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(54) Title: ENGINE VALVE

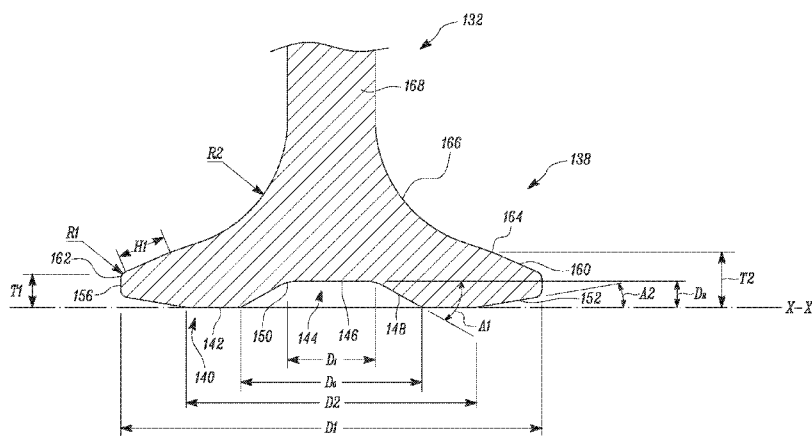


FIG. 4

(57) Abstract: A valve for use in an internal combustion engine (100) is provided. The valve includes a valve head. The valve head (138) includes a combustion face (140) configured to face a combustion chamber (110) of the internal combustion engine (100). The combustion face (140) includes an angular side portion (152). The combustion face (140) also includes a central recess portion (144) defining an inner diameter (Di) and an outer diameter (Do). The inner diameter (Di) and the outer diameter (Do) together define a depth (DR) of the central recess portion (144). The valve also includes a neck portion (166) configured to connect the valve head (138) with a valve stem (168) of the valve.

Description

ENGINE VALVE

Technical Field

5 The present disclosure relates to a valve, and more particularly to a gas exchange valve for use in an internal combustion engine.

Background

Each cylinder of an internal combustion engine includes a gas exchange valve, such as an intake valve and an exhaust valve. The gas exchange valves selectively open and close in order to control flow of gases into and out of the cylinder. During engine operation, the gas exchange valves are subjected to loading under high pressures and temperatures. Further, due to the loading, the gas exchange valves experience wear which may sometimes lead to valve failure. Also, an under head portion of the gas exchange valves typically experiences a classical chordal failure due to tensile stresses, which is not desirable.

U.S. Patent Number 8,869,511 describes a large sized two stroke diesel engine and a process for reducing the NOx-emission of the large sized two stroke diesel engine having at least one combustion room, a reciprocating piston and an exhaust opening controlled by an exhaust valve at each work cycle a small volume of burnt gas is retained in the combustion room and so added to the fresh air for the next combustion. For achieving this retention of burnt gas the underside of the valve disc of the exhaust valve is provided with a shallow concave face building a basin-like collection room, whose depth is within a range of 2-10% of the outer diameter of the valve disc.

25 Summary of the Disclosure

In one aspect of the present disclosure, a valve for use in an internal combustion engine is provided. The valve includes a valve head. The valve head includes a combustion face configured to face a combustion chamber of the internal combustion engine. The combustion face includes an angular side portion. The combustion face also includes a central recess portion defining an inner diameter and an outer diameter. The inner diameter and the outer diameter

together define a depth of the central recess portion. The valve also includes a neck portion configured to connect the valve head with a valve stem of the valve.

In another aspect of the present disclosure, an engine is provided. The engine includes a cylinder block having at least one combustion chamber.

5 The engine also includes a cylinder head positioned on the cylinder block, the cylinder head defining at least one passage. The engine further includes a gas exchange valve received within the at least one passage defined in the cylinder head. The gas exchange valve is configured to allow selective fluid communication between the at least one combustion chamber and the at least

10 one passage. The gas exchange valve includes a valve head. The valve head includes a combustion face configured to face the at least one combustion chamber of the engine. The combustion face includes an angular side portion and a central recess portion. The central recess portion defines an inner diameter and an outer diameter. The inner diameter and the outer diameter together

15 define a depth of the central recess portion. The valve also includes a neck portion extending from the valve head. The valve further includes a valve stem connected to the neck portion.

In yet another aspect of the present disclosure, a valve for use in an internal combustion engine is provided. The valve includes a valve head.

20 The valve head includes a combustion face configured to face a combustion chamber of the internal combustion engine. The combustion face includes an angular side portion. The combustion face also includes a central recess portion defining an inner diameter and an outer diameter. The inner diameter and the outer diameter together define a depth of the central recess portion. The valve

25 also includes a neck portion configured to connect the valve head with a valve stem of the valve. Further, a deflection of the combustion face relative to an imaginary plane is between 0.07 mm and 0.082 mm.

Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

30 Brief Description of the Drawings

FIG. 1 is a cross-sectional view of a portion of an exemplary engine, according to one embodiment of the present disclosure;

FIG. 2 is a cross-sectional view illustrating an enlarged view of portion 2-2 in FIG. 1, showing an intake valve associated with a cylinder head of the engine;

FIG. 3 is a perspective view of the intake valve, according to one embodiment of the present disclosure; and

FIG. 4 is a perspective view of the intake valve shown in FIG. 3.

Detailed Description

Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or the like parts. FIG. 1 illustrates an exemplary Internal Combustion (IC) engine 100, according to one embodiment of the present disclosure. The IC engine 100 is hereinafter interchangeably referred to as the engine 100. The engine 100 may include a multi cylinder IC engine. The engine 100 may be powered by any one or a combination of known liquid or gaseous fuels including, but not limited to, gasoline, diesel, natural gas, petroleum gas, bio-fuels, and the like.

The engine 100 includes a cylinder head 102 and a cylinder block 106. The cylinder head 102 is positioned on the cylinder block 106. The cylinder block 106 may include a number of cylinders 108. One such cylinder 108 is shown in the accompanying figure. The cylinder 108 defines a combustion chamber 110. The combustion chamber 110 slidably accommodates a piston 112. The piston 112 may have a translatory movement within the cylinder 108. The piston 112 may be coupled to one end of a connecting rod (not shown). Another end of the connecting rod may be coupled to a crankshaft (not shown). The connecting rod may be configured to convert the translatory movement of the piston 112 to a rotary movement of the crankshaft.

Further, the cylinder head 102 includes an intake passage 114 defined in the cylinder head 102. The intake passage 114 allows introduction of gases such as compressed air and/or an air and fuel mixture into the combustion chamber 110. During an intake stroke of the engine 100, the gases enter the combustion chamber 110 via the intake passage 114. The intake passage 114 terminates at an intake port 116 that leads to the combustion chamber 110. The intake port 116 includes a seat 118. Further, a seat insert 120 is positioned within the seat 118 of the intake port 116.

A gas exchange valve, hereinafter interchangeably referred to as an intake valve 130, is received within the intake passage 114. The intake valve 130 selectively opens and closes the intake port 116 in order to control a flow of the gases into the cylinder 108, to facilitate combustion.

5 The cylinder head 102 includes an exhaust passage 122 defined in the cylinder head 102. During an exhaust stroke of the engine 100, products of combustion such as exhaust gases and residual gases are expelled from the combustion chamber 110 and introduced in the exhaust passage 122. An exhaust port 124 is defined by the exhaust passage 122. The exhaust port 124 includes a
10 seat 126. Further, a seat insert (not shown) may be positioned within the seat 126 of the exhaust port 124. An exhaust valve 132 is positioned within the exhaust passage 122. The exhaust valve 132 selectively opens and closes the exhaust port 124 in order to expel the products of combustion from the combustion chamber 110.

15 The intake and exhaust valves 130, 132 embody a poppet valve. The intake and exhaust valves 130, 132 are movable between a first position and a second position. In the first position, the valves 130, 132 are in engagement with the respective seats 118, 126 to inhibit fluid flow through the intake and exhaust ports 116, 124 respectively. The intake and exhaust valves 130, 132 are
20 biased in the first position by spring elements 134, 136. In the second position, the valves 130, 132 move away from the respective seats 118, 126 to allow a fluid flow through the intake and exhaust ports 116, 124. Although a single intake and exhaust valve 130, 132 is shown in the accompanying figure, a number of the intake and exhaust valves may vary based on the number of
25 cylinders 108 of the engine 100. For example, when the engine 100 is embodied as a six cylinder engine, the engine 100 may include six intake valves and six exhaust valves.

 The engine 100 also includes other components (not shown), such as, a camshaft, a tappet, a push-rod, and a rocker arm. The camshaft may be
30 disposed within the cylinder head 102 of the engine 100. Alternatively, the camshaft may be disposed within the cylinder block 106 of the engine 100. The camshaft may be configured to operate the tappet, followed by the push rod, the rocker arm, and thereafter the respective valves 130, 132 to switch the valves between the first and second positions.

Design and structural details of the intake valve 130 will now be explained with reference to FIGS. 3 and 4. However, it is contemplated that the description provided below is equally applicable to the exhaust valve 132 of the engine 100, without limiting the scope of the present disclosure.

5 Referring to FIGS. 3 and 4, the intake valve 130 includes a valve head 138. The valve head 138 defines an outer diameter "D1" (shown in FIG. 4). The outer diameter "D1" of the valve head 138 is between 50 mm to 65 mm. In one example, the outer diameter "D1" is approximately equal to 59 mm. The valve head 138 includes a combustion face 140. The combustion face 140 of the
10 valve head 138 faces the combustion chamber 110. The combustion face 140 includes a planar surface 142. A diameter "D2" (shown in FIG. 4) of the planar surface 142 is between 35 mm to 45 mm. In one example, the diameter "D2" of the planar surface 142 is approximately equal to 39 mm.

The combustion face 140 includes a central recess portion 144.
15 The central recess portion 144 defines a bottom surface 146. The bottom surface 146 is parallel to the planar surface 142. An inner diameter "D_I" (shown in FIG. 4) of the central recess portion 144 is defined at the bottom surface 146. The inner diameter "D_I" is between 10 mm to 15 mm. In one example, the inner diameter "D_I" of the bottom surface 146 is approximately equal to 12.5 mm.

20 Further, the central recess portion 144 defines a side surface 148. The side surface 148 extends angularly from the bottom surface 146. An angle "A1" (shown in FIG. 4) is defined between the bottom surface 146 and the side surface 148. The angle "A1" may be within a range of 26° and 40°. In one example, the angle "A1" is approximately equal to 30°. Further, a fillet 150 (see
25 FIG. 4) is provided at a junction of the bottom surface 146 and the side surface 148. A radius of the fillet 150 may be within a range of 3 mm to 4 mm. In one example, the radius of the fillet 150 is approximately equal to 3.5 mm.

The central recess portion 144 defines an outer diameter "D_O". The outer diameter "D_O" is defined along a periphery 151 (see FIG. 3). Further,
30 the inner diameter "D_I" and the outer diameter "D_O" together define a depth "D_R" (shown in FIG. 4) of the central recess portion 144. The depth "D_R" may be within a range of 3 mm to 4 mm. In one example, the depth "D_R" is approximately equal to 3.75 mm.

The combustion face 140 includes an angular side portion 152. The angular side portion 152 extends angularly from an outer periphery 154 of the planar surface 142. An angle "A2" (shown in FIG. 4) is defined between the planar surface 142 of the combustion face 140 and the angular side portion 152 of the combustion face 140. The angle "A2" may be within a range of 9° and 10°. In one example, the angle "A2" is approximately equal to 9.5°.

A side face 156 of the valve head 138 extends from the angular side portion 152. Referring to FIG. 4, the side face 156 defines the outer diameter "D1" of the valve head 138. A thickness "T1" is defined between an upper periphery 158 (see FIG. 3) of the side face 156 and the planar surface 142. The thickness "T1" may be within a range of 5 mm to 6 mm. In one example, the thickness "T1" is approximately equal to 5.3 mm.

As shown in the accompanying figures, the valve head 138 includes a sealing face 160. The sealing face 160 extends angularly from the side face 156 of the valve head 138. When the intake valve 130 is in the first position, the sealing face 160 is in contact with the seat insert 120 (see FIG. 2). A slant height "H1" of the sealing face 160 may be within a range of 9.5 mm to 11 mm. In one example, the slant height "H1" is approximately equal to 10.6 mm. A curvature 162 is provided at a junction of the sealing face 160 of the valve head 138 and the side face 156. A radius "R1" of the curvature 162 may be within a range of 1 mm to 2 mm. In one example, the radius "R1" of the curvature 162 is approximately equal to 1.4 mm. Further, a thickness "T2" defined between a periphery 164 of the sealing face 160 and the planar surface 142 may be within a range of 7 mm to 9 mm. In one example, the thickness "T2" is approximately equal to 8 mm.

The intake valve 130 includes a neck portion 166. The neck portion 166 extends from the periphery 164 of the sealing face 160. The neck portion 166 connects the valve head 138 with a valve stem 168 (shown in FIG. 3) of the intake valve 130. A radius "R2" of the neck portion 166 may be within a range of 12 mm and 20 mm. In one example, the radius "R2" of the neck portion 166 is approximately equal to 17 mm.

Referring to FIG. 3, the intake valve 130 includes the valve stem 168. The valve stem 168 extends from the neck portion 166. The spring element 134 surrounds a portion of the valve stem 168. One end of the valve

stem 168 contacts the rocker arm for the movement of the intake valve 130 between the first and second positions. A length "L" of the valve stem 168 may be within a range of 200 mm and 250 mm. In one example, the length L" of the valve stem 168 is approximately equal to 238.8 mm. Further, a diameter "D3" of the valve stem 168 may be within a range of 11 mm and 14 mm. In one example, the diameter "D3" of the valve stem 168 is approximately equal to 12 mm.

The intake valve 130 may be made of a metal that is resistive to high pressures and high temperatures. In one example, the intake valve 130 may be made of chromo alloy, such as chromo 193[®]. The metal of the intake valve 130 may be subjected to one or more surface treatments, based on system requirements. Also, to arrive at a desired surface finish, one or more surfaces of the intake valve 130 may undergo a surface finishing process.

The intake valve 130 disclosed herein may embody a single unitary component. Alternatively, the components of the intake valve 130 such as the valve head 138, the neck portion 166, and the valve stem 168 may be manufactured as separate components that are assembled to form the intake valve 130. The intake valve 130 may be made using any additive manufacturing process or subtractive manufacturing process known in the art, without limiting the scope of the present disclosure.

Industrial Applicability

The present disclosure relates to the intake valve 130 of the engine 100 having a design that increases flexibility of the intake valve 130. The intake valve 130 includes increased amount of material provided on the combustion face 140 and a larger radius "R2" at the neck portion 166, as compared to known intake valves.

The dimensions and design of the valve head 138 improves the flexibility of the intake valve 130 to conform to cylinder head geometry at engine operating conditions. More particularly, the design of the valve head 138 of the intake valve 130 is such that a deflection of the combustion face 140 relative to an imaginary plane X-X' (see FIG. 4) is between 0.07 mm and 0.082 mm. For a 450 deg C inlet valve temperature, the deflection of the combustion face 140 relative to the imaginary plane X-X' is approximately equal to 0.7695

mm. Further, for a 650 deg C inlet valve temperature, the deflection of the combustion face 140 relative to the imaginary plane X-X' is approximately equal to 0.081 mm.

5 The intake valve 130 disclosed herein is subjected to reduced magnitudes of maximum principal stress during engine operation, thereby reducing any possibility of a chordal failure. More particularly, the design of the intake valve 130 is such that the neck portion 166 is subjected to a reduced principal stress of magnitude 246 MPa as compared to known intake valves that are subjected to principal stresses of magnitude 304 MPa at 450 deg C inlet
10 valve temperature. Further, the neck portion 166 is subjected to a reduced principal stress of magnitude 248 MPa as compared to known intake valves that are subjected to principal stresses of magnitude 303 MPa at 650 deg C inlet valve temperature.

15 While aspects of the present disclosure have been particularly shown and described with reference to the embodiments above, it will be understood by those skilled in the art that various additional embodiments may be contemplated by the modification of the disclosed machines, systems and methods without departing from the spirit and scope of what is disclosed. Such embodiments should be understood to fall within the scope of the present
20 disclosure as determined based upon the claims and any equivalents thereof.

Claims

1. A valve for use in an internal combustion engine (100), the valve comprising:

a valve head (138) comprising:

5 a combustion face (140) configured to face a combustion chamber (110) of the internal combustion engine (100), the combustion face (140) comprising:

an angular side portion (152); and

10 a central recess portion (144) defining an inner diameter (Di) and an outer diameter (Do), wherein the inner diameter (Di) and the outer diameter (Do) together define a depth (DR) of the central recess portion (144); and

a neck portion (166) configured to connect the valve head (138) with a valve stem (168) of the valve.

15

2. The valve of claim 1, wherein the valve includes at least one of an intake valve and an exhaust valve (132).

3. The valve of claim 1, wherein a deflection of the combustion face (140) relative to an imaginary plane (X-X') is between 0.07 mm and 0.082 mm.

20

4. The valve of claim 1, wherein the depth (DR) of the central recess portion (144) is between 3 mm and 4 mm.

25

5. The valve of claim 1, wherein a radius of the neck portion (166) is between 12 mm and 20 mm.

6. The valve of claim 5, wherein the radius of the neck portion (166) is 17 mm.

30

7. The valve of claim 1, wherein an angle defined between the angular side portion (152) of the combustion face (140) and a planar surface (142) of the combustion face (140) is between 9° and 10°, the planar surface

(142) being disposed between the angular side portion (152) and the central recess portion (144).

8. An engine comprising:

5 a cylinder block (106) having at least one combustion chamber (110);

a cylinder head (102) positioned on the cylinder block (106), the cylinder head (102) defining at least one passage; and

10 a gas exchange valve (130) received within the at least one passage defined in the cylinder head (102), the gas exchange valve (130) configured to allow selective fluid communication between the at least one combustion chamber (110) and the at least one passage, the gas exchange valve (130) comprising:

a valve head (138) comprising:

15 a combustion face (140) configured to face the at least one combustion chamber (110) of the engine, the combustion face (140) comprising:

an angular side portion (152); and

20 a central recess portion (144) defining an inner diameter (Di) and an outer diameter (Do), wherein the inner diameter (Di) and the outer diameter (Do) together define a depth (DR) of the central recess portion (144);

a neck portion (166) extending from the valve head; and

25 a valve stem (168) connected to the neck portion.

9. The engine of claim 8, wherein the gas exchange valve (130) includes at least one of an intake valve and an valve (132).

30 10. The engine of claim 8, wherein an angle defined between the angular side portion (152) of the combustion face (140) and a planar surface (142) of the combustion face (140) is between 9° and 10°, the planar surface (142) being disposed between the angular side portion (152) and the central recess portion (144).

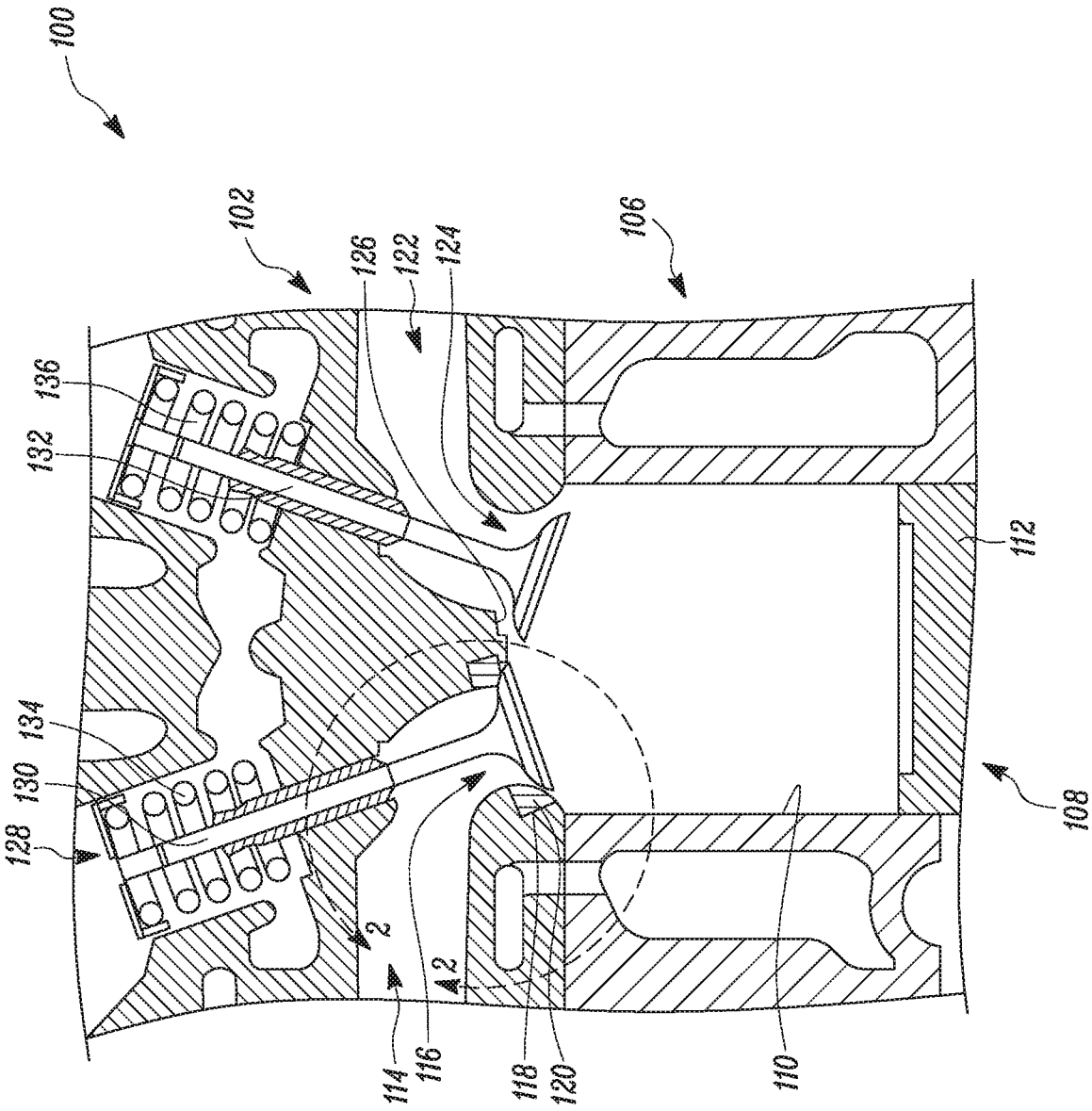


FIG. 1

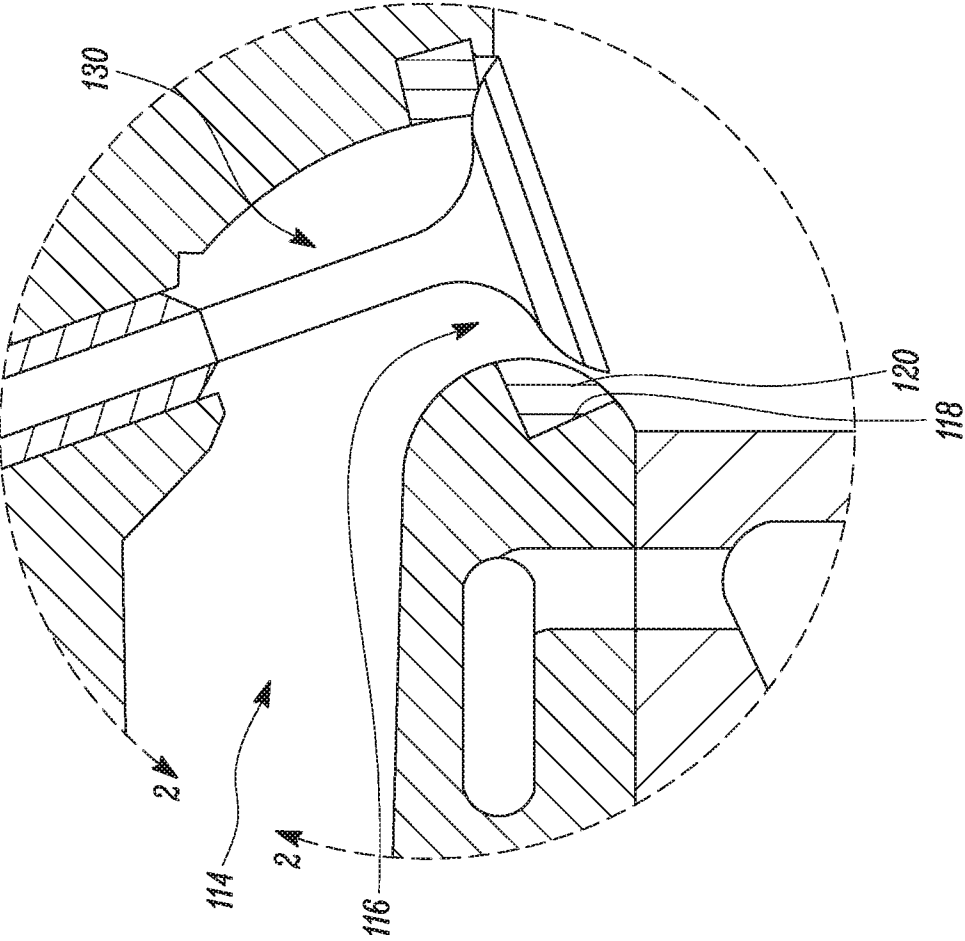


FIG. 2

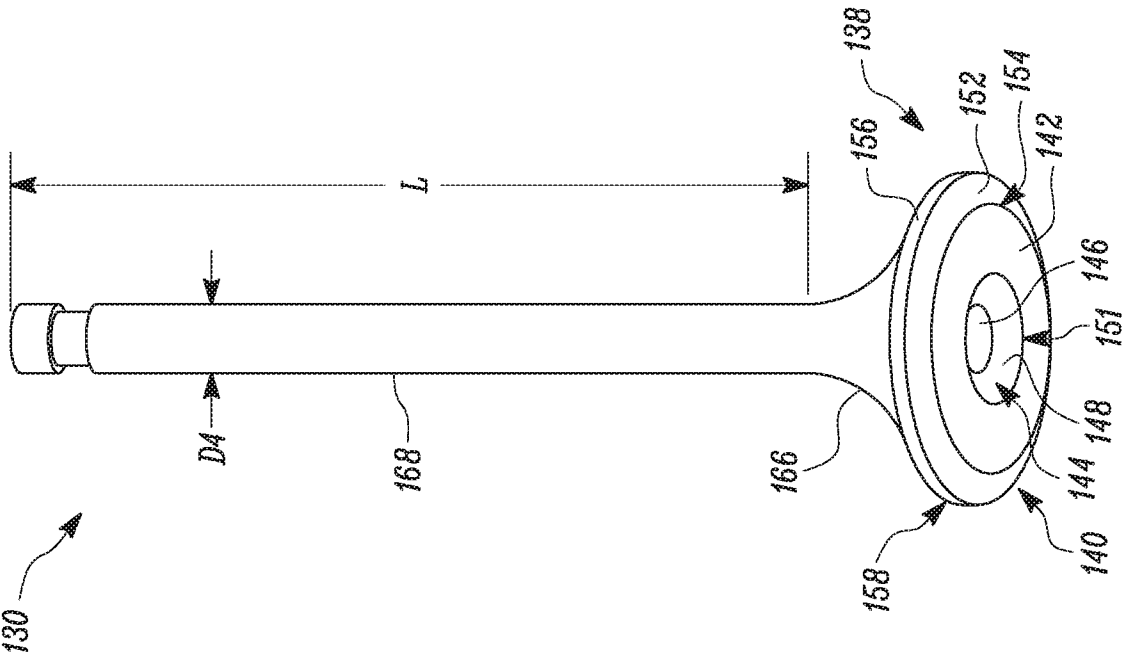


FIG. 3

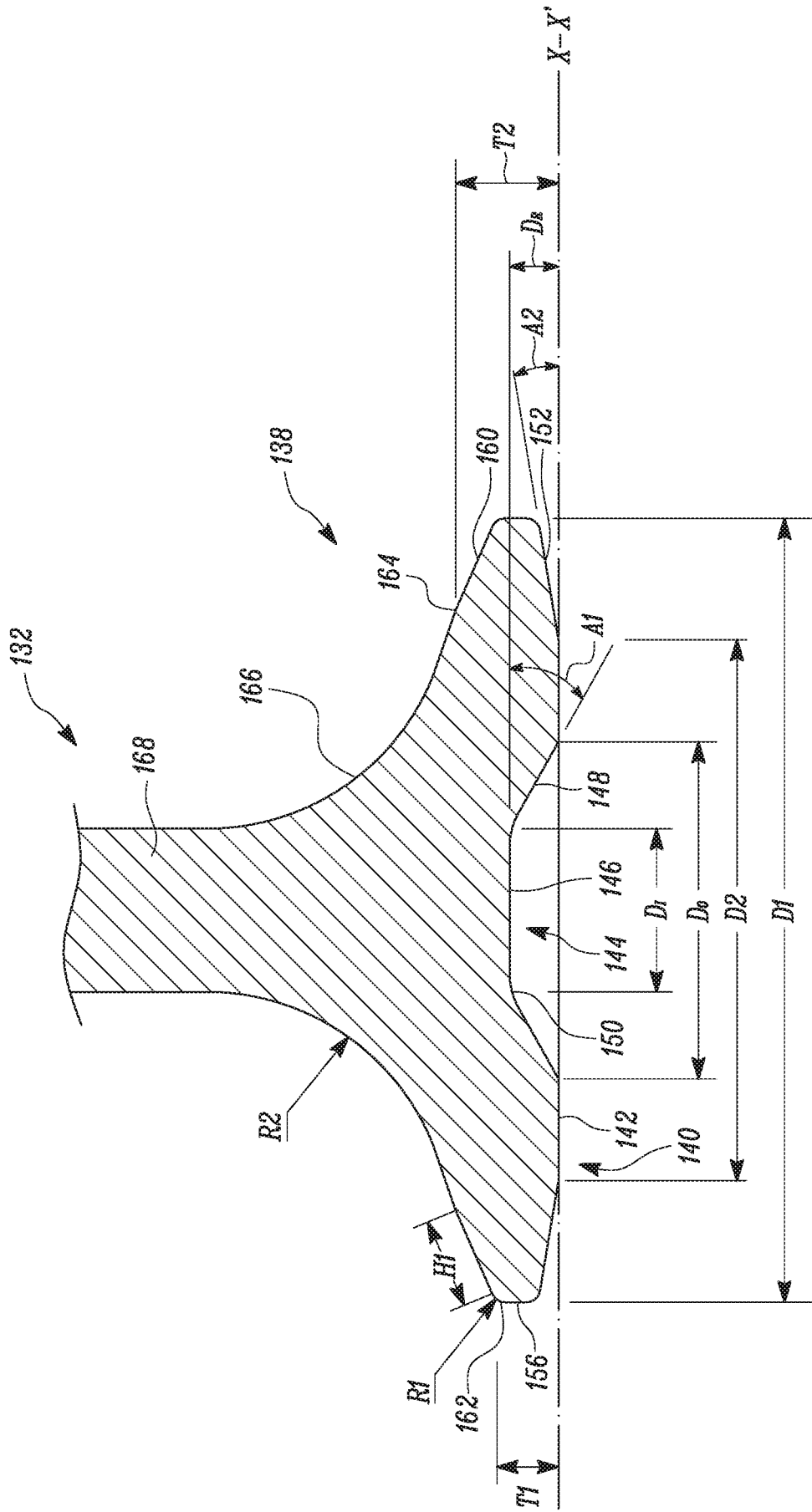


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/064060**A. CLASSIFICATION OF SUBJECT MATTER****F01L 3/02(2006.01)i, F01L 3/20(2006.01)i, F01L 3/22(2006.01)i**

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)

F01L 3/02; F01L 3/06; F16K 1/48; F01L 3/20; F01L 3/00; F01L 3/22

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: combustion, engine, intake, exhaust, valve, head, concave, hollow, recess, face, neck

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1643087 A1 (EATON S.R.L.) 05 April 2006 See paragraphs [0008], [0015]-[0018], [0022]-[0024]; and figures 2-3.	1-10
A	US 5081965 A (WALTERS et al.) 21 January 1992 See column 3, lines 5-30; column 4, lines 3-21; and figures 2-3.	1-10
A	US 4779584 A (MOSLER, WARREN B.) 25 October 1988 See column 5, lines 8-65; and figures 3-4.	1-10
A	US 4815706 A (FEULING, JAMES J.) 28 March 1989 See column 5, lines 4-24; and figures 5-6.	1-10
A	US 2007-0040144 A1 (ABELE et al.) 22 February 2007 See paragraphs [0003], [0006]-[0009], [0019]-[0024]; and figures 1-4.	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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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

"T" 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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/064060

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