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Datasheet for the decision of 11 December 2019

Case Number: T 1815/16 - 3.2.04

Application Number: 10747261.5

Publication Number: 2452074

IPC: F04C18/08, F04C18/16

Language of the proceedings: EN

Title of invention:
DRY SCREW DRIVER

Patent Proprietor:
GARDNER DENVER S.r.l.

Opponent:
Atlas Copco Airpower N.V.

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - (no)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 1815/16 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 11 December 2019

Appellant: (Patent Proprietor)	GARDNER DENVER S.r.l. Via Giacomo Brodolini, 17 Cormano (MI) (IT)
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Respondent: (Opponent)	Atlas Copco Airpower N.V. P.O. Box 101 Boomsesteenweg 957 2610 Wilrijk (BE)
Representative:	V.O. P.O. Box 87930 2508 DH Den Haag (NL)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 2 June 2016 revoking European patent No. 2452074 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	A. de Vries
Members:	S. Oechsner de Coninck
	T. Bokor

Summary of Facts and Submissions

I. The appellant (proprietor) lodged an appeal received on 30 July 2016 against the decision of the opposition division dispatched on 2 June 2016 on the revocation of the patent EP 2 452 074, and simultaneously paid the appeal fee. The statement setting out the grounds of appeal was received on 12 October 2016.

II. The opposition was based on Article l00(a) EPC together with Articles 52(1), 54(1) and 56 EPC. The Opposition Division found claim 1 as granted to lack novelty, found the auxiliary requests 1 to 3, 6 and 7 not allowable for either lack of novelty or inventive step, and did not admit auxiliary requests 4 and 5.

III. In the present decision, reference is made to the following documents:

O8: N. Weckes: "Ein Beitrag zur Optimierung geometrischer und thermodynamischer Kenngrössen von Schraubenladern", Universität Dortmund, Dissertation 1994

O9: US 2007/0207050 A1

O11: J.Gieras and M.Wing "PERMANENT MAGNET MOTOR TECHNOLOGY" Design and Applications Second Edition, Revised and Expanded, front page to page 18; published 2002

IV. The Board issued a communication in preparation for oral proceedings and setting out its provisional view on the relelvant issues.

Oral proceedings were held on 11 December 2019.

V. The appellant (patent proprietor) requests that the decision under appeal be set aside and the patent be maintained as granted (main request) or in an amended form on the basis of one of the first to third auxiliary requests filed with the grounds of appeal dated 12 October 2016.

VI. The respondent (opponent) requests that the appeal be dismissed.

VII. The wording of the independent claim 1 of the different requests reads as follows:

Main request (as granted)

"Dry screw compressor (1) having a male rotor (2) whose peripheral speed is lower than 80 m/s; compressor (1) comprising:
- a casing body (4) having an inlet (10) for a gaseous fluid to be taken in and at least an outlet (11) for the compressed fluid;
- at least a male rotor (2) and at least a female rotor (3) meshed together, said rotors (2, 3) being arranged inside said casing body (4);
compressor (1) characterized in that the ratio between the length (Lm) and the external diameter of the male rotor (2) is higher than or equal to two, and in that the winding angle (φ) of the male rotor (2) is smaller than or equal to 300°."

First auxiliary request

1. Dry screw compressor (1) having a male rotor (2) whose peripheral speed is lower than 80 m/s; compressor (1) comprising:

- a casing body (4) having an inlet (10) for a gaseous fluid to be taken in and at least an outlet (11) for the compressed fluid;

- at least a male rotor (2) and at least a female rotor (3) meshed together, said rotors(2, 3) being arranged inside said casing body (4);

compressor (1) **characterized in that** the ratio between the length (Lm) and the external diameter of the male rotor (2) is higher than or equal to two and the winding angle (φ) of the male rotor (2) is smaller than or equal to 300°, and **in that** the driving shaft is a shaft (17) on which said female rotor (3) is keyed.

Second auxiliary request

1. Dry screw compressor (1) having a male rotor (2) whose peripheral speed is lower than 80 m/s; compressor (1) comprising:

- a casing body (4) having an inlet (10) for a gaseous fluid to be taken in and at least an outlet (11) for the compressed fluid;

- at least a male rotor(2) and at least a female rotor (3) meshed together, said rotors (2, 3) being arranged inside said casing body (4);

wherein the ratio between the length (Lm) and the external diameter of the male rotor (2) is higher than or equal to two, and **in that** the winding angle (φ) of the male rotor (2) is smaller than or equal to 300°;

wherein the driving shaft is a shaft (17) on which said female rotor (3) is keyed;

characterized in that it further comprises an electric motor (16) operationally acting on the shaft (17) of the female rotor (3) for starting its rotation around a first axis of rotation (01); **in that** the rotor of said electric motor (16) is keyed on said shaft (17) of the female rotor (3); and **in that** said electric motor (16) is a permanent magnet motor.

Third auxiliary request

1. Dry screw compressor (1) having a male rotor (2) whose peripheral speed is lower than 80 m/s; compressor (1) comprising:

- a casing body (4) having an inlet (10) for a gaseous fluid to be taken in and at least an outlet (11) for the compressed fluid;

- at least a male rotor (2) and at least a female rotor (3) meshed together, said rotors (2, 3) being arranged inside said casing body (4);

wherein the ratio between the length (Lm) and the external diameter of the male rotor (2) is higher than or equal to two, and **in that** the winding angle (φ) of the male rotor (2) is smaller than or equal to 300°;

wherein the driving shaft is a shaft (17) on which said female rotor (3) is keyed;

characterized in that it further comprises an electric motor (16) operationally acting on the shaft (17) of the female rotor (3) for starting its rotation around a first axis of rotation (01); **in that** the rotor of said electric motor (16) is keyed on said shaft (17) of the female rotor (3); **in that** said electric motor (16) is a permanent magnet motor; and in that the number of lobes (6) of the male rotor (2) is lower than the number of lobes (9) of the female rotor (3) by at least one unity.

VIII. The appellant argues that O8 fails to teach the combination of all features and even teaches away from their combination. O8 seeks to find optimal parameters, and suggests L/D ratio as 1.1-1.5, this being the optimum. The teaching of O8 is to refrain from parameters outside the optimum ranges. As explained in paragraphs 30 and 31, the claimed combination of features brings advantages, e.g. high flow, i.e. high capacity.

IX. The respondent argues that O8 clearly teaches the combination of all claimed features, e.g. in Fig. 7-25 together with the explanation of the simulation method and the parameters held constant. O8 teaches that a high L/D ratio offers high air mass pumping speed, thus the skilled person would seriously consider values of L/D above 2.

Reasons for the Decision

1. The appeal is admissible.

2. Background

The invention is concerned with a dry screw compressor with meshing male 2 and female rotors 3 within a casing 4. According to claim 1 this compressor is characterized by ranges for particular design parameters of the male rotor, namely the ratio of length to external diameter of the male rotor which should be equal to or above 2; and winding angle which should be equal to or smaller than 300°. This is said to result in a compressor that "can work under lower pressure, with a high flow and thermodynamic efficiency", patent specification, paragraph [0011].

3. Non-admission of the Document O8

The document O8 was filed on 17 February 2016 one month before the oral proceedings before the Opposition Division on 17 March 2016. There the division admitted it into the proceedings. The appellant requests that this document now be disregarded in appeal.

The Board observes that the Opposition Division, after having given the parties ample occasion to comment in

oral proceedings, made a thorough assessment of the relevance of O8 at first sight, and decided to admit it in view of its chances to change the outcome of the case (points 2.1 and 2.2 of the decision).

The Board finds that the division, having exercised its discretionary power on the basis of *prima facie* relevance and having heard the parties, exercised its power under Article 114(2) EPC according to the correct principles and in a correct manner. Moreover, the Board sees no legal basis for formally not admitting a document into the proceedings which was admitted and dealt with by the Opposition Division, and on which the appealed decision is mainly based.

Therefore the Board concludes that there is no reason to overturn the admission of O8 by the division and to disregard it in appeal.

4. Main request - inventive step

4.1 Document O8 is a doctoral thesis evaluating several designs for optimizing the geometry and thermodynamics of a screw compressors. O8 is concerned with the use of screw compressor for supercharging combustion engines of various types and for various applications (pages 1 and 2 chapter 1). In particular O8 studies by simulation the effects of variation of several central design parameters on performance; in the final summary recommendations are then made regarding ranges for optimal performance of the combination screw compressor/combustion engine (pages 122-123, chapter 9 "Zusammenfassung"). The parameters studied include in particular the geometrical parameters mentioned in claim 1: winding angle (Item 7.2.1, pages 48-62), the length to diameter ratio (Item 7.2.2, pages 63-83), as

well as the influence of the operational parameter of peripheral speed on each of these geometrical parameters. The influence of each of these relevant parameters (L/D, winding angle or peripheral speed) are evaluated separately, with each varied in the simulation model with all other parameters held constant (page 42, paragraph 3). The results are shown in graphs and discussed to identify optimal ranges (e.g figures 7-14, page 56 and figure 7-17 on page 59 for the parameter winding angle and figure 7-25 on page 69 for L/D).

All the values of winding angles simulated and explained in chapter 7.2.1 from page 48 to 62 concern values below 300° and therefore all fall within the claimed range. O8 thus discloses this feature.

4.2 However, for the winding angle simulations it is not clear at what particular aspect ratio these were conducted, or - and assuming such a feature relating to the operation of the compressor implies any structural limitations - whether they were conducted at peripheral speeds under 80 m/s. Though the different simulations of O8 do mention values in the respective parameter ranges, O8 is not considered to provide a direct and unambiguous disclosure of the combination of the values given in those disparate parts. Thus, the claimed compressor differs from the disclosure in those part of O8 that generally teaches winding angles below 300° by the aspect ratios of 2 and over, and by peripheral speeds below 80 m/s.

4.3 The patent in paragraphs [0030] and [0031] associates L/D values above 2 (in combination with winding angles under 300°) with maximised compressor capacity and high gas flow. This appears to echo the objective identified

in paragraph [0011] of proposing a dry screw compressor that can work under low pressure with high flow and thermodynamic efficiency. Thus, by choosing aspect ratios in the desired range - a critical design parameter according to O8 - compressor capacity and gas flow are optimized for low pressure conditions. The objective technical problem can be formulated accordingly in general terms, as optimizing a dry screw compressor.

4.4 O8 itself is already concerned with the optimization of dry compressors, see title, with a focus on geometric and thermodynamic characteristic parameters. It identifies aspect ratio L/D as one of these, see sections 3.1.1 and 7.2.2. Section 7.2.2 in particular considers the results of simulations for variations in L/D. As is evident from figures 7.20, 7.22 to 7.26 and 7.29 to 7.36 the variations extend to values of L/D beyond 2 and up to 3. Indeed figure 7.21 c shows an example of a screw rotor with an aspect ratio of 2.5. It thus undoubtedly discloses values within the claimed range. However, in the summary in section 9, page 123, last sentence of paragraph 1, O8 then gives a recommended range of values for the aspect ratio L/D between 1 and 1,5, considered as favorable in the context of the combination of a screw compressor with a combustion engine. The question therefore arises, whether the skilled person, tasked with optimizing a dry screw compressor, would seriously contemplate trying values outside the recommended range in the expectation of some benefit.

4.5 Turning to the recommendation of O8 to work within a certain range of values of aspect ratios, the Board does not consider this to be a disincentive *per se* to explore other values of L/D. It is no more than an

advice that is normally conditional to given circumstances. The summary itself makes the recommendation in the context of optimising screw compressors for supercharger of an internal combustion engine, and it is thus clear that the recommendation is valid for this particular application (page 122, first paragraph of chapter 9 "abgasturboaufgeladener Verbrennungsmotoren"). This is alos apparent in the last paragraph on page 82, where an L/D value of 3 is described as unfavourable for engine chargers ("Motor-Lader-Kombination"). This is because in this application the advantage of high compression and gasflow is balanced out by high drive torque. It is therefore within the particular context of screw compressors in the automotive industry that the skilled person understand values of L/D from 1,1 to 1,5 to be advantageous and much larger ones of 3 being less so. However, this does not exclude that under certain circumstances and other applications or conditions the skilled person might arrive at a different balance. Taking the example of page 82, it may well be that for certain motor charger applications the skilled person gives high compression rate and gas flow a much greater weight than high drive torque, and thus strikes a different balance.

4.6 Figures 7-25, 7-26 and 7-29, show different measures of efficiency or effectiveness (charging efficiency or "Liefergrad" in figure 7.25; relative work ratio or "Arbeitsflächenverhältnis" in figure 7.26; thermodynamic relative efficiency or "Gütegrad" in figure 7.29) as a function of aspect ratio and peripheral speed. Each is in the form of a surface with different shaded areas that are taken to represent some form of grading. Thus, darker areas appear to indicate less favourable, lighter areas more favourable values;

indeed the lighter areas are close to or include the reference value e ("Bezugswert") at and L/D value of 1.5 and peripheral speed of 100 m/s, while the darker areas are distant from the reference value. In all three graphs the unshaded or lightly shaded areas of relative favourability include points with high aspect ratio (2 and above) at low peripheral speed (below 80 m/s), which in figure 7.25 and 7.26 also include local optima. They are certainly not points that appear unsuitable because, for example, they lie in the dark shaded areas far from the reference value. Consequently, in the Board's view these figures provide a further clear indication that the skilled person would seriously contemplate trying such values or value combinations when optimizing a dry screw compressor for given conditions.

4.7 The appellant has further submitted that the design combination of L/D above 2, operated at rather low speeds under 80m/s, is associated with specific advantages or effects as explained in paragraph 30 and 31 of the patent, and which would constitute a rather surprising effect. This would be all the more surprising because of the recommendation to work in the range from 1,1 to 1,5 expressed on page 173, and page 82's mention of a large L/D value of 3 as unfavourable.

4.8 However, the Board does not consider this increased capacity to represent a surprise for the skilled person. Rather, from straightforward geometrical considerations they will expect capacity to increase for larger values of L/D. Indeed at constant diameter a longer screw increases the pumping volume available between both screws with a corresponding effect on capacity. This expected effect on capacity is apparent from the mention on page 82, last paragraph, third

sentence of O8 of increased mass flow of compressors for an L/D value of 3. Therefore the effect is far from unexpected, and cannot be considered as indicative of inventive step, see Case Law of the Boards of Appeal, 9th edition 2019, I.D.10.8.

4.9 From the above the Board concludes that O8 does not teach away from L/D values above 2 and that therefore the skilled person would have seriously contemplated L/D values above 2 in the process of routine optimisation of the capacity, for example to adapt a screw compressor to other applications or operating conditions. Nor is that range associated with a surprising effect. Hence, the screw compressor of claim 1 as granted lacks an inventive step in view of O8.

4.10 The Board thus confirms the opposition division's negative finding for claim 1 of the granted patent, but for other reason, as it does not meet the requirements of inventive step pursuant Article 56 EPC.

5. Auxiliary requests 1 to 3 - inventive step

The features added to claim 1 according to these requests either represent common general knowledge or are already known in the field of dry compressors.

Thus, keying the female rather than the male rotor on the driving shaft (auxiliary request 1), where both rotors do not contact and are rotated in unison with synchronising gears, appears to be a simple choice between the only two possible drive configurations. Such a compressor drive configuration is also known from O9, see paragraph 46 and figures 2 and 4.

Similarly, a permanent magnet motor as direct drive is an alternative to the direct current motor described in O8 (page 28, figure 4.1) that is well-known to the skilled person from his common general knowledge of electrive drives. O11 at page 18 for example mentions their application to air compressors.

Finally, all configurations considered in O8 have a smaller number of lobes on the male rotor, see figures 7.47 and 7.63.

In the light of the above the Board concludes that none of these features contribute to inventive step.

6. Since none of the submitted requests contains subject-matter that involves an inventive step under Article 56 EPC, the Board can but confirm the impugned decision to revoke the patent pursuant to Article 101(3)(b) EPC.

Order

For these reasons it is decided that:

The appeal is dismissed

The Registrar: The Chairman:

G. Magouliotis A. de Vries

Decision electronically authenticated