BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

A		B		C	X

File Number: T 150/92 - 3.5.2

Application No.: 86 115 083.7

Publication No.: 0 220 738

Title of invention: Intermetallic compound-based, composite superconductor

Classification: H01B 12/10

D E C I S I O N
of 22 January 1993

Applicant: Hitachi Ltd.

Opponent: Vacuumschmelze GmbH, Hanau

Headword:

EPC Article 56

Keyword: "Inventive step (no)"

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number : T 150/92 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 22 January 1993

Appellant : (Proprietor of the patent)
Hitachi Ltd.
6, Kanda Surugadai 4-chome
Chiyoda-ku
Tokyo 100 (JP)

Representative :
Patentanwälte
Dr. Timpe, Dr. Franke
Steinsdorfstrasse 10
W-8000 München 22 (DE)

Respondent : (Opponent)
Vacuumschmelze GmbH, Hanau
Bereich Verträge und Patente
Grüner Weg 37
Postfach 2253
W-6450 Hanau 1 (DE)

Decision under appeal :
Decision of the Opposition Division of the European Patent Office dated 16 December 1991 revoking European patent No. 0 220 738 pursuant to Article 102(1) EPC.

Composition of the Board :

Chairman : E. Persson
Members : A.G. Hagenbucher
J.A. van Voorthuizen

Summary of Facts and Submissions

I. The Appellant (Patentee) contests the decision of the Opposition Division revoking European patent No. 0 220 738 on the ground that the intermetallic compound-based composite superconductive wire member according to granted Claim 1 did not involve an inventive step in the light of the following documents:

D1: DE-C-2 339 525
D2: DE-B-1 284 502.

II. In a communication, the Rapporteur additionally referred to

D3: US-A-4 330 347 (mentioned in col. 2, lines 34-38 of EP-B-220 738).

IV. In response to this communication the Appellant filed with the letter of 12 November 1992 amended Claims 1 to 3, a new independent Claim 4 and an adapted description (main request).

V. The Respondent additionally referred to

D4: US-A-4 329 539 (mentioned in col. 2, lines 20-27 of EP-B-220 738 with respect to the preamble of Claim 1).

VI. Independent Claim 1 now reads:

"1. An intermetallic compound-based, superconductive strand (1) which comprises a plurality of filaments (2) containing a superconductive compound formed by diffusion reaction with a surrounding matrix (3), a stabilizer (5) surrounding the matrix (3), and a diffusion barrier (4)

provided between the stabilizer (5) and the matrix (3) for preventing diffusion of the superconductive compound-forming elements into the stabilizer (5) during the diffusion reaction,
characterized in that
a metal layer (7) of niobium, tantalum, vanadium, chromium, molybdenum or tungsten is provided on the outer periphery of the stabilizer (5)."

Claims 2 and 3 are dependent on Claim 1.

Independent Claim 4 is worded as follows:

"4. Use of the intermetallic compound-based, superconductive strand as defined in Claim 1, wherein a plurality of the strands are stranded and disposed in a conduit cooled by a coolant."

VII. At the oral proceedings, which were held on 16 December 1992, the Appellant submitted a supplement to the description and filed by way of a first auxiliary request a first set of Claims 1 and 2, respectively corresponding to Claims 1 and 4 according to the main request, and by way of a second auxiliary request a new use claim combining the features of Claims 1 and 4 according to the main request.

VIII. The Appellant's arguments can be summarised as follows:

The contested patent related to the problem of providing a superconductive strand with a coating to reduce the AC-loss caused by current coupling between strands and to ensure high heat transfer from the strand to the coolant and current transfer between strands in the event that the superconductive compound in a strand left the superconductive state. Although it was known from D3 to

provide a superconductive strand with an electrically insulating coating to reduce AC-loss, the material used, a semiconducting film of cuprous sulfide, had poor thermal conductivity. D1 and D2 disclosed the use of the claimed metals as a diffusion barrier between the superconductive compound and the metal stabiliser in an intermetallic compound-based superconductive wire member. There was no suggestion, however, that the metals of a diffusion barrier could be used as insulating coatings for reducing AC-loss. In fact, D1 and D2 did not relate to stranded wires and therefore were not concerned with the problem of current coupling. D4 (especially Claim 13 and col. 10, lines 15-18) disclosed the features in the preamble of Claim 1 but no particular inorganic materials.

IX. The Respondent argued essentially as follows:

The new sets of claims included a claim to the use of the strands. This claimed use introduced a new feature, namely a conduit, which was neither claimed before nor described in connection with the two embodiments according to Figs. 1 and 2.

Only at the oral proceedings did the Appellant submit that the purpose of the claimed coating was not only to reduce AC-losses in superconductive strands but also to ensure good heat dissipation. Such new argument should not be taken into account when assessing the inventive step. In any case, the new formulation of the problem reflected only the general requirements to be satisfied by the coating of a superconductive strand. D3 and D4 disclosed the features in the preamble of Claim 1. It was known therefrom that a coating of sufficient resistivity, at least at cryogenic temperatures, must be used to reduce coupling currents between strands. From D1 it could be inferred that the metals claimed in the contested patent

were suitable not just as a diffusion barrier between the superconductive compound and the metal stabiliser but also as a coating layer. In particular from D2 it was known that some of these metals fulfilled also the function of an insulating layer between the superconductive core and the stabiliser at cryogenic temperatures. For the skilled person it would be obvious to combine the teachings of D3 or D4, D2 and D1 and thus arrive at the claimed subject-matter.

X. The Appellant requested that the decision of the Opposition Division be set aside and the patent be maintained on the basis of Claims 1 to 4 and a description as filed with the letter of 12 November 1992, paragraph 3 of page 3 of the description being replaced by the supplement to the description filed at the oral proceedings (main request), or on the basis of Claims 1 and 2 and a description as filed at the oral proceedings (first auxiliary request) or on the basis of Claim 1 (second auxiliary request) as filed at the oral proceedings.

The Respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. Amendments

The amendments comply with the requirements of Article 123(2) and (3) EPC.

Claim 4 (main request), Claim 2 (first auxiliary request) and the single claim (second auxiliary request) can be

derived from the disclosure at col. 3, lines 46-57 when interpreted in the light of the prior art acknowledged at col. 1, lines 40-65 of EP-B-220 738.

3. Main request

3.1 It is not in dispute that an intermetallic compound-based superconductive strand comprising the features referred to in the precharacterising part of Claim 1 and the additional feature that such a strand is coated with a material of high electrical resistance or electrical insulation in order to reduce AC-losses is known from D3 (figure 1) and D4 (cf. figures 8 and 15; col. 10, lines 1-33). According to D3 a reduction of the AC-loss due to coupling currents between strands is achieved by providing the outer periphery of the stabiliser (5) (D3, fig. 1) with a semiconducting film of cuprous sulfide (Cu_2S). This layer provides not only enough insulation between the strands to reduce AC-losses, but also enough conductivity to allow current transfer between strands in the event that the superconductive compound in one strand leaves the superconductive state (D3, col. 3, line 47 to col. 4, line 2).

3.2 As pointed out by the Respondent, in the original disclosure the main emphasis was on the reduction of the AC-loss in a superconductive strand. However, in the light of the arguments submitted by the Appellant at the oral proceedings, the Board accepts that the problem underlying the subject-matter of Claim 1 consists in selecting materials for the outer coating of the stabiliser which are suitable not only to reduce strand coupling loss (AC-loss) but also to improve thermal diffusion from the strand to the coolant. The Board is satisfied that a metal layer as defined in the characterising part of Claim 1 solves the above problem.

3.3 The Appellant maintains that the gist of the invention lies in the selection of metals which provide due to their electrical and thermal characteristics an appropriate trade-off between AC-loss reduction on the one hand and high strand current sharing and heat transfer on the other hand.

3.4 In the opinion of the Board, a skilled person starting from D3 and wishing to improve the strand current sharing and the thermal conductivity of a strand's insulating coating would start looking for materials meeting the general requirements for an insulating layer of a superconducting strand as laid down in D3. This document specifies, inter alia, that:

(a) a coating material need not be insulating at room temperature although it must be resistive at cryogenic temperatures (D3, col. 1, lines 49 and 50);

(b) it must not diffuse into the stabilising layer (Cu) or attack it in any way such as to lower its electrical conductivity during the reaction anneal (D3, col. 1, lines 44-46);

(c) it must withstand a reaction temperature of 700°C (D3, col. 1, lines 42 and 43).

Moreover, even if D3 is silent about the thermal characteristics of the coating, it is well known that sufficient heat flow from the superconductive core to the coolant must be provided in order to ensure a stable operation of a semiconductor; cf. D4, col. 13, lines 15-18; col. 14, lines 10-22.

3.5 Regarding requirement (a):
D2 (col. 2, lines 30-38) teaches that in the field of superconductors the insulating properties of a material must be considered in respect to the transition temperature of a superconductive compound and that metals such as molybdenum, chromium, their alloys or alloys of such metals with tungsten, behave as electrical insulators because of the finite resistivity at the operating temperature of the superconductive compound. Although niobium, vanadium and tantalum are superconductors below 9.22°K, 4.3°K and 4.38°K respectively, it follows from the above that these metals can be used as resistors in the range of operating temperatures between 9.22°K (4.3°K and 4.38°K) and 18°K.

Regarding requirement (b):
From D1 it is known that the claimed metals niobium, tantalum, vanadium, chromium, molybdenum and tungsten additionally meet requirement (b) above, because their diffusion is small in a stabilising layer of copper (col. 7, second column of Table 1).

Regarding requirement (c):
It is generally known that these metals are stable at a temperature of 700°C and meet requirement (c) above.

Regarding the desired thermal conductivity attention is drawn to the fact that according to D1 (col. 4, lines 23-32) the above metals should not react with the metal of the stabiliser so as to form layers which could impair the heat flow. It is implicit therefrom that the indicated metals as such meet the requirement of sufficient thermal conductivity.

3.6 According to the Appellant the teachings of D1 and D2 should not be relevant to a superconductive strand since these documents do not relate to stranded superconductors. The Board shares, however, the Respondent's view that it is standard practice in the field of superconductors to start testing materials in a simpler configuration (e.g. unstranded superconducting wires) and then extend the acquired know-how to more complex applications (e.g. stranded superconductors). Therefore the skilled person looking for coating materials apt to ensure AC-loss reduction, strand current sharing and high heat transfer in a superconductive strand according to D3 or D4 would find it obvious to consider also the teachings of D1 and D2 as far as metal characteristics are concerned and thus realise that the electrical and thermal characteristics of the claimed metals provided a suitable solution to the addressed problem.

3.7 Hence, the use of the claimed metals as insulating coating in a superconductive strand as known from D3 or D4 cannot be considered as providing a surprising effect. The subject-matter of Claim 1 does not involve an inventive step.

3.8 Claim 4

Independent Claim 4 is directed to the use of a superconductive strand according to Claim 1, in which the strands are stranded and disposed in a conduit cooled by a coolant. It follows from col. 1, lines 40-65 of EP-B-220 738 that the use of strands disposed in a conduit cooled by a coolant is known. The application of this general teaching to the strands specifically defined in Claim 1 must be considered as obvious to the person skilled in the art.

4. First auxiliary request

The first auxiliary request differs from the main request only in that dependent Claims 2 and 3 have been deleted and Claim 4 has been renumbered as Claim 2. Since Claims 1 and 2 according to the first auxiliary request correspond to Claim 1 and 4 according to the main request, the same arguments apply and thus also the first auxiliary request is not allowable.

5. Second auxiliary request

The only claim according to the second auxiliary request is effectively a combination of Claims 1 and 4 according to the main request. For essentially the same reasons as given above in respect of Claim 4 of the main request, it is not allowable.

Order

For these reasons, it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Kiehl E. Persson