Jan. 16, 1968 P. S. FLETCHER 3,363,942

RECLINING CHAIR SEQUENCING ARRANGEMENT

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FIG. 1.

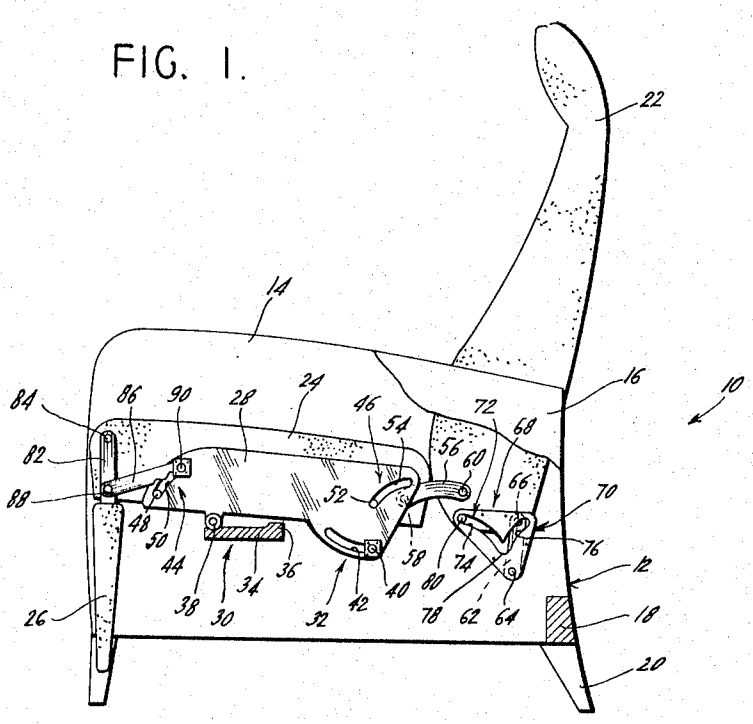
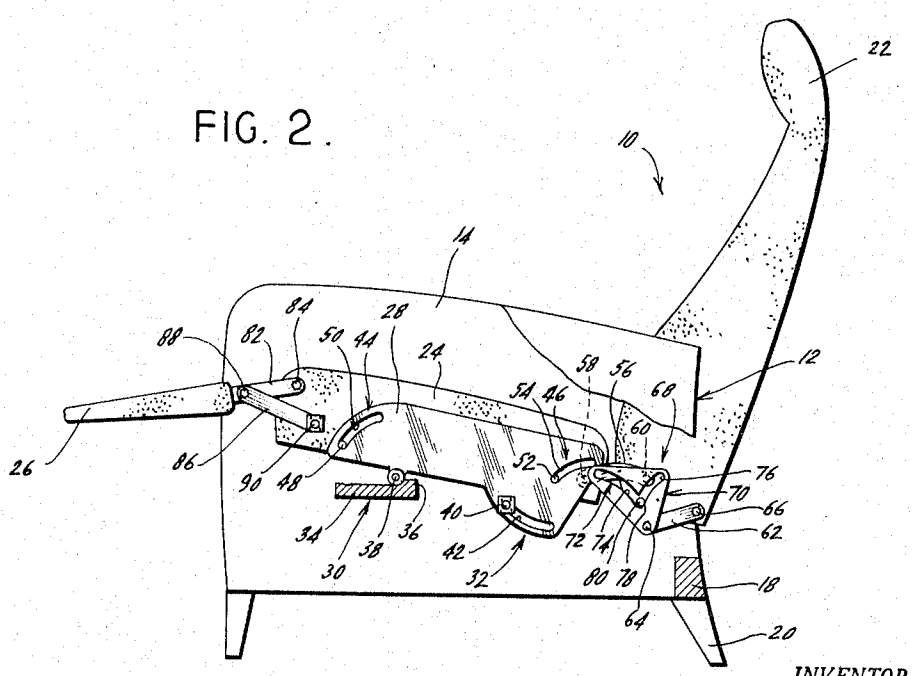


FIG. 2.



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FIG. 3.

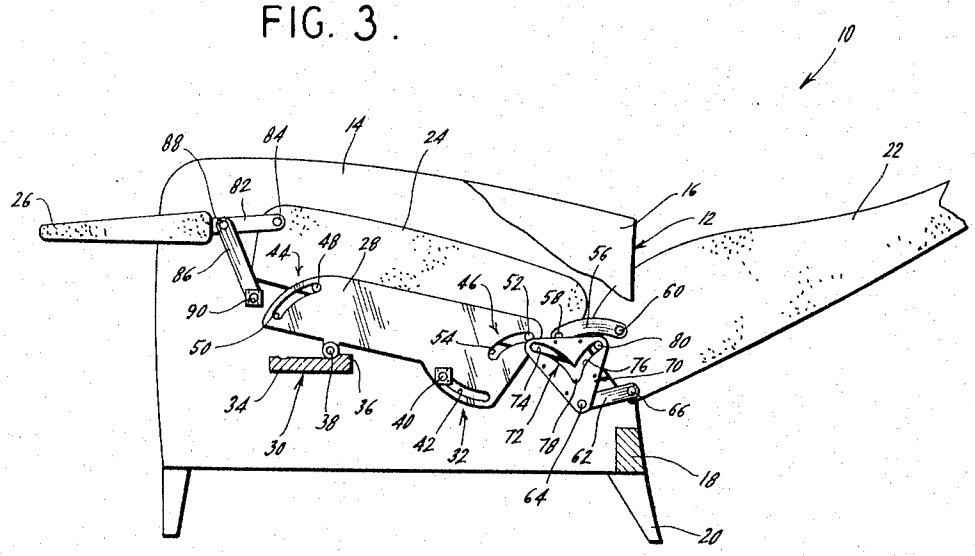
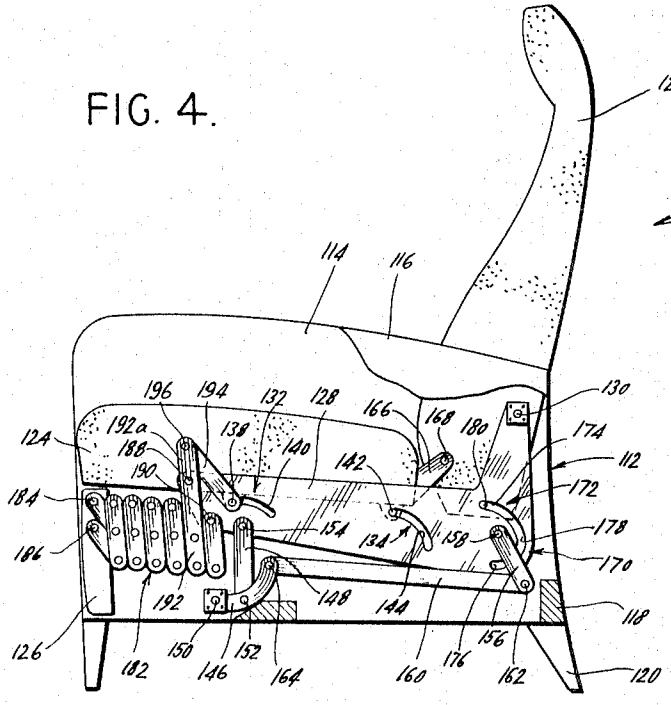


FIG. 4.



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FIG. 5.

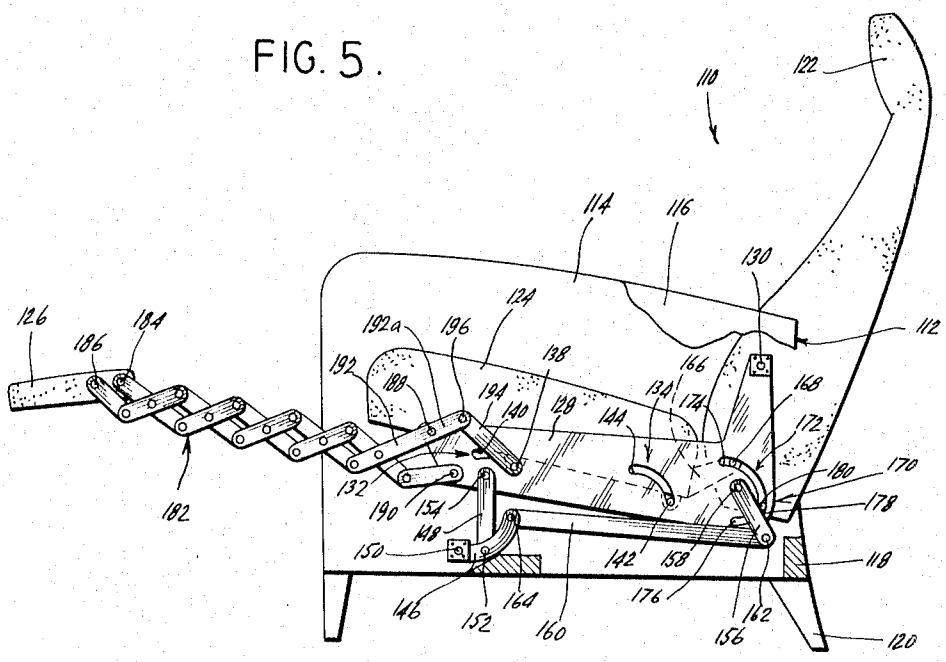
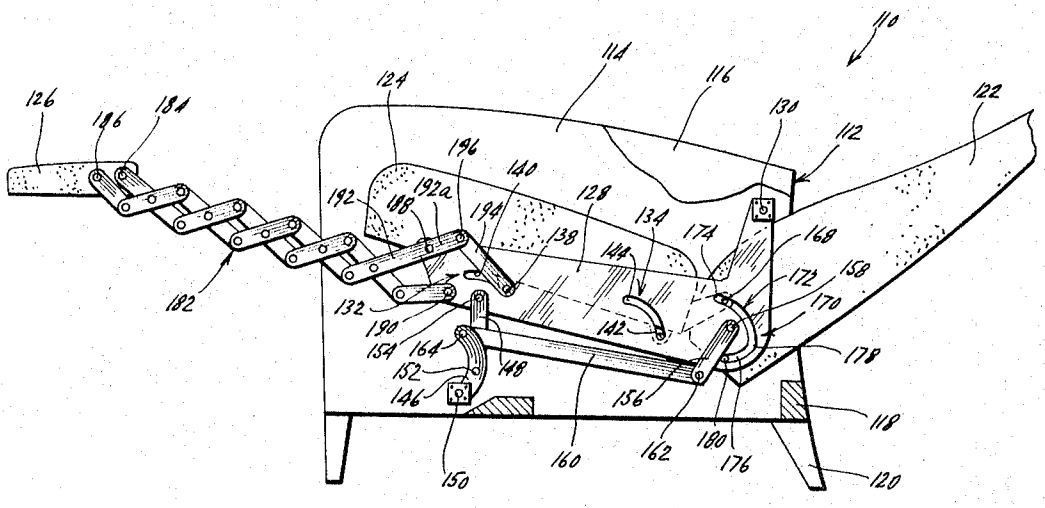


FIG. 6.



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FIG. 7.

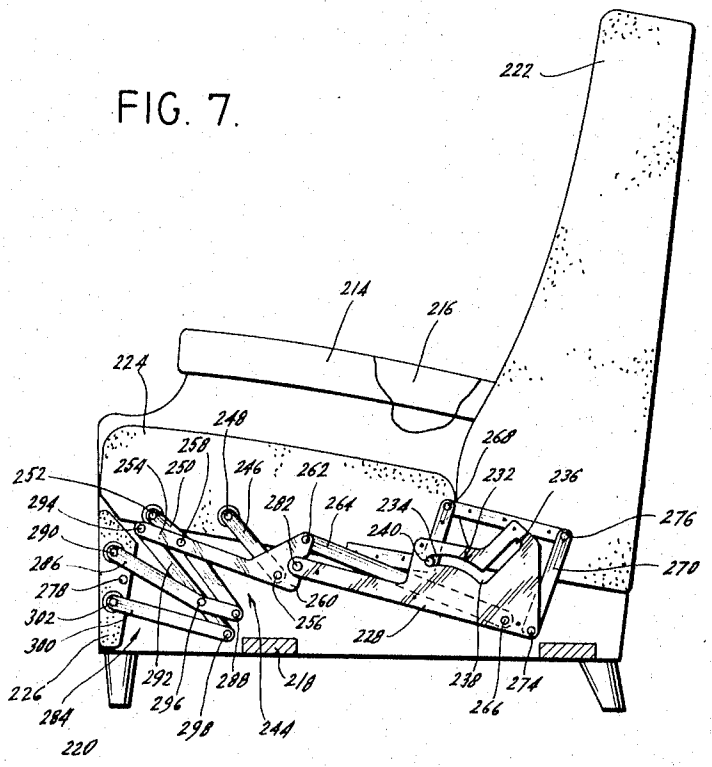
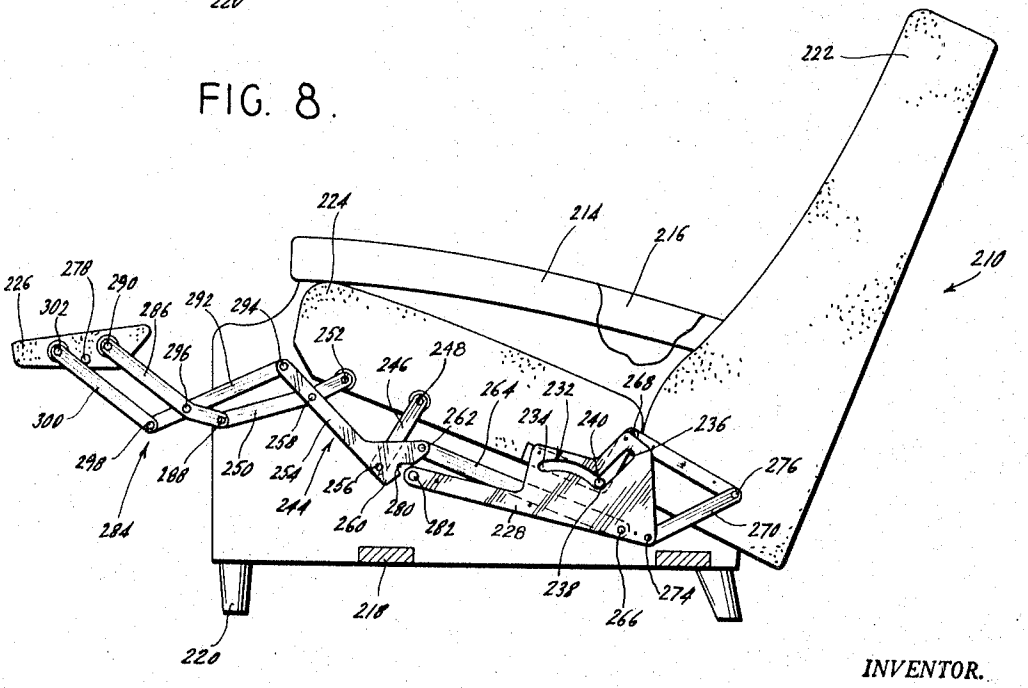


FIG. 8.

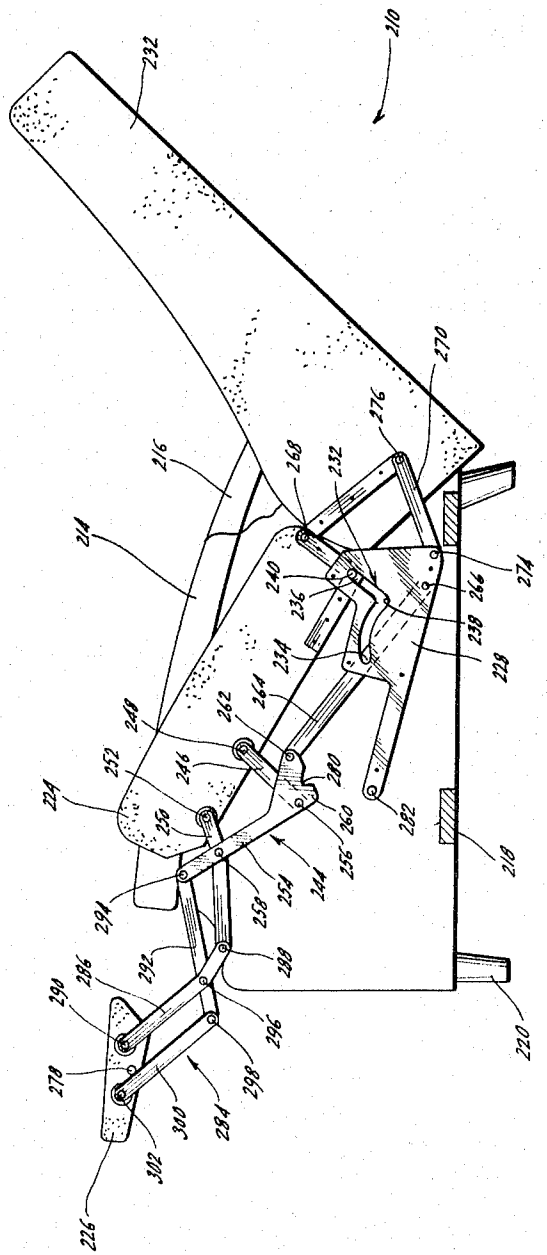


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FIG. 9.



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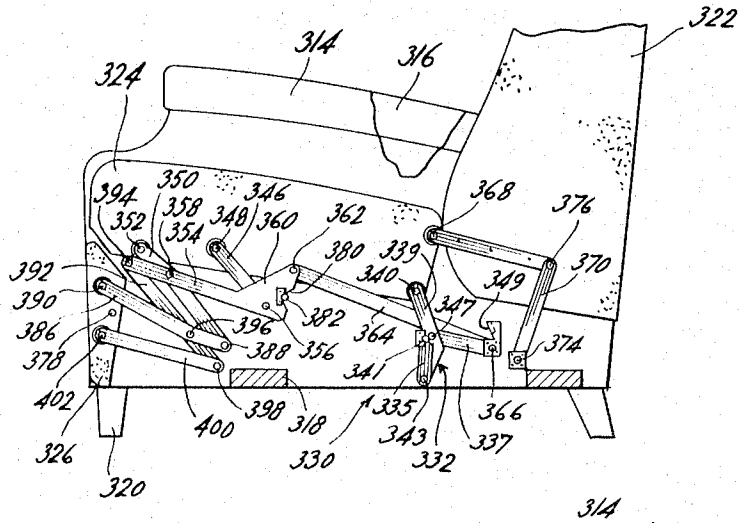


FIG. 10.

FIG. 11.

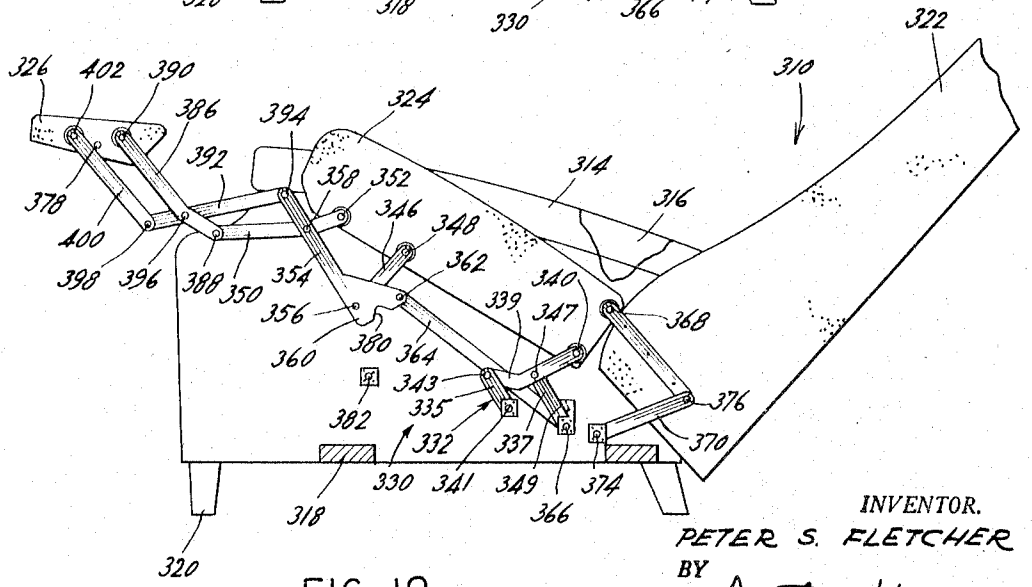


FIG. 12.

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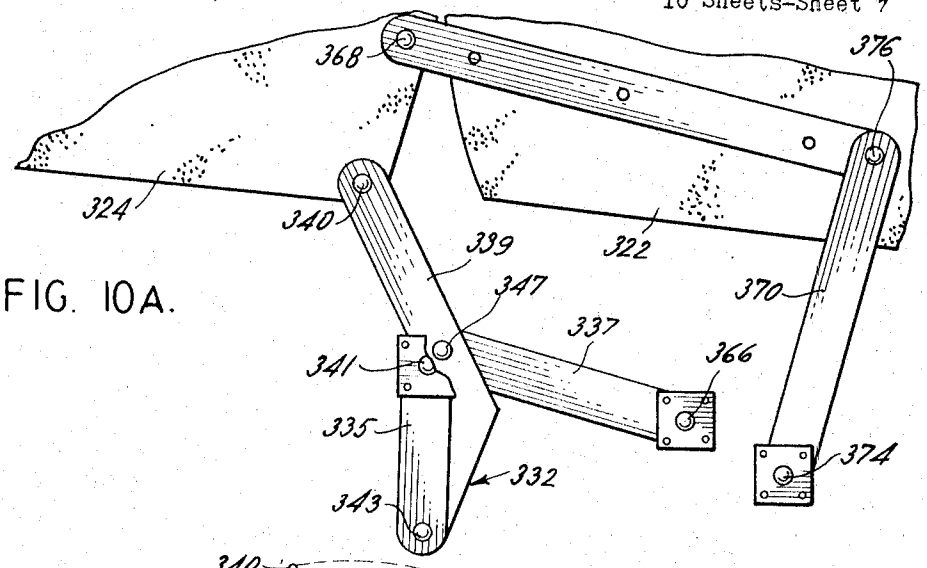


FIG. 10A.

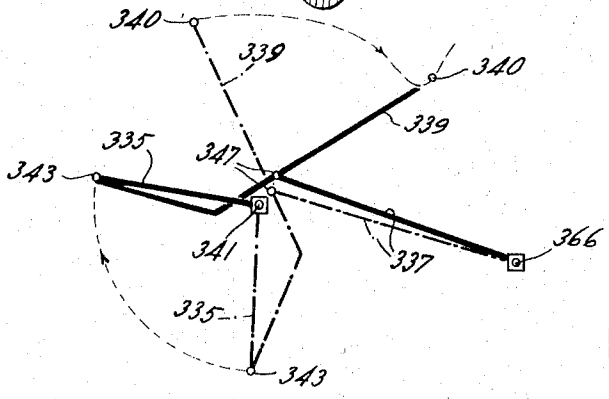


FIG. 11A.

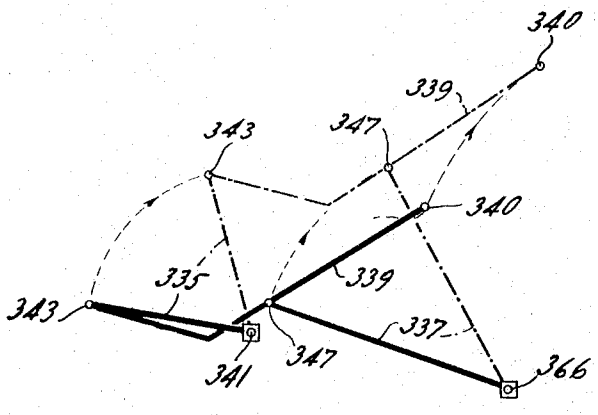


FIG. 12A.

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FIG. 13.

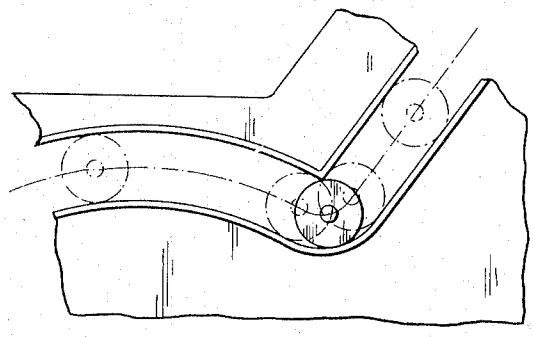


FIG. 14.

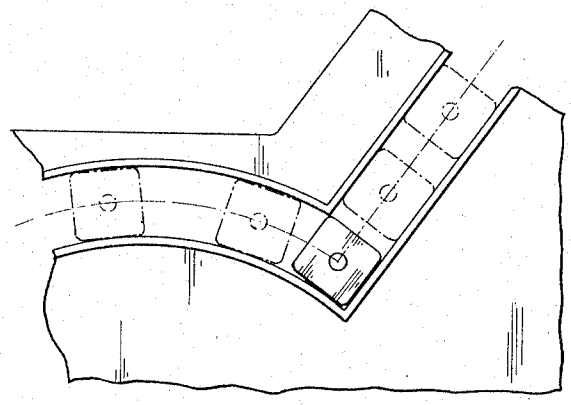
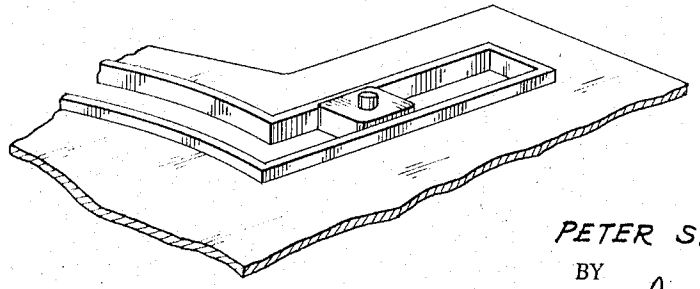


FIG. 15.



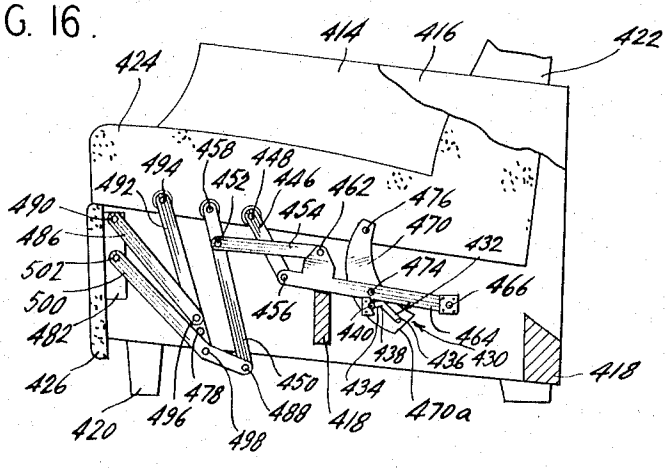
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RECLINING CHAIR SEQUENCING ARRANGEMENT

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FIG. 16.



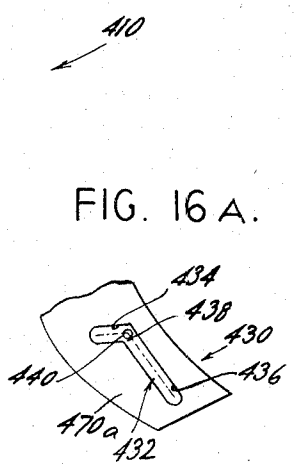
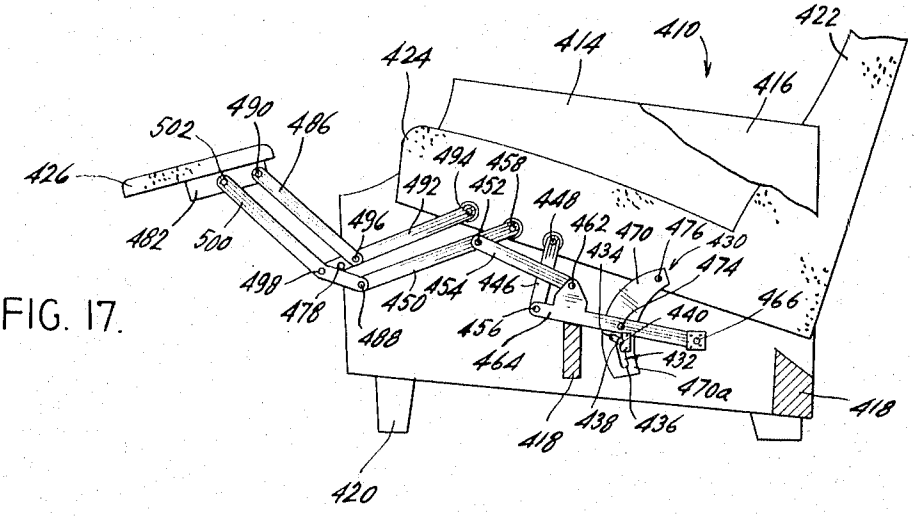


FIG. 16A.

FIG. 17.



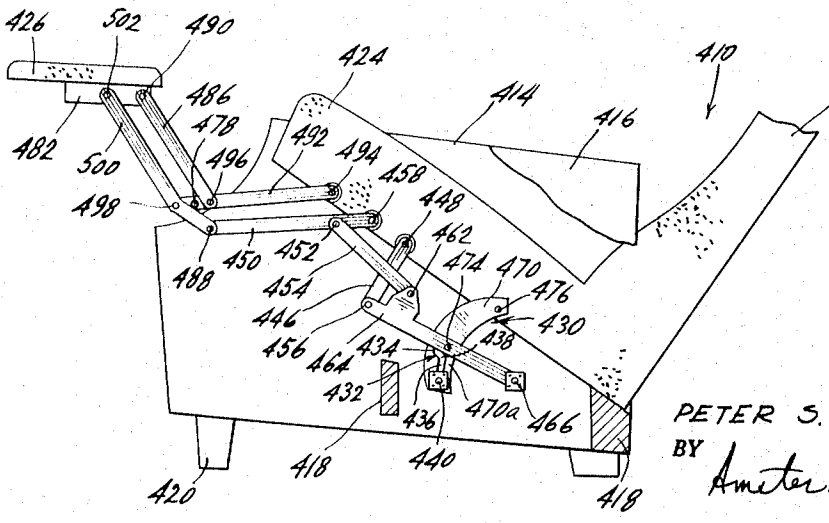


FIG. 18.

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FIG. 19.

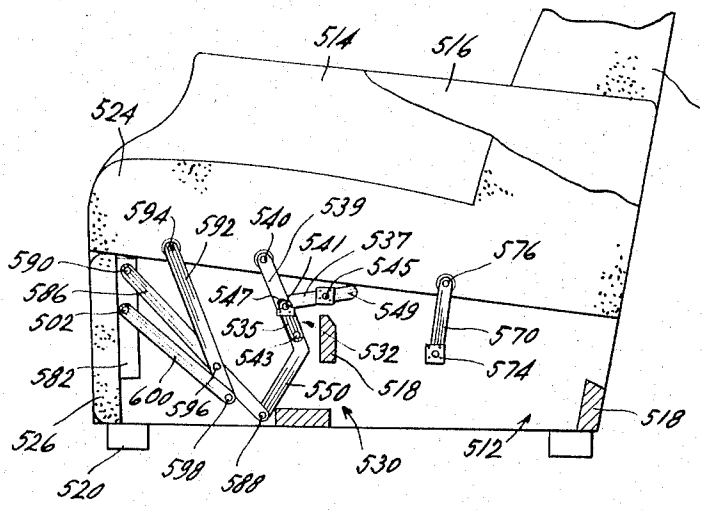
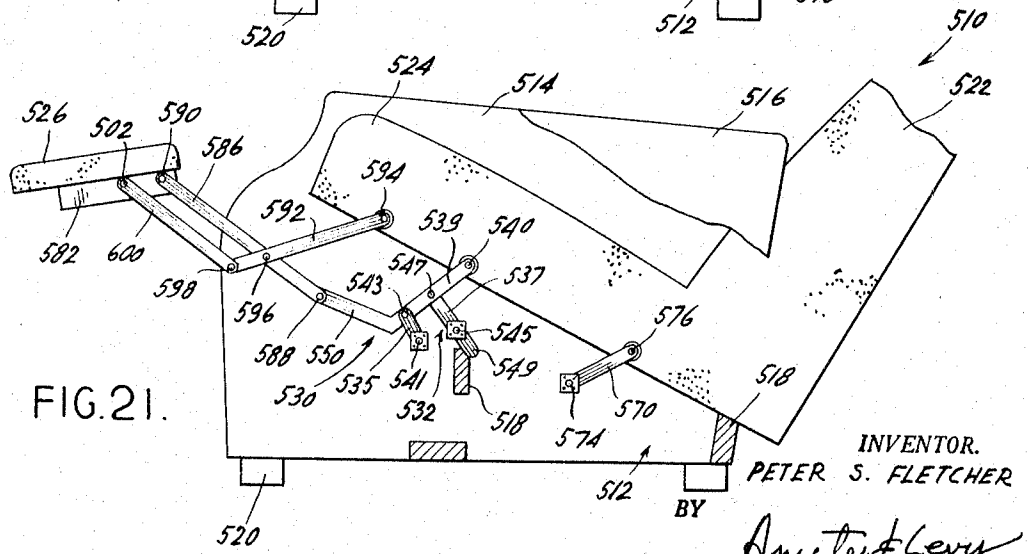


FIG. 20.

FIG. 21.



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United States Patent Office 3,363,942 Patented Jan. 16, 1968

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RECLINING CHAIR SEQUENCING ARRANGEMENT

Peter S. Fletcher, 20 NW. 95th St., Delray Beach, Fla. 33444

Continuation of application Ser. No. 242,581, Dec. 3, 1962. This application Dec. 24, 1963, Ser. No. 334,687
8 Claims. (Cl. 297—322)

The present invention relates to reclining chairs of the type including body-supporting means mounted to have at least two distinct phases of chair movement, and in particular to a sequencing arrangement for a reclining chair of this type to establish the order of operation of the several phases. This is a continuation of my earlier filed co-pending application Ser. No. 242,581, now abandoned filed on Dec. 3, 1962, which in turn was a continuation-in-part of my earlier filed application, Ser. No. 838,539 filed on Sept. 8, 1959, entitled, Sequencing Arrangement for Reclining Chairs of the Multiple Movement Type, which was a continuation-in-part of my application Ser. No. 601,885 filed on Aug. 3, 1956, and entitled, Movable Reclining Chair with Back-Rest, Seat and Leg-Rest.

Heretofore there have been two distinct types of single movement reclining chairs, those constructed with a unitary back-rest and seat mounted on the support for movement into various tilted positions, and those constructed with a movable back-rest and movable seat mounted on the support for reclining and inclining movement respectively. Chairs of the single movement type incorporating a unitary back-rest and seat are most suitable for accommodating the chair occupant in a tilted back position, but in a sitting attitude with the occupant's legs supported on the elevated leg-rest. Such chairs are particularly suitable for accommodating the chair occupant in an attitude appropriate for television viewing, reading, sewing and like activities. Chairs of the type incorporating a movable back-rest and movable seat are found to be more suitable for accommodating the chair occupant in a complete and full relaxation position in that the angle between the seat and back-rest increases in response to the reclining movement of the chair. Such chairs are particularly suitable for accommodating the chair occupant in a stretched out or fully reclined attitude.

Of recent times there have been developed improved multiple-movement reclining chairs which exhibit attributes of both types of chairs which have been heretofore sold, to wit, those suitable for accommodating the chair occupant in a tilted back attitude, and those which will accommodate the chair occupant in a fully reclined or completely relaxed attitude. The multiple movement chairs may be of the type incorporating a unitary back-rest and seat wherein there are first and second movement phases, with the chair moving from an upright sitting position to an intermediate, tilted sitting position during the first movement phase and from the intermediate, tilted sitting position to a reclining position in the second movement phase, with no change in the angular relationship between the seat and back-rest during such two movement phases; or the multiple movement chairs may be of the type incorporating a movable seat and movable back-rest wherein there are first and second movement phases, with the chair moving from an upright sitting position to an intermediate, tilted sitting position during the first movement phase and from the intermediate, tilted sitting position to a reclining position in the second movement phase, with an increase in the angular relationship between the seat and back-rest during the second movement phase. In both types of chairs a leg-rest is included, the leg-rest being elevated to the leg-supporting

position in front of and substantially at the level of the front of the seat during the first movement phase, the leg-rest being maintained substantially in this position during the second movement phase. Both of these types of chairs usually include first and second guide means which movably mount the body-supporting means on the support for a first movement phase from an upright sitting position to an intermediate, tilted sitting position and for a second movement phase from the intermediate, tilted sitting position to a reclining position. Such first and second guide means are subject to a great deal of variation and change on their construction, but the problem exists to establish the order or sequence of operation of such guide means to assure that the body-supporting means will be properly guided during the first and second movement phases respectively to establish the several positions for the chair. Such sequencing should be of a positive and reliable nature and preferably should be automatically operable when the chair occupant is seated and exerts the necessary actuating force upon the body-supporting means of the chair. Further, the sequencing should be established in a manner compatible with the more generalized requirements of simplicity in construction and facility to mass production manufacture.

Broadly, it is an object of the present invention to provide a sequencing arrangement for a reclining chair of the type including at least two distinct phases of chair movement. Specifically, it is within the contemplation of the present invention to provide a continuous constraining means useful in reclining chairs of the multiple movement type which is effective to establish the sequence of operation for the chair automatically as the chair is operated by the chair occupant.

In accordance with an illustrative embodiment demonstrating features and advantages of the present invention, a sequencing arrangement is provided for a reclining chair of the type which comprises a support, body-supporting means including a back-rest and seat, and means movably mounting the body-supporting means on the support for a first movement phase from an upright sitting position to an intermediate, tilted sitting position and for a second movement phase from said tilted position to a reclining position. The sequencing arrangement includes a continuous constraining means operatively connected to the body-supporting means. The continuous constraining means constrains the body-supporting means during the first movement phase to move along a first prescribed path and further constrains the body-supporting means during the second movement phase to move along a second prescribed path to establish the sequence of operations of the chair.

The above brief description as well as further objects, features and advantages of the present invention will be more fully understood by reference to the following detailed description of several illustrative embodiments according to the present invention, when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevational view, with parts broken away and sectioned, showing a reclining chair of the double movement type embodying a sequencing arrangement in accordance with the present invention, with the chair shown in the upright sitting position;

FIG. 2 is a side elevational view similar to FIG. 1, but showing the chair in an intermediate, tilted sitting position, with the leg-rest moved to an elevated leg-supporting position, and the sequencing arrangement in its corresponding intermediate position;

FIG. 3 is a side elevational view similar to FIG. 2, but showing the reclining chair in a fully reclined position, with the leg-rest being disposed in an elevated leg-supporting position, and the sequencing arrangement shown in its corresponding end position;

FIG. 4 is a side elevational view, with parts broken away and sectioned, showing a further reclining chair of the double movement type embodying a further sequencing arrangement in accordance with the present invention, with the chair shown in the upright sitting position;

FIG. 5 is a side elevational view similar to FIG. 4, but showing the chair in an intermediate, tilted sitting position with the leg-rest moved to an elevated leg-supporting position, and the sequencing arrangement in its corresponding intermediate position;

FIG. 6 is a side elevational view similar to FIG. 5, but showing the reclining chair in a fully reclined position, with the leg-rest being disposed in an elevated leg-supporting position, and the sequencing arrangement shown in its corresponding end position;

FIG. 7 is a side elevational view, with parts broken away and sectioned, showing a reclining chair of the double movement type embodying a sequencing arrangement in accordance with the present invention, with the chair shown in the upright sitting position;

FIG. 8 is a side elevational view similar to FIG. 7, but showing the chair in an intermediate, tilted sitting position with the leg-rest moved to an elevated leg-supporting position, and the sequencing arrangement in its corresponding intermediate position;

FIG. 9 is a side elevational view similar to FIG. 8, but on an enlarged scale and showing the reclining chair in a fully reclined position, with the leg-rest being disposed in an elevated leg-supporting position, and the sequencing arrangement shown in its corresponding end position.

FIG. 10 is a side elevational view, with parts broken away and sectioned, of a still further double movement reclining chair embodying a further sequencing arrangement in accordance with the present invention with the chair being shown in its upright sitting position;

FIG. 11 is a view similar to that of FIG. 10, showing the chair in its intermediate, tilted sitting position with the leg-rest moved to an elevated leg-supporting position and the sequencing arrangement in the corresponding intermediate position;

FIG. 12 is a view similar to that of FIGS. 10 and 11 illustrating the chair in its fully reclined position with the leg-rest being disposed in an elevated leg-supporting position and the sequencing arrangement shown in its corresponding end position;

FIG. 10A is an enlarged elevational view of the linkage incorporated in the chair of FIGS. 10, 11 and 12.

FIGS. 11A and 12A are schematic line drawings of the linkage incorporated in the chair of FIGS. 10, 11 and 12. FIG. 11A shows the linkage in dotted line configuration in the upright sitting position and in solid line configuration in the intermediate, tilted sitting position and illustrates the paths of motion of two points on the linkage during the first motion phase. FIG. 12A illustrates the position of the linkage in the intermediate, tilted sitting position in solid line configuration and the position of the linkage at the fully reclined position in dotted line configuration and illustrates the paths of motion of three points on the linkage during the second motion phase.

FIG. 13 is an enlarged partial elevational view of a positive displacement cam and associated follower roller of the type which may be incorporated in a sequencing arrangement in the chair of FIGS. 7, 8 and 9, illustrating the curved path of travel of the follower;

FIG. 14 is a view similar to that of FIG. 13 however, showing a generally rectangular follower rather than a round follower and illustrating the sharp-cornered path of travel of the follower;

FIG. 15 is a partial perspective view of a positive cam and cam follower which may be employed in the sequencing devices according to the present invention;

FIG. 16 is a side elevational view, with parts broken away and sectioned, showing a still further reclining chair of the double movement type embodying a still further sequencing arrangement in accordance with the present invention, the chair being shown in its upright sitting position;

FIG. 17 is a side elevational view similar to that of FIG. 16 illustrating the chair in its intermediate, tilted sitting position with the leg-rest elevated in a leg-supporting position and the sequencing arrangement in its corresponding intermediate position;

FIG. 18 is a view similar to FIGS. 16 and 17 illustrating the chair in its fully reclined position with the sequencing arrangement in its corresponding end position;

FIG. 16*a* is an enlarged elevational view of a portion of the sequencing arrangement utilized in the chair of FIGS. 16, 17 and 18;

FIG. 19 is a side elevational view, with parts broken away and sectioned, showing a reclining chair of the double movement type embodying a still further sequencing arrangement in accordance with the present invention, with the chair shown in its upright sitting position;

FIG. 20 is a view similar to FIG. 19 illustrating the chair in its intermediate, tilted sitting position with the leg-rest in an elevated leg-supporting position and the sequencing arrangement in its corresponding intermediate position; and

FIG. 21 is a view similar to that of FIGS. 19 and 20 illustrating the chair in its fully reclined position with the leg-rest maintained in its elevated leg-supporting position and the body supporting unit in its fully reclined position with the sequencing arrangement at its corresponding end position.

Referring now specifically to FIGS. 1 to 3 of the drawings, there is shown a first embodiment of reclining chair incorporating a sequencing arrangement demonstrating features of the present invention. The chair, which is generally designated by the reference numeral **10**, which includes a support or frame **12** having opposite side walls **14**, **16** interconnected by suitable cross braces **18** and supported on depending legs **20**.

Body-supporting means including a back-rest **22** and a seat **24** are movably mounted on the support for reclining and inclining movement respectively for a first movement phase from the upright sitting position illustrated in FIG. 1 to the intermediate, tilted sitting position illustrated in FIG. 2 and for a second movement phase from the intermediate, tilted sitting position illustrated in FIG. 2 through a series of reclining positions to a fully reclined or complete relaxation position illustrated in FIG. 3.

Disposed beneath the forward end of the seat **24** is a leg-rest **26** which is mounted for movement from the stored position illustrated in FIG. 1 to the elevated leg-supporting positions illustrated in FIGS. 2 and 3. As will be described the leg-rest **26** is operatively connected to the body-supporting means for movement into the elevated leg-supporting position in response to the first movement phase of the chair, with the leg-rest remaining substantially in the elevated leg-supporting position as the chair moves from the intermediate, tilted sitting position of FIG. 2 to the fully reclined position of FIG. 3.

In this illustrative embodiment, a seat guiding plate or member **28** is guidingly mounted on the chair support or frame **12** by respective front and rear plate guide means **30**, **32** which together guide the seat during the first movement phase from the upright sitting position illustrated in FIG. 1 along a prescribed path to the tilted sitting position illustrated in FIG. 2. The front plate guide means **30** includes a guide rail or track **34** formed at its rearward end with a stop **36**. The guide plate or member **28** has mounted thereon a roller **38** which moves along the guide track or rail **34** from the forward limit position shown in FIG. 1 to the rear limit position against the stop **36** as shown in FIG. 2. The rear plate guide means includes a fixed mounting pin **40** on the chair frame or support which is engaged within an arcuate slot **42** formed in the plate **28**. As seen in FIG. 1, the mounting pin **40** is normally disposed at the lower and rearward end of the arcuate slot with the slot translating

rearwardly relative to the stationary mounting pin **40** in response to chair movement to guide the rearward portion of the plate **28** rearwardly and downwardly during the first phase of the chair. The joint effect of the front and rear plate guide means **30**, **32** for the first movement phase is to guide the forward portion of the plate **28** rearwardly at substantially the same level and to guide the rearward portion of the plate **28** rearwardly and downwardly. The seat **24** in turn is mounted on the guide plate **28** through respective front and rear seat guide means **44**, **46** which together guide the seat **24** during the second movement phase from the tilted position illustrated in FIG. 2 along a prescribed path to the inclined position illustrated in FIG. 3. The front seat guide means **44** is in the form of a pin and slot interconnection including a pin **48** fixed to the forward portion of the seat and engaged within an arcuate slot **50** formed at the forward end of the guide plate **28**. A similar pin and slot interconnection **46** including a pin **52** on the rearward portion of the seat and a slot **54** at the rearward portion of the guiding plate **28** is provided for guiding the rearward portion of the seat. During the first movement phase, the respective pins **48**, **52** are seated at the lower ends of the respective slots **50**, **54** and for all intents and purposes the seat **24** may be considered to be unitary or rigid with the plate **28**, as may be appreciated by inspecting the relative positions of the plate **28** and the seat **24** in FIGS. 1 and 2. However, during the second movement phase the seat **24** translates upwardly and rearwardly relative to the guiding plate **28** which remains stationary during the second movement phase, as may be appreciated by progressively inspecting the relative positions of the seat **24** and the plate **28** in FIGS. 2 and 3. Although the respective front and rear plate guide means **30**, **32** and seat guide means **44**, **46** for the first and second movement guiding arrangement has been shown as including pins and slots and/or cam and follower arrangements, it will be appreciated that such pins and slots and/or cams and followers may be replaced by the link equivalents.

The back-rest **22** is flexibly coupled to the seat **24** by a coupling link **56** which has a pivotal connection **58** at its forward end to the rear end of the seat **24** and a pivotal connection **60** at its rearward end to the lower end of the back-rest **22**. The back-rest **22** in turn is mounted on the support **12** by a mounting link **62** which has a pivotal connection or mount **64** at its lower end on the support **12** and a pivotal connection **66** at its upper end to the back-rest **22**.

In this illustrative embodiment, a sequencing arrangement, generally designated by the reference numeral **68**, is coupled to the back-rest **22** and provides a continuous constraining means operatively connected between the body-supporting means **22**, **24** and the support **12** for constraining the body-supporting means during the first movement phase to move along a first prescribed path and for constraining the body-supporting means during the second movement phase to move along a second prescribed path to establish the sequence of operations of the respective first and second guide means for the chair in the order named. The sequencing arrangement **68** includes a sequencing plate **70** formed with a double-arced slot **72** including a first slot section **74** which is effective during the first movement phase and a second slot section **76** which is effective during the second movement phase. The first and second slot sections **74**, **76** extend from respective outer ends toward each other and merge at a junction **78** at their adjacent ends. Confined within the double-arced slot **72** is a pin **80** which in this illustrative embodiment is fixed to the back-rest **22**. The pin or cam follower **80** moves from the outer end of the slot section **74** toward the junction **78** during the first movement phase to constrain the back-rest **22** of the body-supporting means to move with the seat as a substantially rigid unit along a first prescribed path and seats itself at the junction **78** in the intermediate, tilted sitting position of FIG. 2. This intermediate, tilted sitting position and the location of the junction **78** is established by the roller **38** coming into contact with the end stop **36** and the forward end of the slot **42** coming into contact with the pivotal mount **40**. During the second movement phase the pin or cam follower **80** moves upwardly and rearwardly along the second slot section **76** toward a limit position at the outer end thereof in the fully reclined position of the chair, as shown in FIG. 3. The pin **80** constrains the back-rest **22** of the body-supporting means during the second movement phase to move exclusively along a second prescribed path. It will be appreciated that incident to the first and second movement phase as established by the respective guide means of the chair, a point on the body-supporting means will move along a complex path which cannot be established by simple link means. Therefore, in order to positively constain the body-supporting means to achieve the desired chair movement with the proper sequencing, it is essential to be able to make a point on the body-supporting means move along the complex path (to the exclusion of all other paths) established in the first instance by the respective guide means for the first and second movement phases of the chair. Such constraining effect could not be positively achieved by a link or a series of links, particularly when it is appreciated that there will be a sharp change in the direction of motion of the point to be constrained. This may be appreciated by reference to the illustrative embodiment where it is seen that the slot section **74** and the slot section **76** have different curvatures, with a sharp change in direction at the junction **78** which could not be duplicated by a simple link means. Thus if the chair would have any tendency to move in the first instance through the second movement phase, the sequencing arrangement **68** dictates that the first guide means must operate first for so long as the pin **80** is confined within the first slot section **74**, the curvature of which is determined by the guiding action of the first movement phase linkage; and only after the pin arrives at the junction **78** and is capable of moving along the second slot section, will the second movement phase mechanism be released for operation.

In this illustrative embodiment, the leg-rest **26** is mounted in a stored position beneath the forward end of the seat **24** by a rigid hanger arm **82** which has its lower end fixed to the leg-rest **26** and has a pivotal mount **84** at its upper end on the seat. Extending rearwardly from the hanger arm **82** is an actuating link **86** which has a pivotal connection **88** at its forward end to the hanger arm **82** at a point spaced from the pivotal mount **84** and has a stationary pivotal mount **90** on the support **12** at a point rearwardly of the leg-rest **26**. Accordingly, in response to the rearward movement of the pivotal mount **84** of the leg-rest on the seat **24**, the leg-rest will tend to turn about the pivotal connection **88**, moving from the stored position illustrated in FIG. 1 to the elevated leg-supporting position illustrated in FIG. 2.

In order to facilitate a more thorough understanding of this embodiment of the present invention, reference will now be made to a typical sequence of operations:

When the chair occupant is seated in the chair and pushes the seat **24** and the back-rest **22** rearwardly, the seat will start to move through the first movement phase as established by the respective front and rear plate guide means **30**, **32**. During such first movement phase the forward portion of the seat **24** remains substantially at the same level, while the rearward portion of the seat is lowered incident to the guiding action of the pin and slot interconnection **40**, **42**. In turn, the back-rest **22**, which is flexibly coupled to the seat **24** for pivotal movement via the link **56** and mounted on the support **12** via the guiding link **62**, is lowered and rearwardly tilted, with the angular relationship between the seat **24** and the back-rest **22** remaining substantially the same.

Although there might have been a tendency for the pins 48, 52 of the respective front and rear seat guide means 44, 46 of the second movement phase to translate upwardly along their respective slots 50, 54, this tendency is precluded by the positive constraining effect of the pin 80 which is confined to move along the slot section 74, which in the first instance is designed only to permit movement of the back-rest as if it were rigid with the seat with both moving together along the first prescribed path as defined by the first guide means. The rearward pressure exerted by the occupant of the chair on the back-rest cannot turn the back-rest because of the positive constraining effect of the slot 74, and therefore, the force transmitted to the seat through the link 56 has no lifting component and consequently no tendency to actuate the seat to move in the upward path dictated by the second movement slots 50 and 54. The pin 80 reaches the junction 78 at the time that the roller 38 reaches the end stop 36 and the forward end of the slot 42 reaches the pivotal mount 40 to establish the end of the first movement phase for the chair. At this point in the chair operation, the guiding plate 28 becomes, for all intents and purposes, a part of the support. Continued pressure by the chair occupant against the back-rest will cause the pin or roller 80 to begin to move upwardly along the slot 76, with the seat being guided upwardly and rearwardly relative to the stationary guide plate 28 by the respective front and rear guide means 44, 46 of the second movement guiding arrangement. During such second movement phase the seat is somewhat elevated relative to the support, but remains more or less in the same inclined attitude, while the back-rest 22 is turned rearwardly relative to the seat to open up the angle between the seat and back-rest to thereby establish the fully reclined position illustrated in FIG. 3. During such second movement phase, the leg-rest 26 continues to turn about the pivotal connection 88 of the contraining link 86, with the link 86 in turn turning about its pivotal mount 90 such that the leg-rest is at substantially the same level as the forward end of the seat in the fully reclined position illustrated in FIG. 3.

When the chair occupant desires to restore the chair to the upright or sitting position, the occupant pulls himself forwardly in the chair which causes the body-supporting means to move through the reverse sequence of operations, arriving first at the intermediate, tilted sitting position of FIG. 2 and finally being restored to the upright sitting position illustrated in FIG. 1.

Referring now specifically to FIGS. 4 to 6 inclusive of the drawings, there is shown a further embodiment of a reclining chair including a further sequencing arrangement demonstrating features of the present invention. The chair, which is generally designated by the reference numeral 110, includes a support or frame 112 having opposite side walls 114, 116 interconnected by appropriate cross braces 118 and supported on depending legs 120.

Body-supporting means including a back-rest 122 and a seat 124 are mounted on the support for reclining and inclining movement respectively for a first movement phase from the upright sitting position illustrated in FIG. 4 to the intermediate, tilted sitting position illustrated in FIG. 5 and for a second movement phase from the intermediate, tilted sitting position illustrated in FIG. 5 through a series of reclining positions to a fully reclined or complete relaxation position illustrated in FIG. 6.

Disposed beneath the forward end of the seat 124 is a leg-rest 126 which is mounted for movement from the stored position illustrated in FIG. 4 to the elevated leg-supporting positions illustrated in FIGS. 5 and 6. As will be described the leg-rest 126 is coordinated to the body-supporting means for movement into the elevated leg-supporting position in response to the first movement phase of the chair, with the leg-rest remaining substantially in the elevated leg-supporting position as the chair moves from the intermediate, tilted sitting position of FIG. 5 to the fully reclined position of FIG. 6.

In this illustrative embodiment a carrier member 128 is pivotally mounted at its rearward end on the chair frame or support 112 at a carrier pivotal mount 130. The carrier member or plate 128 serves as a stationary support for the seat guide means for the first movement phase and serves as one movable link of the second movement phase linkage, as will now be described. Specifically, the seat 124 is mounted on the carrier member 128 by respective front and rear seat guide means 132, 134 which are effective together to guide the rear of the seat 124 rearwardly and downwardly during the first movement phase. Specifically, the front seat guide means 132 includes a pin or follower 138 carried on the forward portion of the seat 124 and confined within an arcuate slot or cam 140 formed in the plate 128. The rear seat guide means 134 includes a further pin or follower 142 fixed to the rearward portion of the seat 124 and confined within an arcuate slot or cam 144 formed in the plate 128. In the upright sitting position of the chair the respective pins 138, 142 are seated at the upper and forward ends of the slots or guideways 140, 144. The joint effect of the front and rear guide means 132, 134 of the first movement phase is to guide the forward portion of the seat rearwardly substantially at the same level and to lower the rearward portion of the seat such that the seat arrives at the inclined position illustrated in FIG. 5. At the end of the first movement phase, the respective pins 138, 142 are seated at the lower and rearward end of the slots or guideways 140, 144 such that the seat 124 becomes a unitary assembly with the carrier member or plate 128 during the second movement phase.

The linkage for the second movement phase of the chair includes a link pair 146, 148 pivotally connected between the support 112 and the forward portion of the carrier member or plate 128. Specifically, the link 146 has a pivotal mount 150 at its forward end to the support 112 and a pivotal connection 152 intermediate its ends to the lower end of the link 148. The link 148 has a pivotal connection 154 at its upper end to the carrier member or plate 128. The linkage for the second movement phase further includes a link 156 which is disposed adjacent the rearward end of the carrier member or plate 128 and has a pivotal mount 158 at its upper end on the carrier member. The link 156 is coupled via a connecting link 160 to the link 146 of the link pair 146, 148. Specifically, the connecting link 160 has a pivotal connection 162 at its rearward end to the link 156 and a pivotal connection 164 at its forward end to the rearward and upper end of the link 146 at a point spaced rearwardly of the pivotal mount 150. As seen in FIGS. 4 and 5, the link 146 of the second movement linkage rests against the adjacent cross brace 118 serving as a stop to establish the carrier plate or member 128 in its initial position in relation to the support during the first movement phase. During the second movement phase, and in response to clockwise turning of the link 156 about its pivotal mount 158 on the carrier member 128, the guide means or linkage for the second movement phase will be actuated with the link 146 turning in the counterclockwise direction about the pivotal mount 150. The second movement linkage includes as movable links thereof the link 146, the link 148, the carrier member or plate 128 intermediate the pivotal connection 154 and the pivotal mount 130, the link 156 and the link 160, with the support intermediate the pivotal mounts 130, 150 serving as the stationary link thereof.

In this illustrative embodiment the sequencing arrangement, generally designated by the reference numeral 170, includes a continuous constraining means operatively connected between the carrier plate or member 128 and the back-rest 122. Specifically, the sequencing arrangement or constraining means 170 includes a double-arced slot 172 formed in the rearward portion of the

carrier member or plate **128** having a first slot section **174** which is effective during the first movement phase and a second slot section **176** which is effective during the second movement phase. The first and second slot sections **174**, **176** extend from their respective outer ends towards each other and merge at a junction **178** at their adjacent ends. Confined within the double-arc slot **172** is a pin **180** which is fixed to the back-rest **122** and moves from the outer end of the slot section **174** toward the junction **178** during the first movement phase to constrain the back-rest **122** of the body-supporting means to move along a first prescribed path, seating itself at the junction **178** in the intermediate, tilted sitting position of FIG. 5. During the second movement phase the pin or cam follower **180** moves downwardly and forwardly along the second slot section **176**, and constrains the back-rest **122** of the body-supporting means to move along a second prescribed path seating itself at a limit position at the outer end thereof in the fully reclined position of the chair as shown in FIG. 6. As seen in FIG. 5, the pin or cam follower **180** contacts the link **156** in the intermediate position due to the arrangement of the double-arc slot **172** and the link **156**. Thus during the second movement phase, the pin or cam follower **180** provides an operative or driving connection from the back-rest **122** to the link **156** of the second movement linkage.

In this illustrative embodiment the leg-rest is mounted in a stored position beneath the forward end of the seat **124** by a multiple link pair lazy tong type of arrangement, generally designated by the reference numeral **182**, which includes a pair of pivotal connections **184**, **186** to the leg-rest and a pair of pivotal connections **188**, **190** to the forward portion of the carrier member or plate **128**. The leg-rest mounting linkage, which will not be described in detail in that it merely is illustrative of the many and varied types of leg-rest mounting linkages which may be employed in this illustrative embodiment, includes a link **192** having upward projection **192***a* which is turned in the clockwise direction about the pivotal connection or mount **188** during the first movement phase to extend the leg-rest **126**. Specifically, an actuating link **194** is disposed between the extension **192***a* and the pin **138** and has a pivotal connection **196** at its upper end to the extension **192***a* and a pivotal connection at its lower end to the seat coaxially with the pin **138**. Accordingly, in response to the rearward movement of the seat and of the pivotal connection **138** during the first movement phase, the actuating link **194** turns the link extension **192***a* in a direction appropriate to extend the leg-rest **126**, as may be appreciated by progressively inspecting FIGS. 4 and 5. During the second movement phase the leg-rest **126** remains in a substantially fixed relation to the seat **124**, with the seat **124** being displaced relative to the support incident to the guiding action of the second movement linkage wherein the carrier member **128** is one movable link thereof.

In order to facilitate a more thorough understanding of this embodiment of the present invention, reference will now be made to a typical sequence of operation:

When the chair occupant is seated in the chair and pushes rearwardly, the seat **124** will move rearwardly relative to the carrier member **128** being guided by the respective front and rear guide means **132**, **134**. During the first movement phase, the forward portion of the seat **124** remains substantially at the same level while the rearward portion of the seat is lowered incident to the guiding action of the pin and slot interconnection **142**, **144** of the rear seat guide means **134**. In turn, the back-rest **122** which is pivotally mounted on the seat **124** and is guided by the pin **180** moving in the slot section **174** is is lowered and rearwardly tilted, with the angular relationship between the seat **124** and the back-rest **122** remaining substantially the same. Although there might have been a tendency for the second movement phase linkage to operate also incident to the pressure by the chair occupant, this tendency is precluded by the positive constraining effect of the sequencing arrangement **170** which in the first instant is designed only to permit movement of the back-rest **122** and the body-supporting means as a whole along the first prescribed path to arrive at the intermeditae, tilted sitting position shown in FIG. 5. The respective pins **138**, **142** arrive at the lower and rearward limits of the slots **140**, **144** when the pin or cam follower **180** arrives at the junction **178** in contact with the back-rest link **156** at the end of the first movement phase of the chair.

Continued pressure by the chair occupant against the back-rest **122** will cause the pin or roller **180** to begin to slide along the slot **176** which turns the back-rest link **156** in a clockwise direction about the pivotal mount **158** to actuate the second movement linkage. During the second movement phase, the link **146** turns in the counter-clockwise direction about the pivotal mount **150** and the carrier member or plate **128** turns in the clockwise direction about the carrier pivotal mount **130**. During such second movement phase, the seat is somewhat elevated relative to the support by the second movement phase linkage, while the back-rest **122** turns rearwardly relative to the seat **124** about the back-rest pivot **168** to open up the angle between the seat and back-rest to thereby establish the fully reclined position illustrated in FIG. 6.

Referring now specifically to FIGS. 7 to 9 of the drawings, there is shown a still further embodiment of reclining chair including a still further sequencing arrangement demonstrating features of the present invention. The chair, which is generally designated by the reference numeral **210**, includes a support or frame **212** having opposite side walls **214**, **216** interconnected by appropriate cross braces **218** and supported on depending legs **220**. Body-supporting means including a back-rest **222** and a seat **224** are mounted on the support for reclining and inclining movement respectively for the first and second movement phases. Disposed beneath the forward end of the seat **224** is a leg-rest **226** which is mounted for movement from the stored position illustrated in FIG. 7 to the several elevated leg-supporting positions illustrated in FIGS. 8 and 9 during the first and second movement phases. In this illustrative embodiment, the mounting member or plate **228** is rigidly secured to the adjacent side frame of the support **212**. In this illustrative embodiment, the sequencing arrangement which is generally designated by the reference numeral **230** provides a continuous constraining means operatively connected between the mounting member **228** rigid with the support **212** and the rearward portion of the seat **224**. Specifically, the sequencing arrangement or constraining means includes a double arc slot **232** formed in the mounting member or plate **228** which has a first slot section **234** which is effective during the first movement phase and a second slot section **236** which is effective during the second movement phase. The first and second slot sections **234**, **236** extend from their respective outer ends toward each other and merge at a junction **238** at their adjacent ends. Confined within the double arc slot **232** is a pin **240** which is fixed to the rearward portion of the seat by an appropriate L-shaped bracket **242**. The pin **240** of the sequencing arrangement **230** slides from the outer end of the slot section **234** toward the junction **238** in a first movement phase to constrain the seat **224** of the body-supporting means to move along a first prescribed path, seating itself at the junction **238** in the intermediate, tilted sitting position of FIG. 8. During the second movement phase the pin or cam follower **240** moves upwardly and rearwardly along the second slot section **236** and constrains the seat **224** of the body-supporting means to move along the second prescribed path, seating itself at a limit position of the chair shown in FIG. 9.

The front of the seat **224** is guided by a front guiding linkage generally designated by the reference numeral

244 of the type disclosed and described in copending application Ser. No. 832,976 filed Aug. 11, 1959 and entitled Reclining Chair Including Improved Seat Control, which is arranged to guide the seat 224 relative to the support into various inclined positions and to move the leg-rest 226 upwardly and outwardly in response to movement of the seat relative to the support. The front guiding linkage or control arrangement includes a first or rear guiding link 246 having a first pivotal connection 248 to the seat, a second or front guiding link 250 having a second pivotal connection 252 to the seat spaced forwardly of the first pivotal connection 248, and a third or connecting link 254 having respective pivotal connections 256, 258 to the first and second links 246, 250 at points spaced from the first and second pivotal connections 248, 252. The link 246, the link 254 intermediate the pivotal connections 256, 258, the link 250 intermediate the pivotal connections 258, 252 and the portion of the seat 224 intermediate the pivotal connections 252, 248 constitute a four-bar control linkage for the seat, with the link 254 opposite the seat having a pivotal mount which remains stationary during the first movement phase. In this illustrative embodiment, the link 254 includes rearwardly projecting integral locking plate 260 which has a pivotal mount 262 on a guiding link 264 of the second movement linkage which guiding link in turn has a pivotal mount 266 on the mounting plate 228. As disclosed in said copending application, the seat-control linkage thus described is exceptionally versatile and by adjustment of the location of the pivotal mount 262 enables variation in the pitch of the seat independent of the elevation of the leg-rest by the leg-rest mounting and control arrangement which will be subsequently described.

The back-rest 222 is pivotally mounted on the seat 224 at a back-rest pivot 268, with the guiding arrangement for the back-rest being completed by a mounting link 270 which has a pivotal mount 274 at its lower end on the mounting plate 228 at a point spaced behind the pivotal mount 266 and a pivotal connection 276 at its upper end to the back-rest 222 at a point spaced behind the back-rest pivot 268.

During the first movement phase the body-supporting means is guided relative to the support in the front by the seat control linkage 244 and in the rear by the mounting link 270. The pin 240 and slot 234 of the sequencing arrangement 230 holds the seat in rigid relationship to the back-rest during the first movement phase. The end of the first movement phase is established, in this illustrative embodiment, by a stop 278 on the leg-rest 226 which abuts one of the links of the leg-rest mounting arrangement, as seen in FIG. 8.

Further provision is made for establishing the sequencing of the second movement phase linkage. Specifically, the locking plate or extension 260 is formed with a notch 280 which engages a locking pin 282 fixed to the forward end of the plate 228. During the first movement phase, the connecting link 254 turns in the clockwise direction about the pivotal mount 262 such that the locking notch 280 swings out of its engaged position with the locking pin 282, thereby releasing the second movement guiding link 264 for movement, as may be appreciated by progressively inspecting FIGS. 7 and 8.

During the second movement phase, the slot section 236 serves as a constraining means and positively holds the link 270 of the first movement linkage against movement such that the pivotal connection 276 of the link 270 to the back-rest 222 effectively serves as a stationary pivotal mount during the second movement phase. Accordingly, the second movement linkage comprises a stationary link provided intermediate the pivotal mount 266 and the pivotal connection 276 and movable links including the link 264, a further link intermediate the pivotal connection 262 and the back-rest pivot 268 and a still further link intermediate the back-rest pivot 268 and the pivotal connection 276.

In this illustrative embodiment the leg-rest 226 is mounted for movement from the stored position beneath the forward end of the seat 224 by a leg-rest mounting linkage, generally designated by the reference numeral 284, which includes three link pairs. The links 246, 254 of the seat control linkage 244 serve as the first and second links of a first link pair, and link 250 of the seat control linkage serves as a first link of a second link pair. The second link pair further includes the link 286 which has a pivotal connection 288 at its rearward end to the link 250 and a pivotal connection 290 at its forward and to the leg-rest 226. The third link pair includes the link 292 which has a pivotal connection 294 at its upper end to the forward end of the link 254, a pivotal connection 296 intermediate its ends to the link 286 of the second link pair and a pivotal connection 298 at its lower end to the second link thereof 300, which in turn has a pivotal connection 302 at its forward end to the leg-rest 226.

In order to facilitate a more thorough understanding of this embodiment of the present invention, reference will now be made to a typical sequence of operation:

When the chair occupant is seated in the chair and pushes rearwardly, the body-supporting means will move rearwardly relative to the support 212, being constrained at its rearward portion by the mounting link 270 and at its forward portion by the front seat control linkage 244. It will be appreciated that there is a slight turning movement of the locking plate 260 during the first movement phase such as to achieve the release of the locking notch 280 from the locking pin 282. The rearward movement of the pivotal connections 248, 252 incident to the rearward displacement of the seat 224 is effective to move the leg-rest 226 to the extended and elevated leg-supporting position. When the pin 240 of the sequencing arrangement arrives at the junction 238 of the slot sections 234, 236, and the link 300 abuts the stop 278, the end of the first movement phase is effectively established, with the second movement linkage unblocked.

When the chair occupant exerts further pressure on the back-rest 222, the pin 240 begins to move upwardly and rearwardly along the slot section 236 and simultaneously the link 264 begins to turn in the clockwise direction about the pivotal mount 266 to achieve the requisite movement for the seat and back-rest for the second movement phase, with the angle between the back-rest 222 and the seat 224 opening up to establish the fully reclined position illustrated in FIG. 9.

In this embodiment it will be noted that although the slot section 234 can be considered as having a guiding action for the seat, it serves the same function as a lock between the seat and back-rest to hold them in rigid relationship during the first movement. Likewise, although the slot section 236 can be considered to have a guiding action on the seat during the second movement phase, in reality it acts as a positive lock to hold the link 270 rigid with the support in order to have the pivot 276 provide, to the exclusion of all other possibilities, a stationary pivot for the back-rest during the second movement phase.

Referring to FIGS. 10, 11 and 12, there is shown another embodiment of reclining chair including another sequencing arrangement demonstrating features of the present invention. This chair is generally the same as the chair shown in FIGS. 7, 8 and 9, the difference being in the sequencing arrangement. The chair of FIGS. 10, 11 and 12 can be characterized as having a link equivalent of the double-arc slot sequencing means of the chair of FIGS. 7 through 9 to produce a path of motion which, from a practical standpoint, is identical to the path of motion in the chair of FIGS. 7, 8 and 9.

In most cases, the desired constraining effect of the present sequencing arrangement may be achieved in practice by using a four bar linkage. Although such four bar

linkages do not offer the simplicity, precision and flexibility of the follower and positive displacement cam, they do afford comparatively easy manufacture and the elimination of the sliding between pin and cam surface which dictates more careful and in some instances more costly manufacture.

Inasmuch as the embodiment of FIGS. 7, 8 and 9 is similar to the embodiment of FIGS. 10, 11 and 12 in most of its parts, like parts of the latter embodiment are given the same identifying numbers but of the 300 series rather than of the 200 series. Specific recitation of like parts will not be made. In this illustrative embodiment the sequencing arrangement, which is generally designated by the reference numeral **330**, provides a continuous constraining means operatively connected between the support **312** and the rear portion of the seat **324**. Specifically, the sequencing arrangement or constraining means includes a four bar linkage **332** mounted on the support which functions as the stationary link of the four bar linkage **332**, the connecting or floating link **339** of the four bar linkage having a pivotal connection **340** to the seat. The pivotal connection **340** follows a double-arc path which for all intents and purposes is identical to the path followed by the pin **240** under the guiding action of the double-arc slot **232** of the embodiment of FIGS. 7, 8 and 9. The first path segment is effective during the first movement phase, the second path being effective during the second movement phase. See FIGS. 11A and 12A.

The four bar linkage of the sequencing means consists of first and second support links **337**, **335** pivoted to the support at **345** and **341** respectively. The connecting link **339** is pivoted to the first and second support links **337** and **335** at spaced points **347** and **343** respectively. The arrangement of this four bar linkage is such that the two supporting links form an approximate right angle with each other in the upright sitting position in FIG. 10. As the chair moves from the upright sitting position to the intermediate, tilted sitting position, the second supporting link **335** rotates to a position more or less parallel with the first support link **337**, as may be seen by inspecting FIGS. 10 and 11 and FIGS. 11A and 12A. The connecting link **339** is guided thereby in a rotary motion to produce an arcuate path along which the pivot **340** on the seat is constrained to move. Simultaneously, with the engagement of the link **400** with the stop **378** and the resulted blocking of the leg-rest linkage in the intermediate, tilted sitting position of FIG. 11, the four bar linkage **332** changes the direction of travel of the pivot **340** on the seat. Thereafter, the first and second support links **337** and **335** move more or less parallel with each other to translate the connecting link **339** upwardly so that the pivot **340** moves in such a manner that the rear guide link **370** is held substantially immovable relative to the support so that the back-rest rotates around the pivot **376** as if it were a fixed pivot on the support. A stop **349** may be provided to engage the first support link **337** to establish the fully reclined position.

The embodiment of FIGS. 10, 11 and 12 operates in identical fashion to that shown in FIGS. 7, 8 and 9, the sequencing linkage **330** replacing the cam and follower sequencing arrangement **230** shown in FIGS. 7, 8 and 9, and the linkage arrangement may be considered the full equivalent of the cam and follower arrangement. Whatever differences that may occur between the two chairs are slight, and for all practical purposes and for the purpose of the invention herein, the two may be considered the same thing. As pointed out previously, the double-arc cam cannot be replaced by a simple linkage i.e., one, two, or three links interconnected in some general arrangement with a relatively wide latitude in the design of the links and pivots, but on the contrary, in this case the constraining sequence means is a very special and precise arrangement of a four bar linkage whose design parameters are limited in the first instance by the motion determined by the guiding means. Furthermore, the substitution of a four bar linkage of the general type illustrated may not necessarily lead in practice to the desired constrained motion. This is because the motion possible with the four bar linkage deviates too far from the ideal or perfect motion necessary in the particular chair in question. In such cases, a cam and follower, or a more complicated linkage, would have to be substituted. It has been found that cam and follower arrangements present technical problems involving easy and at the same time economical manufacture. The advantages of flexibility and simplicity found in cam and follower arrangements usually make them more desirable for use in the instant invention than the corresponding linkages more complicated than the four bar linkage. These problems, discussed in more detail below, are more in the nature of engineering and design problems and do not relate to the inventive concept herein, which is the positive constraint of the typically unconstrained multiple movement chair linkage thereby insuring positive sequencing of the movements.

It should be noted that the positive displacement cams and equivalent four bar linkage generally have very similar characteristics in their guiding action during the switch from one phase to the other. In particular, except in special cases dealt with below, they each produce a rounded "corner" at the intermediate, tilted sitting position in the constrained path that they produce. For example, note the path of point **340** on the chair **310** as illustrated in the schematical views of FIGS. 11A and 12A which is essentially the same as the path of the follower in FIG. 13.

It should be noted that the typical guiding mechanism used in multiple movement chairs having two or more degrees of freedom will produce a sharp corner at the intermediate, tilted sitting position for the path that any point on the body-supporting means will trace. Thus, in the case where the positive constraining sequence means has a guiding function as well, there is usually a slight deviation from the ideal path desired. The action of a pin guided by a positive displacement cam is well known. In FIG. 13, which is an enlarged partial view of the sequencing means of FIGS. 7, 8, 9, it is shown that the pin "rolls" around the inside corner of the cam to produce a rounded transition from one motion phase to the other. It should be noted that if a four sided slider is used as shown in FIG. 14 instead of a round pin or round roller as shown in FIG. 13, the path traced has a sharp corner. In this case, inasmuch as there is sliding between the two surfaces, the two surfaces must be designed so that they slide easily without any noise produced in the chair and so that they do not wear out which is generally the problem with using economical sliding joints in reclining chairs. In such a case, the cam may be stamped and formed with flanges to produce sufficient bearing surface and a suitable plastic slider used, the slider being mounted on a pin so its surfaces will align themselves with the sides of the cam. Such a design is illustrated in FIG. 15.

Referring now specifically to FIGS. 16, 16*a*, 17, 18, there is shown a reclining chair demonstrating features of the present invention, generally designated by the reference numeral **410**, which includes a support or frame **412** having side walls or frames **414**, **416** interconnected by suitable cross braces **418** and supported on depending legs **420**.

A body-supporting unit including a back-rest **422** and a seat **424** rigid therewith is mounted on the support **412** for a first movement phase from the sitting position shown in FIG. 16 to an intermediate, tilted sitting position shown in FIG. 17 and for a second movement phase from the intermediate position to a reclining position shown in FIG. 18.

Disposed beneath the forward end of the seat **424** is a leg-rest **426** which is mounted for movement from a stored or retracted position, shown in FIG. 16, to an elevated leg-supporting position relative to the seat as shown in FIGS. 17 and 18. As will be described, the leg-rest **426** is coordinated to the movement of the body-support-

ing unit such that in response to the first movement phase of the chair, the leg-rest moves to the elevated leg-supporting position shown in FIG. 17, with the leg-rest remaining substantially in a fixed elevated position relative to the body-supporting unit during the second movement phase.

In this illustrative embodiment an elongated carrier member or link 464 extending from front to rear of the chair is mounted at its rear end on the support at a carrier pivot 466. A stationary position is established for the carrier member 464 during the first movement phase by the cross brace 418. The brace 418 precludes the counterclockwise turning movement of the carrier member 464 about the carrier pivot 466, but permits the clockwise turning movement thereof during the second movement phase, as may be appreciated by progressively inspecting FIGS. 17 and 18. Extending upwardly from the forward end of the carrier member or link 464 is a front guiding link 446 which has a front pivotal mount 456 on the carrier link 464 and a front pivotal connection 448 to the seat 424 of the body-supporting unit. Extending upwardly from an intermediate point of the carrier member 464 is a rear guiding link 470 which is pivotally mounted on the carrier member 464 at a rear pivotal mount 474 and is pivotally connected to the body-supporting unit at a rear pivotal connection 476. The front guiding link 446, the portion of the seat 424 intermediate the front and rear pivotal connections 448, 476, and the rear guiding link 470 serve as movable links of the first motion phase linkage, with the portion of the carrier member 464 intermediate the front and rear pivotal mounts 456, 474 serving as a stationary link thereof.

The first motion phase linkage is operative to guide the body-supporting unit for rearward tilted movement relative to the support, and during the first movement phase the front guiding link 446 swings through an upward and rearward arc from its forwardly inclined position to a position slightly to the rear of dead center, while the rear guiding link 470 swings through a rearward arc to a position to the rear of dead center, with the links 446, 470 being effective to impart the requisite tilting to the body-supporting unit to establish the desired intermediate position appropriate for television viewing and the like.

The leg-rest 426 is mounted for movement from the stored position to the extended and elevated leg-supporting position by a leg-rest mounting linkage which includes a first pair of links 492, 486 having a pivotal connection 496 at their adjacent ends and a second pair of links 450, 500 having a pivotal connection 488 at their adjacent ends. The link 492 of the first link pair has a pivotal connection 494 to the forward end of the seat 424, while the link 486 has a pivotal connection 490 to the leg-rest 426 adjacent the upper end thereof. The link 450 of the second link pair has a pivotal connection 458 to the seat 424 at a point spaced rearwardly of the pivotal connection 494, while the link 500 of the second link pair has a pivotal connection 502 to the leg-rest 426 at a point spaced below the pivotal connection 490. The first and second link pair 492, 486 and 450, 500 are coordinated by the provision of an integral extension of the link 492 which has a coordinating pivotal connection 498 to the link 500.

A leg-rest actuating link 454 has a pivotal mount 462 on the carrier member 464 and a pivotal connection 452 to the link 450 at a point spaced below the pivotal connection 458 on the seat. Thus, in response to the rearward tilting movement of the body-supporting unit during the first movement phase, the portion of the link 450 intermediate the pivotal connections 452, 458 turns in the clockwise direction about the pivotal connection 452, with a corresponding upward and forward swinging movement of the leg-rest mounting linkage which is effective to extend and elevate the leg-rest 426.

Provision is made for blocking either the first movement guide linkage or the leg-rest mounting linkage at the end of the first movement phase such that the body-supporting unit and the leg-rest 426 move together about the carrier pivot 466 incident to the turning movement of the carrier member about the carrier pivot 466 during the second movement phase. In this illustrative embodiment the stop 478 is fixed to the link 450 which stop serves two functions. First, the stop 478 establishes the stored or retracted position for the leg-rest in that it abuts the link 500 at a location forwardly of the pivotal connection 498 and precludes further collapsing movement of the leg-rest mounting linkage; and second, in the extended and elevated position of the leg-rest shown in FIG. 17, the stop 478 abuts the link 500 at a location rearwardly of the pivotal connection 498 (due to the relative movement of the links of the leg-rest mounting linkage) to effectively block the leg-rest mounting linkage. Through the constraining link, the first movement linkage built onto the carrier member 464 is also blocked such that the leg-rest remains in a fixed position relative to the body-supporting unit which in turn remains in a relatively fixed position to the carrier member 464.

Referring to FIG. 16*a*, a constraining seqeuncing arrangement 430 is operatively interconnected between the body-supporting means and the support 412 to constrain the body-supporting unit to move along a first path during the first movement phase and to constrain the body-supporting unit to move along a second path during the second movement phase. This establishes the sequence of operations for the chain to assure that the four bar linkage built onto the carrier member 464 will first be operative to move the body-supporting unit to the intermediate, tilted sitting position of FIG. 17, with the carrier member 464 thereafter turning about the carrier pivot 466 to establish the reclining position shown in FIG. 18. The sequencing arrangement is provided by an integral downward extension 470*a* of the rear guiding link 470 which is formed with a two-directional slot 432 which guidingly engages a pin 440 fixed to the support. The slot 432 includes first and second slot sections 434, 436 extending from respective outer ends towards each other and merging at a junction 438 at their adjacent ends. The pin 440 is disposed at the outer end of the first slot section in the upright sitting position as shown in FIG. 16, moved to the junction 438 in the intermediate, tilted sitting position as shown in FIG. 17, and is at the outer end of the second slot section 436 in the fully reclined position of FIG. 18.

In order to facilitate a more thorough understanding of this embodiment of the present invention, reference will now be made to a typical sequence of operation.

The chain occupant is initially seated in the chair in the upright sitting position of FIG. 16 and, upon exertion of a rearward pressure, the body-supporting unit will be moved rearwardly in relation to the support 412 to the intermediate, tilted sitting position shown in FIG. 17. The rearward movement of the pivotal connection 458 of the link 450 of the leg-rest mounting linkage on the body-supporting unit will cause the turning movement of the link 450 about the pivotal connection 452, with a corresponding movement of the leg-rest 426 to the elevated leg-supporting position shown in FIG. 17. The stop 478 is arranged to block further movement of the leg-rest 426 beyond the elevated leg-supporting position and at the same time the pin 440 of the pin and slot interconnection of the sequencing means is at the junction 438 of the slot sections 434, 436. When the chair occupant desires to bring the chair to the reclining position of FIG. 18, further rearward pressure is exerted on the body-supporting unit, as by placing the hands on the arms of the chair frame and pushing rearwardly, whereupon the carrier member 462 will turn in the clockwise direction about the carrier pivot 466 which brings the body-supporting unit and the leg-rest 426 to the fully reclined position shown in FIG. 18. This position is established when the lower portion of the body-supporting unit contacts the rear cross brace 418 serving as a stop. When the chair occupant

desires to restore the chair to either the intermediate, tilted sitting position shown in FIG. 17 or the upright sitting position of FIG. 16, forward pressure is exerted by the occupant by pulling on the arms of the chair which brings about the reverse sequence of operations.

If the sequencing arrangement is called on to perform only sequencing then the positive displacement cam can be made with sufficient clearance at the junction of the two slot sections so that it does not interfere with the action of the guiding means for the body-supporting means at the intermediate, tilted sitting position. This is shown in FIG. 16A by the sharp cornered path (dotted line) of the relative motion of the pin **440** within the slot **432** at the junction **438** with the pin and slot **432**, **440** functioning solely as a sequencing means.

Furthermore, where the sequencing arrangement is not called on to guide as the body-supporting means in any way, as in the embodiment of FIGS. 16, 17, 18, its design can be such that there is normally no excessive physical contact to cause wear or noise in the cam and/or the follower. The sequencing arrangement is then a preventative against the wrong sequence of operation and serves in a passive capacity. Such design may be achieved by providing sufficient clearance so that the pin and slot do not normally touch each other except in the upright sitting and fully reclining positions.

In FIGS. 19, 20, and 21, still another embodiment of reclining chair is shown. This chair **510** is of the unitary back-rest and seat type of the preceding embodiment. That is, the seat **524** and the back-rest **522** are formed rigidly with each other, the angle therebetween remaining fixed all the time. The chair of this embodiment employs a sequencing arrangement **530** which uses a four bar linkage **532** similar to that shown in the chair of FIGS. 10, 11, and 12. Although this four bar linkage arrangement is used in a chair having a rigid seat and back and although it mounts the seat intermediate the front and rear portions thereof, it functions in almost identical fashion to that shown in the chair of FIGS. 10, 11 and 12. Specifically, the first and second support links **537**, and **535** are pivotally mounted on the support at **545** and **541** respectively, the support **512** thereby functioning as the stationary link of the four bar linkage **532**. A connecting or floating link **539** is pivotally connected to links **537** and **535** at spaced points **547**, **543** respectively. The connecting or floating link **539** is pivotally connected at its upper end at **540** to the seat. This sequencing arrangement provides the constrained two directional path for the pivot **540** which is necessary to positively insure the proper sequence of operation of the multiple position chair shown herein.

In this embodiment there is also included a rear guide link **570** pivotally connected to the support at its lower end at **574** and pivotally connected at its upper end to the seat and **576**. Further, the chair includes a leg-rest **526** supported on the seat by a double four bar lazy tong type of linkage. Specifically, the leg-rest is mounted on a bracket **582** which carries two links **586** and **600** at pivotal connections **590** and **602** respectively. Links **586** and **600** are supported by and pivotally connected to links **592** and **550**. Link **592** is pivotally connected at its upper end to the seat **524** at **594**. The lower end of link **586** is pivotally connected at **588** to link **550** which is integral with or rigid with the connecting or floating link **539** of the four bar linkage **532**. By virtue of the identity or rigid relationship of links **550** and **539**, the lazy tong linkage may be considered to be completed by the pivotal connection **540** on the seat.

In this embodiment, it will be noted that although the positive sequencing arrangement **530** can be considered to have both a primary guiding function and also a leg-rest control function, it retains its positive sequencing action and serves to constrain the rigid seat and back-rest to move along one path of movement in the first phase of operation of the chair to the exclusion of all other paths and then to move along a second path of movement in the second phase of operation to the exclusion of all other paths including the first path. This embodiment demonstrates therefore that while the positive sequencing arrangement of the instant invention may assume additional functions in the chair it always provides positive constraint and therefore positive sequence of operation as far as the two phases of motion are concerned.

In the case of the leg-rest linkage, it should be noted that the integral relationship of links **550** and **539** is possible because of the similarity between the movement of the seat links in a lazy tong linkage in a multiple movement chair and the connecting or floating link in the four bar sequencing linkage shown in the chairs of FIGS. 10 through 12 and 19 through 21. It can be noted, for example, in FIGS. 10, 11, and 12 that the leg-rest link **350** which is part of the leg-rest linkage and is pivoted to the seat rotates clockwise in the first movement of the chair to fulfill its function in the leg-rest linkage of extending the leg-rest. Thereafter, the link **350** is carried by the seat and translates upwardly relative to the support. As described in connection with this embodiment of FIGS. 10, 11, and 12, the link **339** moves generally in the same manner. That is, it rotates clockwise in the first phase of movement until the supporting link **335** has become approximately parallel with the first supporting link **337** and then in the second phase of movement the link **339** translates upwardly. Therefore, it would be possible as shown in the chair of FIGS. 19, 20, and 21 to make the leg-rest link and the floating link integral with each other thus effecting a saving in parts. It is important to note that since the functions are combined a certain amount of compromise may be involved in the design of an actual chair. However, whatever the deviation from the ideal movements desired, the positive constraint and positive sequencing action is nevertheless present. Again, it should be noted that the sequencing function of the positive constraining means of the instant invention is not negatived by the positive costraining means assuming other functions even to the extent that the assumption of these other functions may produce compromise results as far as ideal operation of the chair is concerned.

It should also be noted that, where there is combining of functions and consequent identity of normally independent parts, constraining linkages more complicated than the four bar linkage may be advantageously used thereby obtaining a resulting saving of parts as demonstrated, for example, in the embodiment of FIGS. 19, 20, and 21.

An examination of the illustrated embodiments shows that the positive sequencing means of the instant invention may be used in two ways. It may be used purely as a sequencing means, or it may be used as a sequencing means and also act as a guiding means. Further, its guiding function may be of a primary nature or of a secondary nature. That is, the positive constraining action on the body-supporting means may be essential to the working of the chair, the constraining means actually producing the guided paths of movement as well as limiting the motion exclusively to those paths of movement; or the sequencing means may act in only a supporting role, the guiding motion it produces being determined in the first instance by the action of other guiding elements on the body-supporting means. Thus, in FIGS. 19, 20, 21, the sequencing mechanism has a primary guiding function in addition to its sequencing function inasmuch as it is essential in determining the motion of the seat and back-rest unit because no motion could be determined without considering the action of that mechanism. In FIGS. 10, 11, 12, on the other hand, the sequencing mechanism could be eliminated and the motion of the seat and back could still be determined, it being remembered that in the first movement the link **364** remains stationary and the seat and back move rigidly together, and that in the second movement the front guide means is blocked rela-

tive to the seat by the stop 378 and the rear guide link 370 is effectively stopped relative to the support. Therefore, while it is obvious that pivot 340 traces a certain path and in consequence produces a guiding action along this path, the effect produced by this guiding action of the sequence means could be achieved by using two stops, one between the seat and back-rest to keep the angle therebetween from decreasing in the first movement phase and one to stop the rear guide link at the intermediate position so that it remained stationary during the second movement phase. In such a case, of course, the stops do not constrain the body-supporting means, the sequencing action of the constraining mechanism 330 is lost, and other motions may be imparted to the chair besides the one desired.

In the above connection it should be noted that while the stops prevent the slightest movement, the constraining means may impart a slight movement to improve the comfort or balance or other characteristics of the chair. For example, the second slot section 236 in the embodiment of FIGS. 7, 8, and 9 is more or less straight so that although line 270 remains substantially stationary during the second movement phase there is some slight movement. In this case this slight movement alters the relative positions of the seat and back-rest with a consequent alteration in balance. Thus it can be seen that the instant invention may aid in producing a chair with good characteristics.

From the foregoing illustrative embodiments it will be appreciated that there is provided in accordance with the present intention, a positive contraining means useful in reclining chairs of the multiple movement type to establish a sequence of operations for the chair automatically as the chair is moved into the several positions by the chair occupant.

A latitude of modification, change and substitution is intended in the foregoing disclosure and in some instances some features of the invention will be employed without a corresponding use of other features. Accordingly it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein.

What I claim is:

1. A reclining chair comprising a support, body-supporting means including a back-rest and seat, means movably mounting said body-supporting means on said support for a first movement phase from a sitting position to an intermediate, tilted sitting position and for a second movement phase from said intermediate, tilted sitting position to a reclining position, and continuous constraining means connected to said body-supporting means for constraining said body-supporting means to move along a first path during said first movement phase and for constraining said body-supporting means to move along a second path during said second movement phase for establishing the sequence of operation of said chair, said continuous constraining means including a double-arced slot and a pin engaged in said slot.

2. A reclining chair comprising a support, body-supporting means including a back-rest and seat adapted to be mounted on said support for reclining and inclining movement respectively, and means movably mounting said body-supporting means on said support for a first movement phase from a sitting position to an intermediate, tilted sitting position and for a second movement phase from said intermediate, tilted sitting position to a reclining position and including a first guide means for said body-supporting means operable to guide said body-supporting means during said first movement phase from said sitting position along a first prescribed path to said intermediate, tilted sitting position and second guiding means for said body-supporting means operable to guide said body-supporting means from said intermediate, tilted sitting position along a second prescribed path to said reclining position, and cam and follower means operatively connected to said body-supporting means for constraining said body-supporting means during said first movement phase to move along said first prescribed path and for constraining said body-supporting means during said second movement phase to move along said prescribed path for establishing the sequence of operation of said first and second guide means in the order named.

3. A sequencing arrangement for use in a reclining chair comprising a support, body-supporting means including a back-rest and seat adapted to be mounted on said support for reclining and inclining movement respectively, and means movably mounting said body-supporting means on said support for a first movement phase from a sitting position to an intermediate, tilted sitting position and for a second movement phase from said intermediate, tilted sitting position to a reclining position and including a first guide means for said body-supporting means operable to guide said body-supporting means during said first movement phase from said sitting position along a first prescribed path to said intermediate, tilted sitting position and second guiding means for said body-supporting means operable to guide said body-supporting means from said intermediate, tilted sitting position along a second prescribed path to said reclining position, said sequencing arrangement including a pin and slot interconnection operatively connected to said body-supporting means and having a first slot section for constraining said body-supporting means during said first movement phase to move along said first prescribed path and having a second slot section for constraining said body-supporting means during said second movement phase to move along said second prescribed path for establishing the sequence of operation of said first and second guide means in the ordered named.

4. A sequencing arrangement for use in a reclining chair comprising a support, body-supporting means including a back-rest and seat adapted to be mounted on said support for reclining and inclining movement respectively, and means movably mounting said body-supporting means on said support for a first movement phase from a sitting position to an intermediate, tilted sitting position and for a second movement phase from said intermediate, tilted sitting position to a reclining position and including a first guide means for said body-supporting means operable to guide said body-supporting means during said first movement phase from said sitting position along a first prescribed path to said intermediate, tilted sitting position and second guiding means for said body-supporting means operable to guide said body-supporting means from said intermediate, tilted sitting position along a second prescribed path to said reclining position, said sequencing arrangement including a pin and slot interconnection operatively connected to said body-supporting means and having a first slot section for constraining said body-supporting means during said first movement phase to move along said first prescribed path and having a second slot section for constraining said body-supporting means during said second movement phase to move along said second prescribed path for establishing the sequence of operation of said first and second guide means in the order named, said first and second slot sections extending from respective outer ends towards each other and merging at adjacent ends, said pin being disposed at the outer end of said first slot section in said sitting position, at the adjacent ends of said slot sections in said tilted position and at the outer end of said second slot section in said reclining position.

5. A reclining chair comprising a support, body-supporting means including a back-rest and seat adapted to be mounted on said support for reclining and inclining movement respectively, and means movably mounting said body-supporting means on said support for a first movement phase from a sitting position to an intermediate, tilted sitting position and for a second movement phase from said intermediate, tilted sitting position to a

reclining position and including a first guide means for said body-supporting means operable to guide said body-supporting means during said first movement phase from said sitting position along a first prescribed path to said intermediate, tilted sitting position and second guiding means for said body-supporting means operable to guide said body-supporting means from said intermediate, tilted sitting position along a second prescribed path to said reclining position, said second guide means being actuated from said back-rest, continuous constraining means operatively connected to said body-supporting means for constraining said body-supporting means during said first movement phase to move along said first prescribed path and for constraining said body-supporting means during said second movement phase to move along said second prescribed path for establishing the sequence of operation of said first and second guide means in the order named, and means operable at the end of said first movement phase for coupling said back-rest to said second guide means.

6. A reclining chair comprising a support, body-supporting means including a back-rest and seat adapted to be mounted on said support for reclining and inclining movement respectively, means movably mounting said body-supporting means on said support for a first movement phase from a sitting position to an intermediate, tilted sitting position and for a second movement phase from said intermediate, tilted sitting position to a reclining position and including a first guide means for said body-supporting means operable to guide said body-supporting means during said first movement phase from said sitting position along a first prescribed path to said intermediate, tilted sitting position and second guiding means for said body-supporting means operable to guide said body-supporting means from said intermediate, tilted sitting position along a second prescribed path to said reclining position, and a pin and slot interconnection operatively connected to said body-supporting means and having a first slot section for constraining said body-supporting means during said first movement phase to move along said first prescribed path and having a second slot section for constraining said body-supporting means during said second movement phase to move along said second prescribed path for establishing the sequence of operation of said first and second guide means in the order named.

7. A reclining chair comprising a support, body-supporting means including a back-rest and seat adapted to be mounted on said support for reclining and inclining movement respectively, means movably mounting said body-supporting means on said support for a first movement phase from a sitting position to an intermediate, tilted sitting position and for a second movement phase from said intermediate, tilted sitting position to a reclining position and including a first guide means for said body-supporting means operable to guide said body-supporting means during said first movement phase from said

sitting position along a first prescribed path to said intermediate, tilted sitting position and second guiding means for said body-supporting means operable to guide said body-supporting means from said intermediate, tilted sitting position along a second prescribed path to said reclining position, and a pin and slot interconnection operatively connected to said body-supporting means and having a first slot section for constraining said body-supporting means during said first movement phase to move along said first prescribed path and having a second slot section for constraining said body-supporting means during said second movement phase to move along said second prescribed path for establishing the sequence of operation of said first and second guide means in the order named, said first and second slot section extending from respective outer ends toward each other and merging at adjacent ends, said pin being disposed at the outer end of said first slot section in said sitting position, at the adjacent ends of said slot sections in said intermediate, tilted sitting position and at the other end of said second slot section in said reclining position.

8. A reclining chair comprising a support, body-supporting means including a back-rest and a seat adapted to be mounted on said support for a first movement phase from a sitting position to an intermediate, tilted sitting position and for a second movement phase from said intermediate, tilted sitting position to a reclining position, means movably coupling said back-rest to said seat, means movably mounting said back-rest on said support, and continuous constraining means operatively connected to said body-supporting means and including a two directional slot and a follower confined within said slot, and means cooperating with said continuous constraining means for guiding said seat during said first and second movement phases to effect said first and second movements in the order named.

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