Decision of Technical Board of Appeal 3.5.2 dated 5 June 2003

T 1173/00 - 3.5.2

(Translation)

Composition of the board:

Chairman: W. J. L. Wheeler
Members: F. Edlinger
P. Mühlens

Opponent/Appellant:
ALSTOM Holdings
Patent proprietor/Respondent:
ABB Patent GmbH

Headword: Transformer with high-temperature superconductor for locomotives

Article: 100(b) EPC

Keyword: "Sufficient disclosure (no)" - "Ability of the inherent technical teaching to be carried out on the date of priority (no)"

Headnote:

I. If the only embodiment disclosed with concrete details in a patent is not disclosed in a manner sufficiently complete for the claimed invention (in this instance a railway traction unit with a liquid-nitrogen-cooled superconductive transformer) to be carried

out by a person skilled in the art on the date of priority with respect to the fundamental scope of said invention, it is of no significance with regard to the question of sufficient disclosure whether on the relevant date of filing a variant (in this instance a railway vehicle with a liquid-helium-cooled transformer) could have been carried out if the variant, although it is covered by the wording of the patent claim, does not fall within the fundamental scope of the claimed invention with regard to the teaching of the patent due to a lack of comparable technical success (see point 3.3).

II. If an invention is insufficiently disclosed, it is of no relevance whether it was objectively impossible to provide the missing information on the date of priority, ie whether nobody could have achieved the intended and claimed technical effect. The decisive issue is whether the invention is disclosed in a manner sufficiently complete for it to be carried out by an average person skilled in the art on the date of priority, with knowledge of the patent and on the basis of that person's common general knowledge (see point 3.9).

Summary of facts and submissions

I. The appeal lies against the decision of the opposition division rejecting oppositions 1 and 2 against European patent No. 590 546.

II. Claim 1 of the patent as granted reads as follows:

"Electric railway traction unit, in particular electric locomotive with a transformer (1) for supplying it with power and with a coolant supply device, characterized in that a superconductive transformer (1) is provided which, together with the coolant supply device, is arranged on the railway traction unit, and in that the coolant supply device is formed exclusively by a liquid gas container (2) which serves as a coolant tank and is connected to the superconductive transformer (1)."

Claim 2 of the patent reads as follows:

"Transformer according to Claim 1, characterized in that liquid nitrogen is provided as a coolant."

The subsequent claims 3 to 6 of the patent are dependent on claims 1 or 2.

III. The two oppositions were based on the grounds of Article 100(a) and (b) EPC. The rejection of the oppositions with regard to the ground for opposition under Article 100(b) EPC is substantiated in the decision under appeal essentially by the fact that it was of no import with respect to assessing whether the invention could be carried out whether high-temperature superconductors were already commercially available on the date of priority of the disputed patent. The objective of the invention was a combination of an electric railway traction unit with a superconductive transformer and a coolant supply device. Superconductive transformers were already known before the date of priority. The construction of the electrical conductors of the transformer was not the subject of the invention. For this reason, the declaration of Dr P. Mocaer of 11 April 2000 (hereinafter referred to as D16) was held to be evidence submitted late and not of prima facie relevance in the decision under appeal and was not admitted.

IV. The appellant submitted with the grounds of appeal a technical opinion and a magazine article written by the author of the technical opinion:

D14: Technical opinion of Mr P. Tixador on the state of the art in superconductors in September 1992 ("Etat de l'art des supraconducteurs en septembre 1992"); January 2001; with nine technical articles published between April 1992 and January 2000;

D15: Magazine article by Mr P. Tixador, "La Recherche", No. 307, March 1998.

V. Oral proceedings took place before the board on 5 June 2003. During these proceedings, the respondent submitted patent DE-C-3919487 (hereinafter referred to as D17).

VI. The appellant (opponent 2) requested that the decision under appeal be set aside and the patent be revoked. The other party to the proceedings (opponent 1) did not make a statement in the matter and did not appear at the oral proceedings.

VII. The respondent (patentee) requested that the appeal be rejected.

VIII. The appellant (opponent 2) argued essentially as follows:

A person skilled in the art would not have been able to carry out an electric railway traction unit pursuant to claim 1 to the full extent claimed on the date of priority (30 September 1992) of the disputed patent. The reason was that a transformer of this capacity (1 to 6 MVA) could not have been realised, at least not with what are known as high-temperature superconductors (ie with liquid nitrogen as the coolant, claim 2). Such a transformer could only have been realised with superconductors which needed to be cooled to temperatures close to absolute zero using liquid helium, which would have involved considerably greater effort.

During the entire opposition proceedings, the patentee had not provided any concrete evidence which might have refuted this detailed submission. Only towards the end of the appeal proceedings did the patentee submit document D17 which was claimed to disclose transformer windings made from high-temperature superconductors prior to September 1992. D17 should therefore not be admitted, since it was furthermore submitted during the oral proceedings in a language with which the appellant's attorney was not familiar.

It was impossible for an opponent to provide contrary evidence in the form of a

single document that the subject-matter of the disputed patent could not have been carried out on the relevant date. The technical opinion and the magazine article by Mr Tixador (D14 and D15) and the statement by Mr Mocaer (D16), however, confirmed that it would not have been possible in practice in September 1992 to fabricate the high-temperature superconductors (as required for cooling with liquid nitrogen) for the windings of such transformers. These documents were therefore of considerable relevance to the question as to whether the invention could have been carried out and should be admitted by the board.

The appellant argued that D14 offered an objective description of the state of the art pertaining at the time from the point of view of a recognised expert in the field of high-temperature superconductors. In doing so, the technical opinion used the nine attached specialist technical articles to support its findings. According to this technical opinion, only short samples of conductors with a maximum length of 114 m were available in September 1992 which demonstrated superconductive properties when cooled with liquid nitrogen (77 K). High critical current densities (in excess of 300 A/mm^2) had only been achieved with small laboratory samples. The available high-temperature superconductors (intermetallic oxide compounds) at that time had poor mechanical properties. They were brittle, not very ductile, showed poor flexibility, were anisotropic in terms of their current-carrying capacity and were of inhomogeneous composition. Relative to the total cross section of a technically feasible conductor, therefore, the current densities (20 to 30 A/mm^2) or current intensities (10 to 30 A) which could be achieved were far smaller. In particular, the fabrication of coils with long wires and strong alternating magnetic fields was at that time an unsolved problem. Furthermore, the conductors available at that time were subject to high a.c. loss. No method existed for establishing a superconductive connection between short lengths of wire. Thus, it was 1994 before high-temperature superconductive wires of a length of approximately 1 km, with a critical current density of only 30 A/mm^2, became available for use in research transformers. In 1996, the first transformer with a capacity of 0.8 MVA cooled with liquid nitrogen was

successfully tested in Japan.

A transformer with a capacity of 1 to 6 MVA would, however, be required for an electric railway traction unit. On the date of priority of the application, it was impossible to fabricate even an experimental transformer of this type. Similarly, in March 1998, Mr Tixador expressed the opinion in D15 that it would only become possible to employ high-temperature superconductors of this type in railway traction units in 5 to 10 years. The declaration of Mr Mocaer (D16) also confirmed that applications with high-temperature superconductors could not have been carried out in 1992 with available products, but could only have been based on theoretical or potential properties of the known materials.

The appellant argued that the disputed patent indirectly confirmed this portrayal of the state of the art. The description (column 1, lines 49 to 52; column 2, lines 13 to 20, and column 3, lines 3 to 7) refer to the low "operating temperature of 4 to 6 K required for maintaining the superconductivity of the superconductors available on an industrial scale today", to the "use of the so-called high-temperature superconductors (HTSC) currently under development with operating temperatures around the boiling point of liquid nitrogen" and the resultant new "application perspectives for the use of superconductive windings" and the total losses to be expected "assuming a.c. losses of the superconductor measured to date on some material samples". The disputed patent, however, did not disclose any possible method of construction of a transformer winding using high-temperature superconductors. On the basis of a single embodiment with liquid nitrogen as the coolant, the patent described the envisaged benefits which would derive from the vaporisation heat of liquid nitrogen which is ten times that of helium. At a total weight of 3 t or a volume of 1 to 2m^3 of liquid nitrogen, it would be possible to ensure "cooling of a superconductive transformer as required for this application for 2 to 3 days" (column 2, lines 27 to 33, of the patent specification). As a direct consequence of this, it would have been impossible to achieve the intended objective using helium

as the coolant (quite apart from the significantly higher costs). This was because at least ten times the quantity of liquid helium would have needed to be provided and employed on the railway traction unit under far more difficult conditions at a temperature approaching absolute zero. The critical issue was thus whether the invention could have been carried out using liquid nitrogen as the coolant.

According to the established case law of the EPO, the scope of protection of a patent must correspond to the technical contribution of the disclosure and must not cover subject-matter which would not have been available without undue effort (T 409/91, OJ EPO 1994, 653; T 435/91, OJ EPO 1995, 188). A patentee has no right to partial areas which have not been sufficiently disclosed (T 612/92, not published in the OJ). The subject-matter of claim 1 of the disputed patent could not have been carried out with the envisaged result as portrayed in the description on the date of priority. In any event, it would not have been possible to carry out the partial area defined in claim 2, and this would have to be struck out (see T 412/93, not published in the OJ; Guidelines, Part C, Chapter III, 6.4; Guidelines, Part D, Chapter V, 4.4.1). The disputed patent thus did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art on the date of priority (Article 100(b) EPC).

It is not necessary to repeat here the arguments brought forward by the appellant with respect to novelty and inventive step.

IX. The respondent (patentee) argued essentially as follows:

D14 to D16 should not be admitted, since they were submitted late and were not of prima facie relevance. They made no reference to the arrangement of a superconductive transformer on a railway traction unit, had for the most part been published at a later date and could at most contribute towards understanding the research background. It was dubious whether D14 could be considered to be an

objective opinion, as the technical opinion had been commissioned by the appellant himself to lend support to his arguments. D15 introduced no new material not contained in D14. D16 was not relevant as it was of no significance whether high-temperature superconductors had been commercially exploitable on the date of priority.

The disputed patent was not concerned with the fabrication of superconductive windings but rather with the combination of a railway traction unit with a superconductive transformer and a coolant tank as the only coolant supply device, ie no further cooling system was required. The aim was to achieve "a good efficiency factor" and to avoid "losses resulting from spatial and weight-related constraints due to the transformer" (patent specification, column 1, lines 32 to 38). The disputed patent provided a concrete technical teaching for solving this problem which could be carried out as shown in the figure in the patent specification, for example. The invention was not restricted to cooling with liquid nitrogen ("liquid gas, in particular nitrogen"; column 3, line 51, of the patent specification), but rather any suitable coolant in a liquid gas container could be used. Liquid helium also represented a possible embodiment. Although this would result in shorter intervals between refilling or greater quantities of coolant, it did not impact on whether the invention could be carried out as such, but was at the most commercially disadvantageous. Stationary helium-cooled transformers were already known at the date of priority. There were no fundamental differences between stationary transformers and those mounted on railway traction units. A skilled person thus had at least one embodiment available. There was therefore no doubt that the subject-matter of claim 1 had been disclosed in a manner sufficiently clear and complete for it to be carried out by a skilled person on the date of priority.

This also applied to the embodiment with liquid nitrogen as the coolant (claim 2). All the necessary information and materials would have been available to a person skilled in the art. Superconductive transformers would have been available, as would

manufacturing methods for high-temperature superconductors and wires with an appropriate current-carrying capacity. Persons skilled in the art would therefore also have been able to fabricate nitrogen-cooled transformers had they wished to do so. Short lengths of wire could have been joined to form longer lengths. D17 explicitly referred to transformer windings made from high-temperature superconductors prior to the date of priority of the present patent. There was thus no reason why it would have been objectively impossible to construct a railway traction unit with such a transformer.

According to established case law (see R. Teschemacher in *Singer/Stauder*, Europäisches Patentübereinkommen, 2nd edition, Heymanns, Cologne 2000, Article 83, hereinafter referred to as "*Singer/Stauder-Teschemacher*"), there was only a case for insufficient disclosure if the relevant technical teaching did not conform to the laws of nature or if the envisaged and claimed technical effect could not objectively have been achieved. The appellant had submitted no document which described the state of the art objectively on the date of priority and had presented no objective reason why a nitrogen-cooled transformer could not have been fabricated. Instead, he had merely made a series of subjective deductions. The fact that a transformer of this type was not available commercially was not a criterion on which to judge whether the invention could have been carried out. The present patent had clearly disclosed to a person skilled in the art at least one way of carrying out the invention, and the invention was thus sufficiently disclosed (T 292/85, OJ EPO 1989, 275). Any possible commercial disadvantages of carrying out the invention using helium as the coolant (such as shorter intervals between refilling) did not represent a reason to conclude that the invention could not be carried out (see T 881/95, not published in the OJ). There had been no objective obstacle to using other coolants. The invention had not been in contravention of the laws of nature and had thus been able to be carried out in its full scope. Decision T 409/91 cited by the appellant did not represent an analogous case, as it was not necessary for all possible transformer embodiments to be available. Also, no parallel could be drawn between

decision T 412/93 in the field of genetic engineering and the disputed patent, since in the present case it was also possible to carry out dependent claim 2 in the combination claimed.

Reasons for the decision

1. The appeal is admissible.

2. Disclosure of the invention in the patent specification

2.1 The invention as described in the patent specification applies to an electric railway traction unit of normal performance categories which should be able to be used practically and meaningfully in normal operation. Within the framework of such use, technical benefits should be achieved compared with the state of the art. The description assumes that, as a result of weight and space constraints, transformers for supplying power to railway traction units are subject to high levels of power loss compared with stationary transformers (column 1, lines 6 to 24). Despite these constraints, the specification maintains that a good efficiency coefficient could be achieved if the transformer were constructed as a superconductive transformer with a liquid gas container to serve as a coolant tank and act as the exclusive coolant supply device (column 1, lines 32 to 46; claim 1). The use of superconductive technology would reduce the overall losses, weight and space requirements of the transformer compared with an oil-cooled transformer constructed using normal conductors (column 3, lines 3 to 27). This would make it possible to accommodate a coolant tank of sufficient size to cool the transformer until such time as the tank could be replaced or refilled (column 2, lines 34 to 55). If liquid nitrogen (at 77 K) were used in place of expensive helium (at 4 K) as a coolant (which is only possible using high-temperature superconductors), only 15 to 35 W would need to be expended to generate 1 W of cooling power instead of 350 to 1 500 W (column 1, line 47, to column 2, line 26). Furthermore, the vaporisation heat of liquid nitrogen is

ten times that of helium. It would then be possible (despite the restricted space available) to ensure sufficient cooling for a transformer for supplying a railway traction unit with power for 2 to 3 days with 1 to 2 m^3 (approx.. 3 t) of coolant (column 2, lines 27 to 33; column 3, lines 28 to 33).

2.2 The patent specification contains no information on the circumstances under which a different coolant could be used. There is no indication of how to implement measures to compensate for the considerably greater effort involved in cooling with liquid helium (weight, space requirements, complexity) in order, under the given conditions, to eliminate the necessity of an additional cooling unit and operate the railway traction unit practically and meaningfully despite the refilling or replacement intervals which would be shorter by a factor of at least ten (or the greater quantity of coolant). Although helium is named in the introduction, and on the date of priority of the disputed patent was for practical purposes the only widely known coolant which could be considered as an alternative to liquid nitrogen, no claim in the disputed patent relates to helium as a coolant. Liquid nitrogen, on the other hand, represents the preferred coolant according to dependent claim 2 (see also claim 3 and "liquid gas, in particular nitrogen" in column 3, line 51). Thus, liquid nitrogen as a coolant and hence a transformer with windings fabricated from high-temperature superconductor material with a transition temperature above 77 K are a fundamental aspect of the invention according to the teaching of the patent. Other coolants could in future become relevant as variants with a similar technical effect if new superconductors with even higher transition temperatures are discovered. It is clear that future variants such as these are also intended to be covered by claim 1. Liquid helium as a coolant is not explicitly excluded in the wording of claim 1, but is not available to a person skilled in the art as an embodiment with similar effects according to the teaching of the disputed patent.

3. Completeness of disclosure (Article 100(b) EPC)

3.1 According to Article 100(b) EPC, the invention must be disclosed in a European patent "in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art". In order to meet this requirement, therefore, a European patent must contain sufficient information for a person skilled in the art, using his common general knowledge, to recognise the technical teaching embodied in the claimed invention and carry it out accordingly. This requirement must be fulfilled by the date of filing or the date of priority as any shortcomings cannot be rectified later without infringing Article 123(2) EPC (see G 2/93, OJ EPO 1995, 275, points 4 and 10 on the corresponding Article 83 EPC; *Singer/Stauder-Teschemacher*, point 14; *Schulte*, Patentgesetz mit EPÜ, 6th edition, Heymanns, Cologne 2001, section 34, hereinafter referred to as "Schulte", point 338).

3.2 According to established EPO board of appeal case law, the disclosure in a patent application or patent must enable a person skilled in the art to carry out successfully the claimed invention in practice in the whole range claimed on the relevant date of filing. A single embodiment can represent sufficient disclosure if the envisaged effect can be achieved in the whole range claimed without undue effort and with due regard to safety. Occasional failure and the unsuitability for use of individual variants are not detrimental in this respect. It is not necessary that all details required for carrying out the invention are described if the raw materials are available to the skilled person and the process for manufacturing a claimed item is known. The necessary scope of disclosure is an issue of fact which must be decided on a case-by-case basis. It is not necessary for the individual components or raw materials to have been commercially available at the time in question. However, it is necessary for the average skilled person with knowledge of the relevant disclosure to have been in a position on the relevant date to carry out the claimed invention in practice according to the embodied technical teaching and to fabricate the claimed item (see the above-mentioned decisions T 409/91, points 2 and 3.5; T 435/91,

point 2.2.1; T 292/85, points 3.1.2 and 3.1.5; and T 612/92, points 12 and 13; see also *Singer/Stauder-Teschemacher*, points 11, 16, 21, 23-26 and 60; *Schulte*, points 278, 279, 306, 315, 332 and 333).

3.3 With regard to the issue of sufficient disclosure of an invention for which protection is claimed under a European patent, it is thus of no significance whether the invention could have been carried out in the form of a variant covered by the wording of the claim on the relevant date of filing (date of priority) if this variant does not correspond to the fundamental aspect of the technical teaching of the invention to which the only concrete embodiment disclosed refers. Established case law (ability of the invention to be carried out in the whole range claimed) assumes that the only embodiment described in concrete terms could be regarded as the basis for generalisation and as representative for the whole range and that it could have been carried out in practice. A variant which is clearly not based on the same technical effect is not suitable as a basis for generalisation of this type.

3.4 In the present case, therefore, the critical question is whether the skilled person, with knowledge of the present patent, was on the date of priority able to carry out in practice a superconductive transformer cooled with liquid nitrogen for supplying power to an electric railway traction unit. Only if the components necessary for this had been available to the person skilled in the art either in the form of raw materials or in the form of common general knowledge as to how they are fabricated is the disclosure of details about the fabrication of superconductive transformer windings of no import. On this assumption, the technical contribution of the invention to the common general knowledge on the relevant date could be seen to be the special coolant supply device according to claim 1 (see figure in the patent specification).

3.5 The discovery of high-temperature superconductors by Bednorz and Müller in 1986 and the discovery in 1987 of superconductors which become superconductive above the boiling point of liquid nitrogen (77 K) led to development activity across

the world. Possible applications were investigated, as a considerable reduction in the technical effort involved in cooling and considerably lower costs as a result of the use of liquid nitrogen in place of helium as a coolant were to be expected. It is not disputed that laboratory samples of relatively short wires fabricated from high-temperature superconductive materials had become known before the date of priority of the disputed patent. Case studies relating to various applications, including transformers, were carried out on the basis of this knowledge. It is also undisputed that on the date of priority of the disputed patent (30 September 1992), a number of unresolved problems still remained with regard to these new materials, in particular relating to the fabrication of long wires from the brittle oxide materials of the known high-temperature superconductors. The materials were anisotropic, not very ductile, showed poor flexibility, and demonstrated relatively low critical current density values. In the case of transformers this was compounded by unavoidable a.c. losses and a reduction in the critical current density under higher bending loads (winding the coils). It is also undisputed that although stationary helium-cooled transformers had already been made in 1992, no transformer using high-temperature superconductors had been made at that time.

3.6 It is, however, disputed whether, as claimed by the respondent, a person skilled in the art would have been able to fabricate a transformer of the capacity required for a railway traction unit (larger than 1 MVA) with the materials and knowledge available at the time, if he had wished to. In this respect, the appellant established a prima facie case on the evidence of D14 to D16 that the fabrication of high-temperature superconductive wire in the required length (in excess of 1 000 m) and the winding of suitable coils with a sufficiently high critical current density would not have formed part of the general knowledge of a person skilled in the art on the date of priority of the disputed patent. In particular D14 together with the specialist articles, some of which were published subsequently, was held by the board to be convincing evidence that the processes known at the time were insufficient to simply fabricate wires of longer lengths or higher critical current densities as required (see

for example the figure on page 5 of D14). The documents report on record lengths that had been achieved and none of the documents referred to by D14 mention any possibility of establishing a superconductive connection between short lengths.

3.7 D14 to D16 represent highly relevant evidence for evaluating the state of the art on the date of priority. These were submitted together with the grounds for appeal or had been submitted beforehand (D16). The state of the art on the relevant date can in practice only be portrayed successfully on the basis of specialist articles using several documents, some of which were published subsequently, unless by chance a particular document was published on precisely this topic (after the relevant date). For this reason, D14 and D16 cannot be ignored in the present case.

3.8 Taking into account D14 to D16, the board concludes that suitable high-temperature superconductive windings for a transformer of the aforementioned capacity were not available to a person skilled in the art in September 1992. Likewise, appropriate manufacturing methods were not available, and accessible specialist knowledge even less so. These were rather the objectives of development activities being carried out at the time. Under such circumstances, disclosure of an invention is only complete if it communicates to a person skilled in the art the information that person lacks and which would put that person in the position to carry out the invention in practice. D17 cannot be admitted as evidence for the availability of such knowledge as common general knowledge because it contains no concrete details on the fabrication of long high-temperature superconductive wires.

3.9 With respect to this insufficiency of disclosure, it is of no relevance whether it was objectively impossible to provide the missing information on the date of priority, ie whether nobody could have achieved the intended and claimed technical effect. It cannot for instance be ruled out that some person had access to the specialist knowledge that was not available to an average person skilled in the art. The present patent, however, does not fulfil the decisive criterion in so far as it does not

disclose the invention at least in a manner sufficiently complete for it to be carried out by an average skilled person on the date of priority, with knowledge of the patent and on the basis of that person's common general knowledge (see also *Singer/Stauder-Teschemacher*, points 18, 23, 29 and 33-35).

4. The board therefore concludes that the present patent does not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art on the date of priority. The ground for opposition mentioned in Article 100(b) EPC prevents the disputed patent from being maintained and the patent is to be revoked in accordance with Article 102(1) EPC.

Order

For these reasons it is decided that:

The decision under appeal is set aside.

The patent is revoked.