

[54] RESILIENT SUPPORTING MEMBER

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[58] Field of Search 52/98, 108, 227, 726;
5/351; 297/284

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Primary Examiner—Casmir A. Nunberg

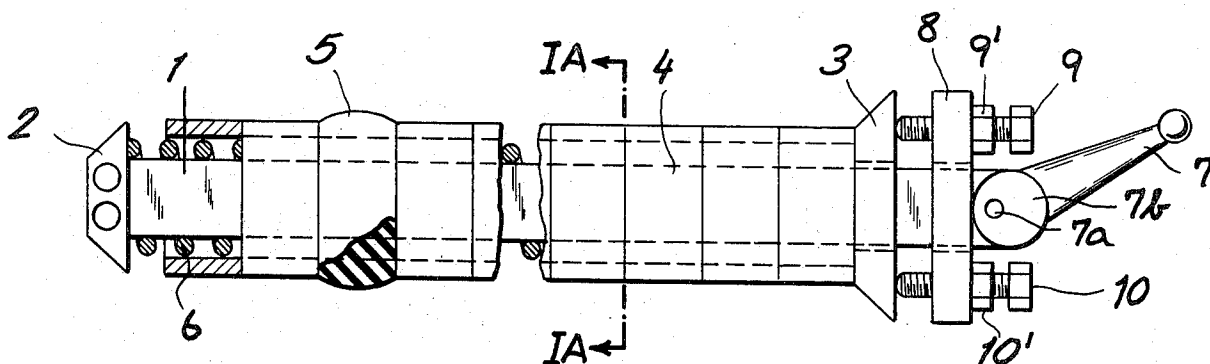
Attorney, Agent, or Firm—Karl F. Ross, Herbert
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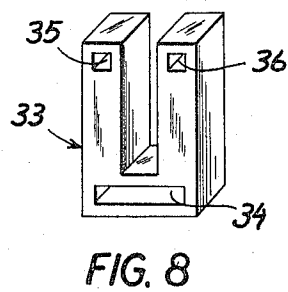
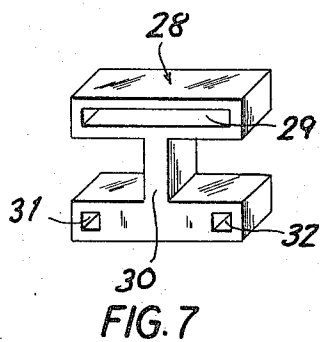
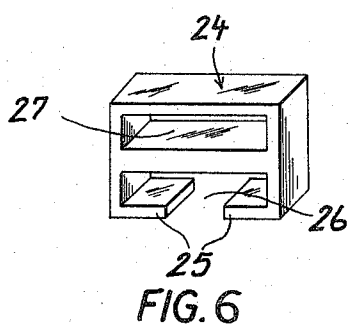
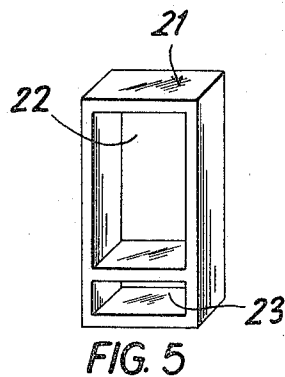
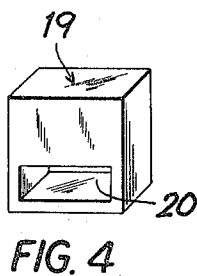
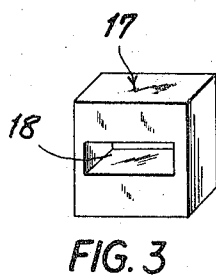
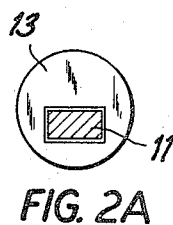
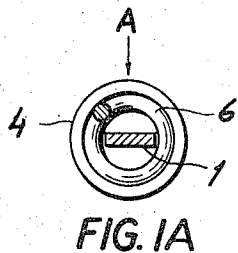
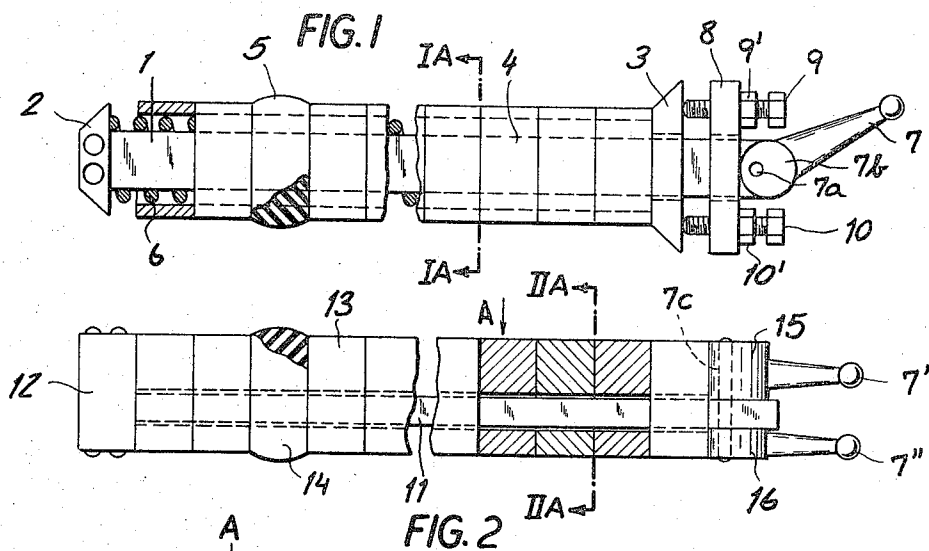
[57] ABSTRACT

An elongate resilient supporting member, designed to

absorb transverse stresses, includes a throughgoing leaf spring along with one or more reinforcing elements disposed along the broad spring surface which increase the spring stiffness upon deflection thereof from a normal position. The reinforcing elements may be a set of longitudinally spaced abutments on the spring surface, produced in the simplest manner by transverse incisions on the spring body; several springs so notched may be superposed to form a stack. Alternatively, the reinforcing elements are part of a column or stack surrounding the spring on which they may slide freely or to which they may be attached in spaced-apart relationship. The overall resiliency of the member may be varied with the aid of an eccentric subjecting the column to adjustable axial pressure, this eccentric acting against the force of a compression spring surrounding the leaf spring within the column. The reinforcing elements can also engage the leaf spring through a lost-motion connection which gives them relative axial mobility unless the lost motion is eliminated by manually or otherwise operable control means.

10 Claims, 27 Drawing Figures





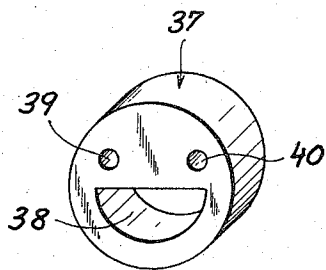


FIG. 9

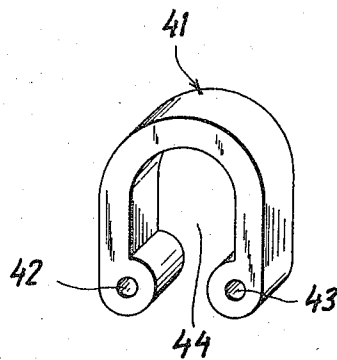


FIG. 10

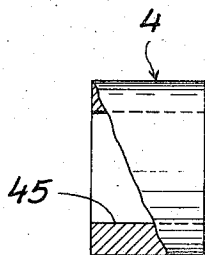


FIG. 11

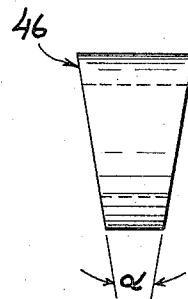


FIG. 12

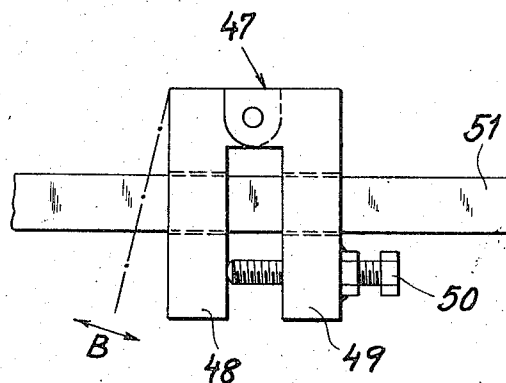
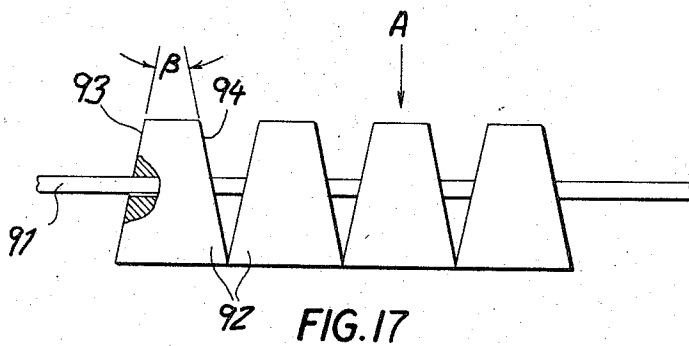
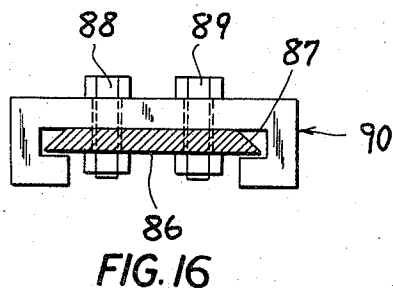
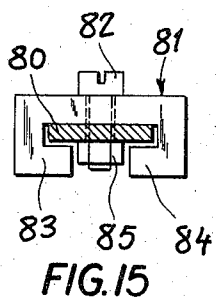
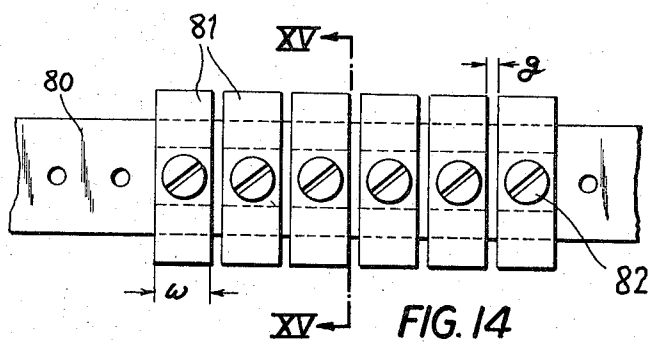


FIG. 13



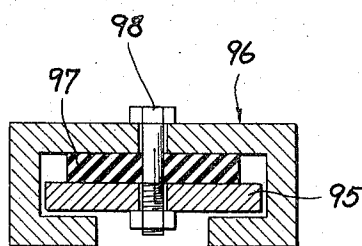


FIG. 18

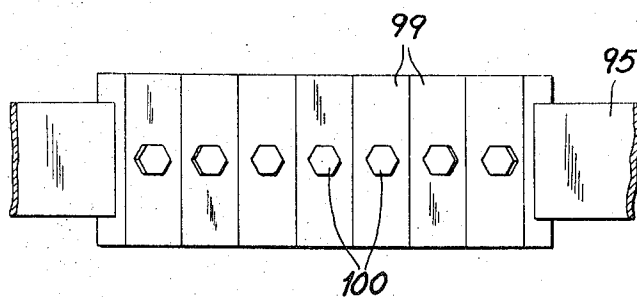


FIG. 19

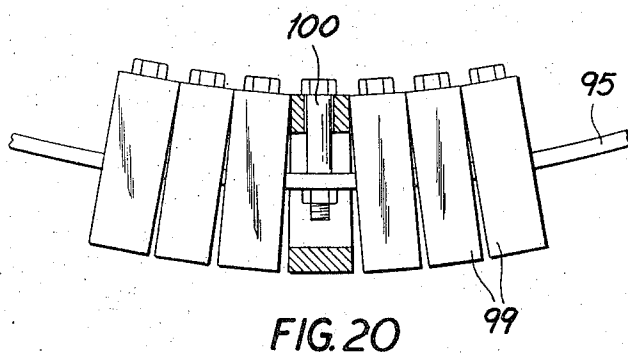


FIG. 20

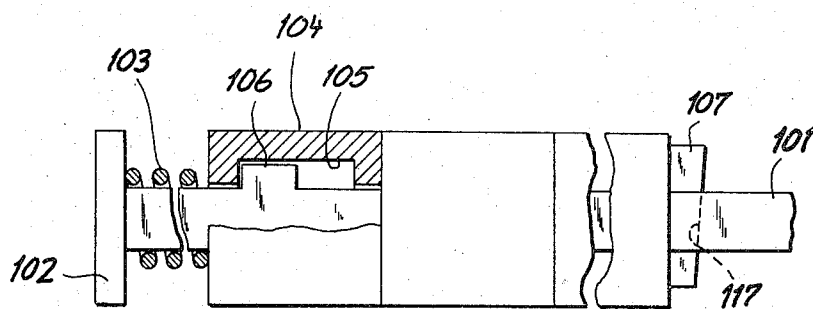


FIG. 21

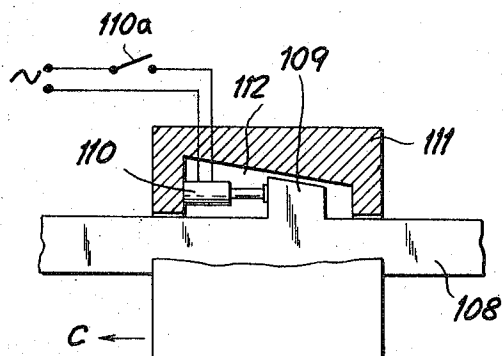


FIG. 22

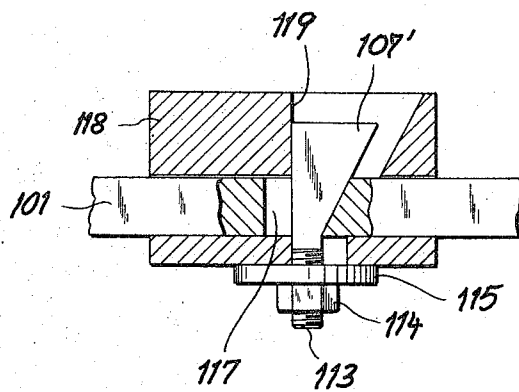


FIG. 23

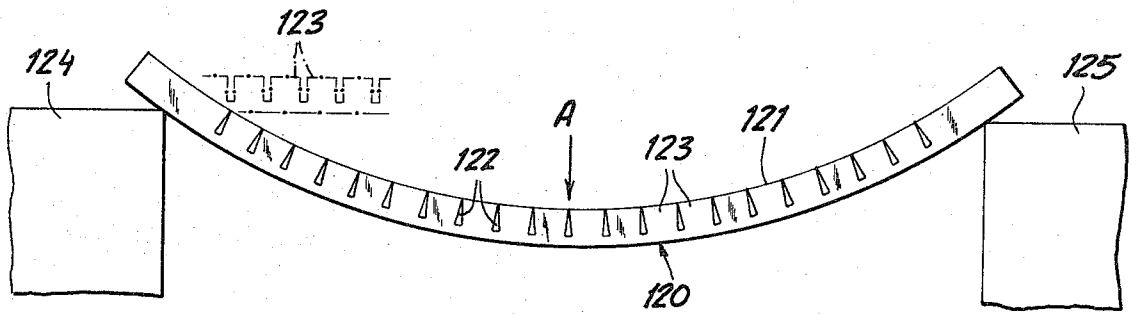


FIG. 24

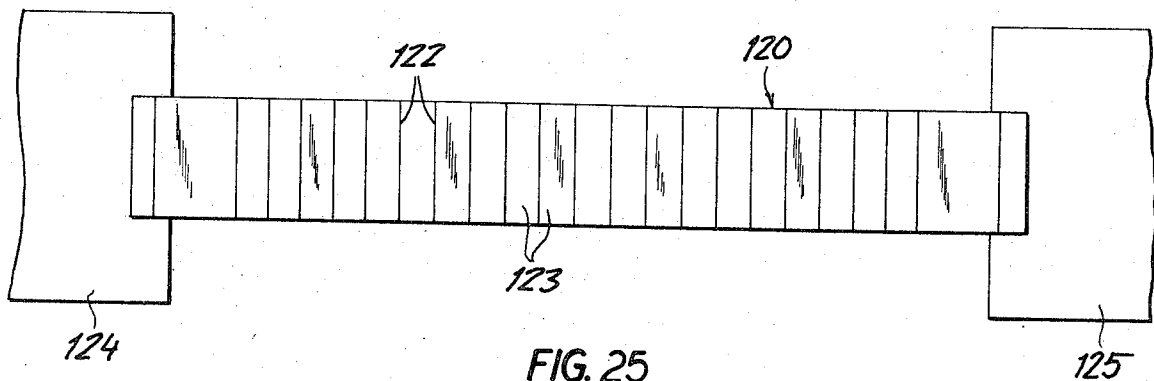


FIG. 25

RESILIENT SUPPORTING MEMBER**FIELD OF THE INVENTION**

My present invention relates to an elongate resilient supporting member to be used, for example, in seats, mattresses and similar load-carrying structures, e.g., as shown in my prior U.S. Pat. No. 3,490,084, in order to absorb transverse stresses such as the body weight of a person resting on a structure of this type.

BACKGROUND OF THE INVENTION

As disclosed in my above-identified prior patent, such a supporting member may comprise a wire or cable passing axially through a column or stack of mutually abutting, compression-resistant tubular elements, the cable constituting a continuous tension element anchored at its ends to the stack. The resulting assembly acts as an elastic rod whose flexibility is determined by the resiliency of both the cable and the tubular pressure elements which, as likewise shown in the patent, may be designed (at least in part) as coil springs.

Such a supporting member may be given an initial upward curvature or camber, as described in my copending application Ser. No. 98,003 filed Dec. 14, 1970 and now U.S. Pat. No. 3,724,144, in order to develop an upwardly acting force component resisting downward deflection upon a straightening of that member by the loading of the associated structure. Without such initial camber, however, the member does not develop an appreciable transverse force component until it has undergone some deflection under load.

OBJECTS OF THE INVENTION

The general object of my present invention, therefore, is to provide a supporting member of this description which resists flexing without cambering or other preliminary deformation from a preferably straight original shape.

A more particular object is to provide a supporting member of this description whose bending resistance increases sharply upon attainment of a predetermined degree of flexure.

A further object, allied with the preceding one, is to provide simple means for adjusting the amount of load pressure required to bring about the stiffening of the member against further flexure.

SUMMARY OF THE INVENTION

A resilient supporting member according to my present invention comprises a throughgoing leaf whose broad surfaces are perpendicular to the direction of stress, this direction being assumed hereinafter as being vertically downward (although this is not an essential condition) so that the surfaces referred to are substantially horizontal. At one of these broad surfaces, namely the one which goes into compression upon deflection of the spring and which is therefore the upper surface under the conditions assumed above, the spring is provided with reinforcing means for stiffening it by resisting further compression beyond a predetermined limit. The member so constructed may be supported by any suitable means permitting such deflection, e.g., by resting with its ends on a pair of spaced-apart piers or by being imbedded in a deformable structure (e.g., a

cushion) as shown in my prior U.S. Pat. No. 3,490,084.

The reinforcing means may comprise a multiplicity of longitudinally spaced abutments which are rigid with the spring body and rise from the surface constituting its compression flange, i.e., the aforementioned upper surface, these abutments contacting one another as soon as the radius of curvature of the spring is sufficiently reduced. Such abutments can be produced in a simple manner by transversely notching the spring surface, yet they could also be formed as separate strips welded or otherwise secured to that surface.

Alternatively, my invention can be embodied in an assembly of the general type disclosed in my above-identified copending application and patents, with the reinforcing means constituted by a tubular body which surrounds the leaf spring at least in part (e.g., from the top and sides) while extending over substantially the entire length of its compression surface. Such a tubular body or stack could be unitary but, for greater adaptability, is preferably divided into a multiplicity of abutting or nonabutting tubular elements which effectively resist axial compression only after an initial deformation of the spring and the stack. If these elements contact one another in the undeflected position of the spring, one or more of them should be elastically compressible to establish a load threshold beyond which the axial compressive strength of the stack is sharply increased so that the stack and the leaf spring act as a relatively stiff unit. Alternatively, these tubular elements could be individually secured to the leaf spring with relative axial spacing, at least in the area of the compression flange of the spring, so that their behavior is similar to that of the aforementioned abutments rising from the spring surface.

In order to vary the threshold point at which the supporting member stiffens, I may provide adjustable cams, wedges or similar pressure means bearing axially upon the stack of compression elements. Such cams or wedges, or equivalent control means acting individually upon each compression element, can also be used to immobilize compression elements with reference to the leaf spring by eliminating a lost motion originally present in a loose connection between these elements and the spring.

BRIEF DESCRIPTION OF THE DRAWING

The above and other features of my invention will be described in detail hereinafter with reference to the accompanying drawing in which:

FIG. 1 is a top plan view (parts broken away) of a supporting member embodying my invention;

FIG. 1A is a cross-sectional view taken on the line 1A — 1A of FIG. 1;

FIG. 2 is a view similar to FIG. 1, illustrating a modification;

FIG. 2A is a cross-sectional view taken on the line IIA — IIA of FIG. 2;

FIGS. 3 — 10 are perspective views of compression elements usable in a supporting member according to my invention;

FIG. 11 is a side view of a compression element of the type shown in FIGS. 1 and 1A;

FIG. 12 is a side view similar to FIG. 11, illustrating a modified compression element;

FIG. 13 is a plan view of an adjustable compression element usable in a supporting member according to my invention;

FIG. 14 is a top plan view similar to FIGS. 1 and 2, showing a modified supporting member;

FIG. 15 is a cross-sectional view taken on the line XV — XV of FIG. 14;

FIG. 16 is a view similar to FIG. 15, showing a further modification;

FIG. 17 is a side-elevational view of yet another supporting member embodying my invention;

FIG. 18 is a cross-sectional view similar to FIGS. 15 and 16, illustrating a still further modification;

FIG. 19 is a top view similar to FIG. 14, showing yet another embodiment;

FIG. 20 is a side-elevational view, partly in section, of the embodiment of FIG. 19;

FIG. 21 is a fragmentary top plan view, partly broken away, of a further embodiment;

FIG. 22 is a top plan view, partly in section, of a modified compression element usable in the assembly of FIG. 21;

FIG. 23 is a cross-sectional view of still another modified compression element for that assembly;

FIG. 24 is a side-elevational view of yet another supporting member according to the invention, shown in a deflected position; and

FIG. 25 is a top view of the supporting member of FIG. 24.

SPECIFIC DESCRIPTION

The supporting member shown in FIGS. 1 and 1A comprises a horizontally positioned leaf spring 1 anchored at its left-hand end to a terminal element or head 2 which serves as an abutment for a compression spring 6 surrounding the leaf spring. The other, right-hand end of coil spring 6 bears upon another terminal element 3 with a central aperture freely traversed by the leaf spring 1. The outwardly projecting extremity of spring 1 is pivotally linked at 7a to an eccentric 7b rigid with a lever 7, eccentric 7b coacting with a transverse plate 8 held at variable distance from terminal element 3 by a pair of screws 9 and 10 that are secured in position by counternuts 9' and 10'. Terminal elements 2 and 3, which may be attached to or supported on an external structure not shown (see FIGS. 24 and 25), bracket between them a stack of annular compression elements 4 of relatively rigid material (e.g., metal) interspersed with one or more generally similar elements 5 of greater elasticity, e.g., made from rubber. Compression elements 4 and 5 form a tubular column or stack of limited axial compressibility surrounding the leaf spring 1 and the coil spring 6.

As will be apparent from FIG. 1A, leaf spring 1 is received in compression elements 4 and 5 with considerable vertical clearance. If the adjustment of screws 9, 10 and the position of lever 7 are so chosen as to allow for a loose juxtaposition of these elements in the undeflected state of the leaf spring, then the column and its internal springs 1, 6 can be deflected under load (arrow A) against practically no resistance other than the bending strength of the leaf spring (supplemented by the much smaller flexural strength of the coil spring) until a position is reached in which the compression elements come to rest against one another and the terminal elements 2, 3 along the upper spring surface (cf. FIGS. 19 and 20 described below). At that point the

axial compressibility of the stack becomes a material factor in resisting further bending, that axial compressibility diminishing sharply upon a sufficient compression of the elastomeric insert or inserts 5 with further stiffening of the composite member. It will be evident that the load pressures required to bring about this progressive stiffening can be varied over a relatively small range by a rotation of the self-locking eccentric 7b and over a larger range by readjustment of the screws 9 and 10.

In FIGS. 2 and 2A I have shown a modified assembly of the same general construction, except for omission of the coil spring, a leaf spring 11 being again disposed with vertical clearance in apertures of a set of compression elements 13 (rigid) and 14 (elastic) bracketed between an end element 12 and a pair of eccentrics 15, 16 that are mounted on a common pivot pin 7c. Eccentrics 15 and 16 are integral with two levers 7' and 7'', respectively, which can be independently adjusted to vary the axial spacing of the compression elements 13, 14 (in the undeflected position of spring 11) to a different extent above and below the moment line of the stack acting as a simply supported beam. Thus, eccentric 15 controls the axial pressure developed, upon deflection under load A, in the region of the upper spring surface, i.e., in the compression flange of the beam, this eccentric being shown larger than the eccentric 16 for the lower part of the stack which acts as the tension flange. As shown in FIG. 2A, compression elements 13 and 14 are largely solid and have only narrow rectangular apertures traversed with limited play by the spring 11.

FIGS. 3 — 13 show various forms which the rigid compression elements of the stacks in FIGS. 1 and 2 may take; the elastic inserts, if present, may of course be similarly constructed.

FIG. 3 shows a prismatic compression element or block 17 of square outline with a narrow rectangular slit 18, similar to that of element 13 shown in FIG. 2A but located centrally within the block. In FIG. 4 a similar block 19 has a slot 20 near its bottom, this element being thus substantially equivalent to elements 13 of FIGS. 2 and 2A. In FIG. 5 I have illustrated a block 21 with an outline in the form of an upright rectangle and a slot 23 near its bottom to accommodate the leaf spring 11 of FIGS. 2 and 2A; the enlarged upper part of this block accelerates the mutual interengagement of adjoining blocks along their upper edges, i.e., at the compression flange of the composite supporting member, upon downward deflection (cf. FIGS. 19 and 20). This upper part of block 28 is shown provided with a large rectangular cutout 22 which not only reduces the weight of the block but also allows the stack to be traversed by a throughgoing link (e.g., a coil spring similar to that shown at 6 in FIGS. 1 and 1A) which maintains the mutual alignment of the blocks without materially restraining their relative mobility in response to a downwardly acting load.

FIG. 6 shows a similar though lower block 24 which, however, does not fully embrace the associated leaf spring that enters a recess 26 bounded at the bottom by two spaced-apart flanges 25. An upper cutout 27 can again be occupied by throughgoing link means such as, for example, a set of laterally juxtaposed coil springs.

A compression element 28, shown in FIG. 7, has an H-profile with an upper and a lower flange intercon-

ected by a vertical web 30, the upper flange being provided with a rectangular slot for the leaf spring whereas the lower flange has two throughgoing holes 31, 32 accommodating guide wires, coil springs or the like for alignment purposes as discussed above. Here the leaf spring is closely spaced from the upper (compression) surface of the stack, this arrangement calling for very little relative mobility of the compression elements in the undeflected position of the leaf spring which also must be virtually inextensible in longitudinal direction in order to transfer its stress to the pressure elements upon a certain initial deflection.

In FIG. 8 I have illustrated a compression element 33 of U-profile, with a bottom slot 34 for the leaf spring in the bight portion of the U and with holes 35, 36 for a pair of guide links near the tops of its arms. This element has essentially the same characteristics as block 21 of FIG. 5.

A cylindrical compression element 37, shown in FIG. 9, is generally similar to element 13 of FIGS. 2 and 2A, except that its slot 38 is of semicircular configuration and occupies most of the lower half of that element; its upper half is provided with holes 39, 40 for a pair of guide links. Evidently, such holes could also be present in the compression elements 13 of FIGS. 2 and 2A.

FIG. 10 shows a horseshoe-shaped compression element 41 whose depending legs have enlarged extremities to define a partly open space 44 accommodating a leaf spring, possibly in combination with a surrounding coil spring as illustrated in FIGS. 1 and 1A. The bottom extremities of the horseshoe legs are provided with holes 42, 43 for the guide links.

FIG. 11 is a side view of the compression elements 4 of FIGS. 1 and 1A, showing its large central aperture 45 which receives the springs 1 and 6.

In FIG. 12 I have illustrated a generally similar element 46 whose end faces, however, are not parallel but converge toward the bottom at a vertex angle α . It will be apparent that the various block configurations shown in preceding Figures could be similarly modified to form a wedge. The use of a stack of such downwardly tapering wedge pieces is advantageous if the leaf spring is not initially flat, as heretofore assumed, but has an inherent upward camber so that the end faces of adjoining wedge pieces are substantially parallel to each other in the undeflected position of the spring. It is also possible to position the wedge pieces with their vertex angle α in a horizontal plane if the spring happens to be curved in that plane. With a straight spring the wedge pieces may be alternately facing in opposite directions (horizontally or vertically) to form a linear stack.

In FIG. 13 I have shown an adjustable compression element 47 with hingedly interconnected legs 48, 49 whose divergence or convergence may be varied by a screw 50, as indicated by an arrow B. A leaf spring traversing respective slots in legs 48 and 49 has been shown at 51. Compression piece 47, which could also be vertically oriented, may be used as a terminal element in a stack additionally including nonadjustable wedge pieces such as element 46 of FIG. 12.

In FIGS. 14 and 15 I have shown a series of compression elements 81 of a structure generally similar to that of element 24 in FIG. 6, except for the omission of an apertured upper part. Each element 81 has a pair of bottom flanges 83, 84 defining a downwardly open recess for a leaf spring 80 which is fastened to the ele-

ment 81 by a screw 82 having a nut 85. In this construction each element 81 initially stiffens the associated spring 80 only over a limited area defined by the width w of the element as measured in the axial direction of the stack. Only after a certain downward deflection, sufficient to close up the gaps g present between these elements along the upper stack surface, will these elements act as a unit to reinforce the flexural strength of the spring.

With a wider leaf spring 86, as shown in FIG. 16, each compression element 90 may be secured to the spring at two points by a pair of bolts 88, 89. FIG. 16 also shows that the longitudinal edges of the spring may be beveled, as indicated at 87.

FIG. 17 illustrates a stack of elements 92, generally similar to wedge pieces 46 of FIG. 12, whose end faces 93 and 94 converge upwardly at a vertex angle β ; these elements are traversed by a leaf spring 91. The upward convergence of wedge pieces 92 results in a progressive separation of their initially contacting broad lower bases as the assembly deflects downwardly under load pressure A ; at the same time, their narrower upper bases approach one another until, upon attainment of a certain degree of deflection, they make contact and stiffen the spring against further deformation.

In FIG. 18 a compression element 96, similar to elements 81 of FIGS. 14 and 15, is secured to its leaf spring 95 by a bolt 98 with interposition of a resilient pad 97, e.g., of rubber, between the spring and the top of element 96. In this case the individual compression elements do not appreciably stiffen the spring, in the manner described with reference to elements 81, until the load pressure is sufficient to flatten the pads 97 to the limit of their compressibility. Thus, the bending resistance of the assembly jumps in two steps, upon attainment of load pressures determined by the absolute and relative magnitudes of the coefficients of elasticity of the pads and the spring.

In FIGS. 19 and 20 I have shown compression elements 99 of considerable height, with a rectangular outline similar to that of element 21 seen in FIG. 5, that are largely hollow and are provided with screws 100 engaging the spring 95 which is thereby maintained at an intermediate level in their interior. The assembly is shown in a downwardly deflected position in which the upper edges of elements 99 contact one another to stiffen the spring.

FIG. 21 illustrates a stack of compression elements 104 each connected with an associated leaf spring 101 via a lost-motion coupling comprising a lug 106 rigid with the spring (actually a pair of such lugs facing in opposite directions) received with axial play in a recess 105 of the compression element. A compression spring 103, bearing upon the stack of elements 104 and upon a head 102 integral with spring 101, urges the elements toward the right against a horizontal wedge 107 driven into a slot 117, cf. FIG. 23, which extends between the narrow sides of the spring. In a range of low load pressures, downward deflection is resisted almost entirely by the bending strength of spring 101 as the compression elements 104 slide almost freely thereon against the relatively weak pressure of coil spring 103. When the deflection reaches a point at which the elements 104 are positively restrained against further sliding by engagement with lugs 106, these elements and the spring begin to act as a unit of greatly increased stiffness. The engagement of the elements 104 with their

respective lugs 106 need not necessarily occur precisely at the same time. It will be apparent that the stiffening threshold is determined by the extent to which the wedge 107 is driven into its slot. Upon complete withdrawal of that wedge, elements 104 will be free to shift even upon major deflection of leaf spring 101; their rightward movement may then be limited by another head (not shown) on leaf spring 101.

FIG. 22 shows a similar lost-motion connection between a leaf spring 108 and a compression element 111 having a recess or undercut 112 to accommodate a pair of oppositely facing lugs 109 (only one shown). A controller 110, such as a solenoid, is inserted between a wall of the recess 112 and the lug 109 and can be operated by a switch 110a to drive the element 111 to the left (arrow C), thereby causing a sloping edge of the lug 109 to engage the similarly slanted bottom of recess 112 so that compression element 111 and spring 108 are again consolidated to act as a unit. As explained above, such consolidation brings about a first stepped increase in the stiffness of the assembly, a second such step occurring when the deflection is sufficient to bring adjacent compression elements 111 into contact with one another.

Solenoid 110 may be replaced by equivalent control means operated from without, e.g., by a hydraulic or pneumatic jack.

FIG. 23 shows an arrangement similar to that of FIG. 21, with a modified wedge 107' traversing the slot 117 of spring 101 and terminating in a threaded pin 113 engaged by a nut 114. Rotation of nut 114, which bears upon a washer 115, enables the wedge 107' to be drawn more or less deeply into the slot 117 for adjustment of the stiffening threshold as explained above. FIG. 23 also shows a compression element 118 formed with a recess 119 which surrounds the broad end of wedge 107' with longitudinal clearance.

FIGS. 24 and 25 show a leaf spring 120, supported at its ends on piers 124 and 125, whose upper surface is formed with a series of transverse incisions 122 separating a set of rib-shaped abutments 123 integral with the spring body. In the undeflected position of the spring, illustrated in phantom lines in FIG. 24, ribs 123 are spaced apart along the upper surface 121 of spring 120 which constitutes the compression flange of the spring regarded as a simply supported beam. Under load pressure represented by arrow A, the spring deforms so that gaps 122 close and the spring stiffens. Naturally, the ribs 123 could also be individually secured to the upper spring surface, e.g., by welding, soldering or cementing. Two or more notched leaf springs 120 may be vertically stacked to form a spring nest.

I claim:

1. In a stress-absorbing structure, in combination,

supporting means and an elongate member carried by said supporting means with freedom of deflection in a predetermined direction under transverse stress, said member comprising a throughgoing leaf spring with broad surfaces perpendicular to the direction of stress and reinforcing means adjacent at least one of said surfaces, going into compression upon deflection, for stiffening the deflected leaf spring by resisting further compression of said one of said surfaces beyond a predetermined limit, said reinforcing means comprising a row of abutments axially spaced apart in a normal position of said leaf spring, said abutments including rigid formations rising from said one of said surfaces at axially spaced locations in positive contact with said leaf spring.

2. The combination defined in claim 1 wherein said formations are ribs integral with said leaf spring.

3. The combination defined in claim 1 wherein said formations are compression elements provided with fastening means securing same to said leaf spring.

4. The combination defined in claim 3 wherein at least one of said elements is a wedge piece with end faces converging in a plane of deflection of said leaf spring.

5. The combination defined in claim 3, further comprising cushioning means interposed between said elements and said one of said surfaces.

6. The combination defined in claim 1 wherein said abutments further include a stack of compression elements each engaging one of said formations with limited relative axial mobility.

7. The combination defined in claim 6 wherein said leaf spring is provided with a pair of end stops bracketing said stack with play, further comprising resilient means inserted between one of said end stops and said stack for urging the latter against the other of said end stops.

8. The combination defined in claim 7 wherein said other of said end stops comprises a wedge member adjustably traversing a longitudinal slot in said leaf spring.

9. The combination defined in claim 6 wherein said elements have internal recesses receiving said formations with longitudinal clearance, further comprising control means in said recesses operable to rigidify said elements with said leaf spring by eliminating said clearance.

10. The combination defined in claim 9 wherein said formations are lugs with sloping edges remote from said leaf spring, said recesses having slanting bottoms paralleling said sloping edges and engageable therewith in a predetermined relative longitudinal position.

* * * * *