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Datasheet for the decision of 10 March 2017

Case Number: T 1845/12 - 3.2.04

Application Number: 04732863.8

Publication Number: 1625291

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Language of the proceedings: EN

Title of invention:
TURBO COMPRESSOR SYSTEM FOR AN INTERNAL COMBUSTION ENGINE COMPRISING A COMPRESSOR OF RADIAL TYPE AND PROVIDES WITH AN IMPELLER WITH BACKSWEPT BLADES

Patent Proprietor:
VOLVO LASTVAGNAR AB

Opponents:
MAHLE International GmbH
BorgWarner, Inc.
Abb Turbo Systems AG

Headword:

Relevant legal provisions:
EPC Art. 56
RPBA Art. 13(1)

Keyword:
Inventive step - main request (no)
Late-filed request - admitted (no)

Decisions cited:

Catchword:

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Case Number: T 1845/12 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 10 March 2017

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Respondent: (Patent Proprietor)	VOLVO LASTVAGNAR AB 405 08 Göteborg (SE)

Representative: Volvo Technology Corporation
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BF14100, M1.7
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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted on 8 August 2012 concerning maintenance of the European Patent No. 1625291 in amended form.**

Composition of the Board:

Chairman A. de Vries
Members: J. Wright
T. Bokor

Summary of Facts and Submissions

I. Separate notices of appeals against the interlocutory decision of the opposition division posted on 8 August 2012 concerning maintenance of the European Patent No. 1625291 in amended form, were received from the appellant-opponent I on 21 August 2012, from appellant-opponent II on 16 August 2012 and from appellant-opponent III on 25 September 2012. All three appellants paid the appeal fees at the same time as filing their notices of appeal. Statements setting out the grounds of appeal were received from the appellant-opponent I on 7 December 2012, from appellant-opponent II on 24 August 2012 and from appellant-opponent III on 18 December 2012.

II. The oppositions were based, *inter alia*, on Article 100(a) EPC for lack of inventive step. The opposition division held that the patent as amended according to an auxiliary request (present main request) met all the requirements of the EPC, *inter alia* because the subject matter of claim 1 as amended involved an inventive step, having regard to the following documents amongst others:

D5 : C. Rodgers : "Centrifugal compressor design options for small turbochargers"; IMechE Conference Transactions, 6th International Conference on Turbocharging and Air Management Systems, London, 3-5 November 1998, 23-31.

D16 : G.F. Hiett et al "Experiments concerning the aerodynamic performance of inward flow radial turbines"; Proceedings of the Institution of Mechanical Engineers, 1963-64, Volume 178 Pt3I(ii), paper 7.

III. All three appellant-opponents request that the decision be set aside and that the patent be revoked in its entirety.

The respondent-proprietor requests that the appeals be dismissed and the patent be maintained in the form held allowable by the opposition division, or in the alternative, that the patent be maintained in amended form according to one of auxiliary requests I and II, both filed with letter of 5 January 2017.

IV. The wording of claim 1 of the various requests is as follows,

Main request (as held allowable by the division):

"A turbocharger unit (18) for an internal combustion engine (10) with at least one exhaust line (15,16) for conducting exhaust gases away from the combustion chamber (11) of the engine and at least one inlet line (12) for supplying air to the combustion chamber, comprising a turbine (17) of radial type which interacts with a compressor (19) of radial type for extracting energy from the exhaust gas flow of the engine and pressurizing the inlet air of the engine, wherein the compressor (19) is provided with an impeller with backswept blades (35) where the blade angle ($ß_{b2}$) between an imaginary extension of the centre line of the blade between a root section and a tip section in the direction of the outlet tangent and a line (36) which connects the centre axis of the impeller to the outer tip of the blade is at least roughly 45°, characterized in that the radial turbine (17) which drives the compressor (19) is made with a hub without cutouts".

Auxiliary request I reads as in the main request except that the words "a compressor (19) of radial type" are replaced by the words "compressor (19)" and just preceding the words "characterized in that...", the words "wherein the turbine (17) has vanes with uniform length," are added.

Auxiliary request II:
"A supercharging system for an internal combustion engine (10) with at least one exhaust line (15,16) for conducting exhaust gases away from the combustion chamber (11) of the engine and at least one inlet line (12) for supplying air to the combustion chamber, the supercharging system comprising two series-connected compressors, i.e. a high-pressure compressor (19) and a low-pressure compressor (23), of radial type with intermediate cooling, the supercharging system comprising a high-pressure turbine (17) of radial type which interacts with the high-pressure compressor (19) and a low-pressure turbine (21) interacting with the low-pressure compressor (23), the high-pressure compressor (19) being driven by the high-pressure turbine (17) and the low-pressure compressor (23) being driven by the low-pressure turbine (21), for extracting energy from the exhaust gas flow of the engine and pressurizing the inlet air of the engine, wherein the high-pressure compressor (19) is provided with an impeller with backswept blades (35) where the blade angle ($ß_{b2}$) between an imaginary extension of the centre line of the blade between a root section and a tip section in the direction of the outlet tangent and a line (36) which connects the centre axis of the impeller to the outer tip of the blade is at least roughly 45°,
characterized in that

the high-pressure radial turbine (17) which drives the high-pressure turbine (19) is made with a hub without cutouts".

V. The appellants argued as follows:

Main request

A turbine hub with cutouts means a hub with scalloped cutouts, that is inwardly curving cutouts in the periphery of the turbine hub backplate.

D5 discloses a turbocharger stage according to the preamble of claim 1. In particular figure 1 shows a turbocharger with a radial turbine and radial compressor. As shown in table 3, the compressor impeller has backswept blades, with backsweep angles of 60° for the best efficiency, thus considerably greater than the 45° minimum defined in the claim. D5 does not disclose whether or not the turbine hub is made with cutouts. Therefore the only difference between the subject matter of claim 1 and D5 is the characterising feature (hub without cutouts). The objective technical problem is to maximise efficiency. Document D16 relates to a turbocharger for the auto industry, so is in the same technical field as the invention and D5. This document discloses that the presence of cutouts decreases efficiency. Therefore, in solving the objective technical problem, the skilled person would forego cutouts in the turbine hub and thereby arrive at the invention in an obvious manner.

Auxiliary requests

Both requests are late filed so should not be admitted.

VI. The respondent-proprietor argued as follows:

A hub with cutouts, in the terminology of claim 1, is broader than the appellants would have it, it also includes a circular hub with blades protruding beyond the backplate.

D5 discloses impellers for a small turbocharger. The skilled person would not take "small" turbochargers into account for a combustion engine. Furthermore it is only an experimental turbocharger, so D5 is not a suitable starting point for assessing inventive step. D5, figure 1 shows a turbine hub with cutouts, which is the standard kind of turbine. The skilled person would not do away with these since they are necessary to reduce stresses and provide sufficient transient response. The invention is based on recognising a synergy between compressor and turbine making the turbocharger more efficient. The prior art gives no hint to this synergy, nor can it be seen from a combination of D5 and D16. If the claimed combination were obvious, the opponents would have found a document disclosing this because turbocharger technology is long established. D16 shows shows that better processing of the turbine with cutouts reduces losses by half, so the skilled person would rather try to do this than get rid of cutouts, which are necessary in D5 for reducing stresses in the turbine.

Auxiliary requests

At least auxiliary request II is not late filed since it was on file in the opposition proceedings. The auxiliary requests were filed in response to the Board's communication. The arguments in support of

inventive step were not filed with the requests since they are the same as for the main request. Both requests should be admitted.

Reasons for the Decision

1. The appeals are admissible.

2. Background of the invention

The patent concerns a turbocharger unit for an internal combustion engine (see specification, paragraph [0001]). An object of the invention is said to be to produce a turbocharger unit with good characteristics in terms of, *inter alia*, efficiency (see specification, paragraph [0008]).

3. Main request, inventive step

3.1 A first question for the Board is what is meant by the claim feature a "turbine ... made with a hub without cutouts". The appellant-opponents interpret the word "cutouts" narrowly to mean inwardly curving cutouts formed in the periphery of the back-plate of a turbine hub, between the blades. The respondent-proprietor has argued for a broader interpretation, also including any spaces between turbine blades where the latter extend radially beyond the periphery of a circular turbine hub back-plate (for example as seen in D16, page 40, Figure 7.20, upper 4 figures, labeled stages 1 and 2).

The term "cutout" appears not to have a particular meaning in turbine technology, thus, as used in the claim in the negative (hub without cutouts), the skilled person will not immediately recognise it to

unambiguously designate a particular kind of turbine hub, nor would they know what missing cutouts in the hub were being referred to. Where the skilled person experiences such ambiguities, they will look to the rest of the specification, namely the description and drawings, to interpret the claim.

The term "cutouts" first appears in the specification paragraph [0006] as "scallop cutouts". Paragraph [0013] goes on to explain that, according to the invention, these "scallop cutouts" can be dispensed with. Finally in paragraph [0027], in conjunction with figure 4, making cutouts in the turbine wheel hub is said to be "what is known as scalloping". Thus the Board holds that where the patent claim talks of "cutouts", scalloped cutouts are meant.

Turning now to what "scalloped" means, the Board notes that in its usual meaning the term is understood to mean "shaped or cut (out) in the form of a scallop-shell" (cf. Oxford Dictionary), which refers to the characteristic wavy edge of the scallop shell. Such scalloped cutouts are shown in the patent as phantom lines 39 in figure 4 (see specification, paragraph [0027] again). There they are inwardly curving inter-blade cutouts in the hub backplate, not spaces between blades extending beyond a circular backplate. Nor does the prior art paint a different picture. For example, referring again to D16, page 39 and figure 7.20, whereas the turbines with blades extending beyond a circular backplate (stages 1 and 2) are described as turbines with unsupported blade tips, only stages 3 and 4, with their inwardly curving cutouts in the turbine backplate, are described as scalloped (page 39, left hand column, section entitled "Rotor lightening modifications").

Thus the Board holds that, consistent with the patent as a whole, "cutouts" in claim 1 are to be interpreted narrowly as scalloped cutouts, that is inwardly curving inter-blade cutouts in the hub back-plate.

3.2 The Board considers D5 to be a good starting point for assessing inventive step because, like the patent, it relates to a turbocharger for an internal combustion engine (title, page 27, line 2, and figure 1). Whether or not the turbocharger in question is a "small" turbocharger and an experimental rather than a production model is immaterial as neither of these aspects are reflected in the claim. Furthermore, like the patent, D5 is concerned with performance, in other words efficiency (page 27 to 29, section 4, "performance comparisons").In any case the turbocharger of D5 is described as small, cf. page 27, 2nd line, and figure 1, caption.

3.3 D5 discloses all the features of the preamble of claim 1. In particular, since it discloses a turbocharger unit for a combustion engine, exhaust and inlet lines to the engine as claimed are implicit. As shown in figure 1, the turbocharger comprises a turbine of radial type (right side of figure 1), for extracting energy from the exhaust and a compressor of radial type, for compressing the engine's inlet air (left side of figure 1). Furthermore, in order to maximise efficiency, D5 discloses a backsweep angle for the compressor impeller of 60°, thus greater than the 45° the claim defines as the minimum backsweep (see page 27, penultimate paragraph, first bullet point, page 28, second paragraph and page 29, second complete paragraph).

3.3.1 It may be that D5, figure 1, shows a turbine with blades that extend beyond the periphery of the hub backplate as the respondent-proprietor has argued. However, as explained above, these are not necessarily scalloped cutouts as the term is understood in claim 1. How the backplate is shaped between the blades cannot be discerned from figure 1 because it shows a sectional view along the blades, nor is the backplate described. Thus D5 is simply silent as to whether or not the turbine hub is made with (scalloped) cutouts.

3.4 Therefore the subject matter of claim 1 differs from E5 only in respect of the characterising feature, namely in specifying that "the radial turbine which drives the compressor is made with a hub without cutouts".

3.5 The patent explains the effect of the known measure of scalloped cutouts to be primarily to improve transient response whilst however reducing efficiency (specification, paragraph [0006]). It is common ground that the skilled person also knows from their general knowledge that scalloped cutouts relieve stresses (see again paragraph [0006]). Consequently, the only advantageous technical effect attributable to their absence, as is claimed, is an increase in efficiency, as indeed the patent confirms (see specification, paragraph [0013]).

Thus the objective technical problem can be formulated as how to maximise efficiency of the turbocharger of D5.

3.6 Tasked with the above problem (increasing efficiency) the skilled person will be well aware of document D16 since it is concerned with performance aspects of radial flow turbines (see title) for, inter alia,

turbochargers in the auto industry (see, page 28, introduction, lines 2 and 3 and page 39, sentence bridging left and right hand columns). This document is concerned with the "established" practice of scalloping the turbine to relieve rotor stresses, more particularly with the effect of this known measure on the turbine's efficiency. It concludes (page 39, right-hand column, 2nd complete paragraph) that scalloping significantly reduces rotor weight and inertia but at the penalty of efficiency losses. Thus page 39, table 7.5 compares efficiency for different turbine rotors shown in figure 7.20. There the turbine hubs of stages 3 and 4 are scalloped, or, in the claim's terminology, have hubs made with cutouts, whereas the stages 1 and 2 do not (see page 39, left hand column, section "Rotor lightening modifications", definitions of the four stages). The skilled person learns from table 7.5 that the presence of (scalloped) cutouts, albeit to different degrees, always reduces efficiency (cf. stages 3 and 4), whereas those stages with no scalloping show no drop in efficiency (cf. stages 1 and 2).

Therefore, when tasked with the above problem (maximising efficiency) and in the knowledge (from D16) that the known measure of scalloping is associated with efficiency loss the skilled person will, as a matter obviousness, choose not to scallop the hub, i.e. provide the hub without cutouts when realising a turbine as in D5. Thus they will arrive at the subject matter of claim 1 without making an inventive step. Whether or not the skilled person adopts a particular measure of known advantages and disadvantages depends on how they weigh them against each other. Weighing up known pros and cons is conducted in relation to the particular requirements or specifications and is

generally speaking routine workshop practice for the skilled person. If, as in this case, the overriding concern is maximizing efficiency (for whatever reason), then he will as a matter of obviousness avoid a measure such as scalloping that reduces efficiency even if this may be at the known cost of increased inertia and stresses.

3.7 The Board is not convinced by the respondent-proprietor's argument that prior art compressors were less efficient and rotated slower with their (compared to the invention) inferior compressor backsweep angles. Consequently the turbine driving it needed to do more work and be larger and would in turn need cutouts to achieve an acceptable transient response and to relieve stress. Therefor, so the argument goes, the skilled person would always use a turbine wheel with cutouts. By contrast, the invention foresees higher backsweep angles which make the compressor more efficient, thus the turbine can be smaller. In this way the turbine surprisingly achieves acceptable transient response and stress levels without the need for cutouts, so these can be abandoned, making the turbine more efficient. In this way the synergic relationship between compressor and turbine makes for a more efficient turbocharger.

3.7.1 It may be that higher backsweep angles in the compressor, as claimed, allow the driving turbine to do less work and rotate at a higher speed, thus to be smaller and have improved transient response. However, the starting document for assessing inventive step is not a prior art document with a compressor backsweep angle below 45°, rather it is D5, with its 60° backsweep angle. Thus according to the above logic, D5 must also allow the turbine to be relatively small and

operate at higher speeds, leading to it having good transient response and exposing it to less stress.

3.7.2 Therefore, if for the invention, for some hypothetical application, higher backsweep angles might mean that the turbine could shrink beyond some critical size below which stress relieving and transient response boosting cutouts were superfluous, this would apply in equal measure to the arrangement of D5 (which in fact refers to its turbocharger as "small", page 27, line 2 and figure 1, caption). Furthermore, the skilled person, a mechanical engineer specialising in turbocharger design, would know this from standard mechanical calculations when solving the objective technical problem (which they would do by making the hub without cutouts, for the reasons explained above).

Thus, if in this way the claimed turbocharger is made more efficient, by the same token it would also be arrived at as a logical consequence of starting from D5, with its 60° compressor backsweep angle and the obvious choice of making the turbine without cutouts, rather than requiring the skilled person to recognise some new-found and surprising synergy between the compressor and turbine.

In any case, since neither the speed of the compressor/ turbine nor their dimensions are reflected in the claim, the consideration of turbine size or operating speed, thus also at what hypothetical critical size of turbine stress relieving and transient response boosting cutouts might become superfluous, can play no role in deciding what the skilled person would or would not do in solving the objective technical problem.

3.8 Finally, the Board is also not of the opinion that the absence of a document showing the combination of a backsweep angle exceeding 45° and a hub without (scalloped) cutouts as claimed proves the subject matter of the claim to be non-obvious, as the respondent-proprietor has argued. However long turbochargers may have existed, the fact that the opponents have not presented such a document cannot change how the Board assesses the claim vis-à-vis the documents they have presented. Therefore the Board's assessment that D5 and D16 prejudice inventive step of claim 1, for the reasons given above, still stands.

3.9 The Board concludes that the subject matter of claim 1 lacks inventive step, Articles 52(1) and 56 EPC, therefore the main request must fail.

4. Auxiliary requests I and II, admission

4.1 In the present case, the first and second auxiliary requests were filed with letter of 5 January 2017. They were thus filed after filing the reply to the grounds of appeal and after oral proceedings had been arranged. Consequently, they constitute amendments to the respondent-proprietor's case in the sense of Article 13 of the Rules of Procedure of the Boards of Appeal (RPBA), whether or not the same or similar requests were on file during opposition proceedings. Under paragraph (1) of that article the Board has discretion in admitting such amendments.

4.2 In the present case the Board is not aware of any significant changes in the appellants' arguments from the start of the appeal proceedings which might be considered a development in proceedings justifying the admittance of new requests, nor has this been argued.

Furthermore, the Board's communication of 21 December 2016 merely summarised the issues raised by the parties, without introducing new substantive issues.

4.3 Moreover, the requests have been filed without any explanation or substantiation in relation to the contentious issues raised by the appellant and identified in the board's communication. Only in the oral proceedings before the board did the respondent admit that the amendments were intended primarily to re-establish priority in relation to a contention of lack of novelty, but that for inventive step the arguments were the same as for the main request (features were indeed added to the preamble). By their own admission therefore, given that the main request was unsuccessful for lack of inventive step, so also the auxiliary requests were doomed to failure. It could therefore serve little or no purpose to now fully discuss these requests as to their merits.

Accordingly, given the current state of the proceedings, the Board decided not to admit the auxiliary requests I and II into the proceedings pursuant to Articles 13(1) RPBA with Article 114 (2) EPC.

5. As the patent according to the main request fails to meet the requirements of the EPC, and no other requests have been admitted, the Patent must be revoked pursuant to Article 101(3)(b) 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. Magouliotis A. de Vries

Decision electronically authenticated