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FOLDING BED MECHANISM

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2 Sheets-Sheet 1

Fig. 1

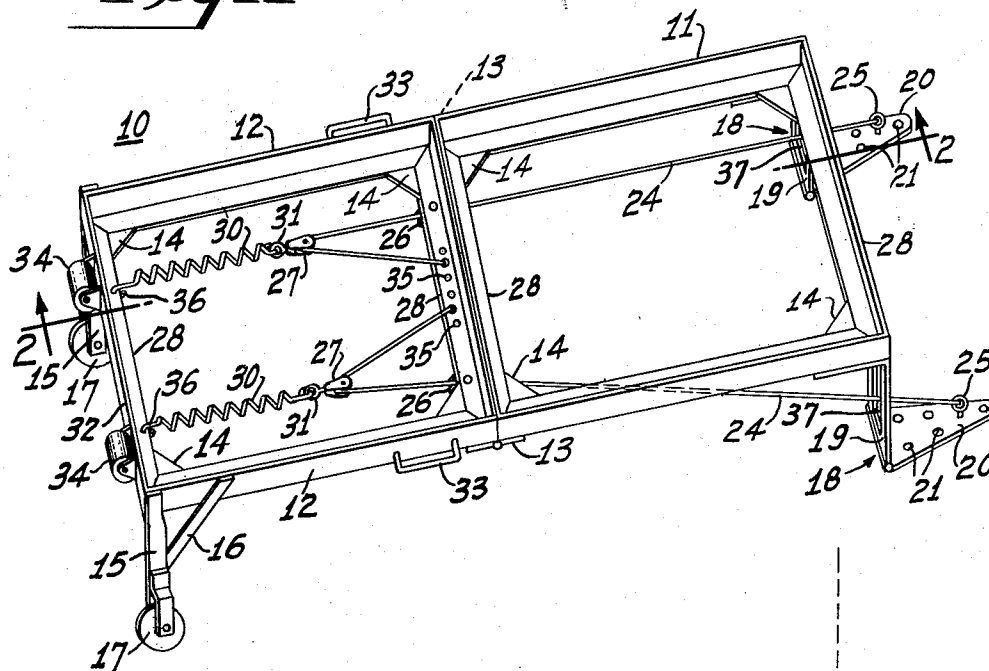
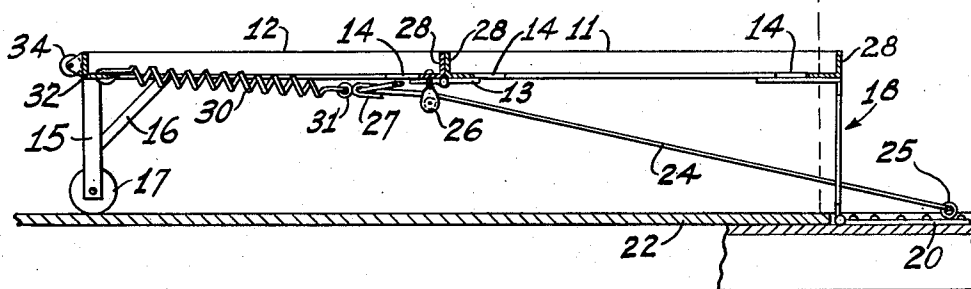


Fig. 2

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Fig. 4

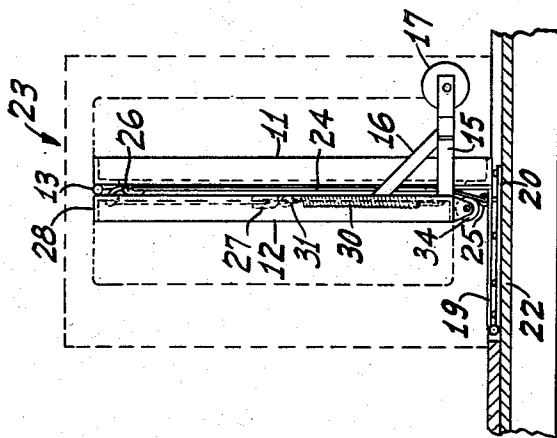
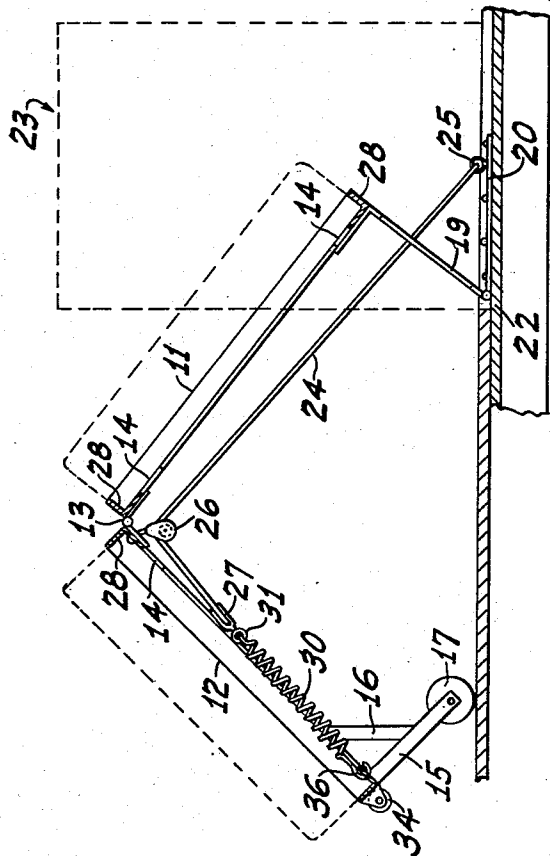


Fig. 3



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FOLDING BED MECHANISM

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9 Claims. (Cl. 5-154)

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This invention relates to improvements in folding bed mechanisms. In particular, it relates to improvements for opposing gravitational forces which are encountered in a folding-and-unfolding cycle of such a mechanism and for doing so with an effectiveness which varies in said cycle as do the magnitudes of certain undesirable effects of these forces.

As is well known, in any of a great variety of mechanisms, such as those of folding beds, the center of gravity of each group of its movable parts which are functionally interconnected is shifted to various positions in the operation of the mechanism. In some positions of the center of gravity, for example when it is at "dead center" over a pivot or fulcrum, the weight of the group of parts may not present any difficulty. However, when the center of gravity is in other positions, considerable force may be necessary to oppose that weight. This is true of a certain type of bed (sometimes known as a "Murphy bed") which can be stored in a vertical position in a wall recess. Though it is easy to start the opening of this bed by pulling it outward and downward, very soon considerable force becomes necessary to prevent the completion of its opening in a dangerous free fall.

And conversely, in closing this bed, considerable force is necessary to first raise its full dead weight, albeit this weight decreases progressively as the bed more nearly approaches a vertical position with its full weight at dead center over its axis of rotation.

In the folding-bed prior art, various systems of counter-weights and springs have been employed for opposing excessive gravitational forces. In general where a spring is used, for example in the folding bed disclosed in my co-pending application Serial No. 82,035, filed March 18, 1949, in which a spiral spring is employed, the spring is wound tighter and tighter as some part of the folding-and-unfolding cycle progresses. As a result, it becomes strongly "loaded" in a way which may have effects as undesirable as those of the gravitational forces. For example, in the case of the bed shown in my above-mentioned co-pending application, if in its fully unfolded condition the spiral springs are tightly enough wound to counterbalance the weight of the frames along with their half-mattresses, then if the mattresses should be removed, e. g., for cleaning, the bed will automatically fold up, probably quite unexpectedly, and possibly with harmful results.

It is an object of the present invention to provide a folding-bed mechanism employing one or

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more springs arranged to oppose undesired effects of certain gravitational forces occurring during a folding-and-unfolding cycle doing so with an effectiveness which varies as the magnitudes of those effects for different portions of the cycle.

It is a further object to provide such a mechanism which will be inherently stable, i. e., will tend to "lock" in either its folded or unfolded condition so that the action of its spring arrangement will be relatively independent of certain likely variations in weight such as that which would be occasioned by the removal of the mattress(es).

In general, these and other objects are attained by the use of one or more pre-loaded counter-springs which are arranged to oppose gravitational forces with an effectiveness which varies over the folding-and-unfolding cycle substantially as needed.

In the drawing:

Fig. 1 is a perspective view of an embodiment of this invention in a fully unfolded condition;

Fig. 2 is a cross-sectional view of the embodiment of Fig. 1, the view being taken in the plane 2-2 of Fig. 1;

Fig. 3 is a sectional view taken in a plane corresponding to that for the view of Fig. 2 but with the embodiment of Fig. 1 shown in a condition intermediate its fully unfolded and its fully folded conditions; and

Fig. 4 is another such sectional view but with the mechanism in a fully folded condition.

The bed mechanism 10 shown in Fig. 1 comprises upper and lower half-frames 11 and 12 which are joined together with hinges 13 as shown. Each of the half-frames 11 and 12 is made of four lengths of angle iron welded together to form a shallow rectangular recess into which a half length box spring mattress may be set (see Figs. 3 and 4). The half frames 11, 12 may be reinforced as shown by welding gussets 14 into their respective corners. A pair of legs 15 are welded to opposite outside surfaces of the foot-end of the bottom half frame 12, the juncture of each with the half-frame being reinforced as shown at 16. At the lower end of each of the legs 15 there is a wheel 17 which preferably is mounted on the outside surface of the leg. As a result of fastening the legs to the outside of the half frame 12 and of fastening wheels 17 to the outsides of the legs 15, there is sufficient space between the inside surfaces of the legs 15 to permit them to pass on opposite sides of the lower

half-frame 11 when the bed mechanism is in its folded condition. This is best shown in Fig. 4.

The head end of the bed is supported on a pair of hinges 18. Each of these hinges has a first arm 19 which serves as a leg for the head end of the bed when it is unfolded and a second arm 20 which is provided with a number of screw holes 21 for attaching the mechanism of the bed to a foundation surface 22 (Figs. 2-4). The foundation surface 22 may be the floor of a cupboard (represented generally by dotted block 23 in Figs. 3 and 4) into which the bed is to be stored when folded, or the bottom of a credenza with which the folding mechanism shown in Fig. 1 may be combined to afford the article of furniture described in my above-mentioned copending application. It should be noted that the mechanism shown in Fig. 1 will sometimes be an article of manufacture complete in itself as a builder's supply item, and that it does not necessarily have to be merely a component part built into an article of furniture. For this reason, in the preferred embodiment shown in Fig. 1, certain anchor points which are needed for the counterspring arrangements herein are located on the hinge arms 20 rather than on the foundation surface 22. Because of this, where the mechanism is to be a complete article in itself, it will be possible to provide it with its counterspring arrangement(s) fully preadjusted, i. e., with its (their) anchor points properly located and its (their) springs under proper tension, and installation will require no more than simply screwing the hinge arms 20 to the intended foundation surface.

The embodiment shown herein by way of illustration has two counterspring arrangements each of which comprises a flexible cable 24, e. g., a light stranded steel cable or a nylon cable having a steel core, which has one of its ends fastened to a hook eye 25 (a first "anchor point") which is welded to the top surface of the arm 20. Each of the cables 24 extends through two pulleys, 26 and 27 respectively to a second anchor point. There its other end is fastened to the cross member 28 of half frame 12 at one of several holes 35 which may be selected in accordance with the tension under which it is desired to place the cable.

Each of the pulleys 26 is hung from the under side of the cross member 28 as best shown in Figs. 2 and 3. Preferably, the distance between each of the pulleys 26 and the point on the cross member 28 from which it hangs is made variable to provide an adjustment which in practice has proven very effective for causing the folding mechanism 10 to operate in the intended manner which is to be described below. However, in certain embodiments this distance may be fixed. For example, where a particular embodiment is standardized for mass production so that certain parameters can be predetermined, e. g., the weights of its component parts, the locations of the anchor points, and the amount of spring tension, the distance between each of the pulleys 26 and the point on the cross member 28 from which it is hung can also be determined in advance and therefore it need not necessarily be adjustable. In embodiments for which this adjusting means is desired, each of the pulleys may be hung from the cross member 28 by any of numerous kinds of suitable suspensions of variable length. In the present example I show it hung on a short flexible cable the length of which may be made adjustable in any suitable manner. In each of the counterspring arrangements a coil spring 30 is

stretched between the hook eye 31 of its pulley 27 and a third anchor point 36. The third anchor points are located as shown in Fig. 1 near the back edge of the bottom cross member 32 of the half-frame 12. As is most apparent from Fig. 2, the tension of the springs 30 tends to draw the cross member 32 toward an imaginary axis extending between the two hook eyes 25. The effect of using the pulley 27 in each counterspring arrangement is to permit the use of a spring 30 of approximately half the physical range of elasticity and twice the tensile force of a spring which would be required without the use of a pulley. It causes a short stiff spring to act in the same way as a long compliant spring, and, since the spring is under twice as much tension as the cable 24, it reduces the free lash of the counterspring arrangement in a region where it can at least well be tolerated, i. e., in a region where it passes close to the bottom of the box spring.

A handle 33 is attached to each side of half-frame 12 near one of the hinges 13. When an upward force is exerted on one or both of the handles 33 in order to fold the mechanism 10, it will not be effective to raise the head end of the half-frame 11 inasmuch as this is fastened down by the hinges 18. Nor will be it effective to raise the foot end inasmuch as far less force is required to buckle the center of the mechanism in an upward direction along the line of the pins of the hinges 13 than to raise the dead weight offered by the lower portion of the half-frame 12, the legs 15, the wheels 17, etc. As a result, an upward force on one or both of the handles 33 will start to jack-knife the two bed halves 11 and 12 toward a position such as that shown in Fig. 3. This will greatly increase the effectiveness of the counterspring arrangements in opposing gravitational forces which tend to keep the mechanism 10 flat and open.

The contractile force which each of the two counterspring arrangements exerts between the first and third anchor points along a line which is broken due to the presence of the pulley 26, has a component which acts along a straight line between those points and which diminishes to a limiting value of zero as the angle between the jack-knifed bed halves, 11, 12, becomes smaller and finally reaches zero degrees. At the same time, the mechanical advantage of the two jack-knifed bed halves to translate a contractile force which is exerted in a straight line between the first and third anchor points into a force acting upwardly at the juncture of the two half-frames increases as said angle decreases. Thus the effectiveness of this mechanism to exert an upward force to oppose the free falling component of its own total weight is the resultant of two oppositely changing variables. I have found that the way in which these variables combine to produce this resultant is a function of the distance from the cross member 28 to each of the pulleys 26. By adjusting this properly, the overall effectiveness of the counterspring arrangement(s) in opposing undesired gravitational forces will vary to sufficiently but not excessively oppose the free falling weight at all points in the folding-and-unfolding cycle. When the mechanism is fully unfolded so that the angle between the half-frames is 180° only a very slight upward force will be exerted. This force is so slight that the weight of the frames with or without mattresses is sufficient to keep the mechanism open. However, the forces stored in the springs 30 have a very substantial effectiveness in an upward di-

rection as soon as jack-knifing is started. In fact, the counterspring arrangements can be so adjusted that once the folding operation is sufficiently started, it will continue by itself until the fully folded condition is reached as shown in Fig. 4. From the foregoing it is apparent that the contractile force acting directly along the straight line between each pair of first and third anchor points rapidly diminishes toward zero as the mechanism approaches its fully folded condition. Therefore toward the end of folding the counterspring arrangement(s) become quite ineffective in urging the half-frames to further jack-knifing. This averts needless banging together of the half-frames. At the same time, i. e., near the completion of folding, the counterspring arrangement(s) become more and more effective to pull together the two arms 19 and 20 of each of the hinges 18. Finally they become primarily effective to simply hold the upper half-frame in a vertical position at which point the lower half frame merely hangs from it by the hinges 13.

It is apparent that when one seeks to unfold this mechanism by pulling outward on the handles 33, he will be assisted by the availability of considerable leverage to pull apart the arms of the hinges against the action of the counterspring arrangement(s). Because of this it will be easy to pull the half-frames out from the recess 23. The considerable leverage (referred to) is available because the distance from each of the handles to the pin of the nearest hinge 18 is so much greater than the length of the vertical arm 19. As a result, it is relatively easy to start the process of unfolding even if the spring 30 have been so greatly loaded that the mechanism 10 will completely fold itself automatically once folding is merely started. Moreover, it will likewise be easy to complete the unfolding. In fact, a point will be reached toward the end of unfolding at which, of its own accord, it will drop the final part of the way to the fully open position where it will remain as though locked. It is possible to adjust the counterspring mechanism(s) so that they just overcome the gravitational forces without having enough reserve left to overcome the friction in the hinge pins and other working parts of the mechanism. As a result, when the mechanism 10 is in an intermediate position, it will stay there unless a slight amount of force is exerted manually to move it in either direction as desired.

It is apparent from the foregoing that during either folding or unfolding, the weight of the foot end of this mechanism is carried on the wheels 17 which roll along the foundation surface 22 inward toward the recess 23 or outward from it as the case may be.

The lower half-frame 12 is somewhat shorter than the upper half-frame 11, so that the wheels 17 are lifted away from the foundation surface 22 when the angle between the bed halves has become very small. Upon continuation of folding beyond that point, the lower half-frame simply hangs on the upper half-frame, from the hinges 13.

Provision is made for the eventuality that one may carelessly reach into the recess 23 and draw out the mechanism without use of the handles 33, for example, by pulling on the upper half-frame. If this is done, there is the possibility that without an enlargement of the angle between the half-frames, the two of them as a still tightly-jack-knifed unit may begin to swing outward on the axis of the pins of hinges 18 to a

point where the foot end of the lower half-frame (or a box-spring mattress carried in it) will bind on the foundation surface. To avoid this, a pair of rollers 34 are carried on the outside surface of the cross-member 32. At the point mentioned immediately above, they will bear slideably upon the foundation surface to prevent binding or reduce the likelihood thereof.

If desired, each counterspring arrangement may utilize another pulley which is hung from the head-end cross-member of the top half-frame to reduce the spacing between the cable 24 and the bottom of this cross member. This will lessen the likelihood of the cable 24 being seen from the side of the bed. Each such additional pulley may consist of a small wheel (not shown) carried on a short shaft mounted across the upper end of the slot 37 (see Fig. 1) which is provided in a respective one of the hinge arms 19 to avoid blocking the path for the cable 24 between the pulley 26 and the hook eye 25. If such wheels are respectively mounted in the arms 19, their slots 37 will not need to extend as far toward their hinge pins as do the slots 37 shown in Fig. 1.

While in the illustrative embodiment shown herein provision is made for adjusting the tension of each of the counterspring arrangements through the use of a plurality of holes any one of which may be selected to serve as its second anchor point, it is obvious that one may use any of a variety of other suitable means. For example, a turn-buckle may be inserted in series in each of the counterspring arrangements, e. g., between the foot end of its spring 30 and its third anchor point 36.

What is claimed is:

1. A folding bed mechanism suitable for use on a relatively flat foundation surface comprising: upper and lower half-frames each having two side members and a top and bottom cross member joined to define a plane corresponding to the underside of a half mattress; hinging means articulately connecting the top cross member of the lower half frame to the bottom cross member of the upper half frame so that in folding and unfolding said mechanism the half frames may be moved relatively to each other between two limiting positions in one of which said planes are mutual extensions of each other and in the other of which they are closely adjacent and parallel; means for articulately anchoring the top end of the upper half frame with respect to a predetermined part of said foundation surface so that said plane defined by the sides of this half frame may be moved about an axis parallel to its top cross member between a position parallel to the foundation surface when the mechanism is unfolded and one substantially perpendicular to said surface when the mechanism is folded; means affording at least one anchor point near to said predetermined part of the foundation surface; one leg attached at its top end to each of the side members of the lower half-frame near to its bottom cross member; one wheel carried on the other end of each leg; at least one counterspring-arrangement means for exerting a variable contractile force directly between said anchor point and a part of said lower half-frame near its bottom cross member to variably urge the two half-frames toward the limiting position in which they are closely adjacent to each other, the last-mentioned means including a spring coupled between said anchor point and said part of the lower half-frame and suitable for pre-loading

under tension, a cable coupled to an end of the spring for coupling said end to said anchor point, for attaching one end of said cable being attached to said anchor point, said anchor point being located near to a portion of said surface which is more closely adjacent to the top cross member of said upper half-frame when the mechanism is unfolded than to any of the other cross members, and a pulley-like cable-carrying means hung from one of the articulately-connected cross members and carrying said cable strung through it; whereby in all positions of the mechanism intermediate said two limiting positions the force along the cable is exerted along a broken line which has an apex at said pulley-like means and said contractile force as directly exerted in a substantially straight line between said anchor point and said last-mentioned part of the lower half-frame varies in magnitude as the upper and lower half-frames are moved between their two limiting positions.

2. A folding bed mechanism as in claim 1 in which said means for articulately anchoring the top end of the upper half-frame comprises a hinge having two arms each having one of its ends articulately joined to a corresponding end of the other at a hinge pin, one of said arms being attached at its other end to the top end of the upper half frame to serve as a leg therefor when the mechanism is unfolded, and the other of said arms being provided with means by which it may be attached to said foundation surface.

3. A folding bed mechanism as in claim 2 in which said means affording at least one anchor point is integral with said last-mentioned arm of said hinge.

4. A folding bed mechanism as in claim 3 in which the path of said cable between said cable-carrying means and said anchor point extends in such a direction with respect to the path to be followed by the first-mentioned hinge arm with respect to the second in the folding of the mechanism that said means for exerting a contractile

force is effective to hold the hinge shut when the mechanism is folded and the half-frames have their second-mentioned limiting positions.

5. A folding bed mechanism as in claim 1 in which the lower half-frame is of such length that when it is suspended by its top cross member from the upper half-frame in the fully folded condition of the mechanism its lower cross member is raised a substantial distance away from a plane corresponding to that of said foundation surface.

6. A folding bed mechanism as in claim 1 which further comprises at least one roller carried on the bottom surface of the bottom cross member of the lower half-frame.

7. A folding bed mechanism as in claim 1 in which said means for exerting a contractile force includes a means for adjusting the loading of said spring.

8. A folding bed mechanism as in claim 1 in which said means for exerting a variable contractile force includes a means which is adjustable in length by which said pulley-like means is hung from said one of the articulately-connected cross members at an adjustable distance therefrom.

9. A folding bed mechanism as in claim 1 in which each of said means for exerting a contractile force includes a pulley arrangement for effectively dividing by a predetermined constant the contractile force exerted by said spring along said broken line while at the same time multiplying by the same constant its contractible range as usefully exerted along said line.

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