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D E C I S I O N
of 19 February 2003

Case Number: T 0571/00 - 3.5.2

Application Number: 93102579.5

Publication Number: 0556837

IPC: H01R 4/68

Language of the proceedings: EN

Title of invention:
Method of joining superconducting wire using oxide high-temperature superconductor

Patentee:
SUMITOMO ELECTRIC INDUSTRIES, LIMITED

Opponent:
Siemens AG

Headword:
-

Relevant legal provisions:
EPC Art. 123(2), 56

Keyword:
"Added subject-matter - main request (yes)"
"Inventive step - auxiliary request (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0571/00 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 19 February 2003

Appellant: (Opponent)
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Representative:
-

Respondent: (Proprietor of the patent)
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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 17 April 2000 concerning maintenance of European patent No. 0 556 837 in amended form.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: J.-M. Cannard
J. H. P. Willems

Summary of Facts and Submissions

I. The opponent appealed against the decision of the opposition division concerning the maintenance of European patent No. 0 556 837 in amended form in accordance with the proprietor's first auxiliary request filed on 27 March 2000 during oral proceedings before the opposition division.

II. The following documents:

D2: DE-A-20 33 615,

D4: Japanese Journal of Applied Physics, vol. 28, No. 7, July 1989, pages 1185-1188, and

D9: DE-A-19 45 640,

considered during the proceedings before the opposition division remain relevant to the present appeal.

III. Claims 1 to 22 according to the first auxiliary request filed on 27 March 2000 during opposition proceedings, of which claims 1, 10 and 19 are independent claims, were promoted to be the main request in the appeal proceedings.

Claim 1 of the main request reads as follows:

"A method of joining tape-type superconducting filament wires with each other, said filament wires are being multi-filament wires each having a plurality of oxide superconductor filaments, said method comprising:

a step of exposing oxide superconductor filaments in

portions (102, 112, 122 ...) of said tape-type superconducting filament wires (101) to be joined with each other by partially removing said tape-type superconducting multi-filament wires for forming superimposable joint surfaces (102, 112, 122 ...); and

a step of joining said exposed oxide superconductor filaments with each other,

said joining step including a step of applying a plastic deformation processing to said joined portions in a direction substantially perpendicular to the principal surface (103) of the tape-type wires and a step of applying a heat treatment."

Claim 19 of the main request reads as follows:

"A method of joining tape-type superconducting filament wires with each other, said method comprising:

a step of exposing oxide superconductor filaments in portions (102, 112, 122 ...) of said tape-type superconducting filament wires (101) to be joined with each other by partially removing said tape-type superconducting filament wires for forming superimposable joint surfaces, and

a step of joining said exposed oxide superconductor filaments with each other,

said joining step including a step of applying a plastic deformation processing to said joined portions in a direction substantially perpendicular to the principal surface (103) of the tape-type wires and a step of applying a heat treatment,

wherein tape-type superconducting wires having oxide superconductors being coated with stabilizers are joined with each other,

said exposing step including:

a step of separating said stabilizers so that the as-defined end surfaces of said stabilizers are inclined at prescribed angles with respect to the directions of width of said superconducting wires in portions of said tape-type superconducting wires to be joined with each other thereby exposing said oxide superconductors;

said step of joining including the interposing of an joint member (106, 116, 144, 154, 164) independently prepared from a single-filament oxide superconducting wire between said exposed oxide superconductors."

IV. Claims 1 to 9 of an auxiliary request were filed during the oral proceedings of 19 February 2003.

Claim 1 of the auxiliary request reads as follows:

"A method of joining tape-type superconducting filament wires with each other having a width and a thickness, said filament wires are being multi-filament wires each having a plurality of oxide superconductor filaments, the c-axes of the superconducting phases are being oriented substantially in parallel with the direction of thickness of the tapes, i.e. in a direction perpendicular to the principal surfaces of the tapes, said method comprising:

a step of exposing oxide superconductor filaments in portions (102, 112, 122 ...) of said tape-type

superconducting filament wires (101) to be joined with each other by partially removing said tape-type superconducting multi-filament wires for forming superimposable joint surfaces (102, 112, 122 ...), the c-axes of the crystals in the exposed oxide superconductor filaments being oriented in the direction of the thickness of said tape-type superconducting filament wires; and

a step of joining said exposed oxide superconductor filaments with each other by superimposing said superimposable joint surfaces (102, 112, 122 ...) in a thickness direction, in such a state that the respective c-axes are directed substantially in the same direction for forming a superconductive joint,

said joining step including a step of applying a plastic deformation processing to said joined portions in a direction substantially perpendicular to the principal surface (103) of the tape-type wires and a step of applying a heat treatment."

V. In a communication accompanying a summons to oral proceedings, the Board indicated *inter alia* that it was inclined to the view that claim 1 of the main request contravened Article 123(2) EPC because the application as filed did not disclose joint surfaces formed by partially removing said tape-type superconducting multi-filament wires which were joined in any arbitrary way.

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

Main request

According to claim 19 of the main request, the step of joining included "the interposing of an joint member independently prepared from a single-filament oxide superconducting wire between said exposed oxide superconductors". This claim therefore covered a method for making a joint in which a joint member was sandwiched between the superposed joint surfaces of the wires to be joined, which was not disclosed in the application as filed.

Auxiliary request

At the priority date of the invention, oxide superconducting multi-filament tapes were standard products, see for example D4. In these tapes the c-axes of the superconducting phases were oriented in the direction of the thickness of the tapes, the a and b-axes being in the plane of the tapes. The problem of joining portions of these tapes by forming a superconductive joint was a well-known requirement for the skilled person.

Document D2 disclosed a method for joining alloy super-conducting wires by forming a superconducting joint. It was a matter of common practice for the skilled person to apply the classical methods for joining superconductors, and particularly that disclosed in D2, to the new oxide superconducting tapes.

The teaching of D2 was not restricted to the particular embodiments shown in the figures, nor to single-filament wires, but was broad enough to cover a more general method for joining superconducting tapes, which comprised a step of exposing the filaments and applying a plastic deformation processing and a heat treatment

to both make the joint and restore the superconductivity in the joint area. Moreover, the standard oxide superconducting multi-filament tapes, which needed a stabilizer, could not be naked in the joint area as were the wires according to Figures 3a and 3b of D2, so it was obvious to remove the stabilizer only to the extent necessary to expose the surfaces of the superconducting filaments where they were to be joined.

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

Main request

The application as filed disclosed that superconducting joints could be made either by directly superimposing the superimposable joint surfaces or by interposing another oxide superconductor. No other arbitrary way of joining the joint surfaces would solve the problem underlying the invention as set out in the patent specification, so as a matter of logic such arbitrary methods were excluded from the scope of the claims, and there was no contravention of Article 123(2) EPC.

Auxiliary request

D2, which formed the closest prior art, disclosed only methods for joining alloy superconducting wires. More specifically, according to Figures 2a and 2b of D2, the wires were not superposed in the joint area and the plastic deformation processing was applied in a direction parallel to the axis of the wires. According to Figures 3a and 3b, the wires, whose ends were naked, were joined by means of an explosion which did not

produce a controlled pressure appropriate for joining multi-filament wires.

The method for joining superconductor wires according to claim 1 of the auxiliary request thus differed from the method disclosed in D2 by the nature of the wires, which were oxide superconducting multi-filament tapes, by a step of partially removing the stabilizer of the tapes and by applying a plastic deformation processing in a direction perpendicular to the principal surfaces of the tapes and applying a heat treatment for orienting the c-axes of the superconducting phases. There was no good reason for the skilled person starting from D2 to replace the alloy superconducting wires by oxide superconducting tapes, in which the filaments were embedded in a stabilizer which could not be totally removed because the filaments would disintegrate.

In the method according to document D9, the joint surfaces of classical superconducting tapes were inclined with respect to the thickness of the tapes and the tapes were joined by applying a plastic deformation processing and a heat treatment. However, the joint produced was not superconductive.

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

IX. The respondent requested that the appeal be dismissed and that the patent be maintained, according to the decision under appeal (main request) or according to the auxiliary request filed during the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

Main request

2. As mentioned in the communication issued with the summons to oral proceedings, although claim 1 of the main request specifies a step of exposing oxide superconductor filaments for forming joint surfaces which are "superimposable", it does not specify that these surfaces are actually superposed one on the other, or joined by interposing another oxide superconductor as recited in the independent claims of the application as filed.

2.1 Moreover, present claim 1 includes the following feature taken from claim 3 of the main request filed during the oral proceedings before the opposition division : "by partially removing said tape-type superconducting multi-filament wires for forming joint surfaces". However, this feature was only identified in claim 3 of the application as filed (which corresponds to claim 3 of the main request referred to above) in combination with other features specifying that the joint surfaces which are superimposed with each other expose substantially all said filaments and are inclined with respect to the principal surfaces of the wires at an angle of about 0.5° to 30°.

2.2 In all the embodiments disclosed in the application as filed, the joint surfaces formed by partially removing the tape-type superconducting multi-filament wires are joined either by directly superposing these joint surfaces, or by interposing another oxide

superconductor between them when the wires are disposed in a common plane adjacent each other. The application as filed did not disclose joint surfaces which are formed by partially removing said tape-type superconducting multi-filament wires and joining them in any arbitrary way. Accordingly, the amendments made in present claim 1 are generalisations which extend beyond the original content of the application and thus contravene Article 123(2) EPC.

2.3 Although the respondent did not dispute the appellant's objection according to which claim 19 contravened Article 123(2) EPC, the Board notes that independent claim 29 and appended claim 30 of the application as filed have a scope broad enough to provide support for a generalised method of joining tape-type superconducting wires, in which a joint member is sandwiched between the superposed joint surfaces of the wires to be joined, as covered by the method recited in claim 19.

Auxiliary request

3. The novelty of the subject-matter of claim 1 according to the auxiliary request has not been disputed. Nor was any objection raised concerning clarity or added subject-matter.

4. Document D4 discloses a method for fabricating tape-type superconducting wires having a plurality of oxide superconductor filaments and a Ag sheath. The tapes are prepared by combination and repetition of cold work (or cold press) and sintering, resulting in a c-axis alignment of the superconducting phases in a direction perpendicular to the thickness of the tapes (see the

abstract and page 1186, left column).

5. The subject-matter of claim 1 according to the auxiliary request is therefore distinguished from the above prior art by:

- a step of exposing the oxide superconductor filaments for forming superimposable surfaces according to the second paragraph of the claim, and

- a step of joining said exposed filaments for forming a superconductive joint according to the third and fourth paragraphs of the claim.

6. In view of the above, the objective problem underlying the present invention can be seen as providing a method for joining portions of the oxide superconducting multi-filament tapes according to D4 with each other and forming a superconductive joint. This problem corresponds to the problem mentioned in the patent in suit (page 2, lines 43 to 47).

7. Document D2 discloses a method for joining superconducting wires and forming a superconductive joint; the wires may be of the tape type comprising a plurality of filaments embedded in a stabilizer (page 2, lines 13 to 17; page 3, lines 10 to 17; page 4, lines 12 to 18; page 6, lines 5 to 7).

7.1 The wires according to D2 are alloy superconducting wires and not oxide superconducting wires. However at the date of priority of the patent in suit (1992), oxide superconducting multi-filaments wires were newly developed materials (see for instance the patent in

suit, page 2, lines 14 and 15). In the judgement of the Board, the skilled person, when working with the new materials, would at first try joining them by the already existing methods (for the classical alloy superconductors) and only turn away from this if he encountered difficulties in doing it. Accordingly, the Board judges that the skilled person faced with the problem addressed would consider the teaching of D2.

7.2 According to the method disclosed in D2, the superconductor filaments in the portions of the wires to be joined are exposed by removing the stabilizer, brought into contact with each other, joined using well known welding processes and then the joint area is submitted to a plastic deformation process followed by heat treatment to restore the superconducting properties of the wires in this area (page 2, line 18 to page 3, line 9; page 4, line 12 to page 5, line 9). In the preferred embodiments described with reference to the figures (page 5, line 13 to page 6, line 13), the end portions of the wires are butted and a plastic deformation is conducted in a direction parallel to the length of wires, or the naked end portions of single-filament wires are superposed and joined by an explosion. However, this is not the only relevant disclosure in D2. In the view of the Board, the skilled man at the priority date of the patent in suit would have taken into consideration all the information in D2 which offered a promising suggestion to solve the problem addressed, in particular the welding process consisting of a plastic deformation process (for instance pressing) directly followed by a heat treatment to make the joint and restore the superconductivity (page 3, lines 10 to 17).

8. The skilled man starting from the oxide superconducting multi-filament tapes according to D4 and wishing to apply the teaching of D2 for forming a superconductive joint between portions of these oxide superconducting multi-filament tapes would immediately recognize that he must:

- first expose the filaments and bring them into contact with each other,

- join the exposed filaments with each other, for instance by using a plastic deformation processing, and

- restore the superconductivity in the joint area.

8.1 It was not disputed that the superconductor filaments of the tapes cannot be exposed by completely removing the stabilizers because the filaments are mechanically brittle and then disintegrate. Accordingly, the joint surfaces should inevitably be obtained by removing as little as necessary of the stabilizer, i.e. partially removing said wires to expose only the surfaces to be joined, or by butting the ends of the wires.

8.2 The restoration step mentioned in D2 should consist of a plastic deformation processing conducted in a direction perpendicular to the principal surface of the tapes to orient the c-axes in this direction and in combination with a heat treatment to restore the superconductivity in the joint area, because this is the known conventional way of establishing the superconductivity of the tapes (see D4, chapter 3: "Results and Discussion"). Therefore it is obvious that the joint surfaces should be superimposed in a

direction perpendicular to the thickness of the tapes. The skilled person would discard arrangements in which the surfaces to be joined are butted (e.g. as in Figures 2a and 2b of D2) or in which they are placed adjacent one another in the plane of the tapes, because such arrangements would not be compatible with the direction of the plastic deformation processing necessary for restoring the superconductivity.

8.3 In view of these circumstances, it would be obvious to the skilled person to try plastic deformation processing for joining the filaments as taught on page 3 of D2, because such processing is also necessary for restoring the superconductivity. Moreover, this processing would not result in a surprising effect because it would weld the metallic stabilizers of the wires in a known way (see for instance D2 or D9).

8.4 Accordingly, the obvious combination of the teaching of the closest prior art document D4 with that of D2 results in a method having all the features of claim 1 according to the auxiliary request. The subject-matter of this claim is not to be considered as involving an inventive step within the meaning of Article 56 EPC.

9. The Board concludes therefore that the grounds for opposition mentioned in Article 100 EPC prejudice the maintenance of the patent in either of the amended forms according to the main and auxiliary requests.

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:

D. Sauter W. J. L. Wheeler