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(54) **Injection nozzle**

(57) An injection nozzle for an internal combustion engine includes a valve member, (30) having at least first (44), second (46) and third (48) distinct regions, and being engageable with a seating surface (32), which defines a seat cone angle (ϑ_s), so as to control fuel delivery through a nozzle outlet (36). The second region provides a seat region (46) of part-conical form, which defines a first cone angle (ϑ_1). The third region (48), of part-conical form, is arranged immediately downstream of the seat region (46) and defines a second cone angle

(ϑ_2), the seat and third regions (46) defining, at their intersection, a seating line (40) for engagement with the seating surface (32). A first differential angle between the first cone angle (ϑ_1) and the seat cone angle (ϑ_s) is greater than a second differential angle between the second cone angle (ϑ_2) and the seat cone angle (ϑ_s), said first and second differential angles being selected to ensure the seating line (40) tends to migrate in an upstream direction along the seat region (46) as the valve member (30) is worn, in use.

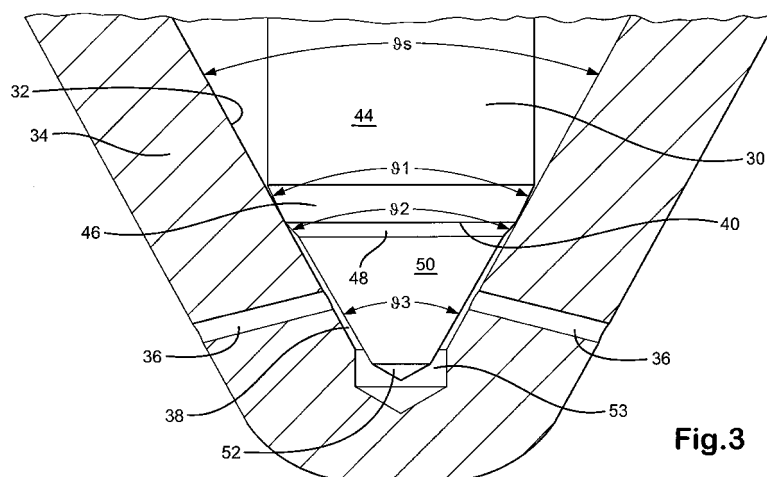


Fig.3



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EUROPEAN SEARCH REPORT

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 March 2005	Examiner Wagner, A
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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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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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet 8

- ☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:



The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-4,18

An injection nozzle having a seat region and a third region defining, at their intersection, a seating line for engagement with a seating surface, wherein a first differential angle between the first cone angle and the seat cone angle is smaller than a second differential angle between the second cone angle and the seat cone angle, said first and second differential angles being selected to ensure the seating line tends to migrate in an upstream direction along the seat region (46) as the valve member (30) is worn, in use.

2. claims: 5-11,18

An injection nozzle having a downstream seat region of part-conical form, which defines a first cone angle, and, at its uppermost edge, a seating line for engagement with the seating surface, a first circumferential groove, arranged immediately downstream of the downstream seat region, a lower region arranged immediately downstream of the first circumferential groove, a lower edge of the first circumferential groove and the lower region together defining a line of intersection which defines, together with the seating surface, a radial clearance that is sufficiently small so that the downstream seat region defines a load bearing surface for the valve needle.

3. claims: 12-17,18

An injection nozzle having a seat region defining a first cone angle, and, at its uppermost edge, a seating line for engagement with the seating surface, (ii) a second region, arranged immediately downstream of the seat region, defining a second cone angle, and (iii) a lower region, arranged immediately downstream of the second region, wherein a first differential angle between the first cone angle and the seat cone angle is smaller than a second differential angle between the second cone angle and the seat cone angle, said first differential angle being selected to ensure the seating line migrates in a downstream direction along the seat region as the valve member becomes worn, in use.

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

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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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