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D E C I S I O N
of 8 February 2001

Case Number: T 0282/99 - 3.5.2

Application Number: 90308965.4

Publication Number: 0413573

IPC: H01F 6/00

Language of the proceedings: EN

Title of invention:
Superconductive tape coils

Patentee:
General Electric Company

Opponent:
Siemens AG

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step, no for all requests"

Decisions cited:
-

Catchword:
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Case Number: T 0282/99 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 8 Februray 2001

Appellant: (Opponent)
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Representative:
-

Respondent: (Proprietor of the patent)
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Representative:
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 24 February 1999 rejecting the opposition filed against European patent No. 0 413 573 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: M. Ruggiu
P. Mühlens

Summary of Facts and Submissions

I. The opponent appealed against the decision of the opposition division rejecting the opposition filed against European patent 0 413 573.

II. During the appeal the appellant referred inter alia to the following prior art documents:

D4: J.E.C. Williams: "Superconductivity and its Applications", Pion Ltd GB, 1970, pages 120-137;

D5: DE-C-1 279 182;

D7: DE-B-1 278 005;

D8: DE-C-1 439 487 (patent of addition to D7); and

D18: K. Pieterman and H. Postma "A 1.5 T superconducting magnet with closed cooling system for spin-imaging: an outline" published in Cryogenics, February 1984, pages 59-62.

III. Following summons to oral proceedings, the respondent (proprietor) filed two auxiliary requests with fax of 2 February 2001.

IV. At the oral proceedings held on 8 February 2001, the respondent amended the second auxiliary request and presented a third auxiliary request. The appellant filed document D18 in response to the respondent's second and third auxiliary requests.

V. Claim 1 of the patent in suit as granted reads as follows:

A superconducting tape coil (11) comprising:

a superconducting foil (15) having a given width and thickness;

a first and second foil (17) of current conducting material soldered (21) symmetrically about the thickness of the superconductive foil to form a superconductive tape (13), characterized by: the tape being wound in helical layers forming the coil (11);

a strip (31) of electrically conductive foil situated between selected adjacent layers of the tape and electrically insulated from the tape, the strip enclosing the inner layers of tape, the ends of the strip joined together to form an electrically conductive loop; and

epoxy resin impregnating the coil and the electrical insulation.

Claim 1 of the first auxiliary request reads as follows (differences from claim 1 as granted underlined by the Board):

A superconducting tape coil (11) comprising:

a superconducting foil (15) having a given width and thickness;

a first and second foil (17) of current conducting material soldered (21) symmetrically about the thickness of the superconductive foil to form a superconductive tape (13), characterized by:

<u>the superconductive foil (15) comprising a central layer of niobium (25) and a layer of niobium-tin (27) on either side of the central layer</u>;

the tape being wound in helical layers forming the

coil (11);

a strip (31) of electrically conducting foil situated between selected adjacent layers of the tape and electrically insulated from the tape, the strip enclosing the inner layers of tape, the ends of the strip joined together to form an electrically conductive loop; and

epoxy resin impregnating the coil and the electrical insulation.

Claim 1 of the second auxiliary request reads as follows:

"1. A superconducting MR tape coil (11) comprising:

a superconducting foil (15) having a given width and thickness;

a first and second foil (17) of current conducting material soldered (21) symmetrically about the thickness of the superconductive foil to form a superconductive tape (13), characterized by: the tape being wound in helical layers forming the coil (11);

a strip (31) of electrically conducting foil situated between selected adjacent layers of the tape and electrically insulated from the tape, the strip enclosing the inner layers of tape, the ends of the strip joined together to form an electrically conductive loop; and

epoxy resin impregnating the coil and the electrical insulation."

Claim 1 of the third auxiliary request is as claim 1 of the first auxiliary request, except for the insertion of "MR" before "tape coil" in the first line of the claim.

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

VII. The arguments of the appellant can be summarised as follows:

Claim 1 as granted defined a superconducting coil per se, independently of the way it was cooled. Features of the cooling system used, be it liquid helium, gaseous helium or indirect cooling, were not recited in the claim and therefore could not distinguish the subject-matter of the claim over the prior art.

Figure 3 of D8 disclosed a superconducting tape coil comprising a superconductive tape wound in helical layers, i.e. forming a solenoid. The tape comprised a superconducting foil and first and second foils of current conducting material disposed one on each side of the superconducting foil. Furthermore D8 suggested to increase the mechanical stability of the coil by impregnation of the whole coil with resin. D8 also disclosed arranging copper strips between selected layers of the superconducting tape coil. D8's parent application, D7, indicated that these strips could be short-circuited and should be isolated from the superconducting tape. This feature was to be considered as present in the coils shown in D8, because D8 was a patent of addition to D7 and described improvements to D7. Furthermore the skilled person would be aware from D5 that short-circuited conductive loops would reduce the risk of destruction of the coil in case of a quench.

All the features of claim 1 were well known in the art and their total effect did not go beyond the sum of

their individual effects. Thus claim 1 as granted defined an aggregation of features which could not involve an inventive step.

As regards the sandwich construction of the tape specified in claim 1 of the first auxiliary request, the appellant considered that it would be obvious to use other tapes than the one specified in D8 and referred to the tape shown in Figure 9.6.3 of D4, which comprised two copper foils soldered one on each side of a niobium-tin foil. Furthermore, in view of the higher critical temperature of niobium-tin, it would be obvious to replace the niobium-zirconium tape of D8 with the tape disclosed in D4.

As regards the second and third auxiliary requests the appellant cited page 134, Chapter 9.7.2 of D4 and asked the Board to consider document D18 which showed that the use of superconducting solenoids for MR imaging was well known to the skilled person.

VIII. The respondent requested that the appeal be dismissed and the patent maintained unamended (main request), or that the patent be maintained on the basis of the first, second or third auxiliary request.

IX. The arguments of the respondent can be summarised as follows:

All the prior art superconducting coils were cooled by circulation of a fluid, in particular liquid helium. The coil defined in claim 1 as granted could be cooled by liquid or gaseous helium, but it had surprisingly been found that it could be cooled by conduction using a cryocooler. Thus the object of the invention was to

provide a superconducting coil that could be cooled by a cryocooler, which was an off-the-shelf device and therefore relatively inexpensive.

The particular combination of all the features recited in the claim was novel. Since the skilled person had no reason to believe that this particular combination of features would be suitable for cooling by a cryocooler, the subject-matter of the claim also involved an inventive step.

A cryocooler was able to cool a coil as defined in the claim to a temperature of about 12°K, well below the critical temperature of niobium-tin (18.3°K).

The coil defined in the claim did not require a space for circulation of helium and thus would be less bulky than the coils of the prior art.

D7 and D8 did not disclose resin impregnation in combination with a superconductive tape. Furthermore, as was apparent from page 3, line 31 et seq. of the opposed patent, the resin used in the invention was not a conductive resin, contrary to D7 and D8.

The copper strips disclosed in D7 were not connected to form loops as in the invention, but were simply connected to each other.

With respect to the first auxiliary request, the respondent stressed that D4 might show features of the tape itself, but did not suggest the whole combination defined in claim 1.

As regards the second and third auxiliary requests, the

respondent indicated that MR is an application which is sensitive to the bulk of the apparatus, so that the coil defined in claim 1 would be particularly suitable.

The respondent submitted that care should be taken to avoid hindsight in a situation like the present one, where individual features of the claim, but not their combination, were known from the prior art.

Reasons for the Decision

1. The appeal is admissible.

2. The appellant has started the discussion of inventive step from the superconducting coil illustrated in Figure 3 of D8.

Figure 3 of D8 shows a superconducting coil which is formed by a superconductive tape wound in helical layers. As described in column 4, lines 34 to 60, the tape comprises a superconducting foil with a given width and thickness and a coating of silver or copper. Furthermore strips of electrically conductive foils made of copper can be arranged between layers of the coil of Figure 3. These copper strips should not directly contact conductive varnish filling the interstices between the turns forming a layer and are provided to remove heat from inside the coil.

D8 refers to niobium-zirconium as superconducting material.

3. *Respondent's main request*

3.1 Thus the coil defined in claim 1 as granted differs from this prior art in that:

(a) a first and second foil of current conducting material is soldered symmetrically about the thickness of the superconducting foil to form the superconductive tape;

(b) the ends of each strip of electrically conductive foil are joined together to form an electrically conductive loop; and

(c) the coil and the electrical insulation are impregnated with epoxy resin.

3.2 D4 describes on pages 127 and 128 a superconductive tape in the form of a niobium ribbon with a niobium-tin layer as superconducting material on each side of the ribbon and a copper ribbon soldered to each side of the tape (see Figure 9.6.3). Thus D4, which is a textbook about superconductivity, discloses a tape having all the features of the tape specified in claim 1 as granted.

The Board considers that the teaching of D4 is part of the common general knowledge of the skilled person, because D4 is a textbook in the technical field of the invention.

The tape shown in Figure 9.6.3 of D4 uses niobium-tin as superconducting material, which has a higher critical temperature than niobium-zirconium. Since a higher critical temperature affords the possibility of operating the superconducting coil at a higher temperature, which is clearly advantageous, it would be

obvious to the skilled person to use the tape shown in Figure 9.6.3 of D4 in place of the niobium-zirconium tape specified in D8.

3.3 Since D8 is a patent of addition to D7, the skilled person would turn to D7 to see more precisely how the copper strips should be arranged.

In the embodiment of Figure 2 of D7, a superconducting coil comprises cooling copper strips arranged between layers of the coil and isolated with respect to them. D7 further indicates that the copper strips can be short-circuited if so desired (see column 5, lines 52 to 58). In the opinion of the Board this passage of D7 points to short-circuited loops. Thus the Board considers that D7 suggests to the skilled person to join the ends of each copper strip together to form an electrically conductive loop.

In any case it is known (see D5, column 4, lines 35 to 43) that shorted loops made of electrically conductive strips can be advantageously used to absorb the magnetic energy stored in the coil when the coil is quenched, which reduces the risk of destruction of the coil.

3.4 It is known from D8 that resin impregnation can be used to reinforce a superconducting coil. Although this feature is disclosed in connection with the pancake coil illustrated in Figure 1 of D8, which is wound from a tape having a rectangular cross-section, it would be immediately apparent to the skilled person that its application to the solenoid coil of Figure 3 would also result in a coil having higher mechanical stability. As is well known, mechanical stability is of considerable

importance for superconducting coils in view of the large forces acting on the coil winding. Epoxy is a very common resin having well known mechanical properties and clearly suitable for reinforcing a coil structure.

3.5 The respondent pointed out that the combination of the features of the claim would result in a superconducting coil that can tolerate a less effective cooling than the liquid helium bath needed in D8, so that a cryocooler could be used to cool the coil of the invention. Indeed the specification of the granted patent indicates that the claimed coil is cooled by conduction without the use of consumable cryogens. However claim 1 does not recite any means for cooling the coil and therefore only defines the structure of the coil as such.

3.6 As explained above each of features (a), (b) and (c) taken in isolation is obvious to the skilled person in connection with a superconducting coil.

In particular the Board notes that feature (a) is derivable from a textbook representing common general knowledge in the art and features (b) and (c) are obvious from other embodiments of D8 and its parent application D7. Thus, in the opinion of the Board the skilled person, without any knowledge of the present patent, would introduce features (a), (b) and (c) into the coil shown in Figure 3 of D8 without exercising any inventive activity.

No features relating to the size of the coil are recited in the claim, so that the argument that the coil defined in claim 1 would be less bulky than the

coils of the prior art is not relevant.

For the above reasons the Board considers that, because it is obvious to construct a coil with the features recited in the claim 1 as granted per se (i.e. independently of how it is to be cooled), the subject-matter of the claim does not involve an inventive step in the sense of Article 56 EPC.

4. *Respondent's first auxiliary request*

Claim 1 of the first auxiliary request further specifies that the superconductive foil of the tape comprises a central layer of niobium and a layer of niobium-tin on either side of the central layer.

As mentioned above under point 3.2, this is known from Figure 9.6.3 of D4 and therefore the subject-matter of claim 1 of the first auxiliary request does not involve an inventive step.

5. *Respondent's second auxiliary request*

Claim 1 of the second auxiliary request specifies that the coil should be suitable for an MR (magnetic resonance) application.

In reaction to this request the appellant filed document D18 which relates to magnets for magnetic resonance imaging and indicates that most superconducting magnet systems with high homogeneity (i.e. suitable for MR applications) are built as solenoids. The Board decided to admit D18 into the proceedings in view of its clear relevance to the second auxiliary request.

Furthermore D4 indicates in chapter 9.7.2 that superconducting magnets have been used for applications requiring high homogeneity such as magnetic resonance.

The Board concludes from these two documents that MR is an obvious application for a superconducting solenoid, i.e. a helically wound superconducting coil. Thus the subject-matter of claim 1 of the second auxiliary request does not involve an inventive step.

6. *Respondent's third auxiliary request*

The subject-matter of claim 1 according to the third auxiliary request also does not involve an inventive step since, for the reasons indicated above under point 5, it is obvious to use a coil according to the first auxiliary request for an MR application.

7. Thus, in the absence of an inventive step, none of the requests of the respondent can be granted (Article 52(1) EPC).

In the circumstances, it is not necessary to consider the further documents and arguments submitted by the appellant.

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:

M. Hörnell W. J. L. Wheeler