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Datasheet for the decision of 28 February 2008

Case Number: T 0947/06 - 3.2.01

Application Number: 98905040.6

Publication Number: 0956223

IPC: B60T 7/04

Language of the proceedings: EN

Title of invention:
Pedal simulator using spring with non-linear response

Patentee:
Kelsey Hayes Company

Opponent:
WABCO GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 123

Relevant legal provisions (EPC 1973):
EPC Art. 56

Keyword:
"Extension of subject-matter (no, after amendent)"
"Inventive step (yes, after amendment)"

Decisions cited:
-

Catchword:
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Case Number: T 0947/06 - 3.2.01

D E C I S I O N
of the Technical Board of Appeal 3.2.01
of 28 February 2008

Appellant: (Opponent)
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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 6 March 2006 concerning maintenance of European patent No. 0956223 in amended form.

Composition of the Board:

Chairman: S. Crane
Members: P. L. P. Weber
G. Weiss

Summary of Facts and Submissions

I. The appeal by the opponent is against the intermediate decision of the opposition division posted on 6 March 2006 that the patent amended according to the 2nd auxiliary request filed during the opposition procedure fulfils the requirements of the European Patent Convention.

II. The notice of appeal was filed on 26 April 2006 and the appeal fee paid on the same day. The statement of the grounds of appeal was filed on 20 May 2006.

III. Oral proceedings were held on 28 February 2008.

The appellant (opponent) requested the setting aside of the decision and the revocation of the patent.

The respondent (patentee) requested the dismissal of the appeal (main request) or in the alternative that the patent be maintained in amended form on the basis of the auxiliary requests 1 to 5 filed with letter dated 28 January 2008 or on the basis of the auxiliary request 6 submitted at the oral proceedings.

IV. The following documents played a role in the appeal procedure:

E1: DE-A-4343386;
E2: EP-A-0708006;
E4: Wabco Hydraulische Pumpenspeicher-Bremsanlage Ausgabe 1995;
E5: EP-A-0590515 filed by the appellant with letter of 21 February 2008.

V. Claim 1 according to the main request reads as follows:

"A pedal simulator (12; 60; 70; 80) comprising:
a housing (14; 71; 82) having a bore (19; 86) therein;
a piston (18; 66; 78; 84) disposed within said bore (19; 86); and
a spring mechanism (40; 72; 94; 104) operatively connected to said piston (18; 66; 78; 84) such that movement of said piston (18; 66; 78; 84) in a direction towards said spring mechanism (40; 72; 94; 104) compresses said spring mechanism (40; 72; 94; 104), said spring mechanism (40; 72; 94; 104) having a non-linear spring constant,
characterized in that
said spring mechanism (40; 72; 94; 104) includes first and second springs (94, 104) operatively connected in a series arrangement, said first spring (94) having a spring constant which is higher than the spring constant of said second spring (104);
wherein during a first portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104) said non-linear spring constant of said spring mechanism (40; 72; 94; 104) is a combination of the spring constant of the first spring (94) and the spring constant of the second spring (104), and during a second portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104), said non-linear spring constant of said spring mechanism (40; 72; 94; 104) substantially approaches said spring constant of said first spring (94)."

Claim 1 according to auxiliary request 1 reads as follows:

"A pedal simulator (12; 60; 70; 80) adapted to generate a braking demand signal for use as an input to an electronically controlled vehicle braking system, the pedal simulator comprising:
a housing (14; 71; 82) having a bore (19; 86) therein;
a piston (18; 66; 78; 84) disposed within said bore (19; 86); and
a spring mechanism (40; 72; 94; 104) operatively connected to said piston (18; 66; 78; 84) such that movement of said piston (18; 66; 78; 84) in a direction towards said spring mechanism (40; 72; 94; 104) compresses said spring mechanism (40; 72; 94; 104), said spring mechanism (40; 72; 94; 104) having a non-linear spring constant,
characterized in that
said spring mechanism (40; 72; 94; 104) includes first and second springs (94, 104) operatively connected in a series arrangement, said first spring (94) having a spring constant which is higher than the spring constant of said second spring (104);
wherein during a first portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104) said non-linear spring constant of said spring mechanism (40; 72; 94; 104) is a combination of the spring constant of the first spring (94) and the spring constant of the second spring (104), and during a second portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104), said non-linear spring constant of said spring

mechanism (40; 72; 94; 104) substantially approaches said spring constant of said first spring (94)."

Claim 1 according to auxiliary request 2 reads as follows:

"A pedal simulator (12; 60; 70; 80) adapted to generate a braking demand signal for use as an input to an electronically controlled vehicle braking system, the pedal simulator comprising:
a housing (14; 71; 82) having a bore (19; 86) therein;
a piston (18; 66; 78; 84) disposed within said bore (19; 86); and
a spring mechanism (40; 72; 94; 104) operatively connected to said piston (18; 66; 78; 84) such that movement of said piston (18; 66; 78; 84) in a direction towards said spring mechanism (40; 72; 94; 104) compresses said spring mechanism (40; 72; 94; 104), said spring mechanism (40; 72; 94; 104) having a non-linear spring constant,
characterized in that
said spring mechanism (40; 72; 94; 104) includes first and second springs (94, 104) operatively connected in a series arrangement, said first spring (94) having a spring constant which is higher than the spring constant of said second spring (104);
wherein during a first portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104) said non-linear spring constant of said spring mechanism (40; 72; 94; 104) is a combination of the spring constant of the first spring (94) and the spring constant of the second spring (104), and during a second portion of said movement of said piston (18; 66; 78; 84) in the

direction towards said spring mechanism (40; 72; 94; 104), said non-linear spring constant of said spring mechanism (40; 72; 94; 104) substantially approaches said spring constant of said first spring (94), with the loading on each of the first and second springs (94;104) being substantially the same."

Claim 1 according to auxiliary request 3 reads as follows:

"A pedal simulator (12; 60; 70; 80) adapted to generate a braking demand signal for use as an input to an electronically controlled vehicle braking system, the pedal simulator comprising:
a housing (14; 71; 82) having a bore (19; 86) therein;
a piston (18; 66; 78; 84) disposed within said bore (19; 86); and
a spring mechanism (40; 72; 94; 104) operatively connected to said piston (18; 66; 78; 84) such that movement of said piston (18; 66; 78; 84) in a direction towards said spring mechanism (40; 72; 94; 104) compresses said spring mechanism (40; 72; 94; 104), said spring mechanism (40; 72; 94; 104) having a non-linear spring constant,
characterized in that
said spring mechanism (40; 72; 94; 104) includes first and second springs (94, 104) operatively connected in a series arrangement, said first spring (94) having a spring constant which is higher than the spring constant of said second spring (104);
wherein during a first portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104) said non-linear spring constant of said spring mechanism (40; 72; 94;

104) is a combination of the spring constant of the first spring (94) and the spring constant of the second spring (104), and during a second portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104), said non-linear spring constant of said spring mechanism (40; 72; 94; 104) substantially approaches said spring constant of said first spring (94) as compression of said second spring (104) ends, with the loading on each of the first and second springs (94;104) being substantially the same."

Claim 1 according to auxiliary request 4 reads as follows:

"A pedal simulator (12; 60; 70; 80) adapted to generate a braking demand signal for use as an input to an electronically controlled vehicle braking system, the pedal simulator comprising:
a housing (14; 71; 82) having a bore (19; 86) therein;
a piston (18; 66; 78; 84) disposed within said bore (19; 86); and
a spring mechanism (40; 72; 94; 104) operatively connected to said piston (18; 66; 78; 84) such that movement of said piston (18; 66; 78; 84) in a direction towards said spring mechanism (40; 72; 94; 104) compresses said spring mechanism (40; 72; 94; 104), said spring mechanism (40; 72; 94; 104) having a non-linear spring constant,
characterized in that
said spring mechanism (40; 72; 94; 104) includes first and second springs (94, 104) operatively connected in a series arrangement, said first spring (94) having a

spring constant which is higher than the spring constant of said second spring (104);
wherein during a first portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104) said non-linear spring constant of said spring mechanism (40; 72; 94; 104) is a combination of the spring constant of the first spring (94) and the spring constant of the second spring (104), and during a second portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104), said non-linear spring constant of said spring mechanism (40; 72; 94; 104) substantially approaches said spring constant of said first spring (94) as said second spring bottoms out, with the loading on each of the first and second springs (94;104) being substantially the same."

Claim 1 according to auxiliary request 5 reads as follows:

"A pedal simulator (12; 60; 70; 80) adapted to generate a braking demand signal for use as an input to an electronically controlled vehicle braking system, the pedal simulator comprising:
a housing (14; 71; 82) having a bore (19; 86) therein;
a piston (18; 66; 78; 84) disposed within said bore (19; 86); and
a spring mechanism (40; 72; 94; 104) operatively connected to said piston (18; 66; 78; 84) such that movement of said piston (18; 66; 78; 84) in a direction towards said spring mechanism (40; 72; 94; 104) compresses said spring mechanism (40; 72; 94; 104),

said spring mechanism (40; 72; 94; 104) having a non-linear spring constant,
characterized in that
said spring mechanism (40; 72; 94; 104) includes first and second coil springs (94, 104) operatively connected in a series arrangement, said first spring (94) having a spring constant which is higher than the spring constant of said second spring (104);
wherein during a first portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104) said non-linear spring constant of said spring mechanism (40; 72; 94; 104) is a combination of the spring constant of the first spring (94) and the spring constant of the second spring (104), and during a second portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104), said non-linear spring constant of said spring mechanism (40; 72; 94; 104) substantially approaches said spring constant of said first spring (94) as compression of said second spring (104) ends, with the loading on each of the first and second springs (94;104) being substantially the same."

Claim 1 according to auxiliary request 6 reads as follows:

"A pedal simulator (12; 60; 70; 80) comprising:
a housing (14; 71; 82) having a bore (19; 86) therein;
a piston (18; 66; 78; 84) disposed within said bore (19; 86); and
a spring mechanism (40; 72; 94; 104) operatively connected to said piston (18; 66; 78; 84) such that movement of said piston (18; 66; 78; 84) in a direction

towards said spring mechanism (40; 72; 94; 104) compresses said spring mechanism (40; 72; 94; 104), said spring mechanism (40; 72; 94; 104) having a non-linear spring constant,
characterized in that
said spring mechanism (40; 72; 94; 104) includes first and second coil springs (94, 104) operatively connected in a series arrangement, said first spring (94) having a spring constant which is higher than the spring constant of said second spring (104);
wherein during a first portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104) said non-linear spring constant of said spring mechanism (40; 72; 94; 104) is a combination of the spring constant of the first spring (94) and the spring constant of the second spring (104), and during a second portion of said movement of said piston (18; 66; 78; 84) in the direction towards said spring mechanism (40; 72; 94; 104), said non-linear spring constant of said spring mechanism (40; 72; 94; 104) substantially approaches said spring constant of said first spring (94) as the coils of said second spring (104) bottom out."

VI. The arguments of the appellant can be summarized as follows:

The description of the embodiment according to figure 8 mentions specifically that the transition from the first portion of the movement to the second portion is when the coils of the one spring bottom out. This is not in claim 1 according to any of the requests 1 to 5 so that these requests are not allowable under Article 123(2) EPC.

Auxiliary request 6

The subject-matter of claim 1 according to auxiliary request 6 is not inventive starting from either E4 or E2.

The brake pedal according to E4 must also be considered to be a pedal simulator since the springs in this pedal arrangement are also there to give the driver a better feel when he is braking. The only difference between the claimed subject-matter and the construction of E4 is therefore that the coils of the one spring do not bottom out when the second alone is active. This can however not be considered inventive as the skilled man would implement the one or the other option without any inventive step.

Also when starting from the pedal simulator according to E2 the difference to the subject-matter of claim 1 is that in the latter the coil springs instead of being arranged in parallel are arranged in series. The skilled man however knows both possibilities and their respective advantages and would choose the one or the other without any inventive step according to the circumstances. In addition E5, which is of such relevance that it should be introduced into the proceedings, also shows a pedal simulator with springs arranged in series.

VII. The arguments of the respondent can be summarized as follows:

The general statement under "summary of the invention" in originally filed description page 3 mentioning the use of springs without specifying the type is support enough for claim 1 as maintained by the opposition division. The subject-matter of claim 1 need not take over all features of the specific embodiment on which it is based.

E4 does not disclose a pedal simulator in the sense of claim 1 since it is not for a brake by wire system. On the contrary E4 discloses an old one circuit brake system which not only cannot be considered an appropriate starting point but will not even be considered by the skilled man at all.

The skilled man has no reason whatsoever to amend the construction according to E2. At several places in the document the advantages of this construction are mentioned and praised. In addition the solution according to claim 1 cannot be considered an equivalent to the construction in E2 since when one spring bottoms out as in the present invention this gives a smoother transition between the first and second portion of movement and thus giving a better feel to the driver.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 Granted claim 1 is a combination of originally filed claims 1 and 5.

The characterising feature of claim 1 as granted requires that the spring mechanism includes first and second springs operatively connected in a series arrangement, said first spring having a spring constant which is higher than the spring constant of said second spring.

Compared to the wording of granted claim 1, claim 1 according to the main request additionally comprises the feature that during a first portion of the movement of the piston in the direction towards the spring mechanism the non-linear spring constant of said spring mechanism is a combination of the spring constant of the first spring and the spring constant of the second spring, and during a second portion of the movement of the piston in the direction towards the spring mechanism, the non-linear spring constant of the spring mechanism substantially approaches the spring constant of the first spring.

This amendment is said to be based on the embodiment according to figure 8 and the corresponding description part of the originally filed application documents.

2.2 From the part of the original description dealing with the embodiment (fig.8) on which present claim 1 is based, see page 13, line 18 to page 15, line 8, (corresponding to paragraphs [0030], [0031] and [0032] of the description of the patent as granted), it is

clearly apparent that the two springs which are in a series arrangement are coil springs and that the second phase of compression or the second part of the movement begins when the coils of the second spring 104 bottom out. This is said to bring about a smoother transition between the first and the second portions of the movement.

2.3 The present wording of claim 1 only requires that

- the spring mechanism includes first and second springs, (thus springs of any kind)
- there is a second portion of the movement of the piston during which the spring constant approaches the one of the first spring.

It thus does not require that the springs are coil springs and that the second portion of the movement begins when the coils of the second spring bottom out.

2.4 According to the respondent original claim 5 and the summary of the invention paragraph in the original specification are a basis for claim 1 according to the main request since these passages do not mention the kind of springs or a specific sequence of movement.

The board cannot agree with the respondent. While it is agreed that claim 1 as granted was a combination of original claims 1 and 5 the introduction of a feature from the description of the embodiment of figure 8 changes the situation.
An intermediate embodiment between the more general one according to claim 1 as granted and the specific one according to the description part dealing with the

embodiment shown in figure 8 has been described neither explicitly nor implicitly in the originally filed application documents. And an essential feature of the embodiment according to figure 8 is that the springs are coil springs and that the second portion of the movement begins when the coils of one of the springs bottom out. This is said to give a smooth transition between the feel given by the combined springs and the feel generated by the then remaining active spring alone, see original page 15, end of the first paragraph.

Unless a teaching to the contrary is present in the originally filed documents, it is not acceptable under Article 123(2) EPC to separate features of an embodiment when it is clear from the description of the specific embodiment that the combination of these features is essential for achieving the desired effect obtained with this specific embodiment. In such a case an intermediately generalised embodiment cannot be considered to be directly and unambiguously derivable from the originally filed application documents.

A general statement in the introductory part of the description cannot change this finding, this introductory part being even more general than the combination of original claims 1 and 5.

2.5 Hence the subject-matter of present claim 1 constitutes an unallowable intermediate generalisation and offends against the requirements of Article 123(2) EPC.

3. *Claims 1 according to auxiliary requests 2 to 5*

3.1 Apart from not including all of the above mentioned features, in all of these requests it has been added that the pedal simulator should be "adapted to generate a braking demand signal for use as an input to an electronically controlled vehicle braking system". This amendment is unclear and inconsistent with the description. The function of a pedal simulator is to imitate a normal braking pedal connected to an hydraulic circuit so that the feel of the driver when he presses on the pedal of a "brake-by-wire" system is comparable in both cases. Hence the pedal simulator as such does not produce any signal. As indicated in the introductory paragraph of the description it is a sensor for measuring the displacement of the pedal which generates the braking demand signal referred to above.

3.2 For the above reason claim 1 according to each of auxiliary requests 2 to 5 also does not fulfil the requirements of Article 84 EPC 1973.

4. Claim 1 according to auxiliary request 6

4.1 In this claim the above mentioned unclear term has been cancelled and it has been further clarified that the springs are coil springs and that the second portion of the movement begins when the coils of the second spring bottom out.

Claim 1 according to auxiliary request 6 thus fulfils the requirement of Article 123(2) EPC.

4.2 The type of springs and the conditions for the transition between the first portion of the movement to the second portion of the movement having been specified, the scope of the claim is narrower than the one of granted claim 1.

Claim 1 according to auxiliary request 6 thus fulfils the requirements of Article 123(3) EPC.

4.3 Novelty of the subject-matter of claim 1 has not been disputed.

4.4 The subject-matter of claim 1 is a pedal simulator. Although this term, taken alone, could be understood in different ways, in the application and the patent in suit it is clearly used to designate a simulator of a braking pedal used in advanced braking systems, also designated as brake-by-wire systems, where actuation of a brake pedal does not directly actuate hydraulic brakes, see page 1 lines 5 to 11 of the originally filed application documents.

The term "pedal simulator" has thus to be understood in the same way in claim 1.

4.5 The closest state of the art is thus disclosed in E2, and more particularly in figure 1, this embodiment being a pedal simulator of the same type also embodying a spring arrangement.

As in the patent in suit the invention in E2 is a pedal simulator which is meant to give the driver a pedal feel similar to that achieved in a conventional hydraulic braking system. In the main embodiment

described in figure 1, E2 proposes a construction with two coil springs 24, 26 in parallel. At the beginning of the movement of the piston and thus of the pedal, the coil spring 24 works alone so that in the first portion of the movement of the pedal the simulator has a relatively soft feel and in a second portion of the movement the second spring 26 becomes active as well and both springs are compressed together increasing the stiffness of the simulator.

In addition an elastomeric disc 22 is present essentially to avoid a solid feel in the rare situation of the pedal being compressed so much that the piston engages an abutment. But this disc does not play any role in a normal braking situation.

4.6 The pedal simulator according to claim 1 comprises a spring mechanism which includes first and second coil springs operatively connected in a series arrangement, said first spring having a spring constant which is higher than the spring constant of said second spring and during a first portion of the movement of the piston in the direction towards the spring mechanism the non-linear spring constant of the spring mechanism is a combination of the spring constant of the first spring and the spring constant of the second spring, and during a second portion of the movement of the piston in the direction towards the spring mechanism the non-linear spring constant of the spring mechanism substantially approaches the spring constant of the first spring as the coils of the second spring bottom out.

4.7 In the construction according to E2 the change between the first portion of the movement to the second portion of the movement happens in a clearly defined and feelable way in that the stiffness increases suddenly from the stiffness of the first spring to the combined stiffness of both springs which is a pure addition of the two stiffnesses of the springs taken alone.

4.8 The use of a second spring according to the characterising portion of claim 1 allows the smoothing out of the transition between the first and the second portion of the movement as it allows the introduction of a third portion of movement between the first and the second one with an intermediate stiffness, this being the result of the coils of the second spring bottoming out.

In other words, the invention as now claimed uses the non linear behaviour of the one coil spring at the end of its compression to obtain in a simple constructional manner a pedal simulator giving a feeling of a smooth transition between a first portion of movement with a first stiffness and a second portion of movement with a higher stiffness.

4.9 In the board's judgment such a construction is neither hinted at by the cited prior art documents, nor by the common general knowledge of the skilled man.

E4 discloses a common traditional one circuit braking system, so that it is already questionable whether the skilled man would consider such a technical field when looking for a solution adapted to improve the feel of a pedal simulator used in a brake-by-wire system.

However even if he did so, E4 could not hint towards the claimed solution since nowhere in this document it is indicated that the coils of any one of the springs bottom out in any situation and what could be the advantage of such a bottoming out of the coils. The system described in this document is a traditional braking system in which once the valve is open the pressure in the hydraulic circuit is felt in the pedal. This has nothing in common with a simulator in which the whole of the generated feel has to come from the simulator alone.

In E1 the spring mechanism is constituted by the single elastomeric spring 63 having a varying spring rate.

In late-filed document E5 there is no indication that the coils of any of the springs acted on when the pedal is depressed bottom out. In view of its lack of relevance this document was therefore not further considered by the board.

The appellant considered that it would be a simple matter of choice between two alternatives to use either springs in parallel or in a series arrangement in the pedal simulator according to E2.

The board cannot agree with this line of argument. While it is accepted that spring theory belongs to the basic mechanical education of any mechanical engineer, the fundamental question here is to assess whether starting from the pedal simulator according to Figure 1 of E2 it would be obvious for the person skilled in the art to come to the claimed subject-matter.

As pointed out by the appellant itself, in a spring arrangement with springs in series the skilled man would generally avoid coming into a situation in which the coils of a coil spring bottom out, since the force/displacement behaviour of the spring is no longer linear when the coils are close to bottoming out. Thus if the person skilled in the art wished to improve the feel obtained with the pedal simulator according to figure 1 of E2, he would not be lead in an obvious manner by his general knowledge to this solution, on the contrary. In addition E2 itself already suggests alternatives: to use wrap springs (see column 3, lines 55 to 58) instead of coil springs, in another embodiment (according to figure 4) to use a single coil spring combined with a damper or in a further embodiment (according to figure 6) to use a single variable rate spring combined with a master cylinder.

4.10 The subject-matter according to claim 1 thus fulfils the requirements of Article 56 EPC 1973.

Order

For these reasons it is decided that:

The decision under appeal is set aside.

The case is remitted to the first instance with the order to maintain the patent in amended form on the basis of the following documents:

– claims	1 to 4 according to the auxiliary request 6 filed at the oral proceedings;
– description:	pages 3 to 5 and 7 of the patent specification, page 2 filed on 18 January 2006, page 6 filed on 28 January 2008;
– drawings:	figures 1 to 7D and 9 of the patent specification, figure 8 filed on 18 January 2006.

The Registrar: The Chairman:

A. Vottner S. Crane