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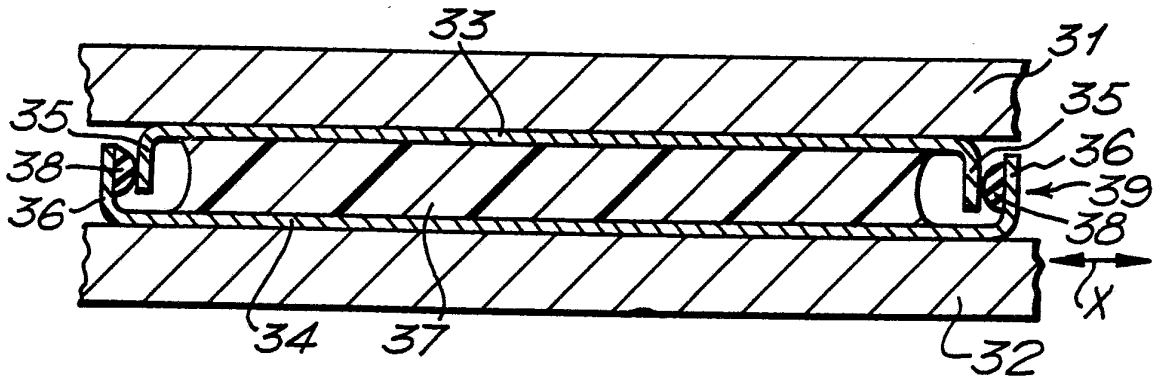
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(54) Title: FRICTION LEAF SPRING FOR VEHICLES



(57) Abstract

A friction control device (39) for a vehicle suspension having at least two elements, such as leaves (31, 32) of a leaf spring, which are slidable with respect to each other in the fore-and-aft direction thereof, the device comprising a resiliently deformable member (37) located or locatable between the elements (31, 32), wherein deformation of the member in the fore-and-aft direction of the elements during use of the device (39) is limited to a predetermined degree which may be defined by a positive stop (35, 36) or may have a progressively increasing resistance (38) to deformation arranged to act prior to the positive stop (38, 39) terminating such deformation.

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TITLE: FRICTION LEAF SPRING FOR VEHICLES

DESCRIPTION

This invention relates to a friction leaf spring for vehicles, particularly heavy commercial vehicles.

In leaf spring vehicle suspensions, the friction between the spring leaves and between the springs themselves and their mountings has both advantages and disadvantages, especially when applied to heavy commercial vehicles. There are existing devices for increasing and/or decreasing this friction for different applications, although such devices tend to be a compromise, providing the higher or lower friction characteristic over the whole range of suspension deflections.

Low friction improves the isolation ride of a vehicle, especially at small load variations or deflections. For instance, when travelling on a relatively smooth road, any static friction tends to lock the suspension up, with small input variations causing the tyres of the vehicle to deflect. As the vehicle tyres are virtually undamped, the vehicle tends to oscillate on the tyres, thereby providing an unpleasant ride.

A disadvantage with low friction leaf spring arrangements is that sophisticated, highly durable dampers are required to control adequately the motions of the vehicle. To be fully effective, such dampers ideally require various settings to suit the different loading conditions to which the suspensions are subjected. Also, with low friction spring arrangements

the rate of vehicle movement, especially in the roll mode, is generally too high under the dynamic loadings which occur when the vehicle is manoeuvring. This often necessitates the use of stabiliser/anti-roll bars which tend to reduce the quality and comfort of the vehicle ride by stiffening the wheel rate when only one wheel is deflected.

On commercial vehicles, where the distribution of load between axles varies considerably in dependence upon the particular application, a high friction spring arrangement tends to dampen any actual frequency combinations which can cause severe ride and handling problems. Therefore, high friction spring arrangements tend to be more adaptable over the practical ranges of vehicle applications.

The present trend for leaf spring suspensions is towards parabolic tapering thickness spring leaves which can be processed to produce more durable assemblies but which tend to have low inter-leaf friction. As indicated above, this tends to give, on the one hand, advantages in the vehicle ride for small input variations but, on the other hand, the disadvantages discussed above for larger deflections.

An attempt has been made to overcome these disadvantages by providing between those parts of a spring which need to contact each other but which also need to slide with respect to each other, such as, the spring and its mounting and/or adjacent spring leaves, an elastomeric member. By a "shearing" action, the elastomeric material of such a member is able to accommodate the differential sliding motion between the spring and its mounting and/or adjacent spring leaves.

However, these shear deflection members also suffer from disadvantages, such as, those discussed above in relation to the parabolic, tapering thickness leaf springs.

Accordingly, it is an object of the present invention to provide such a deflectable shear member, or a vehicle suspension incorporating such a member, which overcomes, or at least substantially reduces, the disadvantages associated with the known suspension arrangements discussed above.

Thus, one aspect of the invention provides a friction control device for a vehicle suspension with at least two elements which are slidable with respect to each other in the fore-and-aft direction thereof, the device comprising a resiliently deformable member located or locatable between said relatively slidable elements of the suspension, wherein deformation of the member in the fore-and-aft direction of the elements during use of the device is limited to a predetermined degree.

Such limiting deformation of the member, which is preferably of an elastomeric material, may be effected by means of a positive stop or a progressively increasing resistance terminating in a positive stop.

Preferably, the predetermined degree to which deformation of the member is limited, is defined by a positive stop.

In a preferred embodiment of the inventive friction control device, the resiliently deformable

member is secured between a pair of generally parallel plates, with means arranged to engage each other when the member is deformed to said predetermined degree and to define a positive stop therefor. Such engagement means may comprise opposed ends of each plate being bent inwardly with respect thereto, such that corresponding pairs of respective bent plate ends can engage each other, to provide the positive stop when deformation of the member in the fore-and-aft direction of the suspension elements reaches said predetermined degree.

In another embodiment, means are arranged to effect a progressively increasing resistance to deformation of the member, terminating in a positive stop, in which case, such progressively increasing resistance means can comprise a resiliently deformable element arranged to act between the plates, preferably between respective cooperating pairs of bent plate ends.

Further, the resiliently deformable member may be secured directly to one of the vehicle suspension elements, such that, in the preferred embodiment described above, one of the generally parallel plates is constituted by that element, whereby the resiliently deformable member is secured directly thereto, with the other plate and associated vehicle suspension element being slidable with respect to each other when the member has reached its limit of deformation.

The at least two elements of the vehicle suspension may be respective leaves of a multi-leaf spring of which at least one leaf is arranged to slide in frictional engagement with any associated plate,

when the resilient deformable member is deformed to the predetermined limited degree and would otherwise deform further. Such an arrangement may also include means for clamping the leaves of the leaf spring together, with another resilient element located between the clamping means and at least one of the spring leaves, preferably with the other resilient element being secured to a clamp plate of such clamping means.

In a further embodiment of the inventive friction control device, the resiliently deformable member may be secured between the confronting faces of two components of a frame mounting bracket of a cam spring suspension arrangement, in which case, a lower one of the two frame mounting bracket components may be arranged upon an associated spring leaf, such that relative movement between the mounting bracket and the spring leaf which would otherwise cause further deformation of the deformable member, causes sliding motion, against friction, between that lower component and the leaf.

The resiliently deformable member is preferably made of an elastomeric material which may be either natural or synthetic, or, indeed, any other suitable, resiliently deformable material.

In order that the invention may be more fully understood, preferred embodiments in accordance therewith will now be described by way of example and with reference to the accompanying drawings in which:

Figure 1 is a side elevation in section of a prior art friction control device located between two leaves of a leaf spring;

Figure 2 is a side elevation in section of one embodiment of a friction control device in accordance with the invention, again located between two leaves of a leaf spring;

Figure 3 is a side elevation in section of a second embodiment of friction control device in accordance with the invention, once again located between two leaves of a leaf spring;

Figure 4 is a side elevation, again in section, of a third embodiment of friction control device in accordance with the invention, this time located between a leaf and a mounting bracket of a leaf spring arrangement;

Figure 5 is a side elevation in section of a modified form of the first embodiment of friction control device shown in Figure 2; and

Figures 6a and 6b are respective side and plan views of yet another embodiment of friction control device used in a particular, single leaf spring arrangement.

Referring firstly to Figure 1 of the drawings, a prior art arrangement comprises upper and lower leaves 101, 102 of a leaf spring vehicle suspension, between which is located a known form of friction control device 110, consisting of respective upper and lower metal plates 111, 112 between which is secured by any suitable means a resiliently deformable member 103.

This prior art arrangement is such that, under

working conditions of the vehicle suspension, the upper leaf 101 and the upper metallic plate 111 cannot, or are highly unlikely to, slide with respect to each other and, in any case, the lower leaf 102 and lower metal plate 112 are secured to each other. Thus, any relative motion taking place in the fore-and-aft direction of the vehicle, as indicated by the double headed arrow X, between the upper and lower spring leaves 101, 102 is represented by the resilient deformation of the member 103 by the corresponding shearing force exerted thereupon in the fore-and-aft direction X. Such deformation of the member 103 tends to be uncontrollable and, hence, somewhat random in its effect.

Under extreme working conditions however, it is possible that sliding motion against friction between the upper spring leaf 101 and associated metal plate 111 of the friction control device 110 will come into effect, when the member 103 has reached the limit of its deformation in the fore-and-aft direction X.

A first embodiment of inventive friction control device, as shown in Figure 2, can be employed to overcome this and other disadvantages associated with the prior art arrangement described above with reference to Figure 1, by limiting the fore-and-aft deformation of the resiliently deformable member of the novel device. In Figure 2, a pair of adjacent, upper and lower leaves 21, 22 of a leaf spring vehicle suspension are separated by a friction control device in accordance with the invention, as indicated generally at 29. This device 29, as in the case of the prior art device 110 described above, also comprises a pair of upper and lower metal plates 23, 24. However, the opposed

ends 25 of the upper plate 23 are bent downwardly and, similarly, the opposed ends 26 of the lower plate 24 are bent upwardly, such that they overlap with the downwardly extending ends 25 of the upper plate 23 being located within the confines of the upwardly extending ends 26 of the lower plate 24, thereby providing respective gaps between the adjacent plate ends 25, 26. In this manner, any fore-and-aft deformation of the associated resiliently deformable member 27, as a consequence certain working conditions of the vehicle suspension, is limited to a predetermined degree or amount by a positive stop provided by engagement of one end 25 of the upper plate 23 with the associated end 26 of the lower plate 24 or vice versa. After such restricted shear deformation of the member 27 in the fore-and-aft direction X any further relative movement between the two leaves 21, 22 is effected by sliding motion against friction between the leaf 21, 22 and associated plate 23, 24 of the friction control device 29.

The second embodiment of inventive friction control device is illustrated in Figure 3, this being similar to the first embodiment described above in relation to Figure 2, except that that limited shear deformation of the resiliently deformable member 37 of the device 39 is subjected to a progressive restriction prior to being subjected to a positive stop, for any relative fore-and-aft movement between the upper and lower leaves 31, 32. Such progressive restriction is provided by a resiliently deformable element 28 positioned between each of the pair of downwardly and upwardly extending ends 35, 36 of respective upper and lower metal plates 33, 34 of the friction control device 39.

For sufficient fore-and-aft relative movement between the upper and lower plates 33, 34, resiliently deformable compression of the associated element 38 which provides the initial progressive restriction will eventually result in such movement being brought to a positive stop.

Any further relative movement between the upper and lower leaves 31, 32 of the suspension which, in the prior art arrangement, would otherwise result in greater shearing deformation of the member 37, causes the confronting faces of the upper/lower leaf 31, 32 and upper/lower plate 33,34 to move slidably with respect to each other, thereby generating the necessary friction therebetween.

A third embodiment of inventive friction control device is shown in Figure 4, as indicated generally at 49, applied to the adjacent faces of a frame mounting bracket of a cam spring suspension arrangement.

In this third embodiment of inventive friction control device 49, the resiliently deformable member 47 is secured between the confronting faces of the two components 33, 34 of the bracket which effectively replace the upper and lower plates 23, 24 and 33, 34 of the respective devices 29, 39 of the first two inventive embodiments described above in relation to Figures 2 and 3.

It is to be noted that in this third embodiment, the resiliently deformable material of the member 47 extends around the inside face of the lower bracket component 34, such that it is located between that component and the upper component 33, thereby pro-

viding limited deformation of the member 47 in a progressively restricted manner, before a positive stop is achieved, for relative movement between the two components 33, 34 fore-and-aft of the vehicle with which this particular suspension arrangement is associated. Relative movement between the mounting bracket and associated spring leaf 42 which, in the prior art arrangement, would otherwise cause further deformation of the member 47 of the friction control device 49, causes sliding motion, against friction, between the lower component 34 and the leaf 42.

The fourth embodiment of inventive friction control device is illustrated in Figure 5 of the drawings, it being similar in construction to the first embodiment of Figure 2, except that an additional, external clamp 60 is employed.

The clamp 60 comprises upper and lower clamping plates 61, 62 and is clamped onto upper and lower leaves 51, 52 of a leaf spring vehicle suspension. Between the upper and lower leaves 51, 52 is located a friction control device 59, such as that described above with reference to Figure 2. Between the upper clamping plate 61 of the clamp 60 and the upper spring leaf 51 is provided a resilient element 62 secured to the plate 61.

This clamping arrangement provided by the clamp 61 serves to force the slidably movable components 51, 59, 52 of the basic leaf spring assembly together, as in the case of conventional friction increasing clamping devices. With the inventive device 59 employed in this arrangement, the friction will still be low for small suspension deflections but, as the shear

deformation limit of the deformable member 57 applies at higher deflections, the required frictional effect comes into play at a higher value than that associated with the conventional leaf spring arrangement without the inventive friction control device present.

Thus, it can be seen that the four embodiments described above with reference to respective Figures 2 to 5 of the drawings, produce low or negligible friction for small movements of the associated leaf spring or other associated spring arrangement but produces higher frictional forces for large deflections of the suspension. As indicated above, this inventive arrangement has particular application with a parabolic tapered leaf spring, thereby allowing for the exploitation of the spring's higher durability, whilst giving low friction characteristics for better quality and smoother surface ride but permitting use thereof where its low friction at high deflections would otherwise give rise to problems.

Also, the progressively restrictive shear deformation control of the deformable member of the inventive friction control device can be designed such that the restriction can be varied in dependence upon the compression of the shear deformable material of that member, namely, the load applied thereto. Thus, friction control can be varied or timed to match the load on the suspension spring.

A further application of the inventive device, or indeed the conventional, unlimited deformation device, such as that described above with reference to Figure 1, might be with radius arms or stabiliser bars associated with leaf springs, such as those des-

described in our co-pending International Patent Application No. PCT/GB90/00436 (Publication No. WO 90/11201) entitled "Vehicle Suspension System".

In this arrangement, the radius arm, such as that illustrated at 78 in Figures 6A and 6B, could be attached to the spring leaf 71 or to the axle 72 by a clip 73 or bracket 74 or other suitable connecting means which incorporates a friction device of the prior art or, in modified form, in accordance with the invention, as defined above.

This particular application might be particularly advantageous when employed with single leaf springs, thereby providing a degree of friction which would otherwise be impossible to achieve with a one leaf arrangement. If the geometry and friction are tuned correctly, this particular application could assist in damping out axle torsional vibrations or spring wind-up oscillations under traction and braking of the vehicle, which normally give rise to problems with single leaf spring suspensions.

Further, it is to be appreciated that, in the relevant embodiment described above, particularly in relation to Figures 2, 3 and 5 of the drawings, the lower plate 24, 34 may be omitted, such that the lower leaf 22, 32, 52 effectively constitutes the lower plate, with the resiliently deformable member 27, 37, 57 being secured directly to that lower leaf. Alternatively, of course, such an arrangement may be applied to the other side of the device, whereby the upper leaf 21, 31, 51 effectively constitutes the upper plate 23, 33, with the member 27, 37, 57 secured

directly to it.

CLAIMS

1. A friction control device for a vehicle suspension having at least two elements, such as leaves of a leaf spring, which are slidable with respect to each other in the fore-and-aft direction thereof, the device comprising a resiliently deformable member located or locatable between the elements, wherein deformation of the member in the fore-and-aft direction of the elements during use of the device is limited to a predetermined degree.

2. A device according to claim 1, wherein the predetermined degree to which deformation of the member is limited, is defined by a positive step.

3. A device according to claim 1 or 2, wherein the resiliently deformable member is secured directly to one of the vehicle suspension elements.

4. A device according to claim 1 or 2 including a pair of generally parallel plates between which the resiliently deformable member is secured and which include means arranged to engage each other when the member is deformed to said predetermined degree and to define a positive stop therefor.

5. A device according to claim 4, wherein said engagement means comprises opposed ends of each plate being bent inwardly with respect thereto, such that corresponding pairs of respective bent plate ends can engage each other, to provide the positive stop when deformation of the member reaches said predetermined degree.

6. A device according to any preceding claim including means arranged to effect a progressively increasing resistance to deformation of the member, terminating in a or the positive stop, as the case may be.

7. A device according to claim 6, when dependent upon claim 4 or 5, wherein said progressively increasing resistance means comprises a resiliently deformable element arranged to act between the plates.

8. A device according to claim 7, when claim 6 is dependent upon claim 5, wherein the resiliently deformable element is arranged to act between respective cooperating pairs of bent plate ends.

9. A device according to claim 4, or any of claims 5 to 8 when dependent thereon, wherein one of the generally parallel plates is constituted by the associated vehicle suspension element, such that the resiliently deformable member is secured directly to that element.

10. A device according to any preceding claim, wherein said at least two elements of a vehicle suspension are respective leaves of a multi-leaf spring of which at least one is arranged to slide in frictional engagement with an or the associated plate, as the case may be, when the member is deformed to said predetermined limited degree and would otherwise deform further.

11. A device according to claim 10 including means clamping the leaves of the leaf spring together, with another resilient element located between said clamping means and at least one of the spring leaves.

12. A device according to claim 11, wherein the other resilient element is secured to a clamp plate of said clamping means.

13. A device according to claim 1 or 2, or claim 6 when dependent upon claim 1 or 2, wherein the resiliently deformable member is secured between the confronting faces of two components of a frame mounting bracket of a cam spring suspension arrangement.

14. A device according to claim 13, wherein a lower one of the two frame mounting bracket components is arranged upon an associated spring leaf, such that relative movement between the mounting bracket and spring leaf which would otherwise cause further deformation of the deformable member, causes sliding motion, against friction, between the lower component and the leaf.

15. A device according to any preceding claim, wherein the deformable member is of an elastomeric material.

16. A friction control device according to claim 1, substantially as hereinbefore described with reference to any of Figures 2 to 5 of the accompanying drawings.

17.A vehicle suspension including a radius arm or stabiliser bar attached to an associated spring leaf or axle by connecting means incorporating a friction control device according to any preceding claim.

18. A vehicle suspension according to claim 17, wherein said connecting means comprises a clip or bracket.

19. A vehicle suspension according to claim 17 or 18, substantially as hereinbefore described with reference to Figures 6A and 6B of the accompanying drawings.

20. A vehicle suspension incorporating a friction control device according to any of claims 1 to 16.

21. A vehicle incorporating a suspension according to any of claims 17 to 20.

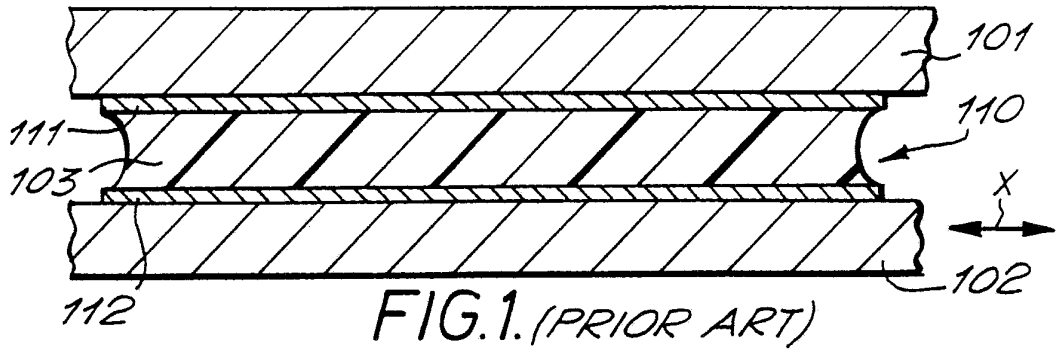


FIG.1. (PRIOR ART)

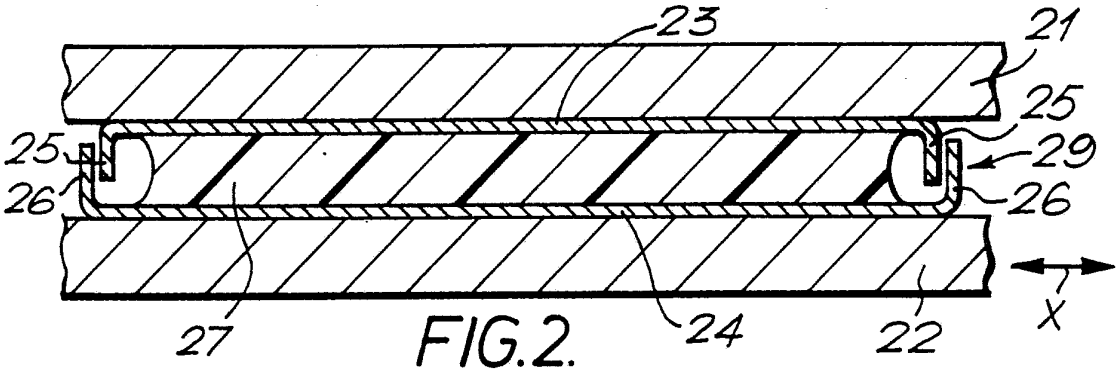


FIG.2.

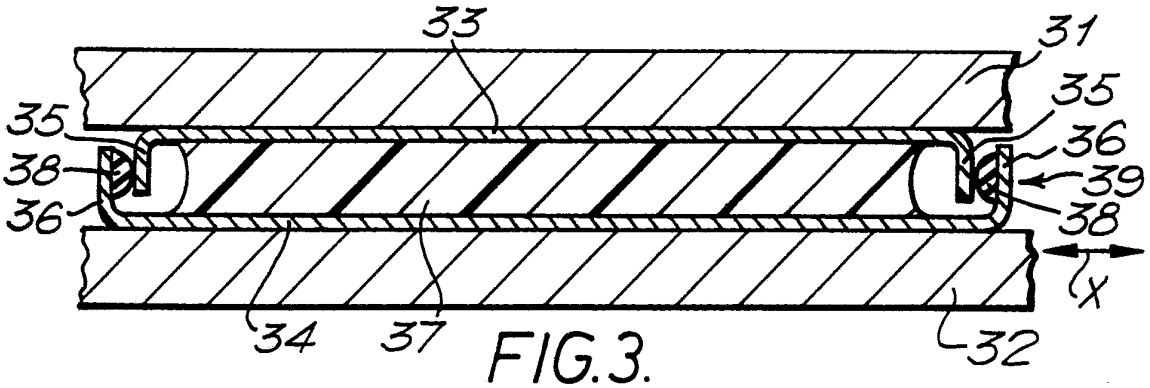
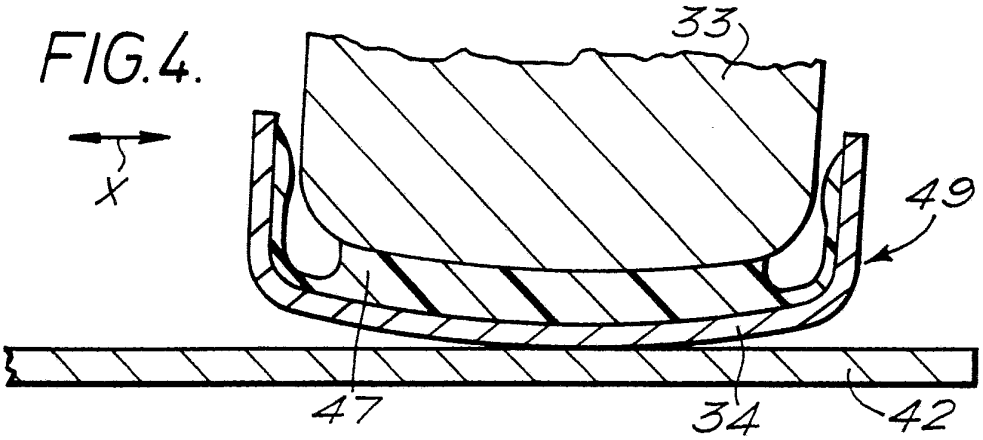


FIG.3.

FIG.4.



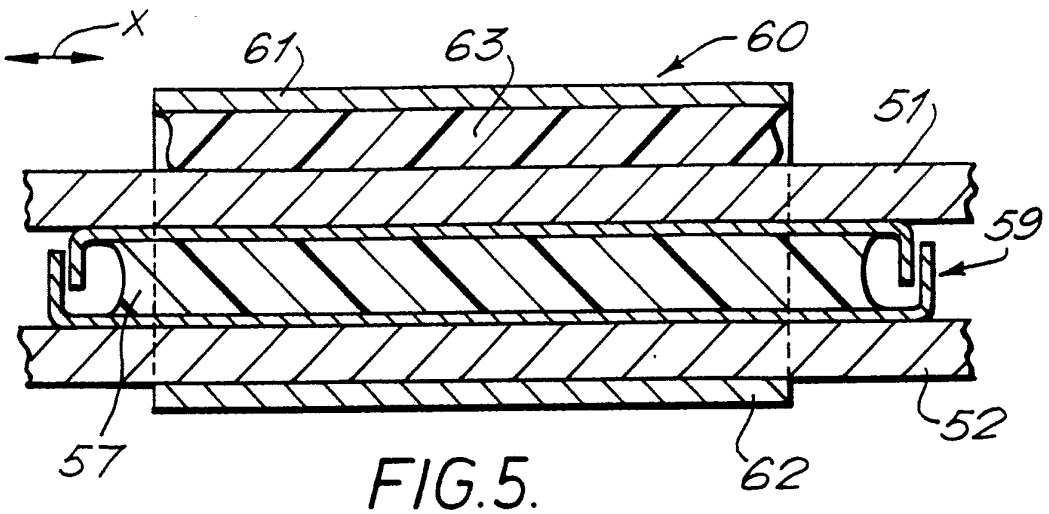


FIG.5.

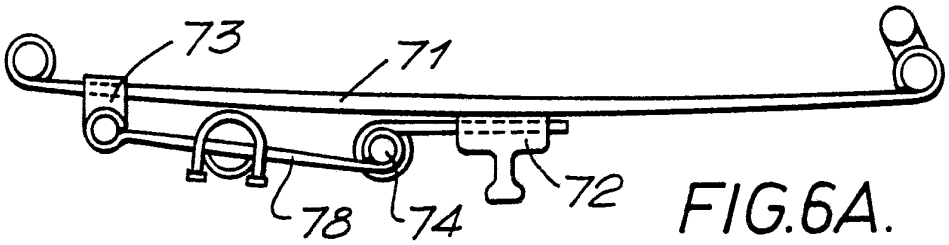


FIG.6A.

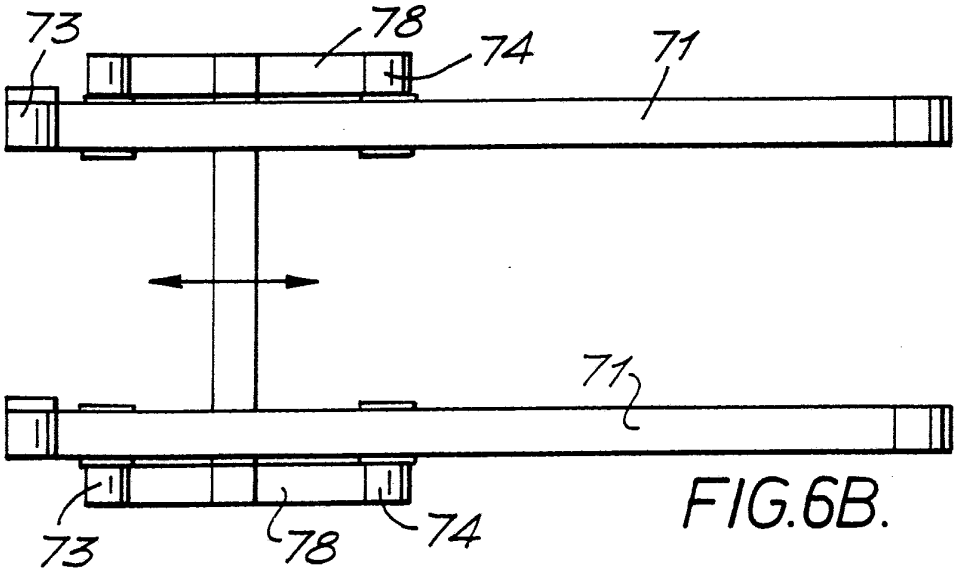


FIG.6B.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/00110

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F16F1/22 ; B60G17/02 ; B60G11/34

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	F16F ; B60G ; B60K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	GB,A,1148870 (RESSORT DU NORD S.A.) 16 March 1969 see page 1, lines 27 - 57; figures 1-5	1, 2, 4-7, 15, 20
A	see page 2, lines 25 - 36; claims 1, 2, 6-8	3, 8-10

X	US,A,2718393 (J.WARREN WATSON) 20 September 1955 see column 1, line 24 - column 2, line 72; figures 5, 6-9	1
A		2, 4, 6-8, 10

Y	PATENT ABSTRACTS OF JAPAN vol. 9, no. 92 (M-373)(1815) 20 April 1985, & JP-A-59 217024 (HINO JIDOSHA KOGYO K.K.) 07 December 1984, see the whole document	11, 12
A		1-10, 17, 18, 20

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° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
16 APRIL 1991	27. 05. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	TSITSILONIS L.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	PATENT ABSTRACTS OF JAPAN vol. 11, no. 76 (M-569)(2523) 07 March 1987, & JP-A-61 233233 (NHK SPRING CO.) 17 October 1986, see the whole document	11, 12
A		1, 15
Y	US,A,2476367 (MARMON-HERRINGTON CO.) 19 July 1949 see claims 1-4; figures 1-6	1, 2, 4-8, 10, 15, 20
A		3, 9, 13, 14, 17, 18
Y	EP,A,0069787 (TOYOTA JIDOSHA KOGYO K.K.) 19 January 1983 see figure 3	1, 2, 4-8, 10, 15, 20
A	FR,A,2526110 (ALLEVARD INDUSTRIES) 04 November 1983 see page 3, lines 7 - 32; figures 1-5	1-9, 15, 20
A	US,A,1952958 (P. WILMART) 27 March 1934 see page 1, lines 47 - 97; claim 1; figures 1-3	1, 2, 4, 5, 15, 17, 18, 21
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A	US,A,1781898 (R.B.FASEOL) 18 November 1930 see page 2, lines 30 - 92; figures 1, 3, 5, 6	1, 15
A	US,A,2161838 (T.H. THOMPSON) 13 June 1939 see column 3, line 51 - column 4, line 2; figures 6-8	1, 2
A	FR,E,30767 (PANHARD & LEVASSOR) 23 August 1926 see figure	1, 2

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/GB 91/00110

SA 43831

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 16/04/91
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		OA-A- 2099	05-05-70
		US-A- 3456939	22-07-69
US-A-2718393		None	
US-A-2476367		None	
EP-A-0069787	19-01-83	None	
FR-A-2526110	04-11-83	FR-A- 2522098	26-08-83
US-A-1952958		BE-A- 359820	
		BE-A- 368762	
		BE-A- 377585	
		DE-C- 503316	
		DE-C- 547264	
		DE-C- 547864	
		FR-E- 39877	
		FR-A- 686718	
		FR-A- 686753	
		FR-A- 686758	
		GB-A- 345526	
		NL-C- 31959	
		US-A- 1866918	
		US-A- 1866958	
		US-A- 1886958	
US-A-2201531		None	
FR-A-569470		None	
US-A-2270516		None	
US-A-1781898		None	
US-A-2161838		None	
FR-E-30767		None	