United States Patent

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[54] **RECLINING CHAIR WITH CONSTRAINED LINKAGE**
5 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **297/83,** 297/85
[51] **Int. Cl.** **A47c 1/02**
[50] **Field of Search** 297/83, 84, 85, 86, 87, 88, 89, 90, 91, 68

[56] **References Cited**

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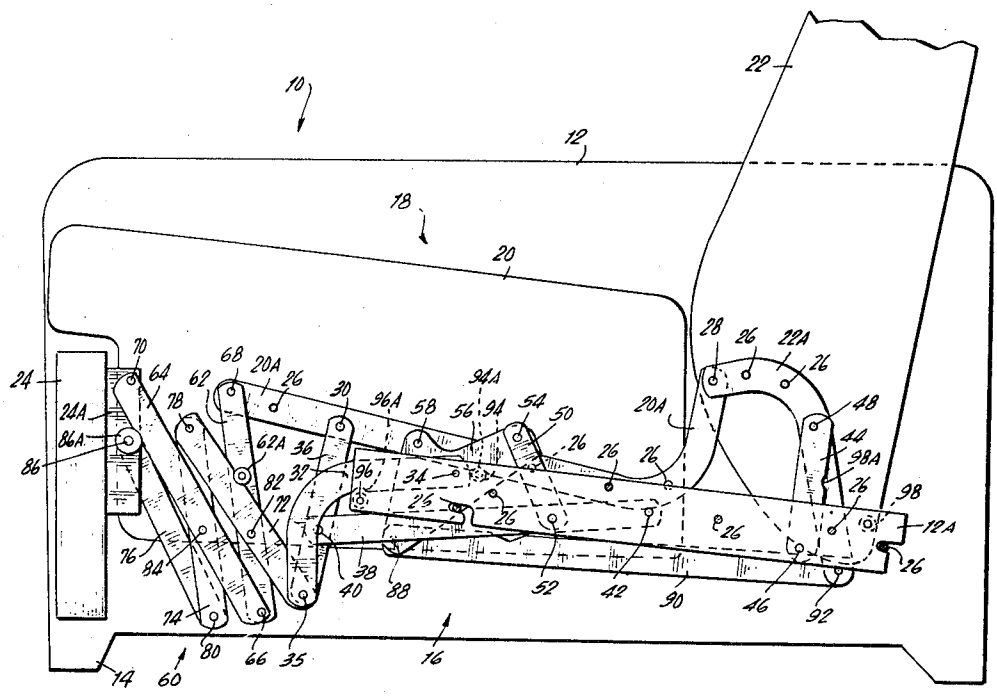
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ABSTRACT: A reclining chair in which a seat, backrest and leg rest are mounted in an arm frame for movement and are guided by a mounting linkage of improved characteristics. The mounting linkage has first constraining means to completely constrain movement of the elements and, in addition thereto, second constraining means are operative during at least a portion of the movement of the elements to constrain them to move in a path slightly different from the path that they would follow under the sole influence of the first constraining means with the mounting linkage being sufficiently flexible to move under the simultaneous influence of the first and second constraining means.



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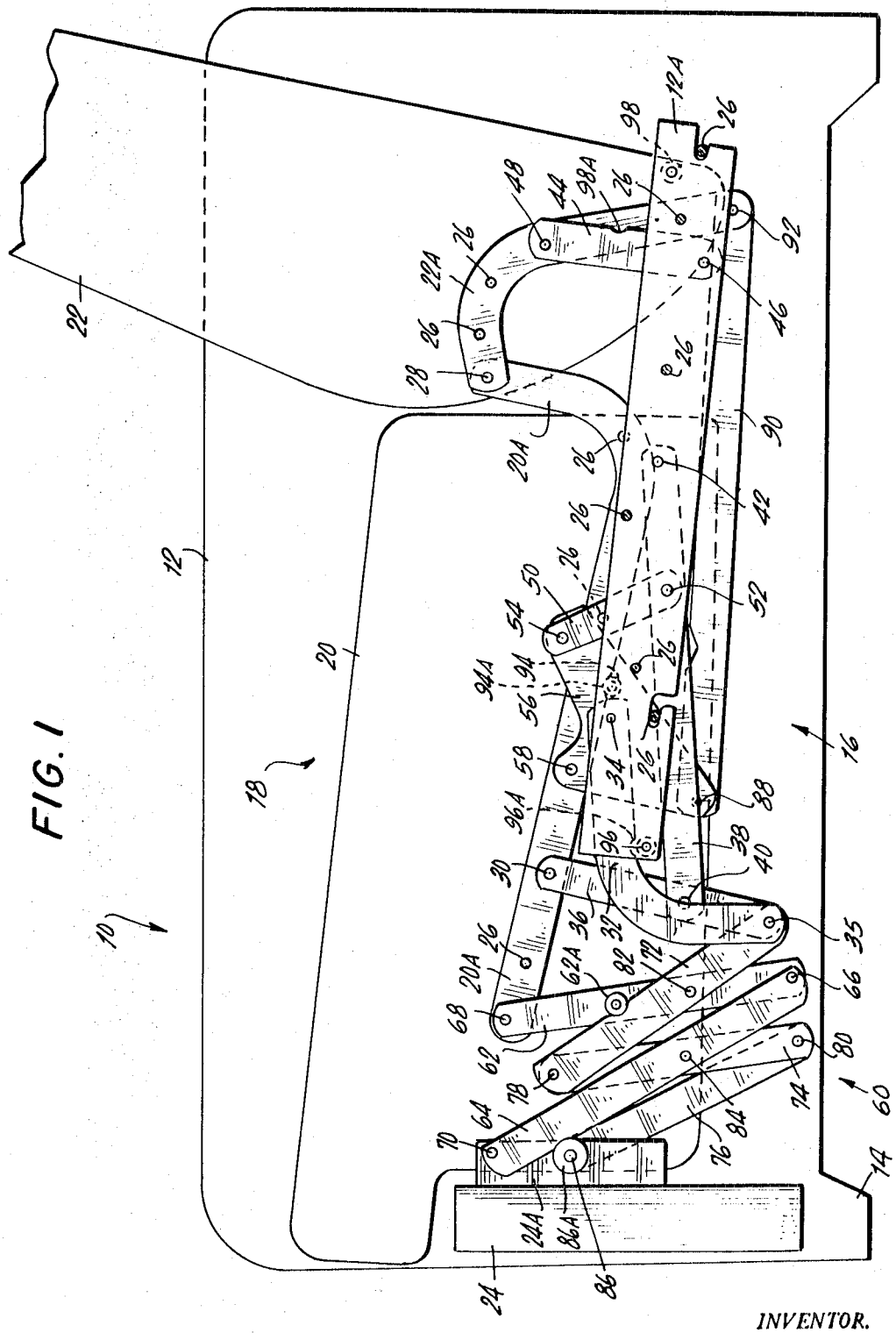


FIG. 1

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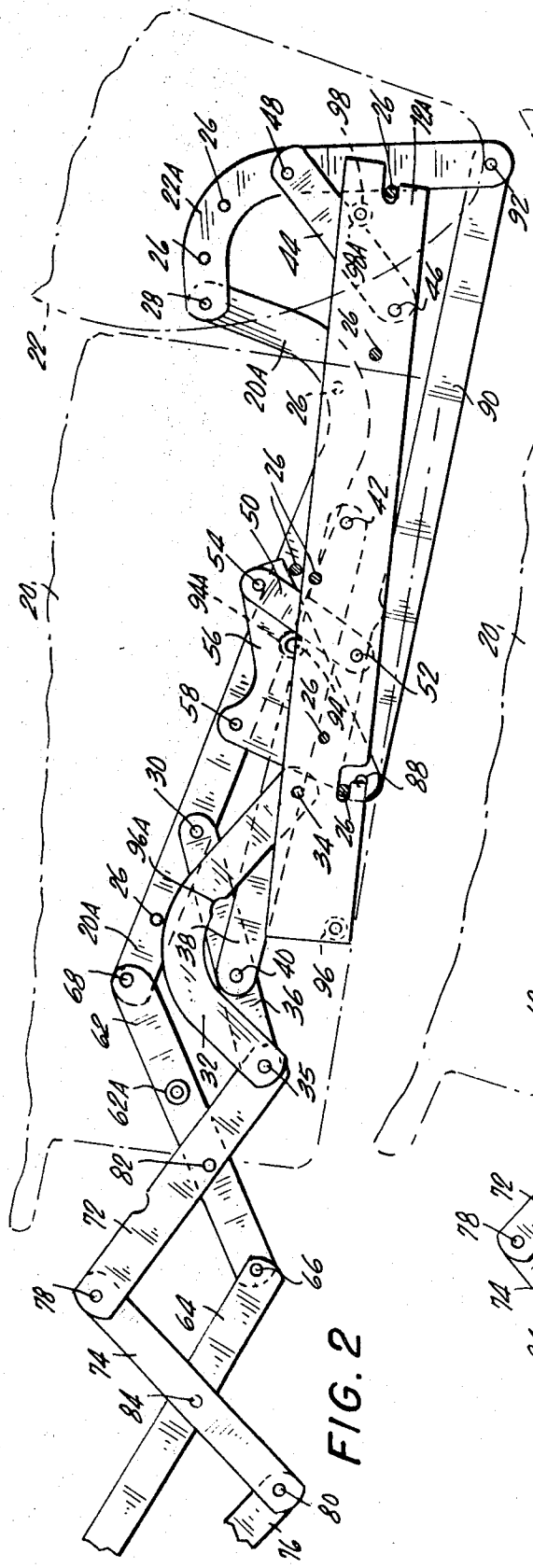


FIG. 2

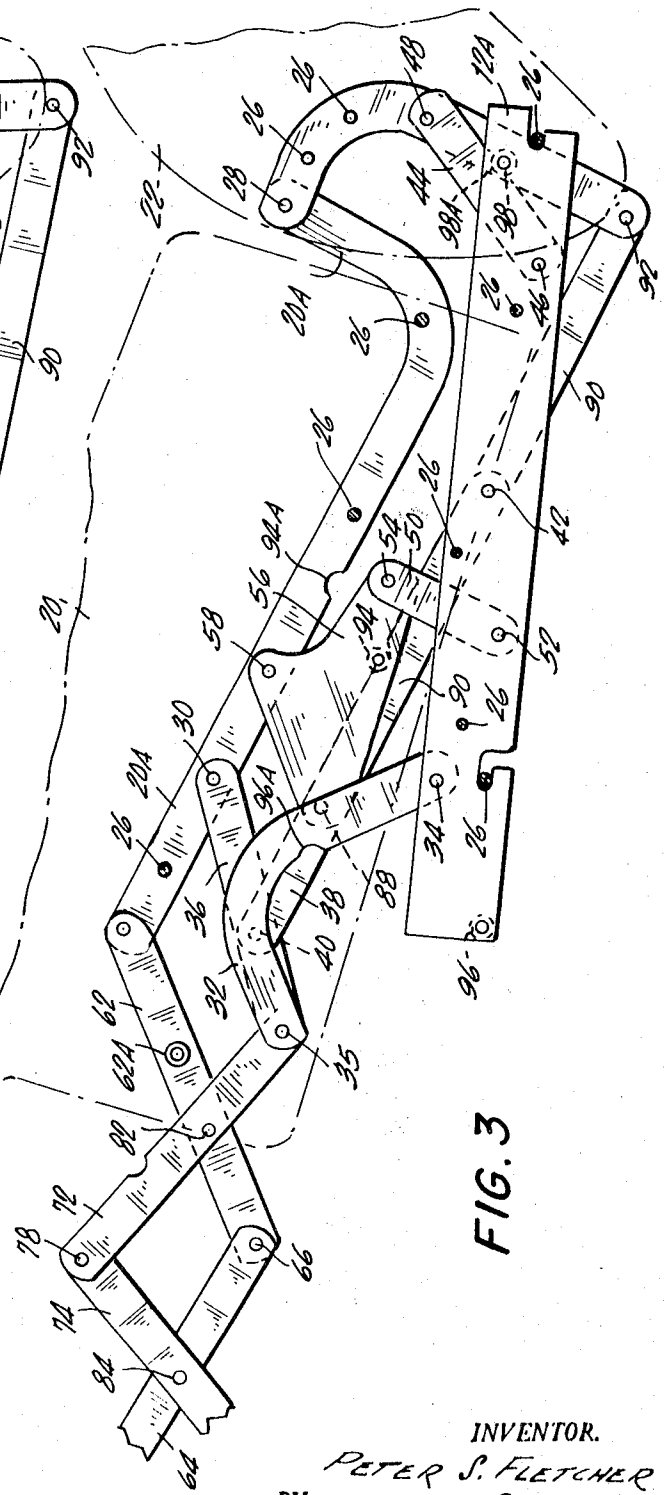


FIG. 3

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RECLINING CHAIR WITH CONSTRAINED LINKAGE

The present invention relates generally to reclining chairs and specifically to an improved reclining chair of the multiple movement type.

With increasing developments in the reclining chair art, there has become an increasing demand for better, smoother operating and more dependable reclining chairs. Among the improvements demanded by the furniture industry and the consuming public are smoother operations, easier operations, more dependable operations and the elimination of even minor misalignments of the various movable elements of the chairs, all coupled with the constant requirement for low unit cost.

In general, it is an object of the present invention to provide a new reclining chair having these desirable features. Specifically, it is an object of the present invention to provide a new reclining chair which is highly dependable, which will operate easily and properly and which will be capable of low cost manufacture.

It is within the contemplation of this invention to provide a reclining chair in which smooth functioning of the movement of the seat, the backrest and the leg rest are consistently demonstrated and in which a high degree of assurance exist that the movable elements of the chair will be well aligned and will be in proper position with respect to each other at all the positions of the chair and particularly in the upright sitting position.

Although the casual observer might believe that differences of one quarter of an inch or so in the position of a seat or leg rest in a reclining chair are unimportant, such variations can and do turn out to be of considerable significance. For example, a misalignment by a small amount in one position of the chair can easily turn out to be a major misalignment, destroying the entire balance, as the chair moves to a different position. More importantly, however, is the fact that small differences in position do make significant differences in the comfort of the chair. In the design of a good reclining chair, extremely careful consideration is given to the precise positioning of the parts, both from the point of view of the comfort of the chair occupant and the balance of the chair demonstrated during the course of its movement. Finally, the precise position of parts becomes highly significant from an esthetic point of view, especially in chairs of modern design or of design where wood edging shows. Even a quarter of an inch sag in a leg rest is visually undesirable in a chair in which thin lines or wood trim makes it easy to see such variations.

It is among the objects of the present invention to eliminate this type of misalignment of the various elements of a reclining chair.

In accordance with one presently preferred embodiment of the present invention, there is provided a reclining chair of the multiple movement type having an arm frame in which is mounted a seat, a backrest and a leg rest by means of a mounting linkage. The mounting linkage is composed of a plurality of individual metallic link members interconnected by appropriate pivot means. The mounting linkage provides for movement of the seat, backrest and leg rest from an upright sitting position through a first movement phase to an intermediate, tilted sitting position and then through a second movement phase to a fully reclined position. The mounting linkage has first constraining means which completely constrains the movement of the linkage and the seat, backrest and leg rest. In addition thereto, and in combination therewith, the mounting linkage has second and further constraining means operative during at least a portion of the movement of the chair. The second constraining means constrains the elements of the linkage to follow a path of movement closely adjacent to but different from the path of constrained movement which the various elements of the linkage would follow under the sole influence of the first constraining means. The linkage itself has sufficient flexibility, resulting from the flexibility in the pivot joints and the inherent flexibility of the materials forming the linkage, to allow the various elements of the linkage to operate under the simultaneous influence of both the first and second constraining means.

The above brief description, as well as further objects, features and advantages of the present invention, will be best understood by reference to the following detailed description of one presently preferred embodiment of the invention when considered in conjunction with the accompanying drawings wherein:

FIG. **1** is a side elevational view of a reclining chair, portions of which have been broken away to expose the metal linkage mounting the seat, backrest and leg rest in the arm frame and with the elements shown in the upright sitting position of the chair;

FIG. **2** is a side elevational view similar to that of FIG. **1** but showing the various elements in the intermediate tilted sitting position; and

FIG. **3** is a side elevational view similar to that of FIGS. **1** and **2** with the elements shown in the fully reclined position of the chair.

Now referring specifically to the drawings, there is shown in FIG. **1** a reclining chair generally designated by the numeral **10**. The chair **10** has an arm frame **12** supported on the floor by appropriate legs **14**. A linkage, generally designated by the numeral **16**, mounts a body-supporting unit, generally designated by the numeral **18**, within the arm frame **12**. The body-supporting unit **18** includes a seat **20** and a backrest **22**. The linkage **16** also mounts a leg rest **24**.

The chair **10** is a multiple movement type of chair and specifically moves from the upright sitting position shown in FIG. **1** through a first movement phase to the intermediate, tilted position shown in FIG. **2**. The chair **10** then moves from the position shown in FIG. **2** through a second movement phase to the fully reclined position shown in FIG. **3**. It will be observed that during the first movement phase, the leg rest **24** moves upwardly and outwardly into a leg-supporting position in response to a relatively minor rearward and tilting movement of the seat and backrest and that the angle between the seat and backrest is maintained substantially uniform. In the second movement phase, the leg rest maintains its elevated, leg-supporting position with respect to the seat **20** and the angle between the seat **20** and backrest **22** opens up significantly to provide a fully reclined position for the chair occupant.

The linkage **16** in accordance with the present invention is characterized by a number of interrelated linkage systems which cooperate to provide the complete range of movement demonstrated by the chair **10**. For manufacturing expediency, the linkage **16** for the reclining chair is made as a separate manufactured item and is fabricated from a plurality of metal link members interconnected by pivots and the like. There are four elements which are rigidly attached to the various structural elements of the lounger-type reclining chair **10**. These are the arm frame bracket **12A** which is rigidly secured in the arm frame **12** by screws **26**, the seat mounting strap **20A** rigidly secured to the seat **20** by further screws **26**, the backrest mounting strap **22A** rigidly secured to the backrest by still further screws **26** and the leg rest mounting bracket **24A** rigidly secured to the leg rest by screws not visible in the drawings. For purposes of ease of description and understanding, the respective chair elements comprising the arm frame **12**, the seat **20**, the backrest **22** and the leg rest **24** and their related mounting straps or brackets will sometimes be referred to interchangeably and collectively in the following descriptions of the chair **10**.

The seat **20** and backrest **22** are directly pivotably interconnected by a seat-backrest pivot **28** located at the rearward end of the seat strap **20A** and the forward end of the backrest strap **22A**. The forward portion of the seat **20** is mounted on the arm frame **12** by means of a first four-bar linkage. Specifically, a control pivot or control point **30** on the seat **20** is guided by a first four-bar linkage for controlled movement along a doubled arc path. The first four-bar linkage comprises a first movable link **32** connected at one end to the arm frame bracket **12A** at mounting pivot **34** and connected at its other end, at pivot **35** to a second movable link **36** which, at its other end is pivotally secured to the control point **30** on the seat **20**.

A third movable link **38** is pivotally connected at **40** on the second movable link **36** at a point between the pivots **30,35** and is pivotally secured by a mounting pivot **42** on the arm frame bracket **12A**. The arm frame bracket **12A** and therefore the arm frame **12**, serves as the stationary link of the four-bar linkage with the first movable link **32**, the second movable link **36** and the third movable link **38** forming the three movable link elements. It will be appreciated by those familiar with standard linkage technology that the control point **30** at the end of the link **36** will describe a double-arced path of movement as the links **32** and **38** are rotated clockwise about their respective mounting pivots **34** and **42**.

Complementary to the mounting of the front of the seat **20** by the first four-bar linkage system is a second seven-bar linkage system which, due to the design of the linkage **16**, is effective to operate as a second four-bar linkage during the first movement phase of the chair **10**. Specifically, there is a backrest link **44** mounted at pivot **46** at the rear of the arm frame bracket which is pivotally secured to the backrest **22** at the backrest strap **22A** at the backrest pivot **48**. As will become clear below, the backrest link **44** is one of three movable links of the second effective four-bar linkage. The second movable link of the second effective four-bar linkage is the holding link **50** secured at its lower end at mounting pivot **52** on the arm frame bracket **12A** and pivotally secured at its upper end, at pivot **54**, to a bellcrank lever **56**. The bellcrank lever **56** is pivoted to the seat **20** at pivot **58** and, during the first movement phase of the chair **10**, the bellcrank lever **56** is rigid with the seat mounting strap **22A** and the seat **22**. Similarly, the seat **20** and backrest are rigid with each other during the first movement phase. Thus, the third effective link of this second effective four-bar linkage is the body supporting unit **18** and specifically it is that portion of the seat **20** and backrest **22** between the pivot **54** at the upper end of link **50** and the backrest pivot **48** at the upper end of the link **44**. The stationary element of the second effective four-bar linkage is, of course, the arm frame **12** and specifically that portion of the arm frame bracket **12A** between the mounting pivot **52** securing the holding link **50** and the mounting pivot **46** pivotally supporting the backrest link **44**.

Even without further considering the addition on specified elements of the linkage **16** of the chair **10**, those skilled in the art will appreciate that there are two effective four-bar link systems, i.e., two constrained link systems, mounting the seat **20** and backrest **22** for movement in the arm frame **12** during the first movement phase. The first four-bar linkage is comprised of links **32,36** and **38** as the three moving links of the four-bar linkage and the arm frame **12** between the mounting pivots **34** and **42** as the stationary link of the first four-bar linkage. The pivot or control point **30** on moving link **36** functions as the mounting point at which the seat **20** is secured to this first four-bar linkage. It will be appreciated by those having even a mild acquaintance with linkages of this basic type that the four-bar linkage is a completely constrained linkage and that the control point **30** will move along a double arc path as the links **32,38** pivot in a clockwise (in the drawings) direction about their respective mounting pivots **34,42**. Thus, the first four-bar linkage constrains the seat **20**, at the control pivot **30** to move in a defined movement, first along one curved path and then along a second and different curved path. Of course, the remainder of the linkage **16** is designed such that the chair is in its first phase of movement during the first portion of this double-arc slot and is in the second phase of movement during the second portion of the double-arc slot with the discontinuity point therebetween occurring when the chair is in the intermediate, tilted sitting position.

The second effective four-bar linkage is made up of more than four separate elements but, due to the design of linkage **16**, these separate elements function as an effective four-bar linkage during the first movement phase. The second effective four-bar linkage has the frame **12** as its stationary member and specifically the portions of the frame **12** between the mounting pivots **52** and **46**. A first movable link is the holding link **50** and a second movable link is the backrest link **44**. The third movable link is made up of several elements which remain rigid during the first movement phase and thus function as a single rigid link. This link can be generally described as the body-supporting unit **18** between the pivot point **54** and the pivot point **48**. Specifically, this third effective movable link is comprised of the portion of the backrest **22** between pivots **48** and **28**, the portion of the seat **20** between the seat backrest pivot **28** and the bellcrank pivot **58** at which a bellcrank lever **56** is attached to the seat **20**, and the portion of the bellcrank **56** between the bellcrank pivot **58** and the pivot **54** to link **50**. By comparing FIGS. **1** and **2**, it will be seen that as the holding link **50** and backrest link **44** rotate rearwardly during the first movement phase, the third effective movable link as defined herein (links **22A**, **20A** and **56**) maintains rigidity and that the angle between the seat and backrest, during the first movement phase, does not change. Hence, we can correctly describe the various link elements in a kinematic definition wherein there is the defined first four-bar linkage and the defined effective second four-bar linkage operating within the chair **10** during its first movement phase.

During the first movement phase, the leg rest **24** is moved from its inoperative position as shown in FIG. **1** to its operative, elevated, leg-supporting position as shown in FIG. **2** in response to movement of the body-supporting means in the first movement phase. The leg rest **24** is mounted by means of a lazy tong type of linkage generally designated by the numeral **60** and includes a first pair of interconnected links **62,64** pivotally joined at pivot **66** with the first link **62** attached to the forward end of the seat rail **20A** at pivot **68** and the further end of the link **64** attached to the leg rest mounting bracket **24A** at pivot **70**. A second chain of interconnected links, pivotally crossed with links **62, 64** is identified in the drawings as links **72, 74** and **76**. Link **76** is connected to link **74** at pivot **78** and link **74** is connected at its opposite end to link **76** at pivot **80**. The intermediate at its ends, link **72** is pivotally crossed with link **62** at pivot **82** and similarly, link **64** and link **74** are pivotally crossed intermediate their respective ends at pivot **84**. The inner end of link **72** is pivotally connected to the first four-bar linkage at pivot **35** on links **32,36** and the far end of link **76** is connected to the leg rest **24** at the leg rest bracket **24A** at pivot **86**. The pivot **86** is provided with a stop **86A** which abuts against link **64** in the upright sitting position of the chair and link **62** is provided with a stop **62A** which abuts link **72** in the upright sitting position, therefore to rigidly define the upright sitting position and to assure the proper location of the leg rest **64** when the chair **10** is fully closed. It will thus be appreciated that the leg rest **24** is mounted for significant extension and moves from its inactive position shown in FIG. **1** to the elevated, leg-supporting position of FIG. **2** in response to movement of the seat **20** and backrest **22** into the intermediate, tilted sitting position and specifically it goes through this movement as link **38, 32** and **36** rotate during the first movement phase.

As referred to above, the seat **20** and backrest **22** maintain a substantially fixed angle between them during the first movement phase. This is accomplished by the fact that the pivotal interconnection at the seat backrest pivot **28** is held free of movement by the coordinated movement of the backrest link **44** with the remaining elements of the mounting linkage **16**. Specifically, the bellcrank lever **56** is pivotally connected to the seat **20** at pivot **58** on the seat-mounting strap **20A**. The third pivot on the bellcrank lever **56**, pivot **88**, provides the pivotal connection between the bellcrank lever **56** and a connecting link **90** which, at its rearward end, is connected to a downward extension of the backrest **22** (at the backrest strap **22A**) at pivot **92**.

From this description, those skilled in the art will appreciate that the second effective four-bar linkage is actually a seven-bar linkage comprising the seat **20**, the backrest **22**, the connecting link **90**, the bellcrank lever **56**, the holding link **50**, the backrest link **44** and the arm frame **12** between the pivotal mounts **46** and **52**. But there is no relative movement between

four of these links during the first movement phase. A stop **94**, shown in dotted outline in the drawings, is rigidly mounted on the inside of the bellcrank lever **56** and engages a complementary seat **94A** formed on the lower edge of the seat-mounting strap **20A**. During the first movement phase, the stop **94** is engaged tightly against its seat **94A** thus holding the bellcrank lever **56** and the seat **20** rigid with respect to each other and effectively making the pivot point **54** between the bellcrank lever **56** and the holding link **50** a stationary pivot on the seat **20**. The fact that pivot **54** is essentially stationary on the seat **20** during the first movement of the phase, combined with the fact that the connecting link **90** makes the entire structure of the bellcrank lever **34**, the seat **20**, the backrest **22** and the connecting link **90** a rigid structure during the first movement phase causes the seven-bar linkage to act as an effective second four-bar linkage.

A support stop **96** is provided at the forward end of the frame bracket **12A** and engages a complementary seat **96A** formed on the lower edge of the link **32**, defining the upright sitting position of the chair and providing support for the seat **20** when the chair is in that position. It will be realized that a great majority of the weight of the chair occupant will normally be exerted through the seat **20** onto the link **36** and from link **36** through to link **32**. The stop **96** serves to support this weight. Similarly, there is a stop **98** formed on the inside surface of the arm frame bracket **12A** and a complementary seat **98A** formed at the rearward edge of the backrest leg **44** to provide a stop for the backrest link when the chair reaches the intermediate, tilted sitting position as shown in FIG. **2** and the fully reclined position as shown in FIG. **3**.

It will be appreciated that, in purely kinematic sense, there is a measure of theoretical redundancy in the constraining means provided in the chair **10**. Theoretically, in a linkage system of absolutely rigid links and perfect pivotal connections, over constraint as incorporated into the linkage **16** is redundant and, therefore, unnecessary. However, the overconstraint incorporated into the linkage **16** is not redundant; it provides significant functional advantages which produce a superior reclining chair. The first effective four-bar linkage (links **32**, **36**, **38** and the arm frame **12** between pivots **34**, **42**) provide continuous constraining means throughout the movement of the chair. Control point **30** is completely defined by the design of the first effective four-bar linkage and that control point would follow a path resulting from the design of that linkage. However, in accordance with the present invention, the reclining chair **10** is overconstrained. The stop **96** is provided between the bellcrank lever **56** and the seat-mounting strap **20A** thus blocking the seven-bar linkage as recited above and causing it to act during the first movement phase as an effective four-bar linkage thus providing a second constrained linkage. However, rather than being redundant, the second constraining system is complementary in that it is designed to produce a path of movement for the chair which is different from, but very close to that which would be demonstrated by the operations of the first four-bar linkage itself. Because the links themselves, being made of ordinary steel, have some degree of flexibility and because the pivotal interconnections are not absolutely precise and have a degree of play in them, the total flexibility thus achieved can accommodate two constraining systems with slightly different theoretical paths of constrained movement. In fact, the two constraining systems, in combination constructively uses the inherent flexibility of the linkage and makes consistent and predictable that which previously operated in an inconsistent and unpredictable manner. The net result is a constrained movement of quite precise and firm characteristics wherein there is virtually no looseness, where the points of discontinuity from one path to another are smoothed out and wherein the chair operates in an easy but nevertheless "tight" manner. Of course, chairs constructed in accordance with the present invention must also have those minimal requirements of good design to produce good positioning of the body-supporting elements and proper balance to enable the chair occupant to remain in any position to which he desires to move the chair. But as an addition thereto, the present invention provides a smooth, dependable and precise feel of movement unavailable in prior art reclining chairs.

A large variety of individual linkage designs may be made which incorporate the present invention. In addition to simple design changes in the specified linkage shown and described here, different linkage systems which nevertheless incorporate the invention may be designed by those skilled in the art. Accordingly, the following claims should be construed broadly in accordance with the spirit and scope of the invention.

What I claim is:

1. In a reclining chair of the multiple movement type having an arm frame, a seat, a backrest and a leg rest, a mounting linkage operatively mounting said seat, backrest and leg rest in said arm frame for movement from an upright sitting position through a first movement phase to an intermediate, tilted sitting position and through a second movement phase to a fully reclined position, the improvement comprising, in combination, said mounting linkage having first constraining means completely constraining the movement of said linkage and said seat, backrest and leg rest during the movement of said chair, second and further constraining means operative during at least a portion of the movement of said chair constraining elements of said linkage to follow a path of movement closely adjacent to the path of constraint of said first constraining means, said linkage having flexibility sufficient for said first and second constraining means to operate simultaneously.

2. In a reclining chair of the multiple movement type having an arm frame, a seat, a backrest and a leg rest, a mounting linkage operatively mounting said seat, backrest and leg rest in said arm frame for movement from an upright sitting position through a first movement phase to an intermediate, tilted sitting position and through a second movement phase to a fully reclined position, the improvement comprising, in combination, said mounting linkage having first constraining means completely constraining the movement of said linkage and said seat, backrest and leg rest during the movement of said chair, second and further constraining means controlling elements of said linkage and constraining them during at least a portion of the movement of said linkage to move along a path of movement slightly different from the path which would result from the sole influence of said first constraining means, said linkage having sufficient flexibility for said first and second constraining means to be operatively simultaneously with elements of said linkage under the influence of both of said first and second constraining means.

3. A reclining chair in accordance with claim **1** wherein one of said first constraining means comprises a four-bar linkage connected between said arm frame and one of said seat and backrest.

4. A reclining chair in accordance with claim **3** wherein said second and further constraining means comprises an effective four-bar linkage connected between said arm frame and one of said seat and backrest.

5. A reclining chair in accordance with claim **1** wherein said first constraining means includes:

1. a first four-bar linkage for constrained control of a control point on said seat throughout said first and second movement phases, said first four-bar linkage having:
   a. said arm frame as a stationary link,
   b. a first movable link pivoted to said arm frame,
   c. a second movable link pivoted to said arm frame, and
   d. a third movable link pivoted to said first and second movable links and pivotally connected to said seat at said control point,
2. a said second constraining means includes a seven-bar linkage acting during at least a portion of said first movement phase, as a second, effective, four-bar linkage, having:
   a. said arm frame as a stationary link,
   b. a holding link pivotally connected to said arm frame and serving as a first movable link,

c. a backrest link as a second movable link pivoted to said arm frame at a point rearwardly from said first movable link, and

d. said body-supporting unit as an effective third movable link,

said first and second movable links pivotally connected at two points respectively, one on said seat and one on said backrest, said seat and backrest between said two points, remaining substantially rigid during said first movement phase,

3. said seven-bar linkage acting as a six-bar linkage operable during said second movement phase to open the including angle between seat and backrest and having:

a. said arm frame as a stationary link,

b. said seat as a first movable link,

c. said backrest as a second movable link pivotally connected to said first movable link,

d. a bellcrank lever having three pivot points as a third movable link pivotally connected at a first one of its pivot points to said seat, and

e. a connecting link as a fourth movable link pivotally connected at one end to said bellcrank lever at a second one of its pivots and to said second movable link at a point spaced from the pivot connection between said first and second movable links,

a holding link pivotally connected at one end to said arm frame and at its other end to said bellcrank lever at its third pivot point.