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Datasheet for the decision of 11 August 2011

Case Number: T 0684/08 - 3.3.05

Application Number: 03795441.9

Publication Number: 1502640

IPC: B01D 39/20

Language of the proceedings: EN

Title of invention:
Honeycomb Structure

Applicant:
IBIDEN CO., LTD.

Opponent:
-

Headword:
Honeycomb structure/IBIDEN CO LTD

Relevant legal provisions:
EPC Art. 54, 56, 123(2)

Relevant legal provisions (EPC 1973):
-

Keyword:
"Added subject-matter (no) - all requests"
"Novelty (yes) - all requests"
"Inventive step - main request and auxiliary request 1 (no) - obvious alternative - auxiliary request 2 (yes) - improvement - technical solution not derivable from prior art"

Decisions cited:
T 0656/90

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0684/08 - 3.3.05

D E C I S I O N
of the Technical Board of Appeal 3.3.05
of 11 August 2011

Appellant: IBIDEN CO., LTD.
1, Kandacho 2-chome
Ogaki-shi
Gifu 503-8004 (JP)

Representative: HOFFMANN EITLE
Patent- und Rechtsanwälte
Arabellastrasse 4
D-81925 München (DE)

Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 22 December 2006 refusing European patent application No. 03795441.9 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. Raths
Members: H. Engl
S. Hoffmann

Summary of Facts and Submissions

I. The appeal is from the decision of the examining division to refuse European patent application EP 03 795 441.9, posted on 22 December 2006.

II. According to the decision of the examining division the closest prior art was represented by document

D4: EP-A-1 142 619.

Said document revealed a honeycomb structural body comprising a plurality of columnar porous ceramic members in which through holes were placed in parallel with one another and partition walls were interposed between them. The problem to be solved by the application under appeal was to provide a honeycomb structural body with increased filtering capacity.

The examining division held that document

D6: DE-A-10 037 403

disclosed the features which distinguished the claimed invention over D4 and that said features had been proposed in D6 for the same purpose of increasing the filtering capacity without increasing the overall filter dimensions. Therefore, the skilled person would have replaced the columnar porous ceramic members of D4 by the ones disclosed in D6 in order to solve the problem posed, and would thus have arrived at the claimed subject-matter.

The examining division remarked that starting from D6 as the closest prior art (as the appellant did), the claimed combination of features taken from D6 and D4 would not give rise to a combined technical effect and was thus a mere non-inventive aggregation of features.

III. Further documents cited during the examination procedure included the following:

D1: JP-A-2001 334 114
D1a: WO-A-02/100 514
D2: US-A-4 276 071
D3: US-A-4 643 749
D7: FR-A-2 789 327
D8: US-A-4 417 908

IV. The notice of appeal of the applicant (henceforth: the appellant) was filed by letter dated 6 February 2007. The statement of grounds of appeal was received under cover of a letter dated 20 April 2007. It was accompanied by two sets of amended claims as a main and an auxiliary request, an amended Figure 9 and by the document

D9: Affidavit of Mr M. Kunieda, dated 19 April 2007.

The appellant requested that Figure 9 be replaced by the amended Figure.

V. The board issued a preliminary communication dated 10 May 2011 in which it informed the appellant that the request to correct Figure 9 of the application as filed was not allowable under Article 123(2) EPC because it

was not immediately apparent that an error existed or what the correction should be.

The appellant itself argued that the verification of the alleged error required performing the experiments following the protocols described for Example 1 and Comparative example 4 in the application (see Mr Kunieda's declaration). This was, in the board's opinion, not reconcilable with the concept of an "immediately recognizable error". The board was furthermore not convinced that nothing else than the proposed solution was apparent.

The board considered D4 as representing the closest prior art because it disclosed a ceramic particulate filter for diesel engines (DPF) having the same "divided structure" consisting of a plurality of columnar porous ceramic members as the present application ("aggregate-type filter"). As the board could not acknowledge an improvement over D4 on the basis of the experimental results provided in the application, the technical problem should be formulated as providing an alternative DPF.

The board saw no prejudice against combining the features of D6 with those of D4 in order to provide an alternative particulate filter. Therefore, the claimed solution did not appear to involve an inventive step.

VI. In response to the said communication of the board, the appellant filed, under cover of a letter dated 11 July 2011, new arguments and new sets of claims as a main request and auxiliary requests I, II and III. These

sets of claims were filed again by the appellant with minor editorial changes on 9 August 2011.

VII. The independent claims 1 in accordance with the main request and auxiliary request I read as follows:

Main request:

"1. A columnar honeycomb structure (10) in which a number of through holes (21, 41, 51, 71, 91) that are placed in parallel with one another in the length direction with partition wall (23, 43, 53, 72 [sic!], 93) interposed therebetween,
wherein

said plurality of through holes (21, 41, 51, 71, 91) comprises:

a group of large-capacity through holes (21a, 41a, 51a, 71a, 91a), with one end thereof being sealed so as to cause the total of areas of cross-section perpendicular to the length direction to become relatively greater; and

a group of small-capacity through holes (21b, 41b, 51b, 71b, 91b), with the other end thereof being sealed so as to cause the total of areas of said cross-section to become relatively smaller,

said columnar honeycomb structure (10) comprising a plurality of columnar porous ceramic members (20, 40, 50, 70, 90), in the columnar porous ceramic member, the respective large-capacity through holes constituting the group of large-capacity through holes (21a, 41a, 51a, 71a, 91a) and small-capacity through holes constituting the group of small-capacity through holes (21b, 41b, 51b, 71b, 91b) constitute a structure wherein cross sections perpendicular to the length

direction of the large-capacity through holes constituting the group of large-capacity through holes occupy a greater area of cross sections perpendicular to the length direction in comparison with the group of small-capacity through holes, with the numbers of the two kinds of through holes being set to the same."

Auxiliary request I:

Claim 1 differs from claim 1 of the main request in that the passage

"partition wall (23, 43, 53, 72, 93) interposed"

is replaced by the passage

"partition wall (23, 43, 53, 7**3**, 93) interposed"

and in that the following passage

"in this columnar honeycomb structure (10), the through holes constituting the group of large-capacity through holes (21a, 41a, 51a, 71a, 91a) and the through holes constituting the group of small-capacity through holes (21b, 41b, 51b, 71b, 91b) are alternately arranged in the longitudinal direction and/or in the lateral direction with a partition wall (23, 43, 53, 73, 93) being interposed therebetween, and the center of gravity of a cross-section perpendicular to the length direction of each of through holes that constitute the group of large-capacity through holes (21a, 41a, 51a, 71a, 91a) and the center of gravity of a cross-section perpendicular to the length direction of each of through holes that constitute the group of small-

capacity through holes (21b, 41b, 51b, 71b, 91b) in each of the directions are located on a straight line"

is added at the end of the claim.

VIII. Oral proceedings were held on 11 August 2011. The appellant filed a new document designated as

Annex A: A graphical representation (in colour) of "Collection Limit" vs. "Aperture Ratio" data, based on Table 1 of the patent application

The appellant furthermore filed a new set of claims as auxiliary request II wherein independent claim 1 now reads:

Auxiliary request II:

"1. A columnar honeycomb structure **(10) for use in an exhaust gas purifying apparatus**, in which **columnar honeycomb structure** a number of through holes **(21, 41, 51, 71, 91)** that are placed in parallel with one another in the length direction with partition wall **(23, 43, 53, 73, 93)** interposed therebetween, wherein

said plurality of through holes **(21, 41, 51, 71, 91)** comprises:

a group of large-capacity through holes **(21a, 41a, 51a, 71a, 91a)**, with one end thereof being sealed so as to cause the total of areas of cross-section perpendicular to the length direction to become relatively greater; and

a group of small-capacity through holes **(21b, 41b, 51b, 71b, 91b)**, with the other end thereof being sealed so as to cause the total of areas of said cross-section to become relatively smaller,

said columnar honeycomb structure **(10)** comprising a plurality of columnar porous ceramic members **(20, 40, 50, 70, 90)**, in the columnar porous ceramic member, the respective large-capacity through holes constituting the group of large-capacity through holes **(21a, 41a, 51a, 71a, 91a)** and small-capacity through holes constituting the group of small-capacity through holes **(21b, 41b, 51b, 71b, 91b)** constitute a structure wherein cross sections perpendicular to the length direction of the large-capacity through holes constituting the group of large-capacity through holes occupy a greater area of cross sections perpendicular to the length direction in comparison with the group of small-capacity through holes, the numbers of the two kinds of through holes being set to the same,

wherein the ratio of the cross-sectional area of the group of large-capacity through holes (21a, 41a, 51a, 71a, 91a) to the cross-sectional area of the group of small-capacity through holes (21b, 41b, 51b, 71b, 91b) is in the range from 2.0 to 2.75."

IX. The arguments of the appellant may be summarized as follows:

D6 should be considered as the closest prior art, because the problem handled by D6 was closer than that of D4. The gist of the claimed invention resided in the discovery that the honeycomb structure having two sub-populations of cells tended to prompt the soot to be piled up unevenly. The heat generated by burning this

unevenly distributed soot in the regeneration step produced early cracks.

Surprisingly, this problem was solved by providing a honeycomb structural body assembled from a plurality of columnar porous members. In such a configuration, thick wall portions at the inlet side disturbed the flow entering the large capacity though holes, reduced the flow rate and led to a more even collection of particulates. As a result, overall pressure loss increase was lower. By assembling a plurality of D6-type filters, the claimed invention thus went against the trend of miniaturizing the filters, for which D6 was conceived.

Table 1 of the description showed that examples 2, 5, 17 and 20, wherein the aperture ratio was set to 2.54, exhibited the highest average collection limit. None of the prior art document could guide a person skilled in the art to a columnar honeycomb structure having such a high collection limit. Document D6 disclosed a higher aperture ratio in the range of from 3 to 4.

Figure 3 of D6 showed a filter having a circular cross-section and 16 small and 13 large through-holes. Such a filter having a circular cross-section could not be easily adapted to the concept of columnar porous ceramic members, which had to have flat faces to allow them to be effectively combined into one assembly.

D4 concerned the different problem of reducing thermal stress generated during use. Another aim of D4 was to reduce the rise width of the pressure loss. These objects were achieved by assembling a plurality of

filters with ceramic sealing layers. However, D4 could not suggest the present invention. D4 was not even combinable with D6 because their technical problems conflicted. According to D4, the outer surfaces of the filter were adhered to one another by means of a ceramic seal layer that would lower filtration capacity. This would go against the task of the present application, which consisted in increasing the collection limit, i.e. in increasing the filtration capacity before regeneration should take place.

With respect to auxiliary request II, the appellant essentially argued that D6 did not disclose the claim feature relating to the ratio of cross-sectional area of the large-capacity through holes to the cross-sectional area of the small-capacity through holes. None of the prior art documents suggested that an aperture ratio in the range claimed in the second auxiliary request would lead to an enhanced filtration capacity. Examples 2, 5, 17 and 20 demonstrated that the honeycomb structures having an aperture ratio of 2.54 had the highest collection limit.

X. Requests

The appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the claims of the main request or the first auxiliary request, both requests filed with letter dated 9 August 2011, or on the basis of claims 1 to 6 of the second auxiliary request filed during the oral proceedings. Further requests were withdrawn.

Reasons for the Decision

1. Amendments (Article 123(2) EPC)

1.1 *Main request*

Claim 1 is based on original claim 1 and the description, page 14, lines 1 to 9, of the application documents as originally filed.

1.2 *Auxiliary request I*

Claim 1 of auxiliary request I is based on original claim 1 and the description, page 14, lines 1 to 9, and page 26, line 25 to page 27, line 1, of the application documents as originally filed.

1.3 *Auxiliary request II*

Claim 1 of auxiliary request II is based on claim 1, 8 and the description, page 17, lines 15 to 23, page 18, lines 16 to 32 and page 8, lines 27 to 29, of the application documents as originally filed. The aperture ratio of 2.0 to 2.75 is disclosed on page 28, lines 27 to 30.

Dependent claims 2 to 6 correspond to original claims 2 to 6.

1.4 The requirements of Article 123(2) EPC are thus met.

2. Novelty (main request, auxiliary requests I and II)

2.1 None of the available documents disclose a honeycomb structure having the claimed combination of features, namely an aggregate-type structure and two sub-populations of through-holes of different cross-section.

D6 discloses a ceramic filter comprising larger-capacity and smaller capacity through holes (i.e. two sub-populations of cells) (see paragraphs [0017] and [0018]; Figure 3). The filter of D6 is of the monolithic type and therefore different from the aggregate-type honeycomb structure claimed in the present application.

D4 discloses a honeycomb filter assembly (9) composed by sealing together a plurality of filter members (F1), each formed from a sintered ceramic body. D4 thus relates to aggregate-type filters. However, the square-shaped through-holes of the filter assembly have a uniform cross-section. D4 thus does not disclose the claim feature according to which the cross sections perpendicular to the length direction of the large-capacity through holes occupy a greater area of cross-sections perpendicular to the length direction of the filter structure, in comparison with the group of small-capacity through holes.

2.2 The board is satisfied that the subject-matter of all the claims of all the pending requests meets the requirements of Article 54 EPC.

3. Inventive step

Main request

3.1 The invention

The invention is concerned a with a columnar honeycomb structure for filtering particulate matter (soot) from the exhaust gases of an internal combustion engine.

The honeycomb structure consists of an assembly of a plurality of columnar porous ceramic members, wherein the total area of the inlet through holes has a cross-sectional area which is larger than the total cross-sectional area of the smaller through holes.

The claimed honeycomb structure may therefore be regarded as an aggregate-type filter, composed of columnar porous ceramic members having two sub-populations of cells (through holes).

The object as set out in the description, page 5, lines 14 to 20, of the application under appeal is to increase the limiting collection amount of particulates (the collection limit), to reduce the pressure loss during use and to reduce fluctuations in pressure loss during fluctuations in the flow rate of the exhaust gases.

3.2 *Closest prior art*

3.2.1 According to the problem-solution approach and to the established practice at the EPO, the closest prior art is normally a document conceived for the same purpose

or aiming at the same objective as the claimed invention and having the most relevant structural features in common. Generally, the closest prior art should deal with the same or a similar technical problem as the claimed invention. However, if there is more than one cited document belonging to the same technical field and technical problem, the closest one is generally the one which is the most promising starting point for making the claimed invention (see T 656/90 of 13 November 1991, Reasons, point 1.1).

3.2.2 The examining division considered document D4 to represent the closest prior art whereas the appellant took document D6 as a starting point for assessing inventive step. The examining division started from D4 because this document disclosed a ceramic particulate filter for diesel engines (DPF) having the same "divided structure" consisting of a plurality of columnar porous ceramic members as the present application ("aggregate-type filter").

The appellant in the appeal brief, pages 14 and 15, point i, started from D6 as the closest prior art, arguing that D6 dealt with the problem of increasing the particulate collection limit and reducing pressure loss, whereas D4 dealt with the problem of mechanical stability.

Starting from D6, the appellant identified three problems emanating from the practical use of this prior art honeycomb structure, namely high overall pressure loss over the whole use period, uneven collection of particulates and sudden increase in back pressure. In the board's view, all these effects are related to the

prior art problems of uneven soot collection and consequential higher overall pressure loss.

The board notes that D4 deals with the technical problem of increasing the mechanical strength of a filter having the same size of through holes (paragraphs [0015] and [0016]), which is achieved by assembling a plurality of such filters with ceramic sealing layers and thus resembles the presently claimed honeycomb structural body. The problem of pressure loss increase is also addressed in D4 (paragraphs [0037], [0155] and [0157] and Table 1).

The board therefore does not see that the examining division erred in selecting D4 as the closest prior art, and therefore starts from D4 for assessing inventive step.

3.3 *Technical problem*

Starting from D4, the technical problem could tentatively be defined as providing a DPF having increased filtering capacity, as expressed by an increased average collection limit.

3.4 *Solution*

The application proposes as a solution to this technical problem a columnar honeycomb structure according to claim 1 of the main request, consisting of a plurality of columnar porous ceramic members each having a plurality of through holes, characterised in that

- said through holes comprise a group of large-capacity through holes and a group of small-capacity through holes, said honeycomb structural body comprising a plurality of columnar porous ceramic members, in the columnar porous ceramic member, the respective large-capacity through holes constituting the group of large-capacity through holes and small-capacity through holes constituting the group of small-capacity through holes constitute a structure wherein cross sections perpendicular to the length direction of the large-capacity through holes constituting the group of large-capacity through holes occupy a greater area of cross sections perpendicular to the length direction in comparison with the group of small-capacity through holes,
- wherein the number of the two kinds of through holes is set to the same.

3.5 *Success of the solution*

It has now to be investigated whether the technical problem has actually been solved.

Examples 1 to 21 illustrating the invention are presented in Table 1 (page 49), to be read in conjunction with the description, page 37 to 48, and the Figures 3 (a) to (h), 7 and 8.

An evaluation of these examples is made in terms of the so-called "collection limit" (g/l) and the "thickness ratio" of the particulates. The collection limit reflects the quantity of particulates collected at the time of occurrence of a crack in the honeycomb structure (see page 48, lines 7 to 18). It is thus

indicative of the filtering capacity of the honeycomb structure. The "thickness ratio of particulates" is determined as described on page 47, line 23 to page 48, line 5 of the application. It measures the evenness of the collection state of the particulates.

In the examples in accordance with the invention, the experimental values found for the said collection limit range from 7.0 g/l (example 15) and 7.1 g/l (example 13) to 9.5 g/l (example 2), depending on the aperture ratio (i.e. the ratio between the cross-sectional area of the group of large-capacity through holes and the cross-sectional area of the group of small-capacity through holes) and the through hole configuration (see Figures 3 (a) to (h), 7 and 8). The thickness ratio of the particulates varies between 0.64 (example 15) and 0.92 (example 1).

In comparison, the honeycomb structure according to comparative example 4 (corresponding to the prior art of D4 and having an aperture ratio of 1.0 [through holes of the same cross sectional area]) exhibits a collection limit of 7.8 g/l, and a thickness ratio of particulates of 0.92. The board notes that these values compare favourably with the less good values of the examples in accordance with the claimed invention.

Therefore, the board cannot acknowledge the presence of an improvement over the closest prior art, either in terms of an increased collection limit (filtering capacity), or in terms of an improved thickness ratio (evenness of particulate collection).

3.6 In view of the above, the problem underlying the patent application under appeal must be re-formulated as providing an alternative honeycomb structure.

3.7 It is plausible in view of the examples provided in the application that this less ambitious problem has indeed been solved.

3.8 *Obviousness*

3.8.1 As mentioned before, D4 discloses a honeycomb filter assembly composed by sealing together a plurality of ceramic filter members. The through holes of the said honeycomb filter assembly have a uniform cross-sectional area.

It has to be decided whether the claimed alternative filter assemblies are obvious in view of other prior art documents.

Document D6 discloses a monolithic ceramic honeycomb particulate filter (DPF) for filtering soot particles from the exhaust gases of an internal combustion engine. The filter is characterised in that the inlet and outlet through holes are of different sizes (i.e. two sub-populations of cells), thereby having the effect of increasing the quantity of collected soot without building up a high back-pressure (see Figures 2 and 3; paragraphs [0006] and [0008]), thereby lengthening the periods between two successive regeneration processes and miniaturizing the filter. D6 thus offers a variant of a honeycomb structure.

The skilled person would combine the features of D6 with those of D4 in view of the problem posed, thereby arriving at an alternative honeycomb structure having the same claimed "divided structure" consisting of a plurality of columnar porous ceramic members as the present application ("aggregate-type filter") and consisting of two groups of through holes (large- and small-capacity through holes).

3.8.2 According to the appellant, D6 and D4 were incompatible because D6 referred to particle filters having a circular cross-section, whereas D4 concerned an assembly formed by bundling and integrating a plurality of columnar filters having cross-sections with one or more flat faces, for instance rectangular or square cross-sections. However, this argument is not convincing, because D4 itself shows ceramic filter assemblies having a circular cross-section similar to D6 (see Figures 2, 13, 15). D4 explicitly teaches how an assembly obtained from rectangular or square ceramic members can be cut and ground to form a round outer cross-section (paragraph [0067]).

The appellant also argued that, even when one combined the disclosures of D6 and D4, one would not arrive at the claimed invention, because neither of the said documents disclosed the claim feature calling for an equal number of through holes of the two kinds (or, in the language of the claim: *"the numbers of the two kinds of through holes being set to the same"*). This particular feature was of importance as it allowed the combination of ceramic members in such a manner that adjacent through holes would always be of a different kind (small or large-capacity) (application,

Figure 3(h)). In accordance with the prior art, such a regular arrangement could not be achieved (see D4, Figure 8) or only by achieved by providing two different kinds of ceramic members.

3.8.3 However, these arguments do not convince the board. Document D4 (page 5, lines 29 and 30) already states that *"among the plurality of cells, about half are opened to the upstream end surface 9a, and the others are opened at the downstream end surface 9b"* (emphasis added). Therefore, D4 teaches employing practically equal numbers of through holes of each kind. Similarly, notwithstanding the specific example of Figure 3, document D6 contains no explicit teaching that the number of through holes of the two kinds should be different.

It is evident that a precisely equal number of cells of each of the two kinds of through holes is mathematically possible only if the total number of cells in each ceramic member is an even number. The embodiments shown in Figure 8, 9, 13 and 15 of D4 all involve a "5 by 5" layout and consequently must result in different numbers of cells open at the upstream and downstream ends, respectively. So, the requirement of an equal number of cells of each kind is not met. However, an alternative "5 by 10" configuration as shown in Figure 10 of D4 would obviously satisfy the through hole number requirement of present claim 1.

The board does not see an important difference between a structure having "about half" of the cells of each kind, and a structure wherein these numbers are precisely equal, particularly given that the total

number of through-holes in a honeycomb filter structure is typically large (several hundreds of holes; see example 1).

The alleged problem of avoiding adjoining through holes of the same kind has already been solved in D4 by the offset arrangement shown in Figure 8.

In any event, the application under appeal as originally filed does not teach why an equal number of through-holes of the two kinds should be of technical relevance. In particular, it does not disclose that this feature was necessary for achieving a regular arrangement of the through holes in the ceramic members. For this reason alone, this claim feature cannot be taken into consideration for assessing the presence of an inventive step.

3.8.4 The appellant argued in writing that the claimed invention was based on the discovery of a yet unrecognized technical problem and therefore may be considered as a "problem invention".

The board is not persuaded by this argument, because it seems to imply that the skilled person would not have been able to detect whatever problem that could be associated with the DPF of D4 or D6. The board is of the opinion that any uneven soot collection taking place during use of the filters of D6 would not go unnoticed by the skilled person, as this required only routine investigation of the filter before and after use.

3.8.5 In view of the above, the subject-matter of claim 1 of the main request does not involve an inventive step (Article 56 EPC).

Auxiliary request I

3.9 Claim 1 of the first auxiliary request differs from claim 1 of the main request in the following additional feature:

"*the through holes constituting the group of large-capacity through holes and the through holes constituting the group of small-capacity through holes are alternately arranged in the longitudinal direction and/or in the lateral direction with a partition wall being interposed therebetween, and the center of gravity of a cross-section perpendicular to the length direction of each of through holes that constitute the group of large-capacity through holes and the center of gravity of a cross-section perpendicular to the length direction of each of through holes that constitute the group of small-capacity through holes in each of the directions are located on a straight line*".

3.10 As before, the closest prior art is represented by D4.

There is no evidence that the added claim feature has a positive influence on the filter performance, in particular on the collection limit. Therefore, the board cannot acknowledge the presence of an improvement having regard to D4. The technical problem thus consists in providing an alternative honeycomb structure.

As the additional claim feature is known from both D4 (see Figure 13) and D6 (see Figure 3), the same arguments on obviousness as those given above (points 3.8.1 to 3.8.4) in connection with claim 1 of the main request apply.

Consequently, the subject-matter of claim 1 of the first auxiliary request does not involve an inventive step (Article 56 EPC).

Auxiliary request II

3.11 As before, the closest prior art is represented by D4.

3.12 *Technical problem*

Starting from D4, the technical problem is defined as providing a filter structure, for use in an exhaust gas purifying apparatus, having increased filtering capacity, as expressed by an increased collection limit.

3.13 *Solution*

The application proposes as a solution to this technical problem a columnar honeycomb structure according to claim 1 of auxiliary request II, consisting of a plurality of columnar porous ceramic members each having a plurality of through holes,

said structure being characterised in particular in that

- the number of the two kinds of through holes is set to the same, and
- **the ratio of the cross-sectional area of the group of large-capacity through holes to the cross-sectional area of the group of small-capacity through holes is in the range from 2.0 to 2.75**.

The claimed invention is thus limited to embodiments having a restricted aperture ratio **in the range from 2.0 to 2.75.**

3.14 *Success of the solution*

In view of the extra limitations in the claim (shown above in **bold**), the invention is now illustrated only by examples 2, 5, 17 and 20 of Table 1 of the application. The examples are again evaluated in terms of the "collection limit" (g/l).

According to Table 1, the average collection limit reaches in fact its highest values, namely 9.5 g/l, 8.8 g/l, 9.3 g/l and 9.0 g/l, respectively, precisely in the aforementioned examples 2, 5, 17 and 20 wherein the aperture ratio is set to 2.54. This value falls in the upper middle part of the claimed range of from 2.0 to 2.75. Examples of columnar honeycomb structures with aperture ratios either lower or higher than the claimed range do not exhibit the high collection limits of the inventive range (for instance example 4: aperture ratio 1.55, collection limit: 7.9; example 6: aperture ratio 4.45, collection limit 8.0). Likewise, in comparative example 4 (corresponding to D4, aperture ratio 1.0) the collection limit is only 7.8 g/l. Monolithic honeycomb structures in accordance with D6 (comparative examples

1, 2 and 3) exhibit a low collection limit (6.1, 7.0, 6.2, respectively) even when the aperture ratio is 2.54.

The question arises whether the claimed range of 2.0 to 2.75 is not unduly broad in view of the single value of 2.54 of examples 2, 5, 17 and 20.

In order to demonstrate that the claimed range was indeed a fair generalization of the results obtained in the above mentioned examples, the appellant provided Annex A, a synoptic graphical representation of data showing curves I, II and III. Each curve is obtained by connecting data points belonging to honeycomb structural bodies of the same type (Figures 3 (a) to (h), 7 and 8). The graphs plausibly suggest that collection limits higher than in the prior art will be found in the immediate vicinity of an aperture ratio of 2.54 singled out by way of the examples. Therefore, in the board's view the claimed range is not unduly broad.

In view of these results, the board can acknowledge the presence of an improvement over the closest prior art of D4 in terms of an increased collection limit (filtering capacity) and in terms of an improved thickness ratio (evenness of the particulate collection).

Consequently, the board is satisfied that the technical problem as formulated above is successfully solved.

3.15 *Obviousness*

It remains to be decided whether the claimed solution is obvious having regard to the prior art.

3.15.1 The skilled person starting from D4 as the closest prior art would, in the board's view, consider the teaching of document D6, in order to improve the filtering capacity.

However, even when combining the disclosures of D6 and D4, one would still not arrive at the invention as defined in claim 1 of auxiliary request II (besides the claim feature relating to the equal number of through holes of the two kinds; see points 3.8.2 and 3.8.3 above). As already noted, D6 expressly teaches an aperture ratio in the range of from 3 to 4 (paragraph [0018]) which is significantly higher than the claimed range of 2.0 to 2.75. The examples and comparative examples of the application under appeal demonstrate however that higher aperture ratios, for instance in the range of from 3 to 4 as suggested by D6, do not lead to an improved collection limit. Therefore, the combination of D4 and D6 cannot provide a solution to the technical problem as defined under point 3.8.

3.15.2 In its appeal brief, pages 14 and 15, point i, the appellant started from document D6 as closest prior art, arguing that D6 dealt with the problem of increasing particulate collection limit and reducing pressure loss, whereas D4 dealt with the problem of mechanical stability.

Starting from D6, the reasoning as outlined under points 3.12 to 3.15.1 would *mutatis mutandis* be essentially the same as before, in view of the fact

that the claimed range of aperture ratios of between 2.0 and 2.75 and its beneficial effect on the collection limit is not disclosed or suggested in either D6 or D4.

3.15.3 The remaining documents do not render the claimed subject-matter obvious either, for the following reasons.

D1 discloses a filter element having different cross-sectional areas of the fluid passages at both end faces (see abstract, Figure; and D1a, Figures 1 and 2). It is therefore similar to document D6. However, there is no disclosure of a preferred aperture ratio range for an increased collection limit.

D3 is concerned with a monolithic ceramic diesel exhaust filter wherein the thickness of the internal walls varies width-wise of the wall (Figures 2, 3 and 4; column 2, line 62 to column 3, line 5). This configuration facilitates uniform carbon particle collection and aims at reducing the pressure loss increase with time (see Figures 6 and 7; column 5, lines 1 to 23). D3 does not disclose two kinds of through holes or different cross-sectional areas of the through holes.

D7 discloses a monolithic ceramic filter with parallel through holes and porous partition walls between them. The through holes have different cross-sections at the entry side and the exit side, for instance as shown in Figures 5 and 7, which decrease along the filter axis in the direction towards their closed end (page 8, line 30 to page 9, line 7; page 9, lines 25 to 31;

Table 1). This design makes it possible to obtain an increased retention volume and a longer service life. D7 does not, however, teach a particular aperture ratio (ratio of cross-sectional areas of the through holes) for the purpose of achieving a high collection limit.

D2 relates to monolithic diesel exhaust particulate filters having openings of uniform cross-section (see Figures 2, 5a to 5p).

D8 relates to monolithic honeycomb filter constructions with various cell geometries, but of uniform cross-sectional shape and area of the through holes. It is therefore not particularly relevant.

3.16 The subject-matter of claim 1 of the second auxiliary request therefore involves an inventive step.

Dependent claims 2 to 6 define particular embodiments of the columnar honeycomb structure of claim 1. These claims derive their patentability from claim 1, on which they depend.

3.17 In summary, claims 1 to 6 of auxiliary request II meet the requirements of Article 56 EPC.

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 claims of the second auxiliary request, filed during the oral proceedings, and a description to be adapted.

The Registrar | The Chairman

C. Vodz | G. Raths