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(54) Engine valve with heat absorbing ridges in the combustion chamber

(57) A poppet valve (50) has a solid head (54) which is thin-walled except for concentric ridges (64,66) on a concave combustion surface (60). These ridges increase the surface area and result in the valve seat-engaging face (58) of the head becoming sufficiently hot as to burn off carbon deposits.

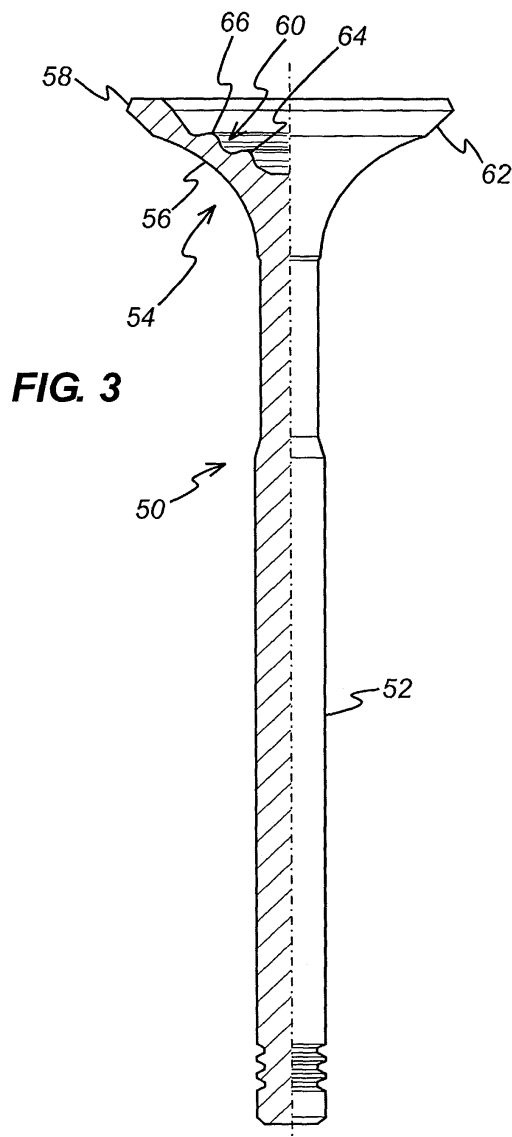


FIG. 3

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to valves for internal combustion engines, and is particularly but not exclusively related to intake valves for direct-injection engines.

Description of the Prior Art

[0002] An engine valve typically has a stem and a head, the head having a combustion face which is directed towards the interior of the combustion chamber when the valve is in use, and a valve seat-facing surface which is directed generally outwardly of the combustion chamber and which has a region which engages the valve seat when the valve is closed.

[0003] US-A-5 413 073 discloses a hollow valve in which the stem is shaped into a funnel-like portion at one end, this portion forming the majority of the outer face of the valve head. A separately-formed cap is fitted to the funnel portion, the cap providing the combustion face and the valve seat-engaging region.

[0004] A problem with such arrangements is that carbon deposits can form on the outer face of the valve head. This probably is mitigated to some extent in conventional engines because the deposits can be washed from the surface of the valve by the surrounding atmosphere which contains entrained combustant. However, this does not apply to direct injection engines, where the problem of carbon deposits, especially on intake valves, is more serious.

[0005] Efforts have been made to mitigate this problem. Some efforts have been directed to coating the exterior of the valve with a material, such as vanadium pentoxide, which does not readily permit the formation of carbon deposits. However, these solutions are expensive, and require polishing of the valve to permit the coating to be securely applied. Other solutions attempt to keep the outer part of the valve cold in order to avoid baking of the carbon deposits. However, these attempts have had limited success.

[0006] It would therefore be desirable to provide a valve design which at least substantially mitigates the problem of the build up of carbon deposits on the outer face of the valve head.

SUMMARY OF THE INVENTION

[0007] Aspects of the present invention are set out in the accompanying claims.

[0008] According to a further aspect of the invention, a poppet valve (preferably an intake valve) of an internal combustion engine (preferably but not necessarily a direct injection engine) has a solid head, preferably integrally-formed with at least a portion of the stem, with a

ridged combustion surface and a smooth outer surface. Preferably, the head has a small wall thickness (e.g. less than 2.5 mm and preferably less than 1.75 mm) in those regions where no ridge is present.

[0009] Because the combustion face is ridged, there is an increased surface area so that the combustion face gets hotter during use of the valve. This heat is conducted through the solid, and preferably thin, wall of the valve head, thereby increasing the temperature of the outer face to such an extent that any carbon deposits are burnt off.

[0010] The ridges, as well as increasing surface area, serve an additional function in that they stiffen the valve head and thus prevent excessive flexibility caused as a result of the absence of the valve cap frequently found in prior art arrangements such as that of US-A-5 413 073, and exacerbated by the thinness of the wall of the valve head.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Arrangements embodying the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal section through a prior art poppet valve;

Figure 2 schematically shows a direct-injection engine in accordance with the invention;

Figure 3 is a longitudinal view, partly in section, of a poppet valve in accordance with the present invention;

Figure 4 is a perspective view of the valve of Figure 3; Figures 5A, 5B, 5C and 5D schematically illustrate variations in the shape of the cross-section of the valve head; and

Figure 6 is a perspective view of another embodiment of a poppet valve in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Referring to Figure 1, there is illustrated a poppet valve 10 corresponding to that shown in Figures 8 and 9 of US-A-5 413 073. The valve 10 comprises a stem element 12 and a head 14. The head 14 is formed of a cap member 16 and a neck formed by a funnel-like extension 18 of the stem element. The cap member 16 is welded or otherwise joined to the neck 18.

[0013] The cap member 16 is a disk which is formed with a combustion face 22 and an internal face 23. A seat face 20, for engaging a valve seat (not shown), can be formed by machining, deposition and machining or other known methods.

[0014] The cap 16 has a plurality of ribs 28 formed on the inner face as shown in full line in Fig. 1. Alternatively, the ribs may be formed on the combustion face as shown

in broken lines at 28°. The ribs act as stiffeners for the cap, and further act to increase the surface area of the cap to improve heat transfer.

[0015] Figure 2 schematically shows a direct-injection engine 40 in accordance with the invention. Each cylinder, one of which is shown at 42 has associated therewith one or two inlet valves 50, one or two exhaust valves 44, a spark plug 46 and a fuel injector 48.

[0016] Figures 3 and 4 show the poppet valve 50 of the engine.

[0017] The valve 50 has a stem 52 and a head 54. The head 54 comprises a funnel-shaped neck portion 56 and an integrally-formed seat-engaging portion 58, both of which are integrally formed with the stem 52. The cap member 16, which was found necessary in the prior art arrangement of Figure 1 for providing a combustion face and strengthening the valve structure, is omitted. Accordingly, the concave interior of the head 54 forms the combustion face 60. The outer surface of the seat-engaging portion 58 includes a circumferential area indicated at 62 for engaging a valve seat (not shown in Figures 3 and 4).

[0018] The combustion face 60 includes raised portions where the wall-thickness of the neck portion 56 is increased. In the embodiment shown in Figures 3 and 4, these raised portions take the form of rings 64 and 66, which are concentric with the longitudinal axis of the valve.

[0019] The height of each raised portion relative to the adjacent thin-walled areas is preferably greater than 2 mm. Preferably, the wall thickness between these regions is less than 2.5 mm and more preferably less than 1.75 mm, e.g. 1.5 mm. The raised portions provide a stiffening effect to ensure that the head can withstand the stresses occurring in the operating environment. In addition, they increase the surface area of the combustion face 60, which thereby transfers more heat into the head.

[0020] This heat is transferred to the outer surface of the head 54, the heat transfer being assisted by the fact that the neck portion 56 is thin in the regions between the ridges. Accordingly, the exterior of the head becomes hotter and any carbon deposits are burned off. A further advantage of this arrangement is that the valves heat up more quickly after the engine is started from cold, thereby reducing the risk of improper combustion. In prior art engines, fuel would tend to condense on the intake valves after a cold start, but this effect disappears using valves in accordance with the present invention.

[0021] In the past, it was felt that concave combustion faces would be undesirable, because they would create unwanted combustion space. However, it has been found that in practice, particularly in direct injection engines, the concavity of the combustion face does not give rise to problems. This is believed to be due to the fact that the combustant in the engine cylinder is stratified.

[0022] The outer face of the neck portion 56 is smooth, as in prior art arrangements, so as to avoid turbulence during engine operation. Also, the temperature of the

head is increased if the exterior surface area is kept small.

[0023] Figures 5A to 5D illustrate schematically various different profiles of the cross-section of the valve head 54, and also schematically show the valve seat 72. In Figure 5A, the combustion face is smooth except for a single ridge in the form of a ring 64 coaxial with and close to the stem 52. Figure 5B shows a similar arrangement except that the ring 64 is disposed about halfway down the head 54. Figure 5C shows an arrangement which is similar to that of Figure 5B, except for an additional hump 74 at the centre of the combustion face 60. In Figure 5D, there are two concentric rings 64 and 66, of relatively low profile compared with the rings in the arrangements of Figures 5A to 5C. The concentric ridges preferably have domed, rather than sharp, peaks when viewed in cross-section.

[0024] The head could be formed by any of a number of methods, including forging and turning. The valve is preferably made from martensitic steel to enable ridges to be formed to a height of 2.5 mm using a forging process. Preferably, there are at least two concentric ridges to ensure a significant temperature increase on the exterior of the neck portion 56. Preferably, this temperature is kept between 400°C and 550°C, in order to be effective in burning off deposits while not being so high that the martensitic material tends to creep. The ridges are preferably in the form of concentric ridges so as to reduce thermal distortion of the valve head. However, other forms are possible, including radial ribs or a rectangular grid, possibly in addition to the concentric ridges.

[0025] Figure 6 shows an alternative embodiment in which reference numerals corresponding to those in Figures 3 and 4 represent like elements. In addition to the two concentric ridges, the valve head is formed with four radially-extending ribs, 80, 82, 84 and 86.

Claims

1. A poppet valve (50), the head (54) of which is solid and comprises a valve seat-engaging portion (58) and a neck portion (56) with a smooth outer surface joining the seat-engaging portion (58) to a stem (52) of the valve, wherein the head has a ridged combustion surface (60).
2. A valve as claimed in claim 1, wherein the valve head (54) has one or more ridges (64, 66) which are concentric with the longitudinal axis of the valve (50).
3. A valve as claimed in claim 2, wherein the valve head (54) has at least two concentric ridges (64, 66).
4. A valve as claimed in any preceding claim, wherein the minimum wall thickness of the head (54) is less than 2.5 mm.
5. A valve as claimed in claim 4, wherein the minimum

wall thickness of the head (54) is less than 1.75 mm.

6. A valve as claimed in any preceding claim, wherein the combustion surface (60) is concave.

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7. A valve as claimed in any preceding claim, wherein the head (54) is integrally-formed with at least a portion of the stem (52) of the valve.

8. An intake valve as claimed in any preceding claim. 10

9. A direct-injection internal combustion engine including one or more valves as claimed in any preceding claim.

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FIG. 1 (PRIOR ART)

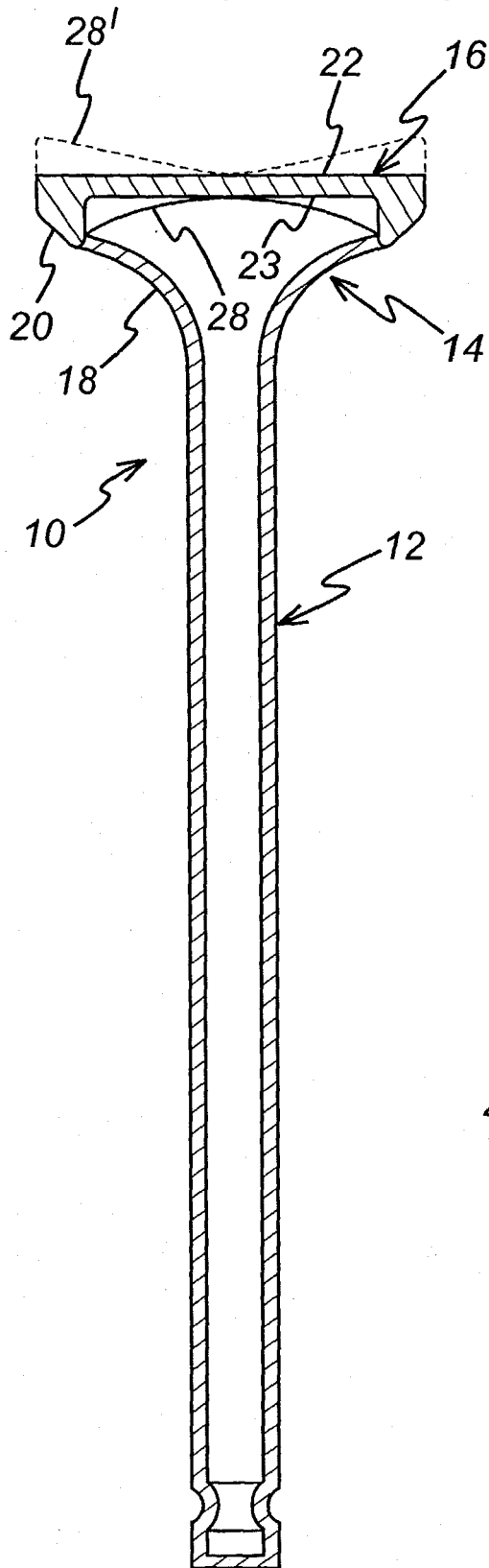
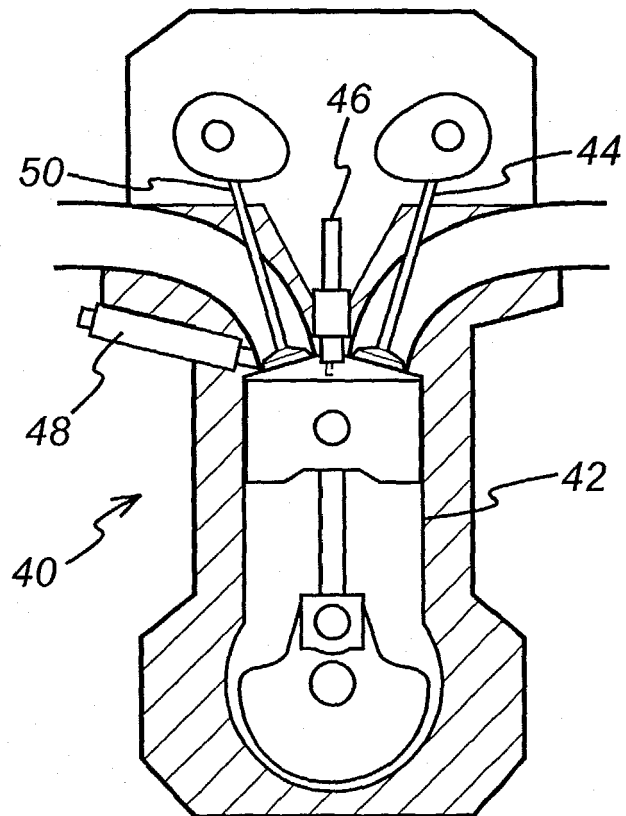


FIG. 2



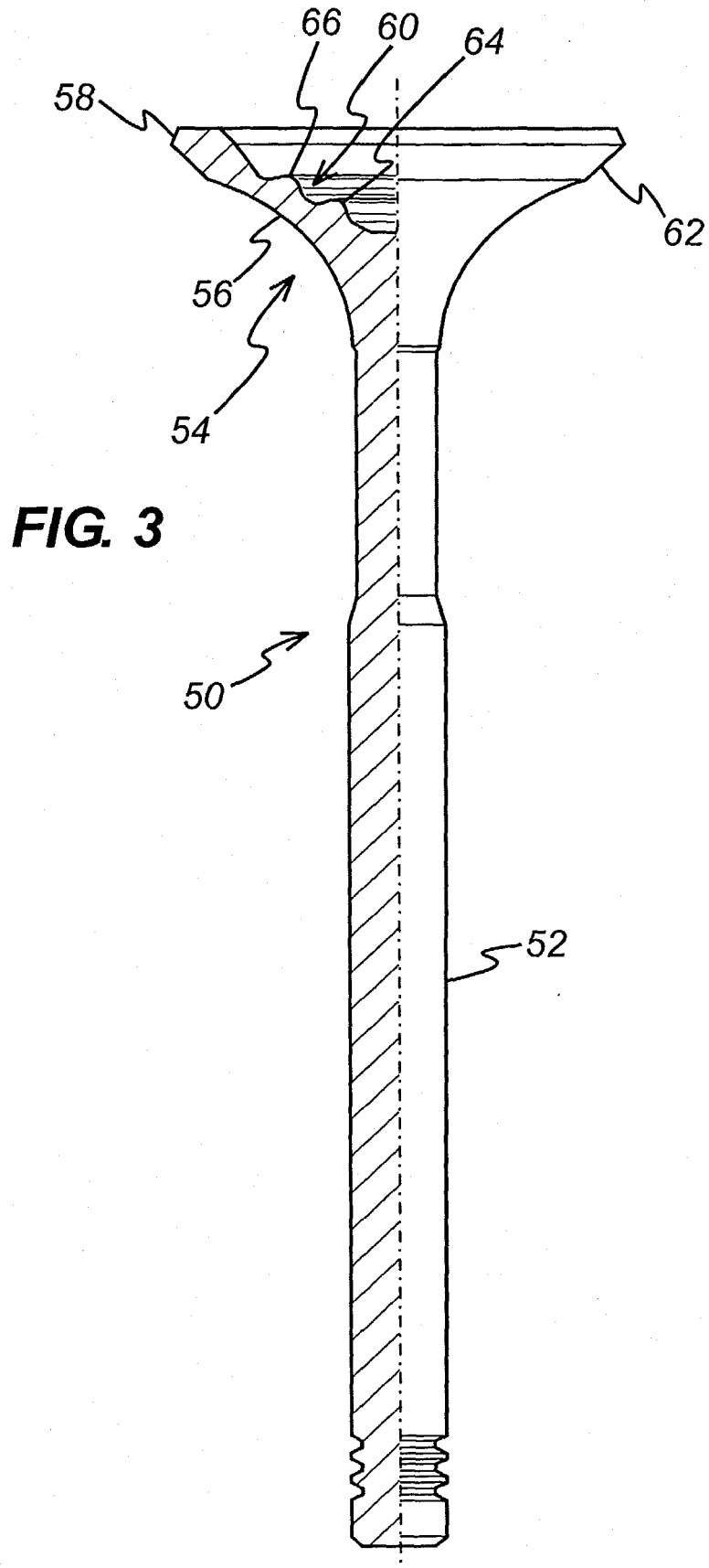


FIG. 4

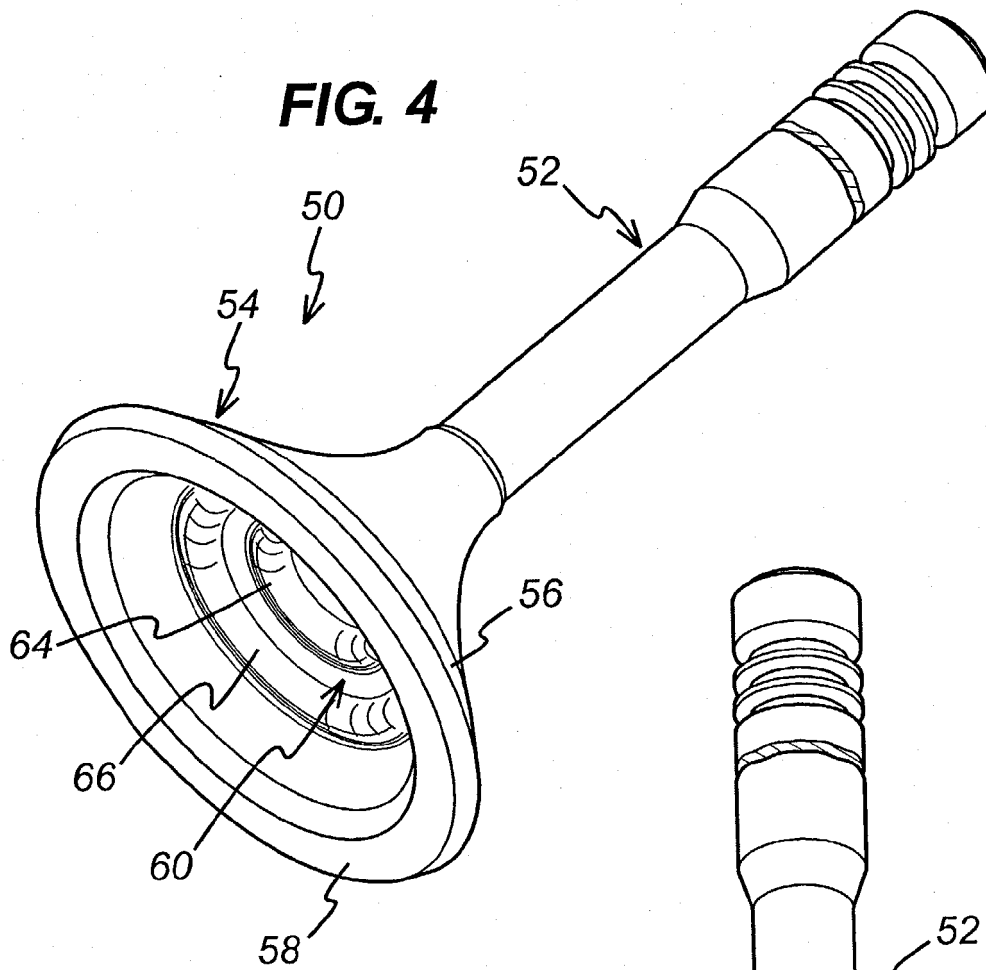


FIG. 6

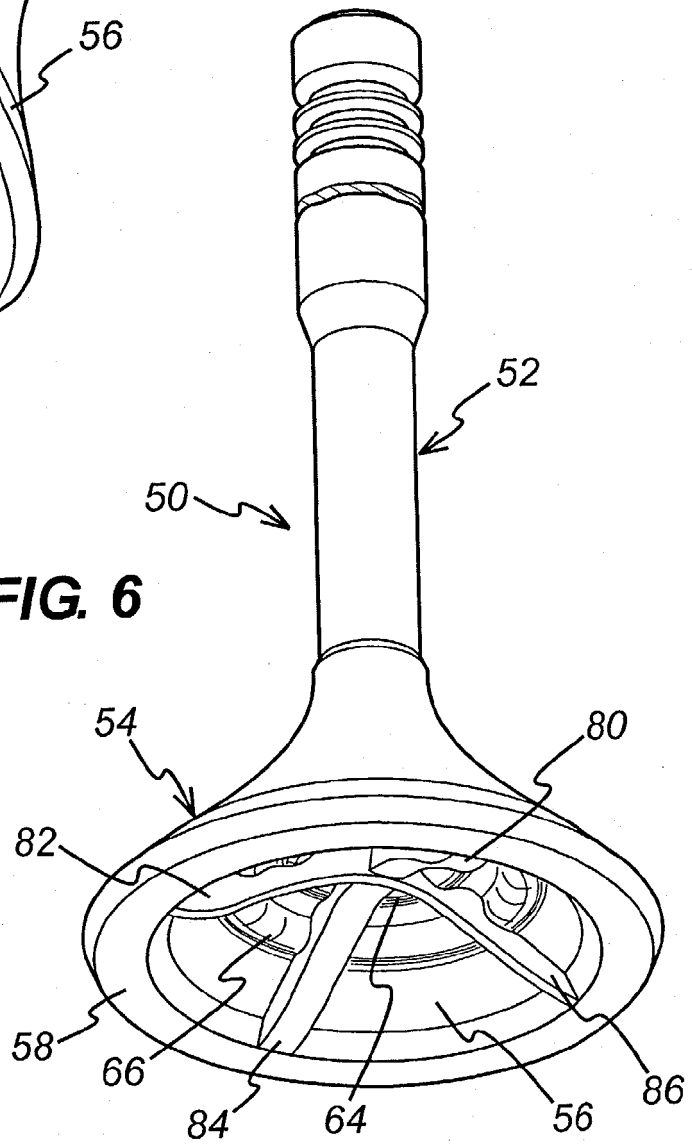


FIG. 5(A)

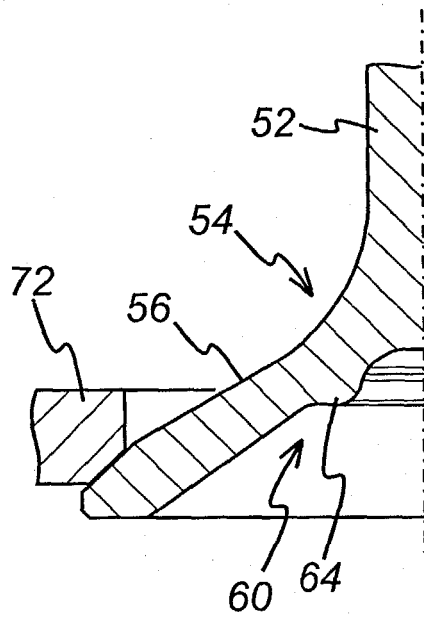


FIG. 5(B)

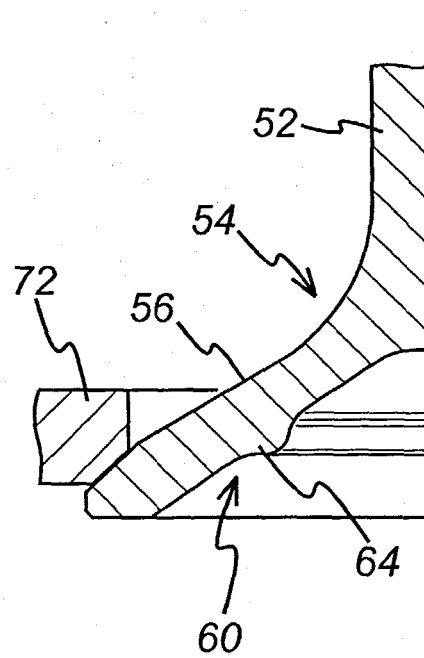


FIG. 5(C)

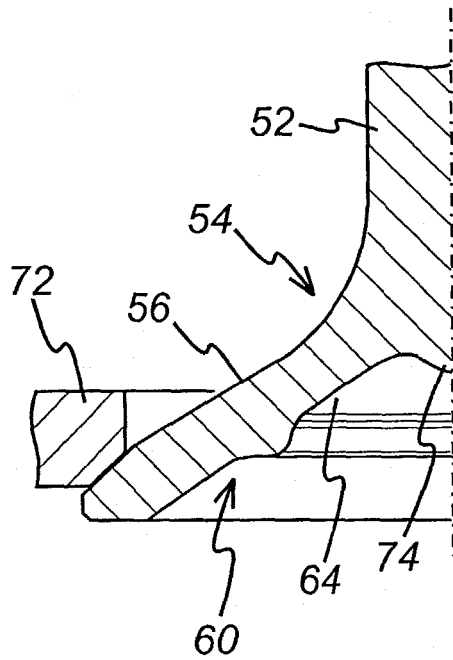
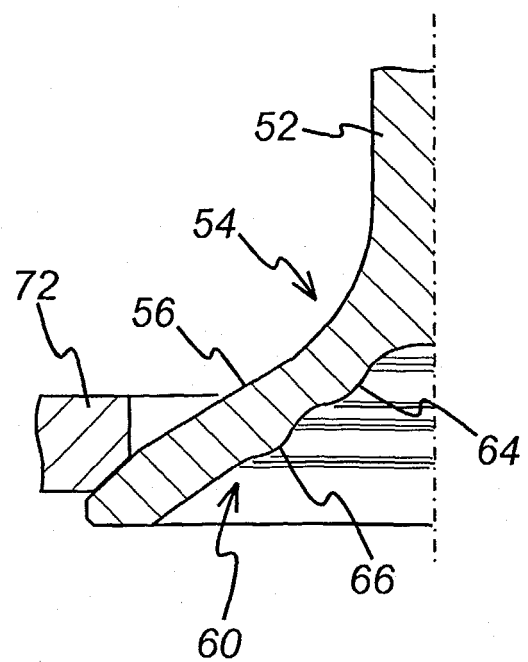


FIG. 5(D)





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 04 25 5827

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	GB 2 341 891 A (* ROVER GROUP LIMITED) 29 March 2000 (2000-03-29) * abstract * * figure 2 *	1,2,6-8	F01L3/20 F01L3/02 F01L3/14
X	US 1 763 340 A (BISSELL RICHARD E) 10 June 1930 (1930-06-10) * figure 1 * * column 3, lines 36-40 *	1,2,6-8	
A	GB 555 378 A (GEORGE ROBERT RICH) 19 August 1943 (1943-08-19) * the whole document *	1-9	
A	US 1 823 452 A (HERON SAM D) 15 September 1931 (1931-09-15) * the whole document *	1-9	
A	US 1 786 285 A (BISSELL GENEVIEVE) 23 December 1930 (1930-12-23) * the whole document *	1-9	
A	US 2 065 049 A (BULLOCK FRANK ERNEST) 22 December 1936 (1936-12-22) * the whole document *	1-9	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7) F01L
Place of search Munich		Date of completion of the search 2 February 2005	Examiner Paulson, B
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 25 5827

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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02-02-2005

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