

Internal distribution code:

- (A) [] Publication in OJ
(B) [] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 14 October 1997

Case Number: T 0773/96 - 3.2.1

Application Number: 90305032.6

Publication Number: 0397488

IPC: B60G 13/18

Language of the proceedings: EN

Title of invention:
Wheel assembly suspending

Applicant:
BOSE CORPORATION

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-



Case Number: T 0773/96 - 3.2.1

D E C I S I O N
of the Technical Board of Appeal 3.2.1
of 14 October 1997

Appellant:

BOSE CORPORATION
100 The Mountain Road
Framingham, Massachusetts 01701 (US)

Representative:

Brunner, Michael John
GILL JENNINGS & EVERY
Broadgate House
7 Eldon Street
London EC2M 7LH (GB)

Decision under appeal:

Decision of the Examining Division of the
European Patent Office posted 3 April 1996
refusing European patent application
No. 90 305 032.6 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: F. A. Gumbel
Members: P. Alting van Geusau
J.-C. Saisset

Summary of Facts and Submissions

I. European patent application No. 90 305 032.6 filed on 10 May 1990, claiming priority of 10 May 1989 from an earlier application in the United States (US 350935) and published under the publication No. 0 397 488, was refused by a decision of the Examining Division announced at the end of oral proceedings held on 21 March 1996.

The decision was posted on 3 April 1996.

II. The reason for the refusal was non-compliance with the requirements of Article 56 EPC with regard to the combined teaching of the documents

D1: SAE Transaction. paper no. 841 253, 1985, New York US pages 5698 to 5707; Thompson et al.: "Active suspensions with vibration absorbers and optimal output feedback control" and

D11: "Kleines Handbuch technischer Regelvorgänge" by W. Oppelt, ISBN 3-527-25347-5

or of the documents

D1 and

D8: EP-A-0 114 757.

Reference was further made to the documents

D2: Machine Design, vol. 56, no. 28, 26 November 1987,
pages 125 to 129 and

D10: DE-A-2 408 292

so as to underline that, at the priority date of the present application, non-linear control had already been applied to a fully active dynamically controlled suspension system.

III. On 28 May 1996 a notice of appeal was lodged against that decision and on 29 May 1996 payment of the prescribed fee was registered.

The statement of grounds of appeal was filed on 25 July 1996.

IV. In a communication issued in preparation for oral proceedings the Board drew attention to the combination of the teachings of the documents D1 and D10 which should, in addition to the combinations relied upon by the Examining Division, be the subject of further discussion during the oral proceedings. Since the dynamic vibration absorber disclosed in D1 was primarily related to damping of axle oscillations there was no apparent reason to omit the dynamic damper in a system combining the teachings of D1 and D10.

It should further be discussed during the oral proceedings whether the claimed advantages were achieved by the combination of features of the present claim 1 only or if further means were necessary to arrive at the desired effects.

V. Oral proceedings were held on 14 October 1997. During the oral proceedings the appellant filed new claims 1 to 8 and description pages 1 to 9.

The appellant requested that a patent be granted on the basis of these new documents together with the originally filed Figures 1 to 7.

Current claim 1 reads as follows:

"1. Suspension apparatus for a vehicle having a sprung mass (11) and an unsprung mass including a wheel (12) and a wheel support member (12A), the suspension apparatus comprising:

an active dynamically controlled suspension system (17) intercoupling the sprung mass (11) and the unsprung mass (12, 12a);

a wheel damper (21, 22, 23) comprising a damping mass (21) and a damping device (22, 23) connecting the damping mass (21) to the wheel support member (12A), the damping mass (21) being relatively movable with respect to the wheel support member (12A) such that there is no transfer of force between the unsprung mass and the sprung mass through the wheel damper; and wherein the suspension apparatus is free of a damping element in parallel with the non-linear ("non-linear" should obviously be deleted at that place) active controlled suspension system; characterised in that

the active dynamically controlled suspension system is a non-linear controlled system;

wherein the ratio of the mass of the wheel damper to the unsprung mass is in the range of 0.5 to 1.5."

VI. In support of its request for grant of a patent the appellant relied essentially on the following submissions:

Since novelty over the closest prior art as represented by D1 was not in dispute the only question to be considered was whether the subject-matter of claim 1 involved an inventive step.

When starting from the active linearly controlled suspension system disclosed in D1 the actual development in this technical field was not to non-linear controlled systems as was clear from documents D12: Vehicle System Dynamics, 20, (1991) pages 381 to 383, "A Technical Note on the Lotus Suspension Patents" by A.G. Thompson and B.R. Davis and

D13: Vehicle Systems Dynamics, 21 (1992), pages 19 to 37, "Optimal Active Suspension Design Using a Frequency-shaping PID Filter" by A.G. Thompson and B.R. Davis,

relating to the same authors as D1 and filed at the oral proceedings before the Examining Division. On the other hand it was admittedly known from documents D8 and D10 to make use of non-linear actively controlled systems, however without using any longer a dynamic vibration absorber.

Furthermore, it had to be borne in mind that the system disclosed in D1 was a system complete in itself which system made use of limited or incomplete state variable

feedback and for that reason was a sub-optimal system. In a non-linear controlled system complete state feedback was even more difficult to attain, another reason why apparently actual development went in a different direction of control and without introduction of further complication by using a dynamic vibration absorber.

Considering the dynamic vibration absorber itself, D1 clearly indicated that the mass ratio should preferably be between 0.2 and 0.5 which led away from the higher values found to give optimal performance in a non-linear controlled system in accordance with the present invention. In the absence of any lead given by the available prior art for improvement of the system disclosed in D1 in the direction to include non-linear control and a vibration damper with a mass ratio higher than anywhere suggested, the suspension system claimed in claim 1 of the present patent application should be acknowledged to be based on an inventive activity.

Reasons for the Decision

1. The appeal is admissible.
2. *Amendments*
 - 2.1 Current claim 1 is based on the subject-matter of the originally filed claims 1, 2, 3, 7 and 13 and in fact now relates to the preferred embodiment disclosed in relation to figure 4 of the application in its

originally filed form.

The dependent claims 2 to 8 are based on the originally filed claims 4, 10, 11, 12, 8, 14 and 15, respectively.

In view of these assessments there are no objections under Article 123(2) EPC to the present set of claims.

2.2 The description was adapted to the subject-matter now claimed and does not give rise to objections under the EPC either.

3. *Novelty and inventive step*

3.1 The closest prior art is represented by D1. As was also acknowledged by the appellant, this prior art document discloses the basic configuration for an active suspension with a dynamic vibration absorber in accordance with the combination of features of the precharacterising portion of claim 1 of the present patent application (see D1, page 5.699, figure 1).

D1 discloses further that the control of the active suspension is based on a linear control model and the optimum feedback gains are computed accordingly.

3.2 The underlying problem to be solved by the present application is to be seen in the provision of an improved vehicle wheel assembly suspension in which essentially no net resistive forces occur between the unsprung and sprung masses and which allows simultaneous control of the vehicle for large vertical road excursions (see page 2, lines 13 and 14 and

page 5, lines 2 to 5 of the present description).

3.3 This problem is solved by the combination of features of the current claim 1. In accordance with the statement on page 5, lines 22 to 27 of the present patent application it has been found by the present inventor that with a non-linear active dynamically controlled suspension system comprising a dynamic vibration damper ratio, which lies between 0.5 and 1.5, the object can be attained.

3.4 Considering what the skilled person would do when trying to improve the active suspension system disclosed in D1, the appellant pointed out that the skilled person would in the first place increase the number of feedback variables along the lines set out in D1 (see page 5.698, right-hand column, lines 12 to 21, "linear optimal control theory requires all the state variables to be fed back"). However, there was no indication whatsoever in D1 that a non-linear control system could lead to any reduction of the resistive forces.

Furthermore, the appellant drew attention to the fact that in the prior art active suspension systems such as shown in D8 and D10 and the systems described in the articles D12 and D13 (both were published after the filing date of the present patent application) no use was made of dynamic vibration dampers at all. Indeed the systems disclosed in D8 and D10 disclosed non-linear control but apparently the skilled person did not need a dynamic vibration damper in such more complicated control systems because of a more advanced

feedback control taking account of the wheel axle (unsprung mass) vibrations. In this respect reference was also made to the paragraph on page 5, lines 19 to 27 of D8 from which it was clear that modification of the effective unsprung mass was taken into account in the control function and therefore additional means for damping the axle vibrations were not necessary.

Moreover, D1 expressly stated that the mass ratio should be preferably lie between 0.2 and 0.5 and certainly such instruction would not lead the skilled person to apply higher mass ratios as claimed in the current claim 1 of the present patent application, let alone to take into consideration a the combination of non-linear control and such higher mass ratios.

The Board follows this analysis of the available prior art.

- 3.5 The further documents cited in the first instance proceedings do not give rise to a different opinion about the line of development of active suspension systems and none of these further documents discloses or suggests non-linear control combined with a dynamic vibration damper, in particular one having a mass ratio of 0.5 to 1.5.

Document D2, referred to in the decision under appeal (see page 5, second paragraph) as further evidence that the problems with linear control, such as its complexity or sub-optimal performance, were known to the skilled person and that consequently a need for improvement of the control itself existed, does not give any hint in the direction of non-linear control of the, in fact, non-linear process (see D2, page 129, the text at the end of the left hand column). On the contrary D2 keeps the control linear but rather focuses on improvement by means of the adaptive feedback control design (see page 129, left hand column: "There are two main approaches to adaptive feedback control design: model reference adaptive control and self-tuning regulators").

The textbook D11, considered to be particularly relevant by the Examining Division because of a probable application of deviation magnitude dependent control (see page 5, last paragraph of the decision under appeal and D11, last paragraph on page 550), does in fact neither allow predictable conclusions as to any reduction of the resistive forces encountered with the linear control of the active suspension system disclosed in D1 by applying non-linear control nor does it give any help in pointing the skilled person to an increased mass ratio of the dynamic vibration damper if non-linear control is applied.

- 3.6 In summary, since no suggestion is derivable from the cited documents to apply non-linear control to the active suspension system combined with a dynamic vibration damper having a mass ratio of the wheel

damper to the unsprung mass in the range of 0.5 to 1.5, the subject-matter of claim 1, in the Board's opinion, was not obvious to the skilled person.

4. The Board, therefore, comes to the conclusion that the subject-matter of claim 1 involves an inventive step in accordance with Article 56 EPC. Consequently, this claim, together with dependent claims 2 to 8, relating to particular embodiments of the invention in accordance with Rule 29(3) EPC, are acceptable.

Since the description and drawings are in agreement with the subject-matter now claimed, no objections arise against the grant of a patent on the basis of the appellant's request.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent on the basis of

Claims: 1 to 8 as filed during the oral proceedings of 14 October 1997, and

Description: pages 1 to 9 as filed during the oral proceedings of 14 October 1997,

Drawings: figures 1 to 7, as originally filed.

The Registrar:

The Chairman:

S. Fabiani

F. Gumbel