

COMMONWEALTH OF AUSTRALIA

The Patents Act 1952

CONVENTION APPLICATION FOR A PATENT

610014

We, ROBERT BOSCH GMBH, of Postfach 10 60 50, 7000 Stuttgart 10, Federal Republic of Germany, hereby apply for the grant of a Patent for an invention entitled "METHOD OF PRODUCING VALVE SEATING OF HIGH SURFACE QUALITY" which is described in the accompanying complete specification.

This application is a Convention application and is based on the Application Numbered P 38 28 987.3 for a patent or similar protection made in Federal Republic of Germany on 26th August, 1988 and Application Numbered P 39 25 043.1 for a patent or similar protection made in Federal Republic of Germany on 28th July, 1989.

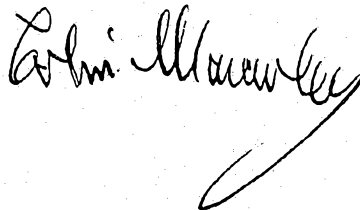
Our address for service is care of CALLINANS, Patent Attorneys, of 48 Bridge Road, Richmond, 3121, Victoria, Australia.

D A T E D this 25th day of August, 1989.

ROBERT BOSCH GMBH

By its Patent Attorneys:

CALLINANS



APPLICATION ACCEPTED AND AMENDMENTS

ALLOWED.....20.2.91.....

M 0 1 8 4 5 250889

To: The Commissioner of Patents.

COMMONWEALTH OF AUSTRALIA

The Patents Act 1952

DECLARATION IN SUPPORT

of the (Convention) Application made by: ... ROBERT BOSCH GMBH .....

(hereinafter termed "the applicant" ) for a patent ~~(of addition)~~ for an invention entitled .....

"METHOD OF PRODUCING VALVE SEATING OF HIGH SURFACE QUALITY" .....

XI/We ..... Klaus Voss and Manfred Knetsch .....

of ..... Postfach 10 60 50, D-7000 Stuttgart 10 - Federal Republic of Germany .....

do solemnly and sincerely declare as follows:

.....  
I am/ We are the applicant- , ~~or~~

.....  
I am/ We are authorised by the applicant to make this declaration on its/their behalf.

.....  
The basic applications as defined by sections 141 and 142 of the Act ~~was/~~ were made

.....  
in Federal Republic of Germany on August 26, 1988

in Federal Republic of Germany on July 28, 1989

in ~~on~~

by ..... ROBERT BOSCH GMBH .....

.....  
The basic applications referred to in this paragraph ~~is/~~ are the first applications made in a Convention country

.....  
in respect of the invention the subject of the application.

I/We ~~am/are~~

.....  
Stegfried Schweizer, Adam-Krafft-Str. 7B, D-8600 Bamberg, Federal Republic of Germany

.....  
Werner Sefz, Am Maienschlag 17, D-8729 Oberaurach-Trossenfurt, Federal Republic of Germany

~~or~~

~~is/~~ are the actual inventor s of the invention and the facts upon which the applicant ~~is/are~~ entitled to make  
the application are as follows:

If a patent were granted upon an application made by the actual inventors,  
the applicant would be entitled to have the patent assigned to it.

Declared at ..Stuttgart..... this...4th..... day of ..July..... 1989

ROBERT BOSCH GMBH

Signed: ..... *Klaus Voss* ..... *M. Knetsch* .....

**(12) PATENT ABRIDGMENT (11) Document No. AU-B-40214/89**  
**(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 610014**

(54) Title  
**METHOD OF PRODUCING VALVE SEATING OF HIGH SURFACE QUALITY**

International Patent Classification(s)  
(51)<sup>4</sup> **B24B 015/08**

(21) Application No. : **40214/89** (22) Application Date : **25.08.89**

(30) Priority Data

(31)	Number	(32)	Date	(33)	Country
	3828987		26.08.88		DE FEDERAL REPUBLIC OF GERMANY
	3925043		28.07.89		DE FEDERAL REPUBLIC OF GERMANY

(43) Publication Date : 01.03.90

(44) Publication Date of Accepted Application : 09.05.91

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(56) Prior Art Documents  
AU 232091 47326/59  
AU 27732/57  
AU 154254 7799/52

(57) Claim

1. A method of producing high surface quality valve seating in a valve, the method comprising the steps of bringing a sealing surface portion on a moveable valve member into contact with a seat on a valve seat body, causing the valve member and the valve seat body to rotate relative to each other about rotational axis under feed of a finely grained lapping abrasive in suspension to the seat, and transmitting to the valve seat body and movable valve member a high-frequency oscillation acting parallelly to the rotational axis.

Australia

PATENTS ACT 1952

Form 10

# COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE

610014

Short Title:

Int. Cl:

Application Number:

Lodged:

Complete Specification—Lodged:

Accepted:

Lapsed:

Published:

Priority:

Related Art:

This document contains the  
amendments made under  
Section 49 and is correct for  
printing

## TO BE COMPLETED BY APPLICANT

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Complete Specification for the invention entitled:

"METHOD OF PRODUCING VALVE SEATING OF  
HIGH SURFACE QUALITY"

The following statement is a full description of this invention, including the best method of performing it known to me:—

\* Note: The description is to be typed in double spacing, pica type face, in an area not exceeding 250 mm in depth and 160 mm in width, on tough white paper of good quality and it is to be inserted inside this form.

The present invention relates to method of producing high surface quality valve seating in a valve and to apparatus for carrying out such a method.

For the achievement of improved tightness in fuel injection valves, it has been proposed to clamp a valve seat body of a valve in a retaining device and to bring the movable valve member of the valve into pressurable contact with a valve seat of the body, the member then being set into rotation relative to the body under addition of a lapping abrasive. However, the surface quality achieved in this case at the seat and at the sealing surface portion of the movable valve member is not satisfactory for long term tightness in an appreciable number of valve groups (movable valve member and valve seat body) thus treated. In use of the valve in an internal combustion engine, when the engine is turned off and with the valve closed and the fuel injection system inoperative, fuel leakage and evaporation at the valve must be prevented for at least several hours both for reasons of safety and in view of the requirement for rapid operational readiness of the engine.

It is also known to improve the surface quality of parts by lapping with the use of lapping abrasives, which can be oscillatory lapping in which high-frequency oscillations are used (see Dubbels Taschenbuch für den Maschinenbau (Springer-Verlag, Berlin/Heidelberg/New York, 1966 12th ed.), Volume II, page 659).

Also known, from German (Federal Republic) patent specification No 639 660, are a method and apparatus for reseating taps, wherein one of the components is held in such a manner that it can rotate

about a longitudinal axis and incline and displace transversely to this axis, although it is fixed in direction of this axis. The other component executes a constrained rotational and reciprocating movement about and in the direction of the longitudinal axis, and grinding agent is introduced between the components.

5 In this case, the component executing the rotational and reciprocating movement performs a long-stroke and low-frequency rubbing movement along a steep helix of the entire envelope surface of the first-mentioned component, to which this reciprocating movement is not transmitted. Consequently, wavelike deviations from the conical surface generatrix are avoided as far as possible, but still produced are the known coarse grinding tracks of such a process in axial and rotational direction, which do not permit high seating requirements to be met.

10  
15 According to a first aspect of the present invention there is provided a method of producing high surface quality valve seating in a valve, the method comprising the steps of bringing a sealing surface portion on a movable valve member into contact with a seat on a valve seat body, causing the valve member and the valve seat body to rotate relative to each other about a rotational axis under feed of a finely grained lapping abrasive in suspension to the seat, and transmitting to the valve seat body and movable valve member a high-frequency oscillation acting parallelly to the rotational axis.

20 According to a second aspect of the present invention there is provided apparatus for performing the abovementioned method the apparatus comprising retaining means to retain either one of the said member



or the <sup>said</sup> body, rotary drive means acting on the respective other one of the member and the body to produce relative rotation of the member and the body about a rotational axis, feed means for feeding finely grained lapping abrasive in suspension to the seat, and oscillatory drive means for acting on the retaining means to produce a high-frequency oscillation acting on the member and the body parallelly to the rotational axis.

According to a third aspect of the present invention there is provided a method of producing high surface quality valve seating  
10 in a valve comprising a valve seat body with a seat and a movable valve member with a sealing surface portion co-operable with the seat, the method comprising the steps of bringing the sealing surface portion into contact with the seat under feed of a finely grained lapping abrasive in suspension to the seat, and transmitting to the valve seat body and movable valve member a high-frequency oscillational movement acting in an actuating direction of the valve.

A method exemplifying the present invention may have the advantage that a high surface quality of the sealing surface portion at the movable valve member and the valve seat at the valve seat body, such  
20 as to ensure long term tightness of the valve in use, can be achieved in a simple mode and manner. In production of such valves, the proportion of valve groups (movable valve member and valve seat body) with inadequate tightness, i.e. where a finishing operation is required or which represents rejects, may be below 1%.

The method takes advantage of the fact that simultaneous excitation of the valve seat body and the movable valve member by way of a high frequency oscillation with interposition of finely grained lapping



abrasive in suspension leads to a super-fine abrasion of the sealing surface portion and the seat, which results in a quasi amorphous surface structure so that the conventional lapping or grinding structures are not present even at 1000 times magnification. The valve member and the valve body oscillate at the same frequency, but at different amplitude, so that a pump effect occurs in the valve seat space and causes an axial relative movement of the lapping abrasive. Thus, the described effect of super-fine abrasion takes place at the boundary surfaces without the known directional surface structures.

- 10 The described effect of super-fine abrasion in the valve seat space between the valve member and valve seat body arises even if these two parts contact each other only by virtue of their own weight. An additional force exerted on the movable valve member in direction of the valve seat body is thus not necessary for achievement of the desired objective, but it can lead to an improvement of the result. In that case, the additional force also represents an element of the oscillatory multi-mass system.

- 20 Examples of the method and embodiment of the application of the present invention will now be more particularly described with reference to the accompanying drawing, the single figure of which is a schematic partly sectional elevation of components of a valve together with apparatus for performance of a method exemplifying the invention.

Referring now to the drawing, there is shown a valve group 1, which can be part of a fuel injection valve for the fuel injection system of a mixture-compressing applied ignition internal combustion engine, for example a valve of the kind described in German laid-



open patent specification (DE-OS) No. 24 58 728 or the corresponding United States Patent Specification No. 40 07 880, and which comprises a metallic valve seat body 2 and a movable valve member 3. The body 2 has a collar 5, at which opens a guide bore 7 extending co-axially with a rotational axis 6. Remote from the collar 5, the guide bore 7 is adjoined by an enlargement 9, which is required for production reasons and the diameter of which is greater than the diameter of the guide bore 7. A conically narrowing valve seat 10 adjoins the enlargement 9 within the body 2 and connects to an injection outlet 13 opening at an end face 11. The movable valve member 3, which can also be termed a valve needle, is inserted into the guide bore 7 of the body 2 and is guided therein by means of a lower guide portion 14 and an upper guide portion 15. A connecting portion 17 of reduced diameter is provided between the guide portions 14 and 15. A neck 18 of the member 3 protrudes out of the bore 7 and is connected to an armature 19. Remote from the armature 19, the member is provided adjacent to the lower guide portion 14 with a cylindrical portion 21 which, at its end remote from the lower guide portion 14, is adjoined by a narrow, conically extending sealing surface portion 22, which passes over into a conically narrowing cone portion 23. The surface portion 22 of the member 3 lies directly and sealingly against the seat 10 of the body 2 when the valve is closed. A needle tip 25, which protrudes through the outlet 13, adjoins the cone portion 23. The guide portions 14 and 15 are provided at their circumference with throughflow passages 26, which can, for example, be defined by surfaces giving the guide portions a four-cornered or other cross-sectional shape. The connecting portion 17 of the member 3 together with the wall of the bore 7 bound an annular flow channel 27 in radial

direction. The valve member 3 can also be made of metal.

For the production of sealing surfaces of high surface quality in the valve, there is provided apparatus which is arranged on a machine tool table 31 and firmly connected thereto by means of a fastening part 32 and which comprises an oscillation generator 33. The generator 33 is constructed as, for example, a magnetostrictive oscillator and converts electrical oscillations in the ultrasonic range, thus high-frequency oscillations, into mechanical oscillations of small amplitude. The generator 33 is electrically connected with

- 10 a high-frequency generator 35 and is excited by this in, for example, a range of between about 20 and 30 kilohertz, i.e. in the ultrasonic range, in which case it executes oscillation amplitudes of about between 3 and 20 micrometres. A retaining unit 37 is fastened to the oscillation generator 33 by, for example, screws 36. The unit 37 comprises a receiving body 39 provided with a receiving bore 40 which is open at a bearing end face 41, remote from the generator 33, of the body 39. The shell of the receiving body 39 is provided with an external thread 43 starting from the bearing end face 41 and extending in direction towards the oscillation generator 33.
- 20 A box nut 44 with an internal thread 45 is screwed onto the external thread 43 of the body 39 as second part of the retaining unit 37. The structure of the unit 37 as the described form of body 39 and nut 44 is only by way of example. The retaining unit can be constructed in any other appropriate form and can have a clamping connection, bayonet connection or similar.

For performance of the method, the valve seat body 2 is pushed by its cylindrical region into the bore 40 of the body 39 until the

collar 5 bears against the end face 41. Subsequently, the nut 44 is screwed onto the body 39, and the base 47 of the nut presses the collar 5, secure gainst rotation, against the end face 41. As already mentioned, the retaining unit can be of any other suitable form for rotationally secure retention of the body 2. The movable valve member 3 is inserted through a bore 48 in the base 47 and into the bore 7 of the body 2, bringing the sealing surface portion 22 against the valve seat 10.

A coupling body 49 firmly engages the end of the member 3 projecting out of the unit 37, for example at the armature 19 connected with the member 3, so that rotational movement about the axis 6 transmitted from a rotary unit 51, for example an electric motor, to the coupling body 49 is followed by the armature 19 and thereby by the member 3. The coupling body 49 can have, for example, a cylindrically or conically extending coupling bore 52, in which the armature 19 is wedged or coupled by friction. For production of the connection between the rotary unit 51 and the member 3, the unit 51 together with the coupling body 49 is mounted to be vertically movable in the directions indicated by a double arrow 53. The member 3 is acted on by a force in direction towards the valve seat 10 during performance of the method. This force is optimally adaptable and is dependent on the diameter of the sealing surface portion 22. The force can be generated by the weight of the coupling body 49 which loads the member 3 and is adapted in suitable manner to requirements, or by a weight 54 placed on the coupling body 49, or by a compression spring 55 which bears on the armature 19 and is arranged in, for example, the bore 52. Apart from the rotary unit 51, a further element of

the apparatus is a lapping abrasive feed device 56, from which finely grained lapping abrasive can be fed by way of a duct 57 and, for example, bore 7 of the body 2 to the region of the seat 10 and surface portion 22. The abrasive can, however, be applied to the seat 10 and/or the surface portion 22 before performance of the method.

The feed of the abrasive can also take place by way of the outlet 13. An oily or aqueous colloidal solution of chromium oxide, boron carbide and other such substances can serve as the abrasive.

In use of the described apparatus, the valve goup 1 is clamped  
10 into the retaining unit 37 in the described manner and brought into rotational connection with the rotary unit 51. Thereafter the unit 51 sets the movable valve member 3 into rotational movement 59 as denoted by an arrow and superimposed on this rotational movement, through simultaneous switching on of the high-frequency generator 35, is a high-frequency oscillation 60 acting parallel to the axis 6 and denoted by a double arrow. In this case, the member 3 with the armature 19 and valve seat body 2 form an oscillatory multi-mass system and oscillations with the same frequency but with different amplitude. Alternatively, the movable valve member 3 could be clamped,  
20 at the armature 19, secure against rotation in a retaining device and the rotational movement could then be produced through rotation of the valve seat body 2 by means of a rotary unit. The high-frequency oscillational movement in that case could be applied by way of the armature. With the addition of lapping abrasive, the sealing surface portion 22 and the seat 10 then act on each other to produce sealing surfaces of high surface quality. The treatment time amounts to a few seconds, for example five seconds.

The sealing surfaces of the valve groups of valves, for example fuel injection valves for internal combustion engines with petrol or diesel oil as fuel, treated by the described method have not only a very high tightness at the outset, but also tightness after an extended period of use of the valve.

The method as described above has been applied to the production of high quality valve sealing surfaces which are rotationally symmetrical and in which the movable valve member 3 is not secured against rotation relative to the valve seat body 2, i.e. the body 2 and the member 3 can rotate relative to each other during performance of the method so that an equally good tightness results in any desired relative rotational position. In addition, however, the exclusive imposition of a high-frequency oscillational movement 60 in axial direction, thus in the opening direction parallel to the axis 6 in which the movable valve member is raisable from the seat and in the opposite closing direction in which the member is brought back into contact with the seat but without relative rotational movement of the body 2 and member 3, also leads to an improvement of the surface quality of the sealing surfaces and thereby to an improvement of the tightness of the valve. This form of the method is appropriate when the rotational movement 59 is excluded from the performance of the method due to constructional reasons, for example, the movable valve member 3 being secured against rotation relative to the body 2 or the sealing surfaces having oval, rectangular or other non-circular cross-sections. In that case, it can again be expedient to load the member 3 relative to the body 2 by a force urging one towards the other.

The claims defining the invention are as follows:-

1. A method of producing high surface quality valve seating in a valve, the method comprising the steps of bringing a sealing surface portion on a moveable valve member into contact with a seat on a valve seat body, causing the valve member and the valve seat body to rotate relative to each other about rotational axis under feed of a finely grained lapping abrasive in suspension to the seat, and transmitting to the valve seat body and movable valve member a high-frequency oscillation acting parallelly to the rotational axis.
2. The method as claimed in claim 1, wherein the step of exerting a force on the valve member in direction towards the seat.
3. Apparatus for perming the method as claimed in claim 1 or 2, said apparatus including retaining means to retain either one of the said member or the said body, rotary drive means acting on the respective other one of the member and the body to produce relative rotation of the member and the body about a rotational axis, feed means for feeding finely grained lapping abrasive in suspension to the seat, and oscillatory drive means for acting on the retaining means to produce a high-frequency oscillation acting on the member and the body parallelly to the rotational axis.
4. Apparatus as claimed in claim 3, further including means to exert a force on the valve member to urge the sealing surface portion towards the seat.
5. A method for producing high surface quality valve seating in a valve comprising a valve seat body with a seat and a movable valve member with a sealing surface portion co-operable with the seat, the method comprising the steps of bringing the sealing surface portion into contact with the seat under feed of a finely grained lapping abrasive in suspension to the seat, and transmitting to the valve seat body and movable valve member a high-frequency oscillational movement acting in an actuating direction of the valve.



6. The method as claimed in claim 5, further including the step of exerting a force on the valve member in direction towards the seat.

7. The method as claimed in any one of claims 1, 2, 5, and 6, the method being substantially as hereinbefore described with reference to the accompanying drawings.

8. A valve when produced by a method as claimed in any one of claims 1, 2, 5 and 6.

9. The valve as claimed in claim 8, the valve being a fuel injection valve for an internal combustion engine.

10. Apparatus as claimed in either claim 3 or claim 4 and substantially as hereinbefore described with reference to the accompanying drawing.

D A T E D this 12th day of February, 1991.

ROBERT BOSCH GMBH

By their Patent Attorneys:

CALLINAN LAWRIE

