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Datasheet for the decision of 4 October 2022

Case Number: T 0696/19 - 3.3.05

Application Number: 12006986.9

Publication Number: 2551560

IPC: F16J9/26, C22C38/00

Language of the proceedings: EN

Title of invention:
Piston ring

Patent Proprietors:
NISSAN MOTOR CO., LTD.
Nippon Piston Ring Co., Ltd.

Opponent:
Hoffmann Eitle

Headword:
Piston ring/NISSAN

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - main request (no) - obvious combination of known features - bonus effect (yes) - auxiliary request (yes) - non-obvious modification

Decisions cited:
T 0551/89, T 0967/97

Catchword:

Europäisches Patentamt
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Beschwerdekammern

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Case Number: T 0696/19 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 4 October 2022

Appellant: (Opponent)	Hoffmann Eitle Patent- und Rechtsanwälte PartmbB Arabellastrasse 30 81925 München (DE)
Representative:	Hoffmann Eitle Patent- und Rechtsanwälte PartmbB Arabellastraße 30 81925 München (DE)
Respondent: (Patent Proprietor 1)	NISSAN MOTOR CO., LTD. 2, Takara-cho, Kanagawa-ku Yokohama-shi, Kanagawa 221-0023 (JP)
Respondent: (Patent Proprietor 2)	Nippon Piston Ring Co., Ltd. 12-10, Honmachi-Higashi 5-chome, Chuo-ku Saitama-shi, Saitama 338-8503 (JP)
Representative:	Hoefer & Partner Patentanwälte mbB Pilgersheimer Straße 20 81543 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 7 January 2019 rejecting the opposition filed against European patent No. 2551560 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	E. Bendl
Members:	T. Burkhardt
	P. Guntz

Summary of Facts and Submissions

I. The opponent's (appellant's) appeal is against the opposition division's decision to reject the opposition against European patent No. 2 551 560 B1.

II. The following documents are relevant and were among those discussed at the opposition stage:

D3 JP S 63-140067 A
D3a English translation of D3
D4 EP 0 949 436 A2
D4a English translation of D4
D5 JP 2004-197807 A
D5a English translation of D5

III. The only independent claim of the main request in appeal proceedings (patent as granted) reads as follows:

"1. A piston ring (R), comprising:

a refined steel including:

carbon C in a range of 0.20 % mass to 0.90 % mass,
silicon Si in a range of 0.10 % mass to less than 0.60 % mass,
manganese Mn in a range of 0.20 % mass to 1.50 % mass,
chromium Cr in a range of 0.30 % mass to 2.00 % mass,
iron Fe as balance,
unavoidable impurity,

and further optionally containing:
at least one selected from the group consisting of:

molybdenum Mo in a range of 0.1 % mass to 0.4 % mass,
vanadium V in a range of 0.05 % mass to 0.40 % mass,
niobium Nb in a range of 0.01 % mass to 0.06 % mass,
titanium Ti in a range of 0.01 % mass to 0.06 % mass,
nickel Ni in a range of 0.40 % mass to 2.50 % mass,
boron B in a range of 0.0010 % mass to 0.0030 % mass
and
phosphor P in a range of 0.01 % mass to 0.05 % mass

and
wherein
a parameter A calculated from the following expression (1) based on contents of the Si, Mn and Cr is 9.0 or less:

parameter A = 8.8 Si + 1.6 Mn + 1.7 Cr
--- expression (1)

and
a parameter B calculated from the following expression (2) based on contents of the C, Si, Mn and Cr is 10.8 or more:

parameter B = 36 C + 4.2 Si + 3.8 Mn + 4.5 Cr
--- expression (2)

wherein
the piston ring (R) has a hardness of 26 HRC or more after a refining including a quench hardening and a tempering,
the piston ring (R) has a thermal conductivity of 36 W/m•K or more after the refining including the quench hardening and the tempering,
wherein

at least one of the followings of the piston ring (R) has a 10-point mean surface roughness Rz in a range of 0.8 µm to 3.2 µm:
upper face (Fu) and lower faces (Fl), and an inner peripheral face (Fi)."

IV. Independent claim 1 of auxiliary request 1 further limits several concentration ranges of the refined steel and the range of parameter B (emphasis and deletions added by the board):

"...
carbon C in a range of ~~0.20~~0.25 % mass to 0.90 % mass,
silicon Si in a range of 0.10 % mass to ~~less than~~ 0.40~~0.60~~ % mass,
manganese Mn in a range of ~~0.20~~0.60 % mass to 1.50 % mass,
chromium Cr in a range of ~~0.30~~0.50 % mass to 2.00 % mass,
...
a parameter B calculated from the following expression (2) based on contents of the C, Si, Mn and Cr is ~~10.8~~14.0 or more ..."

Dependent claims 2 to 9 refer to preferred embodiments.

V. At the appeal stage, the appellant submitted the following documents:

D10 "ISO 6621-4:2003(E), Internal combustion engines - Piston rings - Part 4: General specifications", International Standard ISO, second edn., 2003, 1-28

D11 Federal Mogul, "Piston Ring Handbook, Tribology Microwelding", 2004

D12 M. Shuster *et al.*, "Piston Ring Microwelding Phenomenon and Methods of Prevention", SAE Technical Paper Series 960745, 1996, 137-44

D13 US 2009/0058014 A1

D14 "ISO 6621/1-1986(E), Internal combustion engines - Piston rings - Part 1: Vocabulary" with the label "withdrawn", International Standard ISO, first edn., 1986, 1-16

VI. With their reply to the statement setting out the grounds of appeal, the respondents submitted clean versions of auxiliary requests 1 and 2 filed with the submission dated 4 October 2018 at the opposition stage.

VII. The appellant's arguments relevant to the present decision can be summarised as follows.

Besides Example A, the general disclosure of D3/D3a also represented a promising starting point for assessing inventive step. A combination with D4/D4a rendered the subject-matter of claim 1 obvious.

The examples of Table 4 of the patent in suit did not prove an effect related to surface roughness. Moreover, the alternative of polishing the inner peripheral face of the piston ring could not achieve an effect since there was no contact between the ring and the piston at this location, as shown by the drawing on page 3 of the respondents' submission dated 4 October 2018. The technical problem to be solved was hence merely the provision of an alternative.

The general part of D3/D3a pointed to a Si content within the range of claim 1 of the first auxiliary

request, and the Si content of Example A was only slightly above the claimed range.

VIII. The patent proprietors' (respondents') arguments relevant to the present decision can be summarised as follows.

The skilled person would not have selected D3/D3a as the closest prior art since this document aimed at improving the workability of the piston ring. The skilled person would have been even less likely to select inventive Example A of D3/Da since it was aimed at improving workability. Moreover, this example had the lowest hardness of the inventive examples, even though hardness had a positive effect on heat fatigue resistance. The skilled person would have selected Examples E or D of D3/D3a instead. Alternatively, D5/D5a was the closest prior art since it addressed the problem of aluminium agglutination.

Wear and aluminium agglutination corresponded to different technical problems. While the former related to the abrasion of material, the latter related to its adhesion.

There was a synergistic effect of surface roughness and steel composition on aluminium agglutination.

Even a combination of D3/D3a with D4/D4a did not lead to the invention since D4/D4a did not address the problem of aluminium agglutination or thermal conductivity.

IX. The appellant requested that the decision under appeal be set aside and that the European patent be revoked.

The respondents requested that the appeal be dismissed or, in the alternative, that the patent be maintained in amended form on the basis of one of the two auxiliary requests submitted with the reply to the statement setting out the grounds of appeal.

Reasons for the Decision

1. Main request: claim interpretation

1.1 In the respondents' view, the "10-point mean surface roughness Rz" of claim 1 is of the steel of the piston ring, prior to any coating.

The board does not share this view. The roughness in the claims is that of the surface of the piston ring. No reference is made to the steel in this regard. The skilled person would therefore understand that the roughness of claim 1 refers to the surface of the piston ring, be it of the steel (if no further coating is present) or any coating.

Paragraph [0052] of the patent in suit confirms that the final roughness is set in combination with the surface treatments. The examples of the patent in suit are not contradictory to such an interpretation either. The roughness of the steel in the examples of the patent in suit, which is attained by polishing, is within the claimed range. However, the roughness remains unaltered by a subsequent triiron tetroxide coating and is thus still within the claimed range (paragraphs [0076] to [0078], Table 4: Examples 42 to 46 vs. 37 to 41).

1.2 The board considers that the skilled person knows that, in the context of aluminium alloy pistons in combination with steel piston rings, the abrasion of aluminium from the pistons and the agglutination or adhesion of aluminium are all closely linked.

2. Main request: inventive step

For the following reasons, the main request does not meet the requirements of Article 56 EPC in view of the combination of D3/D3a with D4/D4a.

2.1 The invention relates to a piston ring.

2.2 Document D3/D3a, and in particular inventive Example A, also relates to piston rings (see claim 1, page 1, lines 25/26 and Table 1 on page 6).

Besides improving workability, D3 aims at obtaining sufficient hardness, wear resistance and heat resistance (page 3, lines 8 to 13; page 4, lines 2 to 4 and 22 to 26; page 5, lines 22 to 26; page 8, lines 10 to 13; Table 3 on page 8).

Since D3/D3a, and in particular Example 1, relates to the same technical field as the current invention and pursues similar objectives (see below), it is, contrary to the respondents' view, a suitable starting point for assessing inventive step.

Inventive Example A in Table 1 of D3/D3a comprises a refined steel with a composition falling under the scope of claim 1 of the current main request and thus also satisfies claimed parameters A and B. Given that parameter A is a measure of thermal conductivity (as

explained in paragraph [0041] of the patent in suit), thermal conductivity is in the claimed range, too. This has not been disputed.

According to page 8, lines 5 and 6, the hardness of Example A of D3/D3a is also in the claimed range.

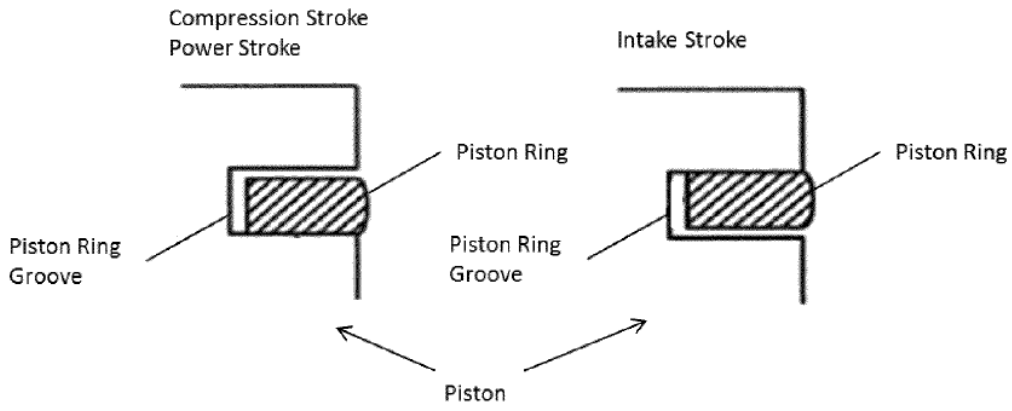
2.3 According to the patent in suit, the technical problem to be solved is to provide a piston ring having, at the same time:
- improved heat fatigue resistance (paragraphs [0001], [0011] and [0042])
- improved thermal conductivity of the contact faces [i.e. between the piston ring and the piston] (paragraph [0050])
- improved "scuffing resistance by the effect of improved thermal conductivity" (paragraph [0053])
- improved aluminium agglutination resistance if "the piston ring .. is applied to an aluminium alloy piston" (paragraph [0050])
- an improved compromise between good sealing and machining cost (paragraph [0054])

2.4 The patent proposes solving this problem by means of the piston ring according to claim 1 characterised in having a 10-point mean surface roughness Rz of at least one of the upper, lower and inner peripheral faces of the piston ring in the range of 0.8 to 3.2 µm.

2.5 In the appellant's view, the examples of Table 4 of the patent in suit did not prove that the problem posed had been successfully solved since all the examples, inventive and comparative, had a roughness in the claimed range. The problem was therefore merely the provision of an alternative.

However, paragraphs [0050] to [0054] of the patent in suit indicate that the improvements mentioned above under point 2.3 are all linked to a reduced surface roughness, and this is credible: a reduced roughness of at least one of the upper, lower and inner peripheral faces of the piston ring indeed reduces the physical engagement between the surfaces of the piston ring and the piston. It is credible that this results in reduced abrasion of and adhesion between the respective surfaces, thus reducing wear and, more particularly, scuffing.

Referring to the schematic drawing on page 3 of the respondents' submission dated 4 October 2018 (reproduced below), the appellant further argued that the alternative of a polished surface of the "inner peripheral face" of the piston ring was useless. This had no influence since there was no contact between the ring and the piston at this location as shown in the drawing.



However, this assertion is not convincing. While the schematic drawing shows a vertical gap between the ring's inner surface and the piston, the accompanying text (first two paragraphs) indicates that "[t]he piston ring repeatedly gets in contact (collision) with

the piston ring groove of the piston under the high temperature while the piston ring rotates around the surface of piston ring groove, thereby causing abrasion of the material of the piston ring" (emphasis added by the board). The generated "fragments of aluminium alloy" from the piston can causes "aluminium agglutination" "at the upper face, the lower face and/ or in the inner peripheral face of the piston ring".

This means that the gap between the ring and the piston in the drawing is not always present during operation due to collisions between the piston and the ring. It is hence credible that a polishing of the inner peripheral face also matters.

Besides, the appellant has failed to provide counter-evidence showing that the technical problem was not solved. There is therefore no reason for doubts in this regard. Neither is there a need to reformulate the technical problem indicated under point 2.3 above.

2.6 Document D4/D4a also relates to steel piston rings (paragraph [0001]) and addresses the problem of wear of the piston ring and the piston itself, mentioning the resulting deterioration of the sealing performance (paragraph [0003] and the end of paragraph [0008]).

Scuffing is a form of wear, and paragraph [0047] of the patent in suit also mentions wear and scuffing in the same context. The skilled person furthermore understands that for aluminium agglutination/adhesion to occur in an aluminium-alloy piston/steel piston ring system, aluminium fragments have to be removed from the piston surface by abrasion or similar in the first place. Consequently, wear and aluminium agglutination/ adhesion are closely linked to each other.

Therefore, the wear and sealing issues mentioned in D4/D4a do relate to several aspects of the problem to be solved.

To alleviate these problems, D4/D4a suggests reducing the surface roughness Rz to 2 µm or below (claim 1).

The skilled person would therefore arrive in an obvious manner at the subject-matter of claim 1 by combining Example A of D3/D3a with D4/D4a (Article 56 EPC).

2.7 In the respondents' view, Example A of D3/D3a was not an appropriate starting point for assessing inventive step since this example related to the first invention of D3/D3a, which aimed at improved workability (page 3, lines 15 to 25 and page 5, lines 22 to 26) and had the lowest hardness of the inventive examples as well as relatively low values for modulus and tensile strength (Tables 2 and 3). However, hardness had a positive effect on heat fatigue resistance, the latter being a primordial aim of the current invention (paragraphs [0016], [0042] and [0045] of the patent in suit). Examples D or E of D3/D3a were to be considered instead since they showed an increased hardness. Alternatively, D5/D5a was to be considered the closest prior art since it dealt with aluminium agglutination/adhesion.

However, as shown above under point 2.2, Example A relates to the same technical field (steel piston rings). It is moreover an example according to the invention of D3/D3a (Table 1). As shown above (point 2.2), Example A shows an acceptable hardness, in line with the requirements of claim 1 of the patent in suit.

Besides, in accordance with established case law, the choice of the starting point for assessing inventive step needs no specific justification if an inventive step is denied (see for example T 967/97, catchword II).

Example A is therefore an appropriate starting point for assessing inventive step.

2.8 The respondents further argued that the steel composition and the surface roughness of the piston ring of claim 1 *synergistically* interacted to increase the thermal conductivity:
- of the piston ring itself
- between the surfaces of the ring and the piston

However, for a synergistic effect to be present, it is necessary to show that the sum of the separate effects is inferior to the effect of the two measures combined. This has not been proven for the sole reason that the patent in suit (and in particular Table 4) contains no examples with a surface roughness outside the claimed range.

Moreover, as explained under point 2.6 above, the choice of a surface roughness in the claimed range is obvious for reducing wear. Whether this surface roughness *additionally* causes an increase of the thermal conductivity between the surfaces of the ring and the piston (thus reducing even more wear and the related aluminium agglutination) is irrelevant. Indeed, an inventive step could even not be acknowledged if the *extent* of the reduction in aluminium agglutination is surprisingly high due to an increase of the thermal conductivity between the polished surface of the ring and the surface of the piston groove (see for example

T 551/89, keyword and the last paragraph of point 4.4 of the Reasons).

Under these circumstances, the increased thermal conductivity between the surfaces merely amounts to the discovery of an inevitable consequence of the reduction of the roughness.

2.9 Similarly, the fact that D4/D4a does not mention aluminium alloy pistons or aluminium agglutination cannot render the subject-matter of claim 1 inventive.

Established case law indicates that if having regard to the state of the art something falling within the terms of a claim would have been obvious to a person skilled in the art because the combined teaching of the prior-art documents could be expected to produce an advantageous effect, such a claim lacks inventive step, regardless of the fact that an extra effect (possibly unforeseen) is obtained (Case Law of the Boards of Appeal, 10th edn., 2022, I.D.10.8).

3. Auxiliary request 1: inventive step

By contrast, the subject-matter of the claims of auxiliary request 1 involves an inventive step for the reasons set out below (Article 56 EPC).

3.1 For the same reasons as for the main request, Example A of D3/D3a is also an appropriate starting point for assessing inventive step of claim 1 of auxiliary request 1.

The contents of C, Mn and Cr as well as parameter B of this example still fall within the more restricted ranges.

3.2 The problem to be solved is the same as for the main request.

3.3 Auxiliary request 1 proposes solving the technical problem by means of the piston ring according to claim 1 characterised in:
- a 10-point mean surface roughness Rz of at least one of the upper, lower and inner peripheral faces of the piston ring in the range of 0.8 to 3.2 µm
- the Si content of the refined steel in a range of 0.10 to 0.40% mass

3.4 According to the patent in suit, a Si content limited to 0.40% improves thermal conductivity (paragraph [0025]).

A comparison between Example 5 and Comparative Example 3 in Table 1 of the patent in suit shows that a decrease in the Si concentration improves thermal conductivity. It is true that the concentrations of other components besides Si, namely the concentrations of C, P, Cr, differ between Example 5 and Comparative Example 3, but the Si content of Comparative Example 3 is the only component of which the concentration lies outside the range of claim 1. In this regard, Comparative Example 3 is comparable to Example A of D3/D3a. Moreover, according to paragraphs [0021] to [0030] of the patent in suit, of these components, only Si has an influence on thermal conductivity.

While Comparative Example 3 in Table 1 of the patent in suit is not representative in every regard of Example A

of D3/D3a (e.g. in contrast to the former, the latter meets the criterion for parameter A in claim 1), the appellant has failed to submit any counter-evidence.

There is consequently no reason to doubt that the technical problem posed has been successfully solved.

3.5 However, D3/D3a specifies that Si between 0.3 and 1.0% acts as deoxidiser and increases thermal resistance (page 4, lines 10 to 15). Since the Si content of 0.45% of Example A falls into this range, the skilled person has no incentive to reduce the Si content to 0.40% or below. They could indeed choose 0.3%, but they could also choose 1.0%.

Moreover, it has not been disputed that the available prior art (including D10 to D14, the consideration/ admissibility of these documents notwithstanding) contains no incentive to choose a Si content in the claimed range to solve the technical problem posed.

3.6 For these reasons, auxiliary request 1 meets the requirements of Article 56 EPC.

3.7 The appellant argues that the general disclosure of D3/ D3a (see e.g. claim 1) is also an appropriate starting point for assessing inventive step.

However, for the following reasons, the general disclosure of D3/D3a is a less promising starting point than Example A.

The Si content of claim 1 of D3/D3a and claim 1 of the patent in suit overlap (0.3 to 1.2% mass and 0.10 to 0.40% mass, respectively).

In addition, while all the other concentrations of Example A fall within the claimed ranges, the concentrations of several components disclosed in claim 1 of D3/D3a and those of claim 1 of auxiliary request merely overlap, i.e. Mn and Cr. Similarly, the resulting parameter A is partly outside the claimed range, e.g. when considering the maximum values of the concentration ranges of Si, Mn and Cr.

Because of these overlapping ranges, it is not certain either that the resulting hardness and thermal conductivity are in the claimed ranges.

Therefore, the general disclosure of D3/D3a is more remote from the invention than Example A.

3.8 A combination of D3/D3a with D5/D5a can also not lead to the invention since the hardness of the piston ring of D3/D3a *after* applying the resin of D5/D5a is unknown and not necessarily within the claimed range.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division with the order to maintain the patent in amended form on the basis of auxiliary request 1, submitted with the reply to the statement setting out the grounds of appeal and a description to be adapted.

The Registrar: The Chairman:

C. Vodz E. Bendl

Decision electronically authenticated