Sofa Bed Folding Mechanism

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This invention relates to household furniture and more particularly to a combination sofa and folding bed structure.

Combination sofa and folding bed structures as presently constructed have many undesirable characteristics, particularly an important drawback being that several structural features usually included in the ordinary sofa must be omitted to permit folding and unfolding of the bed frame into and out of the sofa frame. The omission of these structural features, a very important one being the omission of a transverse member at the front of the end members or arm rests of the sofa, reduces the strength and rigidity of the sofa frame. In many present sofa bed combinations it is also necessary to omit any customary springing and padding in the upright back portion of the sofa frame to obtain the space necessary to accommodate the folded bed frame. This omission greatly reduces the comfort of the upright back when the combination is being used as a seat.

The folding mechanisms for the bed frames in known sofa bed combinations are also subject to the fault that they require the casted legs supporting the bed frame in extended position to roll along the surface on which the sofa bed rests whenever the bed frame is being extended or retracted. If this surface is a carpeted floor which is usually the case, the casters will, in a short time cause unsightly wearing of the carpet; if the surface is merely a wooden floor, the casters will badly scar the surface thereof.

Another major fault in present folding mechanisms is that the nature of their folding actions and the space required for the bed frame within the sofa are such that the seat portion does not slope down to the back of the sofa for greatest seating comfort, but rather inclines forwardly.

I have invented a sofa bed and a folding mechanism which overcomes these faults in a very satisfactory manner. My new sofa bed includes a sofa frame having an upright back and end members and an upright structural member fixed between the end members of the frame. The sofa frame is a unit having four sections pivotally connected together end to end in the order named. The first of these sections is a seat section, a back section, a return section and a leg section. Each section is pivotally connected to the return section, and, in turn, has a foot section pivotally connected thereto. These four sections are constructed to provide a suitable continuous support for a mattress.

The back and foot sections are each provided with a pair of casted legs to support the bed frame when in the extended bed position. All of the sections are joined by trains of pivotally connected links and levers constructed and arranged to lift the pairs of legs on the back and foot sections directly off the floor at the commencement of the retracting and folding action and thereupon to guide the return, back and foot sections of the bed frame over the upright transverse structural member between the end members and into a folded position within the sofa frame. In the course of this folding action, the legs are folded parallel to the sections to which they are attached and the seat is completely inverted.

A feature of the folding mechanism according to my invention is the lifting of the legs occurring simultaneously with the retracting action. By this means the supporting legs are taken out of contact with the floor before they have moved along it, thereby precluding any possibility of wear of the floor covering.

The folding action of the mechanism then progresses so that the extended sections of the bed frame are carried high enough in the vicinity of the front transverse structural member of the sofa frame so that every part of the bed frame passes over the structural member. The entire frame is self-supporting throughout the course of the folding action. This is in contrast to mechanisms of the prior art which require support from the casted legs until the folding action is nearly completed, thereby precluding the inclusion of the very necessary transverse structural member at the front of the sofa frame. Without this structural member, the sofa frame lacks the rigidity and strength which is present in a sofa bed according to my invention.

A further feature of my new folding mechanism is that the bed frame thereof comprises four folding sections rather than the usual two or three as in the present art. Furthermore, these four sections are all pivotally connected together which permits continuous support of the spring and mattress in the bed frame and the entire length of the mattress may be firmly anchored to the frame sections at all times during folding and unfolding of the frame.

My new four-section bed frame also permits individual sections of shorter span lengthwise of the bed and, consequently, more compact folding. A particularly desirable feature which stems from this is that the folded bed frame does not extend far up into the upright back structure of the sofa, but is almost entirely contained within the base of the sofa frame. This permits the inclusion of conventional springing and padding in the upright back structure and does not require recourse to impractical expedients often found in prior art sofa beds, where the upright back must be hollow to accommodate the folded bed frame.

Another advantage stemming from the four-section bed frame is that the mattress may be more compactly folded within the base of the sofa frame. Furthermore, the proportions of the four sections are easily made so that, in the sofa position, the seat section of the bed frame slopes downwardly toward the upright back structure of the sofa frame rather than downwardly toward the front of the sofa frame. This obviously affords much greater comfort for persons sitting on the sofa.

The bed frame sections and the links and levers of the folding mechanism are all pivotally connected in such a manner that no section, link or lever is free to rotate or translate independently of any other section, link or lever in the entire mechanism. To achieve this desirable result I utilize the principle of determinant motion in the construction and arrangement of the links and levers which constitute the linkages of my new folding mechanism. This feature of my invention has the particularly desirable consequence that the folded frame may be simply and easily folded and unfolded by one person standing at the foot of the bed frame.

For a detailed description of a preferred embodiment of the sofa bed and folding mechanism according to
my invention, attention is directed to the following de-
scription and the accompanying drawings in which
Fig. 1 is a partial plan view of an extended sofa bed;
Fig. 1a is a partial cross-section of the sofa bed of
Fig. 1;
Fig. 2 is a side elevation of the sofa bed of Fig. 1;
Fig. 3 is a side elevation of the sofa bed of Fig. 1 in
partially retracted position;
Fig. 4 is a side elevation of the sofa bed of Fig. 1 in
a fully retracted position.
The sofa bed and folding mechanism of my invention
is only partially illustrated in Fig. 1, namely the right
side as viewed from the foot of the bed frame, and the
description will be given in terms of this partial illus-
tration. However, it is to be understood that the left
portion of the mechanism which is not included in Fig.
1 is identical in every respect with that portion of the
mechanism shown there and is merely a duplicate thereof.
Referring now to Figs. 1 and 2 the sofa bed com-
prises a sofa frame having upright end members 1, an
upright back structure 2 and a front transverse struc-
tural member 3 fixed between the end members 1. The
folding bed frame comprises a seat section 4 having
transverse structural connections 6 fixed to L-section side rails 5 which are in turn bolted to L-section side rails 7 as illustrated in Fig. 1a.
The rail 7 is provided with pivot plates 8 and 10 riveted to the rail and depending therefrom when the bed
frame is in the extended bed position shown in Fig. 1.
These pivot plates 8 and 10 have pivot points 15 and
18, respectively, at which the seat section 4 is invertibly
mounted on a quadrilateral linkage between the end mem-
bers 1. One side of this linkage is a fixed link 11 se-
cured to the end member 1 of the sofa frame by screws
or bolts 12. An L-shaped link 14 is pivotally mounted
at its opposite ends at point 13 on link 11 and point 15
on plate 8. The third component of the linkage is a
link 16 which is pivotally mounted at its opposite ends
at point 17 on link 11 and on plate 10. The fourth compo-
nent is the side rail 7 pivoted to link 16 at 18 and
to L-link 14 at 15.
The bed frame further comprises a return section rail
26 pivotally connected to the seat section at pivot point
24 on a pivot plate 23 fixed to rail 5. This return
section has a transverse structural rail 27 supported be-
neath the section on posts 28. Pivoted to the return
section rail at point 31 is a back section rail 30 which is
in turn, pivoted at point 32 to a foot section rail 33. At
the intermediate portion of the foot section there is a
transverse foot rail 34. All of the rails of the bed
frame described up to this point are preferably con-
structed of L-section steel shapes.
The foot section is provided with legs 35 having wheels or casters 36. The supporting legs 35 at
each side of the bed frame are separated by a trans-
verse structural member 37 and are pivotally connected
to the foot section side rails 38. Another pair of supports
legs 39 is provided at the hinge connections
31 between the return section side rails 26 and the back
section side rails 30. The legs 39 of this pair are
similarly provided with casters 40 and are braced against
lateral movement by transverse structural member 41.
The bed frame retracting and folding mechanism ac-
cording to my invention comprises trains of links and
levers embodying the principle of determinant motion
and which are pivotally connected among themselves and
to the sections of the bed frame and the trilateral sup-
portage for the seat section.
A multiple pivot bracket 20 having pivot points
21 and 22 is adjustably secured to the L-link 14 and extends
beyond the point 15 at which bracket 14 is pivoted to
the plate 8. A first actuating link 42 is connected be-
 tween the pivot point 21 on bracket 20 and a pivot
point 43 on an angle extension plate 25 of return section
rail 26. This link 42 serves to rotate the return section
rail 26 about the pivot point 24 as the folding motion of
the mechanism progresses.
A second actuating link 44 is pivoted to bracket
20 at the pivot point 22 and is utilized to operate the train
of levers and links which retract and fold the back
and foot sections of the bed frame. The end of the link 44
opposite pivot point 22 is connected to an intermediate
point 46 of a secondary lever 45, which lever is pivoted
at one end at an intermediate point of, on the return
section rail 26. At the other end of lever 45 there is a
pivot point 48 to which there is connected one end of
a primary lever 52 whose fulcrum is the pivot point
51 on plate 50, the latter being secured to the back section
rail 50 at an intermediate point between pivot points 31
and 32. Lever 52 is in turn pivotally connected at point
57 to a bellcrank 53. This bellcrank comprises the
lever 54 riveted to plate 55 and the fulcrum on which
it is pivotally mounted is secured, at 58 on plate 56,
to the foot section rail 33.
To retract the leg 35 I provide a link 61 pivotally
connecting points 63 on bellcrank plate 55 and point
62 on pivot plate 60 fixed to the leg 35. The pair of legs 39 is retracted by a link 64 connecting
a pivot point 66 located between the fulcrum point 51
and the pivot point 48 on lever 52. The other end of
link 64 is connected at point 65 on the leg 39. As
previously stated the characteristic feature of my novel
mechanism is the provision of determinant motion for
each of the bed frame sections and the supporting legs
through the unique construction and arrangement of the
several links and levers. The kinematic relation of the parts
of my mechanism may be analyzed into systems ofour-element linkages and connecting linkages. The
invertible quadrilateral linkage by which the seat section
is suspended between the end members of the sofa frame,
as previously described, is a first four-element linkage of
a first determinant system of linkages. The link 11
fixed to the end member 1 constitutes one element of
this linkage and its opposite element is the seat section
side rail 7. For the purposes of this analysis and the
claims side rails 5 and 7 will be considered as an integral
element inasmuch as they are bolted together and their
motions are the same.
A second four-element linkage in the first system
comprises the integral side rail 7 and plate 23 pivoted
at point 24 to plate 25, integral with return section rail
26. This second linkage also includes the first actuating
link 42 pivotally secured to plate 8 at point 32 and to
point 21 on bracket 20 at the other end, the bracket
being integral with L-link 14 and pivoted to pivot plate
8 as previously explained. It is noted that the linkage
elements constituted by the side rail 7 and the integral
link 14 and bracket 20 are common to the two four-
element linkages comprising the first system.
This first system of linkages provides determinant
motion for the return section with respect to the seat
section. It will be seen that the return section can rotate
and translate in only one predetermined manner as the
seat section is inverted in the course of the retraction
or extension of the bed frame.
A second system of linkages comprises third and fourth
four-element linkages. The third four-element linkage
includes the following elements: the back and return
section side rails 30 and 26 respectively pivoted to-
gether at 31, the secondary lever 45 pivoted to rail 26
at 47 and the lever 52 pivoted to lever 45 at 48 and
to back section 30 at 51. The fourth linkage is made
up of foot section side rails 30 and 33, the lever 52 pivoted to plate 50, integral
with rail 30, at 51 and the lever 54 pivotally connected
between lever 52 at 57 and to plate 56, integral with
rail 33, at 58. These third and fourth linkages have the
lever 52 and the side rail 30 as common adjacent
elements.
The two systems of linkages described thus far while providing determinant motion within themselves, are independent. A tying linkage is utilized to coordinate the motion of the first system with that of the second system to provide completely determinant motion for all the linkages of both systems with respect to each other. This tying linkage has three elements in common with the second linkage and two elements common to the third linkage. Common to the first linkage are side rail 26 pivoted to link 42 which is in turn pivoted to bracket 20 at 21. Common to the third linkage are the return section rail 26 and the lever 45 pivoted together at 47. The linkage is completed by the link 44 pivoted to the lever 45 at 46 and to bracket 20 at 22. The aspect of this linkage which makes it determinant is that the pivot points 24 and 15 are fixed with respect to each other by means of the plates 8 and 23 being rigidly fixed to the bed frame.

It can be seen from the analysis this far that the motion of all sections of the bed frame is now completely determined and is confined to a unique path for each of them. Moreover, the return, back and foot sections are suspended from the seat section in cantilever fashion throughout the course of the extending or retracting motion of the bed frame. The operator need not provide any support for the framework only supply the impetus to actuate the mechanism.

The retraction and extension of the leg 35 is coordinated with that of the frame by a fifth four-element linkage, the elements of which are the leg 35 pivoted to the side rail 33 at 38, plate 55, integral with lever 54, at 56, and link 61 pivotally connected between points 62 and 63. This linkage has side rail 33 and lever 54 as common adjacent elements to the fourth four-element linkage and the motion of leg 35 is therefore made determinant with respect to the foot section side rail 33.

The motion of leg 39 is coordinated with the motion of the bed frame by means of link 64 pivotally connected between link 52 at 66 and leg 39 at 65. The foregoing comprises three elements of a four-element linkage, the fourth element being the back section side rail 30 pivoted to the leg 39 at 31 and to the link 52 at 51. This linkage has the side rail 30 and the link 52 as adjacent elements common to the third four-element linkage. The motion of the leg 39 is therefore determined with respect to the side rail 30.

This completes the description of the elements of my sofa bed folding mechanism and their relation to each other. The operation of the mechanism and its progression is clearly illustrated in Figs. 2, 3 and 4. Beginning with the mechanism in the extended position shown in Fig. 2 the retracting and folding action is initiated merely by pushing the rail 34 toward the sofa structure which starts the inversion of the seat section 4. The interdependence of the links and levers and the sections of the bed frame immediately cause the legs 35 to be lifted from the surface on which they rest as the foot section 33 is caused to rotate upwardly about point 32. Simultaneously with the lifting action the bellcrank 53 and the link 54 cooperate to rotate the leg 35 about point 38 to fold the leg toward the foot section 33 in the direction of the bellcrank 53. A like lifting action of the leg 39 is derived from an initial rapid rotation of the leg about the point 31, which rotation is effected by the lever 52 rotating counterclockwise about point 51 and pulling link 64 upward. In both instances the legs 35 and 39 are lifted clear of the floor before the respective casters 36 and 40 are rolled along the floor.

As previously pointed out, simultaneously with the lifting of the legs from the floor, the seat section 4 begins an inverting motion which progresses from the position illustrated in Fig. 2 through the position shown in Fig. 3 and continues to the fully inverted position illustrated in Fig. 4 at which time its height above the floor has been appreciably reduced and the headboard 6 rests securely on the transverse structural member 3. In the course of this inverting motion of the seat section, the return, back and foot sections have been folded and retracted into the structural frame of the sofa through a path which carries them over the structural member 3. In the fully folded condition the back section 3 assumes a substantially upright position in the rear of the sofa frame. The return section joins the uppermost end of the back section and the rearmost end of the seat section slopes downwardly to permit a rearward and downward slope of the seat section. The foot section 33, after passing over the transverse structural member 3, has lowered into a position at the bottom of the frame of the sofa. Throughout this motion the elements of the mechanism are rotating and translating with respect to each other, yet they provide a continuous support for the extended portions of the bed frame without additional support from the legs which are, meanwhile, being retracted into positions parallel with the bed frame rails. Fig. 3 shows the position of each element of the mechanism at intermediate points in the course of progress from the fully extended position to the completely folded position shown in Fig. 4.

It will be seen that a mattress carried by the bed frame is not caused to undergo any undue distortion at any time during the course of the folding mechanism. On the contrary it has merely been doubled over on itself while at all times being firmly secured to the bed frame and at no point in the course of the folding action of the mechanism is it necessary to provide for separation of the mattress from the bed frame.

This, it is seen that I have invented a novel and useful sofa bed folding mechanism having features which overcome many of the objectionable characteristics of similar mechanisms prior to my invention. I am aware that many of the elements included in the preferred embodiment of my invention may be modified by one skilled in the art. Therefore, I do not intend that my invention be limited by the specific construction described and illustrated, but only by the scope of the subjoined claims.

I claim:

1. A sofa and foldable bed comprising a structural frame having an upright back and end members, a sectional seat and bed frame including pivotally connected seat, return, back and foot sections, a first quadrilateral linkage including a member of said seat section as an element thereof for invertibly mounting said seat section in said structural frame between said end members, a second quadrilateral linkage including members of said seat and return sections as elements thereof for rotating said return section with respect to said seat section as the latter is inverted, a primary lever and a secondary lever forming a third quadrilateral linkage including members of said return and back sections as elements thereof, a first linking between said first linkage and said secondary lever for rotating said back section with respect to said return section as said seat section is inverted, and a lever link connecting a pivot pin with a member of said foot section to form a fourth quadrilateral linkage for rotating said foot section with respect to said back section as said seat section is inverted, whereby said return, back and foot sections are supported entirely from said seat section during folding and unfolding of said bed frame.

2. A sofa and foldable bed comprising a structural frame having an upright back and end members, a sectional seat and bed frame including pivotally connected seat, return, back and foot sections, a first quadrilateral linkage including a member of said seat section as an element thereof for invertibly mounting said seat section in said structural frame between said end members, a second quadrilateral linkage including members of said seat and return sections as elements thereof for rotating
2,876,461

said return section with respect to said seat section as the latter is inverted, a primary lever and a secondary lever forming a third quadrilateral linkage including members of said return and back sections as elements thereof, a first supporting leg pivotally connected to said first linkage and said secondary lever for rotating said back section with respect to said return section as said seat section is inverted, a first supporting leg pivotally connected to said first leg and said secondary lever, a second leg retracting link connected to said second leg, a bell crank pivot at its fulcrum to said foot section and connected at one end to said primary lever, a second leg retracting link connected between the other end of said bell crank and said second leg, whereby said legs are retracted at the commencement of the folding action of said seat frame and thereafter said return, back and foot sections are supported from said seat section independently of said legs throughout the course of the folding action.

3. A convertible sofa bed comprising a sofa frame, a seat section, a return section, a back section, and a foot section, said frame and said seat section forming opposite links of a first invertible four-element linkage, a second four-element linkage connecting said seat section and said return section, of which linkage said seat section and return section comprise adjacent links, said invertible linkage and said second linkage having two adjacent links in common, a third four-element linkage connecting said return section and said back section, of which said return and back sections comprise adjacent links, said return section comprising the only link common to said second and third linkages, a fourth four-element linkage connecting said back section and said foot section, in which said back and foot sections comprise adjacent links, said third and fourth linkages having two adjacent links in common, and a connecting link extending from one link of said invertible linkage to a link of said third linkage, and providing in combination with said last-mentioned links and said second linkage a tying linkage connecting the system comprised of said invertible and second linkages with the system comprised of said third and fourth linkages whereby the motion of all links in the first-mentioned system will be controlled by the motion of all links in the second-mentioned system, and vice versa.

4. A convertible sofa bed according to claim 3 and having a supporting leg pivotally connected to said foot section and a fifth four-element linkage having said leg and said foot section as adjacent elements and said foot section and another element common to said fourth linkage.

5. A convertible sofa bed according to claim 3 and having a supporting leg pivotally connected to said back section and a sixth four-element linkage having said leg and said back section as adjacent elements and having said back section and another element common to said third linkage.

6. A convertible sofa bed according to claim 3 and having a supporting leg pivotally connected to said back section and a connecting link pivotally connected at its opposite ends to said leg and to an element of said third four-element linkage adjacent said back section.

7. A convertible sofa bed comprising a sofa frame, a bed frame having a seat section, a return section and a back section pivotally connected together in the order named, a first invertible four-element linkage having said sofa frame and said seat section as opposite elements thereof, a second four-element linkage connecting said seat section to said return section and having two adjacent elements in common, a third four-element linkage connecting said return section to said back section, said return section being the only element common to said second and third linkages and a tying link extending from one link of said first invertible linkage to a link of said third linkage and providing in combination with said last-mentioned links and said second linkage a tying linkage connecting the system comprised of said first and second linkages with the system comprised of said third linkage and second linkage whereby the motion of all links in the system of linkages will be controlled by the motion of all links in said third linkage and vice versa.

8. A convertible sofa bed according to claim 7 and having a supporting leg pivotally connected to said back section and a seventh four-element linkage having said leg and said back section as adjacent elements and having said return section to another element common to said third linkage.

9. A convertible sofa bed according to claim 7 and having a supporting leg pivotally connected to said back section and a connecting link pivotally connected at its opposite ends to said leg and to an element of said third four-element linkage adjacent said back section.

10. A convertible sofa bed comprising a sofa frame having oppositely disposed end members, and a bed frame having a seat section, a return section, a back section and a foot section pivotally connected together in the order named, each of said sections having a pair of side rails, one of said end members and one of said seat section side rails forming opposite elements of a first invertible four-element linkage, a second four-element linkage having two adjacent elements common to said first linkage, a second-four-element linkage having one of said return section rails and one of said back section rails as adjacent elements, a fourth-four-element linkage having one of said back section side rails and one of said foot section side rails as adjacent elements, said third and fourth linkages having two adjacent elements in common, and a determining tying linkage connecting said first and second linkages and including elements common to said second linkage.

11. A sofa and foldable bed comprising a structural frame adapted to support the structure on a floor and having an upright hollow back member and end members, a sectional seat and bed frame having pivotally connected seat, return, back, and foot sections, said back and foot sections each having a retractable supporting leg, means for mounting said seat section to invertibly swing between said end members and at least one train of pivotally connected links and levers constructed and arranged with said legs and sections to form mutually determine linkages for connecting each of said sections to every other section and for connecting each of their respective sections, said linkages being adapted to guide said sections between an extended bed position, in which the legs also rest on a floor, and a folded sofa position, every one of said sections, legs, links, and levers being constrained to rotate and translate through predetermined paths with respect to every other section, leg, link, and lever upon the movement of any one of said sections, legs, links, and levers, and the rotation and translation imparted to said legs carrying the lower ends thereof through paths which are everywhere higher than the lower ends of the legs when the frame is in extended bed position.

12. A convertible sofa bed comprising a structural frame having an upright back and a pair of end members, an extensible and retractable bed frame having at least two transverse sections, one of said sections being invertibly suspended between said end members by a quadrilateral linkage at each end of said one section, each of said quadrilateral linkages having an end member and one end of said one section as opposite elements, a quadrilateral linkage for suspending another of said sections from said one section and in which said sections constitute adjacent elements and in which said other section and an element other than said end member or said one section of said invertible suspending linkage con-
stitute opposite elements, whereby determinate motion
is provided for said other section with respect to said
end member.

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