

BESCHWERDEKAMMERN  
DES EUROPÄISCHEN  
PATENTAMTS

BOARDS OF APPEAL OF  
THE EUROPEAN PATENT  
OFFICE

CHAMBRES DE RECOURS  
DE L'OFFICE EUROPEEN  
DES BREVETS

**Internal distribution code:**

- (A) [ ] Publication in OJ  
(B) [ ] To Chairmen and Members  
(C) [X] To Chairmen

**D E C I S I O N**  
of 9 October 1997

**Case Number:** T 0539/94 - 3.2.1

**Application Number:** 85308860.7

**Publication Number:** 0185492

**IPC:** B23H 7/08

**Language of the proceedings:** EN

**Title of invention:**

Electrode wire for use in electric discharge machining and process for preparing same

**Patentee:**

FUJIKURA LTD.

**Opponent:**

Berkenhoff GmbH

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 56

**Keyword:**

"Inventive step (yes)"

**Decisions cited:**

-

**Catchword:**

-



Europäisches  
Patentamt

European  
Patent Office

Office européen  
des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Case Number: T 0539/94 - 3.2.1

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.1  
of 9 October 1997

**Appellant:**  
(Opponent) Berkenhoff GmbH  
Berkenhoffstr. 14  
35452 Heuchelheim (DE)

**Representative:** Missling, Arne, Dipl.-Ing,  
Patentanwalt  
Bismarkstrasse 43  
35390 Giessen (DE)

**Respondent:**  
(Proprietor of the patent) FUJIKURA LTD.  
No. 5-1 Kiba 1-chome  
Kohtoh-ku  
Tokyo (JP)

**Representative:** Jones, Stephen Anthony  
E. N. Lewis & Taylor  
144 New Walk  
Leicester LE1 7JA (GB)

**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 17 May 1994  
rejecting the opposition filed against European  
patent No. 0 185 492 pursuant to Article 102(2)  
EPC.

**Composition of the Board:**

**Chairman:** F. A. Gumbel  
**Members:** P. Alting van Geusau  
V. Di Cerbo

## Summary of Facts and Submissions

I. The mention of the grant of European patent No. 0 185 492 in respect of European patent application No. 85 308 860.7, filed on 5 December 1985, and claiming priority from the applications 259459/84 and 113685/85 filed in Japan on 8 December 1984 and 27 May 1985, respectively, was published on 4 September 1991.

II. Notice of opposition was filed by the appellant on 23 May 1992 on the grounds of Article 100 (a) EPC.

In respect of an alleged lack of novelty and inventive step the opposition was supported in particular by the following documents:

D1: DE-C-2 906 245  
D3: GB-A-2 059 324 and

the alleged prior uses:

U1: concerning an electrode wire designated SW 25 X, which was allegedly manufactured by the opponent and delivered to Ateliers des Charmilles SA, Geneva, before the earliest priority date of the contested patent and

U2: concerning an electrode wire designated SW 25 SX manufactured by the company THERMO IMPACT and delivered to Charmilles SA in 1984.

As evidence for the public use of the wire in accordance with U1 the testimony of the witness Mr Heinrich Groos was offered together with the following documents:

M1: Copy of a letter of the opponent to Charmilles SA dated 8 June 1984,

- M2: Copy of two photomicrographs "Erodierdraht SW-X", not dated,
- M3: Copy of two further photomicrographs "SW-X Ø 0,25" not dated,
- M4: Copy of a letter of CSEM to Charmilles SA dated 16 December 1985 with two diagrams appended thereto,
- M5: Copy of several drawings and specifications from Charmilles SA bearing dates of 17 October 1984, 29 October 1984 and 13 November 1984,
- M6: Copy of a leaflet from Charmilles SA dated August 1984,
- M7: Copy of an information sheet of Charmilles SA dated April 1981,
- M9: Copy of a leaflet from Charmilles SA not dated.

As evidence for the public use of the wire in accordance with U2 the following document was submitted:

- M8: Copy of a letter of opposition against a patent of the present opponent, dated 5 August 1993, with enclosures.

III. By a decision which was given at the end of oral proceedings held on 28 April 1994 and issued in writing on 17 May 1994 the Opposition Division rejected the opposition.

The Opposition Division was of the opinion that, starting from the prior art disclosed in D1, neither of the other available prior art documents nor the alleged prior uses gave the skilled person any lead to the claimed composition of the electrode wire or to the claimed methods for preparing such wire.

- IV. On 17 June 1994 a notice of appeal was lodged against that decision and the appeal fee was paid on 27 June 1994.

Together with the statement of grounds of appeal, which was filed on 14 September 1994, the appellant (opponent) further introduced in respect of the alleged prior use U1

M10: Copy of leaflet "Charmilles Series F",

M11: Article " Stratified wire for TW/EDM" by Mark Albert, from the magazine "Modern Machine Shop", May 1981, pages 97 to 102.

Later on the following further evidence was submitted:

M12: Statement by Mr H. Groos with attachments 1 to 3 and wire probes A and B

M13: letter dated 8 November 1994 from "Laboratorium Dr Dienwiebel" concerning investigations with respect to the wire probes A and B,

M14: Report dated 17 October 1994 by "Laboratorium Dr. Dienwiebel" in respect of the wire probes A and B.

- V. With its response dated 31 January 1995 the respondent referred to the prior art disclosed in

D4: "AES investigation of diffusion formed brass coatings" by D.A. Stout and R.J. Rife published in the Journal Vac.Sci.Technol., 20(4), April 1982, pages 1400 to 1402.

VI. In a communication issued in preparation for oral proceedings the Board observed that, having regard to the documents M4, M5 and M14 which pointed to diverging results, obviously sufficient proof was lacking that the wire indicated "SW 25 X" had an alloy layer falling within the range claimed in claim 1 of the patent in suit. It was also noted that the public availability of the wire SW 25 X did not appear to have been sufficiently substantiated.

In respect of the issue of inventive step, important questions to be discussed during the oral proceedings were considered to be whether the skilled person was led to introduce an annealing step for the wire known from D1, as was submitted by the appellant, and if so, whether the skilled person would then arrive in an obvious manner at the subject-matter of the present claim 1 or methods in accordance with claim 3 or claim 6 then on file.

For the discussion of this question documents M10 and M11 and also D4 appeared to be of interest.

It was further noted that, although revocation of the patent in its entirety was requested, the appellant's arguments submitted so far essentially addressed the wire claimed in the granted claim 1 but not specifically the method claims, which were not limited to the production of an electrode wire as claimed in claim 1.

VII. Oral proceedings were held on 9 October 1997.

The appellant requested setting aside of the decision under appeal and revocation of the patent in its entirety.

During the oral proceedings the respondent filed new claims 1 to 7 and an adapted patent description. The respondent requested that the patent be maintained in amended form on the basis of these new documents together with the granted figures 1 to 7.

As a subsidiary request claims 2 and 5 should further specify that the heating step is carried out under non-oxidative atmosphere.

The independent claims 1, 2 and 5 according to the main request read as follows:

"1. An electrode wire for use in wire electric discharge machining a workpiece by means of electric spark discharge, the electrode wire (10) comprising a core wire made of a copper clad steel wire (13) and a copper-zinc alloy layer (14) covering the outer periphery of said core wire; wherein said alloy layer has a thickness of from 0.1 to 0.15 microns, 10 to 70% of the sectional area of said core wire is occupied by copper, and the concentration of zinc in said copper-zinc alloy is increased gradually along the radially-outward direction at a predetermined concentration gradient, the average concentration of zinc in said copper-zinc alloy layer (14) being less than 50% by weight but not less than 10% by weight."

"2. A process for preparing an electrode wire for use in wire electric discharge machining a workpiece by means of electric spark discharge, comprising:

- (a) the step of preparing a core wire made of a copper clad steel wire (13) wherein 10 to 70% of the sectional area is occupied by copper;
- (b) the step of depositing a zinc layer over the outer periphery of said core wire by electroplating and
- (c) the step of heating said core wire coated with said zinc layer so as to disperse copper in said zinc layer to convert said zinc layer into a copper-zinc alloy layer (14), wherein

said alloy layer has a thickness of from 0.1 to 0.15 microns, 10 to 70% of the sectional area of said core wire is occupied by copper, and the concentration of zinc in said copper-zinc alloy is increased gradually along the radially-outward direction at a predetermined concentration gradient, the average concentration of zinc in said copper-zinc alloy layer (14) being less than 50% by weight but not less than 10% by weight."

"5. A process for preparing an electrode wire for use in wire electric discharge machining a workpiece by means of electric spark discharge, comprising:

- (a) the step of preparing a core wire made of a copper clad steel wire (13) wherein 10 to 70% of the sectional area is occupied by copper;
- (b) the step of dipping said core wire in a molten zinc bath so as to form a copper-zinc alloy layer (14) covering the outer periphery of said core wire and a zinc layer covering said copper zinc alloy layer; and

(c) the step of heating said core wire coated with said copper zinc alloy layer and said zinc layer to disperse copper in said zinc layer thereby to convert said zinc layer into a second copper zinc alloy,

wherein said alloy layer has a thickness of from 0.1 to 0.15 microns, 10 to 70% of the sectional area of said core wire is occupied by copper, and the concentration of zinc in said copper-zinc alloy is increased gradually along the radially-outward direction at a predetermined concentration gradient, the average concentration of zinc in said copper-zinc alloy layer (14) being less than 50% by weight but not less than 10% by weight."

VIII. In support of its request the appellant essentially relied upon the following submissions:

Considering the subject-matter of the current claim 1, both the documents D1 and D4 disclosed highly relevant prior art. In fact D4 disclosed most of the features of claim 1 and also addressed the amount of  $\alpha$  and  $\beta$  brass from which, having had regard to the Cu-Zn phase diagram, could be concluded that the brass layer contained less than 50% zinc.

Since a wire with essentially the same structure was shown in D1 and such wire was used for electric spark machining it would be obvious to the skilled person to use the wire known from D4 in a wire cutting electric spark erosion machine.

Also when starting from D1, no inventive step was necessary to arrive at the subject-matter of claim 1. Compared to the wire disclosed in D1 the wire in accordance with claim 1 differed only in that the zinc alloy layer thickness could also lie in the range of

0.1 to 1 micron, the zinc gradient in the alloy layer increased gradually along the radially outward direction of the wire and the average concentration of zinc in the alloy layer was smaller than 50% by weight.

However, the wire cutting machines in use at the time of the publication of D1 comprised annealing equipment for annealing the wire before it entered the cutting area. In this respect reference could be made to D3, D11 and M5. Heating of the wire to the annealing temperature inevitably led to diffusion of the copper and zinc to form a brass alloy with a predetermined zinc gradient along the radially outward direction, as could be derived from the samples A and B submitted with the appellant's statement of grounds of appeal.

Furthermore, when considering the evidence in respect of the prior use U1, there could be derived from M5 (see last page), that the wire designated SW 25 X was in fact a zinc plated copper wire named "25 SW", which wire after being annealed, was drawn to the required diameter. In order to be able to draw such wire the amount of zinc in the alloy layer had to be lower than 50% because at higher percentages the very brittle  $\gamma$ -phase would prevent any normal diameter reduction by drawing of the wire. It was therefore implicit to the skilled person that the average amount of zinc in the alloy layer should not exceed 50%.

Therefore, having regard to the relevant prior art, the skilled person, when starting from the wire disclosed in D1, did not need any inventive activity to arrive at the claimed electrode wire. Since the claimed methods for producing such wire did not contain any new features when compared to the usual fabrication of an electrode wire, such as disclosed in D1 and D4, these methods were not inventive either.

IX. The respondent disputed the appellant's view and its arguments may be summarised as follows:

The closest prior art was disclosed in D1, however, this known wire contained a zinc layer and no zinc-copper alloy layer. The opponent's allegation that intermediate annealing of the wire disclosed in D1 would inevitably produce a zinc-copper alloy having the same zinc concentration gradient as was specified in the patent was mere speculative and of hindsight character. Not only did D1 lack any hint to such annealing operation but D4 proved also that heating did not necessarily produce a zinc concentration gradient in accordance with the claimed wire.

As regards the document M5, attention had to be paid to the patent numbers shown on page 2 thereof, which were in fact the patent numbers of D1 and D3. In so far as a thermal treatment of the wire was concerned, D3 clearly stated that the pure zinc on the outside of the wire disappeared to the gain of a Cu-Zn alloy comprising around 10 to 20% copper and consequently 80 to 90% zinc. There was thus no support for the appellant's allegation that the amount of zinc in the alloy necessarily would be less than 50%.

Moreover, document M5 was not considered to be comprised in the prior art since it concerned a lot of only 4 coils, apparently intended for test purposes.

Since none of the other prior art documents contained any incentive for developing the wire known from D1 to include all the features of claim 1 with a view to improve its cutting speed abilities, the subject-matter of claim 1 was based on an inventive step. The claimed methods were now limited to obtain the claimed wire and inventive step of their subject-matter was therefore supported by the new and inventive product obtained.

## Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 Current claim 1 is a combination of the granted claims 1 and 2, which subject-matter was claimed in the originally filed claims 1 to 3.

Method claims 2 and 5 are based on the granted claim 3 and 6, respectively, which correspond to the originally filed claims 4 and 7. Both method claims are limited by introducing features, to be found in the originally filed claims 1 to 3.

Claims 3, 4, 6 and 7 are repetitions of the granted claims 4, 5, 7 and 8, which themselves correspond to the originally filed claims 5, 6, 8 and 9.

In view of these assessments no objections arise under Article 123(2) and (3) EPC.

2.2 The description was amended to bring it in line with the subject-matter now claimed and does also not give rise to objections under the EPC.

3. *Discussion of prior art*

3.1 In the Board's opinion the closest prior art is represented by D1. This prior art discloses an embodiment of an electrode wire for use in wire electric discharge machining in which the wire electrode comprises a core wire made of a copper clad steel wire and has a zinc layer on the outside of the wire (see D1 column 4, lines 24 to 26).

Such wire has good cutting characteristics, since because of the latent heat of vaporisation of the zinc, the core of the wire gets not hotter than the temperature at which the zinc outer layer will vaporise. Therefore more electrical energy can be carried by the wire and more powerful sparks can be discharged, leading to a higher machining speed (see page 100 of M11 and also D1, column 2, lines 55 to 63).

- 3.2 The appellant considered that D4 came even closer to the subject-matter of claim 1 because the wire disclosed therein contained virtually all the features of claim 1.

However, it is observed that the disclosure of D4 essentially concerns the manufacture of a steel wire with a brass coating rather than a wire for electric discharge machining.

Although during the manufacturing of the wire firstly a copper layer is deposited on the steel after which the copper is covered with a zinc layer, the intention is clearly to select the thicknesses of the layers such that during subsequent heating of the wire the copper and zinc layer diffuse to a relatively homogeneous layer of brass (see the abstract on page 1400).

This known wire does not, therefore, have a copper layer with a thickness of 10 to 70% of the sectional area of the core wire which copper layer is intended as the main conductor of electric current in the wire and which layer is an essential feature for use of the wire as an electrode wire for electric spark erosion machining.

- 3.3 The appellant also relied on the electrode wire in accordance with the prior use U1 and in particular the evidence disclosed in M5.

This prior use concerns a wire indicated "SW 25 X" which is an annealed and drawn to size "SW 25" wire. According to M5, (see the top of the specification No. 442330), SW 25 is a copper wire with a zinc layer on it.

The SW 25 wire appears to be of the same structure as the wire referred to in D1 and shown in curve 23 of Figure 2. It also discussed in prior art document M7 and therefore forms part of the prior art.

However, the Board follows the respondent's opinion that it is not proven with sufficient certainty that the wire designated SW 25 X was also part of the publicly available prior art.

As was also noted by the Opposition Division, document M5 consists of a number of drawings and a specification of the wire SW 25 X, which were all drawn up by the company Charmilles SA and served for specification of an order. In view of the fact that only 4 coils, each with 4 kg of wire, were involved and no exact details of delivery are available, the Board takes the view that most probably the content of M5 was confidential, such as is normally the case when samples are tested. No proof to the contrary was provided by the appellant and also none of the other evidence presented in support of the alleged prior use U1 is suitable to substantiate the public availability of the SW 25 X wire before the priority dates of the present patent.

Anyhow, even if the SW 25 X wire were to be considered publicly available before the priority dates of the present patent its content is not considered more relevant than the content of D1 or D3 for the following reasons:

The SW 25 X wire does not have a steel core, its alloy layer thickness falls essentially outside the claimed range (see M5, specification no 442331, point 1.6: "25  $\pm$  10  $\mu$ m", and middle of specification no. 442330: "après tréfilage = 22  $\pm$  10  $\mu$ m") and there is no information available allowing a conclusion as to the gradient of zinc or average concentration of zinc in the alloy layer.

- 3.4 The appellant argued that the claimed gradient of zinc and average zinc concentration in the alloy layer were simply the results of an annealing step and the necessary precautions to allow for a subsequent wire drawing step. Since the skilled person was well aware of the formation of brittle brass phases in case more than 50% zinc was present in the alloy layer, drawing could only be effected if such brittle components were not present in the alloy layer.

Considering this argumentation the Board draws attention to document D3, its patent specification number being indicated on the sticker for the wire coil in M5 (see specification No. 442321).

This document is a further patent specification relating to the company Charmilles SA and concerning similar wires as disclosed in D1, the specification number of which is also indicated on the coil sticker, but which wires are heated to cause the formation of zinc oxide on the outside surface. In the example mentioned on page 2, lines 60 to 64 the Cu-Zn alloy formed by heating comprised around 10 to 20% copper, thus leading to the conclusion that the alloy contained 80 to 90% Zn, which is well over the 50% claimed in the patent in suit.

In accordance with the specification 442330 of M5 the heating step for the SW25 wire is carried out at 850°C at 5 to 10 seconds. When comparing such heating step with the heating method described in the patent in suit, in which the wire is maintained at about 300°C over a period of one hour (see for example page 7, lines 20 to 24), it will be clear that fully different conditions for the diffusion of the Cu and Zn atoms exist.

Attention can also be drawn to the specification of the present patent in relation to figures 4(a) and 4(b) in which the effects of insufficient heating treatment are exemplified.

The report M14, presented by the appellant as proof of the inevitability of arriving at the claimed nature of the alloy layer, relates to investigations about the percentage of zinc in the outer layer of wire probes A and B, allegedly concerning SW 25 wire before and after annealing.

However, in view of the fact that the heating temperature and time duration of heating during annealing is of decisive importance for the zinc concentration gradient and average concentration, which was admitted by the appellant in its response dated 8 September 1997, in the absence of any objectively verifiable proof that the annealed wire in accordance with probe B conforms exactly to an electrode wire SW 25 used in the cutting area of an electric discharge wire-cutting machine in accordance with M10, this evidence cannot be taken into account.

Moreover, it is to be noted that the results from 17 October 1994 as given in M14 are not in agreement with those shown in M4, dating from 1985.

In this respect it is also to be noted that on the machine described in M10 (see page 3) the wire was firstly drawn to size and then annealed so that the problems of drawing a wire having a brittle  $\gamma$ -phase brass on its surface did not occur in this prior art.

- 3.5 The appellant did not any longer rely on the alleged prior use U2.

Since this prior use was not sufficiently substantiated in respect of the date of delivery of 420 Kg of wire it cannot be taken into account in the present proceedings.

- 3.6 There is no need to consider the other available documents which were not any longer relied upon by the appellant in the appeal proceedings, since these documents are clearly less relevant than the material discussed above.

#### 4. *Novelty*

- 4.1 From the above discussion of the prior art it follows that the subject-matter of the independent claims is novel because none of the available pieces of prior art disclose a wire comprising the combination of characteristics claimed in claim 1 or methods steps leading to such electrode wire.

In particular the prior art is lacking any indication to a electrode wire having a concentration of zinc in an outer copper zinc alloy layer which increases gradually along the radially outward direction at a predetermined concentration gradient and in which the average concentration of zinc in said copper-zinc alloy layer is less than 50% by weight but not less than 10% by weight.

5. *Inventive step*

5.1 The electrode wire according to claim 1 of the patent in suit differs from the closest prior art as is represented by D1 in that

- (a) the wire is covered by a copper-zinc alloy layer,
- (b) the alloy layer has a thickness of 0.1 to 15 microns,
- (c) 10 to 70% of the sectional area of the core wire is occupied by copper,
- (d) the concentration of zinc in the copper-zinc alloy layer increases gradually along the radially outward direction at a predetermined concentration gradient,
- (e) the average concentration of zinc in the copper-zinc alloy layer is less than 50% by weight but not less than 10% by weight.

The appellant considered that the alloy layer range of 1 to 15 microns was also disclosed in D1. However, in so far as the range of 1 to 15 microns is disclosed in D1, another embodiment than the wire having a copper clad steel core and outer layer of zinc is involved. Combining features of different embodiments does not fall within the concept of determining novelty of a claimed feature.

5.2 The technical problem solved by the electrode in accordance with claim 1 can be seen in improved durability and cutting abilities of the wire electrode known from D1.

As can be derived from the explanations in respect of figure 7 of the patent in suit the combination of characteristics of the claimed wire leads to an optimal cutting wire for electric discharge machining, which was in fact not disputed by the appellant.

- 5.3 Having regard to the available prior art in a search for suggestions in the direction of the claimed combination of characteristics, in the Board's opinion at least the above features (d) and (e) lack any antecedent in the cited documents and hence there could be no lead to include such features in a electrode wire in accordance with D1.

As was already discussed with respect to the documents D3, D4 and M5 and M11, the application of an annealing step to the wire known from D1 does not necessarily give rise to the features (d) and (e) because the duration and degree of heating to achieve sufficient diffusion of the copper and zinc so as to form a copper zinc alloy with a predetermined concentration gradient as well as an average concentration of the zinc in the alloy layer of less than 50%, is not taught in these documents.

Moreover, no lead is derivable from the available documents that the machining speed could be improved by the combination of characteristics of the claimed wire. The annealing step was either introduced to make the wire soft for a subsequent drawing of the wire to the required diameter (see M11 page 102, lines 10 to 15) and not because improved machining speed was intended or the annealing step was used after drawing to size in order to remove stresses in the material (see M10, page 3).

D4, considered particularly pertinent by the appellant as regards the combination of the features (d) and (e), cannot give any lead to the skilled person either for incorporation of its known alloy layer in the wire known from D1. Clearly the publication D4 relates to a wire having a different structure (see point 3.2 above) and does not give rise to any intellectual link with electric discharge machining nor does it hint to a possible solution of the problem to be solved by the subject-matter of claim 1.

6. The Board therefore concludes that the subject-matter of claim 1 according to the respondent's request cannot be derived in an obvious manner from the cited prior art and accordingly involves an inventive step (Article 56 EPC).

The independent process claims 2 and 5 relate to methods specifically designed for preparing an electrode wire having all the features of claim 1. Novelty and inventive step of these methods therefore is supported by the novel and inventive product obtained.

Consequently, the independent claims 1, 2 and 5 with their dependent claims 3, 4, 6 and 7, the revised description and the drawings as granted provide a suitable basis for maintenance of the patent in amended form.

7. Since the respondent's main request is acceptable, there is no reason for dealing with its subsidiary request.

**Order**

**For these reasons it is decided that:**

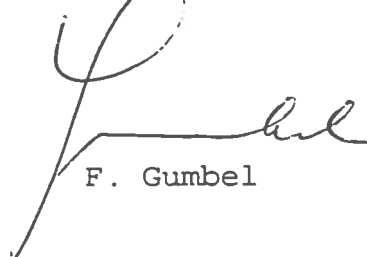
1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent with the following documents:
  - claims 1 to 7 and description filed at the oral proceedings
  - figures 1 to 7 as granted.

The Registrar:



S. Fabiani

The Chairman:



F. Gumbel

