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D E C I S I O N
of 9 June 2005

Case Number: T 0169/04 - 3.2.3
Application Number: 99306181.1
Publication Number: 0980729
IPC: B22D 13/02, B23H 9/00,
C10G 9/20
Language of the proceedings: EN

Title of invention:

Centrifugally cast tubes, method and apparatus of making same

Patentee:

DONCASTERS LIMITED

Opponents:

Schmidt + Clemens GmbH + Co. Edelstahlwerk Kaiserau
MANOIR INDUSTRIES

Headword:

-

Relevant legal provisions:

EPC Art. 100(a)(b), 52(1), 56

Keyword:

"Inventive step - no"
"Insufficiency of disclosure (no)"

Decisions cited:

T 0014/83, T 0079/88, T 0156/84, T 0633/97, T 0718/98

Catchword:

-



Case Number: T 0169/04 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 9 June 2005

Appellant: Schmidt + Clemens GmbH + Co.
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Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
2 December 2003 concerning maintenance of the
European patent No. 0980729 in amended form.

Composition of the Board:

Chairman: U. Krause
Members: G. Ashley
J. P. B. Seitz

Summary of Facts and Submissions

I. European patent 0 980 729 relates to centrifugally cast tubes, and in particular, tubes used for pyrolysis cracking furnaces in the petrochemical industry.

Grant of the patent was opposed by Appellant 01 (Opponent 01) on the grounds that the claimed subject-matter is not patentable because it does not involve an inventive step (Article 100(a), 52(1) and 56 EPC), and that the invention is insufficiently disclosed for it to be carried out by a person skilled in the art (Article 100(b) EPC). During the opposition procedure, Appellant 01 withdrew his further objections under Articles 54 and 57 EPC.

Appellant 02 (Opponent 02) also opposed the grant of the patent, and requested revocation to the extent of claims 1 to 8, 18 and 19 of the granted patent. The opposition of Appellant 02 was based on the grounds of lack of novelty, inventive step and industrial applicability (Articles 100(a), 52(1), 54, 56 and 57 EPC). However, the Opposition Division considered that the objections under Articles 54 and 57 EPC had not been sufficiently substantiated in the Notice of Opposition, and hence were inadmissible.

According to the interlocutory decision of the Opposition Division dispatched on 2 December 2003, the patent was maintained in amended form; this decision was appealed by all parties. Appellant 01 filed a notice of appeal together with the appeal fee on 28 January 2004; a statement setting out the grounds of appeal was filed on 13 April 2004. Appellant 02 filed

an appeal and the appeal fee on 2 February 2004; the grounds were filed on 9 April 2004. Appellant 03 (Patent proprietor) filed his appeal and appeal fee on 5 February 2004, and the grounds of appeal on 13 April 2004. Oral proceedings were held on 9 June 2005.

II. Requests

Appellant 01 requested that the decision under appeal be set aside and that the patent be revoked.

Appellant 02 requested that the decision under appeal be set aside and the patent revoked to the extent of claims 1 to 9 and 19 to 20 as maintained by the opposition division.

Appellant 03 requested that the decision under appeal be set aside and that the patent be maintained on the basis of his main request filed with the letter dated 8 April 2005, or on the basis of the auxiliary request filed during the oral proceedings.

III. Claim 1 of the main request corresponds to claim 1 of the granted patent and reads as follows:

"1. A centrifugally cast tube comprising creep resistant alloy, which alloy either
a) comprises the following constituents in the proportion indicated, the balance being iron:

Element	% by weight
Carbon	0.1 - 0.5
Chromium	20 - 35

Nickel	20 - 45
Niobium	0 - 2
Silicon	0 - 2
Tungsten	0 - 5
Additions	0 - 1

or,

b) has a mean 100,000 hour stress rupture value of more than 6 MPa at 1000°C, and preferably greater than 10 MPa, and

wherein said tube has an internal profile which is non-circular, such that, in cross-section, the length of the internal profile is at least 10% longer than the circumference of the smallest circle which encompasses the entire profile."

Dependent claims 2 to 6 define preferred embodiments of the tube of claim 1. Independent claim 7 defines a method of forming a tube as claimed in any of claims 1 to 5, and independent claim 16 defines a method of forming a pyrolysis or reformer tube; dependent claims 8 and 17 concern preferred embodiments of method claims 7 and 16 respectively. Independent claim 9 defines an electrochemical machining apparatus to carry out the method of claims 7 or 8, and dependent claims 10 to 15 concern preferred embodiments of the apparatus.

Claim 1 of the auxiliary request reads as follows:

"1. A centrifugally cast tube comprising creep resistant alloy, which alloy either
a) comprises the following constituents in the proportion indicated, the balance being iron:

Element	% by weight
Carbon	0.1 - 0.5
Chromium	20 - 35
Nickel	20 - 45
Niobium	0 - 2
Silicon	0 - 2
Tungsten	0 - 5
Additions	0 - 1

or,

b) has a mean 100,000 hour stress rupture value of more than 6 MPa at 1000°C, and preferably greater than 10 MPa, and

wherein said tube has an internal profile which is non-circular, such that straight fins are formed along the internal bore of the tube, said fins being symmetrical and essentially sinusoidal in form and such that, in cross-section, the length of the internal profile is at least 10% longer than the circumference of the smallest circle which encompasses the entire profile."

Claims 2 to 16 of the auxiliary request correspond to claims 3 to 17 of the main request.

IV. The following documents referred to during the opposition proceedings are relevant for this decision:

D3: S.B. Parks and C.M. Schillmoller, "Use Alloys to Improve Ethylene Production", Hydrocarbon Processing, pages 53 to 61, March 1996.

- D4: J. Jones and J. Huber, "Improved Reformer Furnace efficiency", ICI Katalco IMTF Conference San Diego, pages 1 to 15, 1997.
- D6: J.V. Albano et al, "Applications of Extended Surfaces in Pyrolysis Coils", Energy Progress, September 1988, Vol.8, No.3, pages 160 to 168.
- D7: DE-A-1916915
- D11: Manoir Industries News, reprinted from Hydrocarbon Processing, October 1991, pages 1 to 4.
- D18: GB-A-969796
- D26: Paper on electrochemical machining delivered by W.M. Wolgin and S.W. Tschastjunin at a conference in Leningrad on December 6/7 1990 and published in 1990 by the "Leningrader Haus für die wissenschaftliche Propaganda".
- D26a: German translation of D26 with the title, "Elektrochemische Bearbeitung von Wendelnuten auf den inneren Rohroberflächen der Wärmeübertragungs-einrichtungen".

V. Arguments of the Parties

1. Article 100(b) EPC

- (a) Appellant 01 submitted that as a result of the vague term "additions", the definition of the alloy by reference to a particular property and

the absence of an upper limit for the internal profile, the invention according to claim 1 of the main and auxiliary requests is not disclosed in a manner sufficiently clear and complete for it to be carried out by the skilled person.

Appellant 01 argued that the definition of the alloy allows for up to 1% unknown additions, which may have a significant effect on the properties of the alloy. The description provides no indication of types of additions which could be added to produce an alloy having the required mechanical, chemical and casting properties, and which do not have an adverse effect on the invention. In addition, the mere definition of a stress rupture value to characterise an alloy, as in claim 1 b), means that the skilled person is faced with great difficulty in determining appropriate alloy compositions. There is an undue burden in establishing suitable additions, since this covers a vast range of both metallic and non-metallic components, and each test to determine the 100,000 hour stress rupture value for new alloys requires at least three years.

Concerning the open-ended definition of the internal profile, Appellant 01 explained that, although an increase in internal profile beyond the defined lower limit improves the heat transfer properties, it also has an adverse effect on the flow characteristics. The upper limit is a balance between these two contrary effects, and the patent provides no indication as to how much increase could be tolerated in practice.

- (b) Appellant 03 replied by stating that the invention is itself not directed to a specific alloy or class of alloys, but rather to a centrifugally cast tube and the skilled person is aware of the alloys used to make such tubes. Citing T 14/83 (OJ 1984, 105) and T 79/88 (not published), Appellant 03 argued that, rather than considering whether there is an undue burden on the skilled person to find suitable alloys, Article 100(b) EPC simply requires that the skilled person must be able put the invention into effect. Since the patent specification gives examples of suitable additions and types of alloys, the skilled person can carry out the invention. The 100,000 hour stress rupture value is a fundamental property for tubes used in the petrochemical industry; in practice, tubes cannot be sold without quoting this value, since it is important to know what the strength will be after ten years in service. Consequently, the skilled person would know whether any given alloy could be used to make the tube of claim 1.

With regard to the internal profile range, Appellant 03 argued that the maximum possible ratio is desirable for the best heat transfer properties, and since there is no prior art disclosing values close to the claimed range, it is sufficient to define the minimum value. Although there must be an upper limit in the practical sense, this is not the concern of the invention, which is simply to improve the ratio beyond 10%.

2. Claim 1 of the Main Request - Inventive Step

- (a) According to Appellants O1 and O2, the starting point for the invention is a centrifugally cast tube made from an alloy as defined in claim 1; document D11 describes such tubes. The problem to be solved is how to improve the heat transfer properties of the tubes, as set out in the disputed patent at [0030]. The skilled person is aware that heat transfer depends on the internal surface area of the tube, and that an increase will lead to improved heat transfer.

The skilled person is also aware of the various techniques, such as machining, using a powder metallurgy route or electrochemical machining (ECM), that may be used to create a profiled surface. Although the skilled person could theoretically choose anyone of these routes, the high carbon content of the alloys from which the tubes of D11 are made limits the choice. D26, which is from the same technical field and refers to the same technical problem, provides the general teaching that the heat transfer of heat exchanger tubes is increased by ECM grooves on the internal surface. Since D26 concerns the same type of tubes being used for the same purpose as those of D11, the skilled person would consult both documents. In reading D26, the skilled person is directed to a specific technique, namely ECM, as a means of providing grooves on the inside of a tube. The subject-matter of claim 1 thus lacks an inventive step with respect to D11 and D26.

Appellant 02 further referred to D18 as disclosing that heat transfer properties of furnace tubes are improved by providing grooves on the internal surface. D18 is neither linked to any particular composition of tube, nor does not mention ECM, but nevertheless provides a general teaching of providing grooves on the internal surface of furnace tubes. Given that claim 1 of the disputed patent is not limited to any specific technique for achieving the increase in profile, there is also a lack of inventive step with respect to D11 and D18.

- (b) Appellant 03 disputed the admission of D26 into the proceedings. He argued that Appellant 01 had known of the translated abstract of D26 before the period for filing an opposition had expired (in this case that was on 3 October 2001), but had waited until 4 August 2003 before filing it. Appellant 01 said that he had waited to assess the original document, which had been difficult to obtain. Appellant 03 did not accept this explanation, since he had been able to obtain a copy of the paper within fourteen days. Consequently, the choice of Appellant 01 to disclose D26 late in the proceedings was deliberate and amounted to an abuse of procedure.

Notwithstanding the submission concerning the admissibility of D26, Appellant 03 argued in support of inventive step as follows.

At the time of the invention, the skilled person was aware of two types of tubes for use in

pyrolysis furnaces. The first type of tube (such as described in D6) is wrought from materials that are susceptible to creep elongation, but which are machined to provide fins or grooves for improving heat transfer properties. The second type concerns tubes made from creep resistant alloys, which can realistically only be made by centrifugal casting (such as described in D3, D4 or D11); these tubes have a smooth bore, as machining hard alloys is difficult. Appellant 03 argued that the opportunity to make the invention had been around for many years, but there existed a prejudice in the art against combining the advantages of each type of tube. For example, both D6 (from 1988) and D3 (from 1996) refer to wrought and centrifugally cast tubes, but it was always a question of choosing either one technology or the other.

Appellant 03 agreed that the closest prior art is a centrifugally cast tube of creep resistant material that meets the requirements of claim 1, such as described in D11. Starting from D11, Appellant 03 formulated the problem as "how to form substantial, longitudinal fins or grooves in centrifugally cast, creep resistant alloy tubes". He argued that the skilled person would not have consulted D26, which was delivered at a conference in Leningrad entitled "Improvement of efficiency of application of electrophysical and electrochemical techniques for treatment of materials". It would require an "inventive step" to locate the document and the importance of the document is only apparent to someone having knowledge of the invention.

Although D26 *prima facie* provides the solution to the problem of creating grooves on the internal surface of a tube, the skilled person would not realistically have considered it when seeking to solve the problem. Firstly, the scale of problem in the patent and in D6 is different; the patent concerns tubes having an internal diameter of about 50 mm with fins having a peak height of about 4.5 mm, whereas the tubes of D26 have an internal diameter of 12 mm and fins of less than 1 mm. Secondly, whereas the alloy of claim 1 is a high carbon, high strength, heat resistant steel, the alloy used in D26 is of lower carbon content and lower strength. Since D26 does not concern tubes from heat resistant materials, it is not in a neighbouring field and would not be consulted by the skilled person seeking to solve the problem. D26 merely discloses ECM as an alternative to mechanically machining steels of lower carbon content.

In summary, the skilled person would not combine the teachings of D11 and D26 and the existence of a prejudice in the art is further evidence of an inventive step.

3. Claim 1 of the Auxiliary Request - Inventive Step

In addition to the features given in claim 1 of the main request, claim 1 of the auxiliary request further defines the shape of the fins as being straight.

Appellant 03 submitted that D26 discloses a tube having a spiral groove; this has the disadvantage that it

causes a pressure drop when fluids or gases flow through the tube. In order to arrive at the subject-matter of claim 1, one must combine the teachings of at least three documents, and this is beyond the inventive capacity of the skilled person.

Appellant 01 argued that D26 discloses grooves on the internal of surface of tubes, and these grooves improve the transfer of heat irrespective of their shape. Both straight and spiral grooves are well known in the art; D18 shows straight grooves, and D6 (page 163, right-hand column and Figures 7 and 8) compares the effects of spiral and straight grooves/fins. There is thus no inventive step in providing straight fins.

Appellant 02 further argued that D26 teaches the principle of making grooves by ECM, and D7 shows the use of ECM to make straight grooves. The two possibilities, straight or spiral, are part of the general knowledge of the skilled person, as evidenced by the large number of publications showing them. He added that there is no special difficulty in making straight grooves, and once the skilled person is taught to make grooves, the choice of dimensions and shape is purely routine.

Reasons for the Decision

1. The appeals are admissible.

2. *Article 100(b) EPC - Sufficiency of Disclosure*

It is alleged by Appellant 01 that the definition of the alloy and of the internal profile given in claim 1 is such that the skilled person is incapable of carrying out the invention. Under Article 100(b) EPC sufficient disclosure is required of a European patent, i.e. the claims together with the description and drawings. It is therefore necessary to examine the disclosure made in the patent specification as a whole.

Appellant 01 alleges that the expression "Additions 0 - 1 % by weight" is so broad that the skilled person is unable to determine suitable elements and compounds. In addition, the functional definition of an alloy by a property also means that the skilled person is incapable of determining appropriate alloys, particularly as the necessary tests are very demanding.

It is apparent to the Board that the heart of the invention lies not in the composition of the tube material itself, but in providing tubes made from known alloys with a certain profile on the inner surface. Appellant 03 himself accepts that tubes made from known commercial alloys, such as is shown in document D11 or marketed by Appellant 03 himself (see paragraph [0055] of the patent), provide the starting point for the invention. The patent specification indicates in paragraph [0012] a typical broad composition for such known alloys, which are referred to as "creep resistant alloys"; this composition corresponds to the definition given in claim 1. Specific examples of suitable alloys are given in Table 1 of the specification and their "100,000 hour" creep rupture strength is given in

Table 2. Alloy H39W in Table 3 shows that Mo and Al are elements falling within the category of "additions". The Board is therefore of the view that the patent specification provides the skilled person with specific examples of alloys which are suitable for putting the invention into practice; also the specification provides a good indication of the class of alloys from which the tubes should be made, so that the skilled person would recognise whether a given tube would be appropriate. The failure to define an upper limit for the internal profile is not seen by the Board as being reason why the invention cannot be carried out. The increase in internal profile is a parameter that can be easily measured and established by the skilled person, who is instructed that it must be greater than 10%. The lack of an upper limit cannot be said to inhibit the invention being put into practice.

Appellant 01 also argued that the disputed definitions mean that the skilled person is not certain of the scope of protection offered by claim 1. Whilst the Board may empathize with this submission, the clarity of scope of protection is a matter falling under Article 84 EPC. Article 100(b) EPC simply requires that the invention be described so that it can be carried out in practice, and in this case the examples given in the specification clearly demonstrate how this can be achieved.

Consequently, the requirements of Article 100(b) EPC are met.

3. *Prior Art - Document D26*

Appellant 03 submitted that D26 should be excluded from the proceedings because the late-filing of the document amounts to an abuse of procedure (see paragraph V 2b above).

Over the years, the admissibility of late-filed documents has been the subject of much discussion in the case law of the boards of appeal, mainly because of the apparent conflict between Article 114(1) EPC, which obliges the EPO to examine the facts of its own motion, and Article 114(2) EPC, which states that EPO may disregard facts or evidence which are not submitted in due time by the parties concerned.

One line of thought is that Article 114(1) takes precedence over Article 114(2); the main criteria for deciding admissibility is the relevance of the prior art (see for example T 156/84 OJ 1988, 372). A second approach is that of "complexity" (see for example T 633/97 (not published)) where the decision to admit late-filed documents is governed by a general interest in the appeal proceedings being conducted in an effective manner. According to T 633/97, new submissions should be disregarded if the complexity of issues raised is such that they cannot be dealt with without adjournment of the oral proceedings. However, T 718/98 (not published) does make the point that admissibility of a document should be refused if it is done as a strategic measure, irrespective of its relevance.

In this case, the Board considers D26 to be a very relevant document for the assessment of inventive step. The document was filed during the proceedings before the department of first instance on 4 August 2003, thus all parties had ample time before the oral proceedings before the Board of Appeal to consider its disclosure. Further, the document is short and easily understood, and thus cannot be said to raise complex new issues, which prevent the proceedings from being conducted in an efficient manner.

Therefore, irrespective as to whether the criteria of "relevance" or "complexity" are applied, D26 should be admitted into the proceedings. The Board is also not convinced that there was any malice behind the decision of Appellant 01 to file D26 late. It was done in response to the preliminary opinion from the opposition division and three months before the oral proceedings were held. The evidence filed with the letter of 4 August 2003 shows that Appellant 01 had been making efforts to obtain the original document, but clearly had not employed such an efficient Russian searcher as that used by Appellant 03. For all of these reasons, the Board decided to take D26 into consideration.

4. *Claim 1 of the Main Request - Inventive Step*

- 4.1 It is clear that novelty is not in question and the main issue here is that of inventive step. All the parties agree upon the starting point for the invention; this a centrifugally cast tube made from a creep resistant alloy, which has a composition which falls within the ranges defined in claim 1 a) or meets the

requirement given in claim 1 b) - such a tube is described for example in D11.

- 4.2 Starting from D11, the problem to be solved is how to improve the heat transfer capabilities of the tube. This problem is also set out in paragraph [0030] of the patent specification. It is thus necessary to consider whether, as argued by Appellants 01 and 02, the skilled person starting from D11 would consult D26 in expectation of finding a solution, and whether D26 actually provides the solution.

D26 has as its purpose the improvement in heat transfer capabilities of heat exchanger tubes. This is achieved by electrochemically machining spiral grooves on the inner surface of the tubes, which at first sight, as acknowledged by Appellant 03, appears to provide the solution. However, Appellant 03 submits that the difference in size of the tubes of the patent or D11 and that of D26 would deter the skilled person from consulting the document. The Board does not agree with this submission. Firstly, although Appellant 03 argued that the description (see paragraph [0059]) discloses tubes of about 50 mm internal diameter, the subject-matter of claim 1 is not restricted to tubes of any particular size; the scope of the claim thus encompasses tubes of 12 mm diameter as disclosed in D26. Secondly, the teaching of D26 is such that at very least the skilled person would be encouraged to try the technique on slightly larger tubes, after all the difference in diameter is only a factor of about four.

- 4.3 Appellant 03 also submitted that D26 concerns a low carbon steel that is not as hard as the creep resistant

materials of D11; thus the skilled person would not realise, without having a deeper knowledge of ECM, that the method of D26 would be suitable for hard materials.

The Board notes that the steel of D26, designated 12X18H9T, is defined as having a carbon content less than 0.12%, and the steel of claim 1 has 0.1 to 0.5% carbon; there is thus an overlap in carbon content and consequently an overlap in hardness. However, irrespective of composition, ECM is generally known as a technique employed for tasks that are difficult or time consuming to carry out by mechanical machining, such as machining hard materials. It is also a known feature of ECM that metal removal rate is not directly related to metal hardness. Thus, the emphasis Appellant 03 places on the differing materials is not convincing.

4.4 The skilled person is taught by D26 to machine grooves on the interior surface of a heat exchanger tube in order to improve its heat transfer properties (see D 26a, the German translation of D26, in particular lines 1 to 4 and 15 to 18 of the text on the first page, and lines 7 to 10 of the second page). D26 teaches further that ECM is a suitable technique for carrying this out, and the skilled person would immediately recognise that this technique is eminently suitable for hard materials of the type described in D11. For these reasons there can be no inventive step in applying the teaching of D26 to D11.

4.5 Appellant 03 submitted that it was as much an "inventive step" to locate D26 and apply its teachings, as it was to independently discover that ECM could provide the solution and break 30 years of prejudice.

The Board does not dispute that the inventors of the disputed patent were not aware of D26 and independently arrived at the invention. However, in the world of patents, it is the objective contribution to existing knowledge that counts, and therefore the skilled person is attributed with all information that is made available to the public before the priority date, and in this case this means that the skilled person has D26 on his table. Given the disclosure of D26, it could be said that it is this document that shows how to break any prejudice that might have existed against providing internal grooves in tubes made from a high carbon steel.

5. *Method Claim 6 of the Main Request*

Claim 6 essentially defines a method of forming tubes made from the heat resistant materials of claim 1 by electrochemical machining. Such a method lacks an inventive step for the same reasons as given in respect of claim 1.

6. *Claim 1 of the Auxiliary Request - Inventive Step*

6.1 Claim 1 of the auxiliary request further defines the internal profile as being non-circular, such that straight fins are formed along the internal bore of the tube, said fins being symmetrical and essentially sinusoidal in form. Support for this feature can be found in Figures 3a, 3b, 6 and 8 to 10 of the application as originally filed, and hence the requirements of Article 123(2) EPC are met.

6.2 Starting again from D11 as the closest prior art, the subject-matter of claim 1 essentially differs in that the tubes have straight fins. D26 teaches that the heat transfer capability can be improved by forming spiral grooves on the internal surface of the tubes. It is thus necessary to consider whether, armed with this knowledge, it would also be obvious to make straight grooves.

As set out above, the problem to be solved is how to improve the heat transfer properties of the tubes of D11. The Board is of the opinion that D26 teaches that this is achieved by the use of spiral grooves, but the skilled person would also recognise that the improvement in heat transfer largely results from the increase in surface area. It is also clear from the cited prior art e.g. D6, pages 163 to 165, that the skilled person would be aware that grooves or fins formed in pyrolysis tubes are either spiral or straight. Having been told that spiral grooves improve heat transfer properties and told how to create them in tubes of hard materials, it cannot be inventive to choose the only other alternative. The shape of grooves is of secondary importance for heat transfer; the skilled person will choose any suitable shape, for example, the symmetric and sinusoidal form shown in Figure 5 of D6 or in Figures 3 and 4 of D18.

Consequently, claim 1 of the auxiliary request fails to meet the requirements of patentability because of lack of inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The patent is revoked.

The Registrar:

The Chairman:

A. Counillon

U. Krause