BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 17 April 2000

Case Number: T 0624/97 - 3.2.2

Application Number: 89106909.8

Publication Number: 0356615

IPC: C22C 38/30

Language of the proceedings: EN

Title of invention:
Piston ring material and piston ring

Patentee:
HITACHI METALS, LTD.

Opponent:
(I) AE GOETZE GmbH
(II) Böhler Edelstahl GmbH
(III) Stahlwerk Ergste GmbH & Co. KG

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:

Catchword:

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0624/97 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 17 April 2000

Appellant: (Opponent II)
Böhler Edelstahl GmbH
Mariazellerstrasse 25
A-8605 Kapfenberg (AT)

Representative:
Wildhack, Helmut, Dipl.-Ing. Dr.
Patentanwälte Dipl.-Ing. Leo Brauneiss
Dipl.-Ing. Dr. Helmut Wildhack
Dipl.-Ing. Dr. Gerhard Jellinek
Landstrasser Hauptstrasse 50
Postfach 281
A-1031 Wien (AT)

Other party: (Opponent I)
AE GOETZE GmbH
Bürgermeister-Schmidt-Strasse 17
D-51399 Burscheid (DE)

Representative:
-

Other party: (Opponent III)
Stahlwerk Ergste GmbH & Co. KG
Letmatherstrasse 69
D-58239 Schwerte (DE)

Representative:
König, Reimar, Dr.-Ing.
Patentanwälte Dr.-Ing. Reimar König
Dipl.-Ing. Klaus Bergen
Postfach 2602254
D-40095 Düsseldorf (DE)

Respondent: (Proprietor of the patent)
HITACHI METALS, LTD.
1-2, Marunouchi 2-chome
Chiyoda-ku
Tokyo 100 (JP)

Representative:
Strehl, Schübel-Hopf & Partner
Maximilianstrasse 54
D-80538 München (DE)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 15 April 1997 rejecting the opposition filed against European patent No. 0 356 615 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: W. D. Weiß
Members: R. Ries
J. C. M. De Preter

Summary of Facts and Submissions

I. European patent No. 0 356 615 was granted on 8 September 1993 on the basis of European patent application No. 89 106 909.8.

II. The granted patent was opposed by three opponents on the ground that its subject-matter lacked an inventive step with respect to the state of the art (Article 56 EPC).

III. With its decision posted on 15 April 1997 the Opposition Division held that the patent could be maintained in the form as granted and rejected the oppositions. The following documents were considered in the opposition proceedings:

D1: JP-B-54 024 365 and translation into English
D2: DE-U-75 25 331
D3: F. Rapatz: "Die Edelstähle", Springer Verag 1962, pages 253 to 259
D4: Stahl-Eisen-Liste, Verlag Stahleisen 1977, Werkstoffnummer 1.4528 and 1.4535 (one page)
D5: E. Houdremont: "Handbuch der Sonderstahlkunde", Springer-Verlag 1956, pages 1111 to 1125; 1330 to 1353
D6: GB-A-106187.

Claim 1 in the form as granted reads as follows:

"1. A piston ring consisting by weight of 0.6 to 1.5% C, not more than 1.0% Si, not more than 1.0% Mn, 7.0 to 25.0% Cr, 2.0 to 13.0% Co, optionally comprising 0.05 to 3.0% V and 0.05 to 3.0% Nb, the total amount of

the content of said V and of Nb being 0.05 to 3.0%, optionally further comprising 0.3 to 2.0% Ni, and the balance Fe and incidental impurities, comprising a nitrided layer provided at least on a sliding surface thereof which slides against a cylinder wall."

IV. On 12 June 1997 the appellant (opponent II Böhler Edelstahl GmbH) lodged an appeal against this decision and the fee for appeal was paid on 13 June 1997. The statement of grounds was submitted on 21 August 1997.

V. The appellant requested in writing that the decision under appeal be set aside and the patent be revoked.

The respondent requested that the appeal be dismissed and, as an auxiliary request, that oral proceedings be appointed.

The parties as of right (opponent I and opponent III) have not filed any submission during the appeal proceedings.

VI. In its written submissions, the appellant argued as follows:

The subject-matter of claim 1 does not involve an inventive step, in particular with respect to the technical teaching of document D5. Although being a comprehensive handbook for special steels, the technical teaching disclosed in this document cannot be regarded as being less relevant than technical information given in a patent document. On page 1121, Table 220, document D5 discloses a heat resistant Co-alloyed steel (alloy no. 4) for use as valve cones, and

goes on to say that nitriding these steels improves surface hardness (end of page 1121 bridging page 1122 lines 1 and 2). Moreover, steel alloy no. 3 according to Table 262 on page 1335 of document D5, which is provided for nitriding to improve wear resistance and is used for valve cones, falls within the compositional ranges defined in claim 1 (cf. D5, page 1337, third paragraph). Document D5 further emphasizes in a more general way the beneficial effect of nitriding upon the wear resistance of various structural parts, including inter alia valves and combustion engine cylinders (cf. D5, page 1341, second paragraph from the bottom and page 1345, chapter e) bridging page 1346, paragraph 3, line 6). Bearing in mind this basic knowledge, a skilled person is led to combine the teaching of document D5 with that of document D6 which discloses a high speed steel composition falling within the elemental ranges claimed in the patent.

Moreover, given that in a combustion engine the outer surface of the piston ring is the mating material to be slid along the nitrided inner surface of the cylinder and the workload of both structural parts is comparable, a skilled person would obviously use the same steel composition for both contacting parts in order to reduce wear and scuffing. The same non-inventive approach can be made when starting from the steel composition used for valve cones according to document D5 which exhibits resistance to heat and wear due to the presence of cobalt, because piston rings undergo the same stress and sliding wear as do valves on the stem. It was therefore, obvious for a person skilled in the art to use the same steel composition for producing heat and wear resistant valves, cylinders

or piston rings.

VII. In reply, the respondent argued as follows:

In highly developed power engines the problem of "scuffing" arises between the cylinder and the piston ring when starting the engine or raising the engine speed abruptly. This problem is not known in other sliding environments where engine parts slide relative to each other. Moreover, scuffing is not identical with resistance to wear and abrasion, and in particular, this phenomenon does not occur with engine valve shafts or valve seats. The claimed piston ring, however, exhibits an improved scuffing resistance due to the selection of a specific steel composition and by providing a nitrided layer on the sliding surface. Specifically, none of the cited six documents even refers to piston rings and, therefore, these documents cannot be helpful in solving the problem underlying the patent. The Co-bearing steel compositions the appellant refers to in document D5 are for use as valve cones or engine cylinders rather than piston rings. There is no indication whatsoever in this document that these steel compositions could be expected to bring about an improved scuffing resistance for piston rings used in high power engines. Since modern piston rings are produced from steel band or wire, as opposed to cylinders and valves which are cast, the material requirements for cylinders are fundamentally different from those for piston rings. It is, therefore, by no means obvious to use the same material for all these structural components of a combustion engine, as alleged by the appellant. Although document D5 includes one steel alloy (1.3-1.5% C; 12-14% Cr, 2-3% Co) which

meets the compositional requirements defined in claim 1, nothing in this document makes it obvious to select this particular composition to minimize scuffing for a piston ring in a high power automotive engine. Given that the remaining documents are even more remote, a combination of the technical teaching of document D5 with any of them also does not make the claimed subject-matter obvious.

The claimed subject-matter, therefore, involves an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Admissibility of the claims (Article 123(2) EPC)*

Claim 1 as granted results from a combination of claims 1, 5 and 7 as originally filed. Claims 2 and 3 as granted correspond to former claims 4 and 2; claim 4 as granted is based on the preferred chromium range disclosed on page 4, lines 12/13 of the published patent application. Hence, there are no formal objections to the claims.

3. *Novelty*

Given that none of the cited documents refers to piston rings, the claimed subject-matter is novel with respect to the cited prior art. Moreover, novelty has not been disputed by the appellant and, hence, there is no need

to deal with this issue in detail.

4. *The closest prior art*

According to the patent specification, page 2, lines 25 to 38, piston rings in automotive engines for severe working conditions have been produced from 13 Cr and 17 Cr martensitic steel (JIS SUS440B). In order to improve the abrasion resistance, the sliding surface of modern piston rings has been nitrided rather than chromium plated.

Given that none of the cited documents D1 to D6 deals with piston rings and, therefore, does not come closer to the subject-matter claimed in the disputed patent, this reference in the patent specification represents the most pertinent prior art.

5. *Problem and solution*

In highly developed power engines, such as high performance diesel engines or turbo charged engines, the phenomenon of scuffing occurs between the cylinder wall and the piston ring when starting the engine or when raising the engine speed abruptly. The problem underlying the disputed patent, therefore, resides in providing a piston ring which - in modern high power engines - exhibits improved scuffing resistance properties, thus having a higher performance than that of the prior art 17 Cr martensitic steel piston ring.

According to claim 1 of the patent, this problem is solved by a piston ring consisting of a 0.6-1.5% carbon, 7-25% chromium, 2-13% cobalt steel and

having a nitrided layer at least on the sliding surface. More specifically, cobalt as an alloying element has been identified to be one of the key features for improving the scuffing resistance property of the claimed piston ring.

6. *Inventive step*

In the attempt to support its assertion that the selection of this steel composition provided with a nitrided layer for piston rings was obvious, the appellant has referred to six documents. None of the citations, however, is particularly concerned with piston rings and or even suggests selecting alloys within the claimed range for a piston ring in order to obtain the desired property of high scuffing resistance. Documents D1 and D2 relate to valve seat rings and document D3, like document D6, is concerned with a high speed (tool) steel alloy which comprises cobalt in order to improve its cutting and staying power (cf. D3, page 256: "Kobaltwerkzeugstähle", Table 39, alloy No. 3; D6, page 1, lines 4 to 13, 20 to 29; page 3, lines 16 to 18). Document D4 is even more remote in that the cutting tool alloys no. 1.4528 and 1.4535 comprise cobalt amounts outside the range claimed in the disputed patent.

Document D5, which the appellant essentially relies upon, discloses on page 1335, Table 262 (among eight different alloys) one CrCo nitriding steel consisting of 1.33% C, 0.3% Si, 0.28% Mn, 13.31% Cr, 0.81% Mo, 3.08% Co, balance Fe which falls within the elemental ranges given in claim 1. A similar non-nitrided steel composition (among five alloys) is given in Table 220,

page 1121 which consists of 1.3% C, 0.35% Si, 0.35% Mn, 13.0% Cr, 2.0% Co, balance Fe which is for use as valves. Another cold working steel alloy (No. D5) falling within the claimed elemental ranges is given in Table 219 on page 1116 and page 1115, lines 3 to 15 of document D5.

In a more general way, document D5 goes on to say on page 1337 that austenitic CrNi or CrMn steels can also be surface-hardened by nitriding, and valve shafts are mentioned as an example. Moreover, it is observed on page 1341, penultimate paragraph and page 1346, paragraph 1 to paragraph 3, lines 1 to 6 that wear can be reduced by nitriding for example fast finishing steels and tool steels as well as valves and cylinders for (aeroplane) combustion engines which undergo hot sliding wear.

All mechanical components that undergo sliding contact are subject to some degree of wear. Sliding wear, commonly known as adhesive wear, occurs when two surfaces slide against each other under pressure. Terms often used to describe the damage associated with sliding wear in the order of increasing severity are: scuffing (or scoring), galling and seizing. A typical component that undergoes sliding wear is a piston ring or the mating inner surface of a cylinder.

However, the rate of thermal strain and abrasive wear in a valve stem or valve seat ring differs from the strain of a piston ring. In operation, the edge of the head of the combustion engine valve repeatedly hits the valve set ring and, therefore, these structural parts are required to exhibit a combination of high

resistance to heat, impact, abrasion and corrosion. In contrast to a piston ring, there is essentially no sliding contact between the valve seat ring and the valve head.

As to the valve stem, there is sliding contact between the stem and guide bush. Although document D5, Table 220 in combination with Table 262 and the accompanying text on page 1337 proposes nitriding of the valve stem to increase the surface hardness and to reduce wear, there is no basis whatsoever in this document for concluding or implying that the scuffing resistance of a piston ring can be improved by selecting - among a plethora of steel compositions - exclusively a Cr-Co containing nitriding steel alloy. On the contrary, document D5 states, on page 1337, that the nitrided surface layer is prone to cracking when bending the nitrided structural part. Moreover, the reader is warned that such parts should not comprise sharp edges since the nitrided edges are extremely brittle and thus break away easily (cf. page 1347, second paragraph). Valve stems and cylinders do not comprise sharp edges, and they are not deformed or bent in operation or when assembling the engine. Contrary thereto, piston rings are bent when inserting them into the cylinder and they comprise sharp edges. Besides, it is fallacious to equate the workload of a piston ring with that of the mating inner cylinder wall and, as a conclusion, to select the same material for both structural components. The outer surface of the piston ring is always in sliding contact with the cylinder, of which only a small area is contacted by the piston ring for a short time. It is also noted in this context that document D5 fails to disclose, among the variety of

steel compositions, any specific steel alloy which is preferred for the production of combustion engine cylinders.

Contrary to the allegation of the appellant, the second full paragraph on page 1337 of document D5 is understood to relate essentially to austenitic CrNi or CrMn nitrided steels for producing valve cones rather than to the exemplifying alloys given in Table 262 or in Table 220 (cf. in this context page 1121, lines 1 to 6 from the bottom). Austenitic CrNi or CrMn alloys are, however, not claimed in the disputed patent.

The first full paragraph on page 1115 of document D5 as well as steel no. D5 of Table 219 relate to a wear resistant CrCo high speed steel composition which is provided for the production of drawing plates or wortles, metal cutting saws, high performance knifes or blanking punches etc. Document D5 further emphasizes in this context on page 1111, last paragraph, line 1, page 1112, first full paragraph, lines 1 to 4, page 1113, last paragraph, that the improvement of the cutting duty for these steels can be attributed to the presence of cobalt. This technical statement is fully consistent with the teaching given in document D3, page 256, paragraph "Zu 2.". However, neither document D5 itself nor D3 or any of the other citations suggest any reason for selecting exclusively the 1.5% C-12% Cr-3% Co high speed steel for the production of piston rings which are to exhibit an improved resistance to scuffing in high performance automotive engines. With particular respect to the combined technical teaching of document D5 and D6 proposed by the appellant, there is no reason to pick features from

document D6 to associate with the teaching of document D5 and even if this were done, the subject-matter of claim 1 would not be arrived at. Hence, the appellant's reliance on document D5 alone or a combination of the technical teaching of documents D5 and D6 or any other document is misplaced.

In conclusion, since the problem addressed by the patent at issue is not realised in any of documents D1 to D6 and any combination thereof is not obvious and, even if nevertheless effected, would not lead to the claimed piston ring, the subject-matter of claim 1 involves an inventive step.

The dependent claims 2 to 4 relate to preferred embodiments of claim 1 and meet, therefore, also the requirements of Article 56 EPC.

7. Since the appellant had not submitted a request for oral proceedings, and since the respondent only requested oral proceedings auxiliarily, the present decision could be taken in writing.

Order

For these reasons it is decided:

The appeal is dismissed.

The Registrar: The Chairman:

V. Commare W. D. Weiß