PATENT REQUEST: STANDARD PATENT

We, being the person identified below as the Applicant and Nominated Person, request the grant of a patent to us for an invention described in the accompanying standard complete specification.

[76 & 71] Applicant and Nominated Person:
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[54] Invention Title:
UNIVERSAL JOINT SHAFT IN A STEERING SYSTEM FOR ABSORBING AND INTERCEPTING IMPACT ENERGY OF A COLLISION

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BASIC CONVENTION APPLICATION STATUS

[60] Application Number and Date:
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MANDO MACHINERY CORPORATION

BY: H.R. HODGKINSON & CO.
Patent Attorneys for the Applicant

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NOTICE OF ENTITLEMENT
TO GRANT OF A PATENT,
PETTY PATENT, OR
PATENT OF ADDITION

We, MANDO MACHINERY CORPORATION

of 730 Dang-Dong, Kunpo-Si, Kyungki-Do, Korea

being the applicant in respect of Application No. ..............................

for an invention entitled: "UNIVERSAL JOINT SHAFT IN A STEERING SYSTEM FOR ABSORBING AND INTERCEPTING IMPACT ENERGY OF A COLLISION"

state the following:

1. The person nominated for the grant of the patent:

   has entitlement from the actual inventor, Ji-Yeol Kim, of 104-203 Samchunlli Apt., Haksung-Dong, Wonju-Si, Kangwon-Do, Korea, and the facts upon which the person nominated is entitled to make the application is as follows:

   The inventor is an employee of the applicant company.

2. and the basic application listed on the request form is the first application made in a Convention country in respect of the invention.

Signed at Milsons Point, Sydney this 3rd day of December 1997

........................

........................H R Hodgkinson

Status: ........Patent Attorney

H.R. HODGKINSON & CO
Patent Attorneys
Sydney
A universal joint shaft in a steering system for absorbing and intercepting impact energy of a collision comprises an upper shaft connected to a steering column at its one end and having an upper slanted surface of a predetermined slant angle at the other end, a lower shaft connected to a gear shaft at its one end and having a lower slanted surface of a same slant angle as that of the upper slanted surface at the other end, an impact absorbing sleeve for supporting the upper shaft and the lower shaft to align the two shafts with each other such that the upper and the lower slanted surfaces are arranged parallel to each other and a plurality of rivets for fixing the impact absorbing sleeve to the upper and the lower shafts.

**Claim**

1. A universal joint shaft in a steering system for absorbing and intercepting impact energy of a collision, which comprises:
an upper shaft connected to a steering column at its one end and having an upper slanted surface of a predetermined slant angle at the other end;

a lower shaft connected to a gear shaft at its one end and having a lower slanted surface of a same slant angle as that of the upper slanted surface at the other end;

an impact absorbing sleeve for supporting the upper shaft and the lower shaft to align the two shafts with each other in such a manner that the upper and the lower slanted surfaces are arranged parallel to each other; and

a clamping means for fixing the impact absorbing sleeve to the upper and the lower shafts.
The following statement is a full description of this invention, including the best method of performing it known to us:
UNIVERSAL JOINT SHAFT IN A STEERING SYSTEM FOR ABSORBING AND INTERCEPTING IMPACT ENERGY OF A COLLISION

BACKGROUND OF THE INVENTION

1.Field of the Invention

The present invention relates to a universal joint shaft in a steering system for absorbing and intercepting impact energy of a collision and, more particularly, to an improved universal joint shaft which can absorb and intercept impact energy of a collision with a quick response to thereby provide enough safety margin for a driver and can be manufactured without necessitating a high precision in machining to thereby increase manufacturing productivity.

2.Description of the Prior Art

A steering system for use in an automotive vehicle normally comprises a handling mechanism, a gear mechanism and a linkage unit. The handling mechanism is to transmit the steering effort on a steering wheel applied by a driver to a steering gear mechanism. The handling mechanism includes a steering wheel, a steering shaft and a steering column. The gear mechanism serves to magnify the steering effort or change direction of the steering effort and then, to transmit the
magnified steering effort to the linkage unit.

Finally, the linkage unit pivotally moves a driving wheel in response to the operation of the gear mechanism. The linkage unit includes a rack gear, a pinion gear engaged with the rack gear, a tie-rod and a knuckle arm.

The steering effort by the driver is transmitted to a gear shaft through the steering wheel, the steering column, a universal joint shaft which connects the steering column to the gear shaft. The rotational force from the gear shaft is magnified and changed in direction, and then transmitted to a pitman arm, a drag link, the knuckle arm and a knuckle spindle for turning the driving wheel. The tie-rod for allowing the pair of driving wheels to turn at a same angle is mounted to a knuckle via the knuckle arm.

On the other hand, in the conventional steering system, the universal joint shaft is designed to absorb impact energy transferred thereto, in the event of a frontal collision of an automobile.

There is shown in Fig. 1 one of the conventional universal joint shaft capable of absorbing impact energy of a collision. The system comprises an external shaft 101 and an internal shaft 102 which are connected to a steering column and a gear shaft respectively, via universal joints 103 and 104.

The external diameter of the internal shaft 102 is
approximately the same as the internal diameter of the external shaft 101 so that, when inserting the internal shaft 102 into the external shaft 101, a predetermined frictional force may be exerted on each other. The external and the internal shafts 101 and 102 are provided with a plurality of through holes for accommodating a pair of molding pins 105 which are manufactured by an injection molding method. The internal shaft 102 is inserted into the external shaft 101 and they are fixedly connected to each other by the molding pins 105.

In such a conventional universal joint shaft, when an impact force exceeding the predetermined magnitude is exerted in axial direction, the molding pins 105 shear and the internal shaft 102 moves into the external shaft 101, absorbing the impact force. The molding pins 105 first absorb part of the impact energy transferred to the external shaft 101 while they shear. The remainder of the impact energy dissipates into the frictional force between the external and the internal shafts 101 and 102 when they move relatively to each other.

However, the conventional universal joint shaft described above which employs friction between the external and the internal shafts to absorb the impact energy may not provide enough safety margin for a driver owing to its poor efficiency.
of absorbing the impact energy. Furthermore, in a manufacturing process of a molding pin, it is necessary to control several factors, e.g., timing and pressure precisely in order to allow the molding pin to have a required strength.

Moreover, since the diameters of the internal and the external shafts must be precisely adjusted in order to have a proper frictional force between the external and the internal shafts, the manufacturing process of the steering column is rather difficult, thereby increasing the production cost thereof.

Summary of the Invention

It is, therefore, a primary object of the invention to provide an improved universal joint shaft which can be quickly disassembled in case of a frontal collision for absorbing and intercepting impact energy in order to provide enough safety margin.

Another object of the invention is to provide an improved universal joint shaft which can be manufactured without necessitating a high precision in machining to thereby increase a whole productivity.

To achieve the above objects, there is provided a universal joint shaft in an automotive vehicle for absorbing and intercepting impact energy of a collision, which compris-
es: an upper shaft connected to a steering column at its one
end and having an upper slanted surface of a predetermined
slant angle at the other end; a lower shaft connected to a
gear shaft at its one end and having a lower slanted su\textit{face}
of a same slant angle as that of the upper slanted surface at
the other end; an impact absorbing sleeve for supporting the
upper shaft and the lower shaft to align the two shafts with
each other in such a manner that the upper and the lower
slanted surfaces are arranged parallel to each other; and a
clamping means for fixing the impact absorbing sleeve to the
upper and the lower shafts.

According to the present invention, the slant angle is
equal to or less than 45°.

As a preferred embodiment of the present invention, the
upper and the lower shafts are of a circular cross-sectional
configuration and the impact absorbing sleeve is a cylindrical
body provided with a pair of lengthwise cutout portions and
a pair of bridge portions and the upper and the lower shafts
are inserted into the cylindrical body to be fixed thereto.

As a modification of the present invention, the upper and
the lower shafts are of a rectangular cross-sectional
configuration and the impact absorbing sleeve is a rectangular
tube provided with a pair of lengthwise cutout portions and
a pair of bridge portions and the upper and the lower shafts
are inserted into the rectangular tube to thereby be fixed thereto.

The clamping means are of a plurality of rivets which are inserted into a pair of rivet holes formed through both end portions of the impact absorbing sleeve and a pair of through holes formed through the upper and the lower shafts, respectively.

Brief Description of the Drawings

The above and other objects and features of the instant invention will become apparent from the following description of preferred embodiments taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a partial longitudinal cross-sectional view of a conventional universal joint shaft;

Fig. 2 is an exploded perspective view of a universal joint shaft in accordance with a preferred embodiment of the present invention;

Fig. 3 is a perspective view of an impact absorbing sleeve shown in Fig. 2;

Fig. 4 is a partial longitudinal cross-sectional view of the universal joint shaft according to the present invention in Fig. 2, when an impact energy is not transferred thereto;
Fig. 5 is a partial longitudinal cross-sectional view of the universal joint shaft according to the present invention, after an impact energy exceeding a predetermined level has been exerted in axial direction;

Fig. 6 is an exploded perspective view of a modification of the present invention; and

Fig. 7 is a perspective view of the impact absorbing sleeve shown in Fig. 6.

Detailed Description of the Preferred Embodiments

Referring to Figs. 2 to 5, a universal joint shaft according to a preferred embodiment of the present invention will be described.

Referring to Fig. 2, a universal joint shaft comprises an upper and a lower shafts 10 and 20 of a circular cross-section, an impact absorbing sleeve 30 for coupling the upper and the lower shafts 10 and 20, and a plurality of clamping members for fixing the impact absorbing sleeve 30 to ends of the upper and the lower shafts 10 and 20.

One end of the upper shaft 10 is connected to a steering column (not shown) via a universal joint 11. The upper shaft 10 has a slanted surface 12 at the other end thereof. One end of the lower shaft 20 is connected to a gear shaft (not shown)
via a universal joint 21. The lower shaft 20 has a slanted surface 22 at the other end thereof. When the upper and the lower shafts 10 and 20 are coupled by the impact absorbing sleeve 30, the two shafts 10 and 20 are arranged and disposed in a line and the slanted surfaces 12 and 22 are arranged to contact each other or to be spaced parallel with a clearance. Preferably, the slanted surface 12 has a same slant angle as that of the slanted surface 22; and the slant angle is equal to or less than 45°.

The impact absorbing sleeve 30 comprises a cylindrical body 31 provided with a pair of lengthwise cutout portions 32 and 33 and a pair of bridge portions 34, as shown in Fig. 3. The internal diameter of the cylindrical body 31 is larger than the external diameter of the upper and the lower shafts 10 and 20 so that the upper and the lower shafts 10 and 20 can be inserted into the cylindrical body 31 by a predetermined length.

The clamping members are a pair of rivets 40. The rivets 40 are inserted into a pair of rivet holes 35 and 36 and a pair of through holes 13 and 23 formed through the upper and the lower shafts 10 and 20, respectively. The rivet holes 35 and 36 are separated by a predetermined distance so that the upper and the lower shafts 10 and 20 may maintain a gap therebetween.
In assembling the components constituting a universal joint shaft according to the present invention as described above, the upper and the lower shafts 10 and 20 are first inserted into the impact absorbing sleeve 30, and then, the rivet holes 35 and 36 are aligned with the corresponding through holes 13 and 23, respectively. As a result, the upper and the lower shafts 10 and 20 may be spaced apart from each other depending upon the distance between the rivet holes 35 and 36. Finally, the rivets 40 are inserted into the rivet holes 35 and 36 and through holes 13 and 23.

On the other hand, the impact absorbing sleeve 30 may be shaped to have a normal cylindrical configuration without the lengthwise cutout portions 32 and 33. In this case, however, there may be a possibility that a break of the cylindrical body does not occur at the time when the rivets 40 are broken. This results in a reduced impact energy absorption.

As described above, the upper and the lower shafts 10 and 20 described above are mounted between the steering column and the gear shaft. Referring to Fig. 5, when an impact force $f_1$ exceeding a predetermined magnitude is exerted on the lower shaft 20, as indicated with an arrow, the rivets 40 shear and at the same time, the impact absorbing sleeve 30 breaks, thereby absorbing the impact energy. When the lower shaft 20 further moves, the slanted surface 22 of the lower shaft 20
frictionally contacts the slanted surface 12 of the upper
shaft 10 and then, the lower shaft 20 is pivotally misaligned
with the upper shaft 10 due to a resultant force F produced
by adding the impact force f1 and a moment force f2 caused by
the slant angle of the slanted surfaces 12 and 22. As a
result, the remainder of the impact energy is intercepted and
prevented from being transmitted to the steering wheel.

Figs. 6 and 7 depict perspective views of a modification
of the universal joint shaft according to the present
invention and the impact absorbing sleeve, respectively. As
a modification of the present invention, the universal joint
shaft comprises an upper and a lower shafts 50 and 60 of a
rectangular cross-section, an impact absorbing sleeve 70 for
coupling the upper and the lower shafts 50 and 60, and a
plurality of clamping members for fixing the impact absorbing
sleeve 70 to the ends of the upper and the lower shafts 50 and
60.

One end of the upper shaft 50 is connected to a steering
column via a universal joint 51. The upper shaft 50 has a
slanted surface 52 at the other end thereof. One end of the
lower shaft 60 is connected to a gear shaft (not shown) via a
universal joint 61. The lower shaft 60 has a slanted surface
62 at the other end thereof. When the upper and the lower
shafts 50 and 60 are coupled by the impact absorbing sleeve
the two shafts 50 and 60 are arranged and disposed in a line such that the slanted surfaces 52 and 62 are arranged to contact each other or to be spaced parallel with a clearance. Preferably, the slanted surface 52 has a same slant angle as that of the slanted surface 62; and the slant angle is equal to or less than 45°.

The impact absorbing sleeve 70 comprises a rectangular tube 71 provided with a pair of lengthwise cutout portions 72 and 73 and a pair of bridge portions 74. The inner width and height of the rectangular tube 71 is larger than the outer width and thickness of the upper and the lower shafts 50 and 60 so that the upper and the lower shafts 50 and 60 can be inserted into the rectangular tube 71 by a predetermined length.

The clamping members are a pair of rivets 80. The rivets 80 are inserted into a pair of rivet holes 75 and 76 and a pair of through holes 53 and 63 formed through the upper and the lower shafts 50 and 60, respectively. The rivet holes 75 and 76 are separated by a predetermined distance so that the upper and the lower shafts 50 and 60 may maintain a gap therebetween.

When an impact force exceeding the predetermined magnitude is exerted on the lower shaft 60, the rivets 80 shear and at the same time, the impact absorbing sleeve 70 breaks, thereby
absorbing the impact energy. When the lower shaft 60 further moves, the slanted surface 62 of the lower shaft 60 frictionally contacts the slanted surface 52 of the upper shaft 50 and then, the lower shaft 60 is pivotally misaligned with the upper shaft 50 due to a resultant force produced by adding the impact force and a moment force f2 caused by the slant angle of the slanted surfaces 52 and 62. As a result, the remainder of the impact energy is intercepted and prevented from being transmitted to the steering wheel.

As described above, the inventive universal joint shaft can absorb and intercept impact energy of a collision with a quick response to thereby provide enough safety margin for a driver and can be manufactured without necessitating a high precision in machining to thereby increase manufacturing productivity.

Although the invention has been shown and described with respect to the preferred embodiments, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the following claims.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A universal joint shaft in a steering system for absorbing and intercepting impact energy of a collision, which comprises:

   an upper shaft connected to a steering column at its one end and having an upper slanted surface of a predetermined slant angle at the other end;

   a lower shaft connected to a gear shaft at its one end and having a lower slanted surface of a same slant angle as that of the upper slanted surface at the other end;

   an impact absorbing sleeve for supporting the upper shaft and the lower shaft to align the two shafts with each other in such a manner that the upper and the lower slanted surfaces are arranged parallel to each other; and

   a clamping means for fixing the impact absorbing sleeve to the upper and the lower shafts.

2. The universal joint shaft of claim 1, wherein the upper and the lower shafts are of a circular cross-sectional configuration and the impact absorbing sleeve is a cylindrical body provided with a pair of lengthwise cutout portions and a pair of bridge portions and the upper and the lower shafts are inserted into the cylindrical body to thereby be fixed
3. The universal joint shaft of claim 1, wherein the upper and the lower shafts are of a rectangular cross-sectional configuration and the impact absorbing sleeve is a rectangular tube provided with a pair of lengthwise cutout portions and a pair of bridge portions and the upper and the lower shafts are inserted into the rectangular tube to thereby be fixed thereto.

4. The universal joint shaft of any one of claims 1 to 3, wherein the clamping means comprises a plurality of rivets which are inserted into a pair of rivet holes formed through both end portions of the impact absorbing sleeve and a pair of through holes formed through the upper and the lower shafts, respectively.

5. The universal joint shaft of claim 1, wherein the slant angle is equal to or less than 45°.

Dated this 3rd day of December 1997

MANDO MACHINERY CORPORATION

by:

Patent Attorney for the Applicant
ABSTRACT OF THE DISCLOSURE

A universal joint shaft in a steering system for absorbing and intercepting impact energy of a collision comprises an upper shaft connected to a steering column at its one end and having an upper slanted surface of a predetermined slant angle at the other end, a lower shaft connected to a gear shaft at its one end and having a lower slanted surface of a same slant angle as that of the upper slanted surface at the other end, an impact absorbing sleeve for supporting the upper shaft and the lower shaft to align the two shafts with each other such that the upper and the lower slanted surfaces are arranged parallel to each other and a plurality of rivets for fixing the impact absorbing sleeve to the upper and the lower shafts.
FIG 1
(CONVENTIONAL ART)
FIG 2
(CONVENTIONAL ART)

FIG 3
(CONVENTIONAL ART)
FIG 4

FIG 5