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Case Number: T 1921/07 - 3.2.06

Application Number: 97941879.5

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Title of invention:
Gas flow silencer

Patentee:
Silentor Holding A/S

Opponent:
Scania CV AB

Headword:
-

Relevant legal provisions:
-

Relevant legal provisions (EPC 1973):
EPC Art. 83, 56

Keyword:
"Sufficiency of disclosure (yes)"
"Inventive step (yes)"

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Case Number: T 1921/07 **-** 3.2.06

D E C I S I O N
of the Technical Board of Appeal 3.2.06
of 17 September 2009

Appellant: (Opponent)	Scania CV AB SE-15187 Södertälje (SE)
Representative:	Thum, Bernhard Wuesthoff & Wuesthoff Patent- und Rechtsanwälte Schweigerstrasse 2 D-81541 München (DE)
Respondent: (Patent Proprietor)	Silentor Holding A/S Baldersbuen 22 DK-2640 Hedehusene (DK)
Representative:	Plougmann & Vingtoft A/S Sundkrogsgade 9 P.O. Box 831 DK-2100 Copenhagen Ø (DK)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted 14 September 2007 concerning maintenance of European patent No. 0934457 in amended form.**

Composition of the Board:

Chairman: P. Alting Van Geusau
Members: G. Pricolo
W. Sekretaruk

Summary of Facts and Submissions

I. The appeal stems from the interlocutory decision of the Opposition Division posted on 14 September 2007 maintaining European patent No. 0 934 457 in amended form with claim 1 reading as follows:

"A device for silencing a gas flow directed therethrough and being adapted for installation in a flow system, said device comprising:
- a single casing (7),
- at least two selected chambers contained in the casing, said chambers (1,2) being adapted to have a gas flow therethrough,
- at least one passage (12) interconnecting the at least two chambers, and of a length L and of a representative cross-sectional area a for leading gas from each one of the at least two acoustic chambers (1) to another of the at least two acoustic chambers (2),
- at least one inlet pipe (6) for leading gas into one of said at least two acoustic chambers (1,2), and at least one outlet for leading gas from the other of said at least two acoustic chambers,
- at least two transitions of cross-sectional area for the flow of the gas therethrough, each transition being between a relatively lower cross-sectional area a_i and a relatively higher cross-sectional area A_i, and
wherein the following applies to at least one selected chamber (1,2) selected from said at least two acoustic chambers:
the mean cross-sectional area A_j of each of said selected chamber (1,2) is at least four times the largest of: the sum of all cross-sectional areas of

passages (12) leading gas to the selected chamber, a_1, and
the sum of all cross-sectional areas of passages (12) leading gas from the selected chamber, a_2,
the mean cross-sectional area, A_j, being defined as the mean value of all cross-sectional areas along a mean trajectory for sound waves travelling from across the selected chamber (1,2), and
the volume, V_j, of at least one of the at least two selected chambers being at least $8(\sqrt{(a_1 + a_2)/2})^3$, a_1 and a_2 being defined as stated above, with the cross-sectional area, A_j, and the volume, V_j, including any elements belonging to sound absorptive material inside the selected chamber (1,2) and any other parts of the device being in acoustic communication with the selected chamber (1,2), and
wherein at least part of at least one passage (12) is curved, the generatrix of the curved part of the passage (12) being wound in a peripheral direction such that at least part of the curved passage (12) has a plane spiral form, or
wherein at least part of at least one passage (12) is curved, the generatrix of the curved part of the passage (12) being wound in a peripheral direction said part of said curved passage (12) extending in a longitudinal direction so as to form a screw-like helical form,
and wherein the curved part of the passage extends radially over one of the following angular extensions: Less than 90°, between 90° and 180°, between 180° and 270°, between 270° and 360°, between 360° and 720°
and further comprising at least one diffuser for diffusing at least part of said gas flow through at least one of said passages."

II. In the decision under appeal the Opposition Division considered that the patent in suit met the requirements of Article 83 EPC (sufficiency of disclosure) and of Articles 123(2) and (3) EPC (amendments), and that the claimed subject-matter was novel and inventive over the available prior art including documents:

D1 : US-A-4 317 502;

D2 : US-5 612 006;

D3 : US-A-4 601 363;

D4 : US-A-4 605 092;

D5 : US-A-3 962 142;

D6 : US-A-4 579 125; and

D28 : extract of the book "Engineering noise control, by D.A. Bies and C.H. Hansen; first published in 1988, pages 234-285.

III. The opponent (appellant) lodged an appeal against this decision. The notice of appeal was received at the EPO on 23 November 2007. Payment of the appeal fee was recorded on the same day. With the statement setting out the grounds of appeal, which was received at the EPO on 18 January 2008, the appellant filed document

D31 : WO-A-96/14497.

IV. In the communication accompanying the summons to oral proceedings, the Board expressed a preliminary opinion according to which:

- the European patent disclosed the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art;
- the analysis of the closest prior art document D1 made by the Opposition Division was correct,
- the technical effect of the distinguishing feature that the device comprised "*at least one diffuser for diffusing at least part of said gas flow through at least one of said passages*" was a reduction of the total pressure drop across the silencer device,
- there was no indication in D28 that would lead the skilled person to modify the helical passage of the device of D1 such as to provide a diffusing function in order to reduce the total pressure drop across the silencer device,
- D31, filed with the grounds of appeal, was to be considered as late filed, even taking into account the appellant's submission that D31 was filed in reaction to the amendments made, because the amendments were based on the combination of features of granted claims. D31 related to a resonance exhaust device in which a diverging section (diffuser) in combination with a converging section was provided in the resonator section of the exhaust device (see page 6, lines 1 to 5). The resonator section did not have a silencing function (see page 1, lines 22 to 24). Therefore, it would appear that D31 would not lead a skilled person to provide a diffuser section in the silencer according to D1. Accordingly, it would appear that D31 was not prima facie relevant and thus should not be admitted into the proceedings.

Finally, the Board commented the disclosure of documents D2, D3, D5 and D6.

V. Oral proceedings, at the end of which the decision of the Board was announced, took place on 17 September 2009.

The appellant requested that the decision under appeal be set aside and that the patent be revoked.

The respondent (patentee) requested that the appeal be dismissed.

VI. The arguments of the appellant in support of its request can be summarized as follows:

Claim 1 required a gas flow from each one of the chambers to the other, i.e. a gas flow back and forth between the two chambers. The disclosure of the patent in suit did not provide any support for such a gas flow, but only for a gas flow in one direction, from one chamber to the other. Claim 1 recited that the curved part of the passage extended radially over several angular extensions. However, a radial extension was a length measured in radial direction from a centre. The patent lacked any explanation of how the curved passage should extend in radial direction over an angular extension. Moreover, the patent in suit lacked sufficient information about the required length of the channel interconnecting the two chambers, which was a decisive factor for achieving a substantial reduction of noise. In particular, the natural frequency of the silencing device, and therefore its silencing effect,

depended on the length of the channel, as could be inferred from claim 7 which included the formula for calculating the natural frequency that comprised, as a parameter, the length of the passage. This formula also included as a parameter the local sound velocity, which was dependent on the temperature of the gas. In the absence of any information about the temperature of the gas to be taken into consideration for determining the local sound velocity, the skilled person was not able to implement the subject-matter according to claim 7. Hence, the patent in suit did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

D1 disclosed a device having all the features of claim 1 except the feature that the curved part of the passage extended radially over one of the following angular extensions: less than 90°, between 90° and 180°, between 180° and 270°, between 270° and 360°, between 360° and 720°, and the feature that the device comprised at least one diffuser for diffusing at least part of the gas flow through at least one of the passages. The former feature did not provide any technical effect over the teaching of D1 in which the curved part of the passage extended over about 3 turns. In fact, the patent as granted included an angular range starting from "less than 90°" and ranging up to "720° or more", i.e. from 0° to infinity. Thus, any angle and therefore any number of turns could be used to fulfil the technical teaching of the patent in suit. As regards the latter feature concerning a diffuser, it was rendered obvious by the teaching of D28, which disclosed the provision of a diffuser exactly for the same purpose of the patent in suit, namely for reducing

the pressure drop over the silencing device, as shown in particular by the passages of D28 included in the extracts presented during the oral proceedings.

The provision of a diffuser was moreover obvious in the light of D2, D5, D6, and D31. This latter document showed a silencer having a compact design including a diffuser formed by a helical channel extending over two turns.

VII. The respondent's reply to these objections can be summarized as follows:

The skilled person would be able to reproduce the invention on the basis of the information given in the patent in suit. Claim 1 required a passage interconnecting the chambers. As stated by the Opposition Division in the decision under appeal, the interconnecting passage was clearly nothing but a length of pipe. The provision of a pipe did not cause any difficulties to a skilled person, irrespective of the direction of gas flow. The term "radially" was to be construed as "developing around a central axis" and therefore it was clear that the requirement that the passage extended radially over an angular extension implied that the passage developed around a central axis over said angular extension. As regards the length of the passage, determining an appropriate value thereof was a matter of normal design procedure for the skilled person. Moreover, the teaching of the patent in suit consisted in increasing the length of the passage as compared to a straight passage, and this effect was achieved solely by the feature that the passage was curved as recited in claim 1. Although the formula

recited in dependent claim 7 included the local sound velocity as a parameter, and this parameter was dependent on the temperature which was not specified, this did not result in claim 7 not being sufficiently disclosed, but simply in claim 7 being broad in scope.

The kind of diffuser adopted in the patent in suit was a pressure-recovering device which produced a rise of static pressure from diffuser inlet to diffuser outlet, whereby the total pressure drop across the silencer was reduced. D28 did not address diffusers as components of muffling devices, but as mufflers per se. Furthermore, D28 was not concerned with reducing the total pressure drop across a silencing device, but the pressure gradient, i.e. the pressure drop per unit length. In any case, the skilled person would not consider modifying the passage interconnecting the two chambers of the silencing device according to D1 in such a manner that the gas flow was diffused because this would imply abandoning the technical teaching of D1 according to which the gas was forced to flow a defined helical pattern defined by a helical member fitted within a tube, and expand on leaving the tube, with the helical member extending beyond the end of the tube.

D31 neither showed a passage between two chambers nor a diffuser as part of the passage. Thus, since it was not prima face relevant, D31 should not be admitted into the proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. *Sufficiency of disclosure*

2.1 The Board agrees with the Opposition Division's view (see page 5 of the decision under appeal) that the wording of claim 1 simply requires the possibility of a gas flow through the passage between the chambers, and that it is clear for a skilled person that what is required for accommodating the gas flow is a length of pipe.

Even assuming that claim 1 is to be read in accordance with the appellant's interpretation according to which the passage must accommodate gas flows in two directions, a length of pipe would still be what is required, since, as correctly pointed out by the Opposition Division (see page 5, first three lines of page 5), "*given the right external condition even simultaneous flows in opposite directions are possible*" through a pipe.

2.2 As regards the length of the passage, the skilled person would not have any difficulties in finding an appropriate length thereof, having regard to his common general knowledge and the general purpose of the device, which consists in silencing a gas flow.

As pointed out by the Board in its preliminary opinion and during the oral proceedings, the technical effect of the features of claim 1, namely a substantial reduction of noise, is provided independently of the

choice of the passage's length, i.e. given a certain length of the passage, the features of claim 1 allow a substantial reduction of noise, as compared to a device that does not fulfil the requirements of claim 1 but has the same passage's length. It might be that this effect is not obtained at all for some specific values of the length, e.g. if the passage is extremely short, as submitted by the appellant. In such a case, however, the skilled person would modify his choice of the length, possibly with some amount of experimentation, with the help of common general knowledge. During the oral proceedings the appellant submitted that, due to the number of parameters involved, the amount of experimentation would pose an undue burden to the skilled person. However, in the absence of any evidence showing that the technical effect of a substantial reduction of noise is only obtained in connection with specific value(s) or limited range(s) of the passage's length, which could not be arrived at without a specific guidance in the patent in suit, it must be concluded that the choice of an appropriate length would not be beyond the skill of the normal practitioner of the art.

The appellant further referred to the natural frequency of the silencing device as being decisive in respect of the silencing effect. However, in analogy to what stated above, the features of claim 1 contribute to a silencing effect irrespective of the specific value of the natural frequency of the silencing device. Moreover, the silencing effect of a silencer having a given natural frequency depends on the acoustical characteristics of the sound source. In other words, the contribution of the natural frequency to silencing

depends on the use of the silencing device (e.g. it depends on the characteristics of the engine to which it is connected) and as such it is not representative of, and consequently not decisive in respect of, the silencing effect obtained by means of the structural features of the silencing device.

2.3 The Board further agrees with the Opposition Division's view that the wording of claim 1 "wherein the curved part of the passage extends radially over one of the following angular extensions..." must be understood as meaning that the curved part "turns" over a certain angle (see page 5 of the decision under appeal). It is accepted that the term "radial" relates to a radius. In the present context, however, where the curved passage has a curved part having a plane spiral form or a screw-like helical form (see the wording of claim 1), it is clear that the "radial extension over an angle" can only refer to the rotation (i.e. turns) made by an imaginary radius defining the curved part from the initial point thereof (where the angle is 0°) to the final point thereof (where the angle corresponds to the angular extension of the curved portion). This interpretation is fully in agreement with the description and figures of the patent in suit (see in particular Fig. 3 and the passage on paragraph [0063] of the patent in suit).

2.4 Claim 7 recites that the local natural frequency f_n of one sub-system comprising the two acoustic chambers and the passage interconnecting said two chambers is approximated by the following expression:

$$f_n = c/2\pi\sqrt{(a/L(1/V_j+1/V_{j+1}))}.$$

This expression includes geometrical data of the device (the volumes V_j and V_{j+1} of the chambers, the length L of the passage and the representative cross-sectional area of the passage interconnecting the chambers) and the local sound velocity c. Claim 7 requires that this local natural frequency is "at the most 0.5 times, such as at the most 0.4 times, 0.3 times, 0.25 times, 0.15 times or 0.1 times" the characteristic frequency of the flow system defined as the ignition frequency of a piston engine. It is true that the local sound velocity c depends on the temperature of the gas. However, this does not directly imply that a device according to claim 7 cannot be reproduced, but only that the limitation introduced by claim 7 is vague. In fact, whether a device meets the requirement of claim 7 depends not only on the structural features of the device itself but also on the use of the device (in particular it depends on the piston engine to which the silencing device is connected and the gas temperature, whereby the gas temperature not only depends on the engine type but also on its operating conditions). Anyway, for reproducing a device according to claim 7 it is only necessary to determine, in addition to the above-mentioned geometrical data, the characteristic frequency of a given piston engine, and to consider a suitable operating gas temperature for determining the local sound velocity. These steps do not present any difficulties for a skilled person.

It is noted that the fact that the limitation defined by claim 7 is vague is not related to insufficient disclosure but rather to the requirements of Article 84 EPC, namely clarity and support by the description.

However, the subject-matter of claim 7 was already present in the patent as granted. Since lack of compliance with Article 84 EPC is not a ground of opposition, an objection of lack of clarity and/or support by the description would not be taken into consideration.

2.5 It follows that that the appellant's objections as to insufficiency of disclosure are unfounded.

3. *Novelty*

The appellant did not raise any objection with regard to the novelty of the claimed subject-matter. The Board does not see any reason to take a view different from that of the Opposition Division.

4. *Inventive step*

4.1 There is agreement between the appellant and the respondent that a silencing device according to document D1, namely the silencing device according to the embodiment disclosed with reference to Fig. 11, represents the closest prior art.

In its reply to the grounds of appeal, the respondent contested the analysis of document D1 made by the Opposition Division (see pages 6 to 8 of the decision under appeal) according to which D1, in the embodiment of Fig. 11, disclosed a device including all the features of claim 1 as granted. The respondent however no longer contested this analysis after the Board expressed, in the annex to the summons to oral

proceedings, the preliminary opinion that this analysis was correct.

It is anyway undisputed that D1 does not disclose the features of granted claims 6 and 8 that have been added to claim 1 as granted during the opposition proceedings, namely
(i) that the curved part of the passage extends radially over one of the following angular extensions: less than 90°, between 90° and 180°, between 180° and 270°, between 270° and 360°, between 360° and 720°, and
(ii) that the device comprises at least one diffuser for diffusing at least part of said gas flow through at least one of said passages.

4.2 It is further undisputed that the technical problem solved by distinguishing feature (ii) is to achieve a reduction of the total pressure drop across the silencer device.

4.3 In its submissions in respect of lack of inventive step starting from D1, the appellant mainly referred to D28. In particular, the appellant referred to chapter 9.2 thereof relating to diffusers as muffling devices, and, during the oral proceedings, to the passage on page 262 where it is stated that "*the introduction of reactive or dissipative muffling systems in a duct will impose a pressure drop. For example an engine muffler will impose a back pressure on the engine which can strongly affect the mechanical power generated*". The appellant further submitted calculations based on the formulae disclosed on page 265 of D28, showing that a diffuser section provides less dynamic losses, and thus a

reduced pressure drop, as compared to a section having a sharp transition.

The Board accepts that D28 teaches that a diffuser can provide a muffling function and also a reduced pressure drop as compared to a sharp transition. However, there is no indication in D28 that would lead the skilled person to modify the silencing device according to D1 by including a diffuser in the passage interconnecting the two chambers. In accordance with the analysis of the embodiment of Fig. 11 made by the Opposition Division, the two chambers of the known silencing device are those identified with the reference numerals 42 and 52. There are two passages interconnecting these chambers, each formed by a tubular member (39 and 40) in which there is positioned a rod (45 and 46) with a helical member (43 and 44), thereby defining a helical path for the gas flow (see col. 7, lines 15 to 18 and 43 to 47). Under the assumption that the skilled person would consider the provision of a diffuser for reducing the pressure drop over this known silencing device, he would not directly come to the conclusion that the diffuser should be positioned within one or both of said passages. Firstly, the passages do not constitute the sole transition within the device, as also the inlet opening 4 and the outlet tube 22 constitute transitions for the gas flow in the sense of D28 (cf. in particular Fig. 9.12 referred to by the appellant), for which a diverging shape might be advantageous in terms of reduced dynamic losses. Secondly, in order for the diffuser to diffuse at least part of the gas flow flowing through the passages, it would be necessary to modify the shape of the helical members such as to accommodate a portion with increasing cross-sectional

area. For this modification, which was mentioned by the appellant during the oral proceedings, there is however no hint in document D28. The appellant submitted that there was also another possible modification, which consisted in providing a flared outlet of the tubular members 39 and 40 whilst keeping unchanged the helical members 43 and 44. Such modification would imply that already within the passage, the gas is no longer forced to follow a restricted spiral course. In fact, both modifications imply that the gas expands within the passage, and in particular the latter modification implies that the gas follows a larger helical path within the passage. This however, is contrary to the explicit teaching of D1, according to which (see col. 7, lines 44 to 50; see also claim 1) the hot exhaust gases are forced to follow a defined spiral pattern [...] to conform to the helix shape of the helical member 9 and only as the gas exits the end 16 of the tubular member it is permitted to expand and since it is no longer forced to follow a restricted spiral course, it follows a larger spiral course.

Therefore, the provision of a diffuser in the passage(s) interconnecting the two chambers of the silencing device of D1 cannot be regarded as obvious in the light of D28 as it would require the modification of the particular shape of the passage which is disclosed as being relevant for achieving the intended purpose of D1.

4.4 The appellant also referred to documents D2 to D6 in its written submissions but no longer during the oral proceedings.

As already stated by the Board in its preliminary opinion, none of documents D2, D3, D5 and D6 suggests the provision of a diffuser in the passage interconnecting the two chambers of the silencing device according to D1.

D2 (under the assumption that it is prior art according to Article 54(2) EPC, which is the case only if the patent in suit does not benefit of the claimed priority of 30 September 1996, since D2 was published on 18 March 1997) discloses (see Fig. 2) an assembly combining a catalytic converter with a spiral muffler (see col. 1, lines 9 to 11). In particular, the assembly comprises an expansion chamber 32, a venturi 64 for leading gas from the expansion chamber 32 to a catalytic converter 74, from which the gas flows into a distribution chamber 110. The gas in the distribution chamber 110 enters, via apertures 120 in a perforated wall 118, a spiral passage 112. The spiral passage constitutes the muffler of the assembly (see col. 9, lines 57 to 65). The appellant referred to the diffuser portion 72 of the venturi as being a diffuser which provides the same technical effect as in the disputed patent. However, the purpose of the venturi is to inject atmospheric air into the exhaust gas stream upstream of the catalytic converter, by dropping the pressure of the exhaust gas stream (see col. 1, lines 54 to 59 and col. 5, lines 59 to 64). The function of the venturi is thus completely different from the function of the passage interconnecting the two chambers of the silencing device of D1 and therefore there is no reason why the skilled person would consider modifying D1 in the light of D2.

D5 discloses a silencer comprising (see Fig. 2) an inlet pipe (16), a spiral duct (15) and an expansion chamber (30). Gases leaving the spiral duct (15) are redirected axially by means of deflectors (24, see col. 2, lines 60 to 65) and flow through a passage way provided by plates (29) towards the expansion chamber (30, see col. 3, lines 1 to 12). The appellant submitted that the passage way was a diffuser. However, this is not clearly stated in D5, nor is there any indication that a diffusing function, in addition to the mere confining function disclosed for the plates 29, is desirable.

D6 discloses a silencer device in which an offset chamber (18, see Figs. 5 and 6) having a cross-section of crescent shape (see col. 3, lines 43 to 45) is enclosed within a peripheral protrusion of a spiral channelling's final outermost turn (6, see col. 3, lines 39 to 42). Although this chamber contributes to reduction of the noise-level (see col. 5, lines 23 to 25), the construction of the silencer device according to D6 is very different from that of D1 and it is not apparent why the skilled person would consider providing such offset chamber in the helical passage of the device according to D1.

Anyway, having regard to the explanations given above in respect of D28, the presence of diffuser portions in the devices according to any of D2, D5 and D6 would not suggest to the skilled person the provision of a diffusing portion within the passage interconnecting the two chambers of the silencing device according to

D1, as this would be contrary to the specific teaching of D1.

Finally, in the grounds of appeal the appellant referred to D3 and D4 and only submitted that these documents were similar to document D1 in that they disclosed silencers having two large chambers connected to each other by means of curved passages. The Board however does not see any reason why D3 and D4 might be more relevant than D1. They are moreover silent about the provision of a diffuser.

Therefore, the provision of a diffuser in the passage(s) interconnecting the two chambers of the silencing device of D1 can also not be regarded as obvious in the light of D2 to D6.

4.5 Thus, the arguments put forward by the appellant with respect to documents D1 to D6 and D28 fail to convince the Board that the subject-matter of claim 1 does not involve an inventive step.

4.6 Finally, the appellant also referred to document D31 in its written submissions but no longer during the oral proceedings.

As already stated by the Board in its preliminary opinion, D31 was filed with the grounds of appeal and must be considered as late filed, even taking into account the fact the appellant's submission that "*the patentee has changed the teaching of original sub-claim 6 by omitting the range 720° or more*" because the range 720° or more is one of the alternatives of dependent claim 6 as granted and the amendment made only consists

in selecting alternatives that were already present in claim 6 as granted.

D31 relates to a resonance exhaust device in which a diverging section (diffuser) in combination with a converging section is provided in the resonator section of the exhaust device (see page 6, lines 1 to 5). The resonator section does not have a silencing function, as apparent from the passage on page 1, lines 22 to 24. Although this passage refers to the prior art, the diverging and converging sections of the invention according to D31 correspond to those of a conventional resonance exhaust device (see the paragraph bridging pages 5 and 6). Since the diverging section does not have a silencing function, it is not readily apparent why D31 would suggest to the skilled person the introduction of a diverging section in the silencing device of D1. Therefore, on a prima facie examination, the late-filed document D31 does not add any further elements such as might convince the Board to adopt a different position as regards the issues being judged, and ultimately change the outcome of the decision. For this reason the Board exercises its discretion pursuant to Article 114(2) EPC and Article 12(4) of the Rules of Procedure of the Boards of Appeal not to admit document D31.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Patin P. Alting Van Geusau