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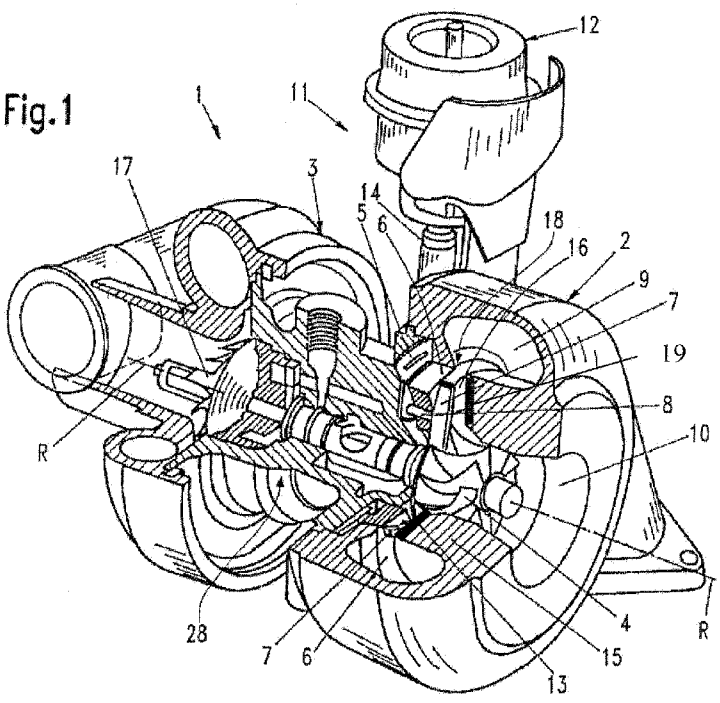
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(54) Title: TURBOCHARGER AND HOLDING DISK THEREFOR

(57) Abstract: The invention describes a holding disk for use in turbochargers, in particular for diesel engines, said holding disk consisting of an iron-based alloy having an austenitic base structure with dendritic carbide precipitations.

Fig.1



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TURBOCHARGER AND HOLDING DISK THEREFOR

DESCRIPTION

The invention relates to a holding disk for use in turbochargers, in particular for a diesel engine, according to the preamble of claim 1, and to an exhaust gas turbocharger comprising a holding disk according to the preamble of claim 4.

Exhaust gas turbochargers are systems intended to increase the power of piston engines. In an exhaust gas turbocharger, the energy of the exhaust gases is used to increase the power. The increase in power is a result of the increase in the throughput of mixture per working stroke.

A turbocharger substantially comprises an exhaust gas turbine with a shaft and a compressor, wherein the compressor arranged in the intake tract of the engine is connected to the shaft and the blade wheels located in the casing of the exhaust gas turbine and the compressor rotate. In the case of a turbocharger having a variable turbine geometry, adjusting blades are additionally mounted rotatably in a blade bearing ring and are moved by means of an adjusting ring arranged in the turbine casing of the turbocharger. Together with the blade bearing ring, a ring arranged in the turbine casing (said ring also being referred to as a holding disk) axially delimits the flow space which is formed by the adjusting blades. Screws are usually used to fasten this ring to the blade bearing ring at a predefined distance, wherein the distance is set by spacers at a predefined level so as to produce a flow duct having desirable dimensions.

Extremely high demands are made on the material of the holding disk. The material which forms the holding disk has to be heat-resistant, i.e. it still has to display

sufficient strength even at very high temperatures of up to about 900°C. In addition, the material has to have high wear resistance and corresponding oxidation resistance so that the corrosion and wear on the material are reduced and therefore the resistance of the material remains ensured under the extreme operating conditions.

Heat-resistant materials for exhaust gas turbochargers and the individual components thereof are known from EP 1 396 620 A1. In this document, a suitable material is considered as being one which has a specific composition, wherein the surface of the components may be coated with a chromium carbide layer and the material contains a small amount of small, non-metallic inclusions. This is intended to achieve a heat resistance of the turbocharger of up to 700°C or more.

In view of this, an object of the present invention is to provide a holding disk according to the preamble of claim 1 or a turbocharger according to the preamble of claim 4 which has improved temperature and oxidation resistance and corrosion resistance at extreme temperatures and also corresponding wet-corrosion resistance and which is distinguished by optimum tribological properties and additionally displays a reduced susceptibility to wear.

This object is achieved by means of the features of claim 1 and of claim 4.

The design, according to the invention, of a holding disk, or of an exhaust gas turbocharger comprising such a holding disk, consisting of an austenitic iron-based alloy achieves better temperature resistance of the material. This resistance is increased many times over by the dendritic carbide precipitations, which are present in the iron-based alloy, and inclusions of

nitrogen. This provides a holding disk, or an exhaust gas turbocharger which contains the holding disk according to the invention, which has an optimum temperature resistance in the range of up to 900°C, is also very resistant to high temperatures, has high wear and corrosion resistance and is also distinguished by very good sliding properties along with a reduced tendency to be oxidized.

The holding disk according to the invention also remains dimensionally stable and therefore very even.

Without being bound to the theory, it is assumed that carbide precipitations in the form of dendrites increase the stability of the alloy material by forming fine ramifications in the microstructure of the material which provide a supporting effect, and therefore this considerably increases the strength of the material and therefore the strength of the holding disk according to the invention owing to its unique structure.

At a bearing load of about 10 N/mm^2, a sliding speed of 0.0025 m/s, a component temperature of 500 to 900°C, a surface roughness Rz of 6.3, a test duration of 500 h, a clock frequency of 0.2 Hz, an adjustment angle of 45°, a friction value of 0.28, a contact area of 10 mm^2, a pressure pulsation of more than 200 mbar, an exhaust gas pressure of more than 1.5 bar and with a diesel exhaust gas as the test medium, the maximum wear rate of the holding disk according to the invention is less than 0.05 mm.

During a thermal shock cycle test, the evenness of the material of the holding disk according to the invention is less than 0.1 mm at a test diameter of 70 mm.

The dependent claims contain advantageous developments of the invention.

In one embodiment, the holding disk according to the invention is distinguished by a specific composition containing the following components:

C: 0.1 to 0.6% by weight,
Cr: 22 to 27% by weight,
Ni: 6.5 to 15% by weight,
Mn: 7.5 to 14.5% by weight,
Si: ≤ 1% by weight,
V: 0.75 to 2.5% by weight,
N: 0.1 to 0.7% by weight
and Fe.

The influence of the individual elements on an iron-based alloy is known, but it has now surprisingly been found that precisely the combination described gives a material which, when processed to form a holding disk, imparts a particularly balanced property profile to said holding disk. This composition according to the invention provides a holding disk which has a particularly high high-temperature strength and temperature resistance (even up to 900°C) and is distinguished by outstanding sliding properties and therefore particularly low sliding wear or abrasive wear. In addition, the corrosion resistance is maximized; this also applies in particular to wet corrosion. The material and therefore the holding disk according to the invention are additionally extremely dimensionally stable.

Therefore, a material according to the invention which is produced in this way has the following properties:

Mechanical property	Value	Measurement process
Tensile strength R_m	> 655 MPa	ASTM E 8M / EN 10002-1; at elevated temp.: EN 10002-5
Yield strength $R_{p0.2}$	> 380 MPa	Standard process
Elongation at break	> 12%	Standard process
Hardness	175-265 HB	ASTM E 92 / ISO 6507-1
Coefficient of linear expansion	16-19 K^{-1} (20 to 900°C)	Standard process

According to a further embodiment of the invention, the holding disk according to the invention is free from sigma phases. This prevents the material from becoming brittle and increases the durability thereof. Sigma phases are brittle, sintered metallic phases of high hardness. They arise when a body-centered cubic metal and a face-centered cubic metal, whose atomic radii match with only a slight discrepancy, strike one another. Sigma phases of this type are undesirable since they have an embrittling effect and also because of the property of the matrix to withdraw chromium. As a result, the material according to the invention is distinguished in that it is free from sigma phases. This prevents the material from becoming brittle and increases the durability thereof. The reduction in or prevention of the formation of sigma phases is achieved in that the silicon content in the alloy material is reduced to less than 1.3% by weight and preferably less than 1% by weight. In addition, it is advantageous to use austenite formers such as, for example, manganese, nitrogen and nickel, if appropriate in combination.

As an object which can be dealt with independently, claim 4 defines an exhaust gas turbocharger comprising a holding disk, as already described, consisting of an austenitic base structure with dendritic carbide precipitations.

Figure 1 shows a perspective view, shown partially in section, of a turbocharger according to the invention. Figure 1 shows a turbocharger 1 according to the invention which has a turbine casing 2 and a compressor casing 3 which is connected to the latter via a bearing casing 28. The casings 2, 3 and 28 are arranged along an axis of rotation R. The turbine casing is shown partially in section in order to illustrate the arrangement of a blade bearing ring 6 and a radially outer guide grate 18 which is formed by said ring and has a plurality of adjusting blades 7 which are distributed over the circumference and have rotary axles 8. In this way, nozzle cross sections are formed which, depending on the position of the adjusting blades 7, are larger or smaller and act to a greater or lesser extent upon the turbine rotor 4 positioned in the center on the axis of rotation R with the exhaust gas from an engine, said exhaust gas being supplied via a supply duct 9 and discharged via a central connection piece 10, in order to drive a compressor wheel 17 seated on the same shaft using the turbine rotor 4.

In order to control the movement or the position of the adjusting blades 7, an actuating device 11 is provided. This may be designed in any desired way, but a preferred embodiment has a control casing 12 which controls the control movement of a tappet member 14 fastened to it, in order to convert the movement of said tappet member onto an adjusting ring 5, located behind the blade bearing ring 6, into a slight rotational movement of said adjusting ring. A free space 13 for the adjusting blades 7 is formed between

the blade bearing ring 6 and an annular part 15 of the turbine casing 2. So that this free space 13 can be ensured, the blade bearing ring 6 has spacers 16. The free space for the turbine blades 7 is delimited toward the top via the spacers 6 by the holding disk 19 according to the invention.

- EXAMPLE -

An alloy from which a holding disk according to the invention was formed was produced from the following elements by means of a conventional process. Chemical analysis resulted in the following values for the elements: C: 0.1 to 0.5% by weight; Cr: 23 to 26% by weight; Ni: 6.5 to 12.5% by weight; Mn: 7.5 to 12% by weight; Si: max. 1% by weight; Nb: 0.75 to 1.7% by weight; N: 0.1 to 0.5% by weight; V: 0.8 to 1.7% by weight; remainder: iron.

The adjusting ring produced according to this example was distinguished by a tensile strength R_m of 668 MPa (ASTM E 8M / EN 10002-1; at elevated temperature: EN 10002-5). The yield strength R_p 0.2 (measured using a standard process) was 384 MPa. The elongation at break of the material (measured using a standard process) was 13.1%. The hardness of the material (measured according to ASTM E 92 / ISO 6507-1) was 207 HB. The coefficient of linear expansion (measured using a standard process) was 16.9 K^{-1} (20 to 900°C). The material was subjected to a validation test series comprising the following tests:

- open-air weathering test
- climate change test
- thermal shock test/cycle test - 300 h
- hot gas corrosion test in cracking furnace

In all the tests, the component was distinguished by an outstanding resistance to the acting forces. Therefore,

the material had extremely high wear resistance and outstanding oxidation resistance so that corrosion and wear on the material under the stated conditions were considerably reduced and therefore the resistance of the material was also ensured for a long period of time.

Thermal cycle test:

The component according to the invention was subjected to a thermal cycle test in which the thermal shocks were carried out as follows:

1. Use of stationary rotors;
2. 2-EGT operation;
3. Test duration: 350 h (about 2000 cycles);
4. The exhaust gas flap of the EGTs remains open by 15° throughout the test;
5. High temperature: nominal horsepower point T3 = 750°C, mass flow EGT on the turbine side: 0.5 kg/s;
6. Low temperature: T3 = 100°C, mass flow EGT on the turbine side: 0.5 kg/s;
7. Cycle duration: 2 x 5 min. (10 min.);
8. Carrying out three intermediate crack tests.

List of reference symbols

1	Turbocharger
2	Turbine casing
3	Compressor casing
4	Turbine rotor
5	Adjusting ring
6	Blade bearing ring
7	Adjusting blades
8	Rotary axles
9	Supply duct
10	Axial connection piece
11	Actuating device
12	Control casing
13	Free space for adjusting blades 7
14	Tappet member
15	Annular part of the turbine casing 2
16	Spacer/spacer boss
17	Compressor wheel
18	Guide grate
19	Holding disk
28	Bearing casing
R	Axis of rotation

PATENT CLAIMS

1. A holding disk for use in turbochargers, in particular for diesel engines, said holding disk consisting of an iron-based alloy having an austenitic base structure with dendritic carbide precipitations.

2. The holding disk as claimed in claim 1, wherein it contains the following components:
C: 0.1 to 0.6% by weight, Cr: 22 to 27% by weight, Ni: 6.5 to 15% by weight, Mn: 7.5 to 14.5% by weight, Si: ≤ 1% by weight, V: 0.75 to 2.5% by weight, N: 0.1 to 0.7% by weight and Fe.

3. The holding disk as claimed in claim 1, wherein it is free from sigma phases.

4. An exhaust gas turbocharger for diesel engines, comprising a holding disk consisting of an austenitic base structure with dendritic carbide precipitations.

5. The exhaust gas turbocharger as claimed in claim 4, wherein the holding disk contains the following components:
C: 0.1 to 0.6% by weight, Cr: 22 to 27% by weight, Ni: 6.5 to 15% by weight, Mn: 7.5 to 14.5% by weight, Si: ≤ 1% by weight, V: 0.75 to 2.5% by weight, N: 0.1 to 0.7% by weight and Fe.

6. The exhaust gas turbocharger as claimed in claim 4, wherein the material of the holding disk is free from sigma phases.

Fig.1

