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 13 December 1994

Case Number: T 0810/92 - 3.2.2

Application Number: 85308624.7

Publication Number: 0186972

IPC: C03B 5/04

Language of the proceedings: EN

Title of invention:
Improvements in or relating to glass melting tanks and to refractory materials for use therein

Patentee:
PILKINGTON PLC

Opponent:
SCHOTT GLASWERKE

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
"Novelty (yes)"
"Inventive step (no)"

Decisions cited:

Catchword:

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0810/92 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 13 December 1994

Appellant: (Proprietor of the patent)
PILKINGTON PLC
Prescot Road
St. Helens
Merseyside WA10 3TT (GB)

Representative:
Palmer, Roger
PAGE, WHITE & FARRER
54 Doughty Street
London WC1N 2LS (GB)

Respondent: (Opponent)
SCHOTT GLASWERKE
Hattenbergstrasse 10
D-55122 Mainz (DE)

Representative:
-

Decision under appeal:
Decision of the Opposition Division of the European Patent Office dated 23 June 1992 revoking European patent No. 0 186 972 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: H. Seidenschwarz
Members: M. Bidet
J. Van Moer

Summary of Facts and Submissions

I. On 1 September 1992 an appeal was filed against the decision of the Opposition Division, issued on 23 June 1992 revoking the European patent No. 0 186 972, the appeal fee being paid on the same date. The statement setting out the grounds of appeal was received on 22 October 1992.

II. The opposition was filed against the patent as a whole and based on Article 100(a) EPC, since the subject-matter of this patent was not novel or at least did not involve an inventive step.

The Opposition Division held that lack of inventive step prejudiced the maintenance of the amended patent having regard to documents D2, D4, D5 and D10. In **Annex I** the prior art documents which have been referred to in the course of the proceedings are listed.

III. With its Notice of Appeal, the Appellant (Proprietor of the patent) filed an amended Claim 1 and asked for oral proceedings if necessary to obtain cancellation of the decision of 23 June 1992.

In the Statement of Grounds, it argued that the invention was concerned with the problems which arise in the very specific environment of a shallow uniflow refining zone in a high quality flat glass melting tank. The Appellant emphasised that due to the high interface temperatures between molten glass and refractory material in the shallow path, it was in no way obvious to overcome the problems of unacceptable contamination at the unusually high temperatures, so as to achieve an acceptable purity level for high quality processes such as the float process.

The Appellant argued that documents D2, D4, D5 and D10 had no relevance to solving the problems of uniflow refiners and in particular it was wrong to interpret document D5 or D2 as giving any clear teaching to solve the present problem. These documents gave no hint of using a substantial amount of electric melting in the melting zone for a uniflow refiner. Electric melting had caused instability in the prior art, and the formation of hot spots. It further denied that the skilled man would immediately condition the refractories in the furnace and in contact with molten glass (i.e. in situ) while starting up the furnaces, since the expectation in the glass melting art was that known refractories would not withstand the higher interface temperature of a uniflow refiner.

According to the Appellant document D2 made it quite clear to the skilled man that at the date of its publication the understanding was that problems were to be expected at temperatures above 1350°C.

As far as document D10 is concerned, it maintained that the disclosed glass melting tank relating to green or semi-white glass containers such as bottle glass was not appropriate for the production of high quality glass as required for the float process.

IV. After receipt of the summons to oral proceedings pursuant to Rule 71(1) EPC issued on 8 September 1994 the Appellant informed the Board with letter of 24 October 1994 that it did not wish to appear at the oral proceedings.

In a communication of the Board issued on 14 November 1994, the Board drew the attention of the parties to the fact that Claim 1 did not seem to fulfil the requirements of Articles 123(2) and Article 84, and that

the documents D1, D2, D4, D5 and D10 seemed to be important for the assessment of the patentability of the subject-matter of Claim 1.

On 2 December 1994 the Appellant filed new requests and maintained its argumentation as regards the non-relevance of the documents referred to in the communication. In particular, it emphasised further that document D1 had no clear teaching due to ambiguity between the description and Claim 1 of this document as regards the values of temperature and duration of the heat treatment. As a result, the skilled man would not consider it for the purpose of finding a solution to his problem.

V. The Appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of:

1. Main request: Claim 1 filed on 2 December 1994; Claims 6 to 13 filed on 10 December 1990 - renumbered 2 to 9 on 1 September 1992; description pages 2 and 4 to 7 as granted, page 3 as granted with replacement of line 1, starting after the word "pass" till line 62 after word "high" by pages 4 and 8 filed on 10 December 1990 and page 8a filed on 2 December 1994; drawings as granted;

2. First auxiliary request: claims, description and drawings according to the main request with deletion of: "of a further embodiment" in line 65, page 4 of the description;

3. Second auxiliary request: claims, description and drawings according to the main request with deletion of lines 65, page 4, line 1, page 5 and

line 43, page 6 through the words "Figure 1" in line 10, page 7 of the description; deletion of Figure 6.

Claim 1, which is the same for all the requests, reads as follows:

"A glass melting tank for producing molten glass for use in a flat glass forming process such as a float process, which tank comprises a melting zone for melting batch material to form molten glass and a refining zone for refining the molten glass, the refining zone being a uniflow refining zone through which glass flows in a shallow flow path away from the melting zone, characterised in that the melting zone (12) is provided with electrical heating electrodes (21) located within the melting zone and arranged to provide at least 15% of the heat required to melt the batch material, and in that to reduce bubble formation and avoid unwanted interaction at an elevated interface temperature of 1450°C between molten glass and a refractory base (30) of the refining zone (13), the base (30) of the refining zone is formed of a refractory material comprising alumina, silica and between 31% and 43% by weight of zirconia, the refractory material being fusion cast and conditioned in position in the refining zone (13) by oxidation in contact with the molten glass at a temperature of at least 1450°C for a period of at least 24 hours.

VI. Oral proceedings were held on 13 December 1994. The Appellant, as previously announced, did not appear. Since it was duly summoned, the proceedings continued without it (Rule 71(2) EPC).

1. The Respondent (Opponent) argued in its written statement and during the oral proceedings that Claim 1 did not fulfil the requirements for the existence of an inventive step (Art. 56 EPC):

The reasons were that

(a) a glass melting tank of the claimed type was known from each of the documents D6, D9 and D10,

(b) electrical heating of glass melting tanks was disclosed in documents D7 and D8, and

(c) conditioning of refractories for use at a high temperature interface was available to the skilled man not only from a process known from document D1 but also from the teaching of documents D2, D3 and D5.

The combination of any one document of any of the aforementioned groups of documents would have led the skilled man to the claimed solution. Thus, the furnace disclosed in document D9 corresponded to that of Claim 1 and was fitted in the refining zone with a refractory (bakor-33), whose composition was the same as that mentioned in Claim 1. The conditioning of known refractories when bubble formation appears in the furnace at high temperatures belongs to the normal activity of the skilled man.

Furthermore, the skilled man was in a position to apply directly the more appropriate conditioning treatment from the two known possibilities of bringing oxygen to the refractory. This was based on the fact that

- oxidation by air was better for conditioning some pieces of refractory, which were spare elements, and

- oxidation by molten glass had to be done in situ, where the glass phase which is exuded from the refractory builds an external layer on the refractory surface. It does not give rise to further oxidation reaction after an appropriate time of conditioning, so that there is no further bubble formation. If this treatment were not be made in situ, then the refractories, which were bound together had to be broken in order to take them out of the furnace. The two methods of oxidation disclosed in the last paragraph of the description of the patent in suit corresponded to the practice in the present technical field.

Since electrical heating means in the melting zone was a usual step in the glass melting technical field and did not interact with the refining zone, the use of such heating means as claimed did not bring any particular effect which was not known or not expected by the skilled man.

2. The Respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

The current Claim 1 is based on granted Claim 1 - comprising the subject-matter of the originally filed

Claims 1 and 2 - which have been supplemented by the insertion of the features

(a) "for producing molten glass for use in a flat glass forming process such as a float process" after the word "tank" at line 1 of the granted Claim 1,

(b) "being a uniflow refining zone through which glass flows in" after the wording "the refining zone" at line 2 of granted Claim 1 replacing the words "providing a", which requires the deletion of the wording "wherein the major portion of the glass flow is forwards" at lines 2 and 3 of the granted Claim 1,

(c) "the melting zone (12) is provided with electrical heating electrodes (21) located within the melting zone and arranged to provide at least 15% of the heat required to melt the batch material" immediately after the wording "characterised in that", and

(d) "in position in the refining zone (13)" at line 6 of the granted Claim 1 after the wording "fusion cast and conditioned".

Feature (a) finds its support in the original Claim 14 and feature (c) in original Claim 13 or Claims 13 and 14 of the patent as granted.

By the insertion of feature (b) and subsequent deletion mentioned under point (b) above, the claimed feature relates now to a uniflow stream, so that there is no return flow, instead of claiming "a major portion of the flow". The feature "uniflow" is supported by the description as originally filed, see for example page 4, first full paragraph, lines 3 and 4.

As regards feature (d), the indication of conditioning the refractory in position in the refining zone is disclosed in the application as originally filed at page 5, last paragraph, by the context of the last sentence, i.e. "the cast refractories are provided as a base for the refining zone and (thereafter) the conditioning is achieved by subjecting the refractory ... so that suitable conditioning is achieved before the glass melting tank is used in the production of saleable glass".

Since the amendments are supported by the description and since they also reduce the scope of the protection, the requirements of Articles 123(2) and (3) EPC are fulfilled.

3. *Novelty*

As far as the available prior art documents are concerned, the Board is satisfied that none of them discloses a glass melting tank comprising all the features described in Claim 1. In any event, novelty has not been disputed.

Therefore the subject-matter of Claim 1 is novel and meets the requirements of Article 54 EPC.

4. *State of the art*

Document D10 discloses a glass melting tank which comprises a melting zone for melting batch material to form molten glass and a refining zone for refining the molten glass, the refining zone being a uniflow refining zone through which glass flows in a shallow flow path away from the melting zone (see page 22; Figure 1(c), the charge (1), the diagram (4) of the velocities of the molten glass in the refining zone, the length (L) of the

refining zone and the thickness (h) of layers of molten glass in the refining zone). At page 23, last paragraph, it is set out that "Fining in a **thin layer**, provided that natural convection is eliminated and the molten glass moves **only in the production flow** (see Fig. 1(c)) should be considered the optimal method of intensifying fining".

The Appellant argued that this furnace does not relate to the production of molten glass for use in a flat glass forming process such as float process, since there is no comparison between the high quality of such molten glass (according to the European patent) and the lower quality of green and semi-white glass containers as disclosed on page 21, first paragraph of document D10. The Board notes that the quoted field of application of the known furnace (first line of page 21) is "**especially**" in the production of green and semi-white glass which cannot be interpreted as "exclusively". Instead, the field of application includes the production of high quality glass, see page 23, first paragraph, which reads: "For many types of glassware, the content of glass inclusions is strictly limited or is **completely impermissible** ...".

It can also be taken from document D10 that the data relating to the output of molten glass and of the dimensions of the basin (see paragraph 3 of page 23, output 100 tonnes/day and the various dimensions, for example, basin of 6 m width) are in the order of those mentioned in the description of the present European patent as indicated at page 4, line 29 ("output in the order of 500 tonnes or more per week), or page 5, lines 4 and 5 (output between 500 and 6000 tonnes per week) and lines 21 and 22 for the dimensions (melting zone of 10 m width).

The Board is convinced that the melting tank known from document D10 firstly is intended for producing not only green and semi-white glass containers but also for glass products of high quality and secondly is adapted for the production of a large quantity of molten glass as required in a flat glass forming process such as a float process.

This document D10 reflects therefore a glass melting tank in the sense of the preamble of Claim 1. It does not contain any information about the refractory or the heating of the melting tank mentioned in the characterising part of Claim 1.

None of the other documents discloses a glass melting tank as specified in the preamble of Claim 1.

5. *Inventive step*

5.1 The Board is convinced that the glass melting tank according to document D10 is necessarily fitted with refractories. The skilled man operating this glass melting tank may note that defects such as bubbles of gas and particles of refractories may appear, depending upon the operating conditions. He is aware that the temperature of the refractory at the base of the shallow path refiner is higher than the temperature of the refractory of a deeper path refiner where substantial return flow occurs.

According to the description of the patent in suit (see page 3, lines 12 to 30), a solution which avoided these defects, when the interface temperature is as high as 1430°C to 1450°C, was known before the priority date of the European patent, which solution consisted in providing a layer of molten metal such as tin at the

base of a refining zone, but there were problems to be solved in containing and maintaining molten metal within the refining zone.

Therefore, the problem to be solved with respect to the glass melting tank known from document D10 is to develop such a tank whose base of the refining zone does not give rise to defects such as bubbles of gas or particles of refractory at a high temperature of 1430 to 1450°C. The solution should not give rise to difficult problems in containing and maintaining molten metal within the refining zone.

The Board is of the opinion this is achieved by the following features mentioned in the characterising part of Claim 1, that the base of the refining zone is formed of a refractory material comprising alumina, silica and between 31% and 43% by weight of zirconia, the refractory material being fusion cast and conditioned in position in the refining zone (in situ) by oxidation in contact with the molten glass at a temperature of at least 1450°C for a period of at least 24 hours.

5.2 Document D1 discloses a method of treatment of an electro-cast brick or refractory based on alumina, silica and zirconia having a high glass phase content (i.e. above 10%), in which the refractory has a good corrosion resistance. The refractory is heated for a long period in an oxidising atmosphere at high temperature. The treated or conditioned refractory is used for lining a glass fusion tank in order to minimise blistering or bubble formation without affecting the corrosion resistance of the refractory (see page 2 of the translation of document D1, first and second paragraphs).

This is a clear hint to the skilled man of the technical field of molten glass to consider the teaching of document D1 in order to avoid the defects caused by bubbles in the product obtained when operating the molten glass tank known from document D10.

5.3 The Appellant argued that document D1 did not give a clear teaching, since there was a "complete ambiguity between the description which refers to heat treatment for 72 hours at 160°C and the claim which refers to heating for over 24 hours at over 1400°C". Therefore, document D1 "cannot possibly form a basis of an attack on the inventive step of the present invention".

However, the whole description makes it clear that the teaching of the method according to document D1 relies on a treatment for a long period at **high temperature.** The skilled man reading the value of 160°C for heating the refractory would not consider it a high temperature in the field of molten glass. It is known that oxidising of the impurities in the glass phase - and therefore the appearance of the bubbles - cannot significantly take place at such a temperature of 160°C.

The ambiguity underlined by the Appellant is removed by consideration of the minimum value of the temperature indicated in Claim 1 of document D1. The value of "over 1400°C" is in line with the concept of a high temperature in the glass melting technology. Furthermore, from the documents dealing with the formation of gas bubbles in the refractory material used in glass melting technology, it is known that this refractory material having a glass phase of about 15 to 21% has a content of zirconia which falls within the range of 31% to 43% as mentioned in Claim 1 of the patent. Since the refractory material according to document D1 has also a glass phase of over 10%, it is

clear that its chemical composition corresponds to those which are used at high temperature in a glass melting tank (see documents D2, page 393 (Table 1); D3, page 323 (Figure 3a); D5, pages 200, 201 (Table 1) and 202 (paragraph 4)).

The Board is therefore of the opinion that the temperature of "over 1400°C" is the realistic value which corresponds to what has to be understood from the whole context of the document D1.

5.4 Document D1 also contains information about the formation of bubbles and about the improvement of the refractory. Thus, bubbles are the result of the oxidation of the impurities contained in the glass phase of the refractory when the **electrocast** brick or refractory which has been **fusion-cast** is in contact with the molten glass. Once most of the impurities have been transformed into oxides, the impurities for the reaction of oxidation are no longer available and the rate of evolution of bubbles is reduced, (see translation of document D1, page 1, last paragraph; page 2, first, second and third paragraphs).

From the above information, the skilled man knows that alumina-silica-zirconia refractory which is used at high temperatures has to be heat treated when the temperature is raised to such an extent that unallowable bubble formation occurs. After heat treatment of the refractory, the oxidation no longer significantly takes place. Since the heat treated refractory according to the teaching of document D1 has not only been improved as regards the reduction of bubble formation but further its erosion resistance has not been impaired, the skilled man finds a very plausible solution to the problem set out above, and this without using a metal liner.

Therefore it is obvious to the skilled man to apply the teaching of document D1, namely oxidising the refractory by heat treatment, in a glass melting tank according to document D10 when he realises that bubble formation arises at a temperature of 1430°-1450°C.

5.5 The argumentation of the Appellant that document D2 (see page 393, left hand column) mentions that exudation and bubble formation could not be avoided altogether, especially at temperatures above 1350°C, does not support the inventive step of Claim 1. It is clear that exudation and bubble formation could not be avoided as a consequence of reactions occurring at high temperature. But in view of the prior art the skilled man will not only consider the teaching of document D2 when exudation and bubble formation occur at 1350°C. Instead, knowing that document D1 deals with the problem of reduction of bubble formation, he would proceed to the oxidation of the impurities in the manner set out in document D1.

5.6 Oxidation of the impurities occurs at high temperature with the formation of aluminium oxide, silicon dioxide and zirconium dioxide by the presence of **oxygen which is abundant** in molten glass (see document D1, page 1 of the translation). It is further well-known that oxidation by the molten glass is more efficient than by air (see for example document D4, page 308, fifth paragraph).

During the oxidation, the glass phase also exudes from the refractory and forms a **layer** which

- flows over the refractory so that all the interstices of the refractory are covered by the exuded glass phase and since the liquid layer may have a higher

density than the molten glass, it remains at the bottom of the glass melting tank even in the presence of molten glass, and

- provides a protective layer against corrosion (see document D5, page 200, lines 3 and 4 of the summary; page 201, left column, last paragraph; document D3, page 324, bridging paragraph of left and right columns).

On the basis of the above information the Board agrees with the Respondent as regards the practices in the different methods of oxidation. Oxidation by air requires a long duration of heat treatment and is more appropriate for treatment of small quantities of bricks or refractory, whereas oxidation by contact with molten glass in a furnace is faster and more efficient (see document D3, page 327, left hand column, second complete paragraph), but in practice renders it impossible to take the bricks away after heat treatment without crushing them, because they are firmly bonded to each other by the cooled exuded glass phase between the bricks.

For the skilled man, the feature of fusion casting and conditioning the refractory in the refining zone of a glass melting tank by oxidation in contact with molten glass follows therefore logically from the known glass melting technology.

5.7 As far as the heating electrodes provided in the melting zone as the other feature in the characterising portion of Claim 1 are concerned, the use of electrodes in the melting zone as additional heating means is well known. Such heating means are not usually attractive from the energy point of view, but can sometimes be economically desirable. This advantage is based on an increase of the

melting efficiency and on an improvement of glass quality (see for example document D7: page 181, English abstract, right column, 2nd paragraph; page 185, 1st paragraph of point 7; page 187, 2nd paragraph of point 7.2).

No effects of using electrical heating means on the preventing of the formation of bubbles or corrosion of the refractory in the refining zone of a glass molten tank are mentioned in the description of the patent in suit. The description dealing with electrical heating means (page 4, lines 23 to 27, lines 29 to 40) relates to phenomena concerning the melting of glass. Therefore, this feature can only be regarded by the skilled man as an obvious alternative to gas or oil firing as mentioned in the description of the patent in suit which is not connected with the defects mentioned in the description of the patent in suit.

5.10 It follows from the above that the subject-matter of Claim 1 does not involve an inventive step (Article 56 EPC) and is thus not patentable under Article 52(1) EPC.

6. Consequently, the patent cannot be maintained.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Fabiani H. Geidenschwarz

ANNEX I

D1 = JP-PS-77 025 403-B

D2 = "Über die Ursache des Glasaustritts und der Blasenbildung an schmelzgegossenen Steinen bei hohen Temparaturen", H. Meyer, H. Poehnitzsch, Glastechnische Berichte, 38. Jahrgang, Oktober 1965, Heft 10, pages 393 to 397

D3 = "Bestimmung der Korrosionsrate von feuerfesten Baustoffen durch Glasschmelze bei freier laminarer Dichte- und Grenzflächenkonvektion", M. Dunkl, R. Brückner, Glastechnische Berichte 53 (1980) Nr. 12, pages 321 to 328

D4 = "Des essais de bullage sur les matériaux réfractaires électrofondus", A. Auerbach, Symposium Elaboration du verre, Meeting date 1973, pages 295 to 312 Union Sci. Cont. Verre, Secr.: Charleroi, Belg.

D5 = "Über die Glasphase in schmelzflüssig gegossenen Aluminiumoxyd-Zirkonoxydsteinen", O. Schmid, Glastechnische Berichte 38 (1965), Heft 5, pages 200 to 206

D6 = "Einfluß der Badtiefe und des Durchsatzes auf die Strömungen in der Glasschmelzwanne", G. Leyens, Glastechnische Berichte 55 (1982) Nr. 5, pages 81 to 87

D7 = "Wärmewirtschaft des Glasschmelzofens im Bereich des Glasbades und des Wannenbeckens - Verbesserungsmöglichkeiten", W. Trier, Glastechnische Berichte, 48. Jahrgang, Heft 9, September 1975

D8 = GB-PS-1 533 979

D9 = "Improving the construction and thermal conditions of a constinuous furnace for melting decolorized glass", V.A. Sibiryakov, L.P. Lebedeva, B.M. Shalunov, A.P. Pronin, Glass and Ceramic, Vol. 35 (1979), pages 317 to 320

D10 = "Bubbling and fining molten glass in continuous tank furnaces", K.A. Pchelyakov, V.A. Sibiryakov, and V.A. Astanin, Glass and Ceramic, Vol. 30 (1973), N. 1-2, pages 21 - 24

D11 = "Wannenbecken und Durchlaß von Glasschmelzöfen", K. Schmidt, Glastechnische Berichte 32 (1959), Heft 6, pages 217-221