

Dec. 25, 1945.

A. J. LOEPSINGER

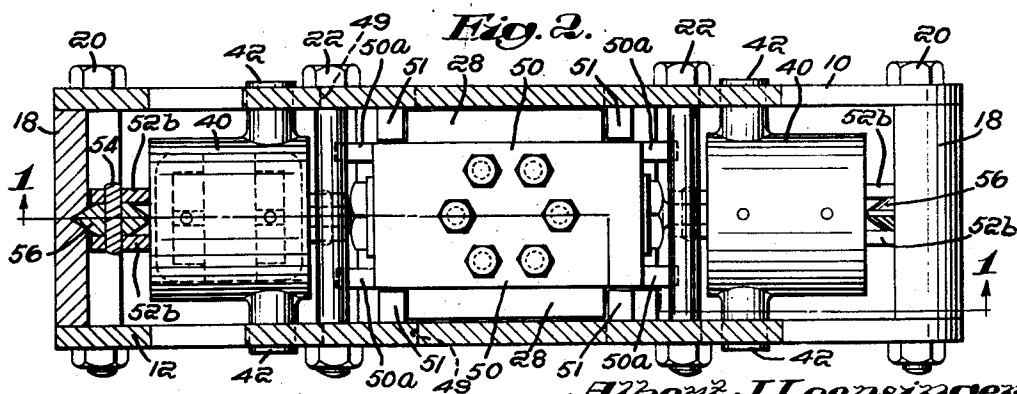
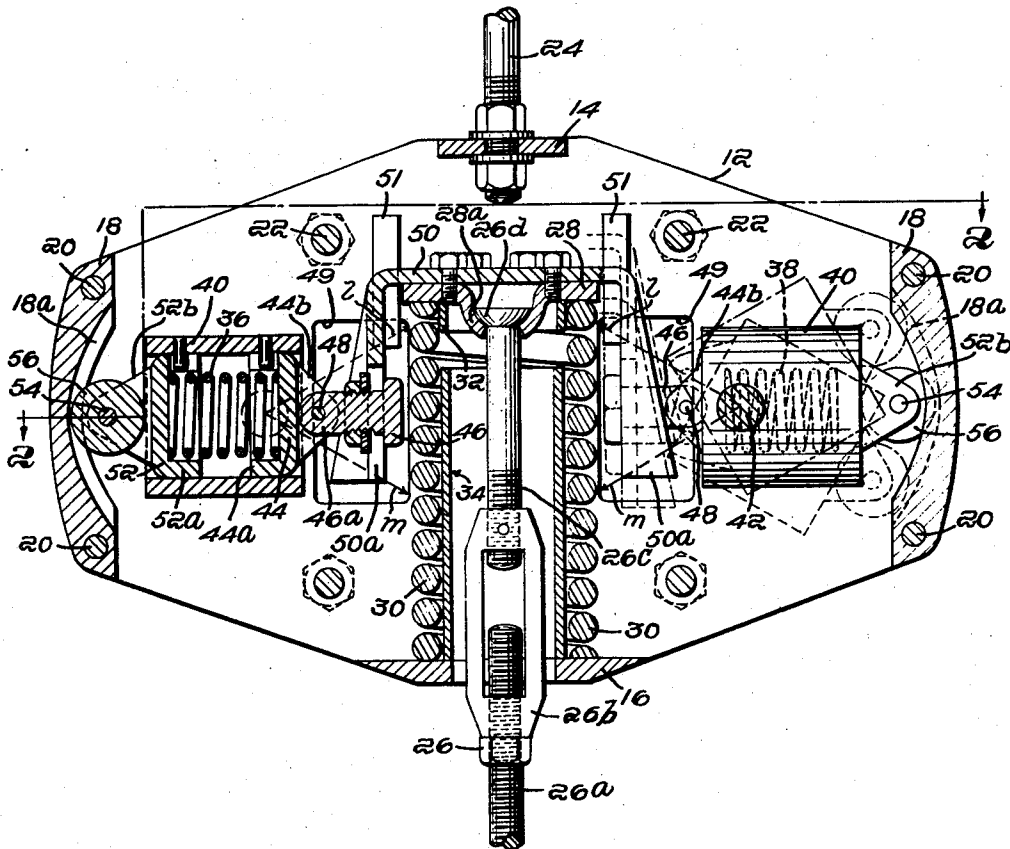
2,391,467

SUPPORTING MEANS

Filed March 29, 1943

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Fig. 1.



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Fig. 3.

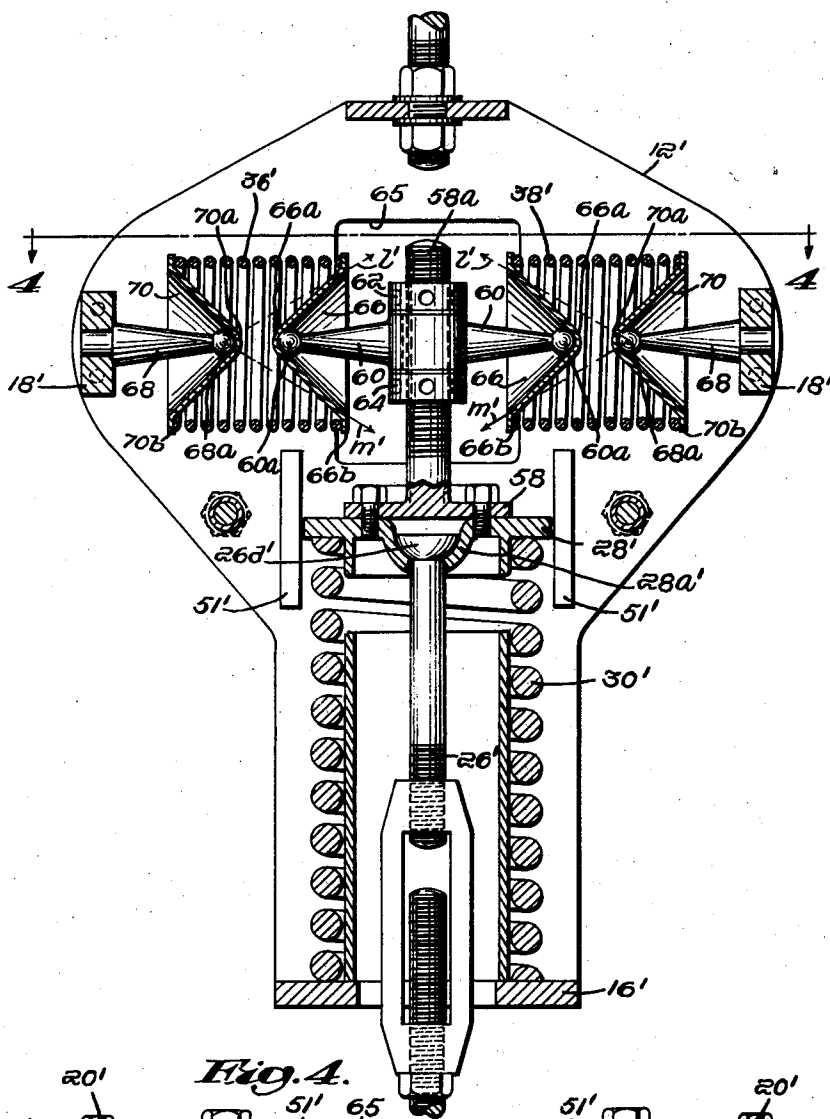
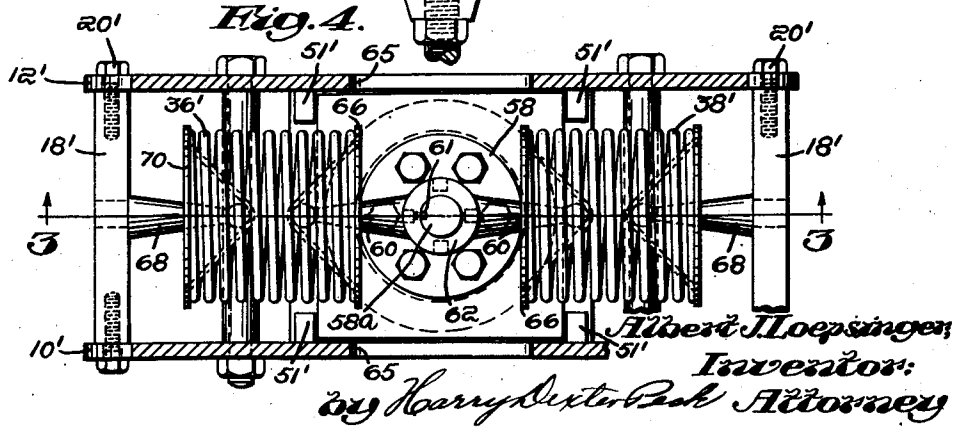


Fig. 4.



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UNITED STATES PATENT OFFICE

2,391,467

SUPPORTING MEANS

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Application March 29, 1943, Serial No. 481,057

6 Claims. (Cl. 248—54)

This invention relates to improvements in supporting means. It is directed to means for so supporting a load of known value which is subject to displacement that the net supporting effect remains equal or substantially equal to the known value throughout the displacement.

An example of a movable load to which my invention is applicable is a system of piping through which flows a fluid of variable temperature. As the latter changes the piping elongates or shortens and such variations in length of the vertical portions of the system cause the horizontal portions to move upward or downward an amount sufficient to cause severe stresses in the piping system. It is highly desirable that the means used to support the piping shall continue to provide the proper supporting effect despite such movements.

The principal object of my invention is to provide in conjunction with primary means capable of supporting a movable load at some predetermined position, but whose supporting effect varies as the load moves away from such position, auxiliary means which are effective during such movement of the load to compensate for the variations of the primary means to the end that the load is supported throughout its movement by a net supporting effect exactly equal to or substantially equal to the weight of the load.

The best modes in which I have contemplated applying the principles of my improvements are shown in the accompanying drawings but these are to be taken as merely illustrative because it is intended that the patent shall cover by suitable expression in the appended claims whatever features of patentable novelty exist in the inventions disclosed.

In the drawings:

Figure 1 is an elevation, partly in section on line 1—1 of Figure 2, of supporting means embodying my improvements;

Figure 2 is a plan view of the same, with parts in section as on line 2—2 of Figure 1;

Figure 3 is an elevation, partly in section as on line 3—3 of Figure 4, showing a modification; and

Figure 4 is a plan in section as on line 4—4 of Figure 3.

Referring to the drawings and particularly to Figures 1 and 2, the improved supporting means there shown has a rigid frame structure comprising front and back plates 10 and 12, between which an upper cross plate 14 and a lower cross plate 16 may be secured as by welding. At the side edges other cross members 18 (to be more

particularly described hereinafter) are secured between the main plates by bolts 20, and if desired, tie bolts 22 may also be used.

The frame is connected by means of a hanger rod 24 to some fixed structural member (not shown) or may be connected to a carriage arranged for horizontal movement as is customary where horizontal movement of a load must be provided for.

Another hanger rod 26 is connected to the load to be supported (not shown) and preferably comprises a threaded rod 26a, a turnbuckle 26b, and a short rod 26c having a semi-spherical head 26d. The latter seats in a socket 28a formed in a plate 28 resting on the free end of a main spring 30 which bottoms on the lower cross plate 16. Sleeve members 32 and 34 are secured to the plates at opposite ends of the spring to maintain the latter in position and also serve, when the occasion demands, as a rigid support for the load. For instance, if the load to be supported is a steam pipe line then upon the latter being filled with water for a hydrostatic test (thereby materially increasing the load) the main spring is compressed until the sleeves 32 and 34 are in contact. Thereafter during the test the load is supported by these sleeves without imposing further stress upon the spring means.

The position of the main spring 30 and hanger rod 26 shown in Figure 1 corresponds to what I shall call a predetermined position of the load. In this position the force exerted by the primary force exerting means (in this case the force of the main spring 30) is equal to the weight of the load and fully supports it. If the load moves upward the spring expands and the force exerted by it is reduced. If the load moves downward the spring is compressed and the force exerted by it is increased. Such changes in the supporting force become progressively larger as the movement of the load continues away from the predetermined position. This is not desirable and my improvements are particularly concerned with the provision of means for compensating for such variations.

The compensating means disclosed in the drawings comprise auxiliary springs arranged in opposed relation so that when the load is in the predetermined position the forces of these springs are preferably exerted at right angles to the direction of movement of the load. Under such conditions the auxiliary springs provide no load supporting effect whatever. Each auxiliary spring is associated with an element movable with the load and is mounted for rotation about

an axis so that as the load moves away from the predetermined position each auxiliary spring assumes a position at an angle to the direction of movement of the load. According to this angular relation the force of each auxiliary spring has a component which is effective along the line of movement of the load and the sum of these components compensates for the variation in the primary supporting force.

If the load moves upward the force of the main spring is reduced, but this upward movement so tilts the auxiliary springs that they have upwardly acting components which make up for the reduced force of the main spring. In this case, the next supporting effect is the sum of the main spring force and the upwardly acting vertical components of the auxiliary springs. If the load moves downward the force of the main spring is increased, but this increase is now compensated for by the auxiliary springs which will have tilted downward so that their vertical components are acting downward in the same direction as the weight of the load acts. In this case, the net supporting effect is the difference between the main spring force and the downwardly acting vertical components of the auxiliary springs.

It is to be noted that in carrying out my invention the forces exerted by both the main or primary force exerting means and the auxiliary force exerting means vary in accordance with the displacement of the load. However, in order to achieve the novel compensating action, the supporting effects of the two force exerting means must be in opposed or inverse relation to one another whenever the supporting effect of the primary means does not equal the known value of the load. That is to say, when the supporting effect of the main force exerting means is less than the load the supporting effect of the auxiliary force exerting means is so applied as to be added to that of the primary means, whereas when the supporting effect of the main force exerting means is greater than the load, then the supporting effect of the auxiliary force exerting means is so applied as to be subtracted from that of the primary means. Either force exerting means acting alone would produce only a variable supporting effect on the load, but organized and combined in accordance with my invention, that is with their individual supporting effects acting in inverse or opposed relation, the result is a constant or substantially constant support of the load.

In Figures 1 and 2 I have shown two auxiliary springs 36 and 38. Each is housed within a cylindrical shell 40 having trunnions 42 journaled in the front and back plates 10 and 12. The axis of these trunnions is the axis about which an auxiliary spring is tilted. The inner end of the spring seats against a plate 44 having an annular flange 44a extending between the spring and the inner wall of the shell 40 and having brackets 44b extending forward to receive between them a suitably shaped end 46a of a bolt 46. A hole through the brackets and bolt end accommodates a pin 48. The bolt is adjustably secured to a leg 50a of a generally U-shaped member 50 attached at its midposition to the main spring bearing plate 28. This adjustment may be made by wrenches inserted through the opening 49 in the front and back plates. This U-plate moves upward and downward with the plate 28, the latter being loosely guided and prevented from rotating by the guides 51 and the front and back plates.

The outer end of an auxiliary spring seats against a plate 52 having an annular flange 52a and brackets 52b for another pin 54. A wheel 56 is journaled on the latter and runs along a track 18a in the side cross member 18. As here shown the track is a V-shaped groove cut in the cross member.

The curvature of this track is important because it determines the length of the auxiliary spring and thereby the vertical component of the spring force effective in the direction of the load movement. For example, assume the load has moved upward so that the U-shaped plate 50 is in the suggested dotted position. Obviously the main spring 30 will have elongated and its lifting force will have been reduced. The bolt 46 will have likewise moved upward and caused the cylindrical shell 40 at the right side of the figure to assume the tilted position shown in dotted outline. The force of its auxiliary spring 38 will be exerted along the dotted center line *l* drawn through the axis of the pin 48 and the axis of the shell trunnions 42. If only two opposed auxiliary springs are used, the force of each must be such that the vertical component of each force is half the reduction of force in the main spring. Accordingly the track is designed so that the distance between where the roll engages it and the axis of the pin 48 will be such that the auxiliary spring will be sufficiently compressed to produce the necessary spring force to give a vertical component equal to one-half the reduction in force of the main spring. The other half of this reduction is made up by the like vertical component of the other auxiliary spring 36 which will be similarly tilted. These components act with the force of the main spring and thus the net supporting effect on the load is the same as when the load was in the predetermined position.

On the other hand, if the load were to move downward so that the U-shaped member 50 and bolt 46 are in the position indicated by dot-dash outline, the main spring 30 will be compressed and its lifting force increased. But the shell 40 and auxiliary spring 38 are now tilted downward so that the force of the spring acts along the dot-dash centerline *m*. The wheel 56 is near the other end of the track 18a which is so disposed that the distance between it and the axis of the pin 48 is such as to cause the auxiliary spring to be sufficiently compressed to exert a force whose vertical component will equal one-half the increase in the force of the main spring. The other half of this increase is offset by the other auxiliary spring 36 which will be similarly tilted downward. These components act against the force of the main spring and thus the net supporting effect on the load is the same as when the load was in the predetermined position or at the assumed high position represented by the dotted outlines.

With the arrangement shown in Figures 1 and 2, every variation of the main spring or supporting force can be exactly compensated for by the auxiliary springs, because the tracks can be designed and shaped to produce any force desired to be exerted by these springs. Moreover, if during the movement of the load away from the predetermined position the load itself should undergo variations which would be compatible with the proper positioning of the roller by a track then these likewise can be compensated for by my improved means. Thus in my preferred form of supporting means the load can be exactly supported at any point in its range of movement

whether or not the load itself remains constant or varies within the limits of practical track design.

Not infrequently, however, it is unnecessary to support the load so exactly and in such cases the track may be omitted and the auxiliary springs may be bottomed on a fixed base, as it were. Such an arrangement is shown in Figures 3 and 4. In this arrangement the front and back plates 10' and 12' are of somewhat different configuration because here the auxiliary springs 38' and 39' are arranged somewhat above the main spring 30'. The latter extends between the fixed bottom cross plate 18' and the movable plate 28' which has the depressed socket 28a' to receive the semispherical upper end 26d' of the hanger rod 26' connecting with the load. Plate 28' is loosely guided and prevented from rotating by the guides 51' and the front and back plates.

A plate 58 having an upstanding threaded stem 58a is secured to the movable plate 28' and on this stem a cross member 60 is keyed at 61 in such manner as to prevent rotation of the member while permitting its longitudinal adjustment along the stem. When properly adjusted the cross member 60 is locked to the stem 58a by the clamping nuts 62 and 64 threaded thereon. Openings 65 in the front and back plates enable this adjustment and tightening of the clamping nuts to be made.

The ends 60a of the cross member are substantially ball shaped to receive the semispherical bottoms 66a of cone plates 66 having outstanding edges 66b against which the auxiliary springs 38' and 39' rest. Opposite each outer end 60a of the cross member is a similar ball shaped end 68a of a post 68 mounted in a side plate 18' that is attached between the front and back plates by cap screws 20'. The fixed ball end 68a of this post receives the semispherical bottom 70a of another cone plate 70 having an outstanding rim 70b against which the outer ends of an auxiliary spring rests.

When the load is in the predetermined position, that is, with the main spring 30' fully supporting it, the cross member 60 is adjusted along the stem 58a so that the longitudinal axis of the cross member is in alignment with the corresponding axes of the fixed side posts 68. In this adjusted position the auxiliary springs are merely opposing one another, without any effect being exerted in the direction of the load movement.

If, however, the load moves upward, the cross member 60 will likewise move and cause both auxiliary springs to tilt about horizontal axes through the ball ends 68a of the fixed posts 68. Thus each auxiliary spring will exert its force in some direction such as is indicated by the dotted line *l'*, and this force will produce a vertical component acting upward on the cross member 60 and consequently upon the load. By suitable selection of auxiliary springs and a known movement of the load, the combined vertical components of these springs can be made to exactly compensate for the reduction in the force of the main spring due to such movement of the load.

If now the load were to move downward an equal distance below the predetermined position, so that the force of each auxiliary spring is exerted in a direction indicated by the dot-dash line *m'*, then in this assumed position the combined downwardly acting vertical components of the auxiliary springs would oppose and offset the in-

creased force of the main spring due to such movement of the load.

From both the upper and lower positions represented by the dotted and dot-dash lines *l'* and *m'* respectively, each auxiliary spring will exert a greater force as it approaches the predetermined or illustrated position. But as this spring force increases, its angular relation to the horizontal becomes less and so its vertical component becomes less despite the greater spring force and finally disappears when the auxiliary spring forces come into alignment at right angles to the direction of movement of the load. Thus by suitable selection of auxiliary springs the load can be exactly supported at its predetermined position and at two selected positions above and below this predetermined position, and between either the upper or the lower selected position and the predetermined position the variation of the auxiliary spring forces from effecting exact compensation can be made of the order of one per cent or less of the load.

Although I have used the terms "upper," "lower," "horizontal" and "vertical" for clarity in the description, these terms are purely relative in meaning because my improved means can be used with the axis of the main spring positioned horizontally or otherwise and with the tie member connected to the load by means of a bell-crank lever or a cable and pulley or the like. Also, although I have shown only a compression spring as the main spring, it is obvious that my improvements can be employed with a main spring of the tension type. Moreover, my auxiliary or compensating means may be used separately and apart from the primary force exerting means provided that their supporting effect on the load is applied in an inverse or opposed relation to the supporting effect of the primary means. Such variations and modifications are deemed to be within the scope of my invention and to be covered in one or more of the appended claims.

I claim:

1. Supporting means for a load of known value subject to displacement from a predetermined position comprising, in combination, a fixed element; a movable element moved by the load; primary spring means interposed between said elements acting parallel to the line of movement of said load exerting a supporting force on the movable element equal to the known value of the load when the latter is at said predetermined position and exerting a supporting force varying in accordance with the displacement of said load from said predetermined position; and auxiliary spring means acting on said movable element at right angles to said line of movement when the load is at said predetermined position and being moved by the movement of the load to act at an angle to said line of movement when the load is displaced; the force of said auxiliary spring means being varied in accordance with the displacement of the load from said predetermined position and being so applied that its component parallel to the said line of movement of the load substantially compensates for the variation in the supporting force of the primary spring means.

2. Supporting means for a load of known value subject to displacement from a predetermined position comprising, in combination, a fixed element; a movable element connected to and moved by the load in a fixed direction; primary spring means interposed between said elements acting parallel to said fixed direction and exerting on the movable element a supporting effect

equal to the known value of the load when the latter is at the said predetermined position, and auxiliary spring means connected to the movable element acting at right angles to said fixed direction and exerting no supporting effect when the load is at the said predetermined position; the forces of said primary and said auxiliary spring means being varied upon displacement of the load from the said predetermined position and so applied to the movable element that the supporting effect of one means compensates for the supporting effect of the other means whereby the net supporting effect of said forces remains substantially equal to the known value of said load throughout its displacement.

3. Supporting means for a load of known value subject to displacement from a predetermined position comprising, in combination, a fixed structure; primary spring means arranged with one end thereof engaging said structure; a movable element engaging the other end of said primary spring means and being moved by said load; said primary spring means exerting on the load a supporting effect which varies in accordance with the displacement of the load; and auxiliary spring means pivotally mounted on said structure with one end in engagement with the said movable element so that as the movable element is moved by the load auxiliary spring means is tilted about its pivotal mounting; the said auxiliary spring means exerting a supporting effect which varies in accordance with the extent to which it is tilted about its pivotal mounting; the varying effect of the auxiliary spring means being applied in inverse relation to the supporting effect of the primary spring means to compensate substantially for the variation in the supporting force of the primary spring means throughout the displacement of the load.

4. Supporting means for a load of known value subject to displacement comprising, in combination; primary spring means exerting on the load a supporting effect which varies in accordance with the displacement of the load; auxiliary spring means exerting on the load a supporting effect in inverse relation to that of the primary means; and cam means controlling the force exerted by the auxiliary means so that its support-

ing effect will exactly compensate the variations in the supporting effect of the primary means and maintain throughout the displacement a constant net supporting effect equal to said known value.

5. Supporting means for a load of known value subject to displacement comprising, in combination, primary spring means exerting a varying supporting effect on said load as the load is displaced; auxiliary spring means exerting on the load a supporting effect in inverse relation to that exerted by the said primary means; said auxiliary means being pivotally mounted so as to be tilted by movement of the load to exert a varying component of force in a direction parallel to that of the force exerted by the primary means; and means effective during the tilting of the auxiliary means to regulate the force thereof so that the said component will exactly compensate for the variations in the supporting effect of the primary means.

6. Supporting means for a load of known value subject to displacement from a predetermined position comprising, in combination, a fixed element; an element linearly movable with the load upon displacement thereof; primary spring means interposed between said fixed and movable elements exerting a primary supporting force on said movable element equal to the load value when the load and said movable element are in the predetermined position but with said primary supporting force varying in accordance with displacement of the load toward or away from said fixed element; and auxiliary spring means interposed between said fixed element and said movable element and arranged, when the load and said movable element are in the predetermined position, to exert a force on said movable element in a direction at a right angle to the linear path of movement of said movable element and, upon linear movement of said movable element in either direction from the predetermined position, to exert a force on said movable element in a direction to compensate for variations in said primary supporting force whereby the net supporting effect on the load remains substantially constant despite displacement of said load.

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