

AN EXHAUST VALVE FOR AN INTERNAL COMBUSTION ENGINE, AND A
METHOD OF STRENGTHENING AN ANNULAR VALVE SEAT AREA IN AN
EXHAUST VALVE

5 The present invention relates to an exhaust valve for an internal combustion engine, the exhaust valve comprising a valve disc having a first side and a second side, a valve stem extending from the first side of the valve disc, and an annular valve seat area located at the first side of the valve disc, which annular valve seat area is of a nickel-base alloy or a chromium-base alloy and has
10 a valve seat surface.

Such an exhaust valve is disclosed in US 6,295,731 where a valve blank has a valve disc of smaller diameter than the disc of the completed valve and excess material above the valve seat. The excess material is shaped as an isosceles-triangle-sectioned lobe on the valve disc covering the complete area
15 of the valve seat. The valve blank is heated to a temperature of 530 to 600°C and is forged in a die having the shape of the completed valve disc. During forging the isosceles-triangle-sectioned lobe is plastically deformed and the outer diameter of the valve disc is increased. The forging of the excess material thus causes plastic flow of all the material at the outer area of the valve disc.

20 EP 0 204 121 discloses an exhaust valve with a valve disc made of a basic material and a welded-on hardfacing of a nickel-based or cobalt-based superalloy. An annular valve seat area is located at the middle area of the upper side of the hardfacing. At the transition between the hardfacing and the basic material, a thin layer of superalloy is melted into the surface in order to prevent
25 corrosion attacks in the transition between the two materials. One such thin layer is applied to the first side of the valve disc, and another such thin layer is applied to the side wall of the valve disc.

EP 0 521 821 B1 discloses an exhaust valve comprising a valve disc having a first side provided with an extending valve stem and an annular valve
30 seat area with a valve seat surface. The annular valve seat area is of a nickel-base alloy or a chromium-base alloy. Forging may be used to globally shape the valve seat area. Hot deformation is recommended in order to distribute carbide formations within the material in order to obtain improved corrosion resistance.

The book 'Diesel engine combustion chamber materials for heavy fuel
35 operation' published in 1990 by The Institute of Marine Engineers, London, collected the experience gained from the whole industry and provided

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the general conclusion that the valve seat area of an exhaust valve must have high hardness.

WO 97/47862 discloses an exhaust valve disc having a base body of austenitic stainless steel and a valve seat area of a nickel-base

disc faces the combustion chamber and is thus subjected to high temperatures in operation and also to corrosive combustion residues adhering to the surface of the disc. The layer of hot corrosion resistant material may improve the life time of the exhaust valve.

5 ~~In another aspect, the present invention relates to a method of strengthening an annular valve seat area in an exhaust valve for an internal combustion engine, which exhaust valve comprises a valve disc having a first side and a second side, a valve stem extending from the first side of the valve disc, and an annular valve seat area located at the first side of the valve disc.~~

10 -In order to improve the manufacturing of the valve seat area, at least the following steps are performed according to the present invention:

 a) a valve disc with a raw seat area is provided, which raw seat area has at least two annular protrusions separated by an intermediate annular area,
 b) the two annular protrusions are plastically deformed,
15 c) the raw seat area is machined to the dimensions of the annular valve seat area,

 d) the valve disc with the annular valve seat area is subjected to heat treatment involving at least an aging heat treatment.

 The separation of the two annular protrusions by the intermediate annular area reduces the area available for the annular protrusions, and they consequently have much less volume than the above-mentioned prior art lobe, and the deformation in step b) thus requires less forces. The deformation of the protrusions in step b) and the machining in step c) form the two second annular portions in the valve seat area, and the first annular portion is located in or
20 formed by the intermediate annular area.

 The smaller size of the two annular protrusions also reduces the need for excess material in the raw seat area, and the valve disc with the raw seat area can be shaped closer to the final dimensions of the valve disc and thus alloying material is saved and the need for machining in step c) is also reduced.

30 The plastic deformation can be effected by forging, but preferably

P A T E N T C L A I M S

1. An exhaust valve for an internal combustion engine, the exhaust valve comprising a valve disc having a first side and a second side, a valve stem extending from the first side of the valve disc, and an annular valve seat area
5 located at the first side of the valve disc, which annular valve seat area is of a nickel-base alloy or a chromium-base alloy and has a valve seat surface, wherein the annular valve seat area has at least a first annular portion located in between two second annular portions, which first annular portion has lower hardness than the two second annular portions.
- 10 2. An exhaust valve according to claim 1, wherein the average hardness at the valve seat surface at the middle of the first annular portion is at least 80 HV lower than the average hardness at the middle of the surface of at least one of the second annular portions.
3. An exhaust valve according to claim 1 or 2, wherein the material of
15 the two second annular portions has a crystallographic grain structure of cold deformation and age hardening below recrystallization temperature.
4. An exhaust valve according to one or more of claims 1 to 3, wherein the material of the first annular portion has a crystallographic grain structure without cold deformation.
- 20 5. An exhaust valve according to one or more of claims 1 to 4, wherein the valve disc carrying the annular valve seat area comprises a base body of stainless steel.
6. An exhaust valve according to one or more of claims 1 to 5, wherein the valve disc at its second side comprises a layer of a hot corrosion resistant
25 material.
7. A method of strengthening an annular valve seat area in an exhaust valve for an internal combustion engine, which exhaust valve comprises a valve disc having a first side and a second side, a valve stem extending from the first side of the valve disc, and an annular valve seat area located at the first side of
30 the valve disc, wherein at least the following steps are performed:
 - a) a valve disc with a raw seat area is provided, which raw seat

area has at least two annular protrusions separated by an intermediate annular area;

b) the two annular protrusions are plastically deformed;

c) the raw seat area is machined to the dimensions of the annular valve

5 seat area;

d) the valve disc with the annular valve seat area is subjected to heat treatment involving at least an aging heat treatment.

8. A method of strengthening an annular valve seat area in an exhaust valve according to claim 7, wherein the plastic deformation in step b) involves
10 rolling with a cylindrically shaped roll.

9. A method of strengthening an annular valve seat area in an exhaust valve according to claim 8, wherein a separate cylindrically shaped roll is provided for each annular protrusion.

10. A method of strengthening an annular valve seat area in an exhaust valve according to claim 9, wherein the separate cylindrically shaped rolls are carried by a common rolling tool, but are allowed to rotate during rolling with mutually different rotational speeds.

11. A method of strengthening an annular valve seat area in an exhaust valve according to one or more of claims 7 to 10, wherein the individual
20 annular protrusion provided in step a) has a curved central portion.