(12) UK Patent Application (19) GB (11) 2 400 589 (13) A

(43) Date of A Publication 20.10.2004

(21) Application No: 0415366.4

(22) Date of Filing: 08.08.2001

Date Lodged: 08.07.2004

(30) Priority Data:
(31) 09634250 (32) 08.08.2000 (33) US
(31) 09635579 (32) 09.08.2000
(31) 09636682 (32) 11.08.2000
(31) 09635791 (32) 11.08.2000

(62) Divided from Application No 0119374.7 under Section 15(4) of the Patents Act 1977

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(continued on next page)

(51) INT CL[7]:
B60G 21/055

(52) UK CL (Edition W):
B7D DSCD

(56) Documents Cited:
GB 0734267 A GB 0454398 A
DE 004427172 A1 DE 001959496 A1

(58) Field of Search:
UK CL (Edition W) B7D
INT CL[7] B60G
Other: WPI, EPODOC, JAPIO

(54) Abstract Title: **Vehicle suspension**

(57) A vehicle suspension comprising a first side mounting plate 10a and a first control arm pivotally coupled to the first side mounting plate. A second control arm is pivotally coupled to the side mounting plate and a torsion bar 112. The torsion bar passes through a first opening 74 in the first side mounting plate.

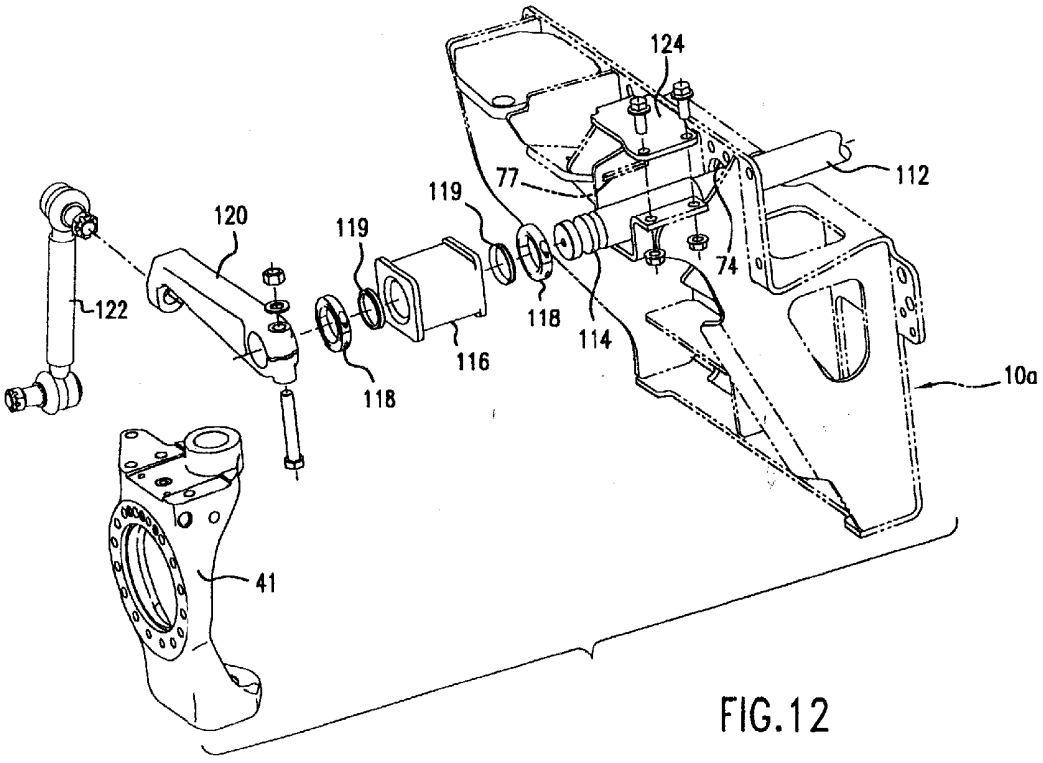

FIG.12

GB 2 400 589 A

GB 2400589 A continuation

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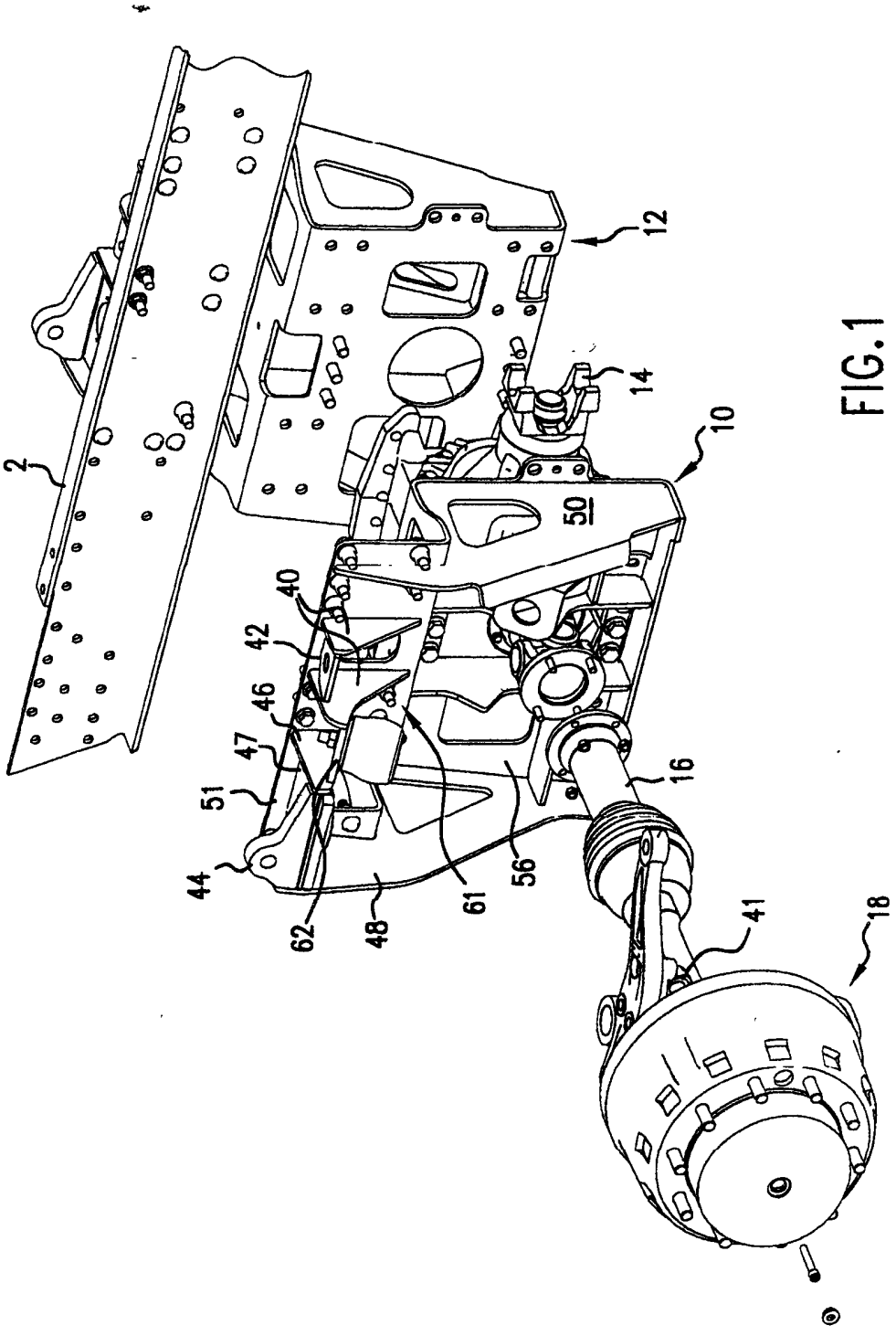

FIG.1

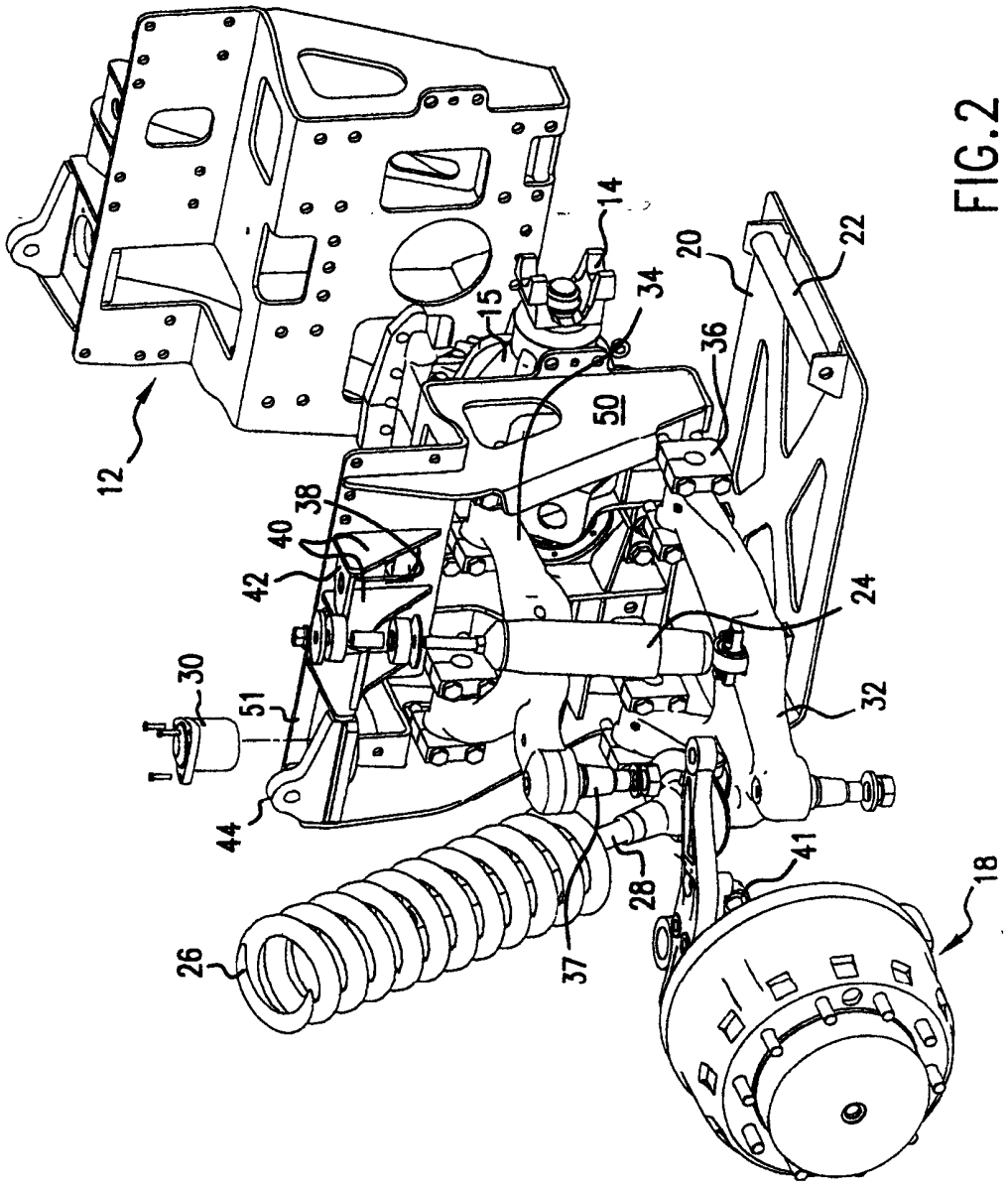

FIG.2

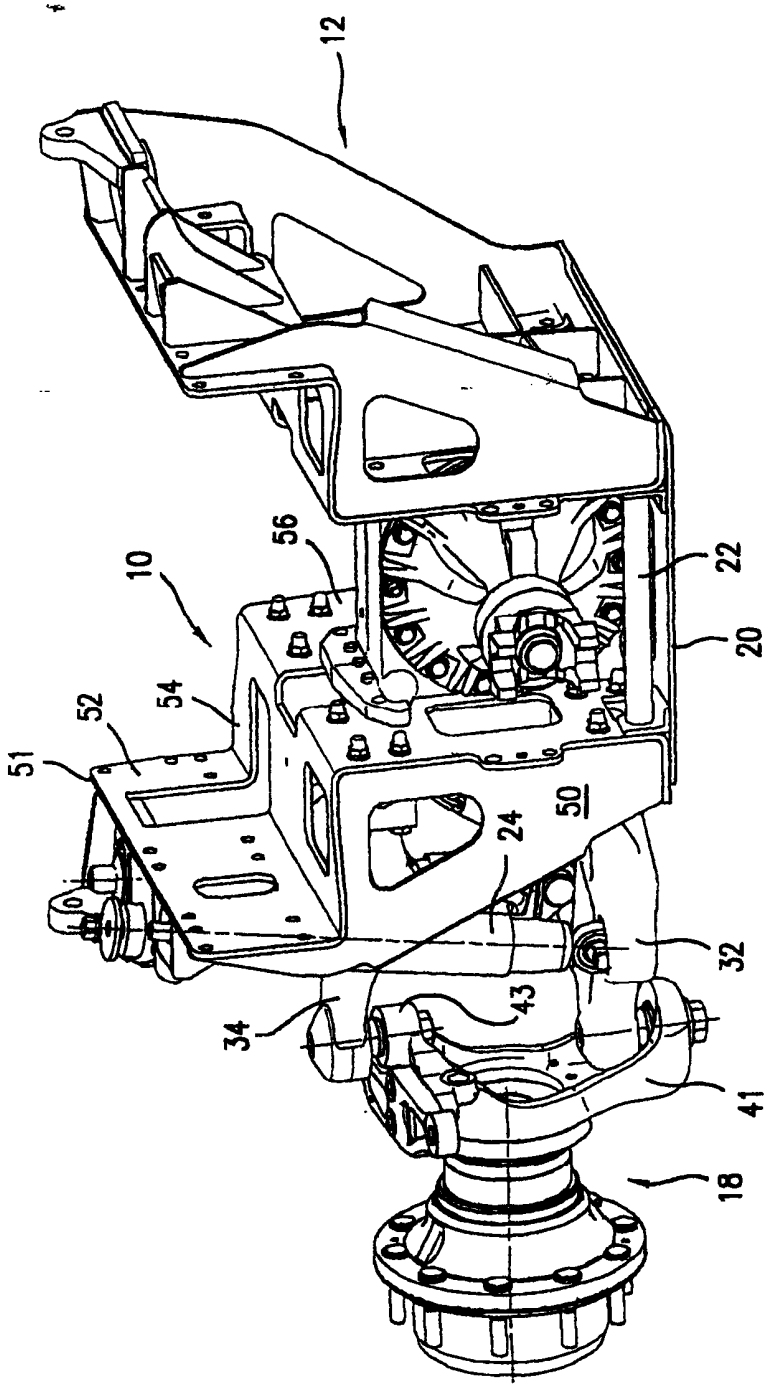

FIG.3

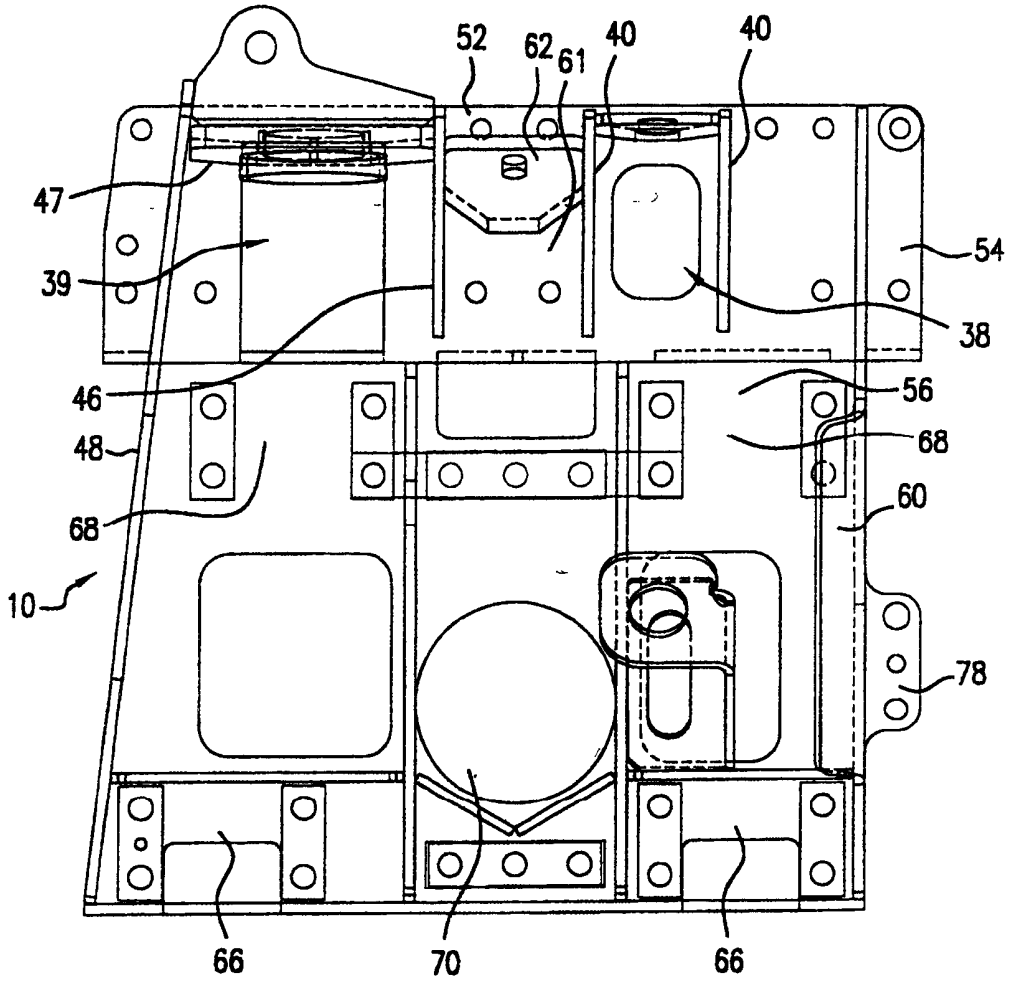

FIG.4

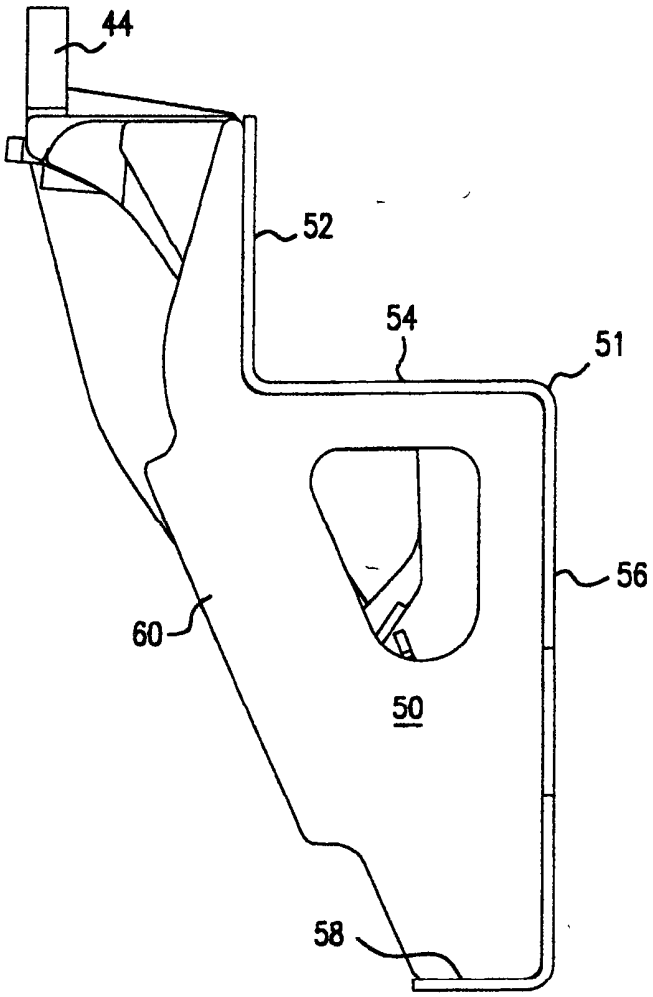

FIG.5

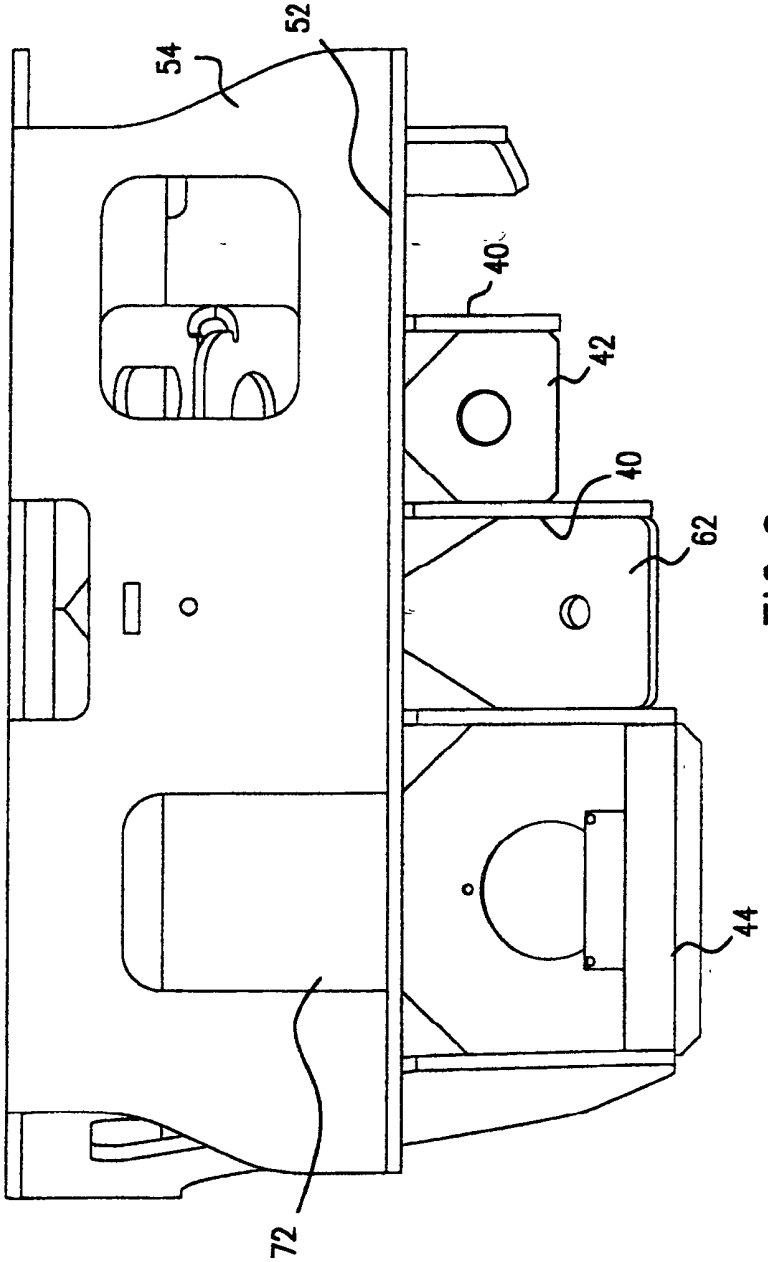

FIG.6

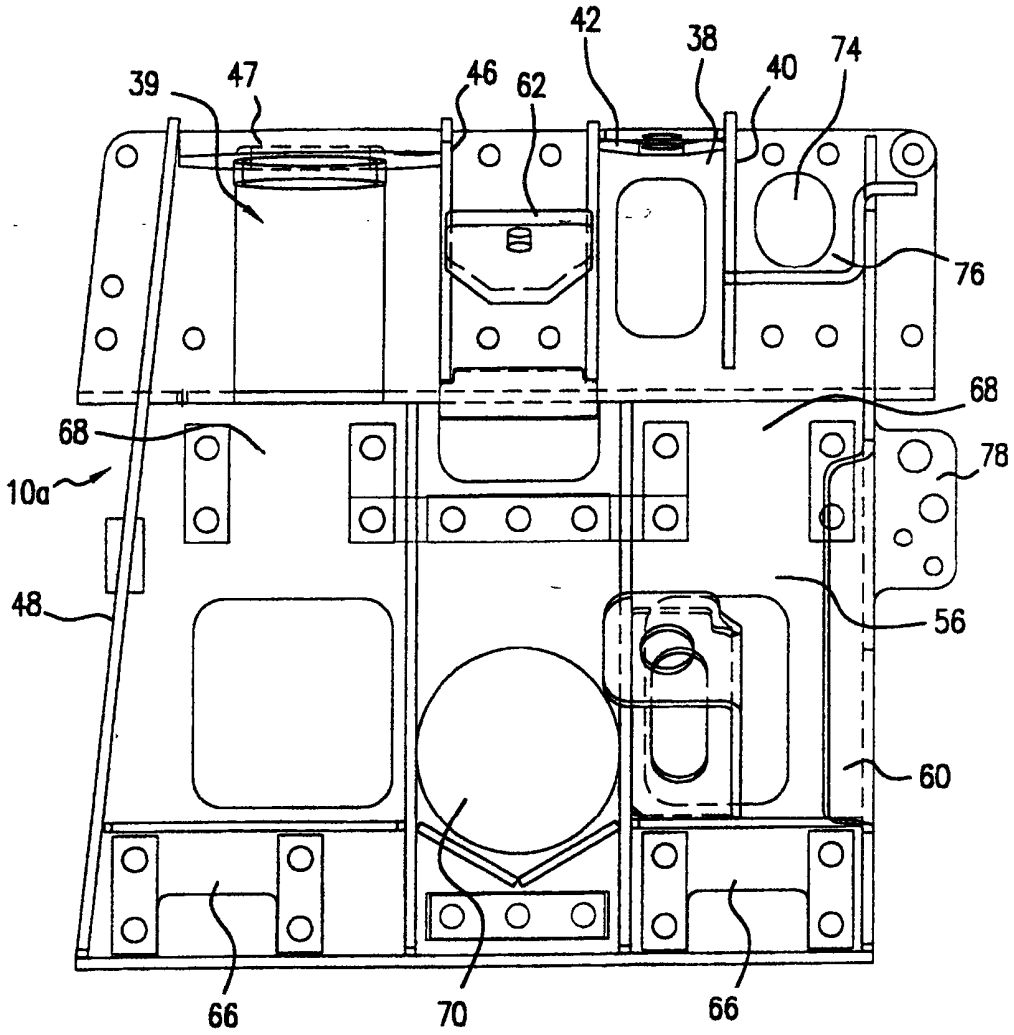

FIG.7

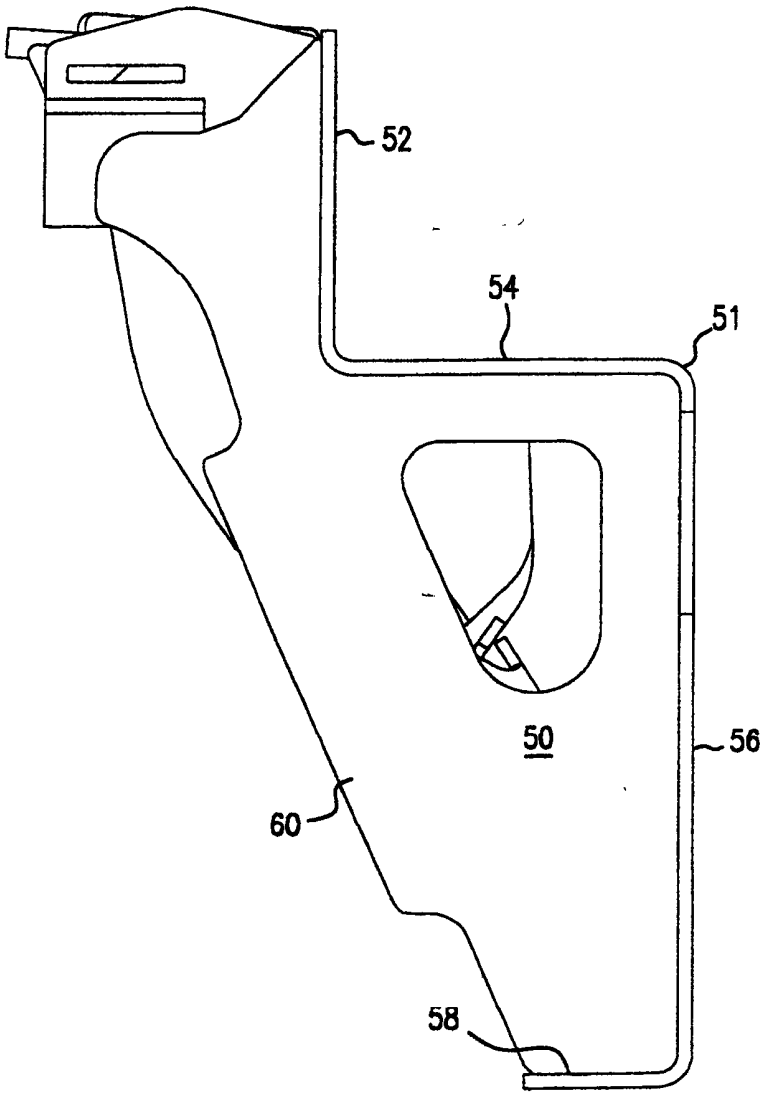

FIG.8

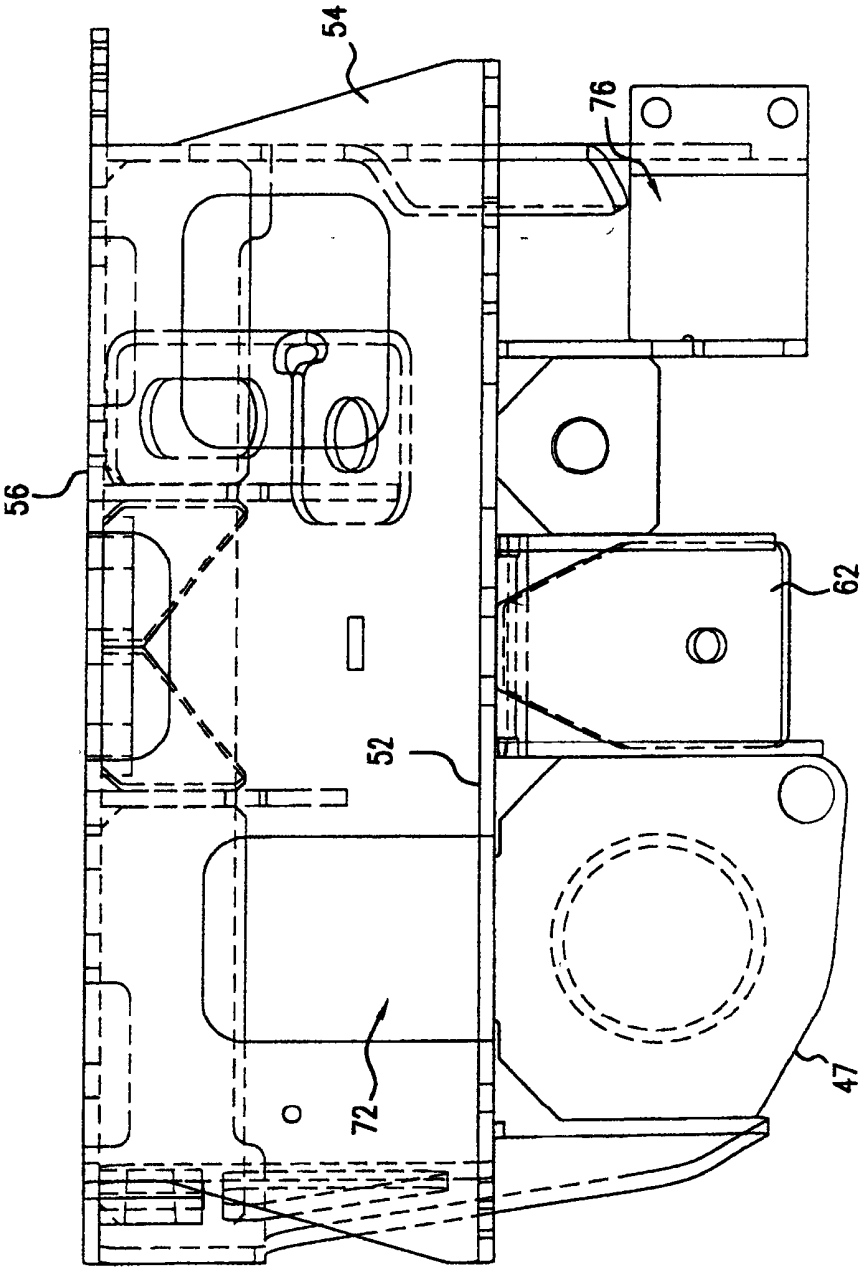

FIG.9

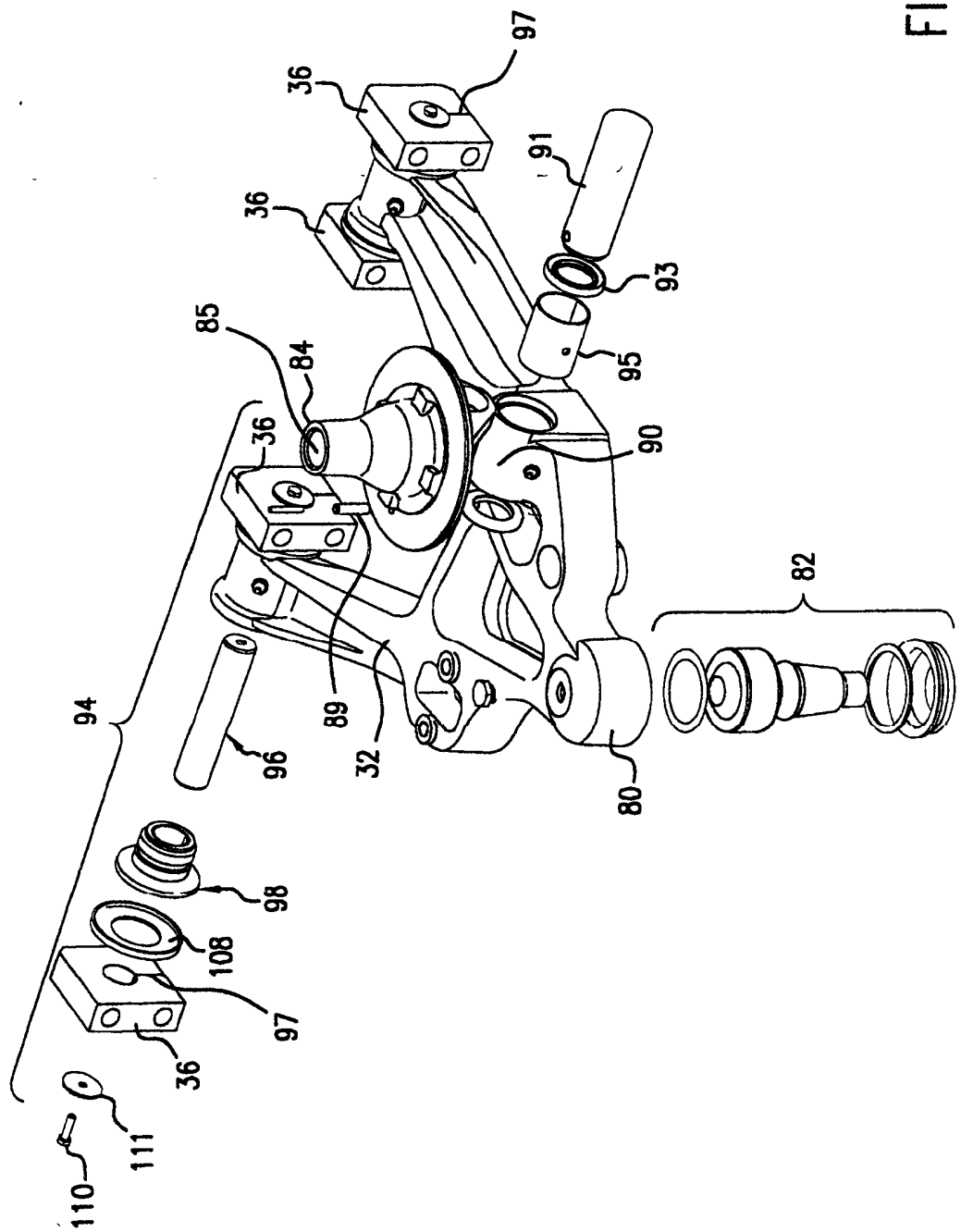

FIG.10

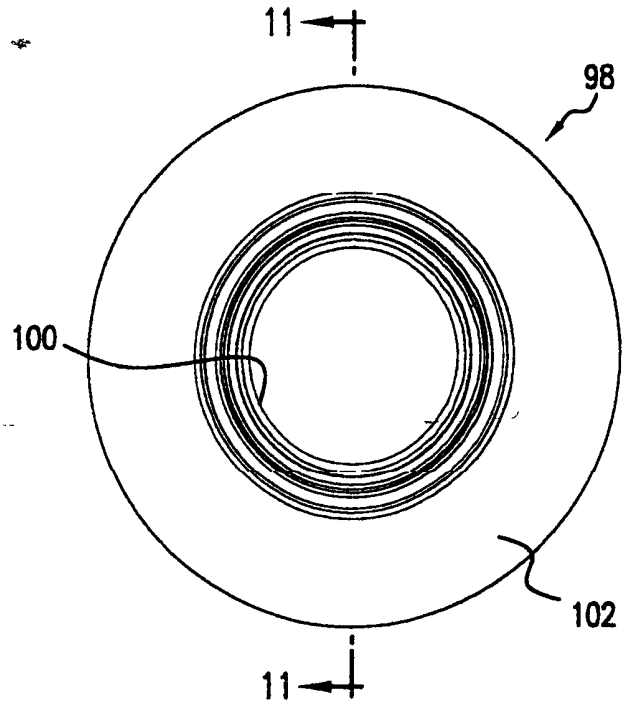

FIG.11A

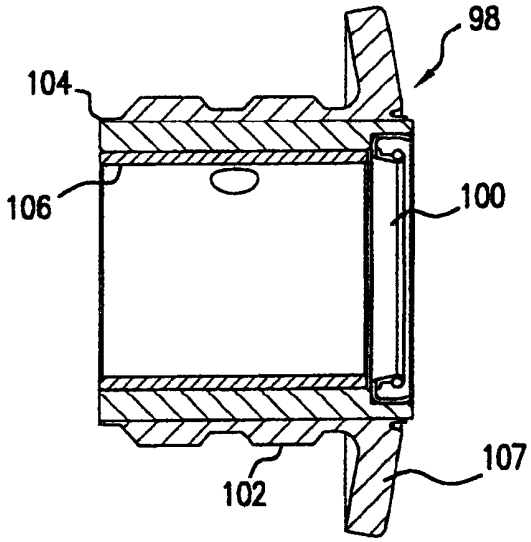

FIG.11

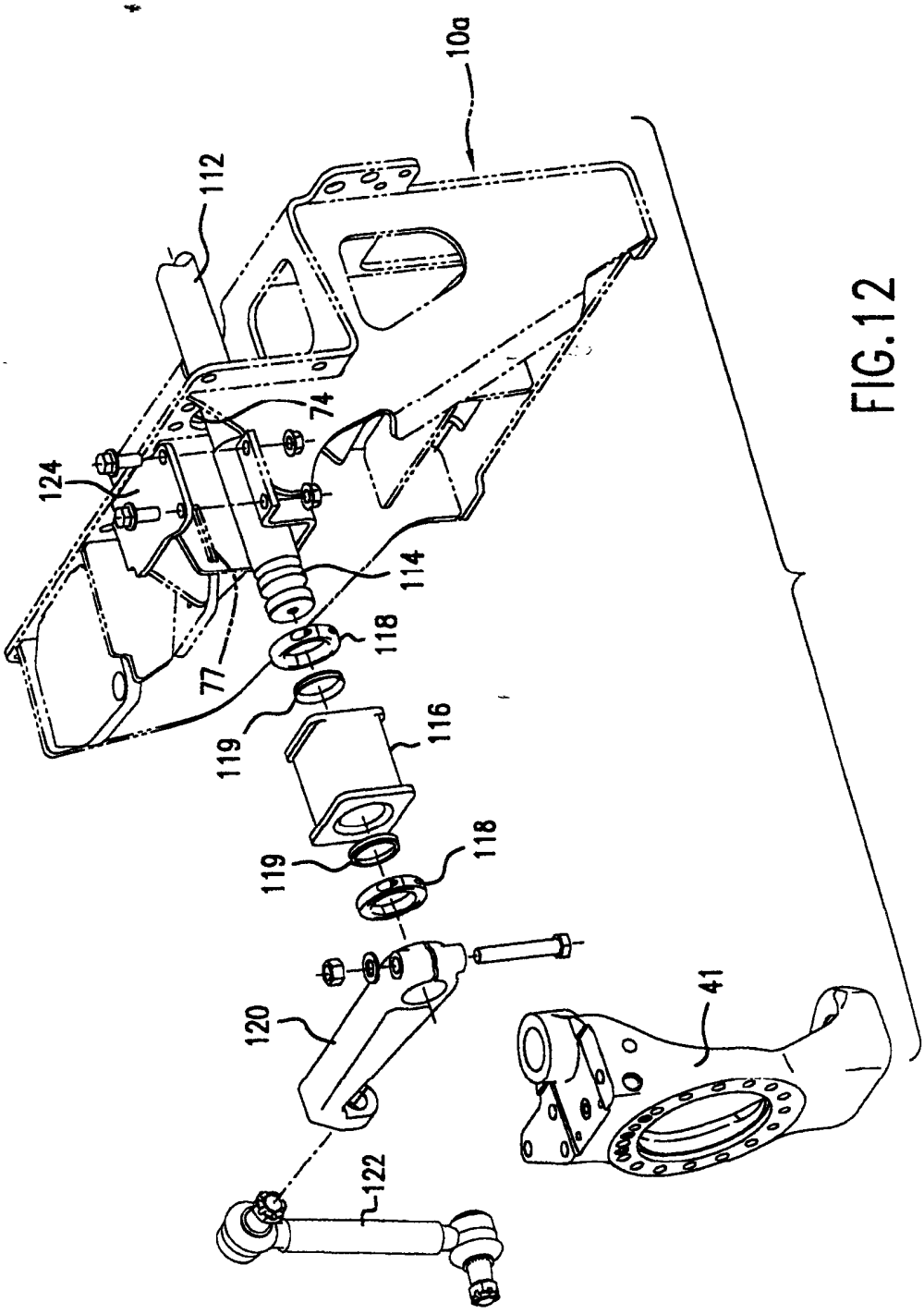

FIG.12

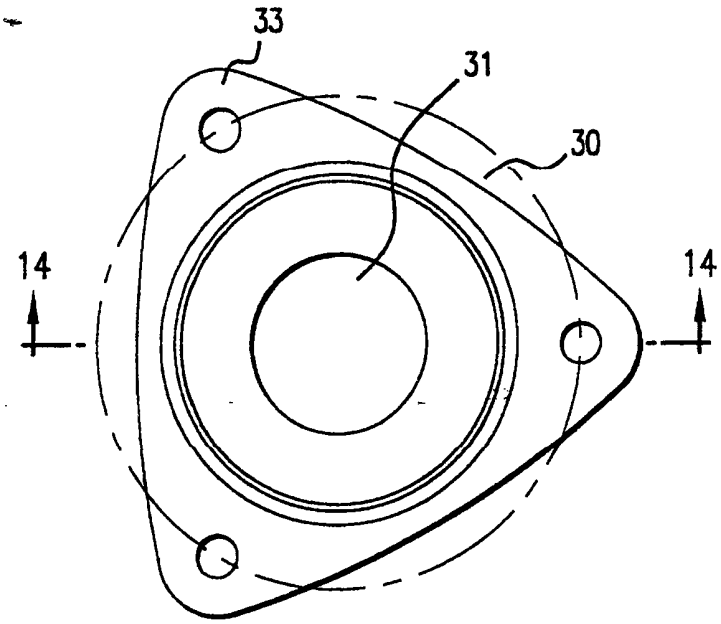

FIG.13

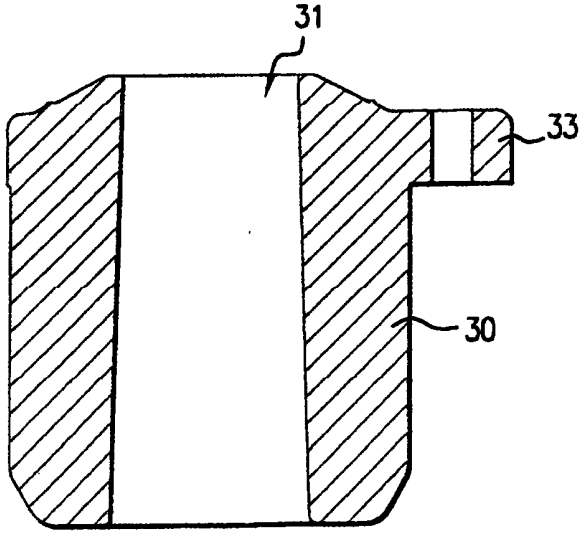

FIG.14

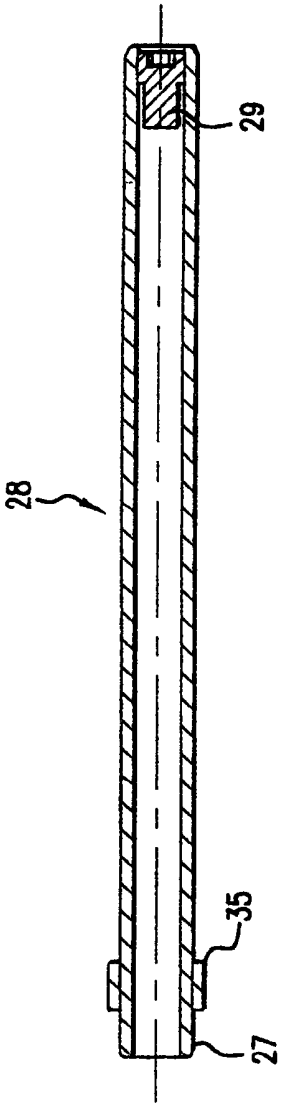

FIG.15

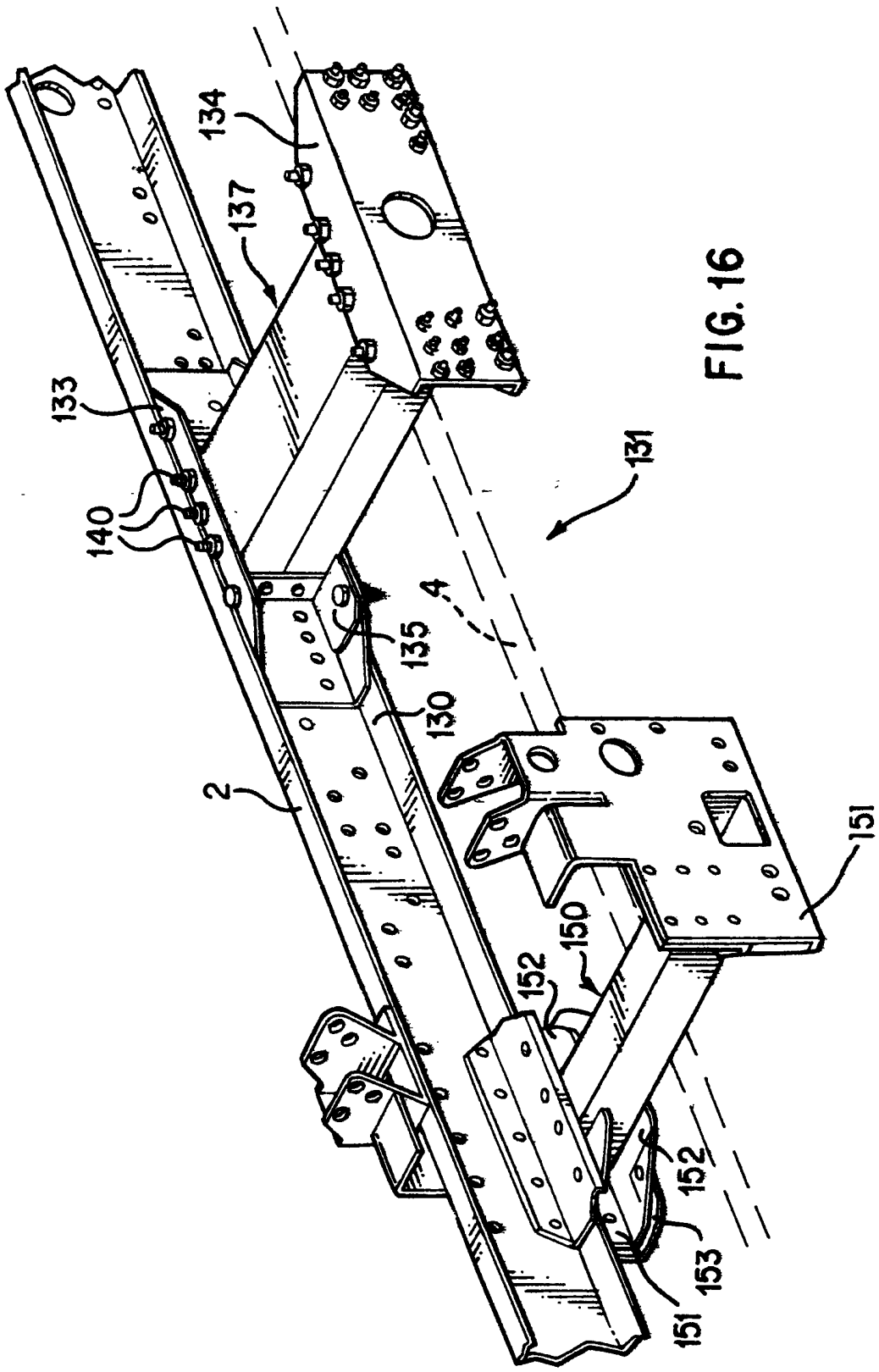

FIG. 16

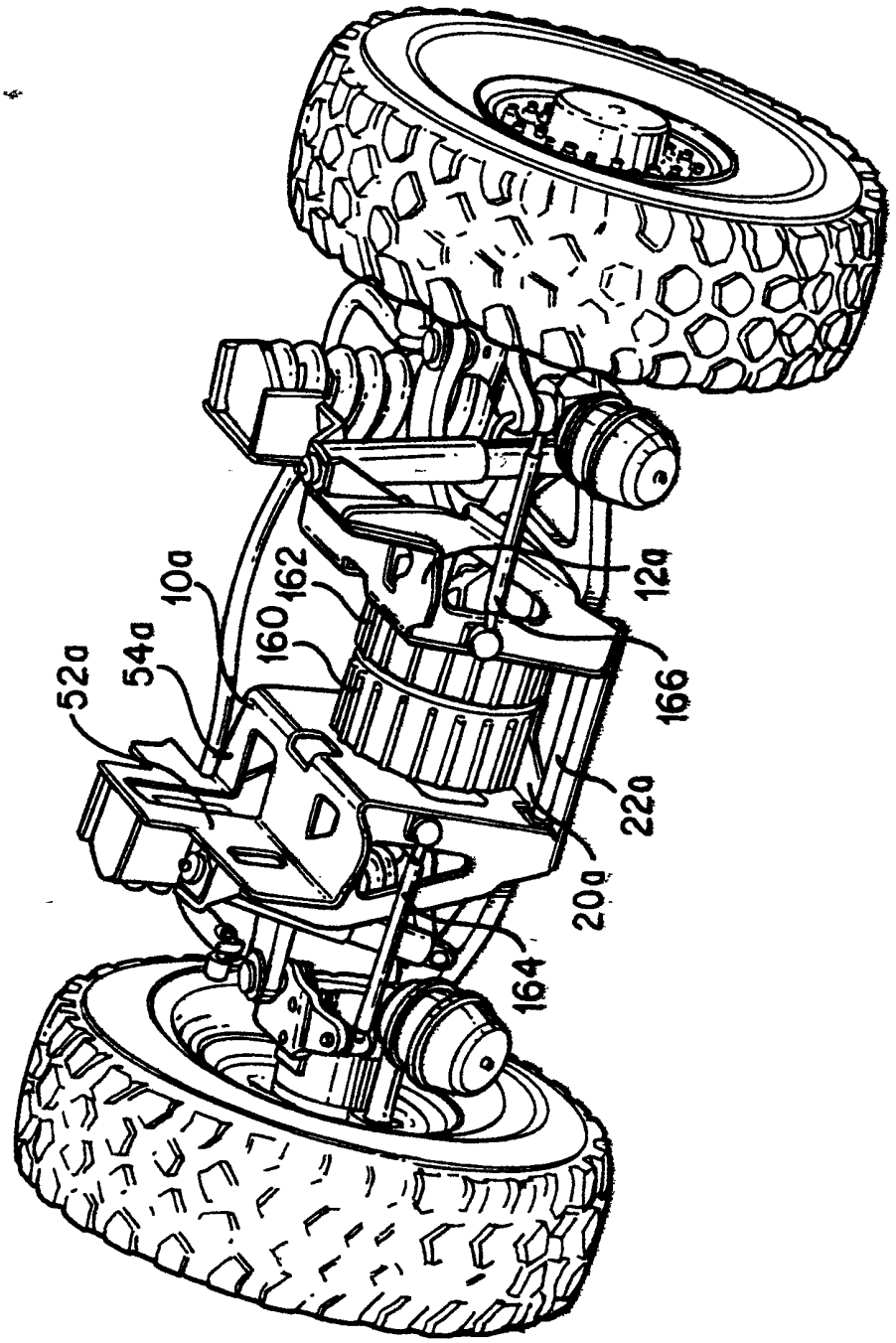

FIG. 17

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VEHICLE SUSPENSION

The present invention relates to large vehicles having independent suspensions, such as those which are typically used in military applications and in large municipal vehicles, such as fire trucks. More especially, the invention relates to an independent suspension assembly which allows a vehicle to have better stability by lowering the center of gravity, and better visibility, because a lower drivetrain and hoodline are made possible by providing more room between the main longitudinal members of the vehicle frame.

Military and other emergency vehicles must be designed to extremely demanding specifications. The vehicles must be capable of driving over or through obstacles which only a tactical or emergency operator would attempt. The vehicles must be able to endure corrosive, partially submerge and frequently dirty environments, such as standing water, chemicals or deep mud.

In addition, it is desirable for such vehicles to provide maximum forward visibility and maximum load carrying capacity. One step which has been taken in the design of heavy duty vehicles has been to utilize C-shaped channels as the main frame members. The use of two widely-spaced beams provides a space where various engine, transmission and other essential components can be mounted. Making more space available along the center line of the vehicle frame allows heavy components to be more effectively mounted at a lower elevation which, in turn, lowers the vehicle's center of gravity. Vehicles with low centers of gravity have improved stability. A lower center of gravity in a vehicle provides improved resistance to overturning as the vehicle traverses rough terrain or maneuvers around obstacles at high rates of speed. The improved visibility that results from the lowering of a vehicle's drive train and hoodline allows for safer operation of the vehicle. While the present invention has particular application in the context of frame members which are C-shaped, the invention

may be used with frame members having other shapes, such as tubular shapes (rounded and rectangular) and other structurally advantageous shapes.

The present invention is directed to a mounting assembly as set out in claim 1. Preferred features are set out in the subordinate claims 2 to 20.

Other features and advantage of the present invention will be better understood upon a reading of the following specification, read together with the accompanying drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a pair of front weldments and portions of a front axle constructed in accordance with the present invention;

Figure 2 is a second perspective view of the weldments shown in Figure 1 with other suspension components shown adjacent thereto;

Figure 3 is a third perspective view of the weldments shown in Figures 1 and 2;

Figure 4 is a side-elevational view of a front left-hand weldment of the present invention, as configured with no anti-sway bar;

Figure 5 is an end view of the weldment shown in Figure 4;

Figure 6 is a top plan view of the weldment shown in Figures 4 and 5;

Figure 7 is side-elevational view of a rear left-hand weldment of the present invention, as configured for use with an anti-sway bar;

Figure 8 is an end view of the weldment shown in Figure 7;

Figure 9 is a top plan view of the weldment shown in Figures 7 and 8;

Figure 10 is an exploded perspective view of a lower control arm constructed in accordance with the present invention;

Figure 11 is cross-sectional view of a bushing assembly of the control arm of the present invention taken along line 11-11 in Fig. 11A;

Figure 11A is a top view of a bushing assembly of the control arm of the present invention;

Figure 12 is an exploded perspective view of an anti-sway bar assembly made in accordance with the present invention;

Figure 13 is an end view of the spring guide bushing shown in Figure 14 made in accordance with the present invention;

Figure 14 is a cross-sectional view taken along line 14-14 in Fig. 13 and showing a bushing for a spring guide; and;

Figure 15 is a longitudinal cross-section through a spring guide made in accordance with the present invention; and

Figure 16 is a perspective view of structural frame elements used in the invention.

Figure 17 is a perspective view of a suspension assembly in which electric motors are held between two side plates of the suspension assembly.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows the front portion of a vehicle and its suspension support in relation to a frame rail 2 of a vehicle. A left-hand or first side plate 10 is mounted beneath a left-hand frame rail (not shown), and a right-hand or second side plate 12 is mounted beneath a right-hand frame rail 2. Several bolts are used to connect each of the side plates 10 and 12 to its respective frame rail. A differential 15 with a differential drive connection 14 is connected to each of the side plates 10 and 12. As further shown in Figures 2 and 3, it is clear that the main side plates 10 and 12 are joined together by the lower plate 20, bar 22 and differential 15 at the lower portions of the side plates 10 and 12. The side plates shown in Figures 1 through 6 are for a suspension that is not equipped with an anti-sway bar.

Referring now to the first plate 10 shown in Figures 1 through 6, it is comprised of three main components which are welded together. Those components are: a longitudinally extending main plate member 51; a leading end plate 48; and a trailing end plate 50. Longitudinally extending plate member 51 includes four sections: an upper vertical plate section 52; a horizontal plate section 54; a lower vertical plate section 56; and a lower lip 58. The upper vertical plate section 52 and the lower vertical plate section 56 are in a off-set and generally parallel relationship. Extending from the outer face of the upper vertical plate section 52 are three pockets including a shock absorber pocket 38 formed by gusset plates 40 and a bearing plate 42, a jounce bumper pocket 61 formed by gusset plates 40 and 46 and jounce bumper plate 62, and a coil spring pocket 39, defined by the end plate 48, gusset plate 46 and coil spring bearing plate 47. A lifting lug 44 may be welded to the bearing plate 47 for use in lifting the complete vehicle. The lower vertical plate section 56 has an opening 70 so that a driveshaft, in the form of a half-shaft 16, can extend from the differential 15 to the wheel end 18 (see Figure 1).

As is most clearly shown in Figure 2, the elements of the suspension system are connected to the outer portions of the first side plate 10. The shock absorber 24 extends from the bearing plate 42 to the lower control arm 32. Similarly, the suspension coil spring 26 extends from the lower control arm 32 to the bearing plate 47. In addition, inside the suspension coil spring 26, a spring guide 28 extends from the lower control arm 32 into the spring guide bushing 30 which is bolted to the coil spring bearing plate 47. An upper control arm 34 is connected by a ball joint 37 to an upper portion of the steering knuckle 41. The upper and lower control arms 34 and 32, respectively, are held in place by four control arm mounting assemblies 94, an example of which is more clearly shown in Figure 10 discussed below. The locations of the control arm mounting assemblies for a left-hand side plate 10 can best be seen in Figure 4 wherein upper control arm attachment locations 68 and lower control arm attachment locations 66 are at upper and lower portions of the vertical mounting plate 56. An ear 78 is used to support various system lines, i.e., hoses and wires, etc., which lead to the wheel end 18. A stiffening flange 60 extends from the outer edge of the end plate 50 to provide the plate 50 with increased resistance to buckling.

Figures 7, 8 and 9 show a left-hand side plate 10a for use with an anti-sway bar. In describing the anti-sway bar equipped left-hand side plate 10a, the same reference numerals which are used to indicate portions of the non anti-sway bar front side plate 10 which are the same. For example, a coil spring bearing plate 47 extends between an end plate 48 and a gusset 46 to define a pocket 39 for a coil spring (not shown in Figure 7). The left-hand side plate 10a includes upper control arm mounting locations 68 and lower control arm mounting locations 66. Gusset plates 40 and shock absorber bearing plate 42 define a shock absorber pocket 38. However, an element which is part of the left-hand side plate 10a, which is not included in the side plate 10 is a bushing pocket 76 and an opening 74 through which extends an anti-sway bar 112, more details of which are shown in Figure 12.

Figure 10 is an exploded view of a lower control arm assembly. The lower control arm 32 has two control arm mounting assemblies 94, one of which is shown in exploded form on the left side of Figure 10. The lower control arm 32 has a longitudinal axis and a cylindrical bore at one end of the lower control arm 32. The cylindrical bore has an axis transverse to the lower control arm longitudinal axis. The control arm mounting assembly 94 includes a pin 96 and two bushing assemblies 98 (more detail of which is shown in Figure 11). The ends of the pin 96 are clamped by the blocks 36 as the blocks 36 are attached to the lower vertical plate section 56 of a side plate. Each of the blocks 36 has a central opening and is circumferentially discontinuous about its central opening. The pin 96 has a length greater than the sum of the lengths of the bushings 98 whereby the pin 96 when passing through the bushings 98 has exposed ends grippable by the clamping blocks 36. The pin 96 can have a threaded bore at each end. The clamping blocks 36 each have aligned holes through which bolts may pass, with tightening of the bolts causing the slots 97 to close and the blocks 36 to grip the pin 96. The aligned holes may be unthreaded. A thrust washer 108 is disposed between each bushing assembly 98 and a block 36. A screw 110 and washer 111 are used to properly pre-load the bushing assembly 98 before installation. These fasteners are threadably engageable in the threaded bore of the pin 96.The lower control arm 32 includes a spring mount 90 through which there extends a spring pivot pin 91 and a sleeve bearing 95. A spring seat 84, with a threaded hole 85 for receiving the spring guide 28, straddles the spring mount 90. A small dowel pin 89 retains the pin 91 in the spring seat 84, and causes the spring seat 84 to rotate the spring pivot pin 91 within the sleeve bearing 95. A pair of seals 93 prevent contaminants from entering the sleeve bearing 95 within the spring mount 90. Figure 10 also shows a ball joint assembly 82, which is housed within a socket 80 on the outer end of the lower control arm 32.

Figure 11 is an enlarged cross-sectional view of the bushing assembly 98 which is part of the control arm mounting assembly 94. The bushing assembly 98 includes an inner sleeve bearing 106, an intermediate sleeve 104 and an outer elastomeric sleeve 102 which has a flange 107 at one end and annular ribs and grooves on the outside surface thereof. A seal 100 engages a shoulder formed on the outer edge of the intermediate sleeve 104. The bushing assembly 98 fits snugly into a bore formed at the inside end of each leg of the lower control arm 32. As the block 36 is tightened into position against the lower vertical plate section 56 of a side plate, the pin 96 is gripped by the block 36 as a result of the closing of the gap formed by the slot 97 in the block 36. A slot in each block 36 of a control arm mounting assembly allows for easy removal of a pin 96 from the assembly 94. Arranging the slots 97 so that they face down makes it harder for water and mud to flow into the pin/block joint.

Figure 12 shows the anti-sway assembly.

An anti-sway bar 112 has a splined end 114 and extends through the opening 74 in the upper vertical plate section 52 of a rear side plate 10a. The anti-sway bar 112 is supported by a bushing 116. The bushing 116 is contained in a pocket 76, the top portion of which is formed by a removable plate 124. One end of the plate 124 is inserted into a slot 77 formed in a gusset plate 40, and the other end of the plate 124 is held in place by bolts. A pair of collars 118 maintain the position of the anti-sway bar 112 in the bushing 116. A pair of seals 119 prevent contaminants from entering the bushing 116. The splined end 114 of the anti-sway bar 112 is engaged in and clamped by an end of the arm 120. A vertical link 122 connects an end of the arm 120 to a lug 43 of the steering knuckle 41.

Figures 13 and 14 show the spring guide bushing 30 which is attached to the coil spring bearing plate 47 on the front side plates 10 and 12. The spring guide bushing 30 includes a tapered bore or opening 31 through which a spring guide 28 extends. The taper allows the spring guide 28 to articulate slightly within the bushing 30. Mounting ears 33

facilitate the connection of the bushing 30 to the bearing plate 47. The bushing 30 is mounted in the orientation shown in Figure 2 so that the narrower end of the tapered opening 31 is upward, i.e., the bushing 30 extends down into and through the opening in the bearing plate 47. The rear spring is stable enough by itself not to need a guide. The spring guide 28 is shown in Figure 15. The spring guide 28 has a threaded end 27 which threads into the threaded hole 85 in the spring seat 84. (See Figure 10.) A stop 35 is welded to the body of the spring guide 28 to limit the threaded engagement of the threaded end 27 and the spring seat 84. At the opposite end of the spring guide 28, a drive socket 29 is incorporated to facilitate the threaded engagement of the spring guide 28 into the spring seat 84 with a common wrench. It should be noted that the diameter of the spring guide 28 is substantially smaller than the inside diameter of the coil spring 26 through which it extends. The result is a non-contact spring guide. The spring guide 28 is free to slide within the tapered opening 31 in the spring guide bushing 30 as the wheel of a vehicle moves up and down. The alignment of the spring seat 84, however, is maintained so that buckling of the coil spring 26 is prevented, even in instances where there is a large compression of the spring as a result of relative movement of the wheel and the frame.

Figure 16 shows how the C-shaped main frame members 2 and 4 are tied together without the formation of holes in the top and bottom flanges thereof. Reinforcing channels 133 and 134 are bolted to the inside of the vertical webs 130 and 131. Angle supports 135 and 136 connect the crossmember 137. In effect, the reinforcing channels 133 provide a horizontal extension of the flanges of the main frame members 2 and 4, and provide a location to which vertical bolts 140 may be used to connect the channels 133 and 134 to the crossmember 137. The crossmember 137 is located just ahead of the rear axle or axles, in the case of tandem rear wheels.

Also shown in Figure 16 is a front crossmember 150, which is located under the main frame member 2 and 4, leaving room between the frame members 2 and 4. The front crossmember 150 is, like the rear crossmember, affixed to the main frame members without compromising the structural integrity of those members, as might be the case if holes in top and bottom flanges of the main frame members were drilled to receive connecting bolts. Large angle plates are bolted to the outside of the main frame members 2 and 4. Inwardly extending flanges 153 on large angle members 151 carry the ends of the front crossmember 150. Smaller angles 152 hold the crossmember 150 in place on the flanges 153. An upper angle plate 154 connects the vertical webs 130 and 131 of the main frame members to the smaller angles 152 and to the crossmember 150.

Figure 17 is a perspective view of a suspension assembly in which two electric motors 160 and 162 are mounted between side plates 10b and 12b, rather than a more traditional differential as shown in earlier described embodiments of the invention. This arrangement allows each of the motors to drive one half-shaft and one wheel. In the particular example shown in Figure 17, the motors directly drive the half-shafts (not shown). To enhance the structural strength of the assembly, which includes the side plates 10b and 12b, the housings of the motors 160 and 162 may be rigidly connected to one another. However, that if larger motors are used a 90 degree drive box may be inserted and the motors mounted in positions in which they are not disposed between the side plates, but are axially offset with respect to one another. Also in the example shown in Figure 17, the wheels are held in aligned positions relative to the frame by stabilizing bars 164 and 166, although the assembly shown is equally applicable to pairs of wheels which are steered wheels.

Having described a number of features, discoveries and principals embodied in the foregoing examples, it is intended and will be understood by those skilled in the art, that a

number of modifications, alternatives and variations thereof may be made while still incorporating the spirit and scope of the inventions as claimed below.

Claims:

1. A vehicle suspension comprising: a first side mounting plate, a first control arm pivotally coupled to the first side mounting plate, a second control arm pivotally coupled to the side mounting plate and a torsion bar, characterized in that the torsion bar passes through a first opening in the first side mounting plate.

2. The suspension of Claim 1, wherein the torsion bar is movable axially into and out of an operating position for repair and replacement.

3. The suspension of Claim 1, wherein the torsion bar has a splined end and wherein the suspension further includes:

an arm having a mating section in gripping engagement with the splined end, the arm being removably attached and extending generally perpendicular to the torsion bar;

a wheel end; and

a link connected between the arm and the wheel end.

4. The suspension of Claim 3, wherein the arm has an internally splined clamp, the clamp making a rigid, non-rotative connection with the splined end of the torsion bar.

5. The suspension of Claim 1 including a bushing through which the torsion bar extends, the bushing being mounted in a pocket in an outside face of the first mounting plate.

6. The suspension of Claim 5, wherein the bushing has end flanges defining a recess on an exterior of the bushing and wherein the side mounting plate fits into the recess to prevent axial movement of the bushing relative to the pocket along an axis of the torsion bar.

7. The suspension of Claim 5 including a collar on each side of the bushing, wherein the collar is configured to hold the torsion bar in a generally fixed position relative to the bushing.

8. The suspension of Claim 1, wherein the torsion bar includes:

a first splined end and a second splined end, wherein the torsion bar is a generally straight round bar and wherein the suspension further includes a first arm and a second arm; and

a first link and a second link, wherein the first arm and the first link are attached to the first splined end and wherein the second arm and the second link are attached to the second splined end.

9. The suspension of Claim 1 including a coil spring extending between the first control arm and the first side mounting plate.

10. The suspension of Claim 9 including a shock absorber extending between the first control arm and the first side mounting plate.

11. The suspension of Claim 1 including a shock absorber extending between the first control and the first side mounting plate.

12. The suspension of Claim 1 including a frame rail mounted to the side mounting plate.

13. The suspension of Claim 12, wherein the side plate includes a vertical plate section and a horizontal plate section forming a shoulder against which the frame rail is mounted.

14. The suspension of Claim 13, wherein the first control arm extends in a first direction from the first side mounting plate and wherein the shoulder faces a second opposite direction.

15. The suspension of Claim 12, wherein the first side mounting plate is mounted beneath the frame rail.

16. The suspension of Claim 13, wherein the first opening is formed in the vertical plate section.

17. The suspension of Claim 1, wherein the first side mounting plate includes a second opening through which a shaft from a differential extends to a wheel end.

18. The suspension of Claim 1, wherein the first side mounting plate includes a first pocket receiving a coil spring.

19. The suspension of Claim 17, where the first side mounting plate includes a second pocket receiving a shock absorber.

20. The suspension of Claim 1, wherein the first side mounting plate includes a second pocket receiving a shock absorber.

Application No: GB0415366.4 **Examiner:** Mr Colin Thompson

Claims searched: 1 to 20 **Date of search:** 13 August 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1,3-5,8,11	DE 1959496 A1 (Daimler-Benz AG) Whole document relevant
X	1,8,11,20	DE 4427172 A1 (Mercedes-Benz AG) Whole document relevant
X	1,5	GB 454398 A (Palmer) Whole document relevant
X	1	GB 734267 A (Auto Union GmbH) Whole document relevant

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W] :

B7D

Worldwide search of patent documents classified in the following areas of the IPC[07]

B60G

The following online and other databases have been used in the preparation of this search report

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