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**D E C I S I O N**  
**of 6 September 1994**

**Case Number:** T 0069/93 - 3.2.1

**Application Number:** 87115971.1

**Publication Number:** 0265959

**IPC:** B60G 3/20

**Language of the proceedings:** EN

**Title of invention:**  
Vehicle suspension system

**Applicant:**  
Mazda Motor Corporation

**Opponent:**  
-

**Headword:**  
-

**Relevant legal norms:**  
EPC Art. 56

**Keyword:**  
"Inventive step (yes)"

**Decisions cited:**  
-

**Catchword:**  
-



Case Number: T 0069/93 - 3.2.1

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.1  
of 6 September 1994

**Appellant:** Mazda Motor Corporation  
No. 3-1 Shinchi  
Fuchu-cho  
Aki-gun, Hiroshima-ken (JP)

**Representative:** Patentanwälte Louis, Pöhlau, Lohrentz and  
Segeth  
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**Decision under appeal:** Decision of the Examining Division 2.3.06.075 of  
the European Patent Office dated 30 October 1992  
refusing European patent application  
No. 87 115 971.1 pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** F. Gumbel  
**Members:** S. Crane  
J.-C. Saisset

### Summary of Facts and Submissions

1. European patent application No 87 115 971 was refused by a decision of the Examining Division dated 30 October 1992.

II. The reason given for the decision was that the subject-matter of at least Claim 1 then on file lacked inventive step with respect to the state of the art as shown in the following documents:

D1: US-A-4 440 420

D2: DE-A-1 938 850

D3: Automobiltechnische Zeitschrift, Vol. 87, No. 2, February 1985, pages 59 to 64, Hiller et al:  
"Bewegungsanalyse einer Fünfpunkt-Radaufhängung."

III. An appeal against this decision was filed on 29 December 1992 and the appeal fee paid on the same date.

The Statement of Grounds of Appeal was filed on 5 March 1993.

IV. In a communication pursuant to Article 11(2) RPBA dated 13 January 1994 the Board pointed out various deficiencies in the terms of Claim 1 then on file. It also indicated that in addition to the prior art documents considered in the contested decision the state of the art shown in (D4) GB-A-2 172 254, cited in the Search Report, could be of relevance to the question of inventive step.

V. Oral proceedings were held on 6 September 1994.

At the oral proceedings the Appellant (Applicants) submitted a new set of Claims 1 to 3 and a revised description (12 pages), on the basis of which, together

with drawings sheets 1/3 to 3/3 filed on 12 August 1992, the grant of a patent was requested.

Claim 1 reads as follows:

"A vehicle suspension system for supporting a dirigible wheel of the vehicle, comprising a wheel-support (1) which rotatably supports the dirigible wheel (2), an upper wheel-support support member (3) comprising a pair of separate link members (5, 6) one end of each of which is pivoted on the vehicle body and the other end of each of which is pivoted on the wheel-support, and a lower wheel-support support member (4) substantially extending in the transverse direction of the vehicle body and comprising a single arm member one end of which is pivoted on the vehicle body at two different connecting points (9) and the other end of which is pivoted on the wheel support (1) at a single point (10), the upper and lower wheel-support support members (3, 4) being arranged to respectively define upper and lower pivot points defining an imaginary kingpin axis (k) characterized in that said link members (5, 6) extend substantially in the transverse direction of the vehicle, whereby the connecting line of the pivot points (7) of the link members (5, 6) on the vehicle body and the connecting line of the pivot points (8) of the link members (5, 6) on the wheel support (1), in the straight ahead position of the wheel, are substantially parallel to the longitudinal axis of the vehicle, and the front link member (5) is inclined with respect to the transverse direction of the vehicle body by an angle  $\alpha$  greater than an angle  $\beta$  by which the rear link member (6) is inclined with respect to the transverse direction of the vehicle body, as viewed in plan when the vehicle is running straight, it being assumed that the angle  $\alpha$  is positive when the front link member (5) is inclined forward with respect to the transverse direction, when

viewed from the outer pivot point to the inner pivot point, and the angle  $\beta$  is positive when the rear link member (6) is inclined rearward with respect to the transverse direction, when viewed from the outer pivot point to the inner pivot point, whereby the dirigible wheel (2) has a negative camber when turned, at least at the beginning of the turn, as the outer wheel when cornering and a positive camber when turned, at least at the beginning of the turn, as the inner wheel when cornering.

Dependent Claims 2 and 3 relate to preferred embodiments of the vehicle suspension system defined in Claim 1.

VI. In support of their request the Appellants argued substantially as follows:

The contested decision was based on a geometrical analysis which purported to show that once the inner and outer pivot points of the link members were required to lie on respective lines substantially parallel to the longitudinal axis of the vehicle then the only possibility for achieving the desired wheel cambers when cornering was to dispose the link members in the way stated in Claim 1. That analysis was however based on hindsight. The claimed arrangement of pivot points and the disposition of the link members represented a combination of features that together constituted the concept of the invention and there was nothing in the state of the art that could lead the skilled person thereto.

## Reasons for the Decision

1. The appeal complies with the requirements of Articles 106 to 108 and Rules 1(1) and 64 EPC. It is therefore admissible.
  
2. *Formal allowability of the amended documents*

Present Claim 1 combines in essence the features of original Claims 1, 3, 4 and 6 together with the restriction that the respective connecting line of the pivot points of the link members on the vehicle body and on the wheel support is substantially parallel to the longitudinal axis of the vehicle. A basis for this latter feature is to be found particularly in the originally filed drawings and the last paragraph of the original description. A basis for the clarifications concerning how the angles  $\alpha$  and  $\beta$  at which the link members are disposed are measured is to be found on page 9, lines 5 to 11 of the original description. Lastly, the final clause of the claim, which states the effect to be achieved in terms of the camber of the wheel when turned as an inner wheel or outer wheel on cornering is supported by page 3, line 24 to page 4, line 4 and page 12, line 17 to page 13, line 7 of the original description.

Present Claim 2 is equivalent to original Claim 5 and present Claim 3 is based on page 7, lines 4 to 8 of the original description.

The amendments made to the description and drawings do not go beyond those necessary to bring these into agreement with the terms of the amendment claims.

There are therefore no objections under Article 123(2) to the amendments made.

3. *State of the art*

3.1 In order to extend the possibilities of designing the suspension of a steerable vehicle wheel document D2 proposes dividing at least one of the upper and lower support members of the wheel carrier into two separate link members individually pivoted to the vehicle body and the wheel carrier. In this way the intersection point of the link members defines a notional pivot point for an imaginary kingpin axis. As shown in Figure 7 it is the upper support member which is divided in this way whereas the lower support member is of conventional wishbone form. This configuration results in a significant negative kingpin angle.

3.2 Document D1 builds on the teachings of document D2 and proposes a suspension system for a steerable vehicle wheel designed to give a negative camber to the wheel when on the outside of a curve. To this end the individual link members constituting the upper support for the wheel carrier are of substantially equal length and arranged so that the line bisecting them extends at a substantial angle to the wheel axis and lies rearwardly thereof. In the preferred embodiment shown both link members lie rearwardly of the wheel axis. As the wheel is turned on the outside of a curve the imaginary kingpin axis is moved to the rear causing a negative camber change. This change is further enhanced by the spring deflection, the upper link member being shorter than the lower wishbone support member. Associated with the movement of the imaginary kingpin axis is also a positive caster distance increase. When the wheel is turned on the inside of a curve its plane extends in the general direction of the line bisecting the link members so that spring movement thereof has

practically no effect on the camber of the wheel. Instead, the spring movement of the lower wishbone leads to the desired positive camber of the wheel.

- 3.3 Document D4 refers to both documents D1 and D2 and states that the advantageous increase in positive caster angle at the outer wheel achieved according to document D1 is obtained only by an inconvenient arrangement of the upper link member which is difficult to realise in practice. It is therefore proposed to achieve this effect by means of a coupler which extends between the outboard ends of the upper link members and to which the wheel carrier is attached, the axis of the coupler extending at an angle to the bisector of the angle enclosed by the link members and extending inwards towards the longitudinal axis at an angle towards the rear of the vehicle.

In the preferred embodiment disclosed the lower support member also comprises two link members connected by a further coupler. It is however stated at page 1, lines 125 to 128, that the lower support member may comprise a single triangular guide link. Furthermore, in the preferred embodiment the bisector of the angle between the upper link member coincides in plan view with the wheel axis in the straight ahead position. It is however stated at page 2, lines 101 to 108, that the upper link members can be so arranged that the bisector makes an acute angle with, and extends either in front of or behind, the wheel axis.

Lastly, it is indicated in general terms at page 1, lines 100 to 108, that the disclosed arrangement gives the possibility during steering of moving the imaginary kingpin axis towards the centre of the vehicle for achieving a desired wheel camber.

3.4 Document D3 is related to a mathematical model for analysing the behaviour of a five-point wheel suspension (i.e. the type of suspension disclosed in document D2). Figure 11 shows the numerical simulation of the steering movement of such a suspension, and according to the associated text the change in camber angle is readily recognisable.

4. *Novelty and inventive step*

4.1 All three of the documents D1, D2 (Figure 7) and D4 (when account is taken of the possibility that the lower support member may comprise a single arm) disclose a vehicle suspension system with the features specified in the preamble of present Claim 1. However, none of these document discloses the arrangement and disposition of the upper link members as specified in the characterising clause of the claim. In particular, in document D1 the rearward link member extends substantially to the rear of the vehicle and the respective lines connecting the inner and outer pivot points of the link members are not parallel to the longitudinal axis of the vehicle. Furthermore, the relationship between the angles  $\alpha$  and  $\beta$ , determined in accordance with the teaching of Claim 1, is the reverse of what is stated there with  $\alpha$  being smaller than  $\beta$ . In the Figure 7 embodiment of document D2 there is no clear information concerning the location of the pivot points of the link members or their angular disposition. As for document D4 it can be seen that in the suggested possible arrangement where the bisector of the angle of the link members extends at a forwardly extending angle to the wheel axis, then the claimed relationship of the angles  $\alpha$  and  $\beta$  would necessarily be given. However in this arrangement the outer pivot points, by virtue of the coupler, cannot possibly lie on a line which is parallel to the longitudinal axis of the vehicle, and no

information is available with respect to the inner pivot points.

Document D3 does not disclose a vehicle suspension system according to the preamble of present Claim 1, all of the examples shown comprising a lower support member comprised of two individually pivoted link members, nor does it disclose the arrangement and disposition of upper link members required by the characterising clause.

It is therefore apparent that the subject-matter of Claim 1 is novel.

- 4.2 In the opinion of the Board the most appropriate state of the art to take as the starting point is that shown in document D1, which is the only one specifically concerned with a vehicle suspension system designed to give a negative camber to the outside wheel and a positive camber to the inside wheel in a curve. The two-part formulation of Claim 1 is therefore based on this document.

In the state of the art according to document D1 the desired camber changes can only be obtained at the cost of having the inner pivot point of the rearward upper link member spaced by a considerable amount in the transverse direction of the vehicle from the pivot point of the forward upper link member. This arrangement of the link members is difficult to achieve with a conventional vehicle lay-out. This inconvenience is avoided by the arrangement of link members set out in the characterising clause of Claim 1 which, as can be seen from a consideration of present Figures 5(a) to (c), leads, at least at the beginning of a turn, to the

required negative camber when the wheel is on the outside of the curve and positive camber when the wheel is on the inside of the curve.

The inconvenience of the proposals made in document D1 had already been recognised in the art, as is clear from document D4. This latter document therefore proposes an arrangement of the upper link members in which their outer ends are pivotally connected to the wheel carrier via a coupler which in the straight ahead position of the wheel extends inwards towards the vehicle longitudinal axis at an angle towards the rear thereof. As described in detail, the effect of this coupler is to increase the positive caster angle when the wheel is turned on the outside of a curve. The effects on the wheel when it is turned on the inside of a curve are not described in detail, nor is the effect on the camber of the wheel, although given the general statement with respect to "achieving a desired wheel camber" it could be expected that the intention, at least on the outside of the curve, is to give a negative camber to the wheel. Be that as it may, it is apparent that document D4, since the angularly aligned coupler is an essential element of its teachings, cannot encourage the skilled person to investigate arrangements where the outer pivot points of the link members lie on a line which is parallel to the longitudinal axis of the vehicle, as is required by present Claim 1.

It is clear from document D3 that a mathematical model for investigating the extremely complex movements of a vehicle suspension system of the type shown in documents D1, D2 and D4 was available, and as indicated by Figure 11 of document D3 the change in camber of the wheel as it is turned is one of the factors that the model can be used to calculate. However, document D3 in itself can give no direct suggestion to the skilled

person that in a vehicle suspension system as defined in the preamble of present Claim 1 the desired wheel camber changes can be achieved with the arrangement of link members as set out in the characterising clause of the claim. Furthermore, the number of variables in the design of such a suspension system is so large that it cannot be reasonably argued that the skilled man, with the aid of a mathematical model as disclosed in document D3, could arrive at the claimed arrangement by a process of trial and error.

The Board therefore comes to the conclusion that the subject-matter of present Claim 1 cannot be derived in an obvious manner from the state of the art and accordingly involves an inventive step (Articles 52(1) and 56 EPC). The geometrical analysis performed by the Examining Division which led to the refusal of the application may well in principle and considered in isolation be correct. However, the Board can recognise nothing in the state of the art which would have led the skilled person to impose the pre-conditions of having the inner and outer pivot point of the upper link members lying on respective lines parallel to the longitudinal axis of the vehicle before preceding to a determination of how those link members should then be disposed to achieve the desired wheel cambers.

Accordingly, present Claim 1, Claim 2 and 3 dependent thereon, and the revised description and drawings form a suitable basis for the grant of a patent.

**Order**

**For these reasons it is decided that:**

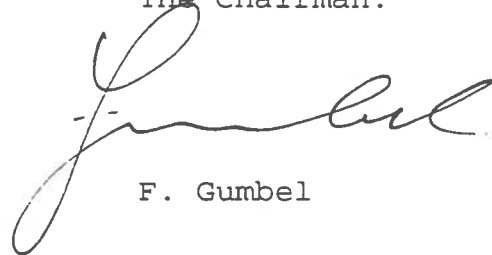
1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent on the basis of the documents set out in Section V above.

The Registrar:

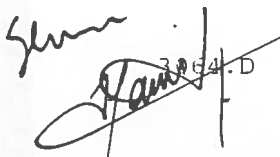


**S. Fabiani**

The Chairman:



**F. Gumbel**



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