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**D E C I S I O N**  
**of 18 October 2002**

**Case Number:** T 0648/98 - 3.4.1

**Application Number:** 92304242.8

**Publication Number:** 0514116

**IPC:** G21C 3/322

**Language of the proceedings:** EN

**Title of invention:**

Spacer associated pressure drop in a boiling water reactor  
bundle having part length rods

**Patentee:**

GENERAL ELECTRIC COMPANY

**Opponent:**

ASEA BROWN BOVERI AB

**Headword:**

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**Relevant legal provisions:**

EPC Art. 54

**Keyword:**

"Novelty (no)"

**Decisions cited:**

T 0963/93, G 0002/88

**Catchword:**

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Case Number: T 0648/98 - 3.4.1

**D E C I S I O N**  
of the Technical Board of Appeal 3.4.1  
of 18 October 2002

**Appellant:** ASEA BROWN BOVERI AB  
(Opponent) S-72183 Västerås (SE)

**Representative:** Boecker, Joachim, Dr.-Ing.  
Grosse Eschenheimer Strasse 39  
D-60313 Frankfurt (DE)

**Respondent:** GENERAL ELECTRIC COMPANY  
(Proprietor of the patent) 1 River Road  
Schenectady NY 12345 (US)

**Representative:** Frohwitter, Bernhard, Dipl.-Ing.  
Patent- und Rechtsanwälte  
Possartstrasse 20  
D-81679 München (DE)

**Decision under appeal:** Interlocutory decision of the Opposition Division  
of the European Patent Office posted 12 May 1998  
concerning maintenance of European patent  
No. 0 514 116 in amended form.

**Composition of the Board:**

**Chairman:** G. Davies  
**Members:** G. Assi  
R. Q. Bekkering

## Summary of Facts and Submissions

I. The appellant (opponent) lodged an appeal, received on 30 June 1998, against the interlocutory decision of the Opposition Division, dispatched on 12 May 1998, maintaining European patent No. 0 514 116 (application No. 92 304 242.8) in amended form. The fee for the appeal was paid on 30 June 1998. The statement setting out the grounds of appeal was received on 5 September 1998.

Opposition had been filed against the patent as a whole, *inter alia* on the basis of Article 100(a) EPC, in particular on the grounds that the subject-matter of the claims was not patentable within the terms of Articles 52(1) and 56 EPC. The Opposition Division held that the grounds for opposition did not prejudice the maintenance of the patent in amended form.

II. With a letter of 17 March 1999, the respondent (patent proprietor) cited the following document and requested its introduction into the procedure:

D11: JP-A-1-176986 with English translation.

III. Oral proceedings were held on 18 October 2002. At the oral proceedings, the Board admitted D11 into the procedure.

IV. The appellant requested that the decision under appeal be set aside and the patent be revoked in its entirety.

V. The respondent requested that the patent be maintained on the basis of the following documents:

**Claims:** No. 1 filed on 18 October 1998 during oral proceedings, No. 4, 5, 7 of the granted patent (to be renumbered),

**Description:** Page 3 filed on 21 April 1998 during oral proceedings before the opposition division, Pages 1, 2, 4 to 7 of the granted patent,

**Drawings:** Pages 10 to 17 of the granted patent.

VI. The wording of claim 1 according to the respondent's request reads as follows:

*"A boiling water reactor having discrete bundles (B) of fuel rods (R) confined within channel (C) enclosed fuel assemblies; wherein said fuel bundle (B) includes: a plurality of fuel rods (R) for placement within said channel (C), each said fuel rod (R) containing fissile material for producing nuclear reaction when in the presence of sufficient moderating water coolant and moderated neutrons; a lower tie plate (L) for supporting said bundle (B) of fuel rods (R) within said channel (C), said lower tie plate (L) joining the bottom of said channel (C) to close the bottom end of said channel (C), said lower tie plate (L) providing defined apertures for the inflow of water coolant in said channel (C) between said fuel rods (R) for generation of steam during said nuclear reaction; said plurality of fuel rods (R) extending from said lower tie plate (L) wherein a single phase region of said water in said bundle (B) is defined to an upward portion of said bundle (B) wherein a two-phase region*

*of said water and steam in said bundle (B) is defined during nuclear steam generating reaction in said fuel bundle (B);*

*an upper tie plate (U) for supporting the upper end of said bundle (B) of fuel rods (R), said upper tie plate (U) joining the top of said channel (C), said upper tie plate (U) providing apertures for the outflow of water and generated steam in said channel (C) during said nuclear reaction;*

*spacers (S) intermediate said upper and lower tie plates (U,L) at preselected elevations along said fuel rods (R) for maintaining said fuel rods (R) in spaced apart location along the length of said fuel assembly; a plurality of said fuel rods (R) being part length fuel rods (P) extending from said lower tie plate (L) towards said upper tie plate (U), said partial length fuel rods (P) terminating within the upper region of said fuel bundle (B) before reaching said upper tie plate (U) and causing decreased pressure drop in said upper two phase region of said fuel bundle (B) during said nuclear steam generating reaction; characterized by :*

*means (109, 132, 139) associated with spacers (S) located at a height above the top of the part length fuel rods (P) for restoring at least some of the decreased pressure drop realized by said part length fuel rods (P) whereby improved critical power performance is achieved at said fuel bundle (B) having said part length fuel rods (P), wherein the means for restoring at least some of the decreased pressure drop is selected from :*

*(i) decreased spacer pitch in the upper two phase region of said fuel bundle; and*

*(ii) vanes (109, 132, 139) attached to said spacers (S) in interstitial volumes between the fuel rods."*

VII. The arguments of the appellant may be summarised as follows.

The ground for opposition laid down in Article 100(a) in conjunction with Articles 52(1) and 54 EPC prejudiced the maintenance of the patent in the amended form requested by the respondent.

Claim 1 comprised two alternatives, a first one including the feature (i) (decreased spacer pitch) and the second one the feature (ii) (provision of vanes). The subject-matter of the second alternative was not novel having regard to the disclosure of document D11. Indeed, D11 disclosed a boiling water reactor having fuel bundles according to the precharacterising part of claim 1. Means, in particular projections or obstacles, were associated with spacers placed above the part length fuel rods (PLRs) in the two-phase region of the fuel bundles. Such means, located in the void volumes above the PLRs, could be considered as vanes attached to said spacers in the volumes between the fuel rods. Being obstacles to the flow of coolant, they necessarily caused a pressure drop in the upper two-phase region of the fuel bundles. As regarded the claimed improvement of the critical power performance, this represented an effect to be achieved and not a limiting structural feature.

VIII. The respondent's arguments can be summarised as follows.

Claim 1 included two essential features concerning the

means for "*restoring at least some of the decreased pressure drop*" and the "*improved critical power performance*". These features distinguished the claimed solution from the disclosure of document D11.

As regarded the former feature, whilst D11 described the provision of projections for affecting the flow of coolant directly above the PLRs only, there was no evidence that such means would lead to an increase in the overall coolant pressure drop. It was rather likely that no measurable overall pressure drop increase would be caused by the known spacers located above the PLRs, because only a relatively small part thereof, *ie* the portions located in correspondence of the void volumes, was modified by the provision of projections, whereas the whole of the spacers was affected according to the invention. Moreover, D11 clearly mentioned the "*adverse effect*" related to the increased resistance to flow and the increased pressure loss caused by projections with tips ending inside the outer periphery of the PLRs. Thus, the prior art document even taught against the present invention, *ie* that an increase in pressure drop was undesirable and every effort should be taken to avoid such an event.

With regard to the latter feature mentioned above, it did not represent a simple effect achieved because the claimed pressure drop restoration involved the use of structural means associated with the spacers. Such means had to be so arranged that, as its immediate consequence, overall critical power performance, *ie* over the whole fuel bundle, was increased. Whereas the solution known from D11 could only improve the situation of the fuel rods adjacent the PLRs, the claimed invention worked across the whole two-phase

flow section. In other words, D11 increased only the thermal margin of a single or at best of a limited group of rods, and the present invention improved the critical power performance of the whole fuel bundle.

In Claim 1, the feature of improving the critical power performance was linked to that of restoring the decreased pressure drop. Claim 1 implied an operating range for the pressure drop restoration extending from "at least some" to "full" restoration. This range, however, was much larger than that to be inferred from D11. A hypothetical overlap could not be excluded but would not be sufficient to deny novelty. Indeed, with regard to the case law, according to decision T 0943/93, the hypothetical possibility of operating within the claimed region *per se* was legally not sufficient to deprive this region of novelty, particularly if the skilled person had no technical motive and thus no practical necessity to work within this region. More generally, attention was drawn to decision G 0002/88 (EPO OJ 1990, 93), in which the Enlarged Board held that whether a previously undisclosed technical effect, which in fact inevitably occurred when a previously disclosed technical teaching in a written description was carried out, had been made available to the public by reason of the written description was a question of fact, which had to be decided in the context of each individual case.

Therefore, the appellant's conclusion denying novelty was not correct.

## **Reasons for the Decision**



1. The appeal is admissible.

2. *Novelty*

2.1 Document D11 concerns a fuel assembly for a boiling water nuclear reactor (BWR) (see page 1, Claim and paragraph bridging pages 3 and 4). Although D11 does not explicitly disclose the nuclear reactor comprising such fuel assemblies, both the appellant and the respondent do not contest that this can be considered to be part of the implicit disclosure of the document. The known fuel assembly comprises the features recited in the precharacterising portion of Claim 1, in particular (see D11, page 2, page 3, first paragraph, Figure 2):

- a plurality of fuel rods is arranged within a channel,
- a lower tie plate supports the lower end of the fuel rods, said lower tie plate closing the bottom end of the channel and being provided with apertures for the inflow of the water coolant,
- the fuel assembly comprises a lower single-phase region cooled by water and an upper two-phase region cooled by a mixture of water and steam,
- an upper tie plate is arranged at the upper end of the fuel rods, said upper tie plate being provided with apertures for the outflow of water and steam,
- spacers are provided between the lower tie plate and the upper tie plate for maintaining the fuel rods in spaced apart location along the length of

the fuel assembly,

- a plurality of the fuel rods consists of PLRs extending from the lower tie plate towards the upper tie plate, said PLRs terminating within the upper region of the fuel assembly before reaching the upper tie plate.

In view of the presence of the PLRs, a "*widened coolant flow path*" is obtained above each of said PLRs (see D11, page 2, last paragraph). This means that there is a "*decreased pressure drop*" in the upper two-phase region of the fuel assembly.

Both the appellant and the respondent agree that a BWR comprising all the features of the precharacterising portion of Claim 1 is indeed known from document D11.

- 2.2 The claimed invention according to D11 (see page 1, Claim) consists in that "*spacer grid portions*" above the PLRs have an increased wall thickness or are provided with projections or with obstacles to coolant flow. In an embodiment of D11 (see page 5), two spacers are provided above the PLRs in the upper two-phase region of the fuel assembly. Such projections or obstacles can be regarded as falling within the scope of the feature recited by Claim 1 concerning the "*means ... associated with spacers ... located at a height above the top of the part length fuel rods*". Indeed, the projections or obstacles disclosed by D11 are not distinguished from the "*vanes*" according to the feature (ii) of Claim 1, the structure of which is not at all defined. An example of projection or obstacle is given in Figure 6(b) of D11 showing the arrangement of means 20 in the void volume above a PLR 21. Such

means 20 is thus placed "*in interstitial volumes between the fuel rods*" 2.

2.3 The skilled person in the field of BWRs knows that the spacers in a fuel assembly restrict coolant flow and, thus, cause an inevitable coolant flow pressure drop. The flow resistance of a spacer depends, in particular, on its projected area, which means that it can be minimized by minimizing the projected area of the structure of the spacer. Conversely, if the spacer or portions thereof have an increased wall thickness (see the Claim of D11 and the patent in suit, column 5, lines 25 and 26) or are provided with projections or with obstacles to coolant flow (see the Claim of D11 and the patent in suit, column 5, lines 13 to 15), the projected area and, therefore, the flow resistance and pressure drop increase. In the present case, considering that the provision of the PLRs causes a decreased pressure drop in the upper two-phase region of the fuel assembly known from D11, the effect is achieved that the means associated with the spacers above the PLRs restores "*at least some of the decreased pressure drop*" realized by the PLRs.

2.4 The respondent argues that each of the solutions for restoring the pressure drop described in the patent in suit (see column 4, line 50, to column 5, line 29) concerns the whole of a spacer and is, therefore, distinguished from the local arrangement claimed in D11, according to which only a relatively small part of the spacer is affected, *ie* the spacer grid portions above PLRs. In the respondent's view, although D11 describes features affecting the coolant flow in the void volumes above the PLRs, the prior art document does not give any evidence for the fact that the means

provided at spacer grid portions above PLRs leads to an increase in the overall coolant pressure drop in the fuel assembly.

The expression on page 4 of D11 (see lines 6 to 8 from the bottom) that the spacer grid portions are provided with "*obstacles 20 to coolant flow*" and the flow lines 19 shown on Figure 6(b) clearly indicate that the coolant flow is affected. The alleged overall coolant pressure drop might well be based on the content of the description of the patent in suit but does not necessarily result from the invention as claimed. The characterising portion of Claim 1 only recites the feature that "*means*" is associated with spacers located above the PLRs "*for restoring at least some of the decreased pressure drop realized by said part length fuel rods*". However, neither the structure of the "*means*", in particular "*vanes*", is mentioned in the claim, nor how and where such "*means*" is associated with the spacers, nor to which extent the decreased pressure drop is restored. In particular, the range claimed by the invention in the respondent's view from "*at least some*" to "*full*" restoration is, as a matter of fact, completely undefined. It follows that the difference outlined by the respondent is irrelevant for assessing novelty of the claimed subject-matter.

- 2.5 According to D11 (see page 7, lines 5 to 9, and Figure 6(b)), "*even if the projections have tips ending inside the outer periphery of the short fuel rod, the projections are equally effective to redirect the flow of the liquid film of water. This however has an adverse effect, that is, increased resistance to flow and increased pressure loss in the fuel assembly*". The

respondent concludes from this passage that D11 teaches away from the invention because it presents the "*increased pressure loss*" as an "*adverse effect*".

This argument is not convincing. The object of D11 consists in that improved thermal margin with respect to boiling transition can be achieved in a BWR fuel assembly comprising PLRs (see page 3, lines 7 to 9 from the bottom). This is achieved by the provision of spacer grid portions above the PLRs, having an increased wall thickness or being provided with projections or with obstacles to coolant flow (see page 1, Claim). The projections may differ in that their tips vertically meet or end inside or are positioned outwardly from the outer periphery of the PLRs (see page 7, lines 2 to 14). This affects the coolant flow and the pressure drop. Thus, whilst designing the projections, the skilled person has to look for a compromise between the pressure drop caused by them and the requirements set by the recirculation pump (see page 6, lines 4 to 6 from the bottom). The effect on thermal margin achieved with the provision of the projection shall not have an adverse effect on the recirculation pump. This does not mean that D11 teaches against restoring the pressure drop, *ie* away from the invention.

- 2.6 Claim 1 further mentions that "*improved critical power performance is achieved at said fuel bundle*" comprising PLRs, the expression "*improved critical power performance*" referring, in the respondent's view, to the overall performance during steam generation of the fuel assembly.

In the respondent's view, this is a feature limiting

the scope of the claim because the claimed pressure drop restoration involves the use of suitable structural means associated with the spacers and has to be so arranged that, as its immediate consequence, overall critical power performance is increased.

It is not denied that there is a link between pressure drop restoration and improved critical power performance. However, the wording of the claim presents the improvement of the critical power performance as a result that is not defined as such in quantitative terms but only indirectly by the mention of structural means for restoring the decreased pressure drop. Since such structural means is claimed in quite a general way and, moreover, is already known from document D11, the requirement concerning the critical power performance cannot be considered as a structural feature of the fuel assembly establishing novelty.

- 2.7 The case law cited by the respondent in support of its arguments is not relevant.

The present case differs from that underlying the decision T 943/93 in the sense that neither Claim 1 nor the prior art document D11 define clear operating regions for the pressure drop restoration, regions limited by numerical values which could be compared. Therefore, it cannot be established whether there is an overlap and the significance thereof.

As to G 2/88, it concerns *inter alia* the question of novelty with regard to a claim to the use of a known compound for a particular purpose based on a technical effect described in the patent. It is, therefore, not relevant for the present case.

2.8 Therefore, the subject-matter of Claim 1 according to respondent's request is not novel. The request is not allowable.

## **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:

R. Schumacher

G. Davies