combustible matter. As a result, the combustible matter is spread largely in the region 212A, corresponding to each nozzle exit 210.

[027] Referring now to FIG. 3A-3B, a sectional front view and a sectional top-view of an exemplary IC engine 300 including the fuel injector 100 is illustrated, in accordance with an embodiment of the present disclosure. The IC engine 300 may be a spark ignition (petrol) IC engine or a combustion ignition (diesel) IC engine. Accordingly, the combustion matter used in the spark ignition IC engine may be fuel-air (i.e. gasoline-air) mixture, and the combustion matter used in the combustion ignition IC engine may be atomized fuel.

[028] The IC engine 300 may include a cylinder 306. The cylinder 306 may include an intake port 302 and an exhaust port 304 fitted to the cylinder 306. The cylinder 306 may further define a combustion chamber 306A. The fuel injector 100 may inject the combustible matter in the combustion chamber 306A of the cylinder 306.

[029] The fuel injector 100 may include the nozzle head 110 and the plunger 102 configured to move inside the nozzle chamber 104 to engage or disengage with the nozzle chamber 104, so as to block or allow, respectively, venting of combustible matter out of the nozzle chamber 104 via the one or more nozzle exits.

[030] The fuel injector 100 may further include the nozzle head 110 comprising one or more channels. The nozzle head 110 may be fluidically coupled to the nozzle chamber 104 via the one or more nozzle exits 108 and the one or more channels 112. Further, the nozzle head 110 may be mechanically coupled to the plunger 102. In response to the downward movement of the plunger 102, the nozzle head 110 may rotate about an axis 114 and simultaneously vent the combustible matter in the combustion chamber 306A of the cylinder 306 via the one or more channels 112. It may be understood that due to the rotating movement of the nozzle head 110, the nozzle head 110 may vent the combustible matter in a rotating (circular) direction 310, and as a result impart swirl to the injected combustible matter which may ensure homogenous mixing and distribution of the combustible matter in the combustion chamber 306A. As shown in the FIG. 3B, the combustible matter may be spread in the region 310A, corresponding to each nozzle exit 108.

[031] Referring now to FIG. 4, a front view of the plunger 102 is illustrated, in accordance with an embodiment of the present disclosure. A shown in the FIG. 4, the plunger 102 may include a plunger head 402. The plunger head 402 may further include one or more projections 404. It may be noted that each of the one or more projections 404 may be configured to engage with one of the one or more follower paths 122 to mechanically couple the nozzle head 110 with the plunger 102. As such, a downward movement of the plunger 102 may cause the nozzle head 110 to rotate about an axis and simultaneously vent the combustible matter in a combustion chamber. It may be further noted that the one or more projections 404 may be built within the body of the plunger 102 as one piece, or the one or more projections 404 may be fitted to the plunger head 402 of the plunger 102.

[032] Referring now to FIGS. 5A-5C, sectional front views and top views of the exemplary fuel injector 100 at different stages of fuel injection are illustrated, in accordance with some embodiments of the present disclosure. As already mentioned, the nozzle head 110 may rotate with respect to the nozzle chamber 104 during injecting the combustible matter in the cylinder combustion chamber.

[033] FIG. 5A shows the nozzle head 110 at a first position with respect to the nozzle chamber 104. In the first position, the plunger 102 may be at a topmost position. As such, in this position of the plunger 102, the nozzle head 110 may be injecting the combustible matter in a combustion chamber of a IC engine cylinder via the one or more nozzle exits. Further, in this position, the one or more projections 404 are at a first position with respect to the follower path 122.

[034] FIG. 5B shows the nozzle head 110 at a second position with respect to the nozzle chamber 104, when the nozzle head 110 has undergone a partial rotation with respect to the nozzle chamber 104. The plunger 102 may be at an intermediary position between its topmost position and its bottommost position, and accordingly, the plunger 102 may have caused the nozzle head 110 to rotate. Further, in this position, the one or more projections 404 are at a second position with respect to the follower path 122. Accordingly, the combustible matter may be vented out from the one or more second openings (not shown in FIG. 5B) simultaneously as the nozzle head 110 may be undergoing rotation with respect to the nozzle chamber 104.

[035] FIG. 5C shows the nozzle head 110 at a third position with respect to the nozzle chamber 104, when the nozzle head 110 has undergone a complete rotation. The plunger 102 may be at the bottommost position, and accordingly, the plunger 102 may have caused the nozzle head 110 to undergone maximum rotation. Further, the one or more projections 404 are at a third position with respect to the follower path 122. It may be noted that the nozzle head 110 may be configured to rotate with respect to the nozzle chamber 104 by a maximum predetermined angle (θ) before the nozzle head 110 may start returning back to the first position. FIG. 5D is a graphical representation of the maximum rotation of the nozzle head 110 though the predetermined angle (θ) between an initial position (i) and a final position (f).

[036] It may be noted that in some embodiments, the movement of the plunger 102 from its topmost to its bottommost position may be actuated by a magnetic solenoid. However, in other embodiments, the movement of the plunger 102 from the topmost to the bottommost position may be actuated using other techniques as well. For example, in some embodiments, this movement of the plunger 102 may be actuated using a spring. In other words, the spring may keep the plunger 102 at its bottommost position, and by a mechanical force acting the spring, the plunger 102 may be caused to move from its bottommost towards its topmost position.

[037] Further, this linear motion of the plunger 102 causes a rotational motion of nozzle head 110. In other words, the plunger 102 acts as a cam and the nozzle head 110 acts as a follower. As the plunger 102 moves downwards, the nozzle head 110 may rotate away from its initial position, and as the plunger 102 moves upwards, the nozzle head 110 may return to its initial position.

[038] Referring now to FIG. 6, a process flow of the rotation of the nozzle head 110 during operation of the fuel injector 100 is illustrated, in accordance with an embodiment of the present disclosure. As already mentioned, the nozzle head 110 may rotate with respect to the nozzle chamber 104 during injecting the combustible matter in the cylinder combustion chamber.

[039] At step 602, at time t=0.0 seconds (s), the nozzle head 110 may be at a first (initial) position with respect to the nozzle chamber 104. In the first position, the plunger 102 may be at a bottommost position. As such, the plunger 102 may keep the nozzle exits 108 blocked, and therefore, the nozzle head 110 may not have started injecting the combustible matter in the cylinder combustion chamber. Further, in this position, the one or more projections 404 are at a first position with respect to the follower path 122. Accordingly, the plunger 102 may not have caused any rotation of the nozzle head 110, i.e. the nozzle head 110 may rest at its initial position.

[040] At step 604, at time t=20 micro seconds (μs), the nozzle head 110 may be at a second position with respect to the nozzle chamber 104. In this position, the plunger 102 may have moved upwards from its bottommost position. As such, the plunger 102 may have exposed the nozzle exits, and therefore allowed the nozzle head 110 to start injecting the combustible matter in the cylinder combustion chamber. Further, in this position, the one or more projections 404 are at a second position with respect to the follower path 122. Accordingly, the plunger 102 may have caused some rotation of the nozzle head 110 from the initial position of the nozzle head 110.

[041] At step 606, at time t=40 μs, the nozzle head 110 may have moved to a third position with respect to the nozzle chamber 104. In this position, the plunger 102 may have moved further upwards from its bottommost position. As such, the nozzle exits may remain exposed, and keep injecting the combustible matter in the cylinder combustion chamber. Further, the one or more projections 404 are at a third position with respect to the follower path 122, as a result of which the plunger 102 may have caused some more rotation of the nozzle head 110 from the initial position of the nozzle head 110.

[042] At step 608, at time t=60 μs, the nozzle head 110 may have moved to a fourth position with respect to the nozzle chamber 104. In this position, the plunger 102 may have moved yet further upwards from its bottommost position to its topmost position. The nozzle exits may remain exposed. Further, the one or more projections 404 are at a fourth position with respect to the follower path 122, as a result of which the plunger 102 may have caused maximum rotation of the nozzle head 110 from the initial position of the nozzle head 110. At this position, the plunger 102 may either stay at rest or keep moving (in order to keep the nozzle head rotating), however, the supply of combustible matter may continue. It may be noted that, for example, the maximum rotation of the nozzle head 110 from the initial position may be 20°.

[043] At step 610, at time t=140 μs, the nozzle head 110 may have moved to a fifth position with respect to the nozzle chamber 104. In this position, the plunger 102 may have moved downwards from its topmost position. The nozzle exits may remain exposed, and keep injecting the combustible matter in the cylinder combustion chamber. Further, the one or more projections 404 are at a fifth position with respect to the follower path 122, as a result of which the plunger 102 may have caused reverse rotation of the nozzle head 110, thereby bringing the nozzle head 110 closer to its initial position.

[044] It may be noted that, in some embodiments, in the duration between time t=60 μs and time t=140 μs, the plunger 102 may keep moving, and therefore, nozzle head 110 may also keep rotating in this duration. This ensures that while the fuel is being injected from the nozzle chamber, the rotating nozzle head 110 may keep imparting swirl to the combustible matter.

[045] At step 612, at time t=200 μs, the nozzle head 110 may have moved back to its first (initial) position with respect to the nozzle chamber 104. As such, the plunger 102 may have moved downwards back to its bottommost position, thereby blocking the nozzle exits, and stopping injecting of the combustible matter in the cylinder combustion chamber. Further, the one or more projections 404 are back at the first position with respect to the follower path 122, thereby bringing the nozzle head 110 back to its initial position.

[046] Referring now to FIG. 7A, a front view of a fuel injector assembly 700A is illustrated, in accordance with an embodiment of the present disclosure. The fuel injector assembly 700A may include the fuel injector 100 and a bearing 702. The fuel injector 100 may include a plunger 102 and a nozzle head 110 which is configured to rotate about an axis. It may be noted that the fuel injector 100 may be configured to be coupled to a cylinder of an IC engine. In some embodiments, in order to couple the fuel injector 100 to the cylinder, the nozzle head 110 may be coupled to the cylinder of internal combustion engine via the bearing 702. For example, the bearing 702 may be fitted to the nozzle head 110 of the fuel injector 100. This assembly of the fuel injector 100 and the bearing 702 may then be fitted to the cylinder of the IC engine. This is further explained in conjunction with FIG. 7B.

[047] Referring now to FIG. 7B, perspective views of components of a cylinder assembly 700B an IC engine are illustrated, in accordance with an embodiment of the present disclosure. The cylinder assembly 700B may include a fuel injector assembly 700A. As mentioned above, the fuel injector assembly 700A may include the fuel injector 100 and the bearing 702. The cylinder assembly 700B may further include a cylinder 712. The cylinder 712 may include a housing 706 for coupling the fuel injector assembly 700A with the cylinder 712. The housing 706 may include a wall 708 and a platform 710. The fuel injector assembly 700A may be coupled to the cylinder 712 by fitting the fuel injector assembly 700A within the confines of the wall 708 and resting on the platform 710.

[048] In order to seal (i.e. making leak-proof) the coupling between the fuel injector assembly 700A and the cylinder 712, a gasket 704 may be positioned between fuel injector assembly 700A and the platform 710. In particular, the gasket 704 may be positioned between the bearing 702 and the platform 710. It may be noted that the gasket 704 may be made of silicone, or any polymer, or any other suitable material. It may be appreciated that the silicon gasket 704 will act as insulator, and prevent heat from permeating to the bearing 702. As such, the temperature of the bearing 702 remains almost same as the IC engine's outer surface temperature, i.e. around 200 ºC when the IC engine is running at its highest maximum revolution per minute (RPM).

[049] As it will be appreciated, by positioning the gasket 704 and the fuel injector assembly 700A on the platform 710, the gasket 704 and the fuel injector assembly 700A, i.e. the fuel injector 100 and the bearing 702, are kept outside of the cylinder. As a result, these components are prevented from being exposed to high temperature and pressure condition inside the cylinder. This helps in avoiding damage due to high temperature and pressure conditions.

[050] In some embodiments, the various components, i.e. the fuel injector 100, the nozzle head 110, and the bearing 702 may be made of same material, for example carburizing steel. Alternately, these various components may be made of steel to avoid corrosive effects due to moisture.

[051] The fuel injector described in various embodiments discussed above, uses a rotating nozzle head to spread the combustible matter (fuel) uniformly and evenly throughout the cylinder volume, thereby covering maximum area by creating a swirl formation of fuel inside the engine. The above described fuel injector may lead to 30% increment in area coverage to the spread of the combustible matter. This leads to more effective combustion inside the cylinder, and as a result, the engine emissions amounting to pollution are reduced. Further, the fuel injector discussed above provides for a cost effective, light-weight, and simple design solution for achieving homogeneous fuel mixture and swirl formation in the engine. This homogeneous mixing of air-fuel mixture allows for cleaner combustion and lower emissions. Further, the homogeneous mixing of air-fuel mixture may lead to richer air-fuel mixture fuel supply, which leads to increase in fuel economy. Moreover, need for extra modification in piston is eliminated, and higher cost due to additional machining and higher piston weight is avoided. Reducing the weight of piston further assists in increasing engine efficiency. Further, the fuel injector is applicable to all types of IC engines (i.e. spark-ignition IC engines and compression-ignition IC engines).

[052] It is intended that the disclosure and examples be considered as exemplary only, with a true scope and spirit of disclosed embodiments being indicated by the following claims.

<u>We claim:</u>

1. A fuel injector (100) comprising:

a nozzle chamber (104) comprising one or more nozzle exits (108);

a plunger (102) configured to move inside the nozzle chamber (104) to engage or disengage with the nozzle chamber (104) to block or allow, respectively, venting of combustible matter out of the nozzle chamber (104) via the one or more nozzle exits (108); and

a nozzle head (110) comprising one or more channels (112), the nozzle head (110) being fluidically coupled to the nozzle chamber (104) via the one or more nozzle exits (108) and the one or more channels (112), the nozzle head (110) being mechanically coupled with the plunger (102), wherein, in response to the downward movement of the plunger (102), the nozzle head (110) is configured to rotate about an axis (114) and simultaneously vent the combustible matter in a combustion chamber of a cylinder of an internal combustion engine via the one or more channels (112).

2. The fuel injector (100) as claimed in claim 1, wherein

the nozzle head (110) comprises one or more follower paths (122);

the plunger (102) comprises a plunger head having one or more projections, wherein each of the one or more projections engages with one of the one or more follower paths (122), to mechanically couple the nozzle head (110) with the plunger (102).

3. The fuel injector (100) as claimed in claim 1, wherein each of the one or more nozzle exits (108)

is arc-shaped extending along the circumference of the nozzle chamber (104), wherein each of the one or more channels (112) remains fluidically coupled with the one or more nozzle exits (108).

4. The fuel injector (100) as claimed in claim 3, wherein the nozzle head (110) comprises one or more first openings (118) and one or more second openings (120), wherein each of the one or more channels (112) extends between a respective first opening of the one or more first openings (118) and a respective second opening of the one or more second openings (120), wherein each of the one or more first openings (118) is fluidically coupled to one of the one or more nozzle exits (108), and each of the one more second openings (120) opens in the combustion chamber of the cylinder of the internal combustion engine, and wherein the nozzle head (110) is configured to vent the combustible matter from the one or more second openings (120).

5. An internal combustion engine comprising:

a cylinder having a combustion chamber; and

a fuel injector (100) configured to inject combustion matter in the combustion chamber of the cylinder, the fuel injector (100) comprising:

a nozzle chamber (104) comprising one or more nozzle exits (108);

a plunger (102) configured to move inside the nozzle chamber (104) to engage or disengage with the nozzle chamber (104) to block or allow, respectively, venting of combustible matter out of the nozzle chamber (104) via the one or more nozzle exits (108); and

a nozzle head (110) comprising one or more channels (112), the nozzle head (110) being fluidically coupled to the nozzle chamber (104) via the one or more nozzle exits (108) and the one or more channels (112), the nozzle head (110) being mechanically coupled with the plunger (102), wherein, in response to the downward movement of the plunger (102), the nozzle head (110) is configured to rotate about an axis (114) and simultaneously vent the combustible matter in a combustion chamber of a cylinder of an internal combustion engine via the one or more channels (112).

6. The internal combustion engine as claimed in claim 5, wherein

the nozzle head (110) comprises one or more follower paths (122);

the plunger (102) comprises a plunger head (402) having one or more projections (404), wherein each of the one or more projections (404) engages with one of the one or more follower paths (122), to mechanically couple the nozzle head (110) with the plunger (102).

7. The internal combustion engine as claimed in claim 5, wherein each of the one or more nozzle exits (108) is arc-shaped extending along the circumference of the nozzle chamber (104), wherein each of the one or more channels (112) remains fluidically coupled with the one or more nozzle exits (108).

8. The internal combustion engine as claimed in claim 7, wherein the nozzle head (110) comprises one or more first openings (118) and one or more second openings (120), wherein each of the one or more channels (112) extends between a respective first opening of the one or more first openings (118) and a respective second opening of the one or more second openings (120), wherein each of the one or more first openings (118) is fluidically coupled to one of the one or more nozzle exits (108), and each of the one more second openings (120) opens in the combustion chamber of the cylinder of the internal combustion engine, and wherein the nozzle head (110) is configured to vent the combustible matter from the one or more second openings (120).

9. The internal combustion engine as claimed in claim 5, wherein the nozzle head (110) is coupled to the internal combustion engine via a bearing.

10. The internal combustion engine as claimed in claim 5, wherein,

the internal combustion engine is a spark ignition engine, and wherein the combustible matter comprises one of gasoline-air mixture; or

the internal combustion engine is a compression ignition engine, and wherein the combustible matter comprises diesel.

Dated this 30th day of December 2019

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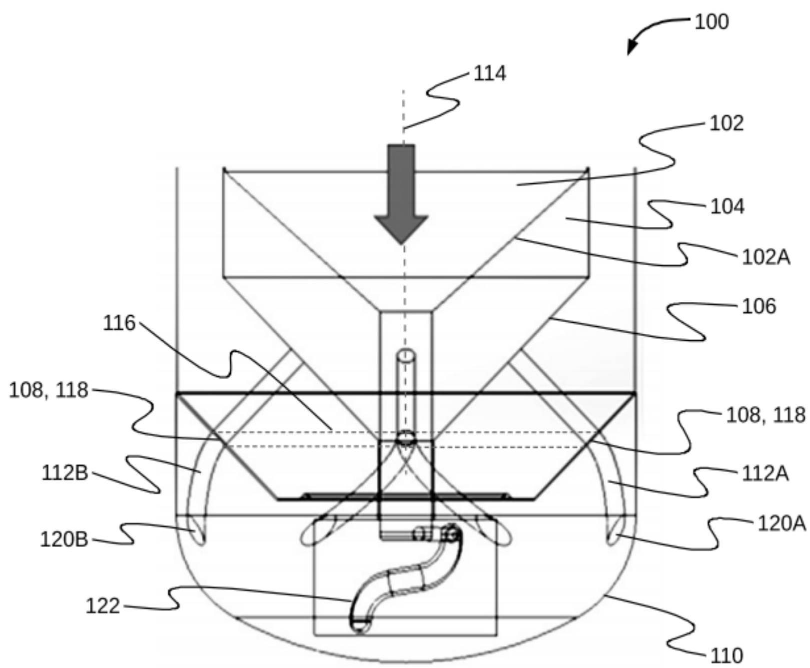
ABSTRACT
ROTATIONAL FUEL INJECTOR

This disclosure relates to a fuel injector (100) having a nozzle chamber (104) with one or more nozzle exits (108), and a plunger (102). The plunger (102) may be configured to move inside the nozzle chamber (104) to engage or disengage with the nozzle chamber (104) to block or allow, respectively, venting of combustible matter out of the nozzle chamber (104) via the one or more nozzle exits (108). A nozzle head (110) having one or more channels (112) may be fluidically coupled to the nozzle chamber (104) via the nozzle exits (108) and the channels (112). The nozzle head (110) may be mechanically coupled with the plunger (102). In response to the downward movement of the plunger (102), the nozzle head (110) may rotate about an axis (114) and simultaneously vent the combustible matter in a cylinder combustion chamber via the one or more channels (112).



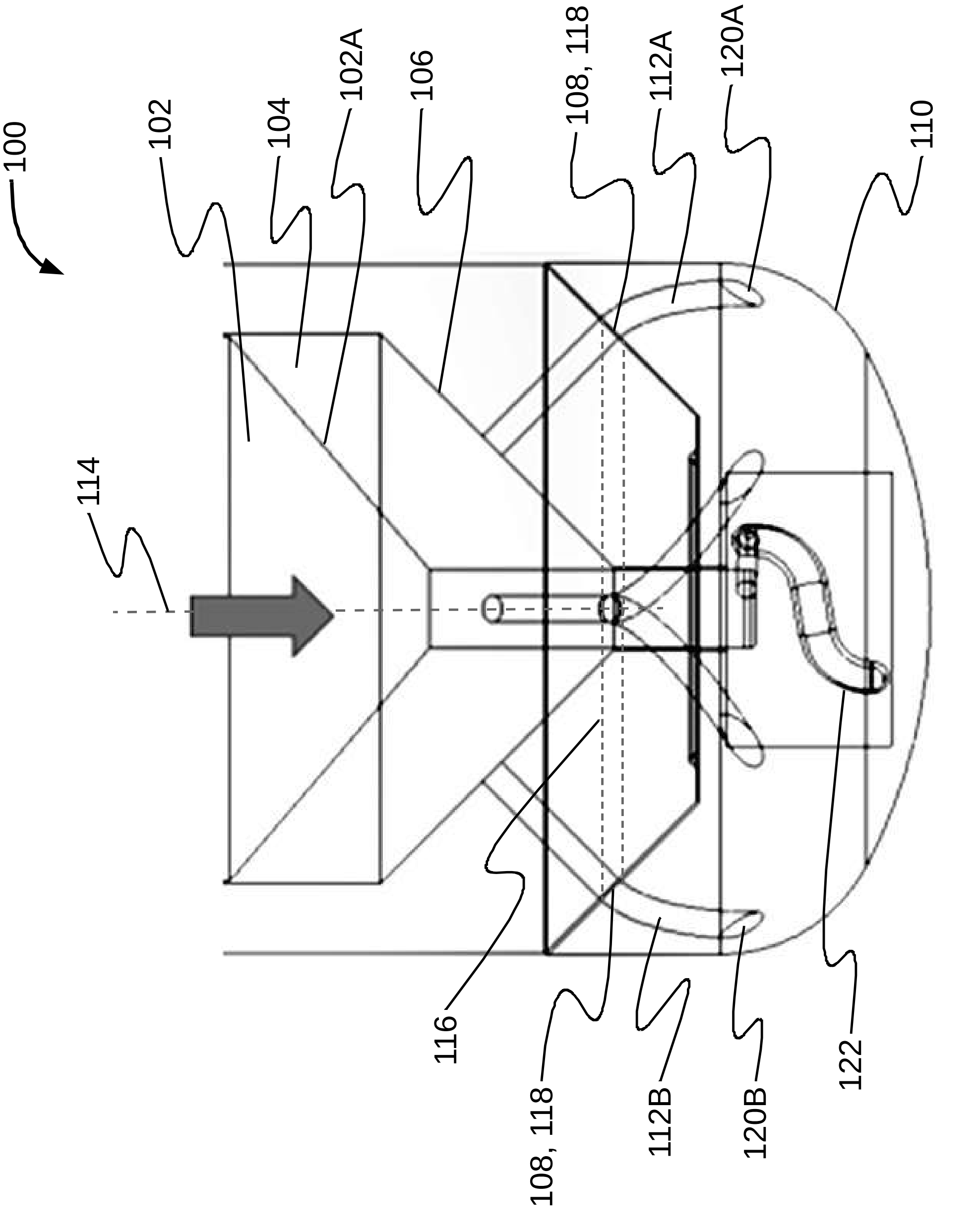


FIG. 1A

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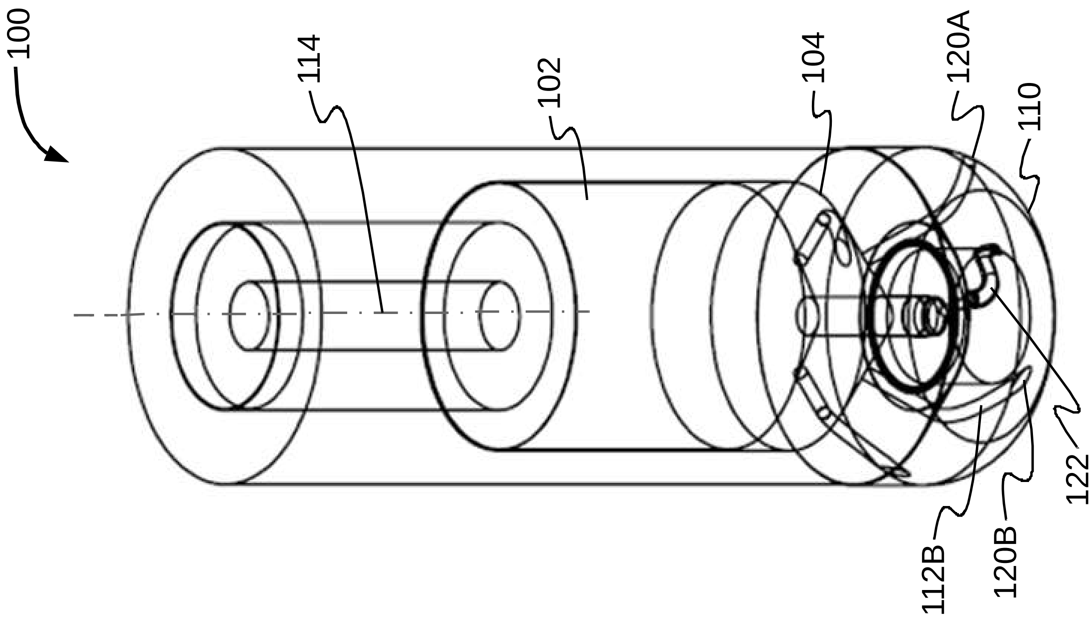

FIG. 1C

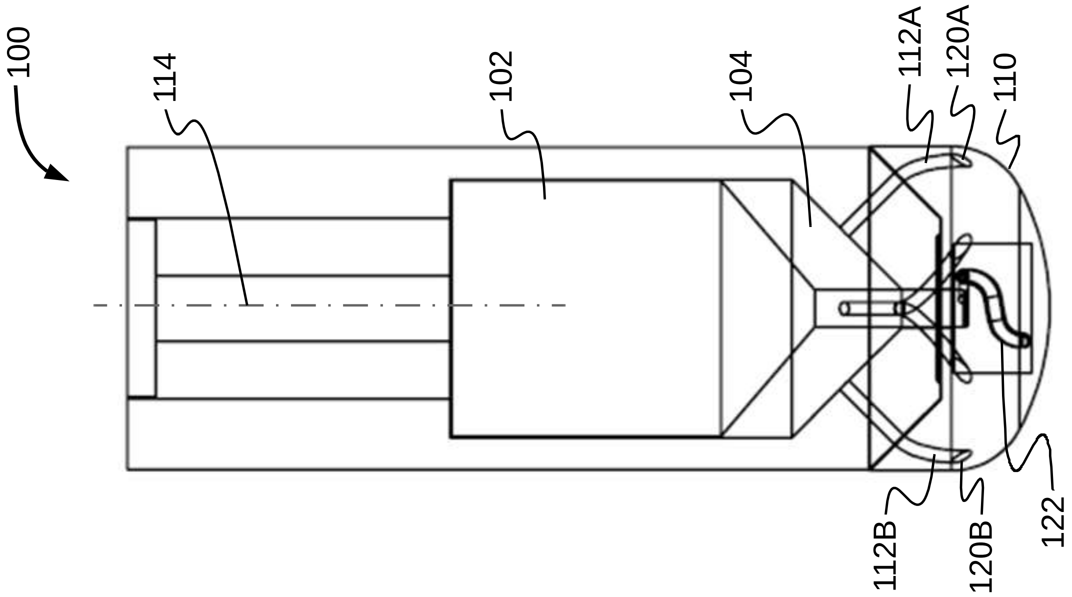

FIG. 1B

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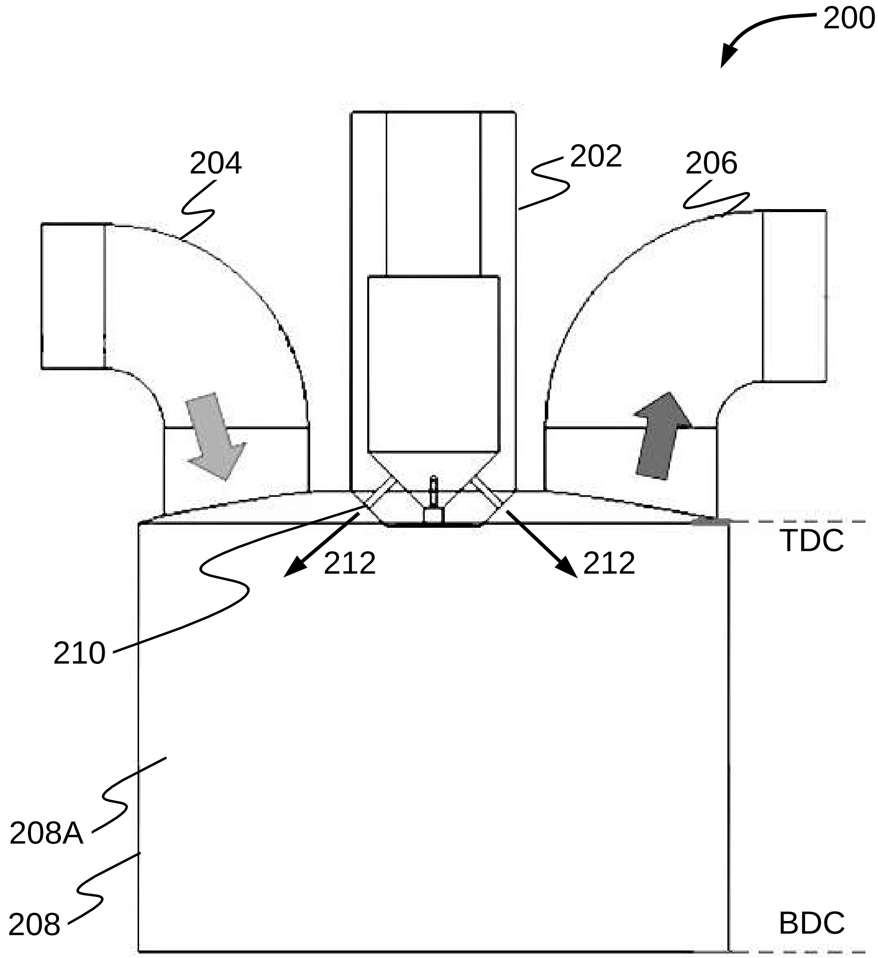

FIG. 2A
(Prior Art)

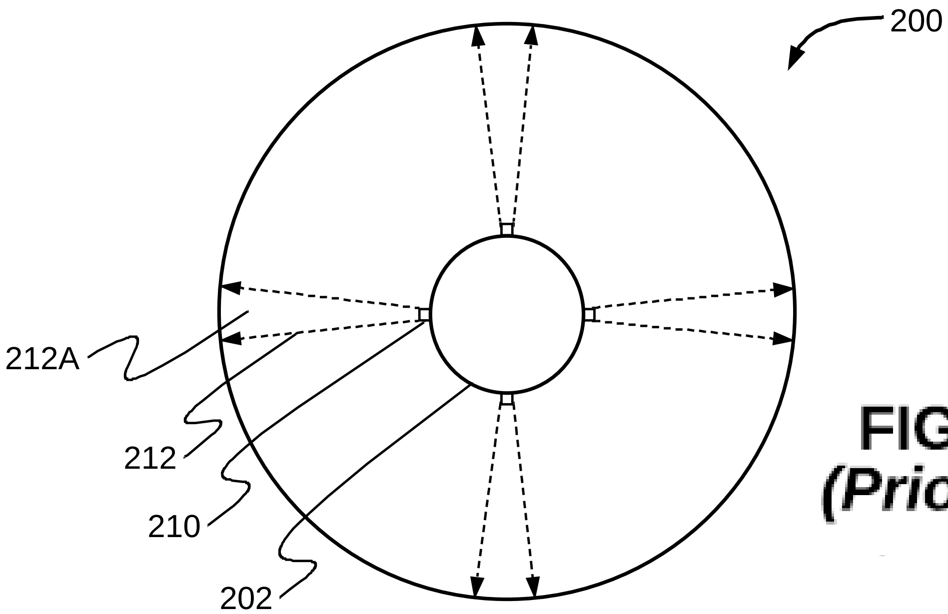

FIG. 2B
(Prior Art)

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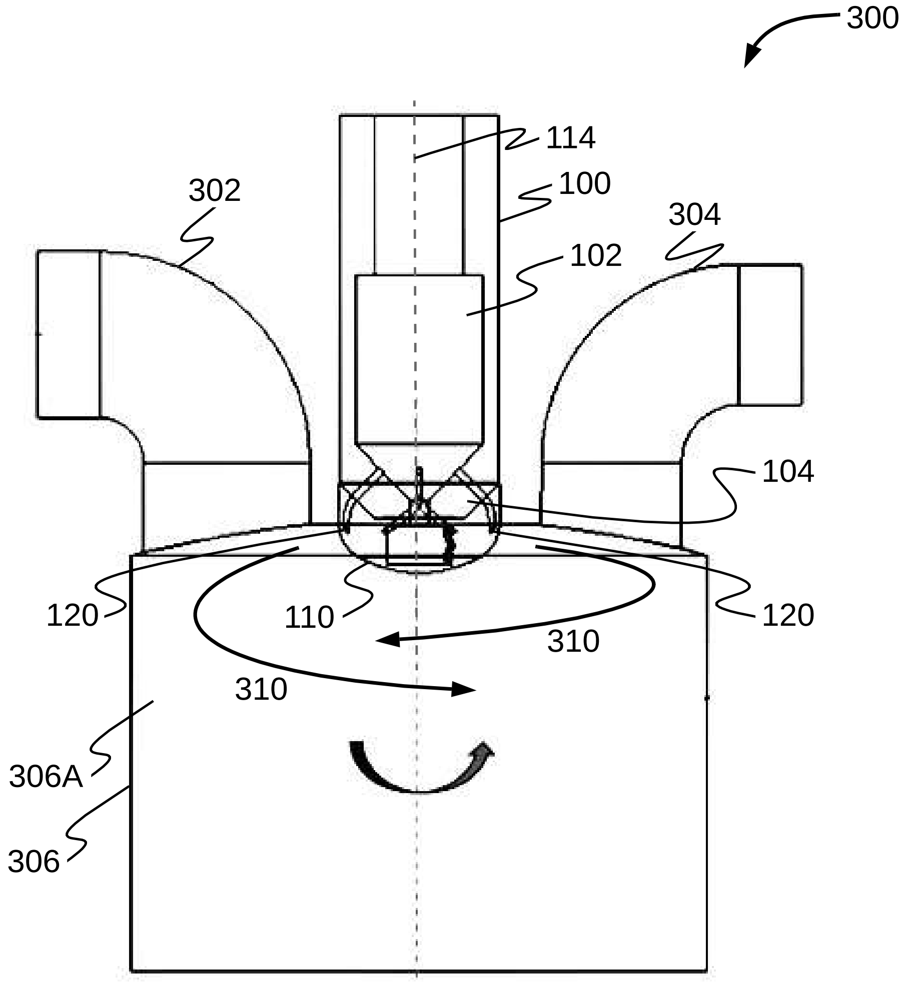

FIG. 3A

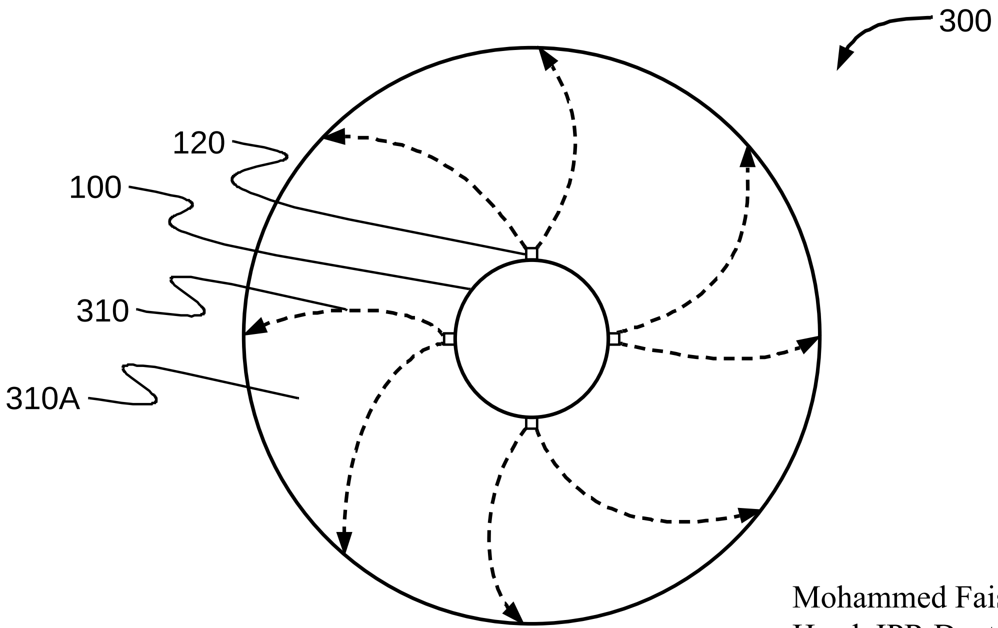

FIG. 3B

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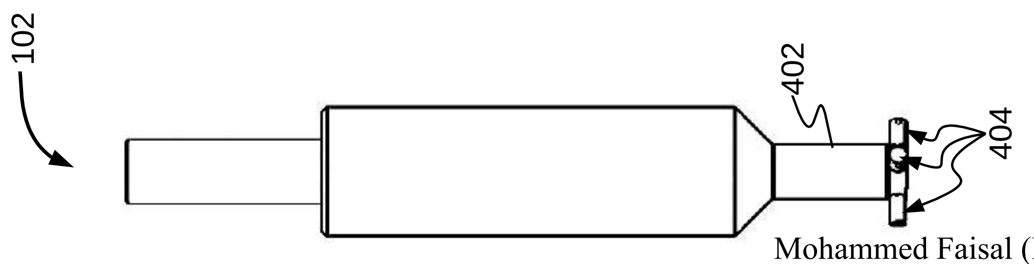

FIG. 4

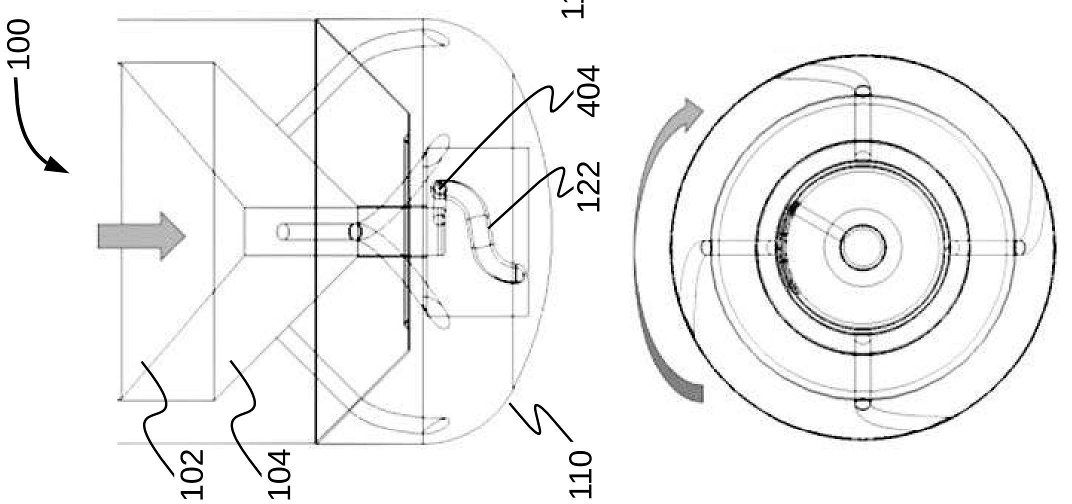

FIG. 5A

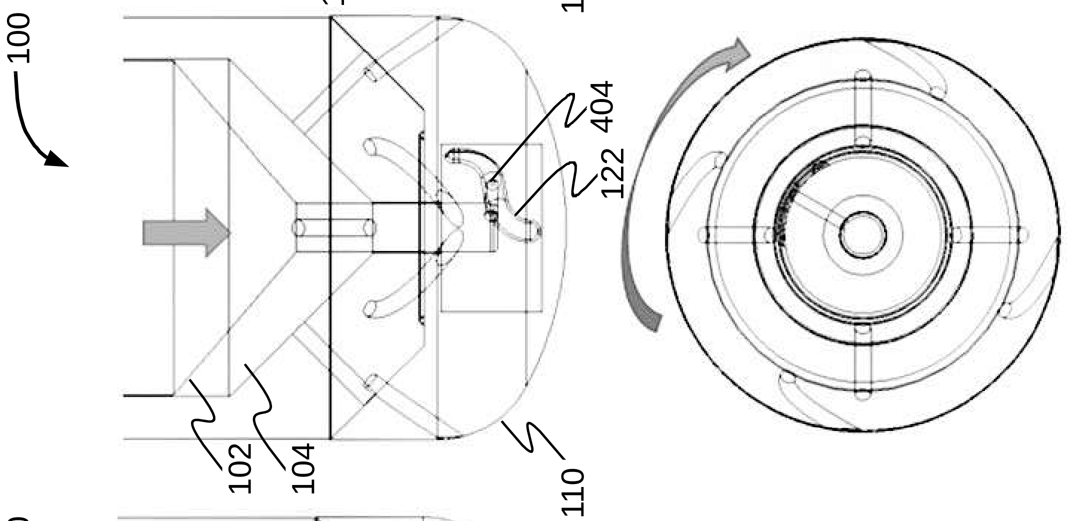

FIG. 5B

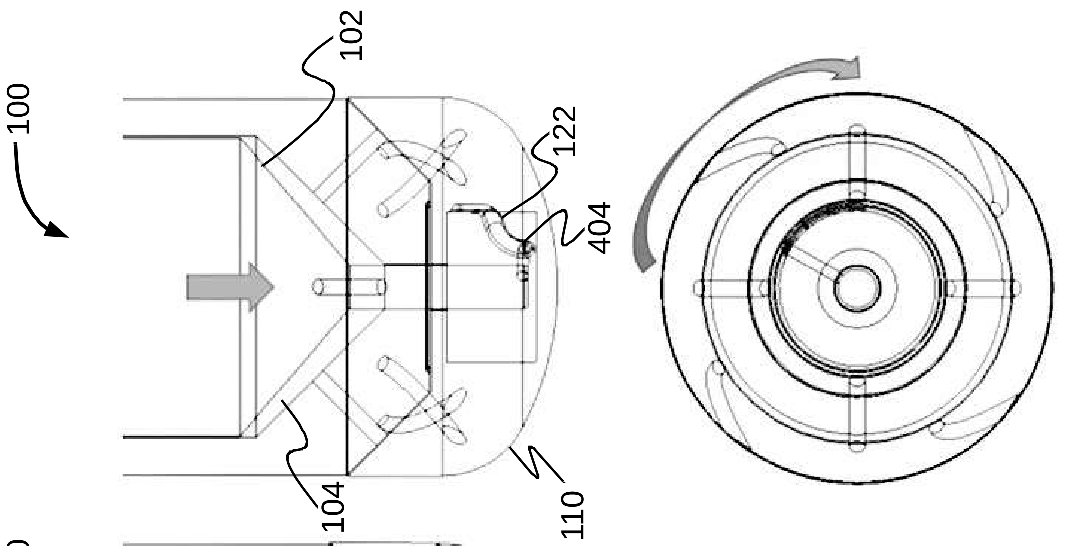

FIG. 5C

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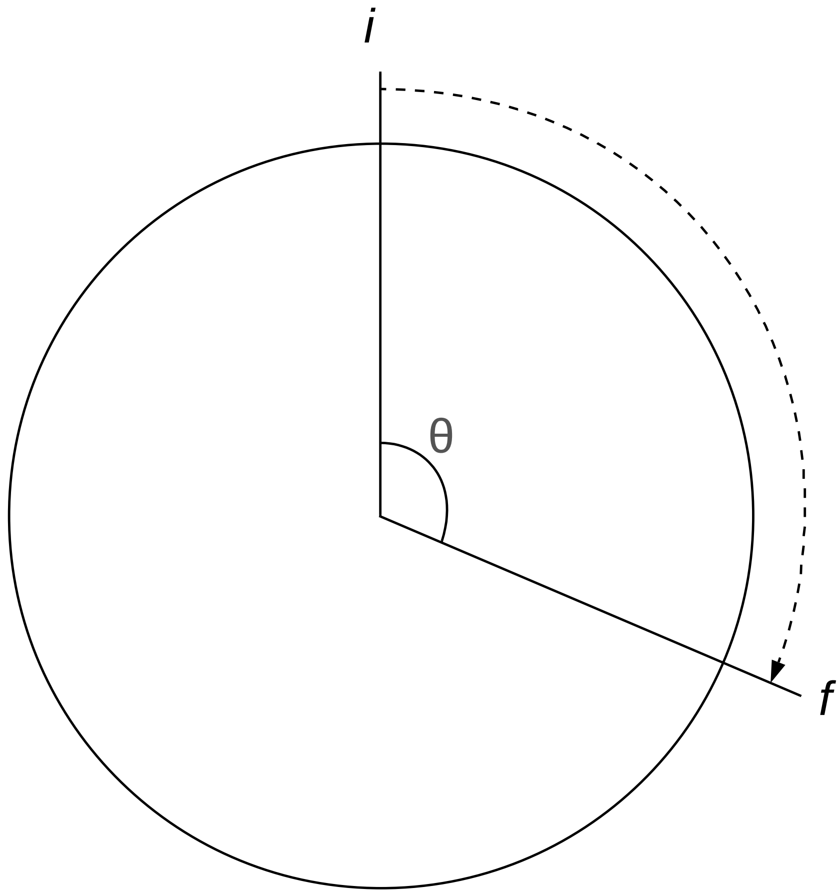

FIG. 5D

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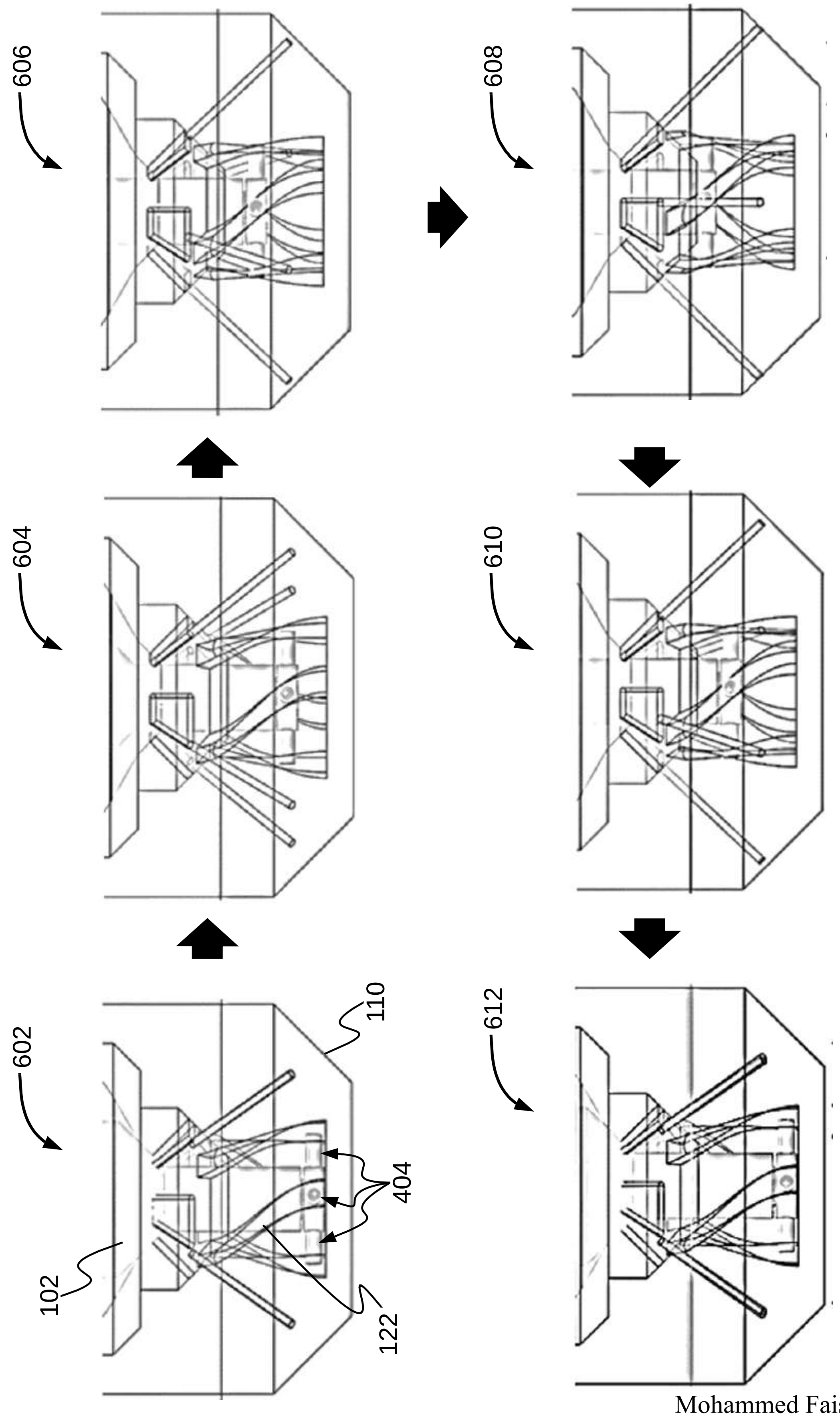

FIG. 6

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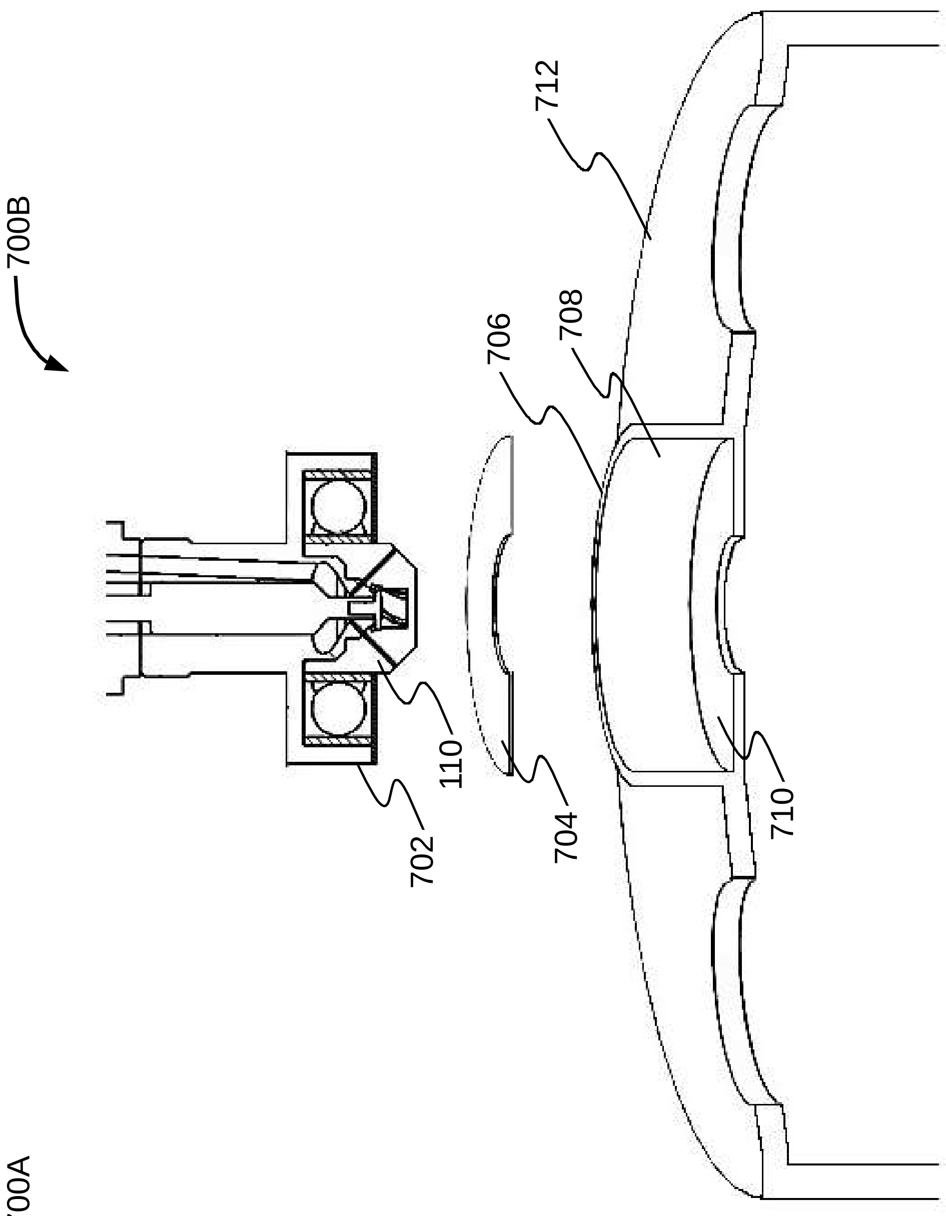

FIG. 7B

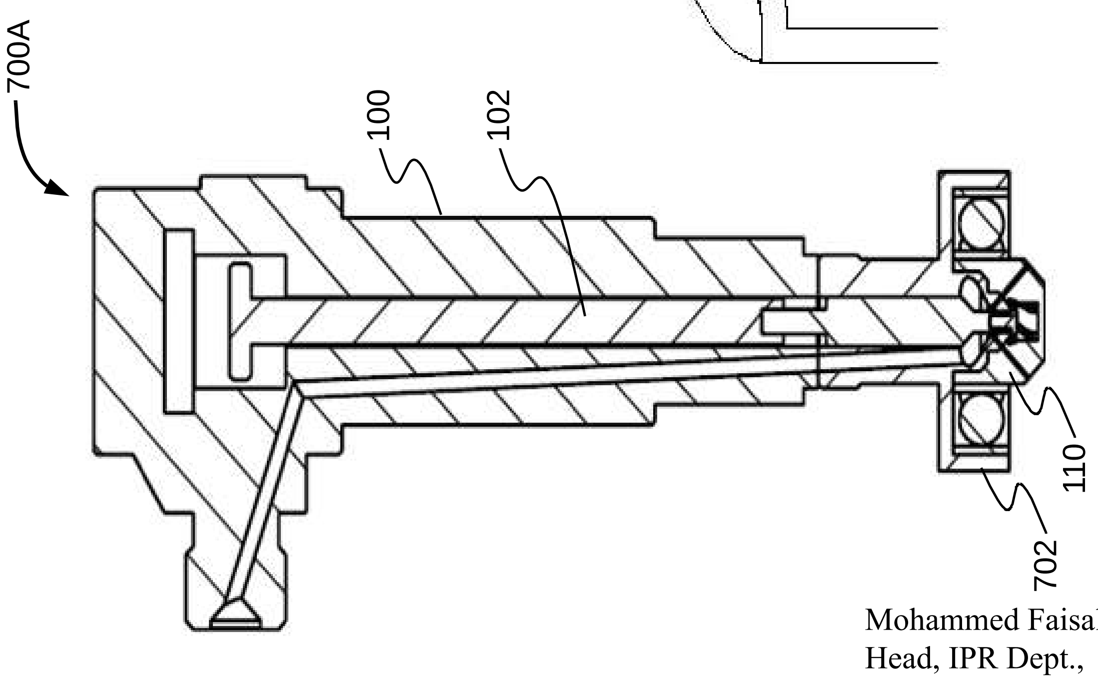

FIG. 7A

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