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# Datasheet for the decision of 21 September 2011

**Case Number:** T 1037/09 - 3.2.04

**Application Number:** 99107114.3

**Publication Number:** 0953765

**IPC:** F04B 27/18

**Language of the proceedings:** EN

**Title of invention:**
Variable displacement type swash plate compressor and displacement control valve

**Applicant:**
KABUSHIKI KAISHA TOYOTA JIDOSHOKKI

**Opponent:**
Sanden Corporation

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 56

**Relevant legal provisions (EPC 1973):**
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**Keyword:**
"Inventive step - no (main request) - yes (auxiliary request 2)"

**Decisions cited:**
-

**Catchword:**
-

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**Case Number:** T 1037/09 **-** 3.2.04

# D E C I S I O N
**of the Technical Board of Appeal 3.2.04**
**of 21 September 2011**

**Appellant**: (Opponent)
Sanden Corporation
20 Kotobuki-cho
Isesaki-shi
Gunma 372-8502 (JP)

**Representative**:
Dr Klein, Peter
Prüfer & Partner GbR
Patentanwälte
Sohnckestrasse 12
D-81479 München (DE)

**Respondent**: (Patent Proprietor)
KABUSHIKI KAISHA TOYOTA JIDOSHOKKI
2-1, Toyoda-cho
Kariya-shi
Aichi-ken (JP)

**Representative**:
Wachenhausen, Marc
TBK - Patent
Bavariaring 4-6
D-80336 München (DE)

**Decision under appeal:**
**Interlocutory decision of the Opposition Division of the European Patent Office posted 26 February 2009 concerning maintenance of European patent No. 0953765 in amended form.**

**Composition of the Board:**

**Chairman:** M. Ceyte
**Members:** A. de Vries
T. Bokor

## Summary of Facts and Submissions

I. The Appellant (Opponent) lodged an appeal, received 7 May 2009, against the interlocutory decision of the Opposition Division posted 26 February 2009 on the amended form in which European patent No. EP-B-0953765 can be maintained, and simultaneously paid the appeal fee. The statement setting out the grounds was received 7 July 2009.

II. The opposition was filed against the patent as a whole and based on Article 100(a) together with Articles 52(1), 54 and 56 EPC for lack of novelty and inventive step.

The Opposition Division held that the grounds for opposition mentioned in Article 100 EPC did not prejudice the maintenance of the granted patent having regard to the following documents in particular:
E2: JP-A-02 181079
E2a: English language patent abstract
E2b: English translation of E2
E3: US-A-5 573 379.

III. With the statement of the grounds of appeal the Appellant submitted the following document among others:
E16: US-A-4 815 358.

IV. The Appellant requests that the decision under appeal be set aside and the patent revoked.

The Respondent (Proprietor) requests that the appeal be dismissed, or, in the alternative, that the patent be maintained in amended form according to one of

auxiliary requests now numbered 2 to 7 and filed with letter 2 March 2011 as auxiliary requests 3, 4, 5, 7, 8 and 9 respectively, or according to auxiliary requests 8 and 9 filed with letter of 10 August 2011 as auxiliary requests 2 and 6 respectively.

V. Oral proceedings before the Board were held on 21 September 2011.

VI. The wording of claim 1 of the main request and auxiliary request 2 is as follows:

*Main Request*

"A variable displacement compressor comprising:
a housing (1, 2, 3, 4), which defines a cylinder bore (1a), a crank chamber (5), a suction chamber (31) and a discharge chamber (32);
a piston (29) accommodated in the cylinder bore (1a)
a drive shaft (6) rotatably supported in the crank chamber (5) by the housing (1,2,3,4);
a drive plate (22) coupled to the piston (29) for converting rotation of the drive shaft (6) to reciprocation of the piston (29), wherein the drive plate (22) is supported on the drive shaft (6) to incline with respect to a plane perpendicular to the axis of the drive shaft (6) and to rotate integrally with the drive shaft (6), wherein the drive plate (22) moves in a range between a maximum inclination angle position and a minimum inclination angle position in accordance with a moment applied to the drive plate (22), wherein the moment includes a moment based on the pressure in the crank chamber (5) and a moment based on the pressure in the cylinder bore (1a) as components,

and wherein the drive plate (22) varies the stroke of the piston (29) in accordance with its inclination angle to change displacement of the compressor; and
a pressure control mechanism for controlling pressure in the crank chamber (5) to change the inclination of the drive plate (22),
wherein the minimum inclination angle (9mm) is smaller than a limit angle (θB), the limit angle (θB) being determined by the lower limit of a range of inclination within which the drive plate (22) can be moved to increase its angle by a reaction force of pressure applied to the piston (29),
wherein an urging member (27) urges the drive plate (22) to increase its inclination angle when the inclination of the drive plate (22) is less than the limit angle (θB),
wherein the inclination angle of the drive plate (22) is zero degrees when located on a plane perpendicular to the axis of the drive shaft (6), wherein a minimum inclination angle of the drive plate (22) is set to zero degrees, or to an angle that produces a load that is substantially the same as that when the inclination angle of the drive plate (22) is zero degrees,
wherein an outer drive source (14) is directly connected to the drive shaft (6) to rotate the drive shaft (6)
characterized in that
the drive plate (22) is constructed and arranged such that an additional moment which is generated based on products of inertia thereof is applied to the drive plate (22) for increasing its inclination angle when rotating while positioned at an angle of inclination that is smaller than the limit angle (θB) so that increasing the inclination angle of the drive plate (22)

from the minimum inclination angle (θmin) is accomplished by the cooperation of the additional moment and the moment generated by the force of urging member (27)."

*Auxiliary Request 2*

Claim 1 is as in the main request but adds the following wording at the end of the claim:

"wherein during idling of the outer drive source (14) the additional moment requires cooperation with the moment generated by the force of the urging member (27) in order to increase the inclination angle of the drive plate (22) from the minimum inclination angle (θmin)."

VII. The Appellant argued as follows:

In the variable displacement compressor of E2 the plate can already assume 0° tilt and wave spring 48 ensures that it can move from this position. E2 however does not provide any information concerning the moment of inertia of the plate. However this depends strongly on the rotation speed and, at the high speeds in question, would therefore need to be taken into account by the skilled person when designing the tilt plate as follows from basic mechanics considerations. It will be very difficult to balance the plate, while he will naturally avoid designing it so as to urge it towards 0°. The only reasonable option is to design the plate inertia so that it is urged away from 0° during rotation. Alternatively, he would look toward E3 which teaches him how to design plate inertia.

In claim 1 of the second auxiliary request it is unclear what the amendment adds with respect to the main request. In as far as the new feature means that neither spring nor moment of inertia are sufficient to increase the inclination angle from 0°, there is no disclosure of such a situation. Cited specification paragraph [0094] refers to a situation with no spring, not a spring that is too weak. It is moreover speculative and does not provide a definite teaching that something is indeed done. Moreover, the paragraph refers to a minimum inclination angle, not an angle near 0° as in the claim.

As for inventive step, the skilled person when applying E3's teaching to E2 will avoid large values for the moment so that the minimum inclination angle is not too large.

Inventive step can also be attacked using E16. It shows the combined use of spring and plate moment of inertia in a single variable displacement compressor.

VIII. The Respondent argued as follows:

The spring in E2 already addresses the so-called hunting effect, whereby for near zero angles the tilt plate is highly responsive to pressure changes. Vis-à-vis E2 the differing feature of a moment of inertia assisting return to larger angles gives better controllability while reducing power consumption. Reduction of power consumption is achieved both by the spring and appropriate dimensioning of the swash plate.

E2 is completely silent on the plate's moment of inertia and thus provides no basis for any assumption how this might act for small angles. That he might optimize the interaction of spring and the plate's moment of inertia goes far beyond the normal design work of the skilled person.

Nor would the skilled person look to E3 as he normally avoids combining effects that act in the same direction. Neither E2 nor E3 indicate sharing their functions, nor does either document deal with power consumption at 0°.

The feature added to claim 1 in the auxiliary request 2 clarifies the optimized dimensioning of the plate's moment of inertia which produces the desired reduction in power consumption. This derives from specification paragraph [0094], which has only one possible reading.

This additional dimensioning requirement is not obvious from a simple combination of the spring of E2 and the unbalanced plate of E3. None of the prior art points in this direction, nor is it self-evident to optimize the plate's dimensioning in this way. There are many other possibilities the skilled person would consider.

E16 is prima facie not relevant and should not be admitted as its plate is not unbalanced but balanced, while the compressor is not clutchless but connected to the drive shaft via a clutch.

## Reasons for the Decision

1. The appeal is admissible.

## 2. *Background of the Invention*

The patent is concerned with a clutchless variable displacement compressor, as shown for example in figure 1, in which a drive (or swash) plate 22 that tilts and slides on a motor driven drive shaft 6 is made to rotate with the shaft, so that when tilted it reciprocates the pistons 29 of cylinders arranged around the drive shaft. The amount of tilt or the inclination angle of the drive plate determines stroke length and thus amount of compression. Normally the tilt angle has a minimum non-zero value so that there is sufficient compressive reaction force from the compressors to urge the plate out from that minimum position.

The invention's main idea is to provide means which allows the plate to assume a 0° tilt angle, from which it can nevertheless return to a larger tilt. This reduces engine load at minimum position and power consumption, see specification paragraph [0009].

To this end the compressor of claim 1 as upheld by the opposition division (main request) includes an urging means 27 (a spring) which pushes the plate away from the 0° position and which is assisted by the moment of inertia of an appropriately designed plate, i.e. an unbalanced plate.

## 3. *Main Request*

3.1 The Board considers E2 to represent the closest prior art. Claim 1 is in fact drafted in two part form

against this prior art. E2 undoubtedly discloses all the features of claim 1's preamble. Thus, figure 1 shows a conventional clutchless variable displacement compressor which features with a housing 44 compression cylinders 28, each with a bore and piston 5, and crank-, suction and discharge chambers. The pistons 5 are driven by a drive plate 3 tiltably mounted on and rotating with drive shaft 1. Tilt is varied in response to the pressure difference between crank- and cylinder bore so as to vary cylinder stroke length and thus compression rate. It varies from a maximum angle (as shown in the figure) and a minimum angle, from which a wavy spring 48 restores it to a larger angle, see the abstract E2a. The minimum angle is zero, see for example page 3, lines 13 and 14 of the translation E2b.

3.2 The compressor of claim 1 differs from this prior art in its characterizing feature, namely the construction and arrangement of the drive plate, which is so as to create an additional moment of inertia that assists the spring as urging member to increase the inclination (tilt) angle from its minimum. The plate is so effectively unbalanced to create an additional moment of inertia out of the minimum tilt. E2, apart from the schematic cross-section of figure 1, offers no detailed information of the plate's construction and arrangement and is silent as to its moment of inertia or how it might effect the plate's behaviour during operation. Vis-à-vis E2 unbalancing the drive plate as claimed represents a particularly advantageous way of realizing the plate which provides an additional return moment from minimum tilt. The objective technical problem can be formulated accordingly as ***how to realize the drive plate of a variable displacement compressor as in E2.***

3.3 Further prior art E3, see its abstract and figure 1, already teaches how to set the moment of inertia of the swash or drive plate of a variable displacement compressor so that a moment is generated to move it from 0° inclination to a larger inclination in response to the slowest possible rotation of the swash plate. In figure 1 the drive plate 14 is shown tiltably mounted via a sleeve element 12 on shaft 6 so as to drive pistons 10 of cylinder bores 9, see also column 5, lines 44 to 63. The underlying mechanics for achieving the desired plate unbalance are explained in detail in columns 10 to 15.

3.4 The skilled person is a mechanical engineer involved in the design of variable displacement compressors and with an extensive knowledge in that field. When tasked with realizing a compressor as in E2, which gives him scant information of its drive plate, he will obviously look towards relevant prior art offering him more detail of drive plate design. Among these E3 will be of particular interest to him as it offers advantages in E2's field of focus, namely helping the plate return from minimum tilt angle. Realizing the two measures - spring on one hand, unbalanced plate design on the other - can be used to support each other, he will as a matter of course adopt E3's teaching to realize an unbalanced drive plate in a variable displacement compressor with return spring as in E2 where the two measures act to assist each other. He so arrives at the compressor of claim 1 of the main request without an inventive step.

3.5 That claim 1 offers further reduction in power consumption as the plate need not be so unbalanced that it returns from minimum tilt on its own is not apparent from the claim's wording. The final feature merely requires cooperation of the urging member's moment and the plate's additional moment. This is the case irrespective of their relative size. The Board thus disregards any such limitation and its effect in its consideration of inventive step.

Nor is the Board convinced that the skilled person is generally disinclined to combine measures with the same effect. Combination often offers useful redundancy, or combined effects may complement each other. As for the increased costs of combining similar measures this is a routine economical concern that can hardly be equated to a generally existing technical prejudice.

4. *Auxiliary Request 2*

4.1 *Article 84 EPC*

The added final feature of claim 1 specifies that during idling the additional (inertial) moment ***requires*** cooperation with the moment due to the urging member in order to effectively move the plate back from its minimum inclination angle. That angle is defined in the preamble as being "set to zero degrees" or a load equivalent angle, which is necessarily a near zero angle. The Board understands this to mean that the inertial moment acting on the plate during idling is insufficient to incline the plate from this minimum zero or near zero angle if it were acting on its own: it needs the assistance of the moment exercised by the

urging means. This adds information as to the relative size of the inertial moment during idling, which is less than that of a plate designed to incline from 0° or near 0° on its own at idling. It thus qualifies the degree of cooperation of the two effects, rather than merely rephrasing that they cooperate. In the Board's view this represents a clear further limitation, Article 84 EPC.

4.2 *Article 123 EPC*

4.2.1 The Board further holds that this limitation can be directly and unambiguously derived from paragraph [0091] of the A-publication (of the as filed application) corresponding to patent specification paragraph [0094] cited as basis. Stating that the two effects cooperate, this passage goes on to explain that "if the return spring 27 were omitted, the compressor could be designed such that increasing the inclination angle from near 0° would mainly depend on the rotational motion moment. In this case, however the products of inertia of the swash plate 22 must be increased to guarantee a force large enough to incline the swash plate when [its] rotational speed ... is minimum (during idling)". The corollary is that when the spring ***is*** present, as it is in the first embodiment, the products of inertia ***must*** be ***smaller*** than necessary to tilt the plate from 0° when acting on their own. Consequently, the plate inertia products are then too small to tilt the plate on their own and thus require the further assistance of the spring force to return the plate from 0°. That the passage contemplates a modification of the compressor without spring, i.e. away from its central idea, thus serves to demonstrate

the relative reduction in the plate's product of inertia made possible by the presence of the spring.

Furthermore, when paragraph [0091] is read contextually, it is clear that the "near 0°" angle mentioned there is to be read as shorthand for the range of minimum inclination angles mentioned in the first sentence of paragraph [0087]. This is the range of smaller than conventional angles around 0° shown in figures 7 and 8, from which return is now possible and for which compressor load on the engine is reduced to a minimum. It corresponds to the minimum angle as defined in the preamble of claim 1, which in turn derives from as filed claim 2.

No further objection under Article 123(2) EPC is raised against claim 1 of this request, nor is it apparent to the Board that this amended version adds subject-matter. Indeed, this version of claim 1 is seen to combine the features of originally filed claims 1, 2, 3 and 8 while adding the qualified cooperation from paragraph [0091] of the published application. The Board is satisfied that claim 1 of the auxiliary request 2 complies with Article 123(2) EPC.

4.2.2 The Board adds that the features added to claim 1 as granted are undisputable limitations of its scope: claim 1 of auxiliary request 2 also complies with Article 123(3) EPC.

4.3 *Patentability*

4.3.1 In addition to the differing feature mentioned in section 3.2 above, the compressor of claim 1 of this

request differs from that of E2 in the implied relative size of the plate's moment. As noted E2 is silent as to the plate's moment of inertia.

The implied relative size naturally differentiates the claimed compressor from that of E3, where the plate's product of inertia is large enough to return the plate from 0° at idling on its own without a spring. E3 moreover also does not directly and unambiguously teach an urging member. The exact function of the forwardly bent part of circlip 30 (a mechanical stop as described in see column 6, lines 49 to 52) cannot be inferred with certainty from figure 1. The forwardly bent leg might also reasonably be read as part of a set self-lock mechanism of a known type of self-lock circlip as argued by the Respondent. This reading would explain the gap seen in figure 1 in the sleeve 12 opposite the end of the projecting leg of the circlip 30: it avoids contact of sleeve and clip so preventing release of the self-lock mechanism.

The feature of the relative size of the plate's inertia is in fact not disclosed in any other document, and the Board finds that this feature alone renders the compressor of claim 1 (auxiliary request 2) novel, Article 52(1) with Article 54 EPC. The Appellant has in fact not disputed novelty for this version of claim 1.

4.3.2 Starting again from E2 as closest prior art the two differences can be summarized as unbalancing the plate to return it from its minimum tilt near 0° to an extent that is smaller than would be necessary if the return movement relied entirely on the unbalancing. Not only does this offer a particular way of realizing the plate,

where E2 was silent, it does so in a manner that is associated with a further reduced load and differential pressure during faster (than idling) rotation speeds, as can be inferred from the final six lines of paragraph [0094] of the patent specification. The objective technical problem can be formulated accordingly as ***how to realize a plate in a compressor as in E2 while reducing load and differential pressure***.

The solution offered in claim 1 of auxiliary request 2 is not suggested by any of the prior art citations. As set out above it may be obvious to adopt E3's teaching to realize a plate that is unbalanced to help return it from near 0°, but there is no suggestion in E3 or elsewhere that the amount of unbalancing can be reduced so as to reduce load and differential pressure. Nor is this advantageous combination of the spring and plate unbalancing obvious in itself. It is based on the dual insight that the spring force relieves constraints on the level of unbalancing, and that load and differential pressure are linked to the level of unbalancing. Such an insight goes beyond the normal skills and knowledge of the skilled person.

The insight that spring and plate unbalancing can be advantageously combined to reduce load and differential pressure also renders the claimed compressor inventive starting from E3 as closest prior art.

4.3.3 E16 filed with the statement of the grounds of appeal is also cited against inventive step of claim 1 of the auxiliary request 2. This document relates to a variable displacement compressor which has a clutch 36 (column 2, line 41) and the main idea of which is to

*balance* the drive plate using an additional balance disk 500, see the abstract in conjunction with figure 1. It thus teaches away from the present invention where the drive plate is unbalanced and the compressor clutchless, let alone that it suggests a degree of cooperation between spring and a balanced plate. For these reasons the Board in fact considered E16 to be prima facie not relevant and did not admit the document into the proceedings pursuant to Article 12(4) of the Rules of Procedure of the Boards of Appeal.

4.3.4 The Board concludes that the compressor of claim 1 of the auxiliary request 2 involves an inventive step, Article 52(1) in combination with Article 56 EPC.

4.4 No further objections are raised or are apparent against claim 1 or its dependent claims according to auxiliary request 2. The description having been brought into conformity with the claims as amended, the Board finds that the patent and the invention to which it relates now meets the requirements of the EPC. It concludes that the patent can be maintained in this amended form in accordance with Article 101(3)(a) 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 order to maintain the patent as amended in the following version:

Description: Columns 1,2,5-62,65 of the patent specification
Columns 3-4 as filed on 2 February 2009 during oral proceedings before the opposition division
Columns 63,64 as filed with letter of 2 March 2011.

Claims: 1-12 as filed with letter of 2 March 2011 as auxiliary request 3 now auxiliary request 2.

Drawings: Figures 1-24 of the patent specification.

The Registrar The Chairman

G. Magouliotis M. Ceyte