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D E C I S I O N
of 7 October 2005

Case Number: T 0507/03 - 3.5.02

Application Number: 95932332.0

Publication Number: 0781452

IPC: H01F 7/00

Language of the proceedings: EN

Title of invention:
Superconducting magnetic coil

Patentee:
American Superconductor Corporation

Opponent:
Siemens AG

Headword:
-

Relevant legal provisions:
EPC Art. 56, 104, 108
EPC R. 65

Keyword:
"Inventive step - main and auxiliary requests (no)"
"Apportionment of costs (no)"

Decisions cited:
-

Catchword:
-



Case Number: T 0507/03 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 7 October 2005

Appellant: Siemens AG
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Representative: -

Respondent: AMERICAN SUPERCONDUCTOR CORPORATION
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 6 March 2003
rejecting the opposition filed against European
patent No. 0781452 pursuant to Article 102(2)
EPC.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: J.-M. Cannard
E. Lachacinski

Summary of Facts and Submissions

I. The opponent appealed against the decision of the opposition division rejecting the opposition filed against European patent No. 0 781 452.

II. Prior art documents:

D15: IEEE Transactions on Magnetism, vol. 28, No. 1, January 1992, pages 701 to 704, Karpushov et al: Superconducting Magnet For L* Detector,

D16: US-A- 3 665 351, and

D17: EP-A- 0 196 511,

were filed for the first time with the appellant's statement of grounds of appeal.

D18: Applied Superconductivity, vol. 1, No. 10-12, 1993, pages 1841 to 1847, I.L. McDougall et al: High temperature superconducting magnets for NMR,

was filed for the first time with the appellant's letter dated 5 September 2005.

III. Oral proceedings were held on 7 October 2005. At the beginning of the oral proceedings, the appellant and the Board raised formal objections to the claims which had been filed in response to the observations accompanying the summons. The respondent filed amended sets of claims 1 to 11 according to a main request, claims 1 to 11 according to a first auxiliary request

and claims 1 to 11 according to a second auxiliary request. Claim 1 of the main request reads as follows:

"A magnetic coil comprising:

an anisotropic high temperature superconductor wound about a longitudinal axis of the coil, wherein the anisotropic superconductor is in the form of a tape wound with the wide surface thereof extending parallel to the axis of the coil, the coil generating a magnetic field that varies along the longitudinal axis, and

a ferromagnetic member disposed proximally to and spaced from at least one end portion of the coil for reducing perpendicular magnetic field components of the magnetic field at the at least one end portion of the coil."

Claim 1 of the first auxiliary request differs from claim 1 of the main request in that the second paragraph of the claim has been amended to read:

"a ferromagnetic member disposed proximally to and spaced from at least one end portion of the coil for minimising perpendicular magnetic field components of the magnetic field at the at least one end portion of the coil."

Claim 1 of the second auxiliary request differs from claim 1 according to main request in that the following feature is included at the end of the claim:

"the thickness of the ferromagnetic member being such as to provide a maximum flux density below a saturation flux density of the member."

IV. The arguments of the appellant opponent can be summarized as follows:

Document D16, which disclosed a magnetic coil having a low temperature superconductive tape, formed the closest prior art. The magnetic coil according to claim 1 of the main request merely differed from this prior art coil in that the tape of the invention was made of a high temperature superconductor. At the priority date of the patent in suit, it was common practice for the skilled person to try to replace low temperature superconductors by the newly available high temperature superconductors, which were known for their higher critical temperature and higher critical current. High temperature superconductors and low temperature superconductors were both type II superconductors in which the component of the magnetic field perpendicular to the wide surface of the tape had to be reduced to a minimum to allow higher current densities to flow in the tape. The coil of claim 1 resulted from an obvious analogous substitution of the low temperature superconductive tape in the coil of D16 by a newly discovered high temperature superconductive tape. No inventive step could be recognized in minimizing the perpendicular component of the magnetic field at one end portion of the coil as recited in claim 1 of the first auxiliary request because this feature simply identified an obvious optimisation of the reduction of the perpendicular component of the magnetic field. Reducing the perpendicular magnetic field component

while the thickness of the ferromagnetic member disposed at a coil end was chosen to provide a maximum flux density below saturation, as in claim 1 of the second auxiliary request, resulted from a trivial experimental compromise between the position and the thickness of this member, which was suggested by the use of a material having a relatively high saturation magnetization in D16.

Regarding costs, opposition proceedings generated high costs for the opponent. The opponent should not be prevented from providing at the appeal stage the facts which would allow the proceedings to be completed. The fresh documents were filed in response to the reasons given in the decision of the opposition division.

V. The arguments of the respondent proprietor can be summarized as follows:

The decision under appeal was correct when considering that the closest prior art was a document (numbered D6 in the opposition proceedings) which disclosed a coil comprising a high temperature superconductor and that the technical problem consisted in aligning the conducting planes thereof and the magnetic field lines. The solution was to adapt the shape of the coil winding to the magnetic field lines and not to reduce the perpendicular component of the field at a coil end, as in claim 1 of the main request. D16 which related to a low temperature superconductor coil was less relevant. At the priority date of the patent, the skilled person would not have looked at D16 which was published 20 years earlier and related to old superconductive magnets. The coil of D16 showed an anisotropic tape

construction and an anisotropic flux jumping, but did not comprise an anisotropic high temperature superconductive material. Already for these reasons, the skilled person would disregard D16. Moreover, D16 gave no hint at the solution recited in claim 1 because it did not provide the effect achieved thereby, namely an increase of the critical current in the coil; rather, it controlled the perpendicular magnetic field component to simply increase the current carrying capacity of the coil. In fact, D16 addressed the totally different problem of flux jumping phenomenon which did not occur in high temperature superconductors. According to claim 1 of the first auxiliary request, the perpendicular component of the magnetic field was minimised, which implied an optimisation of the coil parameters, and excluded an accidental reduction of the component by a shield. The prior art did not suggest a simultaneous optimisation of the spacing and thickness of the ferromagnetic member disposed at a coil end for reducing the perpendicular field component and at the same time maximising the flux density below saturation density, as in claim 1 of the second auxiliary request.

An apportionment of costs was requested because the opponent was solely responsible for the late introduction of fresh prior art at the appeal stage. If all the relevant documents had been submitted during the nine month period for filing an opposition, the costs incurred at the appeal stage would have been avoided.

- VI. The appellant (opponent) requested that the decision under appeal be set aside and that the European patent No. 0 781 452 be revoked.

VII. The respondent (patentee) requested that the appeal be dismissed, that the patent be maintained in amended form on the basis of claims 1 to 11 of the main request filed in the oral proceedings, or claims 1 to 11 of the first auxiliary request filed in the oral proceedings, or claims 1 to 11 of the second auxiliary request filed in the oral proceedings and that the costs due to the late filing of D15 to D18 be apportioned.

Reasons for the Decision

1. The appeal is admissible.

Admissibility of new submissions filed during the appeal proceedings

2. Given that document D16 filed with the statement of grounds of appeal is prima facie highly relevant and is responsive to the reasons given in the contested decision (*infra*, paragraph 10.1), the Board admitted it into the proceedings.

3. The Board decided to admit into the proceedings and consider the claims of the new main request and first and second auxiliary requests filed shortly after the beginning of the oral proceedings. Claim 1 of the new main request was amended to specify that the anisotropic superconductor is a high temperature superconductor in the form of a tape wound with the wide surface thereof extending parallel to the axis of the coil. These amendments are supported by the application as filed (see dependent claim 6 and the

description, page 4, lines 1 to 7 of the published application). They clearly restrict the scope of amended claim 1 to one of the alternatives covered by claim 1 of the patent in suit and attempt to respond to the grounds for opposition. Hence, amended claim 1 did not raise new issues which could have taken the appellant by surprise and it could reasonably be dealt with during the oral proceedings. Corresponding amendments were made in the other independent claims of the main, first and second auxiliary requests.

Claim 1 of the main request - inventive step

4. Having regard to D16 and the common knowledge in the art of high temperature superconductors at the time of filing of the patent in suit, the subject-matter of claim 1 according to the main request is not to be considered as involving an inventive step within the meaning of Article 56 EPC.

5. The high temperature superconductors (HTS) were discovered in 1986 and the late 1980s. Before 1986, superconductive coils were formed from tape-like bodies, i.e. composite tapes including low temperature (LTS) superconductive compounds or alloys (see, for instance, D16, column 1, lines 4 to 17, which was published in 1972). The high temperature superconductors achieved astonishing high critical temperature as well higher critical magnetic fields and critical currents. They offered thus an attractive alternative to improve the performance and reduce the operating (e.g. cooling) costs of the electromagnets using the then conventional low temperature superconductive tapes. It was then common practice for the skilled man to try to replace

- the low temperature superconductive tapes by tapes formed from the newly discovered high temperature superconductors. Considering these historical facts, which were not disputed by the respondent, the Board judges that the superconductive electromagnet disclosed in D16 can be taken as a realistic starting point for assessing the inventiveness of the magnetic coil according to claim 1 of the main request.
6. The superconductive magnetic coil according to claim 1 of the main request comprises a high temperature superconductor and differs from the second embodiment of the electromagnets disclosed in D16 only in this respect.
- 6.1 D16 (Figure 2; column 1, line 69 to column 2, line 9; column 2, lines 24 to 54, and 68 to 73) discloses a magnetic coil (10) which comprises a superconductor (12 to 18) in the form of a tape wound about a longitudinal axis of the coil with its flat surface extending parallel to this axis, the coil generating a magnetic field that varies along the longitudinal axis, and a ferromagnetic member (20) disposed proximally to and spaced from at least one end portion of the coil for reducing perpendicular components of the magnetic field at an end portion of the coil, as recited in claim 1.
- 6.2 The superconductor of D16 is anisotropic because it is in the form of a flat tape and affected by flux-jumping when a component of a magnetic field is applied perpendicularly to the flat surface of the tape (column 1, lines 52 to 68).

6.3 However, the tape of D16 is formed of low temperature superconductive compounds or alloys (column 1, lines 10 and 11 and column 2, lines 12 to 16).

7. In view of the development of superconductors (point 5 above), the Board judges that the skilled person would try to replace the LTS superconductors used in D16 by HTS superconductors. The HTS superconductors would be plainly suitable for a use in the electromagnet of D16 on basis on their known properties and in the manner known from D16 to obtain the effects disclosed in D16, particularly having regard to the reduction of the perpendicular component of magnetic field in the coil for increasing current density. No unexpected effect was reported by the respondent. Following the case law of the Board of appeal, such an analogous substitution of a LTS superconductor by a HTS superconductor is considered to be obvious.

7.1 The HTS and the LTS superconductors both are fabricated as a composite tape including superconductor filaments and belong to the category of type 2 superconductors. In type 2 superconductors, the reduction of the current density results from an interaction between pinning centres and the fluxoids created in the mixed state by the penetration of an external magnetic field inside the superconductors. According to D16, a magnetic field component which is applied perpendicularly to the wide surface of a LTS superconductive tape causes a flux-jumping phenomenon and reduces the current carrying capacity of the coil. At the priority date of the patent, it was part of the general knowledge of the skilled person that, in a similar way, the critical current in a HTS superconductive tape is lower in the

presence of a magnetic field perpendicular to the wide surface of the tape. Hence, the skilled person would not have expected difficulties in the substitution of the superconductive tape of D16 by a high temperature superconductive tape, because he was aware that the reduction of the perpendicular magnetic field component provided by the ferromagnetic member would have a similar effect on the current density in these two tapes which both are made of a type 2 superconductor.

Auxiliary requests 1 and 2 - Inventive step

8. The subject-matter of claim 1 according to the first and second auxiliary requests is not considered as involving an inventive step within the meaning of Article 56 EPC.
- 8.1 Claim 1 of the first auxiliary request is amended to specify that a ferromagnetic member is disposed proximally to and spaced from one end portion of the coil for minimising perpendicular magnetic field components at this end. This feature is obvious in view of the teaching of D16, whose principal object is to increase the current carrying capacity (column 1, lines 40 to 44). Consequently, it is obvious to the skilled person that the end disc of ferromagnetic material (20), which is disposed to provide an alternative path of higher magnetic permeability and reduce the field component perpendicular to the tape surface in this zone (see columns 1 to 2, bridging paragraph), should be so disposed as to optimise the reduction of, thus to minimise, this perpendicular field component.

8.2 The feature introduced in claim 1 of the second auxiliary request (see above paragraph III) is not disclosed in D16, in which the end disc (20) has a given thickness. However, this feature specifies a characteristic of the ferromagnetic member which would be obvious to the skilled person. According to D16 (column 3, lines 14 to 16), to form the end disc (20), "a material having a relatively high saturation magnetization such as mild steel may be employed to control flux jumping". This teaching of D16 suggests that the flux density in the end disc (20) should be such as to optimise the reduction of the perpendicular magnetic field component at a coil end. Following this hint, the skilled man would find by routine trial a thickness of the ferromagnetic member which provides a maximum flux density below a saturation flux density.

9. The Board concludes therefore that the grounds for opposition mentioned in Article 100 EPC prejudice the maintenance of the patent.

Apportionment of costs

10. The request for a different apportionment of costs in accordance with Article 104(1) EPC relates to the additional costs incurred by the respondent because of the filing of documents D15 to D18 in the course of the appeal proceedings, thus after the nine-month period for filing opposition. This request is refused, for the following reasons.

10.1 According to the decision under appeal, the claimed invention was considered patentable because none of the documents cited by the opponent disclosed a

ferromagnetic member disposed at an end portion of the coil to reduce the perpendicular component of the magnetic field. The introduction of fresh prior art, in particular D16, in support of the appeal grounds appears thus to be a logical reaction to the reasons given in the impugned decision. According to Article 108 and Rule 65 EPC, a statement of grounds of appeal should identify the extent to which amendment or cancellation of the decision is requested. This however does not forbid a losing opponent to file new pieces of prior art if it is felt that they could counter the reasons given in the appealed decision. Therefore, the filing of D15 to D18 is not regarded by the Board as an abuse of proceedings.

- 10.2 Even if the appellant successfully argued in appeal proceedings that D16 forms the closest prior art, an objection of lack of inventive step based on the substitution of a LTS superconductor in a known coil by a HTS superconductor does not amount to a "new opposition" because such an objection had already been raised in the notice of opposition. The statement of grounds of appeal indicates clearly why the newly cited documents, and their relevant passages, were thought to be responsive to the reasons given in the contested decision. Further, these new documents are all easily understandable and they have not caused an unreasonable amount of extra work such as to justify departure from the normal rule that each party meets its own costs pursuant to Article 104 EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The patent is revoked.
3. The request for apportionment of costs is refused.

The Registrar:

The Chairman:

U. Bultmann

W. J. L. Wheeler