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DECISION
of 9 April 2003

Case Number: T 0911/98 - 3.5.1
Application Number: 85307532.3
Publication Number: 0179625
IPC: B60H 1/00
Language of the proceedings: EN

Title of invention:
Air conditioner for automobiles

Patentee:
NIPPONDENSO CO., LTD.

Opponent:
Robert Bosch GmbH
Rodacher Autoklima GmbH
Behr GmbH & Co.

Headword:
Air conditioner/NIPPONDENSO

Relevant legal provisions:
EPC Art. 56, 100(a)
EPC R. 57a

Keyword:
"Inventive step (no)"
"Late filing of claims (yes)"
"Amendments occasioned by grounds of opposition (no)"

Decisions cited:
T 0623/97, T 0527/92, T 0227/95

Catchword:
-



Case Number: T 0911/98 - 3.5.1

DECISION
of the Technical Board of Appeal 3.5.1
of 9 April 2003

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Decision under appeal:

Interlocutory decision of the Opposition
Division of the European Patent Office posted
24 July 1998 concerning maintenance of European
patent No. 0179625 in amended form.

Composition of the Board:

Chairman: A. S. Clelland
Members: R. R. K. Zimmermann
S. C. Perryman

Summary of Facts and Submissions

- I. European patent number 0 179 625, granted with effect of 7 March 1990, claims priority from patent applications filed in the years 1984 and 1985.
- II. On 26 November 1990 and 3 and 6 December 1990, the whole of the patent was opposed in separate oppositions by respective opponents O1, O2 and O3. One of the grounds for opposition raised was Article 100(a) EPC, lack of inventive step, *inter alia* with regard to following prior art documents:
- D1: P-A-0 021 353 (NIPPONDENSO CO.), 1981
- D12: L. T. Fan et al.: "Applications of Modern Optimal Control Theory to Environmental Control of Confined Spaces and Life Support Systems, Part-5 Optimality and Sensitivity Analysis", Build. Sci., vol. 5, 1970, Pergamon Press (GB), pp. 149-152
- D14: Armin Schöne: „Prozessrechensysteme", 1981, Carl Hanser Verlag (DE), pp. 362-364
- III. In two successive appeals, T 527/92 and T 227/95 decisions given by the opposition division in favour of the patent proprietor had been reversed by the Board (sitting, however, in different compositions). In a subsequent interlocutory decision by the opposition division posted on 24 July 1998 the patent was found to meet the requirements of the Convention. The decision was based on an amended claim 1 filed with a letter dated 12 May 1998, the claim reading as follows:

"1. An air conditioner for automobiles comprising: blow off air control means (M2) for controlling at least temperature and flow rate of blow off air discharged into a vehicle compartment (M1); internal air temperature detecting means (M3) for detecting the temperature within said vehicle compartment; and air conditioning control means (M4) for feedback controlling said blow off air control means so that said detected internal air temperature (TR) equals a setting target temperature (TR*), characterized in that, said air conditioning control means (M4) is formed as an integral-added optimal regulator, said optimal regulator comprising:

- a perturbation component computing portion (P3) for computing a perturbation component of a parameter of an air conditioning system including said vehicle compartment, the computed perturbation component being derived from a measured value (TR) and from a reference parameter value (TRa) which occurs under a state where steady air conditioning is being performed;
- a state observer (P4) for estimating state variables (δTB , δTC , δTD) on the basis of the perturbation component (δTR) computed by the perturbation component computing portion (P3) and perturbation components (δVB , δVC , δVD) calculated by a feedback amount determining portion (P5), said estimated state variables indicating a dynamic internal state of the air conditioning system including said vehicle compartment;
- wherein said feedback amount determining means (P5) determines a feedback control amount of said control means (M4) on the basis of said estimated state

variables (δTB , δTC , δTD) and an optimal feedback gain (F) which is predetermined according to dynamic models of said air conditioning system;

- and wherein variables (VB, VC, VD) of blow off air controlled by said blow off air control means (M2) include at least the amount of air flow (VB) from a blower motor (3) which sends said blow off air, cooling capability (VC) for cooling air sent by said blower motor (3), and a controlled variable (VD) of an actuator (24) which causes the temperature of the blow off air to raise by reheating said sent air, and wherein for each variable (VB, VC, VD) a corresponding state variable (δTB , δTC , δTD) is estimated by said state observer (P4)."

IV. The decision was again appealed by opponent O2, with the filing of the notice of appeal and the payment of the appeal fees executed on 15 September 1998 and the filing of the statement of grounds on 6 November 1998.

V. This present, third, appeal resulted in oral proceedings on 9 April 2003, at the end of which the Chairman announced the Board's decision on the basis of claim 1 of 12 May 1998, the main request, and the following claims of first and second auxiliary requests filed during the appeal proceedings:

Claim 1 filed with a letter dated 24 September 2001, amending claim 1 of 12 May 1998 by inserting the words "by means of controlling an air blower motor (3), an evaporator (5) and an actuator (24) for an air mixing damper (9);" into the first paragraph of claim 1 after the words "into a vehicle compartment (M1)" and by replacing, in the last paragraph of the claim, the

words "a blower motor" by "the blower motor" and the words "an actuator" by "the actuator".

Claim 1 filed in the oral proceedings of 9 April 2003 adding, to claim 1 of 12 May 1998, the words "which dynamic models are determined in advance through system identification and through experimental analysis of the system," directly at the end of the penultimate paragraph of the claim after the words "according to dynamic models of said air conditioning system", and removing the word "and" at the start of the last paragraph.

- VI. In the decision presently under appeal the opposition division took the view that the claimed air conditioner solved the problems of poor transient response and high fuel costs existing with conventional systems. The control conditions and the control variables used in the integral-added optimal regulator according to claim 1 distinguished the claimed air conditioner in an inventive manner over the prior art.
- VII. The appellant argued that the same measuring and control variables were used in the prior art of document D1 as in the alleged invention, namely drive signals VB, VC, and VD and measured values for the internal air temperature. The state variables defined in claim 1 did not contribute to inventive step since such definitions followed automatically from applying so-called "modern control theories" which had been known long before the priority date of the patent and were well documented as common general knowledge in documents D12 and D14.

The use of state-space models and integral added optimal regulators was, at the priority date of the contested patent, known to the skilled person. A state-space control system with observer was shown, for example, in document D14, page 362, Figure 7.25. Applying the state-space method to the prior art system of document D1 meant using δTB , δTC , and δTD as the state space variables, computed on the basis of perturbation components δTR , δVB , δVC , and δVD .

The claimed system did not bring any other advantage or effect than to keep internal air temperature TR at a setting target temperature TR^* , which was the normal aim of automotive air conditioning.

The alleged invention, therefore, was a mere alternative to conventional control systems for automotive air conditioning. The contested patent did not disclose anything which might considered to involve an inventive step.

VIII. The appellant (opponent O2) requested that the decision under appeal be set aside and the European patent no. 0179625 be revoked.

The respondent (patent proprietor) requested that the appeal be dismissed or as auxiliary requests that the decision under appeal be set aside and that the patent be maintained on the basis of claim 1 of the first auxiliary request submitted on 24 September 2001 or claim 1 of the second auxiliary request submitted at oral proceedings on 9 April 2003.

IX. The respondent agreed that the prior art of document D1 came closest to what was claimed. This document disclosed an automotive air conditioning system which allowed the control of the air temperature in a predetermined pattern with the control of the air mixer damper and blower motor and disclosed, in combination, the features of the first part of claim 1 in the version of the first auxiliary request. The results to be achieved with such a system, however, were very sensitive to the design of the control system.

Compared with the prior art of document D1 the invention improved the time response, as clearly illustrated by the dashed line in Figure 8 of the European patent specification, and reduced the power consumption of the system. Excellent results were achieved by the selection of specific system parameters and the application of modern control theories on the basis of a digital state-space approach and the use of an integral-added optimal regulator.

The invention provided, in comparison to the prior art of document D1, a dynamic model of an automotive air conditioning system requiring a specific design of the control system, the identification of an appropriate set of measuring and control variables and the design of an optimal feedback gain. By implementing such a dynamic control model the invention achieved, in a surprisingly successful manner, a double aim, namely improving the time response and at the same time reducing the power consumption. These problems had not been satisfactorily solved in the prior art systems.

Document D14 was an extract from a textbook which explained digital control using a state observer in abstract and general terms. Document D12 outlined, again only in general terms, environmental control of confined spaces and life support systems without mentioning that it could be applied to automotive air conditioning. It was undisputed, and indeed acknowledged in the patent specification, that integral-added optimal regulators and state-space techniques in themselves formed part of the prior art.

The appellant had not succeeded in establishing any clear link between such modern control concepts and their use in an automotive air conditioning system. The invention was moreover the first use of modern control techniques in the automotive sector.

Reasons for the Decision

1. The appeal complies with the requirements of Articles 106 to 108 and Rules 1(1) and 64 EPC and is thus admissible.

The appeal is also allowable since the interlocutory decision under appeal, deciding that the amended patent meets the requirements of the EPC, cannot stand in respect of the requirement for an inventive step (Articles 56, 100(a) and 102(3) EPC) and must thus be set aside.

Moreover, the patent must be revoked, as requested by the appellant, since none of the requests submitted by the respondent is allowable.

Main request

2. It follows from the legal definition of Article 56 that an invention is considered to lack an inventive step if having regard to the prior art it is obvious to a person skilled in the art. This obviousness criterion is generally applied by starting from an appropriate point in the prior art (the "closest prior art") and analyzing the invention on the basis of the so-called problem-and-solution approach (see Case Law of the Boards of Appeal of the European Patent office, 4th edition, 2002, pages 101 and 102).

Prior art document D1 is in the field of automotive air conditioning systems and clearly relevant to the invention to which claim 1 relates. It discloses an air conditioner for automobiles (see Figure 1 with the accompanying parts of the text) comprising blow off air control means (elements 18 to 21), internal air temperature detecting means ("in-car sensor" 10), and air conditioning control means (elements 11 to 17) controlling said blow off air control means so that said detected internal air temperature equals a setting target temperature (see "temperature setting means" 13 and page 6, lines 1 to 6 and 24 to 27) . In the embodiment described in document D1 on page 17, lines 9 and 10, the variables of blow off air controlled by said blow off air control means include at least the amount of air flow (see also page 5, lines 12 to 17 "rate of air flow") from a blower motor ("blower motor" 3), cooling capability for cooling air sent by said blower motor (loc. cit.), and an actuator ("position adjusting actuator" 19) which causes the temperature of

the blow off air to rise by reheating ("air mixing damper" 6 in cooperation with "heater core" 5). The air conditioning control means ("microcomputer" 16) determines a feedback control amount of the air conditioning control means (see page 8, line 27 to page 9, line 12).

3. The claimed air conditioner is distinguished from this prior art in that the air conditioning control means "is formed as an integral-added optimal regulator" comprising a perturbation component computing portion P3 for computing a perturbation component δTR derived from the measured internal air temperature TR and from a reference parameter value TRa; a state observer P4 for estimating state variables δTB , δTC , δTD ; and feedback amount determining means P5 for determining the feedback control amount, providing an optimal feedback gain F which is predetermined according to dynamic models of said air conditioning system.

In other words, the invention as set forth in claim 1 of the main request differs from the disclosure of document D1 in that it provides

- (a) a general state-space approach to the control system design, the design including
- (b) a "state observer" for estimating the state variables, and
- (c) a regulator which is
- (d) "optimal", i.e. the system provides for an optimal feedback gain, and
- (e) "integral-added", i.e. the control loop includes an integrating function.

The state-space approach is substantially a control algorithm for calculating, in the present context, the feedback signals for driving the respective actuators of the automotive air conditioner from the measured internal temperature TR. Except for the definition of the measuring and controlling variables TR, VB, VC, and VD, claim 1 defines the control system only in terms of the abstract components and parameters of the state-space model, with the consequence that the invention as claimed does not manifest itself in any concrete physical properties of the control system. If for example the control features necessary for implementing the control algorithm (not present in claim 1) are chosen inappropriately as a result of an inadequate system analysis or of an inappropriate definition of the optimization problem, the time-response and the power consumption of the air conditioner will turn out to be worse than the results achieved with a simple on-off control or the control system of document D1, regardless of the measuring and controlling variables used in the state-space model and the potentially advantageous effects achievable by features (b) to (e) cited above.

Thus, the mere use of the state-space approach does not in itself provide any advantage over the D1 system. Accordingly, in the context of the problem-and-solution approach for assessing inventive step, the technical problem to be solved is seen as providing an alternative to the control algorithm used in the air conditioning system of document D1.

4. In seeking such an alternative control algorithm the skilled person could be expected to take prior art document D12 into account since this document deals with matters relating to air conditioning and temperature control systems in confined spaces. The circumstance that the confined spaces are part of life support systems is not relevant since the technical issues in respect to air conditioning and temperature control are largely the same as in an automotive system.

It is apparent from document D12, in particular page 151, last paragraph, that "the modern optimal control theory is very much suited for such systems", the skilled person thus being taught that these control methods are a very suitable alternative to known control schemes, and thus as a possible solution of the technical problem defined above.

5. Regarding the expression "modern control theory", it was not contested by the respondent that well before the priority date of the contested patent, it had a known meaning in the art, being synonymous with the use of a state-space digital control method, which is based on a linearised mathematical model of the control system. Having decided in favour of the "modern optimal control theory" suggested by document D12 as an appropriate alternative to the prior art system of document D1, the skilled person, therefore, could be expected to realise an automotive air conditioning and temperature control system of the type comprising features (a), (c) and (d) cited above.

6. Nevertheless, various technical problems remain to be solved since document D12 contains no relevant details concerning the theory or the design of such modern optimal control systems, although "many facets to the modern control theory" are said to exist (see document D12, page 151, penultimate paragraph). The skilled person, however, can be expected to apply his common technical knowledge in this field, which is, to a considerable extent, acknowledged in the present patent specification itself (see page 4, lines 17 ff. and following pages).

7. In the first place, a mathematical model of the automotive air conditioning and temperature control system has to be formulated. For such a complex system normal practice requires that this model be determined through system identification and experimental system analysis.

8. Secondly, the complex environmental conditions inside and outside of automobiles generally do not allow the measurement of all relevant model parameters of the automotive air conditioning and temperature control system. In the prior art system of document D1 for example, the temperature is measured only at a few locations. The normal practice to deal with the problem of incomplete information regarding the model parameters is the use of so-called "observers" as described in the present patent specification, page 5, lines 9 ff. and also shown as "Regelgrößen-be-obachter" in the prior art document D14, page 362, Figure 7.25. A state observer according to feature (b) above thus does not contribute to inventive step, at least if considered in isolation.

9. A third problem to be solved is the residual errors which are commonly known to exist in closed-loop controllers under steady process conditions. Adding an integrator to the control loop is a standard technique to solve this problem, which is also applied in modern control methods as acknowledged for example in the present patent specification at page 4, lines 17 ff. Therefore, at least if considered in isolation, the integral-added regulator defined in the last feature (e) does not involve an inventive step either.
10. Finally, features (a) to (e) remain obvious even if their contribution to the prior art is considered as a whole and possible combinatorial effects are taken into account.

The technical contribution to the prior art indicated by feature (a) resides in the general decision for using a modern state-space control method as an alternative to the document D1 system. This decision is the first step which has to be taken and which is, under technical aspects, independent from possible subsequent embodiments of the general state-space model, which the embodiments according to features (b) to (e) above actually are.

Taking feature (e) first, it is clear that steady-state errors and the use of an integrator to reduce them are not specific to any particular control method. They are also relevant in the classical regime of control techniques. Using feature (e) in the context of an optimal state-space model with observers does not add any technically relevant aspects so that even in

combination with such other claim features the integrating function remains a technically independent aspect of the invention and thus is an obvious addendum to the state-space model defined in claim 1.

Regarding feature (b), the situation is slightly different since the model building of the state-space approach (feature (a)) may be understood as a prerequisite of implementing the state observer defined in feature (b). However, as explained in T 623/97 ((not pub. in OJ EPO), point 4.4 of the reasons, an invention even requiring two or more steps for arriving at a complete solution may be obvious to the skilled person if the technical problem to be solved leads the skilled person step-by-step to the solution, each individual step being obvious in the light of what has been accomplished and of the residual task remaining to be solved.

In the present case indeed, the information gap present in document D12 forces the skilled person, after having decided in favour of a modern optimal control system, to make further steps to arrive at a workable design. Choosing to solve first the one or the other from the many design problems evidently present and solving this in an obvious manner does not involve an inventive step.

11. In conclusion, the subject-matter of claim 1, even if considered as a whole, lacks inventive step, which prejudices maintenance of the patent amended on the basis of respondent's main request (Articles 52(1), 56 and 102(3) EPC).

First auxiliary request

12. The first auxiliary request amends claim 1 of the main request by introducing features from the second part into the first part of the claim, without adding any technical information to the claim. As follows from respondent's letter of 24 September 2002 these amendments merely serve the purpose of bringing the claim wording into compliance with the requirements of Rule 29(1)(a) EPC. The amendments are thus not occasioned by any grounds of opposition, with the consequence that they are not admissible into the appeal proceedings, and the first auxiliary request thus not being allowable (see Rule 57a EPC and chapter VII.C.10.1.1 in Case Law of the Boards of Appeal of the European Patent Office, 4th edition 2001, pages 483 f.).

Second auxiliary request

13. Claim 1 of the second auxiliary request was filed at the oral proceedings held before the Board, which was thus obliged to decide whether to exercise its discretion whether to admit it to the proceedings (see chapter VII.C.14 in Case Law of the Boards of Appeal of the European Patent Office, 4th edition 2001, pages 545 ff.).

The amended claim only adds to claim 1 of the main request an explanation of the term "dynamic model" appearing in the penultimate paragraph of claim 1 of 12 May 1998. This explanation, however, is of a very general character and indicates only what was already normal practice in applying a state-space model to complex systems. These amendments do not *prima facie*

render the subject-matter of claim 1 patentable. In addition, the amendments were not occasioned by any new evidence or arguments which were produced at this stage of the appeal proceedings. Neither has the respondent given any other acceptable reason for the late filing. The Board, therefore, decided not to admit the amended claim to the proceedings.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The patent is revoked.

The Registrar:

M. Kiehl



The Chairman:

A. Clelland