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D E C I S I O N
of 15 April 1997

Case Number: T 0847/95 - 3.2.1

Application Number: 91101070.0

Publication Number: 0440132

IPC: B60K 28/16

Language of the proceedings: EN

Title of invention:
Slip control system for motor vehicle

Patentee:
MAZDA MOTOR CORPORATION

Opponent:
Robert Bosch GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0847/95 - 3.2.1

D E C I S I O N
of the Technical Board of Appeal 3.2.1
of 15 April 1997

Appellant: (Proprietor of the patent)
MAZDA MOTOR CORPORATION
No. 3-1, Shinchi
Fuchu-cho
Aki-gun
Hiroshima-ken (JP)

Representative:
Müller-Boré & Partner
Patentanwälte
Grafinger Strasse 2
D-81671 München (DE)

Respondent: (Opponent)
Robert Bosch GmbH
Postfach 30 02 20
D-70442 Stuttgart (DE)

Representative:
-

Decision under appeal: Decision of the Opposition Division of the European Patent Office posted 7 August 1995 revoking European patent No. 0 440 132 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: F. A. Gumbel
Members: P. Alting Van Geusau
G. Davies

Summary of Facts and Submissions

I. European patent No. 0 440 132 was granted on 24 November 1993 on the basis of European patent application No. 91 101 070.0.

II. With notice of opposition filed on 23 August 1994 the respondent (opponent) requested revocation of the patent for the reason of non-compliance with the provisions of Article 100(a).

In respect of an alleged lack of novelty and inventive step the opposition was essentially supported by the following prior art documents:

D1: EP-A-0 338 588
D2: GB-A-2 188 996.

In respect of an auxiliary request for maintenance of the patent in amended form the respondent referred with telecopy dated 5 July 1995 additionally to

D3: DE-A-3 611 822

III. By its decision given at the oral proceedings on 20 July 1995 and issued in writing on 7 August 1995 the Opposition Division revoked the patent.

The Opposition Division was of the opinion that starting from the closest prior art as represented by D1, it would be obvious to a skilled person to replace the known computation of the correction amounts for the slip decrease by the use of predetermined threshold values if circumstances made this desirable and thus arrive at the subject-matter of the patent without any inventive activity.

IV. An appeal was filed against this decision by the appellant (proprietor) on 5 October 1995 and the appeal fee was paid at the same time.

With the statement of grounds of appeal, filed on 13 December 1995, the appellant also filed amended claims.

V. In a communication in preparation for oral proceedings the Board expressed the provisional opinion that the system disclosed in respect of Figure 6 of D1 represented the closest prior art. Starting from this known slip control system the issue to be discussed during the oral proceedings would essentially relate to the question whether the skilled person was led by the cited prior art to envisage, in addition to the other characterising features of claim 1, a determination of different steer conditions based on individual comparisons of sensed yaw rates and steering amounts to predetermined values rather than calculated expected values such as was known from the system of Figure 6 in D1.

VI. Oral proceedings before the Board were held on 15 April 1997.

During the oral proceedings the appellant submitted a new set of amended claims 1 to 14 and an amended description.

The appellant requested that the decision under appeal be set aside and that the patent be maintained in amended form on the basis of claims 1 to 14 and the amended description as filed during the oral proceedings, with the drawings as granted.

The respondent requested that the appeal be dismissed and the patent revoked in its entirety.

Claim 1 of the appellant's request reads:

"1. A slip control system for a motor vehicle (A) controlling slips in driving wheels (1RR, 1RL) comprising:

- means (UTR, 32, 34, 36R, 36L, 37RR, 37RL, 106) for decreasing a slip of each driving wheel (1RR, 1RL) by controlling a driving force transmitted to the driving wheel (1RR, 1RL) so that the slip ratio (S_{RR}, S_{RL}) of the driving wheel (1RR, 1RL) is at least equal to a predetermined desired slip ratio (S_E, S_B);

- means (74; 69, 63, 64) for detecting a yawing rate of the vehicle (A); and

- means (69) for detecting a steering amount of the vehicle (A);

- wherein said slip decreasing means (UTR, 32, 34, 36R, 36L, 37 RR, 37RL, 106) includes correcting means for decreasing the desired slip ratio (S_E, S_B) when a steering condition is detected based on amounts detected by both the yawing detecting means (74, 69, 63, 64) and the steering amount detecting means (69);

- wherein said slip decreasing means (UTR) carries out a feed back control of the driving force effective at the driving wheel (1RL, 1 RR) so that the slip ratio (S_{RR}, S_{RL}) of said driving wheel (1RR, 1RL) becomes the desired slip ratio (S_E, S_B);

characterised in that

- there are provided means (65, 66, 73) for detecting a slip ratio of each driving wheel (1RR, 1RL);

- said correcting means store a predetermined yawing rate amount value (α) and a predetermined steering amount value (β) with the condition that with yawing rates less than the predetermined yawing rate value (α) the vehicle is regarded to run straight, and calculate the desired slip ratio (S_E, S_B) in direct dependence on a slip value (SET, SBT) regarding the conditions when the vehicle is running straight;

- said correcting means decreases the desired slip ratio (S_E, S_B) by a first correction amount (S_E-S_E', S_B-S_B')when

  - the yawing rate ϕ which is more than or equal to said predetermined value (α) is detected by the yawing rate detecting means (74; 69, 63, 64) and

  - the steering amount θ which is less than or equal to said predetermined value (β) is detected by the steering amount detecting means (69), and

- said correcting means decreases the desired slip ratio by a second correction amount (S_E-S_E'', S_B-S_B'') which is smaller than the first correction amount (S_E-S_E', S_B-S_B') when

  - the yawing rate ϕ which is more than or equal to said predetermined value (α) is detected by the yawing rate detecting, means (74, 69, 63, 64) and

- the steering amount θ which is more than said predetermined value (β) is detected by the steering amount detecting means (69);

the slip control system comprising means (UTR, 82 - 84) for setting and adapting the desired slip ratio (S_E, S_B) inversely related to the vehicle speed."

VII. In support of its request for maintenance of the patent the appellant relied essentially on the following submissions:

When compared to the slip control system disclosed in D1, the slip control system in accordance with the present claim 1 made use of actual measured values rather than calculated values and therefore was more accurate and reliable. Starting from the system known from D1 it was therefore an object of the patent to provide a slip control system with improved stability of the vehicle in the steering operation with a good controllability avoiding undue correction of the slip control by making more effective use of the actual values of the yaw rate and the steering amount, and with more precise slip control and concentration on the problems related to oversteering. In this respect the system in accordance with claim 1 distinguished between relatively stable and unstable over-steering conditions which were different from the over- and under-steering conditions referred to in D1.

In accordance with the system of D1 the desired slip ratio was corrected to be decreased with increasing steering angle or with increasing yaw rate. In contrast thereto, when distinguishing between relatively stable and unstable driving conditions, an unnecessary decrease of the driving wheel was avoided in the present invention in case a relatively stable slip condition was detected. Neither the idea behind the

invention nor the conditions for determining the distinguishing parameters were known or obvious from the cited documents.

VIII. The respondent contested the appellant's views and its arguments can be summarised as follows:

The system of Figure 6 of D1 not only disclosed the precharacterising features of claim 1 but it also led the skilled person in an obvious manner towards the characterising features of this claim. The separate detection of driving wheel slip could be derived from the disclosure on page 3, line 22 in which the slip condition of the left and right front wheels was referred to. Furthermore, the acceptable slip rate of the driving wheels was controlled to be higher in case a relatively stable slip condition was determined than in case of a relatively unstable slip condition.

The only difference between the system known from D1 and the system claimed in claim 1 of the patent was that according to D1 the reference slip rates were adapted in a continuous manner rather than that only two discrete values were used. However, such difference was nothing more than an obvious simplification and could not support an inventive step with the subject-matter of claim 1. Moreover, the values y_D and y_c taken for the correction in D1 were almost fixed values as could be derived from Figure 4 of D1 and in this respect already hinted to the use of fixed reference values.

Anyhow, document D3 disclosed how fixed threshold values were used to set different slip rates in accordance with sensed yaw and steering angle.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 Claim 1 combines the features of the granted claims 1 and 2 and additionally includes the features:

in the precharacterising part;

- that the slip decreasing means carries out a feed back control of the driving force effective at the driving wheel so that the slip ratio of said driving wheel becomes the desired slip ratio,

and in the characterising part;

- the correcting means store a predetermined yawing rate amount value and a predetermined steering amount value with the condition that with yawing rates less than the predetermined yawing rate value the vehicle is regarded to run straight and calculate the desired slip ratio in direct dependence on a slip value regarding the conditions when the vehicle is running straight,

- the slip control system comprising means for setting and adapting the desired slip ratio inversely related to the vehicle speed.

This subject-matter is disclosed in the originally filed description on page 18, lines 6 to 12 (column 10, lines 30 to 38 of the patent description), on page 24, lines 20 to 25 (column 14, lines 14 to 20 of the patent

description) and in respect of the last feature it follows immediately from the calculation of the desired slip ratios, disclosed on page 15, line 10 to page 16, line 1 of the originally filed description (column 9, lines 1 to 11 of the patent description).

2.2 The dependent claims 2 to 14 are essentially repetitions of the granted dependent claims 3 to 15, which were themselves based on the originally filed claims 3 to 15.

2.3 The amendments to the description merely concern some clerical corrections and the drawings remain as originally filed and granted.

2.4 In view of these assessments no formal objections, in particular in respect of Article 123(2) and (3) EPC, arise against the present patent documents.

3. *Novelty*

Novelty of the subject-matter of claim 1 follows from the fact that none of the available prior art documents discloses a slip control system for a motor vehicle in which three different slip rate conditions are established and correction amounts for desired slip ratios for these different conditions are set, which amounts are determined by comparisons between sensed yawing rates and steering amounts with fixed predetermined values of yawing rate and steering amount.

Novelty of the subject-matter of current claim 1 was in fact not contested by the appellant in the appeal proceedings.

4. *Inventive step*

4.1 It is undisputed that document D1 constitutes the closest prior art for the claimed subject-matter and in fact the combination of precharacterising features is based on the disclosure of this prior art document.

In the slip control system known from D1, final driving wheel torque is reduced so as to reduce driving wheel slip. Thereby higher lateral forces can be achieved at the driving wheels leading to improved vehicle stability in under- and oversteering conditions (see page 5, line 46 to page 6, line 5 of D1).
The driving wheel torque reduction quantity B is calculated in accordance with the expression

$B = (|D_r| - y_c)/(y_D - y_c)$ (see page 5, line 30)

in which $D_r = y - y_b$ and is calculated from the yaw rate y obtained by the yaw rate detection means and the reference yaw rate y_b obtained by reference yaw rate setting means (see page 4, lines 42 to 45 of D1). If $(|D_r| - y_c)$ is negative, B = 0 is set.

The actual values of D_r and y_b determine a steering condition in accordance with criteria shown in Table 1 (see page 5) and is preliminarily defined in the steering characteristic determining means 13 (see Figure 6).

Reference values y_c and y_D are generated in deviation setting means 4 such that when the steering angle is small the reference values are set as shown in Figure 4 according to the vehicle speed and the result from the steering characteristic determining circuit. When the steering angle becomes relatively large the reference values y_D and y_c are set to be larger than those shown in Figure 4. The reference value y_c is set corresponding

to a condition where an actual steering characteristic starts to deviate from a steering characteristic peculiar to the vehicle, while the reference value y_D is set corresponding to a condition where the deviation of the actual steering characteristics from the peculiar steering characteristic falls outside a permissible range (see page 5, lines 12 to 22).

The driving wheel torque reduction quantity B is input to the final control quantity setting means.

4.2 The object underlying the subject-matter of claim 1 of the amended patent is the provision of a slip control system for improving the stability of a vehicle in the steering operation with a good controllability avoiding undue correction of the slip control by making use of actual values of the yaw rate and the steering amount (see column 2, lines 15 to 21 of the patent description).

4.3 Although the control known from D1 indeed takes different steering characteristics of a vehicle into account these conditions are related to understeering and oversteering of the vehicle with respective torque reduction control rather than to distinguishing between ranges of relatively neutral, relatively unstable oversteer and relatively stable oversteer conditions and set correction amounts for these ranges, as defined in the characterising part of the amended claim 1 of the patent under consideration.

Furthermore in D1 the driving wheel torque reduction control quantity for a particular driving condition is calculated on the basis of a number of pre-stored different values of parameters y_b, y_D and y_c of which y_D and y_c are partly stored as vehicle speed dependent values. However, since the actual values are not known for the different situations although it can be assumed

that the driving wheel torque reduction is carried out so as to increase lateral stability for higher yaw rates and steering angles, there is no means allowing clear conclusions about the exact and realistic interrelation of yawing rate, steering amount and torque reduction control quantity for the different driving situations.

In the Board's opinion D1 does not in this respect teach the skilled person a direct comparison of a sensed yawing rate and a sensed steering amount with predetermined values in order to differentiate between three driving conditions in the manner as claimed in claim 1. In D1 rather the driving condition is determined in circuit 13 first, on the basis of yaw rates only (in accordance with $D_r = y - y_b$ and y_b). Thereafter reference values y_D and y_C are generated in circuit 4. Apparently the sensed steering value is taken into account only for switching from particular reference values y_D and y_C to other reference values y_D and y_C. Thus only indirectly (see page 5, lines 12 to 22) account is taken of the steering angle.

For these reasons the Board cannot follow the respondent's opinion that the system in accordance with claim 1 is an obvious simplification of the system disclosed in D1. Clearly the basis of the correction is different in the system of D1 when compared to the system claimed in claim 1 and no indication is derivable from D1 that points in the direction of either the determination of the three vehicle conditions claimed or to the specific manner as to how these conditions are determined.

4.4 In an attempt to substantiate the alleged obviousness of the determination of the vehicle conditions by using a comparison of sensed and predetermined values the respondent also referred to D3. In this embodiment of

the anti-lock brake control disclosed in D3, wheel slip rate reference values are corrected on the basis of a comparison between sensed steering angle and yaw rate values with predetermined values.

However, not only does this document relate to braking and therefore concerns a different vehicle driving condition when compared to acceleration of a vehicle, the comparison steps for determining the driving conditions are also different in that the steering amount or the steering speed value is itself used as a parameter to decide on setting the slip rate to a low value or the yaw rate comparison is used to differentiate between high and low slip reference rate between the front and rear wheels.

In view of the totally different object and the differences in the resulting control disclosed in D3, the Board sees no reason why the skilled person could be led to use method steps disclosed in D3 in the system of D1 and even if he would there was no hint given in either D1 or D3 to determine different correction amounts of desired slip ratios based on the specific comparisons defined in claim 1 under consideration.

Moreover, it is to be noted that, in addition to the determination of the different driving conditions, further features, relating to the detection of a slip ratio in each driving wheel and the setting and adapting of the desired slip ratio inversely related to the vehicle speed, are specified in claim 1, and to which no lead for their use in a system similar to the one as claimed 1 can be derived from any of the cited documents. In this respect the respondent's submission

that D1 hinted at separated driving wheel slip detection cannot be followed because clearly in both embodiments disclosed in D1 one of the driving wheel speeds is selected in circuit 9 before wheel slip is determined.

4.5 In the appeal proceedings, the respondent no longer relied upon D2. Neither this document nor any of the other available documents discloses or hints at the combination of features of the present claim 1.

4.6 Summarising, in the Board's judgment the proposed solution to the technical problem underlying the patent in suit defined in the independent claim 1 is based on an inventive step and therefore this claim as well as its dependent claims 2 to 14 relating to particular embodiments of the invention in accordance with Rule 29(3) EPC can form the basis for maintenance of the patent (Article 52(1) EPC.

5. The description and drawings are in agreement with the wording and scope of the current claims. Hence these documents are also suitable for maintenance of the patent in amended form.

Thus, taking into account the amendments made by the appellant, the patent and the invention to which it relates meet the requirements of the EPC and the patent as amended is to be maintained in this form (Article 102(3) EPC).

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 maintain the patent in amended form on the basis of claims 1 to 14 and the description as filed during the oral proceedings with the drawings (Figures 1 to 15) as granted.

The Registrar: The Chairman:

S. Fabiani F. Gumbel