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Datasheet for the decision of 9 April 2013

Case Number: T 1279/09 - 3.3.05

Application Number: 00114881.6

Publication Number: 1069071

IPC: C01B 13/11

Language of the proceedings: EN

Title of invention:
Ozone generating apparatus

Applicant:
MITSUBISHI DENKI KABUSHIKI KAISHA

Headword:
Ozone generating/MITSUBISHI

Relevant legal provisions:
EPC Art. 52(1), 54, 56, 76(1), 84, 123(2)

Keyword:
"Amendments allowable under Art. 76(1) and 123(2) EPC (yes)"
"Novelty (yes)"
"Inventive setp (yes): improved method not suggested by prior art"

Decisions cited:
-

Catchword:
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Case Number: T 1279/09 - 3.3.05

D E C I S I O N
of the Technical Board of Appeal 3.3.05
of 9 April 2013

Appellant: (Applicant)
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Decision under appeal:
Decision of the Examining Division of the European Patent Office posted 21 January 2009 refusing European patent application No. 00114881.6 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman: G. Raths
Members: B. Czech
C. Vallet

Summary of Facts and Submissions

I. The appeal is from the decision of the examining division refusing European patent application No. 00114881.6 (referred to as "divisional application" hereinafter). The application at issue is a divisional application from European application No. 95106162.2 (referred to as "parent application" hereinafter).

II. In the contested decision the examining division held *inter alia* that the respective claims 1 according to the two requests then on file were objectionable under Article 76(1) EPC since they referred to an "*energy consumption per gas molecule*" of "***50 Wmin/Nl*** *or more*" (emphasis added by the board). For the examining division, this specific numerical value defining the lower limit of the applicable range of energy consumption values could not be unambiguously derived from the parent application as filed even when considering the graphs depicted in Figure 11 and the corresponding explanations in the description.

III. In its statement of grounds of appeal, the appellant maintained the request refused by the examining division. Under cover of said statement, the appellant also filed two sets of amended claims as auxiliary requests. Relying also on documents filed as Enclosures 1 to 3, it argued that the pending claims met the requirements of Articles 76(1) and 123(2) EPC. Moreover, it held that the claimed subject-matter was novel and inventive.

IV. The appellant was summoned to oral proceedings in accordance with an auxiliary request to this end. In a

communication issued in preparation of the oral proceedings, the board *inter alia* raised objections under Articles 76(1), 123(2) and 84 EPC and Rule 12(4) RPBA concerning the claims according to the pending requests. The board also identified documents of potential relevance in the assessment of novelty and inventive step, namely the following documents cited in the search report:

D1: US 4 213 838 A;

D2: US 4 049 707 A;

D3: A. Szymanski et al.: "Ozone synthesis in a plasma generated in the presence of ferroelectrics"; Chem. Plazmy, 1979, pages 93 - 97 (copy attached to this communication);

D4: JP 55 075905 A;

D5: JP 51 110494 A;

and a document cited in the description of the application in suit (page 7, line 17), namely

D6: Dřímal et al.: "The dependence of ozone generation efficiency in silent discharge on a width of a discharge gap"; Czech. J. Phys. B38 (1988), pages 643 to 648.

V. In response, the appellant filed four sets of amended claims and some amended description pages as further auxiliary requests. It also presented arguments

regarding objections raised by the board and enclosed a "presentation" consisting of five pages printed slides.

VI. Oral proceedings were held on 9 April 2013. In response to concerns expressed by the board with respect to the requests on file, regarding in particular their compliance with Articles 123(2) and 84 EPC, the appellant submitted a single claim as its sole ("main") request, said claim reading as follows:

"*1. An ozone generating method using at least one ozone generating unit including:*
two electrodes (2, 31) mutually opposed to generate discharge in response to high voltage applied therebetween in a discharge space, the discharge space having a discharge gap length of 0.6 mm or less,;
at least one dielectric (4) interposed between the electrodes; and
a gas supply mechanism to supply oxygen gas between the electrodes so as to generate ozone by the discharge;
wherein in the method oxygen gas is supplied from the gas supply mechanism between the two electrodes and a high voltage is applied to the two electrodes;
wherein in the discharge space (5) the oxygen gas has a gas pressure of 1.7 atm or more, and the product pd of the gas pressure and the discharge gap length is about $1.034 \cdot 10^4$ *Pa cm (77.52 Torr cm), or less, and further the energy consumption per gas molecule is set to a value sufficiently high so as to achieve an increased ozone concentration compared to the ozone concentration achieved with a discharge using a gas pressure of 101325 Pa (1 atm) and a discharge gap length of 1.2 mm.*"

VII. Having regard to this request, the appellant essentially argued as follows:

The amended claim met the requirements of Articles 84, 76(1) and 123(2) EPC. The claimed subject-matter was novel and inventive in view of the prior art disclosed by documents D1 to D6. More particularly none of these documents disclosed or suggested a method for generating ozone under the specific conditions recited in claim 1 at issue.

At the oral proceedings, the appellant expressly confirmed that a process as represented by the lowermost curve in figure 11 belonged to the prior art to be considered in the present case in the assessment of inventive step.

VIII. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of claim 1 according to the main request filed at the oral proceedings.

Reasons for the Decision

1. Admissibility of the appellant's request

1.1 The proposed amendments to the claims can be regarded as straightforward attempts to overcome objections raised by the board in its communication and/or at the oral proceedings with respect to one of the auxiliary requests earlier on file, i.e. the second auxiliary request filed under cover of the statement of grounds.

1.2 The board, in the exercise of the discretion conferred on it by Article 13(3) RPBA, thus decided to admit the appellant's new main request to the proceedings despite its late filing.

2. Clarity and support by the description (Article 84 EPC)

2.1 The board is satisfied that the claim at issue is clear and supported by the description (Article 84 EPC).

2.2 More particularly, claim 1 at issue clearly expresses that "*oxygen gas*" is supplied as feed gas to the ozone generating unit, as illustrated by the experiments illustrated by Figure 11 (see the reference to "*O_2 gas*"). The objections raised by the board with regard to the relative and ambiguous expression "*oxygen-**rich** gas*" comprised in the claims previously on file is thus no longer relevant. The skilled person understands without doubt that in the context of claim 1 the expression "*oxygen gas*" refers to a gas that may not contain substantial amounts of other gases besides impurities stemming from its production.

2.3 The newly added features define the minimum "*energy consumption per gas molecule*" to be respected in a functional and relative manner, namely to "*a value sufficiently high so as to achieve an increased ozone concentration compared to the ozone concentration achieved with a discharge using a gas pressure of 101325 Pa (1 atm) and a discharge gap length of 1.2 mm*". The board accepts that these features permit a sufficiently clear distinction between the claimed method(s) according to the invention and methods to be excluded, i.e. the methods falling within the area

defined by and below the lowermost (reference) curve in Figure 11. A skilled person can verify without undue experimentation whether a given process meets the recited requirement of claim 1 in terms of the energy applied and the ozone concentration achieved by comparing it to the reference process.

3. Allowability of the amendments
(Articles 76(1) and 123(2) EPC)

3.1 Amended claim 1 no longer comprises a numerical value defining the minimum energy consumption, as objected to in the decision under appeal. The energy consumption is now defined by comparison to a reference process. The objection that led to the refusal of the application by the examining division, i.e. the non-compliance of the insertion into claim 1, as a range defining minimum value, of a discrete numerical value allegedly derivable from the graph shown in Figure 11, is no longer a relevant issue.

3.2 The board is satisfied that the subject-matter of claim 1 at issue is directly and unambiguously disclosed in both the parent application as filed and the divisional application as filed. More specifically the combination of features recited in claim 1 finds a basis in the following parts thereof (basis in the divisional application indicated in parentheses), which the skilled person reads and considers in conjunction with each other:

i) Page 8, "Summary of the invention" and claim 1 (page 8, "Summary of the invention" and claim 2):

These parts disclose constructional and operating features of the apparatus to be used for the ozone generation, i.e. two opposed electrodes, the dielectric arranged between them, the gas supply mechanism for feeding gas into a discharge gap between the electrodes, and high voltage applied to the electrodes to generate ozone in said discharge gap.

ii) Figure 11 and the corresponding description from page 49, line 8, to page 50, line 10 (Figure 11; page 20, line 8, to page 21, line 10):

The parts disclose ozone generation in an oxygen gas stream within discharge gaps of 0.6 mm, 0.2 mm and 0.1 mm and at a pressure of 1.7 atm (1292 Torr), the corresponding (calculated) pd value being 77.52 Torr · cm or less, as compared to the value of 91.2 Torr · cm for the lowermost reference curve.

From the experimental results displayed in Figure 11, the skilled person immediately gathers that provided the discharge gap is 0.6 mm or smaller, the gas pressure is 1292 Torr, i.e. 1.7 atm, and the Wmin/Nl value is sufficiently high, the process results in a higher ozone concentration in the treated oxygen gas stream, compared to the ozone concentration achieved at the same (high) energy input for a process with d = 1.2 mm and p = 760 Torr, i.e. 1 atm. The limit value of 1.7 atm or 1292 Torr is illustrated by three of the curves shown in Figure 11 and the limit value for the gap size

is illustrated by one example and more generally in the description

iii) Page 48, lines 18 to 26; page 50, lines 14 to 19 (page 19, lines 18 to 26; page 21, lines 14 to 19):

From these parts the skilled person gathers that a relatively higher gas pressure is generally advantageous, and in particular in the case of oxygen gas being fed to a gap of 0.6 mm or less.

iv) Page 51, lines 19 to 23 (page 22, lines 19 to 23):

This passage emphasises the importance of setting the product pd to a sufficiently low value when generating ozone in an oxygen gas stream, the limit value of 77.52 Torr · cm being specifically disclosed in connection with one of the example curves in Figure 11.

v) Finally, in view of Figure 11 and the corresponding parts of the description, the skilled person understands that the higher ozone concentrations aimed for are achieved at relatively higher energy input values provided the gap size, gas pressure and pd values are set as recited in claim 1 at issue.

4. Novelty

4.1 The board is satisfied that none of the prior art documents D1 to D6 discloses directly and unambiguously a method for generating ozone with all the features of present claim 1. As to the specific differences between the disclosures of these documents and the method of

claim 1 at issue, it is referred to points 5.2 and under points below 5.6.2 to 5.6.7.

4.2 The subject-matter of claim 1 is thus novel (Articles 52(1) and 54(1)(2) EPC).

5. Inventive step

5.1 The invention concerns a method for generating ozone by subjecting oxygen gas to electric discharge in a narrow gap formed between two electrodes.

5.2 As to the closest prior art to be considered in the assessment of inventive step, the content of a published document is usually taken as the starting point. However, in the present case the appellant expressly indicated that the process represented by the lowermost curve in Figure 11 of the application in suit belonged to the prior art to be taken into account. The board thus accepts that the closest prior art can be seen in a process for ozone generation by electric discharge in an oxygen gas stream flowing through a gap of 1.2 mm at a pressure of 760 Torr, i.e. 1 atm. This method is characterised by a saturation level in the ozone concentration (of about 100 mg/Nl) that may be achieved with increasing energy input (see also slides 2, 4 and 5 of the explanatory presentation filed by the appellant).

5.3 Starting from such a method, the technical problem can be seen in providing a method for generating ozone in a highly efficient manner, that is in higher concentrations than those achievable by the process

according to the prior art (see also page 8, third paragraph, of the divisional application as filed).

5.4 As a solution to this problem the application now proposes the method of claim 1 at issue, according to which oxygen feed gas is treated under very specific conditions characterised in particular by the following features (emphasis added by the board):
- the discharge space has "*a discharge **gap** length of **0.6 mm or less***";
- "*in the discharge space (5) the oxygen gas has a gas pressure of **1.7 atm** or more*";
- "*the product pd of the gas pressure and the discharge gap length is about **1.034 · 10^{-4} Pa cm** (77.52 Torr · cm), **or less***", and
- "*the **energy consumption** per gas molecule is set to a value **sufficiently high** so as **to achieve an increased ozone concentration compared to** the ozone **concentration achieved with a discharge using a gas pressure of 101325 Pa (1 atm) and a discharge gap length of 1.2 mm***".

5.5 The board is satisfied that the stated technical problem is indeed successfully solved by the method according to claim 1 at issue.

5.5.1 In particular, the data displayed in Figure 11 in conjunction with the corresponding information provided in the description of the application at issue show that under the operating conditions recited in claim 1 regarding the gap width, the oxygen gas pressure and the value of the product pd, an increased ozone concentration is obtained at relatively high energy input (Wmin/Nl) values, compared to the concentration that can be achieved with the prior art method referred

to as comparative basis in claim 1 and represented by the lowermost curve (d:1.2 mm / p:760 Torr).

5.5.2 More particularly the curves in Figure 11 show that both an increase in pressure and a decrease of the gap size lead to an increase of the ozone concentration achieved at higher energy input values. This is visualised by the curves for runs at higher pressure and smaller gap sizes bifurcating from the lowermost curve (prior art). Hence, considering also the explanations of the underlying phenomenon given in Figures 12 and 13 in conjunction with description pages 21 and 22, it is plausible that the curves corresponding to the process carried out in a gap of 0.6 mm or less **and** at a pressure of 1292 Torr, i.e. 1.7 atm, or more would be located above the reference curve for d = 0.6 mm and p = 1292 Torr and would thus result in higher ozone concentrations for energy input values superior to the value at which the lowermost reference curve bifurcates from the other curves displayed.

5.6 What remains to be assessed is whether or not, starting from a method according to the closest prior art (point 5.2 above), a process as claimed is obvious in the light of the prior art.

5.6.1 The board is satisfied that none of the prior art documents D1 to D6 suggests modifying the process according to the closest prior art by applying the set of conditions in terms of pressure, gap size, pd value and energy input in order to achieve a significant increase in the resulting ozone concentration. More specifically, it can readily be gathered from the following analysis of documents D1 to D6 that none of

them contains a pointer towards the application of the set of conditions according to claim 1 at issue.

5.6.2 Document D1 relates to ozone generation in air or oxygen gas by corona discharge. D1 addresses the possibility of using an inter-electrode spacing d of down to 0.01 inch, i.e. 0254 mm (see e.g. claim 1, in particular column 20, lines 1 and 2; column 6, lines 56 to 61). The product of gas pressure and electrode spacing is addressed and stated to determine the voltage level to be applied (see column 8, lines 55 to 60). In column 13, table I, a general preference for a gap spacing of at least 40 mils, i.e. of about 1 mm, is expressly indicated as being "optimal", inter alia in connection with gas pressures from 15 to 25 psia, i.e. from 1 to 1.7 atm. Only example I of D1, relating to the treatment of oxygen gas, expressly mentions both electrode spacing and pressure values. The reported pressure values are 2.00 and 1.87 atm (see table II). However, the indicated electrode spacing (1 mm or 1.5 mm; see column 17, lines 2 to 3 and line 38) is much higher than the maximum value of 0.6 mm recited in claim 1 at issue. As a consequence, the values of the product pd is also outside the claimed range. Moreover, the achieved ozone concentrations (see table II: 0.5 wt.%) are much lower than the ones obtained achievable when carrying out the process according to claim 1 (compare to Figure 11 of the application in suit, y-axis values).

5.6.3 D2 also relates to an apparatus for ozone generation by means of corona discharge in oxygen or an oxygen containing gas. Gap sizes down to 0.010 inches, i.e. to about 0.25 mm, are mentioned (see column 1, lines 24 to

32; column 10, lines 6 to 14). However, D2 contains no specific indications concerning oxygen pressures to be applied, let alone concerning values of the product pd to be respected or the minimum energy input.

5.6.4 Document D3 (see the abstract in English and figures 1 and 2, tables 1 and 2, of the original document) discloses the synthesis of ozone in an oxygen stream, the method comprising the generation of plasma using an inter-electrode distance d in the range of from 0.2 to 0.6 mm. However, D3 does not disclose the oxygen gas pressure in the gap, let alone a gas pressure p of 1.7 atm or more, and pays no attention to the value of product pd. Moreover, the values indicated regarding applied energy input per volume and time (see tables 1 and 2, columns 3 and 4) and the achieved ozone yields achieved (tables 1 and 2, rightmost column) appear to be very low compared to those implicit to the process of claim 1 at issue (compare to Figure 11 of the application in suit).

5.6.5 Document D4 (see the English PAJP and WPI abstracts and Figures 3 to 6 of the document in Japanese) discloses the generation of ozone in a oxygen containing gas stream using silent discharge and pays attention to the product pd of pressure and gap size. However, as confirmed by the appellant at the oral proceedings, air is mentioned as the feed gas, and the disclosed values for d are in the range of from 1.20 to 4.75 mm (see Figures 3 to 5). The recommended value for the product pd is set in the range of from 150 to 250 cm · mm Hg (see the abstracts), and the lowest pd value disclosed is 93.6 cm mm Hg (see Figure 3). The energy input is low, compared to the value of about 50 Wmin/Nl required

according to Figure 11 of the application in suit) the highest values applied according to D4 being below 0.4 Wh/l (see Figures 3 to 5).

5.6.6 D5 discloses (see the WPI abstract in English and Figures 2 to 5) the generation of ozone in an air stream and also pays attention to the product pd of pressure and gap size. However, as confirmed by the appellant at the oral proceedings, D5 describes the treatment of an air stream. Experimental runs were carried out in gaps with d = 2.3 or 3.7 mm at pressures p of 1, 1.6 or 2 atmospheres, the product pd being 5 mm atm (as indicated in the abstract), i.e. about 0.5 · 760 = 380 cm mm Hg or less.

5.6.7 Document D6 investigates the efficiency of ozone generation in *inter alia* oxygen gas using silent discharge in gaps with d = 3.0 to 0.1 mm (see page 645, Figure 3). However, all experimental runs described in document D6 were carried out at atmospheric pressure (see page 644, section "II. EXPERIMENTAL ARRANGEMENT") and lead to rather low maximum ozone concentrations of up to 30 % · 10^{-3} (see Figure 3), to be compared to the at least about 100 mg/Nl achieved according to Figure 11 of the application in suit. Under said experimental conditions, the optimum gap size was found to be in the range of from 0.8 to 1.1 mm (see page 648, Figure 7 and first subsequent sentence).

5.7 The board concludes that the subject-matter of claim 1 involves an inventive step (Articles 52(1) and 56 EPC).

6. Hence, the appellant's (main) request is allowable.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the main request filed at the oral proceedings and a description and drawings to be adapted where necessary.

The Registrar The Chairman

C. Vodz G. Raths