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Datasheet for the decision of 31 January 2017

Case Number: T 0566/15 - 3.2.01

Application Number: 02726346.6

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Language of the proceedings: EN

Title of invention:
REGENERATION OF AIR DRYER

Patent Proprietor:
WABCO GmbH

Opponent:
Knorr-Bremse Systeme für Nutzfahrzeuge GmbH

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
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Decisions cited:

Catchword:

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Case Number: T 0566/15 - 3.2.01

D E C I S I O N
of Technical Board of Appeal 3.2.01
of 31 January 2017

Appellant: (Opponent)	Knorr-Bremse Systeme für Nutzfahrzeuge GmbH Moosacher Str. 80 80809 München (DE)
Representative:	Maiwald Patentanwalts GmbH Grünstrasse 22-24 40212 Düsseldorf (DE)
Respondent: (Patent Proprietor)	WABCO GmbH Am Lindener Hafen 21 30453 Hannover (DE)
Representative:	WABCO GmbH Intellectual Property Department Am Lindener Hafen 21 30453 Hannover (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 15 January 2015 rejecting the opposition filed against European patent No. 1390244 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	G. Pricolo
Members:	W. Marx
	P. Guntz

Summary of Facts and Submissions

I. The appeal of the opponent is directed against the decision of the opposition division rejecting the opposition against European patent No. 1 390 244.

II. In its decision the opposition division held that the subject-matter of claim 1 as granted involved an inventive step in view of the following prior art:
D1: DE 199 11 741 A1;
D2: EP 0 808 756 B1.

III. Oral proceedings before the board took place on 31 January 2017.

The appellant (opponent) requested that the decision under appeal be set aside and that the European patent be revoked.

The respondent (patent proprietor) requested that the appeal be dismissed or, in the alternative, that the patent be maintained in amended form on the basis of one of auxiliary requests 1 to 6 as filed with the letter dated 14 December 2016. The objection regarding the inadmissibility of the appeal due to an alleged lack of reasoning was not upheld.

IV. Claim 1 as granted reads as follows (broken into a feature analysis adopted by the parties):

(a) A method of initiating a regeneration event for the air dryer of a vehicle air braking system, the method comprising the steps of:

(b) estimating in real time the instantaneous forward flow rate of air from an air compressor;

(c) modifying the instantaneous forward flow rate according to conditions of the air braking system;

(d) calculating the volume of forward air from the compressor for a predetermined time interval;

(e) repeating said estimating, modifying and calculating steps for successive time intervals to provide a current forward tally of forward air volume;

(f) periodically comparing the current forward tally with a saturation threshold of a desiccant material;

(f1) and initiating a regeneration event when said forward tally reaches or exceeds said saturation threshold,

characterised in that

(g) the method further comprises estimating the volume of backflow of dry air during a regeneration event, and comprises the steps of:

(h) estimating in real time the instantaneous reverse flow rate of dry air to the air dryer;

(i) modifying the instantaneous reverse flow rate according to conditions to the air braking system;

(j) calculating the volume of reverse air for a predetermined time interval;

(k) repeating said estimating, modifying and calculating steps for successive time intervals to provide a current reverse tally of reverse air volume;

(l) periodically comparing said reverse tally with a dryness threshold of said desiccant material;

(m) and ceasing a regeneration event when said reverse tally reaches or exceeds said dryness threshold.

V. The appellant essentially argued as follows:

The subject-matter of granted claim 1 did not involve an inventive step in view of D1 and D2. Features (a) to (g), (l) and (m) were known from D1, and feature (h) described a method known from D2, feature (i) a method known from D1. Features (j) and (k) related to a loop in a computer program for calculating an integral over time, as included in the methods known from either D1 or D2.

Monitoring of pressure via a pressure sensor in D2 was made in "real time" and was "instantaneous", and the regeneration air volume was calculated on the basis of the measured air pressure (column 5, lines 34-38). The electronic control unit knew the actual pressure and pressure gradient at any time and calculated the flow rate from a change in pressure over time (column 4, lines 40-45). Although no mathematic formula was given, the skilled person knew how to transform a pressure into a flow rate (e.g. via the ideal gas equation $pV = nkT$, showing the influence of temperature which could be taken into account, see feature (i)). Moreover, the advantage of a volume-based control (calculating the regeneration air volume from the pressure gradient), in comparison to a time-based control of regeneration, was summarised in D1 which explicitly mentioned D2 when describing the known prior art (page 2, lines 21-27).

The influence of temperature (as mentioned in the contested patent) on regeneration was known from D1 (page 2, lines 55-56; claim 2), i.e. the total content of feature (i). D1 did not explicitly disclose a modification of the air flow rate, but according to the contested patent (column 4, lines 6-9) it was equally possible to modify the calculated regeneration air volume. It was only important to take into account the temperature influence, irrespective of where it was considered within the algorithm, and selecting the air flow rate could not be considered to be an inventive contribution. Moreover, applying the concept of known feature (c) also on air flowing in a second direction was obvious.

D1 and D2 only disclosed a flow rate and an air volume as an end result, but not explicitly features (j) and (k). However, these steps were performed because a rate could only be transformed into a volume by integrating it. Both D1 ("counting") and D2 ("monitoring") showed an iterative method comprising a loop, and the "reverse tally of reverse air volume" of feature (k) was the integrated regeneration air volume. Moreover, specifying a numerical integration was not inventive.

Starting from D1 as closest prior art, the only feature distinguishing the subject-matter of claim 1 from D1 was feature (h). There was no explicit disclosure in D1 of an instantaneous reverse flow rate of dry air, but according to D1 (page 4, line 63) the regeneration air volume was determined (feature(g)). In D1, the duration of regeneration phase was fixed at the beginning of the

regeneration phase, whereas in the contested patent it was dynamically adapted to the reverse air flow. The teaching of D1 was not limited to a mere time-dependent control. During a regeneration phase, a counter was decremented in D1 and, in parallel, also a regeneration air volume (see page 4, lines 60-62). The regeneration air volume was known in D1, and the counter reading was only related to the regeneration air volume (page 4, lines 10 ff). D1 was silent on how to "count" the regeneration air volume, but the skilled person would mirror the teaching known from D1 for a forward direction of air flow to the reverse direction of air flow. Therefore, the subject-matter of claim 1 was already obvious in view of D1 alone.
When starting from D1 the problem was that D1 did not show how to determine the regeneration air volume. The solution was known from D2 (which was already cited in D1). According to D2, the volume of air used during regeneration was determined by means of a pressure sensor which provided a system pressure value to the electronic control unit (column 5, lines 34 ff; see also claim 1, column 7, lines 31 ff; also claim 2). Calculating the regeneration air volume from pressure values was merely a matter of well-known physics. It was known that the flow rate was dependent on the pressure difference (equation of Hagen-Poiseuille for tubes), and the volume was obtained by integration of the flow rate. In the same way, the volume of reverse air was estimated from information on the system pressure in the contested patent. As regards the step of modifying the instantaneous reverse flow rate (feature (i)), it just meant a correction factor as included in the calculation of the flow rate in a forward direction in D1. Due to the temperature influence on compressible fluids such as air, there was

no reason why this should not be considered in the reverse direction.
When formulating the objective technical problem as providing a more efficient regeneration phase, the solution to this problem was mentioned in D1 with reference to D2 (page 2, lines 21-27). D2 described an improvement over the drawbacks of the known prior art cited before (pressure sensors to determine the air volume instead of having a time counter), so the skilled person was motivated to combine this known method with the teaching of D1.

Starting from D2, although not reciting literally a "saturation threshold" or "dryness threshold" (as in features (f), (f1), (l), (m)), the technical teaching in D2 was identical (column 4, lines 29-33). The time for starting regeneration was the time when the saturation threshold was reached, and the volume of reverse air that had to flow across the air dryer corresponded to the volume of dry air necessary for reaching the dryness threshold. Therefore, all the features of claim 1 were disclosed in D2 except for features (c) and (i), which related to modifying the forward or reverse flow rate dependent upon conditions of the air braking system. The objective technical problem was to make more efficient use of the available compressed air.
The rather general formulation of features (c) and (i) comprised e.g. switching off the regeneration system (condition) and setting the reverse flow rate of dry air to zero (modifying). Such a self-evident method step did not justify an inventive step. Even assuming a limitation of "conditions" as mentioned in the description of the contested patent (paragraph [0013]; column 5, line 41; paragraph [0020]: air density, humidity or temperature), such teaching was known from

D1 as argued above, so in view of D1 the skilled person could have performed these steps. Moreover, as a motivation, the skilled person knew that a compressed air system could be operated more efficiently by taking into account parameters such as pressure and temperature, which were physically linked to the volume (via ideal gas equation). Features (c) and (i) did not provide any additional surprising effect, and the only exception mentioned in the contested patent was an "adjustment according to the country of operation" in order to "avoid unnecessary regeneration" (column 5, lines 42-45).

VI. The respondent's arguments relevant to the present decision can be summarized as follows:

D1 did not disclose all features (a) to (g), (l), (m). The appellant's interpretation of documents D1 or D2, in particular regarding features which were not explicitly mentioned in D1 or D2 but allegedly were included in those documents according to the knowledge of the skilled person, was based on an ex-post-facto analysis. D1 only disclosed a time-dependent control and calculated the total volume of forward air which had passed through the air dryer, assuming that the saturation level was 100% (page 4, line 63). Depending on the pressure in the reservoir, it was possible to estimate the time needed for regenerating the air dryer (at higher pressure, the amount of reverse air flow was higher, resulting in a shorter time). A pressure gradient was only mentioned in D1 when citing D2 as prior art which needed improvement. D2 even did not disclose monitoring of a pressure gradient, but compared the pressure values in the reservoir and behind the air dryer (see column 4). Moreover, none of the documents took into account a step of modifying the reverse flow rate according to conditions of the air braking system. The subject-matter of claim 1 was therefore not obvious in view of any combination of D1 and D2.

Reasons for the Decision

1. The subject-matter of claim 1 as granted according to the main request involves an inventive step in view of the prior art cited by the appellant (Article 56 EPC).

2. Starting from document D1 as the closest prior art:

2.1 D1 discloses a method of initiating a regeneration event for the air dryer of a vehicle air braking system comprising steps (a) to (f1) according to the preamble of claim 1. Moreover, features (g), (l) and (m) can be identified in D1.

The calculation of a forward tally of forward air volume in accordance with features (b) to (e) is described in D1 by a formula (page 4, line 20), which includes an estimation of the instantaneous forward flow rate from compressor specific data, a modification dependent on temperature, a volume calculation for a given time interval and a repeating step expressed by a summation operator. A counter is incremented in accordance with the increase of forward air volume (see page 4, lines 13-17). When reaching a predetermined counter reading, which corresponds to a saturation threshold of a desiccant material, a regeneration event is initiated (page 4, lines 27-28), i.e. D1 shows the steps of periodically comparing the counter, which represents the current forward tally, with a dryness threshold and initiating a regeneration event according to features (f) and (f1).

D1 also discloses (as mentioned on page 4, line 63) an estimation of the volume of backflow of dry air during a regeneration event according to feature (g). This regeneration air volume is controlled in D1 (as mentioned before on page 4, lines 36-38) by determining a regeneration time and switching off the regeneration event at the end of the regeneration time, namely by decrementing a counter until a predetermined counter value is reached (page 4, lines 60-62). Thus, D1 also shows the steps of comparing a current reverse tally of reverse air volume with a dryness threshold and ceasing a regeneration event according to features (l) and (m), whereby the current regeneration air volume is represented by the current counter value.

2.2 There is no teaching in D1 on estimating in real time the instantaneous reverse flow rate of dry air according to feature (h), and consequently D1 cannot show a modification of the instantaneous reverse flow rate according to feature (i) either. Taking features (j) and (k) together, they define a numerical integration to provide a current reverse tally of reverse air volume. As agreed by the appellant, D1 is silent on how to "count" the regeneration air volume, so features (j) and (k) are also not shown in D1.

2.3 According to a first line of argument of the appellant, the skilled person would mirror the teaching known from D1 for a forward direction of air flow to the reverse direction of air flow, in order to fill a lack in the teaching of D1 with regard to "counting" the regeneration air volume. However, except for mentioning that a regeneration air volume is determined (page 4, line 63; also line 10), D1 does not provide any indication that, in parallel to the time counter being decremented in D1, this regeneration air volume is decremented on the basis of an estimation of instantaneous reverse flow rates of dry air. It is agreed that the counter which is decremented during regeneration has a value which relates to the regeneration volume during regeneration and is representative of the current saturation level (see page 4, lines 12-13). But there is no indication that a variable decrement has to be assumed which might represent a value indicative of the instantaneous reverse flow rate, as required by feature (h), so there is no prompting for the skilled person to mirror the steps known from D1 for a forward flow of air when the reservoirs are being charged by the compressor (i.e. for mirroring steps (b) to (e)) to steps (h) to (k).

The passage cited by the appellant (page 4, lines 60-62: "Während der Regenerationsphase wird der Zählerstand entsprechend der verbrauchten Regenerationsluftmenge bzw. entsprechend der abgelaufenen Regenerationszeit t_{Reg} dekrementiert"), in particular the word "bzw.", does not suggest that either a time counter or a counter representing the regeneration air volume might be decremented alternatively in D1. In the context of the disclosure of the regeneration phase as a whole (on page 4, lines 36-38 and lines 60-62), the regeneration air volume is controlled according to the time t_{Reg} needed for regeneration, and during the regeneration phase the counter is decremented until a predetermined counter value is reached. On a reasonable interpretation, the counter reading must be assumed to represent the time remaining for completing the regeneration event, and a counter decrement represents at best a fictitious value of a reverse flow rate, but not the instantaneous reverse flow rate as claimed.

Therefore, the board finds that the skilled person would not arrive at the subject-matter of claim 1 in an obvious manner in view of the teaching of D1 alone.

2.4 According to a second line of argument, the appellant asserts that the subject-matter of claim 1 would be obvious in view of D1 in combination with D2.

The board does not agree with the appellant's first formulation of the problem to be solved of how to determine the regeneration air volume, since D1 does not suggest to "count" this value during regeneration, as argued above. The problem to be solved by the distinguishing features (h) to (k) may be seen in the provision of a more efficient regeneration phase. Indeed, D1 addresses in its introductory portion (page 2, lines 21-27) the drawbacks of the known prior art where a time-dependent control of the regeneration air volume is performed and refers then to D2, in which the regeneration air volume is determined on the basis of pressure gradients. Since the invention as described later in D1 still relates to a time-dependent control of the regeneration phase, the board has already serious doubts whether the skilled person would take into account the teaching of D2 at all which is purely pressure-based. But even considering D2 and assuming that the pressure monitoring described in D2 would allow for an estimation of reverse flow rates of dry air to the dryer, there is no indication in D2 to modify the instantaneous reverse flow rate repeatedly as required by features (i) and (k).

The appellant argues that D1 already includes a correction factor when calculating the volume of air flowing in a forward direction, so there was no reason to omit such a modification in the reverse direction. However, the point is not whether a temperature correction is reasonable in view of D1, but whether due to a prompting in the prior art the skilled person would seriously consider to include such a correction (known from D1 for an instantaneous forward flow rate) when estimating the reverse flow rate on the basis of measured pressure values as known from D2. There is no indication in D2 (column 5, lines 34 ff) to take into consideration conditions of the air braking system when determining the volume of air used during regeneration, and the appellant has not provided further evidence in this respect. D2 only teaches that the regeneration air volume is determined on the basis of pressure measurements, without giving further details on a further modification step with regard to the regeneration air volume or even with regard to an instantaneous reverse flow rate estimated in real time.

Therefore, the board concludes that the skilled person would not arrive at the subject-matter of claim 1 as granted in an obvious manner when combining the teaching of D1 with D2.

3. Starting from D2 as the closest prior art document:

3.1 The appellant admits that D2 does not show modifying steps as specified by features (c) and (i). The appellant argues with respect to features (b) and (h) that D2 discloses a real-time estimation of the instantaneous air flow rates in the forward and reverse direction on the basis of a system pressure value provided by a pressure sensor and the well-known formula or physical relationship between pressure and flow rate. Following the appellant in that features (b) and (h) and also thresholds according to features (f), (f1), (l), (m) are at least implicitly known from D2, the distinguishing features (c) and (i) take into consideration conditions of the air braking system in order to modify the instantaneous flow rates in both directions. The objective technical problem may therefore be formulated as how to make more efficient use of the available compressed air.

3.2 A temperature correction might be known from D1, as argued by the appellant, but only in the context of a given formula including the delivered volume and rotational speed of the compressor for calculating the instantaneous forward flow rate. The board finds that it is not obvious to the skilled person to include such a correction in the method known from D2 which only relies on data derived from monitoring pressure values. As argued already above in paragraph 2.4, the point is not whether the skilled person **could** have arrived at the invention by modifying D2 in view of the teaching in D1, but whether he **would** have done so because of any prompting in the prior art. The skilled person certainly has knowledge of the ideal gas equation, which links temperature as a variable to pressure and volume. However, since no details are given in D2 on how pressure values measured by a pressure sensor are transformed into a flow rate, the board finds that there is no motivation to include a further correction or modifying step, e.g. dependent upon temperature, in the method disclosed in D2. On the contrary, the appellant referred to the equation of Hagen-Poiseuille, according to which a flow rate in a tube can be calculated by measuring the pressure difference, but which does not include any temperature coefficient or other condition of the air braking system.

The appellant also argued that features (c) and (i) did not provide any additional surprising effect. However, at the same time he referred to the contested patent (column 5, lines 42-45) in which it is described that by applying correction factors mathematically to the estimated values, an "adjustment according to the country of operation may differentiate between relatively dry and relatively humid countries, and thus avoid unnecessary regeneration". Therefore, the appellant's argument is not convincing to the board.

3.3 A further argument of the appellant related to the formulation of features (c) and (i), being so general that they comprise the self-evident step of switching off the regeneration system (condition) and setting the reverse flow rate of dry air to zero (modifying). Such a step might be self-evident on its own and might be provided in an algorithm which controls regeneration events, but it would relate to a step of resetting the program variables to default or initial values when switching off the system, not to a step which is repeatedly executed within the iterative structure comprising a numerical integration as specified by features (b) to (e) for the forward flow of air from a compressor or features (h) to (k) for the reverse flow of dry air to the air dryer. Assuming that D2 at least implicitly shows an iterative structure comprising program loops performing numerical integration, the skilled person would not be prompted to include a step of resetting a flow rate within the program loop, i.e. he would not arrive at steps (c) and (i) in a program structure as required by the method of claim 1.

3.4 Therefore, also when starting from D2 as the closest prior art document, the skilled person would not arrive at the subject-matter of claim 1 as granted in an obvious manner.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

A. Vottner G. Pricolo

Decision electronically authenticated