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Toyota

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[45] **Dec. 18, 1973**

[54] **ANGLE VARIABLE JOINT FOR FOLDABLE CHAIR**

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[73] Assignee: **Sanshin Kinzoku Industries Co., Ltd.,** Tokyo, Japan

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[52] **U.S. Cl.** **403/93**

[51] **Int. Cl.** **F16c 11/00**

[58] **Field of Search** 287/14, 99; 297/366, 297/356, 367; 5/111

[56] **References Cited**

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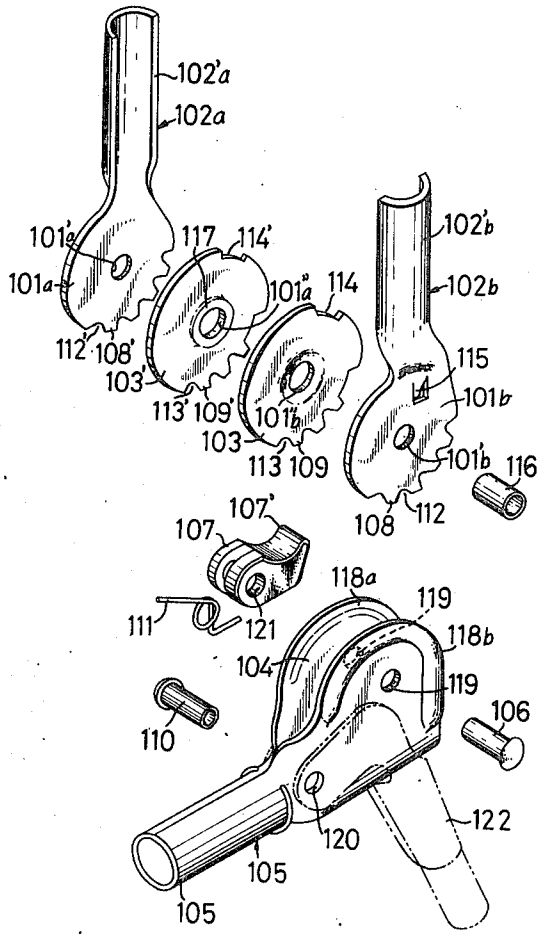
Primary Examiner—Andrew V. Kundrat

Attorney—James E. Armstrong et al.

[57] **ABSTRACT**

A joint comprising a movable rod to be attached to a back-rest frame member and having at its lower end a pair of flat discs spaced apart in facing relation to each other and including outer peripheral gear portions respectively, free cam discs of approximately the same size as the flat discs disposed in the space between the flat discs and including outer peripheral gear portions having a pitch equal to that of the gear portions, a pin member for pivotably supporting the flat discs and cam discs at the junction of a stationary support member to be attached to a seat frame member, and a latch member accommodated in the stationary support member and having a support pawl urged into resilient contact with the outer peripheries of the flat discs and cam discs, the movable rod being thus supported by and connected to the stationary support member in a forward and backward inclinable manner at progressively decreasing and increasing variable angles for changing the angle of inclination. The joint is applied to a resting sofa, deck chair or camping bed for connecting two frame members at their junction in a foldable or collapsable manner.

2 Claims, 19 Drawing Figures



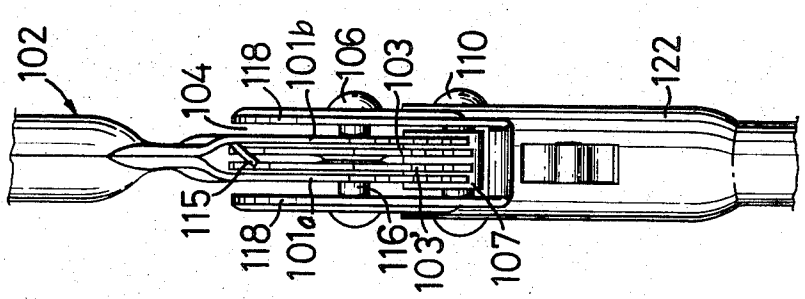


Fig 4

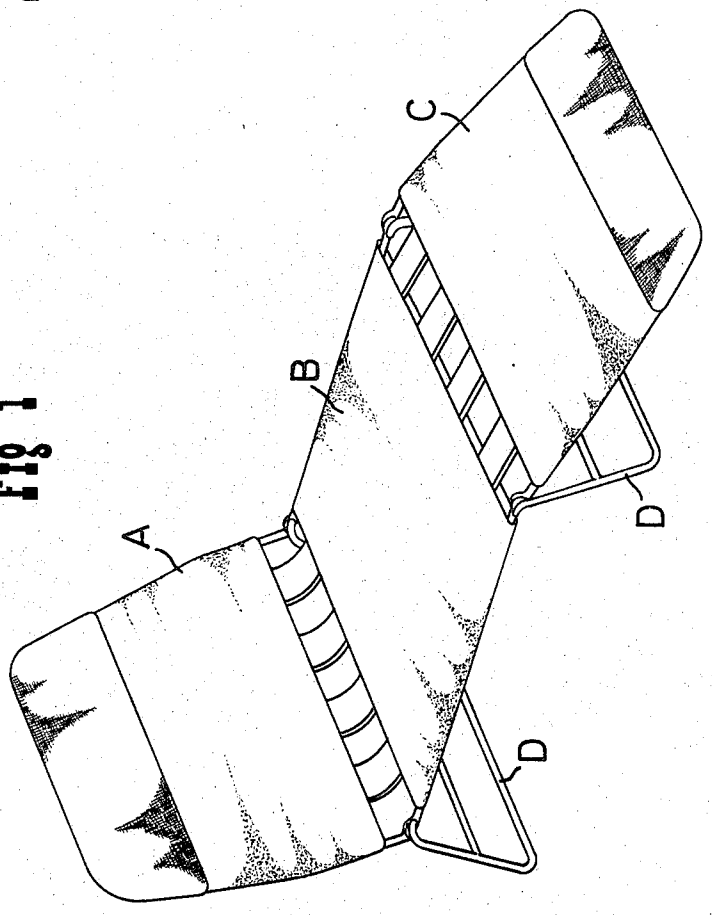


Fig 1

Fig 2

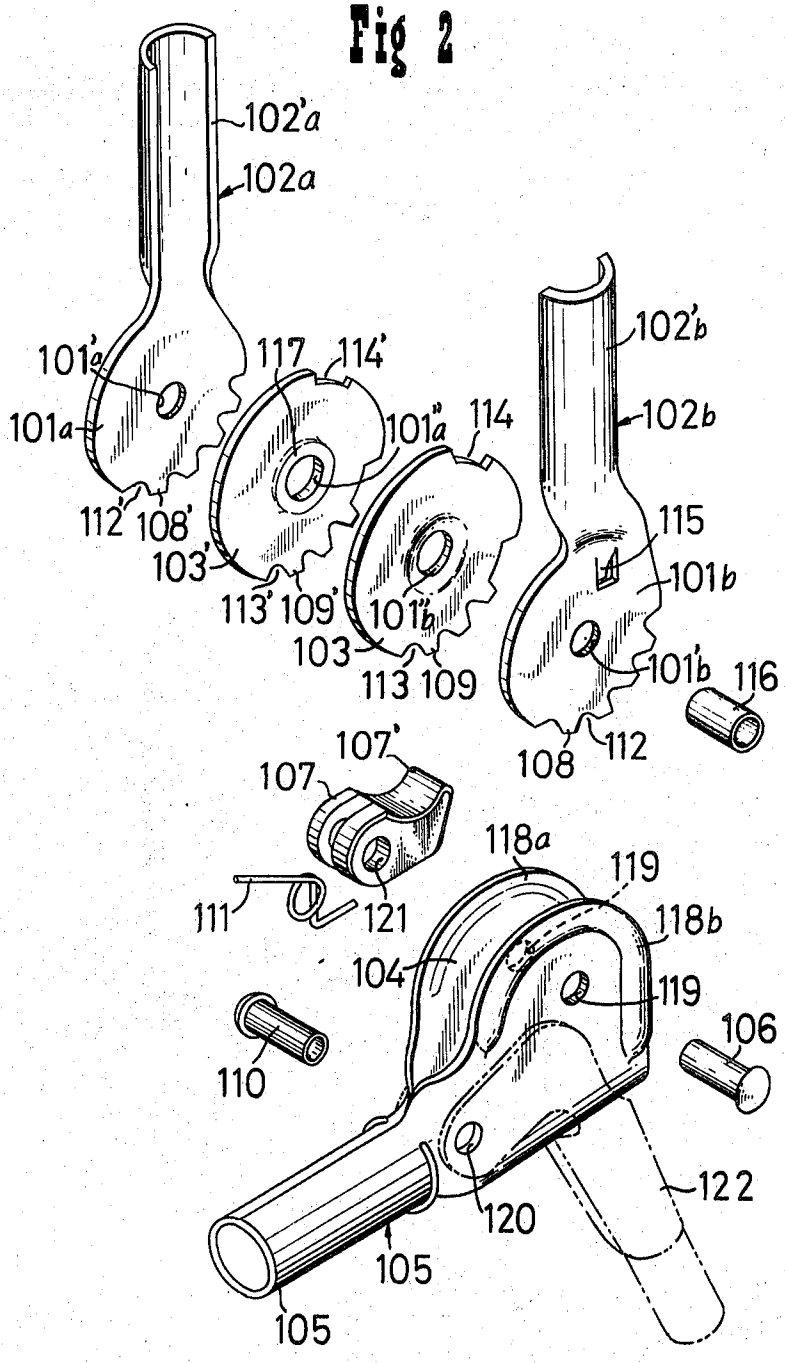

102'a
102a
101'a
117
114'
101a
101"a
114
102'b
102b
112'
108'
103'
113'
109'
101"b
115
101b
103
113
109
101'b
116
108
112
107'
107
118a
119
111
121
118b
104
119
106
110
122
120
105
105

Fig 3

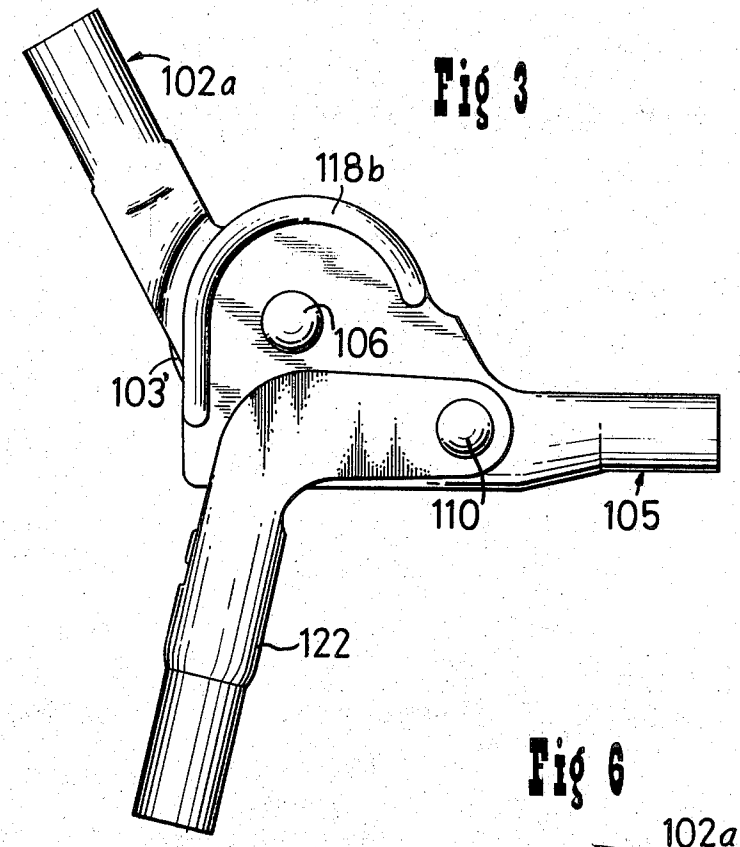


Fig 5

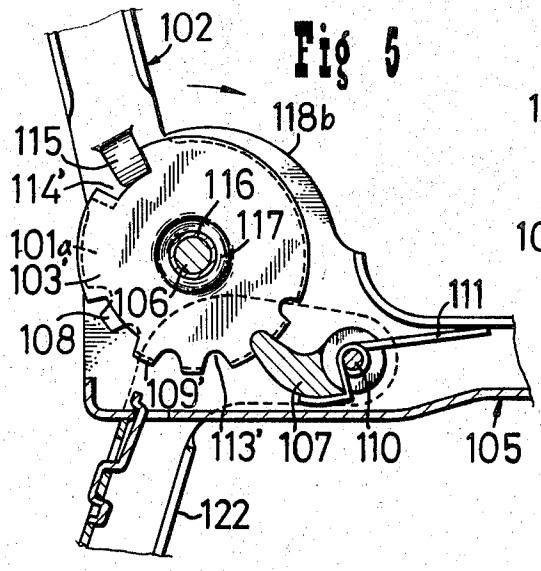


Fig 6

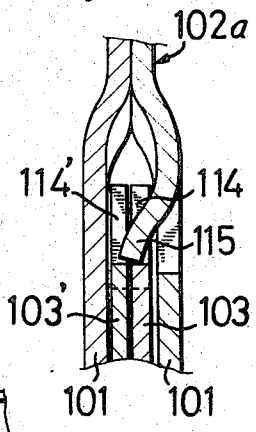


Fig 7

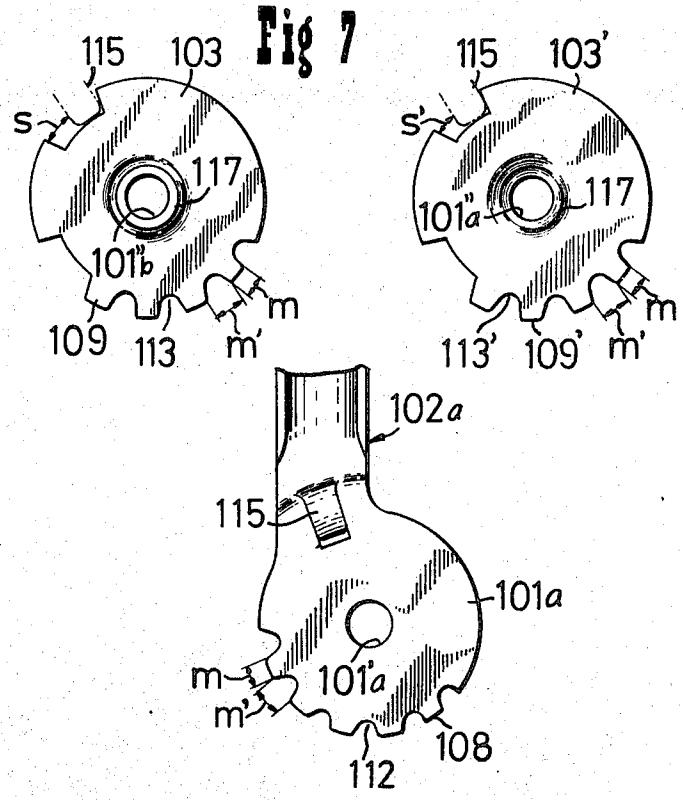

115
103
S
117
101"b
109
113
m'
m
115
103'
S'
101"a
117
113'
109'
m'
m
102a
115
101a
m
m'
101'a
112
108

Fig 8

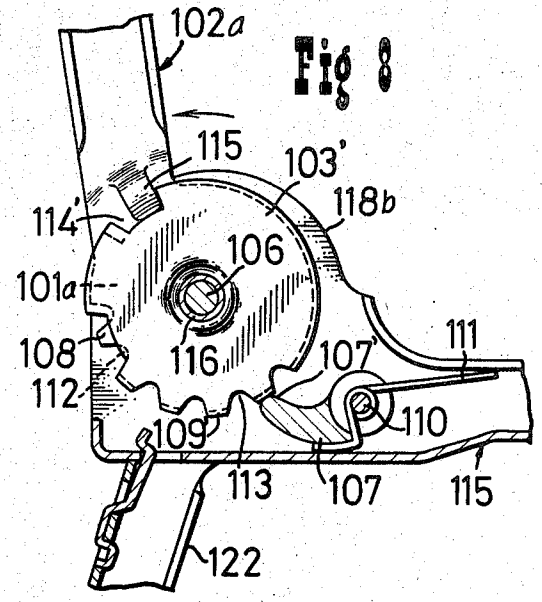

102a
115
103'
118b
114'
106
101a
108
116
107
111
112
109
110
113
107
115
122

Fig 9

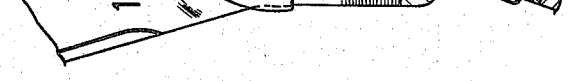


Fig 10

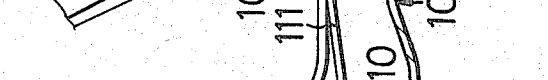


Fig 11



Fig 12

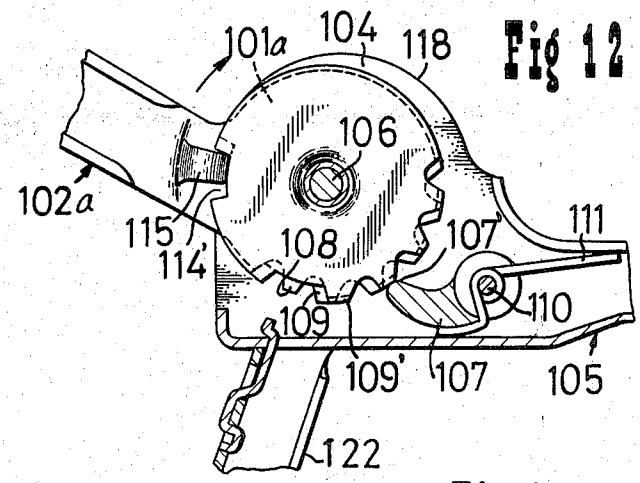


Fig 13

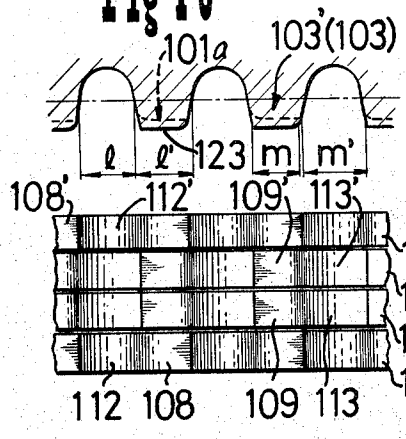


Fig 14

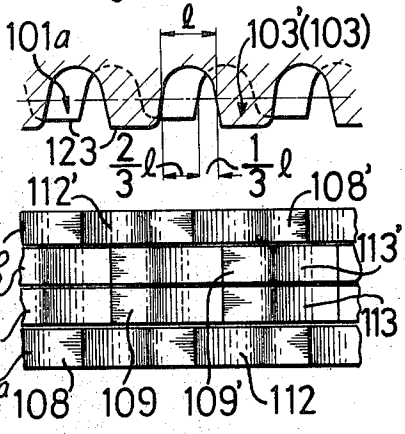


Fig 15

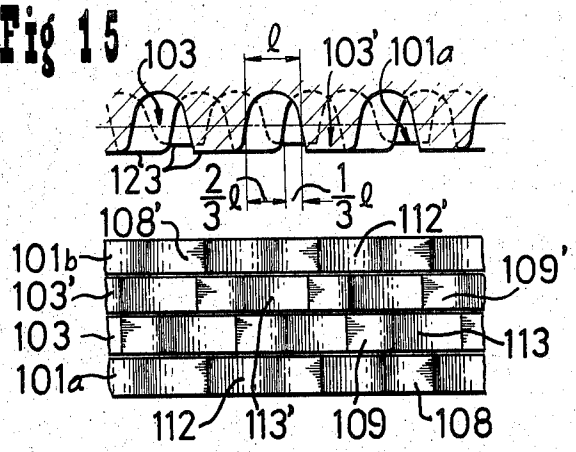


Fig 16

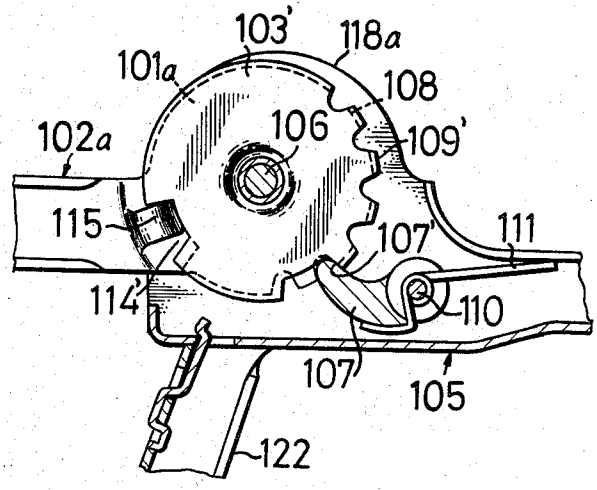
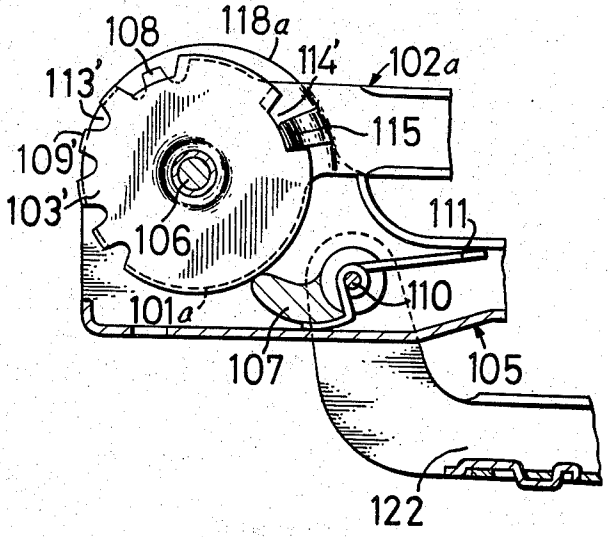

103'
118a
101a
108
106
102a
109'
115
107'
111
114'
110
107'
105
122

Fig 17


108
118a
114'
102a
113'
115
109'
111
103'
106
110
101a'
107
105
122

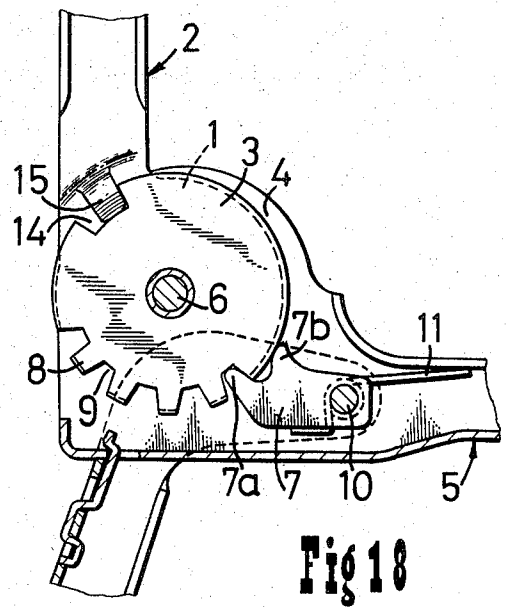


Fig 18
PRIOR ART

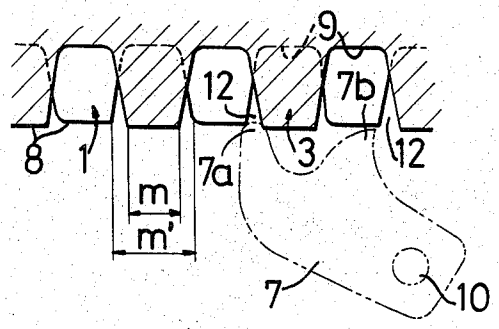
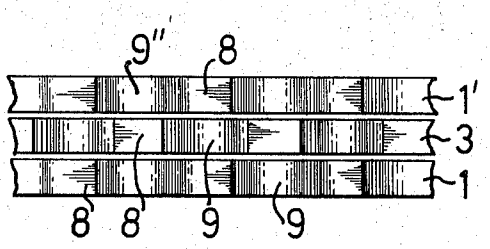


Fig 19
PRIOR ART



ANGLE VARIABLE JOINT FOR FOLDABLE CHAIR

BACKGROUND OF THE INVENTION

The present invention relates to a joint to be used at the junction of two frame members as seen in a foldable deck chair, camping bed and sofa for reclining in a variety of angular positions whereby the back-rest frame member is foldably supported, at a desired angle of inclination, on the seat frame member placed in position. More particularly the invention relates to improvements in a joint of the type whereby when the angle of inclination of the back-rest frame member is to be varied and the back-rest frame member is supported on and connected to the seat frame member at the desired angle of inclination, the back-rest frame member can be pivotally moved about the junction backward or forward as desired, i.e. at a variable inclination angle such as at progressively increasing or decreasing angles of inclination so that the back-rest frame member can be supported on the seat frame member in the desired position relative thereto.

A joint for use at the junction of two members has already been known and put to practical use. Such a joint comprises a movable rod to be attached to the back-rest frame member, a stationary support member to be attached to the seat frame member and a pin member for pivotally connecting these two members so that the back-rest frame member can be folded over the seat frame member. Such joint as heretofore known is divided into two types: one where the back-rest frame member is movable only in one direction for the adjustment or angle between the seat frame and back-rest members, i.e. the inclination angle can be changed only in a progressively decreasing manner, and the other wherein the angle of inclination between the two foldably connected members can be increased and decreased from a given angle as desired. With the former type, when a given angle of inclination is to be changed to a greater angle for adjustment, the back-rest frame must be completely closed and folded over the seat frame member and it is then pivotally moved in the reverse direction to a fully opened position substantially in alignment with the back-rest frame member. The back-rest frame member is then raised to the desired position where it is supported by the seat frame member. Thus, the joint has the drawback that when the angle is to be changed to a large angle, the user has to leave the seat frame member for the angle changing procedure.

On the other hand, the joint of the latter type is convenient and well-fitted for practical use in that the back-rest frame member can be moved both forward and backward to vary between a large angle and a smaller angle, and vice versa.

FIG. 18 shows part of a joint of the latter type which comprises a movable rod 2 providing at its lower end a pair of parallel flat discs 1 and 1′ spaced apart by a predetermined distance, a free cam disc 3 loosely disposed in the space therebetween, a stationary support member 5 having a recess 4 for accommodating the discs 1, 1′ and 3 in an overlapping state, a pin member for pivotally supporting the movable rod 2 and the stationary support member 5 at their junction and a latch member 7 always urged into resilient contact with the outer peripheries of the discs 1,1 and 3 for preventing the inclination of the rod 2 toward the member 5.

The upper end of the movable rod 2 is connected to the lower end of the back-rest frame member by suitable means, while the other end of the stationary support member 5 is fixed to the seat frame member. Thus, both the rod 2 and member 5 are foldable or inclinable at their junction, with the movable rod 2 supported on the support member 5 at the desired angle.

The flat discs 1 and 1′ are bulged at the lower end of the movable rod 2. The free cam disc 3 interposed between the opposing discs 1 and 1′ is somewhat larger in diameter than the discs 1 and 1′ and is supported on the pin member 6 coaxially therewith.

The outer peripheries of the lower half portions of the flat discs 1 and 1 and free cam disc 3 are formed with gear portions including tooth profiles 8 and tooth grooves 9 for engagement with the pawl of the latch member so that the back-rest frame member in a substantially upright state can be positioned at angles increasing or decreasing in increments with respect to the seat frame member. The gear portions of the discs 1, 1′ and 3 have an identical pitch.

At the junction of the stationary member 5, the latch member 7 which is urged by a spring 11 into resilient contact with the outer peripheries of the discs 1, 1′ and 3 is continually supported on another pin 10. By virtue of the engagement of the pawl 7*a* of the latch member 7 with the registered tooth grooves 9 of the gear portions, the movable rod 2 can be joined with the stationary support member 5 at various angles and further angular displacement of the former is prevented once it is set at the desired angle.

The free cam disc 3 is formed in its upper half portion with a recess 14 for changing the angle, wherein is engaged a projection 15 having a smaller width than the recess 14 with a given clearance or play, the amount of the play being half the pitch of the gear portions of the discs 1, 1′ and 3. As shown in FIG. 18, the projection 15 is formed by stamping out a base portion of the movable rod 2 in one direction. When the movable rod 2, as it is positioned at a right angle with the stationary support member 5 as seen in FIG. 18, is to be adjusted to a greater angle of inclination as desired, the movable rod 2 is pivotally rotated about the pin member 6 in a clockwise direction, whereby the flat discs 1 and 1 and free cam disc 3 are moved together against the action of the spring member 11, since the projection 15 is in engaged with the recess 14, permitting the support pawl 7*a* and auxiliary pawl 7*b* of the latch member 7 to ride on the toothless portion.

The movable rod 2 in this state is then turned in a counterclockwise direction. However, the movable member 2 alone is moved pivotally, with the free cam disc 3 retained in position, inasmuch as the cam disc 3 which is slightly greater in diameter than the flat discs 1 and 1′ is in resilient contact with the support pawl 7*a* and auxiliary pawl 7*b* under the action of the spring 11.

When the counterclockwise movement of the movable rod 2 has moved the gear portions of the flat discs 1 and 1′ a distance corresponding to half the pitch, the tooth profiles 8 and 8 of the flat disc 1 and 1′ come to the opposite sides of the grooves 9 of the free cam disc 3 in registry therewith as shown in FIG. 19, with teeth 8 of the free cam disc 3 disposed between and aligned with the tooth grooves 9 and 9 of the flat discs 1 and 1′. As a result, the tips of the teeth prevent the tooth grooves 9, 9′ and 9″ to form a space for the latch member 7 to engage. Thus the surfaces of the tooth tips de-

fine a plane for the pawls 7*a* and 7*b* of the member 7 to slide on. When the movable rod 2 is further moved in the same direction to the desired position, the foregoing misalignment of the teeth is corrected to provide a space for the pawl 7*a* to drop in.

Thus, the joint of the latter type is of practical use in that the movable rod 2 connected to the stationary member at a given angle can be moved for adjustment either forward or backward as desired.

A further study will find it advantageous to make the movable rod 2 pivotally movable about the pin member 6. In order to permit the pawl 7*a* of the latch member 7 to engage with or disengage from the tooth grooves 9 in the gear portions during the movement of the rod 2, it is further advantageous to provide gear portions having tooth profiles 8 and tooth grooves 9 such as are generally used wherein the width m of the tooth tip face is smaller than the width m' of the tooth groove 9 to be engaged by the pawl 7*a* as seen in the drawing.

With gear portions of such configuration, it is noted that even if a smooth plane fo the pawl 7*a* to slide on is formed by displacing the gear portions of the flat discs 1 and 1′ from the gear portion of the free cam disc 3, there is formed in each of the tooth grooves 9 a clearance corresponding to the amount of $m'-m=\Delta m$ insofar as $m < m'$ as already described. Thus, the clearance Δm is formed as clearances 12 on the opposite sides of the tooth profile 8 each of which clearances corresponds to $\Delta m/2$ as seen in FIG. 19.

Although the clearance 12 will not substantially permit the pawl 7*a* of the latch member 7 to engage therein, the clearance 12 will progressively be enlarged due to errors involved in the manufacture and wear and damage of the gear portions and pawl 7*a* resulting from use, rendering the pawl 7*a* liable to incidentally drop in the clearance despite the provision of a continuous smooth surface defined by the tooth tip surfaces.

It is further noted that with the joint to be incorporated in a foldable sofa to which the invention is chiefly applied, the gear portions, included in the joint are not generally machined with a very high accuracy for economical reaons. In some cases, therefore, the clearance 12 may possibly be greater than required. Moreover, despite the fact that the pawl 7*a* of the latch member 7 is resiliently pressed against the outer periphery of the free cam disc 3 all the time, the free cam disc 3 which is loosely mounted on the pin member 6 tends to move along with the flat discs 1 and 1′ in contact therewith when the angle adjustment is made, making it more likely to enlarge the clearance 12.

It will now be apparent that the provision of the clearance 12 causes incidental dropping of the pawl 7*a*, enhancing the trouble involved in the angle varying procedure which makes the joint defective in that the smooth manipulation is not assured.

SUMMARY OF THE INVENTION

We have accomplished improvements in the joint of the latter type described above. In brief, the joint of the present invention comprises a movable rod attached to a back-rest frame member and having at its lower end a pair of flat discs spaced apart in facing relation to each other and including outer peripheral gear portions respectively, free cam means in the form of a disc of approximately the same size as the flat discs disposed in the space between the flat discs and including outer peripheral gear portions having a pitch equal to that of the gear portions, a pin member for pivotably supporting the discs and disc means at the junction of a stationary support member attached to a seat frame member, and a latch member accommodated in the stationary support member and having a support pawl urged into resilient contact with the outer peripheries of the discs and the disc means, the movable rod being thus supported by and connected to the stationary support member in a forward and backward inclinable manner for the change of the angle of inclination, one of the pair of opposing flat discs being formed with a projection positioned at an upper portion of the space, the free cam means being composed of two discs including in their toothless circular arc portions recesses to be engaged by the projection and permitting the projection to move freely in predetermined amounts with different amounts of play, whereby when the movable rod is pivotally moved a predetermined amount for changing the angle, the flat discs alone are moved to displace their gear portions the predetermined amount with the two free cam discs retained in a stationary position by the resilient contact with the latch member and when the movable rod is subsequently moved the same amount as above in the same direction, the free cam disc with the recess of a smaller width and the flat discs are moved together to displace their gear portions the same amount as the predetermined amount throughout the engagement of the projection with the recess while the aforementioned displaced relationship is being retained therebetween. Thus, the two modes of relative displacement thus effected permit the respective tooth grooves to be overlapped with the tooth profiles whose tooth tip faces are in a partially overlapped relation to each other so as to cause the tip faces of the respective teeth to form a smooth plane for the pawl of the latch member to slide on.

Accordingly, an object of this invention is to provide a joint wherein when a movable member is moved for the change of angle, flat discs the and free cam disc are moved to displace their tooth profiles small distances and thereby permit the tooth grooves to be out of alignment with each other and to be overlapped with tooth profiles whose tip faces are in partially juxtaposed relation to each other so as to cause the tip faces to form a smooth continuous plane for the pawl of a latch member to slide on.

Another object of this invention is to provide a joint wherein even when the tooth profiles, tooth faces and tooth tip faces of the flat discs and free cam discs, pin member for supporting the discs and pawl of the latch member are worn, the respective tooth profiles can be overlapped with the tooth tip faces partially in overlapped relation to each other so as not to form a clearance for the pawl of the latch member to incidentally drop in even in an event of the above-mentioned wear taking place.

Another object of this invention is to provide a joint wherein when the pawl of the latch member is in engagement with the aligned tooth grooves in order to support the movable member on a stationary support member and connect the same thereto, the pawl can be in snug-fit contact with the gear groove without rattling and which assures smooth disengagement of the pawl for the change of angle.

Another object of this invention is to provide a joint whereby a given angle of inclination can be varied in a clockwise or counterclockwise direction with smooth-

ness and reliability and which is easy and economical to manufacture and convenient to handle.

Still another object of this invention is to provide a joint wherein the means for connecting the movable rod to the stationary support comprises four overlapped plates comprised of a pair of flat discs and two free cam discs accommodated in a space defined by opposing faces of the stationary support member and supported on a pin member so that the junction of the rod and support member is strong and fully capable of supporting, the joint thus being covered by the opposing walls to give a good appearance.

These objects and other features of this invention will become more apparent from the following description with reference to a preferred embodiment to follow.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 to 17 show a joint in accordance with this invention and FIGS. 18 and 19 show a joint of the prior art;

FIG. 1 is a perspective view showing a sofa which serves also as a bed and incorporating therein a joint of this invention;

FIG. 2 is a perspective view showing respective constituent parts of the joint in accordance with the invention as they are disassembled and seen in an oblique direction;

FIG. 3 is a side elevation showing the parts assembled into the joint;

FIG. 4 is a rear view of the same;

FIG. 5 is a fragmentary side elevation in vertical section showing the same;

FIG. 6 a fragmentary enlarged front view in section showing recesses and a projection for changing the angle as they are in engagement;

FIG. 7 is a side elevation showing two free cam discs and a flat disc as they are disassembled, the view illustrating the size and position of the tooth profiles and recesses;

FIGS. 8 to 12 are views illustrating the movement of the parts when the angle of inclination of a movable rod supported on a stationary support member is to be changed to a desired angle,

FIG. 8 being a side elevation in section showing a pawl riding on the tooth tip faces of the respective discs during a primary mode of movement, the movable rod being free to incline in this state;

FIG. 9 being a side elevation in section showing the tooth profiles of the flat disc as they are slightly displaced relative to the tooth grooves of the free cam when the movable rod has been moved from the state of FIG. 8 in a counterclockwise direction,

FIG. 10 being a side elevation in section showing the flat disc and one of the free cam discs as they have been slightly displaced together by moving the movable rod from the state of FIG. 9 further in a counterclockwise direction, the view showing a continuous smooth surface thereby formed for the pawl of the latch member to slide on,

FIG. 11 being a side elevation in vertical section wherein supporting connection is about to be established at the desired position, and

FIG. 12 being a side elevation showing the operation to align the displaced gear profiles so as to establish supporting connection at the desired position after the parts have been moved from the state of FIG. 11;

FIG. 13 includes a side elevation in section and a plan view illustrating the tooth profiles and tooth grooves of the flat discs and free cam discs in alignment in the state of FIGS. 5 and 8;

FIG. 14 includes a side elevation in section and a plan view showing the relation between the position of the tooth profiles and that of the tooth grooves in FIG. 9;

FIG. 15 includes side elevation and plan view similar to FIG. 10;

FIG. 16 is a side elevation in section showing the parts when the movable rod has been fully unloaded relative to the stationary support member;

FIG. 17 is a side elevation in section showing the movable rod and leg member as they have been fully folded onto the stationary support member;

FIG. 18 is a side elevation in section showing the junction of the conventional joint; and

FIG. 19 includes a side elevation and a plan view corresponding to FIG. 15 and showing the conventional joint for comparison with the joint of this invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

As shown in FIG. 1, the joint of this invention is used as a hinge means for chairs and sofas to be used at the junction of a back-rest frame member A and a seat frame member B and at the junction of the seat frame member B and a leg-rest frame member C to provide foldability and support and connection at desired angles.

This invention will be described with reference to an embodiment used as a joint for the two junction portions of the back-rest frame member A and the seat frame member B.

As shown in FIG. 2, a movable rod 102 to be fixed to the lower portion of the back-rest frame member A comprises a pair of parts each including a semicylindrical mounting member 102' for fixing the joint to the member A and a flat disc 101*a* extending from the lower end of the mounting member 102' in the form of a disc.

The flat discs 101*a* and 101*b* are formed with central pin bores 101' and 101' respectively. When the discs 101*a* and 101*b* are fitted together in facing relation, there is provided a space therebetween. A projection 115 is formed in one of the discs 101*a* and 101*b* by stamping out its base portion inward and raising the stamped out portion. The projection 115 extends downward in the space. The mounting members 102' and 102' are fitted together and attached to the member A.

Two free cam discs 103 and 103' are disposed in the above-mentioned space. The discs 103 and 103' have central pin bores 101''*a* and 101''*b* which are somewhat greater in diameter than the foregoing pin bores 101'*a* and 101*b*. The bores 101''*a* and 101''*b* of the free cam discs 103 and 103' and the opposing flat discs 101*a*, 101*b* and 101'*a*, 101'*b* are in alignment and receive therein a tubular boss 116. The free cam discs 103 and 103' thus positioned are free to rotate loosely on the boss 116 and movable to some extent axially of the boss 116.

For this purpose, the free cam discs 103 and 103' are formed with annular protrusions 117 in their opposing faces so as to minimize the frictional contact between the free cam discs 103 and 103'.

The flat discs 101*a* and 101*b* and free cam discs 103 and 103' have gear portions including tooth profiles

108, 108' and 109, 109' and tooth grooves 112, 112' and 113, 113' respectively in equal numbers. The respective tooth profiles as well as the tooth grooves are of an identical shape, while the widths l and l' of the tooth profile and tooth groove are equal to each other (see FIG. 13). Consequently, the pitch of teeth of the flat disc 101*a* and 101*b* and that of the cam discs 103 and 103' are equal.

The two free cam discs 103 and 103' have in their toothless portions recesses 114 and 114' in which the projection 115 is engageable with a predetermined amount of play. The recess 114 is greater than the recess 114'. The projection 115 and recesses 114 and 114' provide relative displacement between the respective gear portions when the inclination angle is to be varied.

The pair of flat discs 101*a* and 101*b* and two free cam discs 103 and 103' supported on the boss 116 are accommodated in a stationary support member 105.

The stationary support member 105 has a tubular mounting member 105' to be inserted into one end of the seat frame member B. The other end of the mounting member 105' is in the form of parallel unstanding walls 118 and 118, with a space 104 formed therebetween. The junction portion of the movable rod 102 is placed in this space.

The opposing walls 118 and 118 are centrally formed with pin bores 119. A pin member 106 having a diameter approximately equal to the inner diameter of the boss 116 extends through the pin bores 119 and boss 116 of the junction portion of the movable rod 102 placed in the space 104, whereby the movable rod 102 is foldably mounted on the stationary support member 105.

Within the space 104 defined by the opposing walls 118*a* and 118*b* of the stationary support member 105, there is provided a latch member 107 for preventing the inclination of the movable rod 102 relative to the stationary support member 105.

The latch member 107 has at its base portion a pin bore 121 identical in diameter with a pin bore 120 formed at the base of the stationary support member 105. The latch member 107 further has a support pawl 107' adapted for fitting engagement with the tooth grooves 112, 112', 113 and 113' of the respective discs 101*a*, 101*b*, 103 and 103'. The latch member 107 is supported on a pin member 110 inserted into pin bores 120 and 121 in alignment. A spring member 111 wound on the pin member 110 urges the support pawl 107' of the latch member 107 into resilient contact with the outer peripheries of the discs 101*a*, 101*b*, 103 and 103' all the time. In the illustrated embodiment, a leg mounting rod 122 for providing a leg frame D is supported at its upper end on the pin member 110 at the same time.

In the foregoing manner, the movable rod 102 is foldably connected to the stationary support member 105 at their junction, with the latch member 107 acting to prevent the inclination of the movable rod. FIGS. 3 and 4 show the external appearance of the joint thus constructed.

The movement of the parts for the change of angle will be described below.

With reference to FIG. 5, the movable rod 102 is supported on and connected to the stationary support member 105 at an angle somewhat greater than a right angle. An angular adjustment of the movable rod 102 from this state to another desired position will now be described.

The tooth grooves 112 and 112' of the flat discs 101*a* and 101*b* and tooth grooves 113 and 113' of the cam discs 103 and 103' are in registry, with the support pawl 107' of the latch member 107 urged into engagement with the grooves 112, 112', 113 and 113' all the time. Accordingly, the pawl 107' must be disengaged from the grooves against the action of spring.

For this purpose, the tip of each tooth 123 where the contact with the inner side of the support pawl 107' takes place is round-faced as shown in FIGS. 13 to 15 so as to ensure smooth and trouble-free engagement and disengagement between the grooves and the pawl. Accordingly, when the movable rod 102 is pivotally moved about the pin member 106 in a clockwise direction as shown in FIG. 5, the flat discs 101*a* and 101*b* and free cam discs 103 and 103' are thereby driven all together, since the projection 115 on the movable rod 102 is in engagement with the aligned walls of recesses 114 and 114' in the free cam discs 103 and 103'. This movement permits the pawl to engage in the next grooves to support the movable rod 102 on the stationary support member 105 at a smaller angle therewith although this position is not shown. Before the movable rod 102 is shifted to this position, the support pawl 107' of the latch member 107 rides on the tooth tip face 123. The parts in the course of this movement are illustrated in FIG. 8 as the movable rod 102 is stopped from the clockwise movement.

To effect angular displacement subsequent to the state shown in FIG. 8, there is a need to block the tooth grooves, namely to provide a smooth surface for the pawl 107' to slide on which is free of recesses for the pawl of 107' of the member 107 to drop in, because the latch member 107 is in resilient contact with the spring member 111 all the time.

Since the free cam discs 103 and 103' are interposed between the discs 101*a* and 101*b* which are integral, it will be seen from FIG. 13 that the tooth grooves 112 and 112' of the flat discs 101*a* and 101*b* can be blocked by the tooth profiles 109 and 109' of the cam discs 103 and 103', and that the tooth grooves 113 and 113' of the cam discs 103 and 103' can be blocked by the tooth profiles 109 and 109' adjacent to each other and by the tooth profiles 108 and 108' of the flat discs 101*a* and 101*b*.

Accordingly, as shown in FIGS. 7 and 13, the tooth profiles and tooth grooves in the gear portions of the pair of flat discs 101*a* and 101*b* and two free cam discs 103 and 103' are formed so that they have an identical pitch and the width l of the tooth profile is equal to the width l' of the tooth groove on the reference pitch line. Further the width m of the tooth tips and the width m' of the tooth grooves on the outer peripheral circle are in such range that $\frac{1}{4}\, m' < m$ and $m' \geqq m$. It is further so designed that the projection 115 is engaged in recesses 114 and 114' of different widths in the free cam discs 103 and 103', with amounts of play S and S' respectively having the following relationships: $S = 2 \times S'$, $S' = \frac{2}{3}l$ and $S' = \frac{2}{3}l'$.

To achieve an angular displacement from the state of FIG. 8 to the desired position, the movable rod 102 is moved counterclockwise an amount corresponding to the amount of play S'.

This movement causes only the pair of flat discs 101*a* and 101*b* to move the amount of play S' while leaving

the two free cam discs **103** and **103'** in a stationary position, inasmuch as the tooth tip faces **123** of the free cam discs **103** and **103'** are in contact with the support pawl **107'** which are urged by the spring member **111.** To assure that the cam discs **103** and **103'** will be held stationary with greater reliability, the cam discs **103** and **103'** may be slightly greater in diameter than the flat discs **101***a* and **101***b* in as seen in the drawings.

The movement of the movable rod **102** by the amount of the play S' causes the tooth profiles **108** and **108'** of the flat discs **101***a* and **101***b* to be displaced an amount of $\frac{2}{3}l$ to overlap by $\frac{2}{3}l$ the tooth grooves **113** and **113'** of the free cam discs **103** and **103'** which are in registry and in a stationary state, the tooth profiles **108** and **108'** being in overlapping relation to the tooth profiles **109** and **109'** of the free cam discs **1, 1' 103** and **103'** by the remaining amount of $\frac{1}{3}l$. Thus, width of $\frac{1}{3}m$ of the tooth tip faces **123** of the displaced flat discs **101***a* and **101***b* overlaps width of $\frac{1}{3}m'$ of the tooth tip faces **123** of the free cam discs **103** and **103'**. This relationship is illustrated in FIGS. **9** and **14.**

The movable rod **102** will be moved further in a counterclockwise direction. The projection **115** is in engagement with the free cam disc **103'** having the recess **114'** of a smaller width, the movable rod **102** will now be moved in the same direction an amount of ½S, which is substantially equal to S' since $S = 2 \times S'$.

During this movement, the free cam disc **103** including the recess **114** of a greater width is held stationary, because the tooth tip face **123** thereof is pressed against by the support pawl **107'** under the action of the spring member **111.**

On the other hand, the free cam disc **103'** with the recess **114'** of the smaller width in which the projection is no longer free to move is moved by S', i.e., $\frac{2}{3}l$ along with the flat discs **101***a* and **101***b*. At this time, the free cam disc **103'**and the flat discs **101***a* and **101***b* are moved together in the displaced state brought about by the already described movement. As a result, the tooth profiles **108** and **108'** of the already displaced flat discs **101***a* and **101***b* overlap the next tooth profiles **109** of the stationary free cam **103** by $\frac{1}{3}l$, while the tooth profiles **109** of the free cam disc **103'** overlap the tooth profiles **109** of the free cam **103** by $\frac{1}{3}l$ with which the tooth profiles **109'** were in fully juxtaposed relation. At the center of the tooth grooves **113** of the free cam disc **103,** the tooth profiles **108** and **108'** of the flat discs **101***a* and **101***b* overlap the tooth profile **109'** of the free cam disc **103'** by $\frac{1}{3}l$. Thus, over the width m' of the tooth groove **113,** as seen along the tooth face, there are formed an overlapping portion of $\frac{1}{3}m$ in the tooth tip face **123** and another overlapping portion of $\frac{1}{3}m$ at the center, whereby a smooth face for the pawl **107'** to continuously slide on is formed which includes partially overlapped portions. This state is illustrated in FIG. **10.** For the support of the movable rod **102** at the desired angle after it has been moved to the desired position, the movable rod **102** is moved by an amount of the play S' of the smaller recess **114'** in a clockwise direction as shown in FIG. **11,** the tooth profiles and grooves of the flat discs **101***a* and **101***b* are brought into alignment with those of the free cam **103'**, although the free cams **103** and **103'** remain stationary due to the contact with the pawl **107'**. The parts are brought to the state shown in FIG. **12.** When the movable rod **102** is further moved an amount of the play S' in the same direction, the aligned tooth profiles and grooves of the flat discs **101***a* and **101***b* and the free cam disc **103'** are driven together in alignment with the tooth profiles and grooves of the free cam disc **103,** whereupon the pawl **107'** of the latch member **107** which is under the action of spring all the time is urged into engagement with the aligned tooth grooves. The round-surfaced tooth profiles ensure smooth engagement at this time. The snug-fit contact of the pawl **107'** with the tooth grooves further serves to keep the movable rod **102** supported and connected without rattling and to thereby provide a junction which retains the back-rest frame A in rattle-free state. Moreover, it will be apparent that in accordance with the invention, the stationary support member **105** and the movable rod **102** can be fully unfolded at its junction as seen in FIG. **16.** This ensures a very advantageous application to a bed.

Furthermore as shown in FIG. **17,** the movable rod **102** can be completely folded onto the stationary support member **105** by moving the movable rod **102** from the state of FIG. **5** in a clockwise direction. In addition, the leg mounting rod **122** can likewise be moved pivotally to a fully closed position. In this way, the back-rest frame member A, seat frame member B, leg-rest member C and leg frame member D can all be folded into a compact form for the convenience of transportation and packaging.

The present invention will fully be understood with reference to the useful embodiment described above. It is to be understood, however, that the invention can be embodied in the form of various alterations and modifications within the scope of the appended claims without departing from the spirit of the invention.

What we claim is:

1. A joint comprising a movable rod attached to a back rest frame member and having at its lower end a pair of flat discs spaced apart in facing relation to each other and including peripheral gear portions respectively, free cam means in the form of two free cam discs of approximately the same size as the flat discs disposed in the space between the flat discs and including outer peripheral gear portions having a pitch equal to that of the gear portions, a pin member for pivotably supporting the discs and cam means at the junction of a stationary support member attached to a seat frame member, and a latch member accommodated in the stationary support member and having a support pawl urged into resilient contact with the outer peripheries of the discs and cam means, the movable rod being thus supported by and connected to the stationary support member in a forward and backward inclinable manner at progressively decreasing and increasing variable angles for the change of angle of inclination, one of the pair of opposing flat discs being formed with a projection positioned at an upper portion of the space, the free cam means being composed of two discs including in their toothless circular arc portions recesses to be engaged by the projection and permitting the projection to move freely predetermined amounts with different amounts of play, whereby when the movable rod is pivotally moved a predetermined amount for changing the angle the flat discs alone are moved to displace their gear portions the predetermined amount with the two free cam discs retained in a stationary position by the resilient contact with the latch member and when the movable rod is subsequently moved the same amount as above in the same direction the free cam disc with a recess of a smaller width and the flat discs are moved together to

displace their gear portions the same amount as the predetermined amount through the engagement of the projection with the recess while the aforementioned displaced relationship being retained therebetween, the modes of relative displacement thus effected permitting the respective tooth grooves to be partially overlapped with the tooth profiles whose tooth tip faces are in partially overlapped relation to each other so as to cause the tip faces of the respective teeth to form a smooth face for the paul of the latch member to slide on.

2. The joint as set forth in claim 1 wherein the amounts of play of S and S' of the projection engaged in the recesses of the free cam discs and tooth profile width l and tooth groove width l' of the flat discs and free cam discs along the reference pitch line have the relationships of $S = 2 \times S'$, $l = l'$ and $S' = \frac{2}{3}l$ and the tooth tip width m and tooth groove width m' of the flat and free cam discs along their outer peripheral circles have the relationships of $\frac{1}{2}m' < m$ and $m' \leqq m$, the partially overlapped portions of the respective tooth profiles being $\frac{1}{3}l$, wherein the tooth profile and groove widths l, $l'$and the tooth tip and groove widths m, m' are the same for the flat and free cam discs.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,779,655 Dated December 18, 1973

Inventor(s) YOSHITANE TOYOTA

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Item [73] in the heading, in the address of the assignee, change the city from "Tokyo" to --Osaka--.

Signed and sealed this 11th day of June 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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