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# Datasheet for the decision of 5 November 2014

**Case Number:** T 0842/11 - 3.2.04

**Application Number:** 07733620.4

**Publication Number:** 2016288

**IPC:** F04C18/12, F04C18/16, F04C18/02, F04C29/00

**Language of the proceedings:** EN

**Title of invention:**
VACUUM PUMP

**Applicant:**
Edwards Limited

**Headword:**

**Relevant legal provisions:**
EPC Art. 56

**Keyword:**
Inventive step - (no)

**Decisions cited:**

**Catchword:**

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**Case Number: T 0842/11 - 3.2.04**

# D E C I S I O N
# of Technical Board of Appeal 3.2.04
# of 5 November 2014

| | |
|---|---|
| **Appellant:** (Applicant) | Edwards Limited<br>Manor Royal<br>Crawley, West Sussex RH10 9LW (GB) |
| **Representative:** | Clark, Charles Robert<br>Edwards Limited<br>Intellectual Property<br>Manor Royal<br>Crawley<br>West Sussex RH10 9LW (GB) |
| **Decision under appeal:** | **Decision of the Examining Division of the European Patent Office posted on 26 November 2010 refusing European patent application No. 07733620.4 pursuant to Article 97(2) EPC.** |

**Composition of the Board:**

| | |
|---|---|
| **Chairman** | A. de Vries |
| **Members:** | J. Wright |
| | C. Heath |

## Summary of Facts and Submissions

I. The Appellant lodged an appeal, received 24 January 2011, against the decision of the Examining Division posted 26 November 2010, refusing the European patent application No. 07 733 620.4 and simultaneously paid the appeal fee. The statement setting out the grounds of appeal was received 25 March 2011.

In its decision the Examining Division held that the application did not meet the requirements of Article 52(1) in combination with Article 56 EPC for lack of inventive step. It considered the following documents inter alia:

D1: EP-A-1 519 045;

D2: E. Carreño-Morelli et al.: "Mechanical Spectroscopy of Austempered Ductile Iron", Scripta Materialia, Vol.38, No.2, Elsevier Science Ltd, 1998, pp.259-265;

D9: "Ductile Iron Data for Design Engineers", Sorelmetal, Section IV: "Austempered Ductile Iron", Montreal, Rio Tinto Iron & Titanium Inc, 1990, pp.4.1-4.44

D10: O.Eric et al.: "Microstructure and toughness of CuNiMo austempered ductile iron", Material Letters 58, Elsevier, 2004, pp 2707-2711

II. Oral proceedings before the Board were duly held on 5 November 2014.

III. The Appellant requests that the decision under appeal be set aside and that a patent be granted in accordance with a Main Request, or one of Auxiliary Requests I and II, all filed with letter dated 7 October 2014, or Auxiliary Request III filed during oral proceedings before the Board.

IV. The wording of the claim 1 of the requests is as follows :

*Main Request and Auxiliary Request I*

"A dry vacuum pump for pumping chlorine, boron trichloride, hydrogen bromide, fluorine and chlorine trifluoride comprising a stator component and at least one rotor component, characterised in that the stator component and/or at least one rotor component are formed from austempered ductile iron."

*Auxiliary Request II*

Claim 1 is as in the main request but is modified to read (text in **bold** added by the Board to indicate added text): "A dry vacuum pump **for use in the semiconductor industry** for pumping ....".

*Auxiliary Request III*

"A dry vacuum pump rotor component for a dry vacuum pump for pumping chlorine, boron trichloride, hydrogen bromide, fluorine and chlorine trifluoride comprising a stator component and at least one rotor component, characterised in that the rotor component is formed from austempered ductile iron."

V. The Appellant's arguments are as follows:

The claimed invention is concerned with the problem posed by corrosive gases used in the semiconductor industries. D1 is thus not a suitable starting point as its pump is not used for corrosive processes such as etching, but for deposition processes and condensable

gases, see paragraph [0004]. Even if it were, inventive step would then require a leap from ductile iron to austempered ductile iron or ADI. Ductile iron however is not noted for its corrosive resistance, but rather for abrasion resistance. Indeed the skilled person would never consider ductile irons for use with corrosive halide gases. Nor is ADI specifically known for its corrosion resistance to halide gases. The skilled person would therefore not consider ADI as suitable material to use in pumps exposed to corrosive halide gases, certainly not instead of better known alternatives such as stainless steel as corroborated by the witness statement.

None of the other documents disclose the corrosion resistance of ADI to halide gases.

These arguments apply in principle to all requests.

## Reasons for the Decision

1. The appeal is admissible.

2. Background

The application concerns dry vacuum pumps, such as a roots pump as shown in figure 2, that have a rotor and stator. In the semiconductor industry, where these pumps maintain a low pressure environment, their main components are exposed to corrosive (halide) gases and are thus usually made of Ni-rich cast iron, which is expensive and difficult to machine, see description page 2, 1st, 2nd and 3rd paragraphs. The invention therefore proposes stator and/or rotor components of austempered ductile iron (ADI), which has good wear and corrosion resistance together with other superior

mechanical properties, but at lower cost, see page 4, last paragraph.

Ductile iron – also known as spheroidal or spherical graphite cast iron or SG (cast) iron - has graphite nodules that give it its typical malleability or ductility. Austempering, refers to the heat treatment by which the microstructure of an iron alloy (steel, cast iron) is changed. Applied to ductile iron it improves various mechanical properties and ductility.

Further, in claim 1 the term "stator" may also be read as the housing surrounding the rotor, as follows from the main embodiment shown described on page 3, lines 19 to 22, with stator 12 identified as the housing in figure 1.

3. Inventive Step

3.1 The decision under appeal based its finding of lack of inventive step on D1 as representing the most relevant state of the art. The Board concurs with this view. D1 concerns the same type of multi-stage dry vacuum pump as the application as is evident from a comparison of figures 1 and 2 of D1 and paragraph [0020] with the two figures of the application and page 3, lines 19 to 20.

3.1.1 The pump of D1 is also used in semiconductor production processes, see paragraph [0004], which mentions as an example "gas ... to deposit reaction product therefrom", understood to refer to chemical vapour deposition or CVD commonly used in the semiconductor industry to deposit reactive precursor material onto a substrate. If the term "reaction product" does not already suggest to the skilled reader corrosive qualities of the gas, i.e. the ability of the gas to

react chemically, this is will be abundantly clear to him from paragraph [0052], first sentence: "gas ... is corrosive". That paragraph and further paragraphs [0037] and [0060] mention the corrosion resistance of the material used in the pump, and this indeed appears to be an important concern in D1. The Board concludes that, contrary to the Appellant's view, the dry vacuum pump of D1 is used for corrosive gases in semiconductor production processes.

3.1.2 The main concern in D1 is heat expansion - the pump operates at high temperature but should have small clearances, cf. paragraphs [0003],[0005] – and manufacturing the pump at low cost with parts that are easy to machine, cf. paragraph [0009]. The solution as outlined in paragraph [0010] is to make the rotational shaft, which is most critical in terms of heat expansion, of a material of low expansion coefficient, (e.g. Ni-rich austenite, such as Invar, paragraph [0033]). The rotor, and also the housing/stator, can be made of more machinable material, thus lowering cost. As an example D1, in paragraphs [0037],[0038],[0052] and [0060], mentions spheroidal graphite cast iron, i.e. ductile iron. Paragraphs [0037] and [0052] in particular highlight that material's good corrosion resistance: thus "spheroid graphite case iron tends to be effective in improving corrosion resistance" (paragraph [0037]) and "...excels in corrosive resistance [compared to] a flake graphite cast iron".

3.2 Vis-à-vis this prior art the only difference is that the housing/stator or rotor is made of an austempered ductile iron. The last paragraph of page 4 of the application associates ADI with high wear and corrosion resistance with reduced weight and cost, in comparison

to more costly Ni-resists (such as Ni rich cast iron). With regard to the pump of D1 with housing-stator assembly and/or rotor of less costly ductile iron already noted for its good corrosion resistance, strength and machinability, the focus must lie on improving or optimizing those qualities. The objective technical problem is then: how to realize a pump as in D1 with ductile iron components where those qualities are optimized or improved.

3.3 There are several publications that mention the special properties of ADI: D2, see introduction on page 259, mentions "good castability, low cost, good wear and corrosion resistance ...[and] strength levels comparable to steel"; D9 in the introduction on page 4-1 identifies its "low cost, design flexibility, machinability, strength to weight ratio, and good toughness wear resistance and fatigue strength" ; and D10, see the introduction on page 2707, mentions its "excellent mechanical properties ... strength, toughness and wear resistance". For the skilled person, who is a mechanical engineer involved in the design and manufacture of dry vacuum pumps, with relevant materials knowledge, these special properties of ADI as a subclass of ductile irons make it an ideal candidate for realizing a dry vacuum pump as in D1 with improved or optimal properties.

3.3.1 This is so as, contrary to the Appellant's arguments, D1 already recognizes the general suitability of ductile irons for rotor or stator components in dry vacuum pumps. Moreover, and as indicated above, D1, at paragraph [0052], identifies ductile iron as particularly suitable for use in a dry vacuum pump in corrosive gas environments because of its good corrosion resistance. In this regard the two "witness

statements" by Mr Jackson carry little weight. Neither the fact that in the first statement Mr Jackson's list of potential alternatives to stainless steel to address the issue of corrosion in dry vacuum pumps does not include ductile iron, much less ADI, nor the broader assertion in the second statement that cast irons for an application requiring corrosion resistance would not be an obvious choice are not to the point: both ignore that D1 already shows that the use of ductile irons in that specific context was known at the priority date.

3.3.2 D1, in the absence of any corroborating evidence to the contrary, also puts paid to the Appellant's assertion that there would exist a general prejudice against ductile irons for use with corrosive halide gases. The corrosive gases mentioned in paragraph [0052] and used in semiconductor production processes - the only field of application mentioned in D1 see paragraph [0004], and which, see point 3.1.1 above suggests CVD - commonly include halides and hydrides. That such particularly reactive or aggressive gases are meant can also be inferred from the additional measure of nickel plating or coating with fluorocarbon resin suggested in further paragraph [0060].

3.4 The specific information in D1 that the skilled person should use ductile iron for its good corrosion resistance for the dry vacuum pump's rotor and stator will lead him or her to expect that a subclass of ductile irons, namely ADIs, will also have a similarly good corrosion resistance, and be similarly suitable for such a pump. This expectation and the knowledge gained from D2, D9 or D10 that ADI's are a special class of ductile irons with particularly good properties, will induce the skilled person to consider and try these materials also in realizing the teaching

of D1. This willingness to try will lead him as a matter of obviousness to the subject-matter of claim 1 of the main request. The subject-matter of this claim, which is identical to claim 1 of the auxiliary request I, therefore lacks inventive step, Article 52(1) with Article 56 EPC.

3.5 As the only application of the pump mentioned in D1 is in the semiconductor industry, this feature added to claim 1 of the auxiliary request II fails to further differentiate its subject-matter from D1. The Board's finding of lack of inventive step holds also for claim 1 of this request.

3.6 Finally, D1 suggests SG iron or ductile iron not only for the housing (stator) but also for the rotor. The reasons given above thus hold also for the rotor. The subject-matter of claim 1 of the auxiliary request III directed to the rotor of a dry vacuum pump made of ADI thus also lacks an inventive step.

4. As claim 1 according to each of the main and auxiliary requests I to III fails to define inventive subject-matter as required by Article 52(1) with Article 56 EPC, none of these requests is allowable. The appeal must therefore fail.

## Order

## For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Magouliotis A. de Vries

Decision electronically authenticated