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(54) Chair having automatic back inclination adjustment

(57) The invention relates to a chair with one or more leg parts (2), a seat part (16) arranged on the leg parts and a chair back part (40) which comprises a first relatively rigid part (46) on the underside for supporting a user, as well as a relatively flexible part (48) arranged above the first relatively rigid part (46) and a second relatively rigid part (50) which is connected on the upper side to the flexible part (48), wherein the chair back part (40) is mounted on the seat part (16) via a frame (12) and at least the second relatively rigid part (50) is connected to the frame (12) for pivoting about a pivot point. According to the invention the chair back part (40) is oriented substantially vertically in its rest position and the second rigid part (50) can be pivoted backward under load, wherein the flexible part (48) is forced forward.

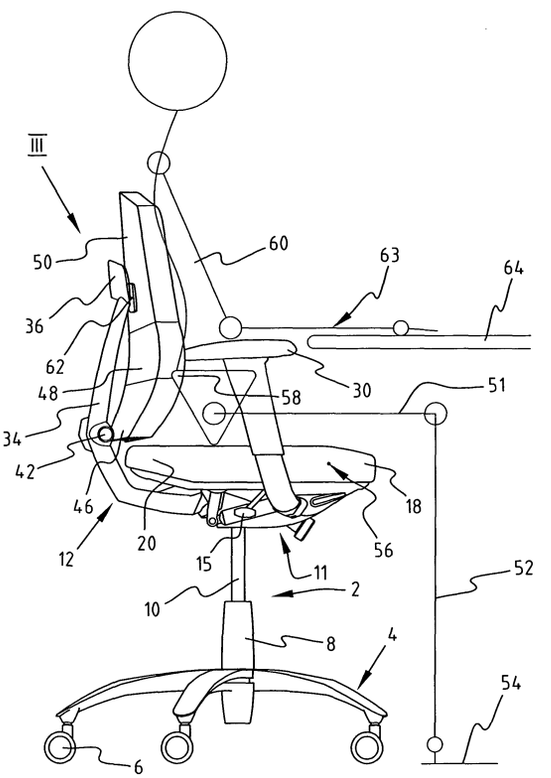

FIG. 2

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Description

[0001] The invention relates to a chair, comprising:

- one or more leg parts;
- a seat part arranged on the leg parts; and
- a chair back part which comprises a first relatively rigid part on the underside for supporting a user, as well as a relatively flexible part arranged above the first relatively rigid part and a second relatively rigid part which is connected on the upper side to the flexible part, wherein the chair back part is mounted on the seat part via a frame and at least the second relatively rigid part is connected to the frame for pivoting about a pivot point. Such a chair is known from US-A-5,975,634.

[0002] Although sedentary activities are better for feet and knees than standing activities, it has been found that sedentary activities can cause back problems. In contrast to the standing position, there is a tendency when sitting for the lower part of the back in particular to curve outward, whereby the so-called lower back muscles and the buttock muscles are subjected to prolonged static load, which can result in acidosis in these muscles and thus to pain symptoms. These pain symptoms can result in lack of movement whereby the body no longer provides sufficient of the synovial fluid which serves to lubricate the lower vertebrae and the intervertebral discs. If this situation continues for a longer period of time, in the order of years, the system around the lower vertebrae will degenerate.

[0003] In contrast to the case with a hollow back, in the case of an outward curved back the vertebrae in the lower part of the back are urged outward, whereby a considerably higher pressure is exerted on the core of those vertebrae and the intervertebral discs.

[0004] The above mentioned older document US-A-5,975,634 describes a chair with a seat and chair back pivotable relative thereto. The chair back is suspended in a reverse U-shaped frame and has a rigid part on its underside, a flexible part thereabove, and another rigid part above this. The upper rigid part is pivotally connected to the upper side of the frame, while the lower rigid part is mounted on a bracket which extends in transverse direction and which is also connected pivotally to the frame close to the underside thereof. The pivot axis of the lower rigid part is hereby situated some distance in front of the chair back. The mounting bracket is flexible and is biased by a spring mechanism to a starting position in which the chair back has a determined curvature such that the flexible part thereof protrudes forward and can function as lumbar support for a user, while the upper and lower rigid parts are directed more to the rear.

[0005] The combination of the bias in the bracket in which the lower rigid part is mounted on the frame and the pivoting suspension of the upper rigid part from the frame ensures that, when the user presses harder against the flexible part with the lower part of his/her back, for instance when he/she bends forward somewhat, both the upper and the lower rigid part pivot forward from their starting position, whereby the chair back as a whole becomes flatter. This movement evidently has the object of supporting the upper part of the back in this situation. The extent to which the chair back can become flatter is determined here by the bias adjusted in the mounting bracket, and is bounded by stops between the bracket and the frame.

[0006] In addition, a chair is known from EP-A-0 793 929 which provides the user with an improved sitting posture and support. In this known chair the angle of the chair back relative to the seat is adjusted specifically per person using an adjusting mechanism.

[0007] The present invention has for its object to provide a chair with an automatic back inclination adjustment. This is achieved in a chair of the type described in the preamble in that the chair back part is oriented substantially vertically in its rest position and the second rigid part can be pivoted backward under load, wherein the flexible part is forced forward.

[0008] Owing to the connection between the second rigid part and the flexible part, the curvature of the chair back is as it were automatically adjusted to the curvature of the back of a user, without a setting of the chair having to be changed for this purpose. The chair can thus be used by different people with a back which is curved to a greater or lesser extent without altering the setting thereof, so that a greater flexibility is obtained. Such a chair therefore has fewer control means than known chairs, so that there is a reduced number of possibilities for error in the adjustment of the chair. Because the second rigid part can be pivoted backward under load, wherein the flexible part is then forced forward, a balancing function is as it were created for adjusting the curvature to a force exerted on the chair back part. The balancing function acts as a balance which creates a balance between the force on the upper side and the centre of the chair back. The chair back thus adjusts to the curvature of the back of a user without use having to be made for this purpose of springs and the like.

[0009] Owing to this combination of measures the chair according to the invention is highly suitable for application where the chair is occupied for a relatively long time, i.e. a full working day.

[0010] In a preferred embodiment, the first rigid part is also connected pivotally to the frame, so that the flexible part can take on an optimal curvature. When the pivot point of the second rigid part is height-adjustable relative to the frame, the point of balance can be set and adjusted for taller or shorter people. In order to retain the shape of the chair back in that case, the pivot point of the first rigid part is preferably height-adjustable relative to the frame. A structurally simple embodiment of the chair is then obtained when it has at least one screw spindle mechanism controllable by a turning knob for

adjusting the height of the or each pivot point relative to the frame.

[0011] In order to guarantee an optimal sitting posture under all conditions, the seat part preferably encloses a constant, substantially right angle with a plane defined by the pivot points of the first and second rigid part.

[0012] The angle between the first rigid part and the seat part is also advantageously acute. The forces exerted on a user by the chair back and the seat are thus found to compensate each other for a comfortable, relaxed and biomechanically correct sitting posture, wherein lower back problems are avoided. The user is supported at the correct position, i.e. the pelvic edge, for a correct sitting posture, so that the vertebrae remain in the correct S-shape.

[0013] In yet another preferred embodiment, the chair back part comprises an arresting element which defines a minimum and a maximum curvature of the flexible part. The user is thus prevented from being pushed out of the chair by the bending of the chair back. A compact and efficient embodiment is obtained when the arresting element comprises at least one leaf spring which is arranged against the flexible part.

[0014] In order to enable quick and simple manufacture and assembly of the chair, the first and second rigid part and the flexible part are preferably formed integrally in a plastic plate. In order to ensure a sufficient rigidity, the plate can then have a number of strengthening ribs at the position of the second rigid part. Bending of the flexible part, which lies at a distance from the neutral line of the chair back, is associated with a lengthening or shortening. This can be compensated when the plate has at the position of the flexible part a number of folds which extend in transverse direction over a part of the width of the plate.

[0015] In a preferred embodiment, the seat part comprises a front part which is arranged at a fixed angle to the leg parts and a rear part which is tiltable relative to the front part. It is thus found possible to combine a correct sitting posture with the advantages of the automatic back inclination adjustment.

[0016] According to a second aspect, the invention provides a chair back part suitable for use in a chair as described above.

[0017] Finally, the invention further relates to a method for the use of such a chair or chair back.

[0018] Further advantages and features will be described with reference to the annexed figures, in which:

fig. 1 shows a perspective rear view of a chair according to the present invention in a first preferred embodiment;

fig. 2 shows a side view of the chair of fig. 1, wherein a representation of a user is shown;

fig. 3A shows a side view of a chair schematized to a basic design with a chair back part according to the present invention in a first position of use;

fig. 3B shows a second position of use of the chair of fig. 3A;

fig. 3C shows a third position of use of the chair of fig. 3A and 3B;

fig. 4A shows a perspective front view of a plate which forms the core of the chair back part according to the present invention;

fig. 4B is a perspective rear view of a variant of the plate of fig. 4A; and

fig. 5 shows a perspective front view of a frame with a height adjustment for the chair back part of the chair according to the present invention.

[0019] A chair 1 according to the present invention comprises a leg part 2 which in the shown preferred embodiment comprises five supports 4 which extend horizontally in a star shape and which are movable relative to a ground surface owing to the wheels 6 mounted rotatably thereon (fig. 1). Arranged in the centre is a hollow cylinder 8 in which a tube member 10 is arranged resiliently for spring-mounting and height-adjustment of chair 1. Arranged on tube member 10 is a support member 11 on which are arranged handles 14, 15 for adjusting, among other things, the height of chair 1. On support member 11 is arranged a seat part 16 with a front part 18 which is not tiltable, and a rear part 20 arranged tiltably relative to the support member and the front part. Armrests 22, 24 extend to the sides of support member 11. These comprise tube elements 26 on which are arranged a height-adjustable upper part 28 and a support member 30 adjustable relative to upper part 28. Such an armrest is for instance described in EP 1 287 765 Al in the name of applicant.

[0020] Frame 12 with rear part 20 thereon is arranged tiltably relative to support member 11. Frame 12 comprises vertically running profiles 32, 34 which are connected by horizontal supports 36, 38. A chair back part 40 is connected to a height-adjustment mechanism, wherein control buttons 42, 44 serve to adjust the height of the chair back part. Chair back part 40 comprises a first rigid zone or part 46 at the bottom, a flexible zone 48 above this and a second rigid zone or part 50 at the top (fig. 1). On the seat part and against chair back part 40 are arranged springy cushions which are covered with for instance fabric or leather.

[0021] Figure 2 shows the chair of figure 1 in a side view, wherein a schematically designated user has sat down on the chair. The front part 18 of the seat part is arranged at a fixed angle of about 4° inclining downward relative to leg part 2, so that the upper legs 51, lower legs 52 and feet 54 of the user are always in a restful stable position relative to a ground surface. The rear part 20 can be tilted relative to front part 18 about a tilt axis 56 at a location forward of the middle of seat part 16. Tilt axis 56 is preferably situated about a quarter to one third along the length as calculated from the front of seat part 16. Frame 12 is fixedly connected to rear part 20 so that the angle between vertical profiles 32, 34 and rear part 20 remains the same during tilting thereof.

[0022] It can be clearly seen how the curved part of the chair back part exerts a force against the pelvic edge 58 of the user. The curved part 60 of the back herein remains in a natural position without the lower vertebrae curving outward. On the upper side of vertical profiles 32, 34 the second rigid zone 50 is connected rotatably and slidably to profiles 32, 34 with sliding mechanism 62, while the first rigid zone 46 is connected rotatably and slidably to profiles 32, 34 at the position of the height-adjusting mechanism.

[0023] The operation of the chair will be elucidated with reference to figures 3A, 3B and 3C. When a user sits on the chair, the rear portion 20 tilts on tilt axis 56 under the influence of gravity. Chair back 40 is herein adjusted such that the curved part comes to rest against the pelvic edge 58. The angle enclosed between the first rigid zone 46 and rear portion 20 is here less than 90°. The forward force exerted by the curved part of the chair back is hereby compensated by a rearward force, i.e. a resultant of gravity, whereby the shear force on the seat surface is roughly zero. This principle is known as 'bracing'.

[0024] Armrests 30 are adjusted practically to the height of a worktop 64 so that forearms 63 come to lie thereon in a relaxed horizontal posture (fig. 3B). The elbows should come to lie just behind support members 30 so that the forearms are supported against the forearm muscle.

[0025] In order to allow adjustment of the curvature of chair back part 40 to the user, the first rigid zone 46 is, as stated, rotatable about an axis 66 and the second rigid zone 50 is rotatable about an axis 68. Owing to an arresting element, which is described hereinbelow with reference to fig. 4, the chair back is situated in a substantially vertical neutral position or rest position with a minimal curvature (fig. 3A). When a user sits down, his/her pelvis will come to rest in the correct position due to the above described co-action between the curved part of chair back 40 and seat 16 (fig. 3B).

[0026] If the user leans back, the upper curve 65 of the vertebrae will push against the upper side of the second rigid zone 50. The second rigid zone 50 is rotatable about a shaft 68 and is always balanced, wherein a rearward movement of its upper side results in a forward movement of its underside so that the curvature of flexible zone 48 possibly changes and the pelvis remains in the correct position (fig. 3C).

[0027] The biomechanical background of this automatic back inclination adjustment with balancing function results in fewer control means being needed to adjust the chair, whereby fewer possibilities for error occur. The chair can hereby be used more easily by different people. It is only necessary to adjust the height of chair back 40 by means of turning knob 42, whereby the height-adjusting mechanism will displace in height the first rigid zone 46 connected thereto, so that pivot point 68 of the second rigid part 50 will move upward or downward in sliding mechanism 62. When a comfortable position is set, a biomechanically correct setting is however immediately achieved, wherein the balancing function is set correctly. This in contrast to known chair backs where a more comfortable setting results in a biomechanically incorrect setting. The present chair back adjusts itself to the curvature of the back of the user, in contrast to known chair backs.

[0028] On the rear the chair back part 40 comprises a plate 140 of plastic (fig. 4A and 4B). At the bottom this plate 140 comprises a first rigid zone 142, above this a flexible zone 144 and a second rigid zone 146 at the top. In side view the plate 140 has a convex C-shape, the above mentioned curvature for supporting the pelvic edge, and in top view has a concave C-shape for lateral support. To enable a force to be exerted on the pelvic edge the first rigid zone 142 extends to a height of plate 140 where the pelvic edge comes to lie thereagainst.

[0029] In the shown preferred embodiment the flexible zone 144 is formed by transverse folds 148. A plate of hard plastic is shown in which five folds are arranged. On the sides of flexible zone 144 are arranged relatively narrow, non-folded strips 150, 152 which, in contrast to the folds, do not absorb stretch. The lateral support is thus maintained when flexible zone 144 bends, and a blocking or stop function becomes possible as described hereinbelow.

[0030] The second rigid zone 146 is provided with transverse strengthening ribs or with lattices 154, 156, 158 (fig. 4B). The lattices prevent the plate from folding too far back, so that the C-shape is maintained.

[0031] On the front side (fig. 4A) a cushion (not further shown) is arranged against the plate for the required comfort, and the whole is provided with an upholstering. On the rear side (fig. 4B) are arranged fixing members 160-166 with which the plate 140 can be fixed to corresponding fixing elements of frame 12. Blocks 176, 178, which each carry a pivot shaft 180, 182, are snapped into the upper fixing members 164, 166. These pivot shafts 180, 182 together define the axis 68 about which the second rigid part 50 can be rotated. The lower fixing members 160, 162 serve to fix plate 140 to the height-adjusting mechanism to be discussed hereinbelow. The snap connection formed by members 160-166 can be easily released for maintenance or for arranging of a different chair back 40.

[0032] One or more leaf springs 168 are arranged in height direction against flexible zone 144. On an outer end thereof is arranged a slot 170 into which a protrusion 172 of plate 140 falls for determining a minimum and a maximum bending of flexible zone 144. The coupling of the protrusion in the slot acts as a stop in the extreme positions. The forces on the second rigid zone are in the order of 300 N, so that the coupling of the leaf spring absorbs about 1200 N. The opposite outer end 174 of leaf spring 168 is fixedly connected to the second rigid zone 146. The leaf spring acts as a blocking for a minimum and a maximum bending. For this purpose the leaf spring is arranged over folds 148 which stretch simulta-

neously with the bending in co-action with strips 150, 152 arranged on the side, which do not stretch. The blocking or stop function is thus realized within the chair back 40 itself.

[0033] In addition to vertical profiles 32, 34 and horizontal support parts 36, 38, frame 12 (fig. 5) comprises curved profiles 80, 82 which end in the strengthened transverse part 84 for arranging thereon of the rear portion 20 of the seat part. Openings 86, 88 arranged in standing side edges form together with hole 89 mounting points for mounting on support member 11. Frame 12 is attached as a whole to rear seat part 20. Together with rear seat part 20, frame 12 is tiltable about axis 56 relative to leg part 2. Front part 18 is arranged at a fixed angle, running roughly 4° downward, relative to the horizontal. At the top the frame 12 comprises guides 90, 92 for guiding the protrusions 68 on the chair back part.

[0034] The chair back comprises a cross-beam 94 which engages on the first rigid zone 46. Arranged on beam 94 is an arm 96 which ends in ball joint 95. Beam 94 and arm 96 are connected to plate 140 via fixing members 160, 162. Ball joint 95 is arranged rotatably in an opening in arm 98. On arm 96 is arranged a protrusion which is guided in slotted recess 100 of guide 102 arranged on profile 32. Arm 98 is arranged at an outer end on a nut 104 of a screw spindle mechanism. Nut 104 is adjustable in lateral direction by turning screw 106 (fig. 5) using knob 44.

[0035] The whole has a mirrored form, wherein on the side of profile 34 knob 42 controls the screw 108 which can adjust nut 110. Nut 110 is coupled to arm 112. A protrusion on an arm (not shown) is guided in guide 114 on profile 34.

[0036] Screws 106 and 108 are connected to each other at the outer ends by means of a spiral-shaped flexible coupling 116 so that screws 106 and 108 move substantially synchronously when one of the knobs 42, 44 is turned. It is possible to envisage other embodiments of coupling 116 wherein the operation remains the same.

[0037] When the screw spindle mechanisms are operated and chair back 40 is adjusted in height as according to the arrows, pivot shafts 178, 180 herein move in guides 90, 92 on the upper side of frame 12.

[0038] Nuts 104, 110 move in opposite direction when screws 106, 108 are operated. For reasons of assembly technique, screws 106, 108 are embodied with left-hand and right-hand screw thread together. Nuts 104, 110 consist of a lower half and an upper half. During assembly the lower half with arms 98, 112 thereon is arranged on screws 106, 108, whereafter the upper half of the nut is arranged on the lower half.

[0039] The invention is not limited to the above described preferred embodiment thereof, in which many modifications can be envisaged. The automatic back inclination adjustment can thus also be applied to chairs with a fixed seat part which is arranged on a leg part at an angle inclining downward to the rear. The invention is further not limited to office chairs but can likewise be applied for all other chairs, for instance conference chairs or car seats. The scope of protection is defined by the appended claims, within the scope of which many modifications can be envisaged.

Claims

1. Chair, comprising:

   - one or more leg parts (2);
   - a seat part (16) arranged on the leg parts; and
   - a chair back part (40) which comprises a first relatively rigid part (46) on the underside for supporting a user, as well as a relatively flexible part (48) arranged above the first relatively rigid part (46) and a second relatively rigid part (50) which is connected on the upper side to the flexible part (48), wherein the chair back part (40) is mounted on the seat part (16) via a frame (12) and at least the second relatively rigid part (50) is connected to the frame (12) for pivoting about a pivot point,

   characterized in that the chair back part (40) is oriented substantially vertically in its rest position and the second rigid part (50) can be pivoted backward under load, wherein the flexible part (48) is forced forward.

2. Chair as claimed in claim 1, **characterized in that** the first rigid part (46) is connected to the frame for pivoting on a pivot point.

3. Chair as claimed in claim 2, **characterized in that** the seat part (16) encloses a constant, substantially right angle with a plane defined by the pivot points of the first and second rigid part (46, 50).

4. Chair as claimed in claim 3, **characterized in that** the angle between the first rigid part (46) and the seat part (16) is acute.

5. Chair as claimed in any of the foregoing claims, **characterized in that** the pivot point of the second rigid part (50) is height-adjustable relative to the frame (12).

6. Chair as claimed in claims 2 and 5, **characterized in that** the pivot point of the first rigid part (46) is height-adjustable relative to the frame (12).

7. Chair as claimed in claim 3 or 4, **characterized by** at least one screw spindle mechanism (104-110) controllable by a turning knob (42, 44) for adjusting the height of the or each pivot point relative to the frame (12).

8. Chair as claimed in any of the foregoing claims, **characterized in that** the chair back part (40) comprises an arresting element (168) which defines a minimum and a maximum curvature of the flexible part (48).

9. Chair as claimed in claim 8, **characterized in that** the arresting element comprises at least one leaf spring (168) which is arranged against the flexible part (48).

10. Chair as claimed in any of the foregoing claims, **characterized in that** the first and second rigid part (46, 50) and the flexible part (48) are formed integrally in a plastic plate (140).

11. Chair as claimed in claim 10, **characterized in that** the plate (140) has a number of strengthening ribs (154, 156, 158) at the position of the second rigid part (50).

12. Chair as claimed in claim 10 or 11, **characterized in that** the plate (140) has at the position of the flexible part (48) a number of folds (148) which extend in transverse direction over a part of the width of the plate (140).

13. Chair as claimed in any of the foregoing claims, **characterized in that** the seat part (16) comprises a front part (18) which is arranged at a fixed angle to the leg parts (2) and a rear part (20) which is tiltable relative to the front seat part (18).

14. Chair back part (40) evidently suitable for use in a chair as claimed in any of the foregoing claims.

15. Method for the use of a chair as claimed in any of the claims 1-13 or a chair back as claimed in claim 14.

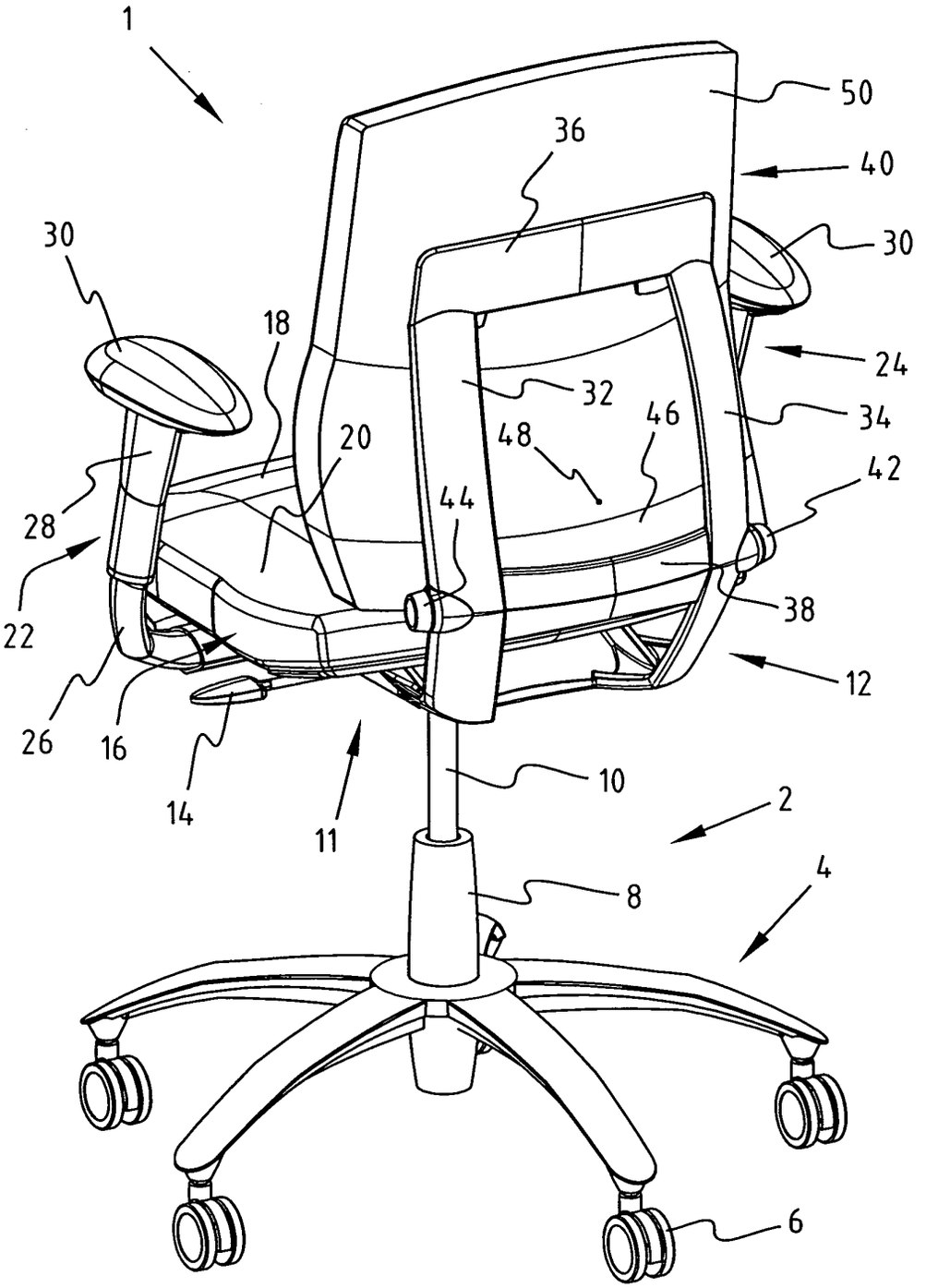
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FIG. 1

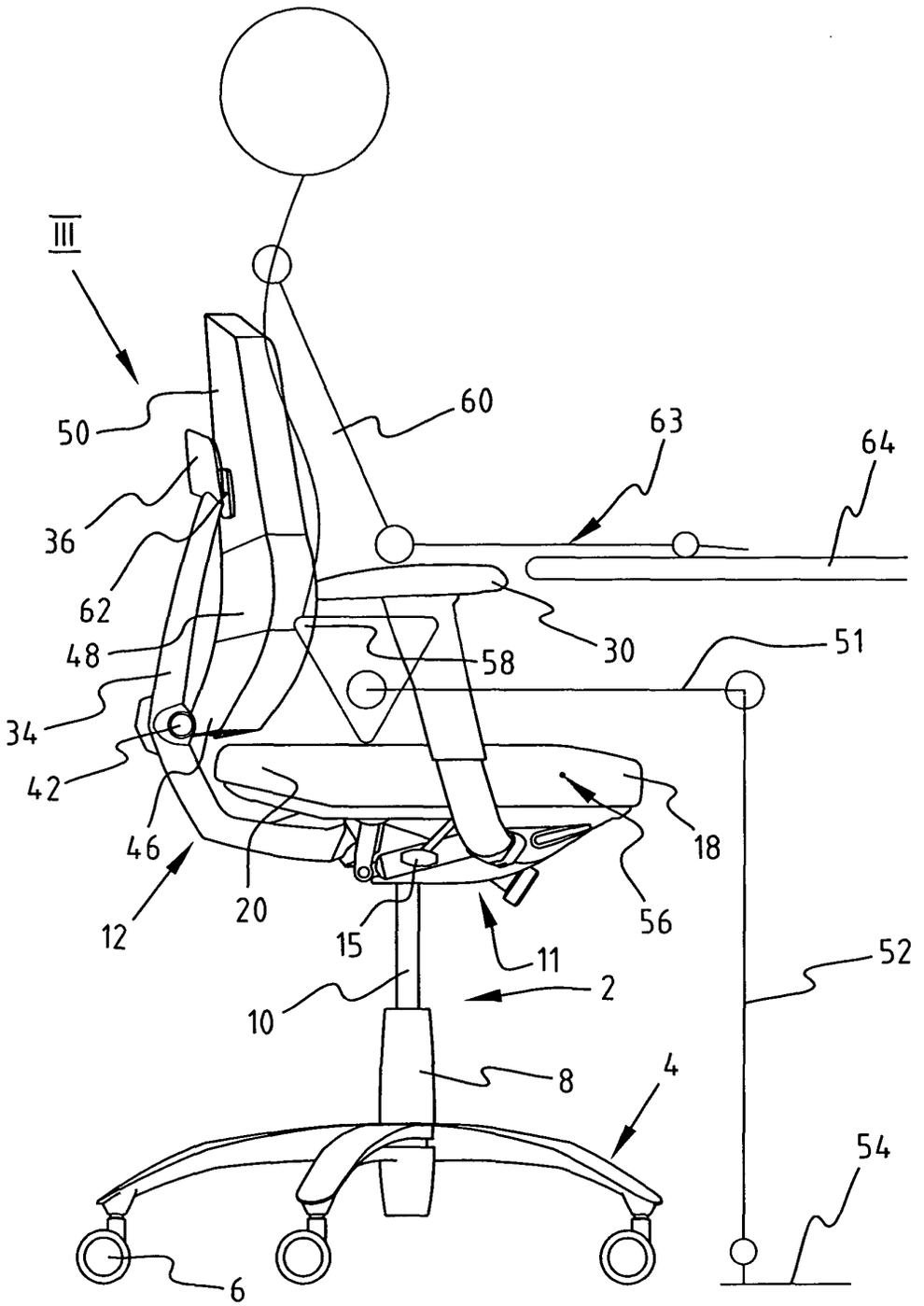
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FIG. 2

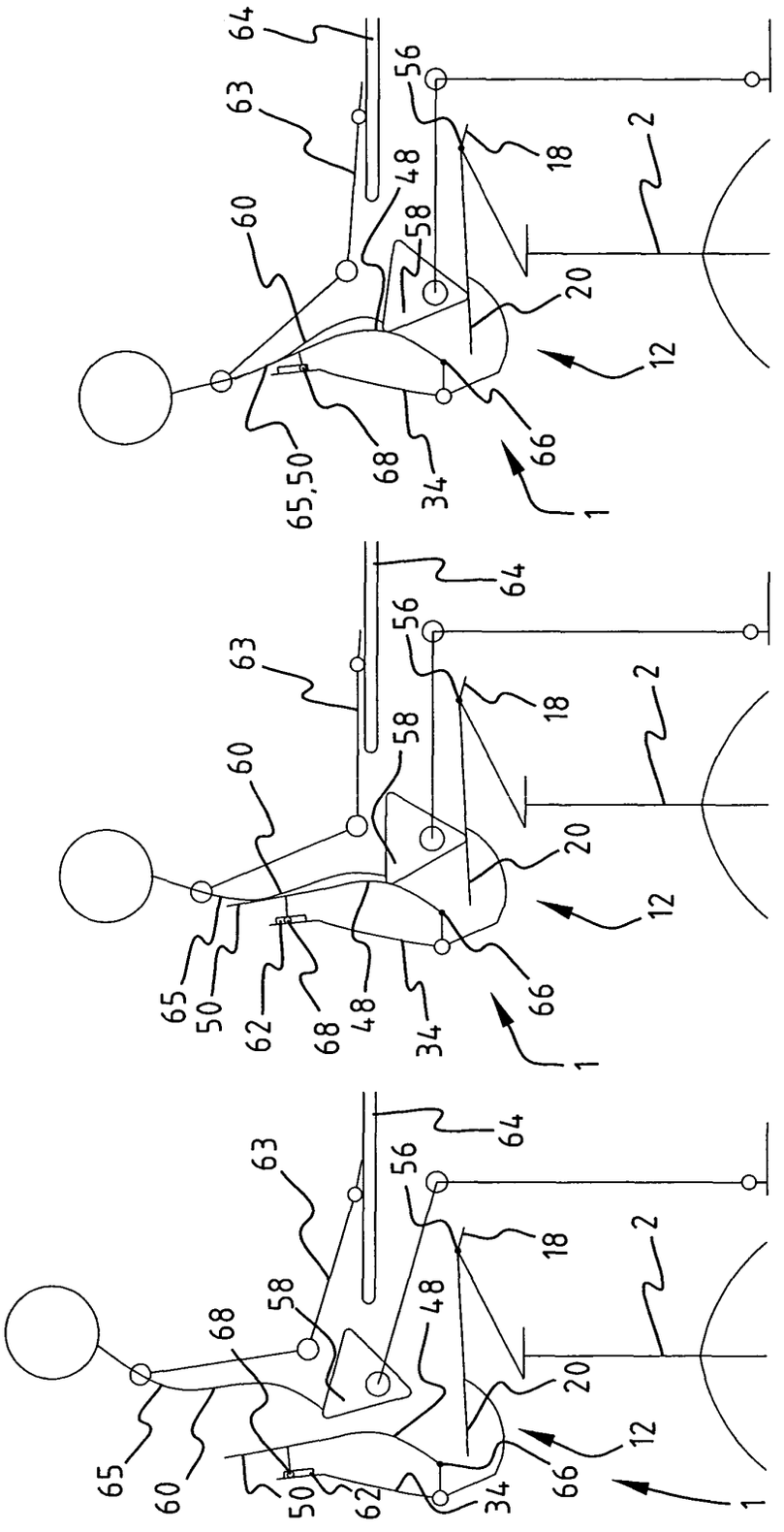

FIG. 3A

FIG. 3B

FIG. 3C

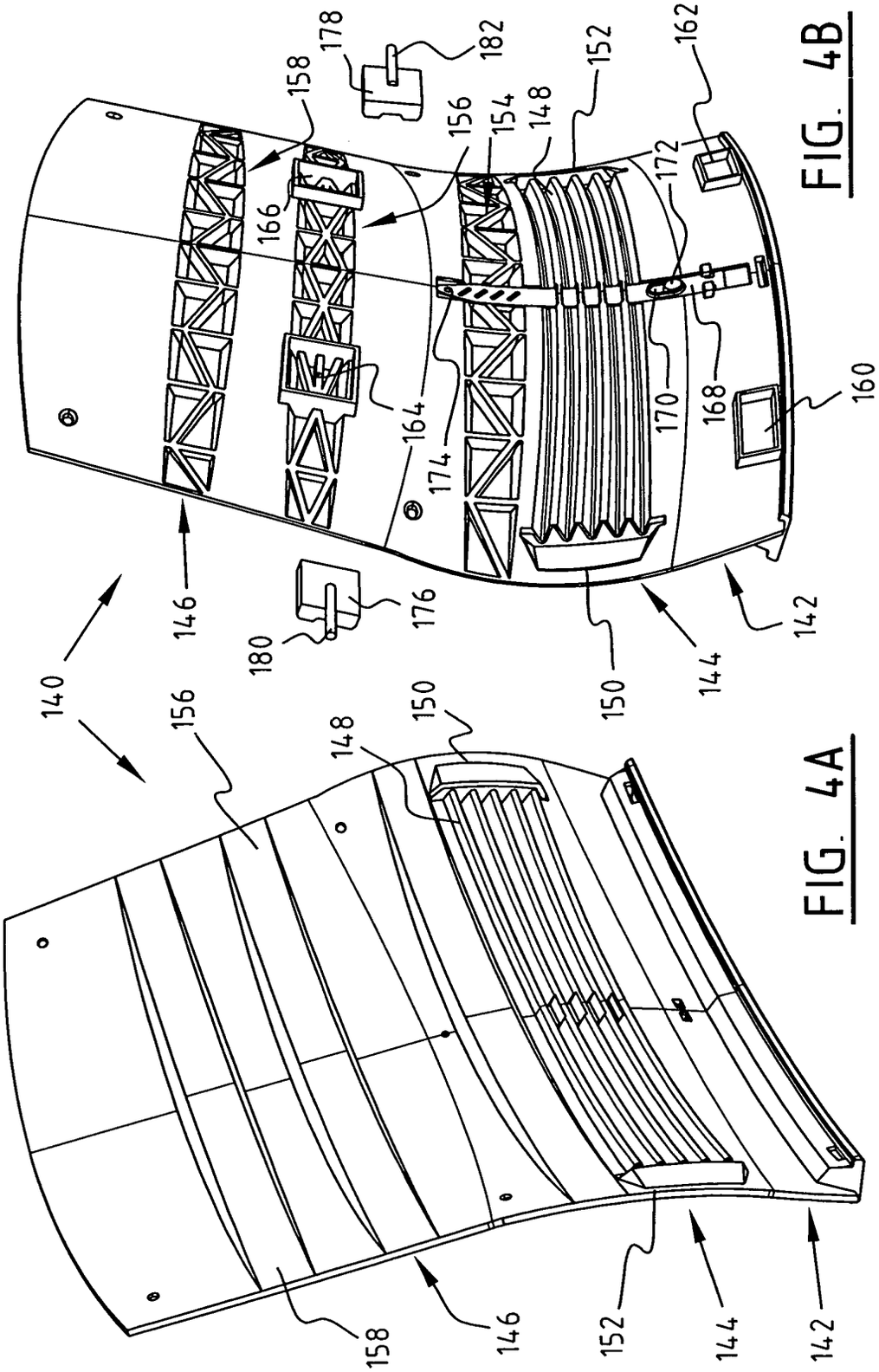
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FIG. 4B

FIG. 4A

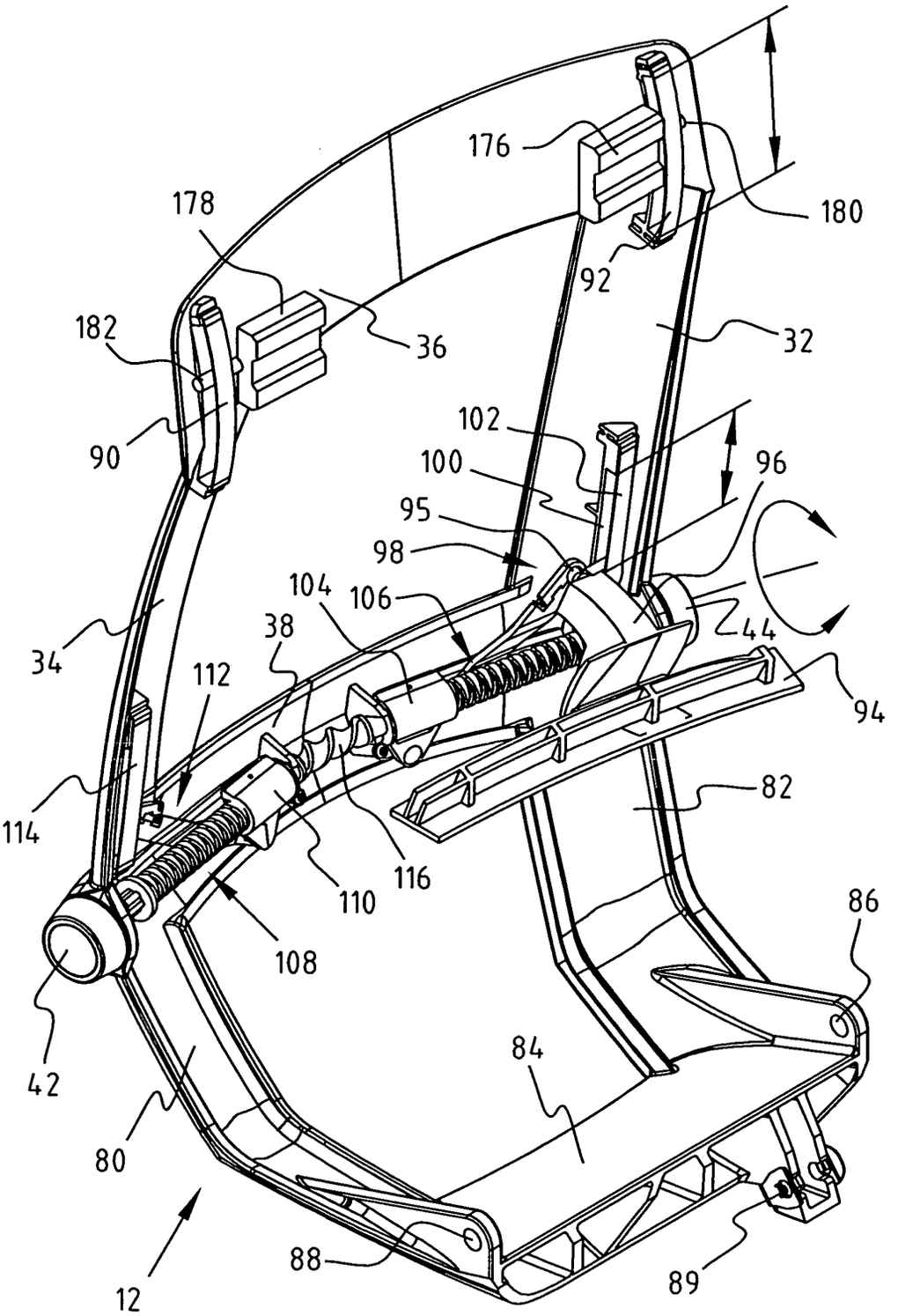
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FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 07 5720

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

A47C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	4 July 2005	VandeVondele, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 07 5720

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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