

[54] **FURNITURE WITH BODY CONTOUR
ACCOMMODATING SUPPORT
SYSTEM**

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248/399, 400**

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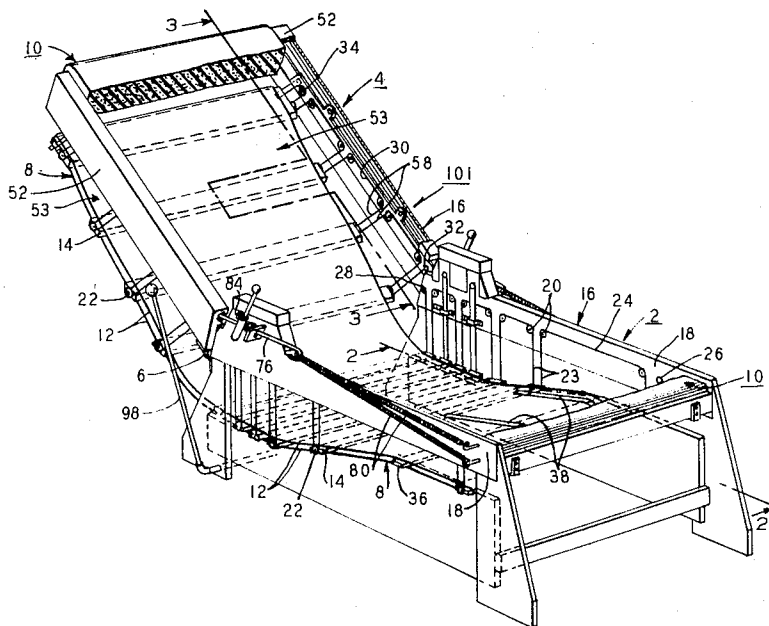
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[57] **ABSTRACT**

An item of furniture such as a bed or chair provides increased comfort by supporting a body resting thereon with a distribution of support forces which match the body's weight distribution while simultaneously conforming to the contour of the supported body. This is accomplished by supporting the body with a plurality of spaced force means which are interconnected with a common force transmitting means. The spacings of the force means, the individual support forces provided by the force means, or both may be adjusted to achieve the desired support force distribution. Changes in body contour are accommodated by a movement of the force transmitting means without changing the magnitudes of the support forces.

14 Claims, 12 Drawing Figures



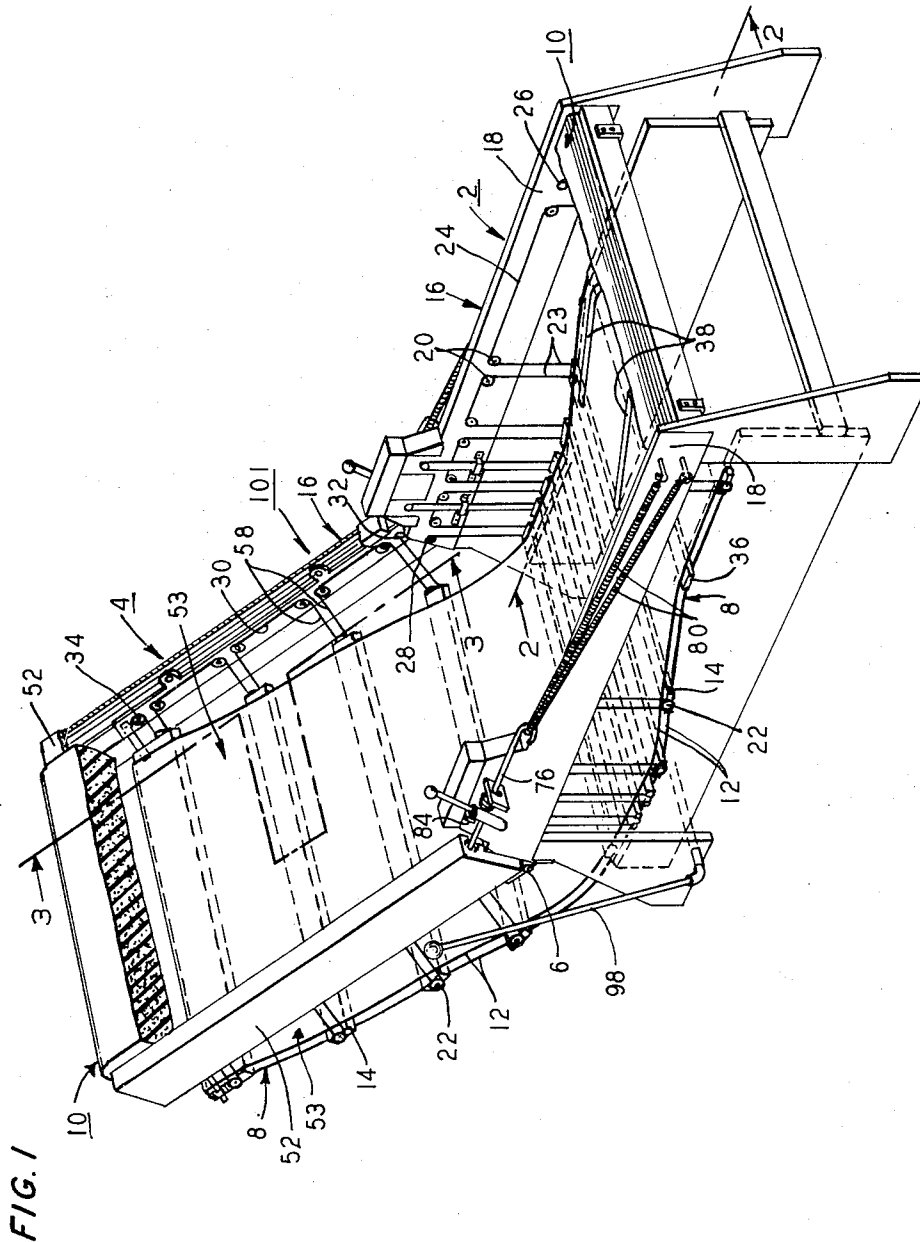
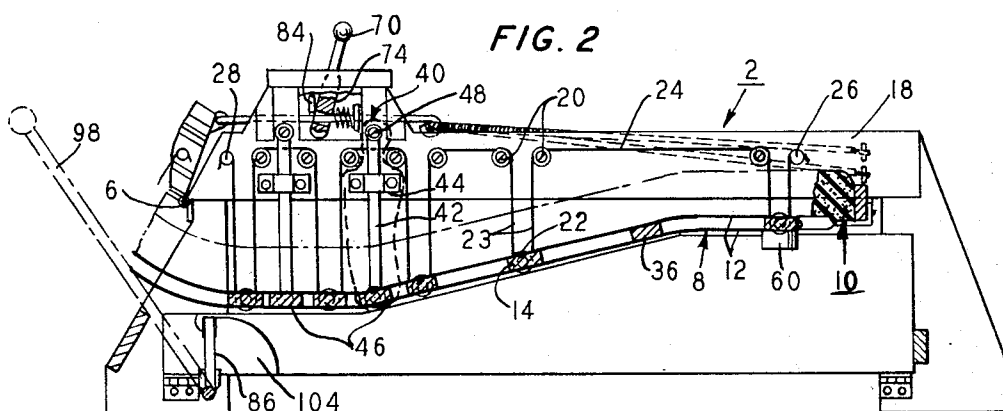
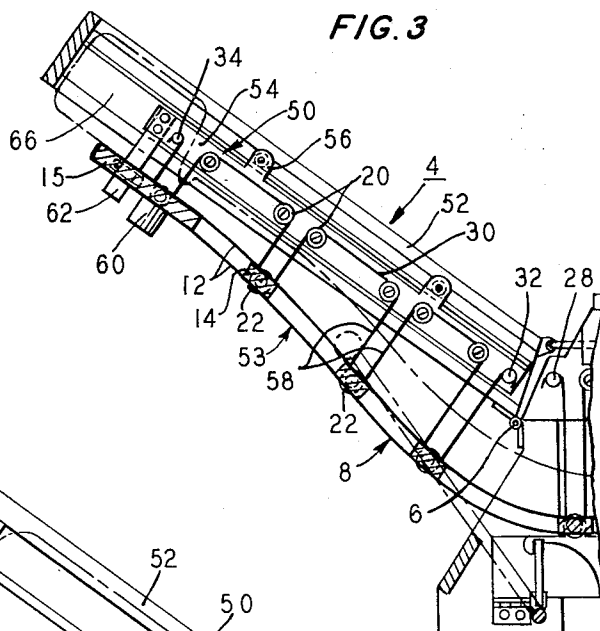
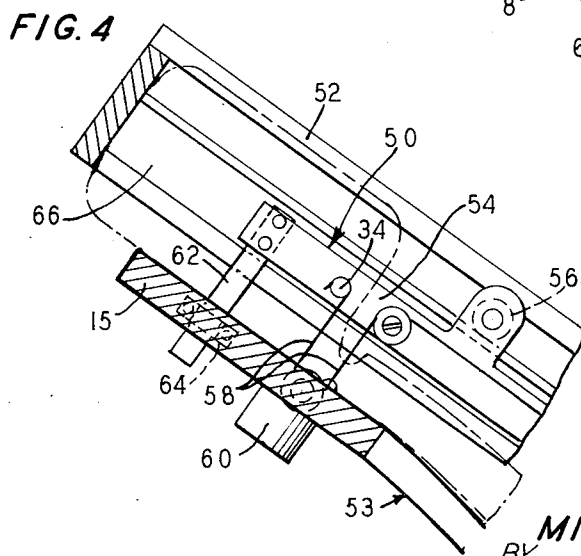


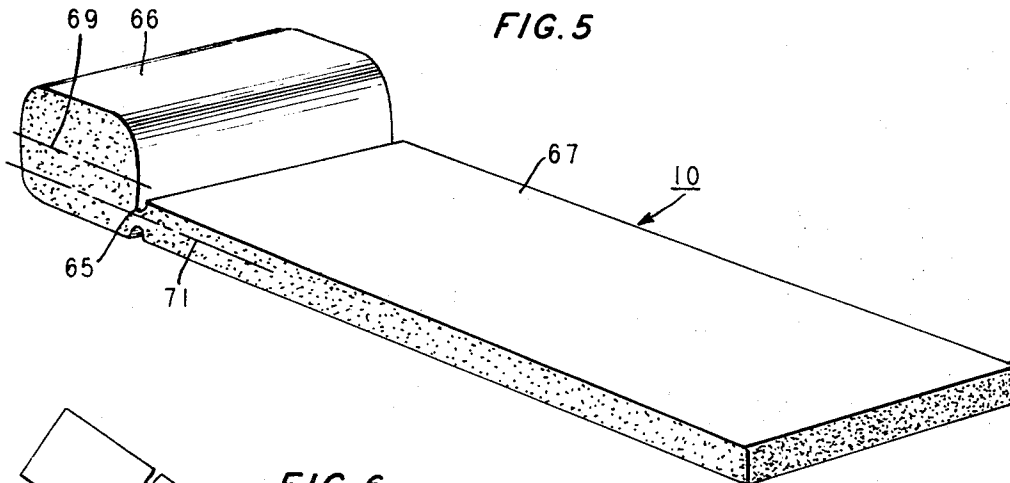
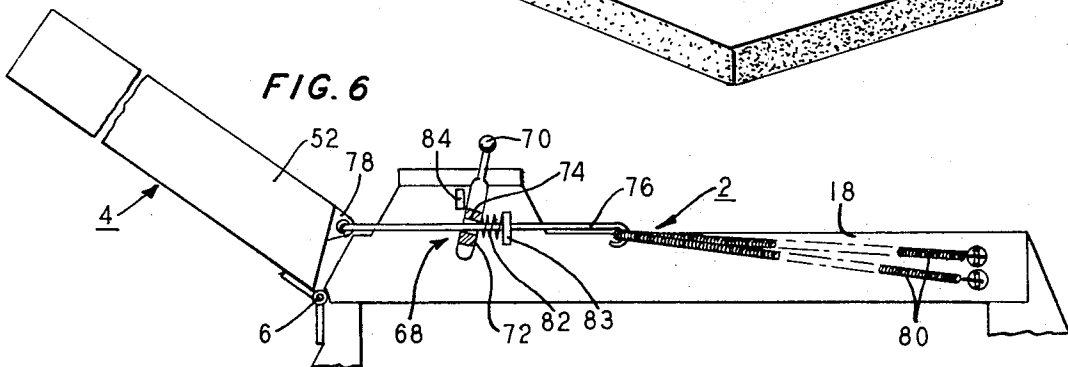
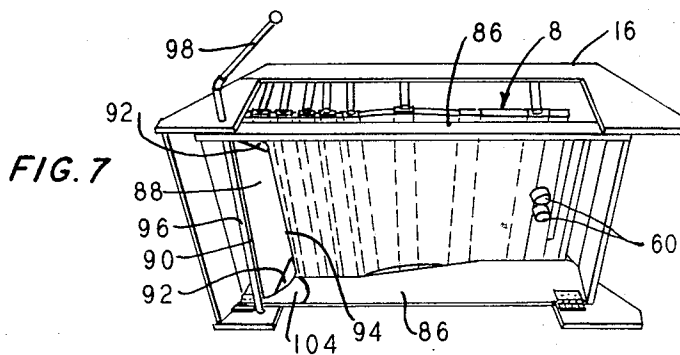
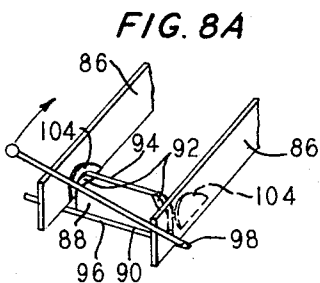
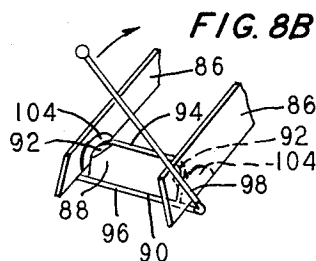
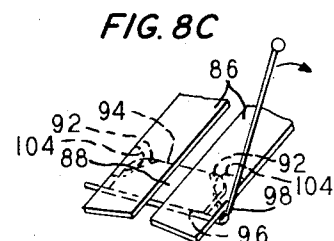
FIG. 1

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FIG. 9

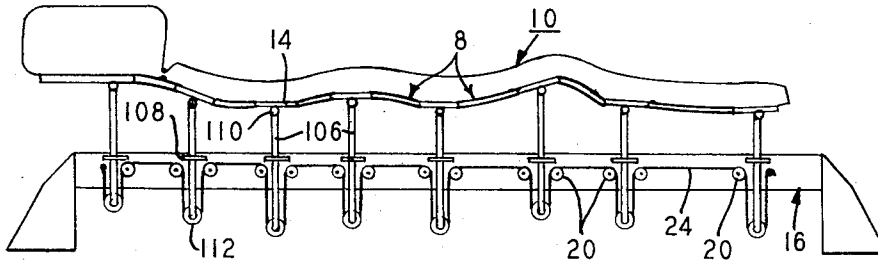
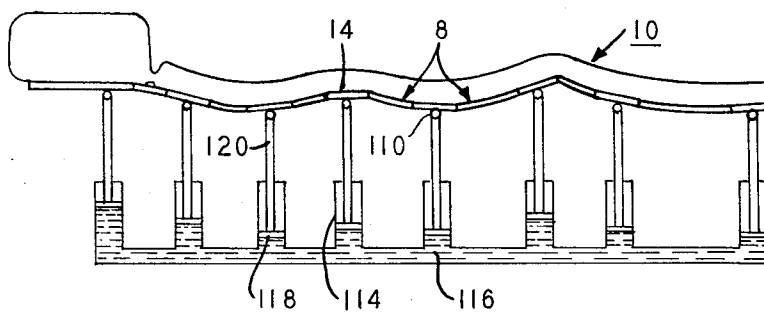


FIG. 10



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FURNITURE WITH BODY CONTOUR ACCOMMODATING SUPPORT SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a support system for furniture such as beds and chairs. More particularly, it relates to a support system for such furniture which readily conforms to the contour of a body resting on the furniture while supporting the body with a support force or pressure distribution matched with the body weight distribution so that increased comfort is provided.

2. Background of the Invention

Most presently used support systems for items of furniture such as beds and chairs utilize spring and wire arrangements in the body support pads thereon which provide at best only limited flexibility in adapting to the specific contour of the supported body. Because the support force distribution from such systems does not necessarily match the weight distribution of the supported body, the body must develop internal bending moments by tensioning of muscles and hence muscle strain in various parts of the body may occur. Such support systems are designed for the average person and thus may not be as comfortable as desired for persons not having the physical characteristics of the average person. Further, such support systems may not be comfortable even to the average person as his body assumes different positions because of lack of conformability of the support system to specific body contours and the irregular support force distribution resulting therefrom. Because of the non-ideal support force or pressure distribution, i.e., some parts of the body are adequately supported while others are not so supported, the body itself must behave as a beam by providing a bridging action from one support point to another thereby decreasing the comfort of the furniture.

Accordingly, it is an object of this invention to provide a support system for furniture such as beds and chairs which will readily adapt to the contour of different bodies supported thereby.

Another object is to provide a support system which will readily conform to changes in contour of a body being supported by reason of the body shifting position.

A further object is to provide a support system for furniture by which bodies thereon are supported by a smooth and predetermined distribution of support forces which does not vary even when the body contour changes.

A still further object is to provide a support system for furniture which provides a support force distribution matched to the weight distribution of the supported body.

Another object is to provide a support system for furniture which permits the selection of any one of a plurality of desired support force distributions.

SUMMARY OF THE INVENTION

The foregoing objects and others are achieved in accordance with the principles of this invention by a support system which has a plurality of force means whose spacings, individual support force magnitudes with respect to each other, or both may be predetermined to provide a desired support force distribution. For example, the support force distribution might match the weight distribution of the supported body. A plurality

of the force means are interconnected by a common force transmitting means and thus some of the force means may readily change their positions relative to the other force means by a movement of the force transmitting means therebetween to accommodate a change in the contour of the body being supported. The normally desired equilibrium positions, at which positions the supported body is not required to provide bridging action, are reached when the support system has adjusted to the contour of the supported body and the support force distribution is the same as the weight distribution of the supported body. At these equilibrium positions there are no internal bending moments in the supported body as the net load at each point along the body is zero. At these positions the total of the individual support forces equals the weight of the supported body; and moment equilibrium of the support force and weight distributions is also assured. Other support force distributions, not necessarily corresponding to the weight distribution, may be desired in some situations. In such situations, the body must provide bridging action. However, many support force distributions may be selected such that moment equilibrium as well as total force equilibrium is assured.

More specifically, in one embodiment of the invention, the support system comprises a cushion, support pad, and a suspension system for the pad including a pulley and cord arrangement. The body to be supported rests on the cushion which rests on the support pad mounted in a frame. The pad is stiff in a direction transverse to the longitudinal axis of the body and has torsional rigidity about this axis but is relatively flexible in the direction of the longitudinal axis. Sets of low friction pulleys are mounted along each side of both the pad and the frame at support points spaced to provide a support force distribution corresponding to the weight distribution of the supported body. The pulleys on each side are interconnected by a continuous force transmitting means, which may be a simple flexible cord. The pulleys and cord thus provide equal support forces at each support point. Changes in the contour of the supported body are accommodated by a shifting or redistribution of the interconnecting cord between pulleys and a consequent deformation of the pad relative to the frame until one of the previously mentioned normally desired equilibrium positions is reached. The particular spacing of the support points, the support point forces, and the mounting of the pulleys are such that the body is supported by a distribution of support forces which does not vary as the body contour varies.

In a second embodiment of the invention, the support system comprises a fluid filled support system. Sets of flexible bellows or fluid cylinders are placed at appropriately spaced points along the pad. The bellows are interconnected by a fluid transmitting means such as a simple tube. The tube and bellows or cylinders contain an appropriate fluid under pressure which is induced by the supported body. Because the spacing and cross sectional areas of the bellows may be freely chosen, the distribution of support force in this embodiment can also be predetermined to a desired distribution. Changes in the contour of the supported body are accommodated by a redistribution of fluid among the bellows and a consequent deflection of the bellows until the equilibrium position is reached with the force distribution unchanged.

DESCRIPTION OF THE DRAWINGS

My invention will be more fully comprehended from the following detailed description, which is directed particularly toward an embodiment utilizing the pulley and cord system in a lounge chair, and the accompanying drawing in which:

FIG. 1 is a schematic representation in perspective of the lounge chair utilizing the support system of this invention.

FIG. 2 is an enlarged schematic representation along direction 2—2 of FIG. 1 showing the suspension system of the lounge chair in greater detail including auxiliary supports which function when the displacement of the support pad exceeds a predetermined amount.

FIG. 3 is an enlarged schematic representation along direction 3—3 of FIG. 1 showing how the suspension system for the back rest portion advantageously is mounted to the chair frame.

FIG. 4 is a schematic representation of a bracket assembly to keep the pad on the back rest portion of the chair from sagging.

FIG. 5 illustrates a configuration for a cushion which can be used advantageously in the support system.

FIG. 6 is a schematic of a latch and spring assembly for locking the back rest portion in a desired position and for aiding in moving the back rest portion from reclining to sitting position.

FIG. 7 is a schematic representation in perspective of the bottom of the chair of FIG. 1 showing in particular a stabilizer assembly.

FIG. 8 A, B, C, is a schematic representation of the operation of the stabilizer assembly of FIG. 7.

FIG. 9 is a schematic representation of another embodiment of the support system of my invention utilizing pulleys and cords and rigid rod links.

FIG. 10 is a schematic representation of still another embodiment of the invention utilizing fluid support means.

DETAILED DESCRIPTION

FIG. 1 is a schematic representation in perspective, partly broken away, of a lounge chair 101 which utilizes a pulley and cord embodiment of my invention in its support system. The chair 101 comprises a seat and leg portion 2 and a back rest portion 4 pivotably mounted at 6 to the rear edge of the seat and leg portion 2. Back rest portion 4 is shown in a partially reclined position but may be placed in any position from substantially upright to fully reclined.

A body resting on the chair 101 is supported by a pad 8 over which a cushion 10 made of some material such as foam rubber may be placed. For reasons which will subsequently become more apparent, the pad 8 should be very flexible along the longitudinal direction of the body being supported and should normally be relatively stiff in a direction transverse to the longitudinal axis of the supported body. The pad 8 should also have substantial torsional rigidity about the longitudinal axis. FIG. 2 illustrates more clearly how these characteristics are obtained. The pad 8 comprises two sheets 12 of flexible material such as polyethylene between which relatively stiff slats 14 such as wooden strips are sandwiched. The sandwich construction gives torsional rigidity and the orientation of slats 14 transverse to the longitudinal axis provides transverse stiffness but the

pad 8 remains quite flexible in the longitudinal direction, i.e., along the longitudinal direction of the body being supported.

Under some circumstances, it might be desirable for the pad 8 to have some flexibility transverse to the supported body. For example, if the chair 101 is to be left in the rigidized or stabilized position, to be subsequently described, for extended periods, some transverse flexibility would be desirable. Further, if significant changes in the transverse contour of the supported body are anticipated, some transverse flexibility is desirable. Such transverse flexibility can be attained by adapting slats 14 to be flexible in their longitudinal direction.

The support pad 8 is suspended from the chair frame 16 in a manner now to be described. As shown in FIGS. 1 and 2 a plurality of low friction pulleys 20 are arranged in pairs and mounted at appropriately spaced points along the inside surfaces of each of the side portions 18 of the chair frame 16. A low friction pulley 22 is also mounted at each end of a number of correspondingly spaced slats 14. A continuous, flexible cord 24 interconnects the pulleys 20 and 22. Cord 24 may be any material such as nylon or wire which has sufficient strength, flexibility and wear properties. The use of a stretchable material such as rubber in cord 24 may be advantageous in certain situations to improve the functioning of the support system. Such a compliant material might be especially desirable in the rigidized or stabilized position and in conjunction with the auxiliary supports, both previously mentioned and to be subsequently described. Stretchability can also be introduced by inserting an element such as a spring in series with cord 24.

The interconnecting cord 24 is cut to a predetermined length and after the pulleys 20 and 22 have been interconnected therewith, the ends of the cord 24 are anchored at points 26 and 28. In a lounge chair as herein described wherein the back rest portion 4 can assume various positions between upright and fully reclined, it is desirable that the support system for the back rest portion 4 be independent of the support system for the seat and leg portion 2. Thus in FIG. 1 and 3 a separate interconnecting cord 30 for the back portion 4 is shown anchored at points 32 and 34. In an application of the invention to a bed mattress support system wherein all portions of the mattress remain substantially horizontal and planar at all times, cords 24 and 30 could be joined and anchors 28 and 32 could be eliminated.

It is apparent from FIGS. 1 and 2 that the pairs of pulleys 20 are variably spaced along the sides 18 of the frame. The spacing ideally is inversely proportional to the incremental density of the supported body. Thus the pulleys 20 in the leg and feed supporting area are spaced further apart than are the pulleys 20 in the hips supporting area where a greater concentration of weight is normally expected. For example, if the density of the body is such that legs and hips create loads of 1 pound and 2 pounds per unit length along the pad, respectively, then the spacings of the pulleys would be 2 units and 1 unit, respectively, in the leg and hip support areas, respectively. Slats 14 in pad 8 are spaced to correspond to the spacing of the pulleys 20. Thus, in some sections of pad 8, such as the feet supporting area

where normally there is very little weight, the slats 14 are widely spaced. The pad 8 may have a tendency to sag in these sections because of its flexibility in the longitudinal direction. Sagging can be prevented by inserting auxiliary slats 36, to which no pulleys are attached, in these wide spaces and bridging across the spaces as shown in FIG. 1 with stiffeners 38 which may be thin metal straps. One of the more important contour changes which can be accommodated is the flexing of the legs at the knees. To help accommodate this particular contour change it may be advantageous to locate one support point at the knees.

Since the cords 24 and 30 are continuous within their respective support areas, and the pulleys 20 and 22 have low friction, it follows that the tension at each point in a particular one of the cords is essentially the same as the tension at every other point within that cord. Also because of the close spacing of the pairs of pulleys 20 at a particular support point, the support force distribution is virtually unaffected by vertical translations of the pulleys 22 relative to the pulleys 20 as the vertical cord segments remain vertical at all times. Thus following any change in the contour of the supported body, the support system will quickly adjust to a new equilibrium position without changing the support force distribution. This is accomplished by vertical movements of pulleys 22 with respect to pulleys 20 and a redistribution of the interconnecting cords 24 and 30 between pulleys. For example, if the legs of the supported body are flexed, the tension in the support cord segments in the foot region would momentarily be greater than the tensions in the cord segments in the hips support section. Thus the foot support section would displace by vertical translation of pulleys 22 with respect to pulleys 20 thereby drawing additional amounts of cord from the hips support section until a new equilibrium position was reached. The tension in the cord after equilibrium has been achieved will be the same as before the change in body contour and the support force distribution likewise is undisturbed even though the contour of the body has changed.

Because only a finite number of pulleys may be used, there is a need for some smoothing of the discrete forces provided at the support points. Cushion 10 provides this smoothing through the use of a compliant material therein.

As the number of pulleys 20 and 22 is increased, thus increasing the number of vertical cord segments 23, the tension required in the interconnecting cords 24 and 30 to support a particular body decreases. The relative spacings between pulleys are maintained so that the support force distribution continues to match the body weight distribution. Thus the function of the cushion 10 becomes less important for smoothing the pressure distribution along the body. The cushion remains important for smoothing the support pressure in the direction transverse to the body however.

In some sections of the suspension system, the addition of large concentrations of weight would upset the ideal condition of having the support force distribution match the body weight distribution. For example, when the back rest portion 4 is elevated to a near upright position, there would be a large weight concentration in the hips support section. This would tend to cause this section to displace excessively and the body would

then act as a bridge or beam in the hip region since the support in this region would be insufficient. In such a case auxiliary supports 40, as shown in FIG. 2 enclosed in the dotted line, can be utilized to provide additional support for the hips region. These auxiliary supports 40 comprise rigid bars 42 slidably mounted in a bracket 44 on frame side portion 18. The bottom end of bar 42 is fastened to an auxiliary support slat 46 and on the top end is mounted a low friction pulley 48, similar to pulleys 22, which normally does not contact cord 24. As the hips support section is displaced downward because of the increased weight concentration, the bar 42 is pulled downward. When the displacement exceeds a predetermined amount, the pulley 48 engages cord 24 and establishes a new support point which supplies a support force for the increased weight. This prevents further displacement of the hips support section. The hips support area of the chair will normally be the only section requiring auxiliary supports and such supports will only come into operation when the chair is raised to an upright position thereby concentrating the supported weight in the hips support area. If cord 24 is stretchable, the increased weight supported in the seat and leg portion 2 when the back rest portion 4 is elevated will lower the entire body. Therefore the auxiliary supports 40 can be brought into play without the hips having to be substantially lower than the legs.

In applications of the support system to a lounge chair 101 wherein the position of the back rest portion 4 may be varied, it is desirable to have the support system for the back rest portion mounted on a movable bar or rail assembly 50 as shown more clearly in FIG. 3. This applies whether the support system for the back rest portion 4 is completely independent of the support system for the seat and leg portion 2 or whether the two sections form a continuous support system.

The horizontal mid-plane of support pad 8, i.e., the mid-plane with respect to the thickness of pad 8, does not pass through the pivot axis 6. Thus when the back frame portion 52 of chair 101 is raised from a horizontal position, the back support portion 53 of pad 8 will tend to be pulled toward pivot 6. This will tend to displace pulleys 22 mounted to the back support portion 53 such that the cord segments 58 joining pulleys 22 and 20 will not remain perpendicular to the back frame 52. The cord segments, when not perpendicular, introduce stretching forces into back support portion 53 making it less comfortable and flexible. This problem can be alleviated by mounting the pulleys 20 for the back rest portion 4 on a rail 54 which is rollably mounted to the back frame 52 on rollers 56 as shown in FIG. 3. As the back frame portion 52 is raised the rail 54 moves along frame portion 52 carrying the pulleys 20 mounted thereon. Thus these pulleys 20 move as pulleys 22 move. This motion of the support rail 54 insures that the support cord segments 58 for the back rest portion 4 remain substantially perpendicular to support pad 8 and the desired support force distribution is maintained.

In some situations it may be desirable to have little or no support force on a particular portion of the supported body. For example, if a particular portion of the body were injured, it might be desirable to eliminate all forces on the injured portion. This result can be achieved by at least two methods. First, the support

cord 24 or 30 may be removed from the pulley 22 on the slat 14 immediately under this portion of the body thereby removing the support force at this point. The supported body must then bridge across this gap between the next adjacent support points thru its internal body structure. Secondly, counterweights 60, shown in FIGS. 2 and 3, can be used to counterbalance the support forces ordinarily applied to the supported body at the support points. The counterweights 60 balance the tension in the cords 24 and 30 thereby resulting in a low net support force being applied to the supported body at the point of interest. The counterweights 60 are attached to the slat 14, preferably along the axis of symmetry of the pad 8, at the points where it is desired to reduce the support force.

Counterweights 60 may also be added in certain portions of the chair 101 such as the foot support area and head support area so that the net support force distribution can be made to match the body weight distribution with a relatively lower number of support points. If a low number of support points is used for the entire pad 8, the tensions in cords 24 and 30 will be greater. This will tend to cause discomfort in the foot support and head support areas because of the relatively high support forces. However, counterweights 60 used in these areas alleviate any discomfort by reducing the net support forces applied to the feet and head.

When counterweights 60 are used in the head support area of the chair, the counterweights 60 may tend to cause the cushion 10 and back support section 53 of support pad 8 to sag when the chair back is in the upright position. This sagging, primarily from the weight of pad 8 and counterweights 60, is in addition to the movement which causes the stretching forces previously discussed. This sagging can be prevented by a small bracket arrangement shown in FIG. 4. A rod or bar 62 has one end fixedly attached to rail 54 substantially perpendicular thereto and the other end is slidably engaged in a bracket 64 mounted on pad 8 on one edge of a widened slat 15. This arrangement constrains the movement of the support pad 8 to be substantially perpendicular to the back frame portion 52 thereby eliminating the problem of sagging. This bracket arrangement may be desirable even when no counterweights are used in order to prevent any sagging from the weight of the pad and support system itself.

Because of the acute profile change encountered between the head and shoulders of a body, it is desirable to design the cushion 10 to help reduce the variations in deflections of the support pad 8 required in this portion of a chair or mattress as the body turns. As shown in FIG. 5, this can be accomplished in part by making the head rest portion 66 of cushion 10 somewhat thicker than the body rest portion 67 of the cushion 10 and connecting the two portions by a relatively thin short flexible section 65. The nominal position of the mid-plane 69 of the head rest portion 66 is higher than the mid-plane 71 of the body rest portion 67 of cushion 10 to most satisfactorily accommodate the various possible contours of the body. The thicker head portion 66 allows the head to be supported, regardless of the position of the body, with the appropriate force corresponding to the weight of the head without the neck being strained or the head being out

of its normal position along the longitudinal axis of the body. In some situations it may be advantageous to have materials of different compliance in the head rest 66 and body rest portion 67 of cushion 10. It also may be advantageous to fasten cushion 10 to pad 8 so that they act as a single unit.

The lounge chair 101 has a latch and spring assembly 68, shown more fully in FIG. 6, for locking the back rest portion 4 in any position between the vertical and horizontal and for automatically raising the back rest portion 4 toward the vertical position when the body is raised from the back rest portion 4. The assembly 68 comprises a handle 70 having affixed thereto a metal block 72 having good wear resistant properties. Block 72 has a hole 74 therethrough. Block 72 could also be formed as a sandwich construction of independent thin slices of material having aligned holes therethrough. A rod 76 having a size only slightly smaller than the size of hole 74 is slidably mounted in hole 74 and has one end thereof engaged in a bracket 78 on back frame portion 52 such that rod 76 may apply a force to frame 52 causing it to tend to rotate about pivot 6. The other end of rod 76 engages one end of a spring 80 having the other end mounted to side frame 18 toward the front thereof. Handle 70 and block 72 float freely on rod 76. Spring 80 is biased so that it exerts a continuous and substantial force on rod 76 tending to cause back frame 52 to rotate to the fully upright position. Handle 70 and block 72 are contacted by a spring 82 which is mounted to a stop 83 on the side of handle 70 adjacent spring 80. Another stop 84 is rigidly mounted to side frame 18 on the opposite side of handle 70. Stop 84 and spring 82 tend to rotate handle 70 and block 72 forwardly in such a manner as to cause the edges of hole 74 nearest spring 80 to bite into rod 76 when rod 76 tries to move rearwardly such that rod 76 is locked in any desired position and prevented from further rearward motion. Rod 76 can be moved rearwardly, thus causing back rest portion 4 to recline, by manually rotating handle 70 rearwardly to counteract spring 82 and simultaneously applying a slight force to back rest portion 4. The rear edges of hole 74 do not bite into rod 76. Thus when all force is removed from back rest portion 4, spring 80 can pull rod 76 forwardly, since it is not locked against forward motion, thereby raising back portion 4. Stop 83 prevents handle 70 from being rotated too far rearwardly which would cause rod 76 to bind.

Although separate spring assemblies 68 are shown on each side of the chair, a single assembly could be utilized. Further, such modifications as utilizing only one handle 70 to control the spring assemblies 68 on both sides could be made. Other latch and spring mechanisms which will be apparent to those skilled in the art can be utilized.

Because of the "floating action" achieved by the support system supplying forces that are independent of body contour changes, it is desirable to temporarily stabilize or rigidize the support system when getting on or off a chair or bed mattress supported by the suspension system of this invention. FIG. 7 discloses one method of so stabilizing the support system.

Two stabilizer boards or panels 86 are rotatably mounted, about axes parallel to the longitudinal axis of the chair or mattress, on the underside of frame 16.

Transversely interposed between, and slightly beneath stabilizer panels 86, and rotatably mounted about an axis perpendicular to the axis of rotation of panels 86, is an actuating panel 88. Actuating board or panel 88 is fastened along one edge 90 to a rod 96, rotatably mounted in frame 16, which is connected on one end to an actuating handle 98. Along the opposite edge 94, the ends 92 of panel 88 are rounded and have increased thickness. The edges of panels 86 opposite their axes of rotation are also rounded. When the chair or mattress is being used, handle 98 is placed in a position such that panel 88 lies flat underneath the frame 16, i.e., handle 98 is rotated to its forward position, and consequently panels 86 also lie flat and do not contact support pad 8. Thus the support system can operate as previously described to accommodate changes in the supported body.

As illustrated in FIG. 8 A, B, C, when handle 98 is rotated rearwardly, actuating panel 88 is caused to rotate also. The rounded ends 92 of panel 88 contact stabilizer panels 86 forcing them to rotate from their previous flat position to an upstanding position and consequently contact support pad 8 along a substantial length of the underside edges thereof. Because of the transverse stiffness of support pad 8, it is subsequently prevented from further movement but is in essence "bottomed" on stabilizer panels 86. Thus movement onto or off the chair or mattress is facilitated. A layer of low friction, wear-resistant material may advantageously be placed on the rounded ends 92 of board 88 and on those portions of panels 86 which are contacted by ends 92. Such a layer 104 is shown in FIGS. 7 and 8.

The suspension system also can be stabilized to facilitate movement onto or off a chair or mattress by locking or holding support cords 24 and 30 in a particular position.

While the invention has been described with particular reference to a reclining lounge chair utilizing pulley and cord apparatus, it should be clearly understood that various modifications to the disclosed embodiment can be made without departing from the spirit and scope of the invention.

For example, as illustrated in FIG. 9, the invention is clearly applicable to a chair or mattress design wherein the support pad 8 and cushion 10 are not suspended between the sides of a frame but are supported above the frame 16. A plurality of pairs of pulleys 20 are mounted on the frame 16 and interconnected by a cord 24. A plurality of rigid links 106 are slidably mounted on frame 16 in brackets 108. One end of each link 106 is pivotably connected to a slat 14 in pad 8 at pivot 110 and the other end of the link contains a pulley 112 which engages cord 24. In this embodiment it would be possible to use a single row of pulleys 20 and supporting links 106 down the center of the pad 8.

Non-rotating wire guides having a moderately low friction surface can be substituted for the pulleys with some departure from ideal behavior. Some friction in the pulleys or cord guides can be tolerated without seriously degrading the performance of the support system as previously described. Two effects are provided by friction which might be beneficial under certain circumstances. These effects are the provision of more traction for the body for shifting positions and the al-

lowance of slight variations from the preselected support force distribution by small movements of the body. The pivots 110 shown in FIG. 9 and 10 also could be replaced by connections having only limited rotational capability without serious departure from ideal behavior. Various pulleys such as the pairs of pulleys 20 might be combined on a single shaft.

Pulleys 20 can be mounted in such a manner as to permit adjustment in mounting position on frame 16. For example, a continuous row of mounting apparatus having a plurality of closely spaced mounting ports for pulleys 20 can be placed along the sides of frame 16. Alternatively, pulleys 20 can be mounted in pairs on brackets that are slidably connected to a rail mounted on frame 16. Pulleys 20 can then be moved in position along frame 16. Corresponding adjustments in position of slats 14 in support pad 8 might also be provided by providing a plurality of closely spaced compartments for slats 14 in pad 8 such that pulleys 22 may correspondingly be moved in position by moving slats 14 from one compartment to another. This adjustable mounting will permit tailoring of the support system for particular persons utilizing the furniture. More convenient methods of adjusting the mounting positions of pulleys 20 and 22 will be apparent to those skilled in the art.

As previously mentioned a fluid or hydraulic system can be utilized in place of the pulley and cord apparatus. One such system is illustrated in FIG. 10. Here a plurality of hydraulic cylinders 114 are interconnected by a continuous tube 116 containing a nearly incompressible fluid. The cylinders 114 can all have the same cross sectional area so that each exerts the same force or the support forces can be varied by varying the cross-sectional area. In the former case the spacings between cylinders are varied while in the latter case the forces are varied to achieve the desired support force distribution. Each cylinder 114 contains a piston 118 having a shaft 120, one end of which is rotatably connected to a slat 14 in support pad 8. Each cylinder 114 contains the same pressure, and thus the fluid will redistribute and the pistons will displace to accommodate any change in the contour of the supported body without changes in the support force distribution. The cylinder and piston arrangement can readily be replaced by a series of flexible bellows.

In some situations it might be desirable to have only part of an article of furniture supported by a support system as herein described. For example, airplane and bus seats might advantageously utilize the support system for only the back rest portion thereof while retaining the presently used designs for the hips support portion. This would provide a seat which would conform to the upper part of the body and greatly facilitate sleeping therein but which would not be too bulky to prevent its usage. Apparatus associated with the stabilizer would not required in such a seat. Such a seat could be designed readily because of the previously described independent support systems for the back rest portion and seat and legs portion of the described lounge chair.

Although the cushion 10 and support pad 8 were described as distinct items in the illustrative embodiment, these items could be made as a single unit.

Various other modifications can be made by those skilled in the art and without departing from the spirit and scope of this invention.

I claim:

1. An article of furniture for supporting a body resting thereon with a preselected support force distribution and conforming automatically to various contours of said body without changing said preselected support force distribution comprising, in combination:

a frame;

a support pad upon which said body rests, said pad having flexibility in the direction of the longitudinal axis of said body;

a first set of low friction pulleys mounted along said frame at spaced mounting points; and

a second set of low friction pulleys mounted at spaced support points along said pad corresponding to said mounting points and providing support forces to said pad, said pulleys having spacings therebetween related to said preselected support force distribution; and

flexible cord means interconnecting said first and second sets of pulleys and suspending said pad from said frame so that by a redistribution of said cord means among said first and second sets of pulleys said pad can conform to changes in said contour by movement of said pad relative to said frame, said cord means having substantially constant tension therein independent of said movement so that said support forces remain constant thereby to maintain said preselected support force distribution.

2. Apparatus in accordance with claim 1 wherein said pad comprises first and second sections, said first section supporting a first portion of said body including the trunk and head thereof, said second section supporting a second portion of said body including the hips and legs thereof;

said first and second sets of pulleys each comprises first and second groups of pulleys associated with said first and second sections, respectively; and

said flexible cord means comprises separate flexible cords interconnecting said first and second groups of pulleys, respectively, and connecting said first and second sections, respectively, to said frame so that said first and second sections function substantially independently of each other.

3. Apparatus in accordance with claim 1 including auxiliary support means mounted to said pad between preselected ones of said support points for providing additional support forces when said movement of said pad at said preselected support points exceeds a predetermined magnitude, said auxiliary support means including a low friction pulley adapted to contact said flexible cord means when said movement equals said predetermined magnitude.

4. Apparatus in accordance with claim 1 wherein said first set of pulleys is mounted on sides of said frame extending in the same direction as said longitudinal axis;

said second set of pulleys is mounted along edges of said pad which lie in the same direction as said longitudinal axis; and

said flexible cord means includes separate cords interconnecting said first and second sets of pulleys along said respective edges and sides.

5. Apparatus in accordance with claim 1 wherein said pad includes a plurality of support slats oriented substantially transverse to said longitudinal axis and having spacings therebetween substantially the same as said spacings between said support points, said second set of pulleys being mounted to the ends of said support slats; and

bridging means oriented transverse to said support slats and connecting adjacent ones thereof when said spacing therebetween exceeds a predetermined amount so that said pad is prevented from sagging between said adjacent support slats.

6. Apparatus in accordance with claim 1 including weights affixed to said pad at preselected ones of said support points, said weights opposing said support forces provided by said pulleys at said support points so that said support forces provided to said pad at said preselected support points can be varied by varying said weights.

7. Apparatus in accordance with claim 1 including stabilizer means for limiting said movement of said pad with respect to said frame for facilitating movements of said body such as required for mounting and dismounting said article of furniture.

8. Apparatus in accordance with claim 1 including: first mounting means for mounting said first set of pulleys to said frame so that said mounting points can be varied in correspondence with variations in said support points; and

second mounting means for mounting said second set of low friction pulleys to said pad so that said spacings between said support points can be varied whereby said support force distribution can be adjusted for said body being supported.

9. Apparatus in accordance with claim 1 wherein said support pad includes a cushion having first and second portions joined by a relatively flexible portion, said first portion supporting the head of said body and said second portion supporting the remainder of said body, said flexible portion accommodating changes in said contour between said head and said remainder of said body.

10. An article of furniture having a frame with sides and a support system mounted to said frame for supporting a body resting thereon including a support pad upon which said body rests having flexibility in the direction of the longitudinal axis of said body, said pad having longitudinal edges opposing said sides of said frame, characterized in that said support system includes:

a first series of low friction pulleys mounted at spaced mounting points along said sides of said frame;

a second series of low friction pulleys mounted at spaced support points along said longitudinal edges corresponding to said mounting points and providing support forces to said pad; and

flexible cords interconnecting said first and second series of pulleys along respective ones of said edges and said sides and suspending said pad within said frame so that by a redistribution of said cords among said first and second series of pulleys said pad can move relative to said frame to conform to changes in contour of said body, respective ones of said flexible cords maintaining substantially constant tension therein so that said sup-

port forces provided to said pad by said second series of pulleys remain constant regardless of said changes in contour.

11. A support apparatus for supporting a body resting thereon with a preselected support force distribution and conforming automatically to various contours of said body without changing said preselected support force distribution, comprising, in combination:

- a frame;
- a support pad upon which said body rests, said pad having flexibility in the direction of the longitudinal axis of said body;
- a set of support means connected to said support pad at support points therealong having spacings therebetween related to said preselected support force distribution, said set of support means comprises a plurality of second low friction pulleys mounted to said support pad;
- a plurality of first low friction pulleys mounted to said frame at spaced points corresponding to said support points; and
- a force transmitting means comprising a flexible cord means interconnecting said pluralities of first and second low friction pulleys and suspending said support pad from said frame so that by a redistribution of said cord means among said pluralities of first and second pulleys said pad can move relative to said frame and thereby conform to changes in said contour; said cord means having substantially constant tension therein independent of movements of said pad so that said plurality of second pulleys provide constant support forces to said support pad.

12. A support apparatus for supporting a body resting thereon with a preselected support force distribution and conforming automatically to various contours of said body without changing said preselected support force distribution, comprising, in combination;

- a frame;
- a support pad upon which said body rests, said pad having flexibility in the direction of the longitudinal axis of said body;
- a set of support means connected to said support pad at support points therealong having spacings therebetween related to said preselected support force distribution, said support means comprises a plurality of fluid force means mounted to said support pad; and
- a force transmitting means comprising a closed, fluid-filled system mounted on said frame and interconnecting said plurality of fluid force means, said system being adapted to permit movement of said fluid among said fluid force means so that said fluid force means can deflect to permit movement of said support pad relative to said frame to conform thereby to changes in said contour; said fluid having a substantially constant pressure therein independent of said pad movements so that said plurality of fluid force means provides constant support forces to said support pad.

13. A support apparatus for supporting a body resting

thereon with a preselected support force distribution and conforming automatically to various contours of said body without changing said preselected support force distribution, comprising, in combination,

- a frame;
- a support pad upon which said body rests, said pad having flexibility in the direction of the longitudinal axis of said body;
- a set of support means connected to said support pad at support points therealong having spacings therebetween related to said preselected support force distribution, said set of support means comprises a plurality of rigid rods each pivotably mounted on one end thereof to said support pad and having one of a plurality of second low friction pulleys on the other end thereof;
- a plurality of first low friction pulleys mounted to said frame at spaced points corresponding to said support points; and
- a force transmitting means comprising flexible cord means interconnecting said pluralities of first and second low friction pulleys and supporting said support pad from said frame so that by a redistribution of said cord means among said pluralities of first and second pulleys said pad can move relative to said frame and hereby conform to changes in said contour; said cord means having substantially constant tension therein independent of said movements of said pad so that said plurality of rods provides a constant support force to said support pad.

14. A support apparatus for supporting a body resting thereon with a preselected support force distribution and conforming automatically to various contours of said body without changing said preselected support force distribution, comprising, in combination:

- a frame;
- a support pad upon which said body rests, said pad having flexibility in the direction of the longitudinal axis of said body;
- a set of support means connected to said support pad at support points therealong having spacings therebetween related to said preselected support force distribution, said set of support means comprises a plurality of second low friction cord guides mounted to said support pad;
- a plurality of first low friction cord guides mounted to said frame at spaced points corresponding to said support points; and
- a force transmitting means comprising a flexible cord means interconnecting said pluralities of first and second low friction cord guides and suspending said support pad from said frame so that by a redistribution of said cord means among said pluralities of first and second cord guides said pad can move relative to said frame and thereby conform to changes in said contour; said cord means having substantially constant tension therein independent of movements of said pad so that said plurality of second cord guides provide constant support forces to said support pad.

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