This invention relates to reclining chairs and fixtures therefor and more particularly to a reclining chair assembly for supporting a chair seat and back rest upon a stationary base for coordinated movement throughout a range of reclining movement wherein the static forces exerted against the seat and back rest by an occupant of the chair are counterbalanced to achieve a static equilibrium at any coordinated position of the seat and back rest within the total range of movement.

It is a primary object of the invention to provide a reclining chair assembly including a fixture for supporting a chair seat and back rest upon a stationary base for reclining movement throughout a range extending between a normal position and a reclined position wherein the chair elements may remain in static equilibrium at any position within the range of movement.

It is another object of the invention to provide a reclining chair fixture for supporting a chair seat and back rest for coordinated movement upon a stationary base wherein T-shaped seat and back rest elements are supported for non-interfering motion with an arm assembly forming a portion of the stationary base.

The forgoing and other objects are achieved in a reclining chair assembly including a fixture which includes a quadric linkage for supporting the chair seat upon a stationary base. The quadric linkage includes a fixed link rigidly attached to the seat and a seat link rigidly attached to the seat, front and rear support links being pivotally supported at the respective front and rear ends of the base link and pivotally connected to the front and rear ends of the seat link to define the quadric linkage. The quadric linkage is constrained to move within a range between a normal position wherein the support links are inclined rearwardly from their fixed pivots and a reclined position wherein the support links are displaced upwardly and forwardly about their respective fixed pivots from their reclined position. This arrangement causes the chair seat to move upwardly and forwardly relative to the stationary base during movement from its normal position to its reclined position, and also applies the weight exerted by an occupant of the chair against the seat to the fixture in a direction tending to move the fixture to its normal position.

The front support link of the fixture is constituted by one arm of a bell crank whose opposite arm is pivotally connected to one end of a control link which extends from the bell crank to an intermediate location upon a back link adapted to be fixedly attached to the back rest of the chair. The back link is pivotally supported at a location spaced below the connection between the control link and back link upon the same pivot which couples the rear support link to the seat link. The angular relationship between the arms of the bell crank is such that the normal static force exerted by an occupant against the back rest of the chair applied to the bell crank in a direction tending to rotate the bell crank about its fixed pivot in a direction opposite to that in which it is urged to rotate by the weight of the occupant upon the chair seat. The proportions of the fixture are such that within the range of movement of the fixture a static balance is achieved in the absence of any active effort on the part of the chair occupant to shift the position of the chair elements relative to the stationary base. Because of the upward and forward bodily motion of the chair seat during movement away from its normal position, interference between the wings of a T-shaped seat cushion and arm portions on the stationary base is avoided, the bodily elevation of the seat during reclining movement being also applied to the lower end of the chair back to avoid interference between the wings of the T-shaped back and the rearward portions of the chair arms.

Other features and objects of the invention will become apparent by reference to the following specification and to the drawings.

In the drawings:
FIG. 1 is a cross-sectional view of a reclining chair assembly embodying the present invention, the section of FIG. 1 being taken on the line 1—1 of FIG. 2;
FIG. 2 is a partial top plan view, with certain parts broken away or shown in section, of the reclining chair of FIG. 1;
FIG. 3 is a view similar to FIG. 1 showing the chair and fixture of FIG. 1 in a reclined position;
FIG. 4 is a view similar to FIG. 1 showing the chair and fixture in a position intermediate the positions of FIGS. 1 and 3; and
FIG. 5 is a detail cross-sectional view taken on the line 5—5 of FIG. 1.

The chair disclosed in the drawings is constructed from right- and left-hand side frame assemblies, each of which includes a front leg 10, a rear leg 12, a lower side frame member 14 and a top side frame member 16. Apart from slight modifications which determine whether the side frame assembly is to be a right- or left-handed one, the two side frame assemblies are identical in construction and hence only one set of reference numerals will be employed to refer to the corresponding parts. The two side frame assemblies are fixedly secured to each other in assembled relationship by front and rear cross frame members 18 and 20.

The chair seat frame includes seat side frame members 22, a seat front member 24 and a rear seat member 26 which, when assembled, define a generally open rectangular frame. In addition to the foregoing frame members, the chair seat frame also includes outwardly projecting wings 28 at each side of the front of the seat frame to support a chair seat cushion S of the T cushion type.

The chair back frame includes vertical side frame members 30 joined into a back rest frame assembly by a suitable number of horizontal cross members such as 32 (FIG. 2). Like the chair seat frame, the chair back is of a T-shaped configuration and an outwardly projected auxiliary frame such as 34 (FIG. 2) is fixedly secured to each vertical side frame member 30 to project outwardly into overlying relationship with the rearward portion of the chair base when the chair is in the position shown in FIGS. 1 and 2.

The foregoing description has been directed solely to the frame elements of the chair and it will be appreciated that in the completed chair, the various frames will be suitably upholstered.

The chair seat and back are supported upon the stationary base for controlled constrained movement relative to the base and to each other by a reclining chair fixture designated generally 36. Fixture 36 includes a stationary base link 38 which, in the completed chair, is fixedly attached to frame member 14 of the stationary base as by screws 40. As is the usual case, each chair includes two fixtures 36, one located at each side of the frame and differing from each other only in being right- or left-handed. The fixture shown in the drawings is that which is mounted upon the left-hand side of the chair.

Base link 36 is constructed with a front fixed pivot 42.
located adjacent the front end of base link and a rear fixed pivot 44 located adjacent the rearward end of the base link. A relatively short rear support link 46 is mounted at one end upon rear fixed pivot 44 and is connected at its other end by a rear seat pivot 48 to the rearward end of a seat link 50 which is fixedly secured to seat side frame member 22 by screws 52. A bell crank designated generally 54 is pivotally mounted upon front fixed pivot 42 and a first arm 56 of bell crank 54 is connected at its distal end 58 to a front seat pivot 60 located on seat link 50 adjacent its forward end. Arm 56 functions as a front support link and defines, with base link 38, rear support link 46, and seat link 50, a closed quadrangular linkage having a stationary link defined by base link 38. Bell crank arm 56 and rear support link 46 thus support seat link 50 for constrained movement relative to stationary base link 38 in which front and rear seat pivots 60 and 48 are swing in arcs respectively centered upon front fixed pivot 42 and rear fixed pivot 44. The total range of movement of the quadrangular linkage referred to above is limited by limiting the amount of relative motion which can occur between bell crank arm 56 and seat link 50 by the engagement between a pin 62 on seat link 50 with the opposite ends of an arcuate slot 64 formed in bell crank arm 56.

A back link 66 is pivotally mounted at its lower end upon rear seat pivot 48 and is fixedly secured to the vertical back rest frame member 30 as by screws 68. A control link 70 is pivotally connected at one end to back link 66 by a pivot 72 spaced upwardly above the pivotional connection between back link 66 and seat link 50 defined by rear seat pivot 48. The opposite end of control link 70 is connected by a pivot 74 to the distal end 76 of the second arm 78 of bell crank 54.

When the chair is unoccupied, fixture 36 is resiliently biased to the normal rest position shown in FIG. 1. By a tensioning spring 80 which is connected between a bracket 82 mounted on the rear of front cross frame member 18 of the chair base and a second bracket 84 mounted on the inner side of seat side frame member 22. With fixture 36 in its normal rest position as shown in FIG. 1, the chair seat and back are likewise disposed in what may be referred to as a normal rest position in which the chair seat is disposed in a substantially horizontal position and the chair back is positioned in a normal upright relationship to the chair seat.

The engagement between pin 62 on seat link 50 and the lower end of slot 64 in bell crank 54 prevents movement of front seat pivot 60 downwardly from the FIG. 1 position. With the fixture in the FIG. 1 position, it will be noted that front fixed pivot 42, front seat pivot 60 and rear seat pivot 48 are in substantial alignment with each other, front seat pivot 60 being located slightly above a straight line passing through the centers of front fixed pivot 42 and rear seat pivot 48. The seating of stop pin 62 against the lower end of slot 64 is best appreciated by observing that slot 64 is formed on bell crank 54 and hence is constrained to move in an arc centered on front fixed pivot 42. Pin 62 is fixedly mounted upon seat link 50 and thus must move about the instantaneous center of rotation of seat link 50. The instantaneous center of rotation of seat link 50 is located at the intersection of a first line passing through front fixed pivot 42 and front seat pivot 60 and a second line passing through rear fixed pivot 44 and rear seat pivot 48. From an inspection of FIG. 1, and FIG. 1 of the fixture is in the FIG. 1 position, the instantaneous center of rotation of seat link 50 is found to be slightly above and to the rear of rear seat pivot 48. Thus, movement of the fixture from the FIG. 1 position in a direction driving front seat pivot 60 downwardly would cause pin 62 on seat link 50 to move somewhat to the right while the walls of slot 64 in rotating downwardly about front fixed pivot 42 must move toward the left.

Fixture 36 is so constructed that the static forces applied to the fixture by an occupant of the chair against the chair seat and chair back are balanced against each other in the fixture so that the fixture is in static equilibrium at any position between the respective end limits of movement shown in FIGS. 1 and 3. The term "static forces" applied to the chair by an occupant refer to those forces exerted on the chair seat and back by an occupant who is sitting immobile as by pushing or pulling against the arms of the chair to move the chair as by pushing rearwardly on the chair arms or leaning forward. Within the fixture, these static forces are balanced primarily within bell crank 54. Because of the fact that front seat pivot 60 is constrained to move in an arc displaced horizontally to the rear of front fixed pivot 42, it is apparent that the weight of the occupant upon the chair seat at all positions of the fixture tends to move the fixture toward the normal position of FIG. 1. The static forces applied by an occupant of the chair against the seat thus always tend to rotate bell crank 54 in a clockwise direction about front fixed pivot 42.

The static forces normally exerted by the occupant against the back rest of the chair are applied to back link 66 of the fixture in a direction tending to pivot back link 66 in a clockwise direction about its pivotional connection 48 to seat link 50. This in turn tends to urge pivot 72 rearwardly and control link 70 so that static force applied against pivot 72 to arm 78 of bell crank 54 in a direction urging bell crank 54 to rotate in a counter-clockwise direction about front fixed pivot 42.

Because the static forces exerted by the occupant upon the chair back rest are usually somewhat less than those static forces normally exerted upon the chair seat, the static force against the back rest is magnified by virtue of the fact that the static force against the back rest is applied to the back rest at a location spaced substantially above the location of pivot 72. In transmitting this static force to fixture 36, link 66 acts as a lever fulcrumed at rear seat pivot 48. The radial distance from the point of application of the static force is substantially greater than the radial distance between rear seat pivot 48 and pivot 72, hence the static force applied to the chair back is applied to link 70 magnified by the ratio of the two aforementioned distances. Within the total range of movement of the fixture between the position of FIG. 1 and the position of FIG. 3, the static forces exerted by the occupant against the chair seat and against the back rest are counterbalanced within the fixture by applying these forces to exert equal and opposite moments upon bell crank 54 about front fixed pivot 42. Since the links of the fixture are completely constrained in that the position of any one of the movable links completely determines the position of all other movable links, this static balance or equilibrium of static forces applied to bell crank 54 will hold the bell crank stationary at any position intermediate the FIG. 1 and FIG. 3 positions and thus cause the remaining links of the fixture to remain stationary with the seat and back of the chair located in corresponding positions.

In the absence of an occupant, spring 80 biases fixture 36 to return the chair seat and back to the FIG. 1 position. If an occupant is seated in the chair, the chair and fixture 36 remain in the FIG. 1 position as long as the chair occupant does not make any active effort to move the chair toward the reclined position of FIG. 3. To move the chair from the normal rest position of FIG. 1 toward the reclined position, the occupant exerts an active rearward force against the chair back rest, as by pushing against the arms of the chair. Since the seat and back are in balance with each other for all positions of the chair and fixture, this force does not have to be exceedingly large and the chair will begin to move immediately toward the FIG. 3 position. When the chair reaches the desired degree of reclinement, the occupant ceases to exert any active effort to make the chair recline further and the chair remains at the desired position.

From a comparison of FIGS. 1 and 3, it is apparent that during movement of the chair and fixture from the normal position of FIG. 1 to the reclined position of FIG.
3,  front and rear seat pivots 60 and 48 are swung upwardly and forwardly about their associated fixed pivots 42 and 44 respectively. Thus, in moving from the normal position of FIG. 1 to the reclined position of FIG. 3, the chair seat is moved bodily upwardly and forwardly of the chair. This motion, because of the respective paths of movement of pivots 42 and 48 is primarily a vertical motion with a relatively small horizontal component. This type of motion is essential in chairs of the type disclosed in the drawings wherein the chair seat cushion and frame are of the so-called T-type since it prevents interference between the front of the chair arm assembly and the wings of the T-shaped back rest upon which the back rest of the chair is support ed, interference is likewise avoided between the projecting wings of the T-shaped back rest and the rearward end of the chair arm assembly.

While one exemplary embodiment of the invention has been disclosed, it will be apparent to those skilled in the art that the embodiment described in detail may be modified. Therefore, the foregoing description should be considered exemplary rather than limiting and the true scope of the invention is that defined in the following claims.

I claim:

1. A self-balancing reclining chair comprising a stationary base having spaced front and rear fixed pivots thereon, a movable seat having spaced front and rear seat pivots thereon, a bell crank pivotally mounted on said fixed front pivot and having a first and a second arm with said first arm pivotally connected to said seat pivot, a back link pivotally connected at one end to said rear seat pivot and pivotally connected at its opposite end to said rear fixed pivot, whereby said bell crank and support link are seat pivotal supports providing constrained movement about said fixed pivots, means confining movement of said seat pivotal support relative to said stationary base in the range between a first end limit wherein said seat is supported in a substantially horizontal position, and a second end limit wherein said seat is supported in a rearwardly tilted reclined position displaced upwardly and forwardly of said horizontal position, a back rest being urged toward said reclined position by the static force exerted against said back rest by an occupant of the chair, a control link pivotally connected at one end to said back link at a location spaced above the pivotal connection between said back link and said seat link and pivotally connected at one end to said rearward end of said seat link and pivotally connected at its opposite end to said distal end of the other arm of said bell crank, a back link pivotally mounted at its lower end upon the rearward end of said seat link, and a control link pivotally connected at one end to an intermediate segment of said back link and pivotally connected at its opposite end to the distal end of the other arm of said bell crank to swing said seat link upwardly and forwardly relative to said base link upon rearward pivotal movement of said back link relative to said seat link.

4. A reclining chair fixture as defined in claim 3 wherein said base link, said one arm of said bell crank, said seat link and said rear support link define a closed quadric linkage, and stop means constraining movement of said quadric linkage to a range wherein said one arm of said bell crank is movable between a substantially horizontal rearwardly directed position relative to its pivotal connection to said base link and an upwardly and rearwardly directed position relative to its pivotal connection to said base line.

5. A reclining chair fixture as defined in claim 4 wherein said stop means comprises a pin mounted upon said seat link at a location spaced from the pivotal connection between said seat link and said one arm of said bell crank, said one arm of said bell crank having a slot therein receiving said pin to confine relative movement between said one arm of said bell crank and said seat link to a range defined by the engagement between said pin and the respective ends of said slot.

6. A self-balancing reclining chair fixture comprising a quadric linkage having a generally horizontal base link, a rear support link pivotally mounted at one end upon the rearward end of said base link, a seat link pivotally mounted at its rearward end on the other end of said rear support link, and means defining a front support link pivotally connected at spaced points to the respective forward ends of said seat link and said base link, means defining a first end limit of movement of said quadric linkage at a rest position wherein said front and rear support links are inclined rearwardly from their respective pivotal connections to said base link, a crank arm on said means defining said front support link having a distal end angularly related to said front support link to project downwardly from the pivotal connection of said means to said base link when said quadric linkage is in said rest position, a back link pivotally mounted at its lower end upon the rearward end of said seat link, and a control link pivotally connected at one end to said distal end of said crank arm and pivotally connected at its opposite end to said back link at a location spaced above said seat link, said control link locating said back link in an upright relationship to said seat link when said quadric linkage is at said rest position and being operable to swing said front support link defining means about its pivotal connection to said base in a direction swinging said seat link upwardly and forwardly relative to said base link upon rearward pivotal movement of said back link on said upright position.

7. A self-balancing reclining chair fixture comprising a base link having a front fixed pivot adjacent its forward end and a rear fixed pivot adjacent its rearward end, a seat link having a front seat pivot adjacent its forward end and a rear seat pivot adjacent its rearward end, a front support link connected at spaced points to said front fixed pivot and to said front seat pivot, a rear support link connected at spaced points to said rear fixed pivot and to said rear seat pivot, said front and rear support links cooperatively supporting said seat link upon said base link for movement between a substantially horizontal rest position and a rearwardly tilted reclined position wherein said seat link is displaced forwardly and upwardly from said rest position, a back link pivotally mounted at its lower end upon the rearward end of said seat link, an angularly projecting crank arm on said front support link, a control link pivotally connected at one end to said back link at a location spaced above said seat link and pivotally
connected at its opposite end to the distal end of said arm for swinging said front support link about said front fixed pivot in a direction moving said front seat pivot upwardly and forwardly of said fixture upon rearward tilting movement of said back link about its pivotal connection to said seat link.

8. A reclining chair fixture as defined in claim 7 wherein said back link is pivotally connected to said seat link by said rear seat pivot, and stop means engageable with said front support link means to define the respective rest and reclined positions of said seat link.

9. A reclining chair fixture as defined in claim 8 wherein said rear support link is oriented relative to said front support link in a fashion such that said rear seat pivot is moved upwardly and forwardly of said fixture during movement of said seat link from said rest position to said reclined position, the length of said rear support link being less than the length of said front support link.

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