

Internal distribution code:

- (A) Publication in OJ
(B) To Chairmen and Members
(C) To Chairmen
(D) No distribution

**Datasheet for the decision
of 26 June 2008**

Case Number: T 0283/06 - 3.2.07
Application Number: 01302596.0
Publication Number: 1136451
IPC: C03B 5/235
Language of the proceedings: EN

Title of invention:

Glass melting process and furnace therefor with oxy-fuel combustion over melting zone and air-fuel combustion over fining zone

Patentee:

AIR PRODUCTS AND CHEMICALS, INC.

Opponent:

Pilkington Group Limited
L'AIR LIQUIDE S.A.

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56, 84, 100(a), 100(b)

Relevant legal provisions (EPC 1973):

-

Keyword:

"Insufficiency - no"
"Novelty - yes"
"Inventive step - no"

Decisions cited:

-

Catchword:

-



Case Number: T 0283/06 - 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 26 June 2008

Appellant: Pilkington Group Limited
(Opponent I) Prescott Road
St. Helens
Merseyside WA10 3TT (GB)

Representative: Jenkins, Peter David
Page White & Farrer
Bedford House
John Street
London WC1N 2BF (GB)

Appellant: L'AIR LIQUIDE S.A.
(Opponent II) 75, Quai d'Orsay
F-75321 Paris Cedex 07 (FR)

Representative: Conan, Phillipe Claude
L'AIR LIQUIDE
D.S.P.I.
75, quai d'Orsay
F-75321 Paris Cedex 07 (FR)

Appellant: AIR PRODUCTS AND CHEMICALS, INC.
(Patent Proprietor) 7201 Hamilton Boulevard
Allentown, PA 18195-1501 (US)

Representative: Burford, Anthony Frederick
Beck Greener
Fulwood House
12 Fulwood Place
London WC1V 6HR (GB)

Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
04 January 2006 concerning maintenance of
European patent No. 1136451 in amended form.

Composition of the Board:

Chairman: H.-P. Felgenhauer
Members: P. O'Reilly
E. Dufrasne

Summary of Facts and Submissions

- I. Opposition was filed against European patent No. 1 136 451 as a whole based on Article 100(a) EPC (lack of novelty and lack of inventive step) and Article 100(b) EPC (insufficiency of disclosure).

The opposition division decided to maintain the patent in amended form. It held that (i) the amendments to the patent made in accordance with the main request complied with Rule 57a EPC 1973, (ii) the invention according to the main request and the second auxiliary request was sufficiently disclosed, (iii) the subject-matter of claim 1 of the main request was not novel, and (iv) the subject-matter of claims 1 and 12 of the second auxiliary request was novel and involved an inventive step. The first auxiliary request had been withdrawn during the opposition proceedings.

- II. The proprietor (hereinafter appellant/proprietor), opponent I (hereinafter appellant/opponent I) and opponent II (hereinafter appellant/opponent II) each filed an appeal against that decision.
- III. The appellant/proprietor requested that the decision under appeal be set aside and that the patent be maintained on the basis of the main request filed with letter dated 6 April 2006, or alternatively on the basis of the set of claims according to the third, the first or the second auxiliary requests filed with letter dated 20 November 2006 in that order. The fourth and fifth auxiliary requests filed with letter dated 23 May 2008 were withdrawn.

Appellant/opponents I and II each requested that the decision under appeal be set aside and the patent be revoked.

IV. The independent claims of the **main request** read as follows:

"1. A process for melting glass forming ingredients in a furnace (140; 200) having a charging end (144), a discharge end (142), a melting zone (184; 236) adjacent the charging end (144), containing significant unmelted batch solids floating on the surface of the molten glass bath, and a fining zone (170; 270) adjacent the discharge end (142), not containing significant unmelted batch solids floating on the surface of the molten glass bath, wherein the glass forming ingredients are introduced into the melting zone (184; 236), travel along a path from the melting zone (184; 236) to the fining zone (170; 270) and are withdrawn as molten glass from the fining zone (170; 270); and providing combustion energy as required over both the melting zone (184; 236) and the fining zone (170; 270); characterized in that:

- (i) the majority of the combustion energy over the melting zone (184; 236) is provided by oxy-fuel combustion, where the oxidant stream is between 50 and 100% oxygen, providing an oxy-fuel combustion flame (172-184; 238-248) directed toward the glass forming ingredients at an angle between 0 and 30° to the horizontal; and
- (ii) the majority of the combustion energy (164-168; 224-234) over the fining zone (170; 270) is provided by air-fuel combustion, where the oxidant stream is between 21% and 30% oxygen."

"14. A furnace for melting glass forming ingredients by a process of Claim 1 comprising:

(a) a charging end (144), a discharge end (142), a melting zone (184; 236) adjacent the charging end (144), and a fining zone (170; 270) adjacent the discharge end (142);

(b) means for introducing the glass forming ingredients into the melting zone (184; 236);

(c) means for withdrawing the glass forming ingredients as molten glass from the fining zone (170; 270);

(d) means for providing combustion energy (172-184; 238-248) over the melting zone (184; 236); and

(e) means for providing combustion energy (164-168; 224-234) over the fining zone (170; 270),

characterized in that:

(i) said means for providing combustion energy over the melting zone (184; 236) provides a majority of the combustion energy (172-184; 238-248) by oxy-fuel combustion by directing the oxy-fuel combustion flame (172-184; 238-248) toward the glass forming ingredients at an angle between 0° and 30° to the horizontal; and

(ii) said means for providing combustion energy over the fining zone (170; 270) provides a majority of the combustion energy (164-168; 224-234) by air-fuel combustion."

The **first auxiliary request** (filed as third auxiliary request) contains claim 1 of the main request as its only independent claim.

The independent claims of the **second auxiliary request** (filed as first auxiliary request) read as follows

(amendments when compared to the independent claims of the **main request** are depicted in bold or struck through):

"1. A process for melting glass forming ingredients in a furnace (140; 200) having a charging end (144), a discharge end (142), a melting zone (184; 236) adjacent the charging end (144), containing significant unmelted batch solids floating on the surface of the molten glass bath, and a fining zone (170; 270) adjacent the discharge end (142), not containing significant unmelted batch solids floating on the surface of the molten glass bath, wherein the glass forming ingredients are introduced into the melting zone (184; 236), travel along a path from the melting zone (184; 236) to the fining zone (170; 270) and are withdrawn as molten glass from the fining zone (170; 270); and providing combustion energy as required over both the melting zone (184; 236) and the fining zone (170; 270); characterized in that:

(i) the majority of the combustion energy over the melting zone (184; 236) is provided by oxy-fuel combustion, where the oxidant stream is between 50 and 100% oxygen, providing an oxy-fuel combustion flame (172-184; 238-248) directed toward the glass forming ingredients at an angle between 0 and 30° to the horizontal; and

(ii) ~~the majority~~ **greater than 70% and up to and including 100% of the combustion energy** of the combustion energy (164-168; 224-234) over the fining zone (170; 270) is provided by air-fuel combustion, where the oxidant stream is between 21% and 30% oxygen."

"134. A furnace for melting glass forming ingredients by a process of Claim 1 comprising:

- (a) a charging end (144), a discharge end (142), a melting zone (184; 236) adjacent the charging end (144), and a fining zone (170; 270) adjacent the discharge end (142);
- (b) means for introducing the glass forming ingredients into the melting zone (184; 236);
- (c) means for withdrawing the glass forming ingredients as molten glass from the fining zone (170; 270);
- (d) means for providing combustion energy (172-184; 238-248) over the melting zone (184; 236); and
- (e) means for providing combustion energy (164-168; 224-234) over the fining zone (170; 270), characterized in that:
 - (i) said means for providing combustion energy over the melting zone (184; 236) provides a majority of the combustion energy (172-184; 238-248) by oxy-fuel combustion by directing the oxy-fuel combustion flame (172-184; 238-248) toward the glass forming ingredients at an angle between 0° and 30° to the horizontal; and
 - (ii) said means for providing combustion energy over the fining zone (170; 270) provides **greater than 70% and up to and including 100%** ~~a majority~~ of the combustion energy (164-168; 224-234) by air-fuel combustion."

The independent claims of the **third auxiliary request** (filed as second auxiliary request) read as follows (amendments when compared to the independent claims of the **first auxiliary request** are depicted in bold or struck through):

"1. A process for melting glass forming ingredients in a furnace (140; 200) having a charging end (144), a discharge end (142), a melting zone (184; 236) adjacent the charging end (144), containing significant unmelted

batch solids floating on the surface of the molten glass bath, and a fining zone (170; 270) adjacent the discharge end (142), not containing significant unmelted batch solids floating on the surface of the molten glass bath, wherein the glass forming ingredients are introduced into the melting zone (184; 236), travel along a path from the melting zone (184; 236) to the fining zone (170; 270) and are withdrawn as molten glass from the fining zone (170; 270); and providing combustion energy as required over both the melting zone (184; 236) and the fining zone (170; 270); characterized in that:

- (i) ~~the majority~~ **greater than 70% and up to and including 100%** of the combustion energy over the melting zone (184; 236) is provided by oxy-fuel combustion, where the oxidant stream is between 50 and 100% oxygen, providing an oxy-fuel combustion flame (172-184; 238-248) directed toward the glass forming ingredients at an angle between 0 and 30° to the horizontal; and
- (ii) ~~the majority~~ **greater than 70% and up to and including 100% of the combustion energy** the majority of the combustion energy (164-168; 224-234) over the fining zone (170; 270) is provided by air-fuel combustion, where the oxidant stream is between 21% and 30% oxygen."

"~~123~~. A furnace for melting glass forming ingredients by a process of Claim 1 comprising:

- (a) a charging end (144), a discharge end (142), a melting zone (184; 236) adjacent the charging end (144), and a fining zone (170; 270) adjacent the discharge end (142);
- (b) means for introducing the glass forming ingredients into the melting zone (184; 236);

(c) means for withdrawing the glass forming ingredients as molten glass from the fining zone (170; 270);

(d) means for providing combustion energy (172-184; 238-248) over the melting zone (184; 236); and

(e) means for providing combustion energy (164-168; 224-234) over the fining zone (170; 270),

characterized in that:

(i) said means for providing combustion energy over the melting zone (184; 236) provides ~~a majority~~ **greater than 70% and up to and including 100%** of the combustion energy (172-184; 238-248) by oxy-fuel combustion by directing the oxy-fuel combustion flame (172-184; 238-248) toward the glass forming ingredients at an angle between 0° and 30° to the horizontal; and

(ii) said means for providing combustion energy over the fining zone (170; 270) provides ~~a majority~~ **greater than 70% and up to and including 100%** of the combustion energy (164-168; 224-234) by air-fuel combustion."

V. The documents cited in the present decision are the following:

- D4: "Can partial conversion to oxy-fuel combustion be a solution to furnace problems?", A. McMahon et al, Glass Industry, Dec. 1994, pages 23 - 24
- D5: US-A-4 531 960
- D8: US-A-4 473 388
- D15: US-A-5 586 999
- D16: "Heat Transfer Optimization in TV Glass Furnaces", W. J. Horan, A.. G. Slavejkov and L. L. Chang, Ceram Eng. Sci. Proc., 17, 1996, pages 141 - 151
- D21: "Installation of oxy-fuel and regenerative ceramic burner firing and its relationship to NO_x/melting

- costs", R.D. Argent et al, Glass Technology, Vol. 36, No. 5, October 1995, pages 142 - 146
- D25: "Handbook of Glass Manufacture", Vol. 1, third edition, 1961, Fay V. Tooley, preface and pages 241 - 255
- D28: "Glass Furnaces Design Construction and Operation", W. Trier, Society of Glass Technology, UK, pages 76 and 77
- D29: "Glass-Making Today", P.J. Doyle, Portcullis Press Redhill, 1979, pages 162 - 163
- D31: "Oxy-fuel boosting maximises productivity", Stephen Hope, Glass, June 1998, pages 170 - 171.

VI. The arguments of the appellant/proprietor may be summarised as follows:

- (i) The arguments of the appellant/opponents against the wording of claim 1 are not directed to the ground of insufficiency but are rather based on lack of clarity which is not a ground of opposition. This ground is therefore not admissible and consequently these arguments are not to be considered.

The skilled person knows the meaning of the term "significant" as used in claim 1 since this is clearly explained in paragraph [0002] of the patent description.

The expression "oxidant stream" as used in claim 1 is clear and can be understood by the skilled person. Streams of fuel and oxidant are intermixed to produce the combustion gas and the relative amounts of both are known which allows the

percentage of oxidant in the stream to be calculated.

The skilled person knows the meaning of the expression "combustion energy" as used in claim 1 since this is clearly explained in paragraph [0031] of the patent description. This is an input parameter and not a measured parameter.

- (ii) The subject-matter of claim 1 of each of the main request and the first auxiliary request is novel.

In the furnace disclosed in D4 there is no indication of the limits of the melting and fining zones and the oxy-fuel burners are partly over the fining zone so that it is not unambiguously disclosed that the majority of the combustion energy over the melting zone is oxy-fuel combustion and that the combustion energy over the fining zone is provided by a majority of air-fuel combustion.

D5 gives no information regarding the amount of oxidant in the oxy-fuel burners. Also the melting zone extends into the area in which there are air-fuel burners as is evident from a consideration of the figures, so that it is not unambiguously disclosed that the majority of the combustion energy over the fining zone is provided by air-fuel combustion.

In D21 there is no indication of the limits of the melting and fining zones so that it is not possible to identify the origin and hence the type

of the combustion energy over these zones. Also the air-fuel combustion is based on regenerative burners so that there may be less than 21% oxygen in the oxidant stream.

- (iii) The subject-matter of claim 1 of each of the main request and the first auxiliary request involves an inventive step.

The problem to be solved is not the one proposed by the appellant/opponents but rather that of providing improved glass quality with no recovery cycle. This is discussed in paragraph [0061] of the patent in suit. The nearest prior art is an oxy-fuel process such as disclosed in D15. Starting from this prior art there is no indication that the skilled person would have considered going back in the direction of air-fuel combustion. In D31 the problems of quality are solved by full oxy-fuel combustion which leads away from the solution proposed in the patent in suit. There is no suggestion in the prior art to go back to air-fuel combustion and to use this only in the fining zone. The combination of the two types of combustion providing the majority of the combustion energy over the respective zones avoids some of the problems associated with oxy-fuel combustion whilst obtaining its advantages.

- (iv) The subject-matter of claim 1 of each of the second and third auxiliary requests involves an inventive step. In claim 1 of the second auxiliary request the percentage of the combustion energy over the fining zone that is provided by air-fuel

combustion is specified to be from 70 to 100%. Additionally in claim 1 of the third auxiliary request the percentage of the combustion energy over the melting zone that is provided by oxy-fuel combustion is specified to be from 70 to 100%. These higher percentages of the respective types of combustion increase the positive effects which have already been described with respect to the subject-matter of the independent claims of the main and first auxiliary requests.

VII. The arguments of appellant/opponent I may be summarised as follows:

- (i) The description of the patent is insufficient. The definition of the melting and fining zones as used in claim 1 is unclear so that the skilled person cannot carry out the invention as he does not know where to position these. In this respect the term "significant", as used to indicate the quantity of unmelted batch solids, is unclear.

The expression "oxidant stream" as used in claim 1 is unclear so that the skilled person would not know how to provide a stream that has the range of oxygen content specified in the claims.

The expression "combustion energy" as used in claim 1 is a parameter that the skilled person does not know how to measure; in particular he would not know how to measure it directly in the furnace.

- (ii) The subject-matter of claim 1 of each the main request and the first auxiliary request lacks novelty over each of D4, D5 and D21. Hereby, it must be taken into account that certain features of the claims as explained in the arguments on insufficiency are not clear and hence cannot be taken into account.

D4 discloses a furnace in which there are oxy-fuel burners at the charge end and air-fuel burners at the discharge end which results in the combustion in the melting zone being predominantly by the oxy-fuel burners and the combustion in the fining zone being predominantly by the air-fuel burners. Although the orientation of the oxy-fuel burners is not stated explicitly it is inevitable that they will be directed downwards in order to be aimed at the batch solids. Also, an oxidant stream of more than 50% is normal for oxy-fuel burners and an oxidant stream of between 21% and 30% is normal for air-fuel burners.

It is clearly visible in the figures of D5 that the melting zone is heated predominantly by oxy-fuel burners and the fining zone by air-fuel burners. It is inevitable that the majority of the combustion energy over the melting zone is provided by the oxy-fuel burners and the majority of the combustion energy over the fining zone is provided by the air-fuel burners whereby it is normal to have an oxidant stream of more than 50% for oxy-fuel burners and an oxidant stream of between 21% and 30% for air-fuel burners. D5

indicates that the oxy-fuel burners are angled downwardly at preferably 10° to 20°.

D21 discloses a furnace with oxy-fuel burners over the first one-third and air-fuel burners over the second two-thirds (see figure 4). Since the melting zone normally covers the first one-third and the fining zone the second two-thirds (see D25, page 243, left hand column, last sentence of top paragraph) this means that the oxy-fuel combustion dominates over the melting zone and the air-fuel combustion dominates over the fining zone. Also, as explained above with respect to D4 and D5, the amounts of the oxy-fuel and air-fuel combustion as well as the percentages of oxygen in the oxidant streams defined in claim 1 are all normal. It is furthermore normal to angle the oxy-fuel burners towards the surface of the batch.

(iii) The subject-matter of claim 1 of each of the main request and the first auxiliary request lacks an inventive step.

Starting from the disclosure of D31 the problem to be solved is to improve further the benefits of oxy-fuel combustion without encountering technical problems in the fining zone.

Since it is known that reboiling can be a problem in the fining zone the skilled person would ensure that the majority of the combustion over the fining zone is by air-fuel combustion. Also, over the melting zone reboiling is not a problem so that the skilled person would also consider

providing the majority of the combustion as oxy-fuel combustion over this zone in order to obtain the benefits of this form of combustion as explained in D31.

- (iv) The subject-matter of claim 1 of each of the second and third auxiliary requests lacks an inventive step.

There is no significance in the value of more than 70% for the percentage of the combustion energy over the melting zone being oxy-fuel combustion and over the fining zone being air-fuel combustion so that the arguments already made against the main request and the first auxiliary request also apply to claim 1 of these requests.

VII. The arguments of appellant/opponent II may be summarised as follows:

- (i) With regard to insufficiency the arguments of appellant/opponent I are agreed with.
- (ii) With regard to lack of novelty of claim 1 of each of the main request and the first auxiliary request the arguments of appellant/opponent I are agreed with. In particular, D5 shows all the features of these claims. It should be noted that the presence of clods is not excluded in a fining zone and that industrial oxy-fuel burners have an oxidant stream of 90-100%.
- (iii) With regard to lack of inventive step the subject-matter of claim 1 of each the main request and the

first auxiliary request appellant/opponent II agrees with the arguments of appellant/opponent I. In addition, appellant/opponent II notes that D31 teaches to go to full oxy-fuel combustion for the melting zone and D16 explains why to stop oxy-fuel combustion at the fining zone, i.e. to avoid reboiling problems so that from the teaching of these documents the skilled person is led to the subject-matter of claim 1.

- (iv) With regard to the subject-matter of claim 1 of each of the second and third auxiliary requests there is no significance in the value of more than 70% so that the arguments already made against the main request and the first auxiliary request also apply to claim 1 of these requests.

Reasons for the Decision

Main request

1. *Insufficiency and the interpretation of the claims*

- 1.1 The appellant/opponents argued that some of the terms of the independent claims are so unclear that the person skilled in the art could not carry out the invention defined therein.

The appellant/proprietor considered that the arguments related to clarity in the sense of Article 84 EPC and hence not to an opposition ground, whereas the appellant/opponents considered that the arguments

related to insufficiency in the sense of Article 100(b) EPC and hence to an **admissible** opposition ground.

It is not necessary to decide to which ground the arguments relate since the Board has in any case come to the conclusion that the invention as defined in the claims can be carried out by the person skilled in the art as is explained below.

- 1.2 The main point of controversy was the definition in claim 1 of the melting and fining zones. These zones are well known in the art though they may not have an exact definition. According to the claim the melting zone is the one "containing significant unmelted batch solids floating on the surface of the molten glass bath" whereas the fining zone is the one "**not** containing significant unmelted batch solids floating on the surface of the molten glass bath" (emphasis added by the Board). According to the appellant/opponents the term "significant" is not clear with the result that the skilled person will not know when he is carrying out the invention (cf. Article 100(b) EPC).

The Board cannot agree with the appellant/opponents in this respect. It is correct that the patent gives no detailed information, e.g. numerical information, as to what exactly constitutes a significant amount of unmelted batch solids. However, in column 1, lines 27 to 31 there is a further explanation of the fining zone in that it is stated that "Foam or scum may be present on the surface of the molten glass bath in the fining zone or it may be clear, termed "mirror surface" glass. In the fining zone glass is homogenized and defects such as bubbles or "seeds" are driven out." From this further

definition of the fining zone it is clear that the term "significant" is meant to mean a very low value which has no discernible effect on the process. This view is consistent with the explanations given in D28 and D29. In any case the term is used to divide the furnace into two zones, i.e. containing or not containing a significant amount of unmelted batch solids, rather than in an absolute sense so that its exact meaning is less important. Moreover, for the purposes of deciding whether the skilled person can carry out the invention, an exact definition of this term is not essential. The skilled person can certainly produce furnaces having melting and fining zones according to the teaching of the claims.

- 1.3 The next point in dispute in claim 1 is the meaning of an "oxidant stream". This is a term that is well known in the art and defines the stream of oxidant that is directed at the stream of fuel in order to provide combustion. Again, the skilled person would have no difficulty in providing such a stream within the specified ranges of oxygen since this is standard practice in the art as known from for example D8, see column 3, lines 29 to 40.

- 1.4 The appellant/opponents further argued that the term "combustion energy" as used in claim 1 indicates a parameter that the skilled person could not measure and hence he could not carry out the invention. In particular the appellant/opponents argued that this would have to be measured directly in the furnace and that there was no available method for this measurement. The Board does not agree with the appellant/opponents in this respect. Fuel and oxidant streams are injected into

the furnace at known positions in known directions and in known amounts. This is necessary in order to operate the furnace in an intended manner, e.g. if stoichiometric or non-stoichiometric amounts of fuel and oxidant are required. Given this information the skilled person can calculate the combustion energy in connection with the oxidant stream over the differing zones. The combustion energy is thus an input parameter as was stated by the appellant/proprietor and not a parameter to be measured as suggested by the appellant/opponents.

1.5 The Board concludes therefore that the skilled person can carry out the invention as set out in claim 1 in the sense of Article 100(b) EPC.

2. *Novelty*

2.1 The principal line of attack of the appellant/opponents with respect to the novelty of the subject-matter of claim 1 was based on D5.

In D5 the furnace contains oxy-fuel burners at the charging end and thereafter air-fuel burners. A part of the furnace that is a melting zone is undoubtedly discernible as it is covered by unmolten glass. Also a part of the furnace that is a fining zone is undoubtedly discernible as it contains no clods. The critical question is where the border lies between these two zones. The drawings show clods of unmelted glass in the area of the air-fuel burners. An important question is whether these clods are "significant" in the sense of the patent. Given the size of the clods and taking account of the definition of the fining zone given in the patent description (see above) it is clear that it

cannot be considered that feature (i) of the claim is unambiguously disclosed in the document with regard to the majority of combustion energy over the melting zone being provided by oxy-fuel combustion. The unmelted clods appear to be still of considerable size in the area where the combustion is air-fuel combustion so that it cannot be concluded that the majority of combustion energy over the melting zone is provided by oxy-fuel combustion since the contribution of the air-fuel combustion over this zone is not ascertainable. A further distinguishing feature of claim 1 over the disclosure of D5 is that the oxidant for the oxy-fuel combustion is an oxidant stream containing between 50 and 100% oxygen. Since D5 does not indicate the percentage of oxygen in the oxy-fuel burners it cannot disclose this feature. Nor can this percentage be considered to be implicitly disclosed since, although the range may be the normal one, an oxidant stream containing 35% oxygen can also be considered for oxy-fuel combustion as is indicated in D15, column 3, line 66 to column 4, line 6.

- 2.2 With respect to D21 reference was made to figure 4. The furnace disclosed in this figure has oxy-fuel burners in the first one-third of its length and regenerative burners in the second two-thirds of its length. However, there is no information in the document regarding the positioning of the melting and fining zones. Moreover, D21 does not indicate the oxygen content of the oxidant stream and for the regenerative air-fuel burners this may be less than 21% (see page 145, right hand column, last sentence of the first paragraph) and hence outside the range specified in claim 1. Furthermore, the angle of the oxy-fuel burners to the horizontal is not

indicated so that this feature of claim 1 is also not disclosed.

2.3 The disclosure of D4 does not go beyond that of D21 so that also this document does not disclose all the features of claim 1.

2.4 Therefore, the subject-matter of claim 1 of the main request is novel in the sense of Article 54 EPC.

3. *Inventive step*

3.1 The closest prior art document according to the appellant/opponents is D31 and this was not contested by the appellant/proprietor. This document explains why oxy-fuel burners should be used over the melting zone.

3.2 The process according to claim 1 is distinguished over the disclosure of D31 in that (i) the majority of the combustion energy over the melting zone is provided by oxy-fuel combustion, where the oxidant stream is between 50 and 100% oxygen, and that (ii) the majority of the combustion energy over the fining zone is provided by air-fuel combustion, where the oxidant stream is between 21 and 30% oxygen.

3.3 The problem solved by the distinguishing features is to increase further the benefits of oxy-fuel burning without having technical problems in the fining zone.

3.4 It is known that oxy-fuel combustion provides a hotter flame which provides more heat to the furnace (see for instance D16, page 142, second paragraph). This is the

reason why the oxy-fuel combustion is provided at least at the start of the melting zone in D31.

There are also incentives to the skilled person to limit the oxy-fuel combustion to the melting zone. As is explained in D16 (see page 142, second paragraph and figure 1) the higher momentum oxy-fuel flame can lead to surface reboiling of the glass in the fining zone. This is not desirable so that there are known reasons for not providing oxy-fuel combustion over the fining zone.

In D31 it is made clear that there is an advantage in providing the oxy-fuel combustion over the melting zone as a boost (see section entitled "Applying oxy-fuel boost" on page 120). The skilled person would understand that this means that it is advantageous that the fining zone may remain with air-fuel combustion.

D31 leaves it open whether the majority of the combustion energy over the melting zone is provided by oxy-fuel combustion and the majority of the combustion energy over the fining zone is provided by air-fuel combustion. However, it is clear to the skilled person wishing to put the teaching of D31 into practice has to decide how much of the combustion energy over each zone will be of the respective form of combustion. Taking into account the teaching D16 in this respect, it is clear to the skilled person that this is an advantageous way to arrange the provision of the combustion energy in the furnace according to D31.

Also, the teaching of D4 and D21 supports this conclusion. In D4 the conversion of the furnace to oxy-fuel burners described therein started with the charge

end, i.e. the melting zone, (see figure 3) and in D21 the first one-third of the furnace is provided with oxy-fuel burners (see figure 4) and the second two-thirds is provided with regenerative air-fuel burners.

The skilled person considering the implementation of the teaching of D31 would realise that the majority of the combustion over the melting zone should be oxy-fuel combustion and the majority of the combustion over the fining zone should be air-fuel combustion.

Although D31 does not give any specific figure for the percentage of oxidant in the oxy-fuel combustion the value of 50 to 100% is normal in the art as evidenced by D8 (column 3, lines 31 to 35) and D15 (column 4, lines 1 to 6).

Also D31 does not give any specific figure for the percentage of oxidant in the air-fuel combustion. However, the value of 21 to 30% is normal in the art since 21% means nothing more than normal air.

3. Therefore, the subject-matter of claim 1 of the main request does not involve an inventive step in the sense of Article 56 EPC.

First auxiliary request

4. *Novelty and Inventive step*

- 4.1 This request was filed as the third auxiliary request and differs from the main request only in that the apparatus claims have been deleted.

4.2 Since the subject-matter of claim 1 of the main request is novel but lacks an inventive step and claim 1 of this request is identical thereto it follows that the subject-matter of claim 1 of this request also is novel in the sense of Article 54 EPC but lacks an inventive step in the sense of Article 56 EPC.

Second auxiliary request

5. *Inventive step*

5.1 This request was filed as the first auxiliary request. Claim 1 of this request differs from claim 1 of the main request in that the combustion energy provided by air-fuel combustion over the fining zone is defined to be greater than 70% and up to and including 100% of the combustion energy whereas in claim 1 of the main request it was merely defined to be the majority.

5.2 In D31 the majority of the area of the furnace is heated by air-fuel burners since the oxy-fuel burners are only provided at the rear section, i.e. the melting zone (see page 170, left-hand column, last paragraph. The extra feature of claim 1 of this request is not disclosed in D31 since D31 does not give any precise information on this point. Nevertheless, the skilled person when considering D31 would have to make a design choice concerning the amount of the combustion energy over the fining zone that should be provided by air-fuel combustion and would notice that the area over the fining zone only contains air-fuel burners and would hence conclude that far more than the majority of the combustion energy over the fining zone should be provided by the air-fuel burners. There is therefore no

inventive step in providing the furnace disclosed in D31 with this feature. No special effects have been disclosed resulting from the selection of this range.

- 5.3 Therefore, the subject-matter of claim 1 of this request does not involve an inventive step in the sense of Article 56 EPC.

Third auxiliary request

6. *Inventive step*

- 6.1 This request was filed as the second auxiliary request. Claim 1 of this request differs from claim 1 of the present second auxiliary request in that the combustion energy provided by oxy-fuel combustion over the melting zone is defined to be greater than 70% and up to and including 100% of the combustion energy whereas in claim 1 of the preceding requests it was merely defined to be the majority.

- 6.2 D31 does not give any information regarding the percentage of the combustion energy provided by oxy-fuel combustion. Nevertheless, the skilled person when considering D31 would have to make a design choice concerning the amount of the combustion energy over the melting zone that should be provided by oxy-fuel combustion and would notice that oxy-fuel burners are only provided over the melting zone and even though there may be some air-fuel combustion over the melting zone the aim is to provide more than simply the majority of the combustion energy over the melting zone oxy-fuel combustion, whereby the value of more than 70% has not been shown to have any significance. There is therefore

no inventive step in providing the furnace disclosed in D31 with this feature.

- 6.3 Therefore, the subject-matter of claim 1 of this request does not involve an inventive step in the sense of Article 56 EPC.

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:

G. Nachtigall

H.-P. Felgenhauer