

A SEAT

TECHNICAL FIELD

5 The present invention relates to a seat; particularly a seat for use in an office chair, task chair, aircraft seat, bicycle, vehicle, wheelchair, pushchair, child's seat/car seat or bench. Specifically, the invention is a seat that actively directs the sitter into a correct
10 sitting position as hypothesised by the inventor, i.e. a position that emulates the position that the sitter's spine and pelvis would achieve if they were standing.

BACKGROUND ART

15 Traditional chairs with near horizontal seat pans (both forward to back and side to side) force people to sit in a posture that is detrimental to proper functioning of their spines and associated tissues, which can lead to
20 strain, injury and, in some cases, spinal degeneration. Specifically, horizontal seat pans force a sitting position with a curved back and reduced thoraco-abdominal space, so causing compression of the abdominal viscera, diaphragm and lungs which can result in hindered
25 digestion and breathing. They also put strain on the sitter's side-to-side spinal curves (scoliosis).

Since the 1970s, following the work of A.C. Mandal and others, designers have developed sitting devices that
30 allow the thighs to be lower at the knee than buttock. However, these devices all have their drawbacks. For example:

"Kneeling Chairs": e.g. US3863978 (Gillings 1975), US3669493 (Vowles 1972), EP0017450 (Mengshoel 1980), SE8600691 (Opsvick 1986) and NO320859 (Mengshoel 2006), were the first attempt to increase sitting thigh angle.

5 In many cases this involved a thigh-to-horizontal angle of up to 45 degrees. The user was prevented from slipping forward in the seat by 'locking' the leg into shin supports just below the knees. There have been several papers reporting knee strain (anterior cruciate

10 ligaments) due to the unnatural pressure on the knee joint caused by such strain. They can also restrict the free movement of the legs and feet which is uncomfortable for the user.

15 "Ergonomic Chairs": chief amongst these (developmentally) being the Aeron (Herman Miller 1994), Leap (Steelcase 1999) and Freedom Chair (Humanscale 1999). These and their imitators can have seat pans tilted but this leads to the user sliding slowly forward. To counter this

20 movement the user tightens leg and trunk muscles so sitting soon becomes painful. The designers of these chairs advocate movement, rather than advising on a beneficial position. The chairs have numerous adjustments for the user; however, research shows

25 unequivocally that the majority of users rarely bother to adjust their chairs. If adjustments are made they are usually limited only to height.

"Saddle Stools/Chairs": e.g. WO0154545 (2001), NO20003763

30 (Mengshoel 2002), US2002167206 (2002), and NO320859 (Mengshoel 2006), use a saddle-like form and achieve the desired thigh angle by allowing the legs to drop either side. These seats work in the same way as a bicycle saddle wherein the weight of the body is taken by the

'hammock' of muscles that form the perineum. This diamond shaped sheet of muscles (containing the reproductive and excretory organs) hangs over the saddle seat, transferring the weight of the body through the muscle insertions at the ischial tuberosities, pubis and coccyx. Such seats have similar drawbacks to bicycle saddles, i.e. discomfort experienced after prolonged use.

"Improved Bicycle Saddles": e.g. GB611899 (Scoular, 1946); address perceived problems of conventional bicycle saddles as mentioned above by including a modification to improve comfort in use. Devices such as GB611899 propose that two seat pads mounted on a lateral bar include a forward tilt of 20 to 30 degrees, but this is only the initial position. The pads are mounted for spring-biased rotation around the lateral bar (horizontal axis) as a user's thighs move up and down to pedal the bicycle. The initial angle is provided for ease of mounting the seat which aids buttock comfort.

"Sittings Balls": are currently popular and, depending on the size of the ball, may allow the user to gain an advantageous thigh angle as well as providing cushioning and some intended instability, which can all be beneficial. However, such devices do not fit well into a conventional office environment.

"Moving/Movement-control/exercise chairs": e.g. US5588704 (Harza, 1996); US7090303 (Kropa, 2006); US2009/0079243 (Kunzler et al, 2009); US2009/0135133 (Kunzler et al, 2009), can involve movement for either exercise or health and the possibility to control other apparatus. Movement is often beneficial to humans and its complete absence for extended periods is detrimental, however, the

addition of poorly controlled or poorly guided movement in a work seat will often lead to distraction and discomfort. It is erroneous to think that by providing ample free movement in a sitting device that the body
5 will find the best position for comfort and health.

“Dual-pad/tilting/Shaped Chairs”: e.g. US4387925 (Barker et al, 1983); US4552404 (Congleton, 1985); GB2226756 (National Research Development Corporation, 1988);
10 US5580128 (Johnson et al, 1996); WO 2006/073019 (Train Corp et al, 2006); WO 01/76420 (Hansen, 2001); (US7387339 (Bykov et al, 2008); US7063386 (Dowty et al, 2006); US6357827 (Brightbill et al, 2002); US5024485 (Berg et al, 1991); US5713632 (Su, 1998); WO2009040861 (Manzini
15 Roberto, 2009); WO 94/08491 (Bustanate Serrano, 1994) are primarily concerned with the comfort of the sitter. Shaped pads often resemble early, shaped “tractor-type” seats. These seats, which keep a central anterior to posterior ridge, create the same problems of discomfort
20 after a little while as the previously mentioned saddle seats. Dual pads are an improvement but providing these without any contouring will not allow adequate forward tilting of the seat pads without the movement of the sitter, the same is true for flat, tilting seats. To be
25 truly comfortable, the inventor has noted, the pads should allow for a small degree of roll, pitch and yaw.

DISCLOSURE OF THE INVENTION

30 By observing patients the present inventor concluded that humans have not evolved to sit and, therefore, any work chair must be designed to emulate the position that the pelvis and spine achieve in the standing posture of the

individual. A detailed anatomical knowledge and expertise in spine, pelvic and musculo-skeletal structure and function led to a hypothesis in how best to achieve this improved seated position.

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In studying spines for many years the inventor realised that when an individual moves from the standing to sitting position there is dramatic change in spinal and pelvic posture. Firstly, as most seats have horizontal or slightly downward sloping seat pans this does not
10 allow the lumbar spine to achieve a stable position and so requires the overuse of insufficient spinal and paraspinal muscles to maintain an upright position. These muscles are not meant to maintain an upright
15 position for a sustained period. Secondly, the human body is full of asymmetries, no place more so than in the legs, as they are the longest parts of the body. Most people have a leg length difference and hence a difference in pelvic height. This uneven pelvic height
20 causes side to side curves (scoliosis) in the spine. When sitting on a normal, fixed, non-adaptive chair the pelvis is usually forced into a horizontal position, hence creating changes, stresses and discomfort on the spinal scoliosis.

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Through an extended process of prototyping and empirical testing resulting in the present invention, it has been possible to reproduce the pelvic and spinal positions achieved when standing.

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The invention produced is counterintuitive, as it looks uncomfortable but, nevertheless, is extremely comfortable. Furthermore, it looks simple but has a high level of complexity and is a practical innovation.

Following the conclusions reached above, the present invention seeks to provide a seat that actively directs the sitter into a sitting position wherein the sitter's spine and pelvis have a similar structural and postural position as when the sitter is standing. In order to achieve this the seat must allow a considerable downward slope of the thighs (from hip to knee), without the sitter sliding forward, and each side of the pelvis must be helped to achieve the same relative height to the other as they have when standing.

In a broad aspect of the invention there is provided a seat with a contoured pan adapted to support each ischial tuberosity of a user and enabling the thighs of a user to be supported at a position between 15 and 45 degrees to the horizontal plane.

The contoured seat pan provides a cup-like support (i.e. concave around at least two axes) such that, even when at an angle, a user will sit comfortably and not slide forward. The function of preventing a user from sliding forward may be achieved through other means that are equivalent to a contoured seat pan, such as ridges, a non-slip rubber surface or even adhesive/straps. These functional equivalents may be incorporated instead of a strictly "contoured" seat pan.

Preferably the seat pan supports a thigh angle of 22 to 32 degrees (but optimally the pan is selected to support the thighs at 27 degrees) to the horizontal plane, which causes the lumbar spine to replicate the anterior facing curve (lordosis) it achieves when a person is standing. In other words, the present invention directs (and

maintains) the body to replicate the position of the pelvis and spine as occurs when standing. During use the sitting thigh angle does not alter significantly.

- 5 When the standing lordosis is achieved it is the natural positioning of the vertebral structures that hold the body upright, not the muscles of the back. When the natural standing lordotic posture is lost, as with a horizontal seat pan, the muscles of the back attempt to
- 10 support the person in an upright position. These muscles soon tire and allow the lumbar spine to curve (slump) forward which has a detrimental effect to the rest of the spine, shoulders, neck, arms and forearms.
- 15 Preferably the seat pan is comprised of two separate, at least partially concave, shaped seat pads for each side of a user, wherein each pad supports the tissues and shapes around each ischial tuberosity. This structure enhances the body's natural cushioning features and so
- 20 reduces the need for wasteful/excessive cushioning.

The seat pan could be formed in a single integrated piece that performs the function of the two seat pads otherwise described herein.

- 25 By focusing on the support of ischial tuberosities and understanding that for the most part, the variation of their distance apart in the adult human population is only approximately 12% it becomes possible to produce
- 30 seats that support a far wider range of users than standard seats.

In a preferred form of the invention each seat pad is attached to a base/pedestal structure by a lug with an

internal silicon bush at the front and is also connected by a pivoting leaf-spring and another silicon bush at the back. This allows each seat pad to vary its height, towards the back, in a linked way, relative to the other
5 pad. This addresses the fact that it is essential for comfortable sitting that one side of the pelvis might be higher than the other as in most standing people.

As mentioned, the pads are concave around two axes (not
10 one as in some prior art, e.g. GB611899) and are preferably able to move around at least four axes and two fulcra (again, distinguished from GB611899 which has only one axis).

15 The leaf spring also allows the springing movement of a back post, a movement that helps in the treatment of hypertonicity in the back muscles provided by a series of "back balls" located on a seat back portion. The pads also have a silicon mounting bush within the lug at the
20 front and between the mountings at the back, which allow for a controlled amount of roll in the seat pad.

Preferably the back portion is self adjusting in response to a user sitting on the contoured pan. The self
25 adjusting back component of the invention can be used to treat hypertonicity (elevated tone) in the postural back muscles. Furthermore, the seat is preferably manually adjustable in height only; with the result that many superfluous and wasteful manual adjustment mechanisms (as
30 found in the prior art) can be discarded.

The seat can be used in an adapted form for use in bicycle and motorcycle seats. Research has shown that use of standard bicycle saddles can lead to low fertility

and erectile dysfunction in males. The standard saddle is also irritating to haemorrhoids. Many people do not ride bicycles as they find them uncomfortable and this is because much of the body weight is transferred through
5 the perineum rather than the ischialtuberosities as outlined by the present invention.

A seat according to the invention, specifically for bicycle use, may be modified by cutting off approximately
10 half of the pad to reduce its size. In other words, some uses of the seat of the invention may necessitate utilising only part of each pad.

The invention is also anticipated for use in wheelchairs
15 and integrated into other seat structures, such as a bench. Indeed the invention could also be in the form of a portable or retrofit insert for any seat/chair.

It is noteworthy that, other than a height-from-ground
20 adjustment, the seat of the invention is intended to automatically adapt to a user and does not require numerous user adjustments/customisation to find a comfortable position. Prior art seating devices are known to provide manual adjustments that may,
25 coincidentally, locate a seating position which would emulate a standing position and, in such a case, the prior art seat may achieve the same benefits as the present invention for that user. However, such a seat cannot adapt to future changes in the user or other users
30 the way the present invention can.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 shows a side view of a seat according to the invention in a raised position;

5 Figure 2 shows a side elevation view of the seat in a lowered position;

Figure 3 shows a rear elevation view of the seat in the lowered position;

Figure 4 shows a general perspective view of the seat of the invention;

10 Figure 5 shows a closer view of the seat when the seat back has been loaded;

Figure 6 shows a closer view of the seat when in a resting position;

15 Figure 7 shows a detailed rear view of the seat;

Figure 8 shows a detailed underneath view of the seat;

Figure 9 illustrates a side view where the seat pads have been tilted by a load;

20 Figure 10 illustrates a front view where the seat pads have been loaded as in Figure 9;

Figure 11 illustrates a rear perspective view of the seat; and

Figure 12 illustrates a detailed rear view, comparable to Figure 7, where the seat pans are tilting.

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MODE(S) FOR CARRYING OUT THE INVENTION

30 Figure 4 best illustrates a general view of a seat according to the present invention incorporated into an office chair which has a base with feet and/or wheels 11 converging into a central pedestal 12. Such a base with wheels is relatively conventional and it should be noted

that any recognisable configuration of chair with ground contacting parts could implement the invention.

A height adjustment means 13 is incorporated into the
5 pedestal 12, which may be in the form of a screw thread
(as shown) or a pneumatic/spring cylinder. Figures 1 and
2 illustrate relatively raised and lowered positions of
the seat by virtue of the height adjustment means 13.
Height of the seat from the ground is adjusted for
10 comfort dependent on the length of a user's legs, e.g. so
feet will be flat on the floor.

The seat itself includes a seat pan preferably formed
from two pads 14 which have an at least partially concave
15 construction and are a mirror-image of each other. These
pads 14 are preferably independently mounted onto a frame
structure 15 at the upper end of the pedestal 12 that
supports each pad and a back portion 16, pivotally
attached at an axis 17 (best seen in Figure 6).

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Seat back 16 also features a series of padded supports 18
or "back balls" that, in use, contact a user's back.

Figure 6 illustrates a side view of a seat according to
25 the invention in its initial unloaded or "resting" state,
i.e. without the weight of a person applied. The seat
pads 14 rest at a relatively high angle and it will be
apparent that seat back 16 is reclined at an angle over
vertical in this first resting position, before a person
30 sits on the seat.

As illustrated in Figure 5, when a force F is applied to
the seat pan 14 (e.g. by a person sitting down), pressure

in the vicinity of the pivot 17 causes the seat back 16 to move in a direction L toward vertical.

Figures 5 and 6 generally show a relative linkage arrangement of the seat pads where the frame structure 15 is connected to the pedestal and the spine-shaped seat back 16 is connected at a second pivot 19 (located between the first pivot 17 and the upwardly curving back portion of seat back 16) by a link arm 20 to a front lug 21 extending from the underside of a seat pad. The lugs include an internal silicon bush that provides some flexibility (i.e. "give") to the pad movement.

The distal end of the curved seat back terminates in the first pivot connection point 17 where a leaf spring 22 is mounted and spans between the two seat pads 14 as best seen in Figure 7. A further set of resilient bushes 23 (made of silicon or equivalent) are mounted with and extend from the rear underside of the seat pads 14 to connect with the leaf spring 22 spanning therebetween. The resilient nature of the bushes 23 provide a limited degree of yaw movement in the pads.

Figure 8 illustrates an underneath view of the seat where a lateral bar 24 passing through the (inboard) lugs 21 at the front side of the seat pads 14 provides a horizontal axis about which the front side of the pads have a degree of movement. The lateral bar 24 is stabilised by outboard lugs 25 extending underneath the pads 14.

In totality the mechanism is designed to articulate each pad using a rose joint pivot system, accompanied by a leaf spring/bush arrangement. Each pad, therefore, has a limited degree of movement in several directions to adapt

to a sitting person, but yet direct said person into an optimum position based around the incline angle of the seat pads. Once seated a person is maintained in an optimal and comfortable position which, so far as the
5 shape of the spine is concerned, emulates standing.

Particularly, by virtue of the seat pads being attached to the base/pedestal structure 15/20 by a lug 21 with an internal silicon bush at the front and also connected by
10 the pivoting leaf-spring 22 and another silicon bush 23 at the back; each seat pad is able to vary its height, towards the rear, in a linked way, relative to the other pad. This addresses the fact that it is essential for comfortable sitting that one side of the pelvis might be
15 slightly higher than the other as in most standing people.

It will be apparent that the preferred seat pads of the invention have some degree of movement about at least four axes and two fulcra. Particularly, the pads move
20 around three axes (pitch, roll, yaw) and a fourth, being the anterior-posterior axis between the back of the seat pads around which the leaf spring rotates.

Figures 9 to 12 illustrate the linked articulated
25 movement of the rear of the seat pads 14 where the right-hand seat pad 14A (see Figure 10) is depressed lower than the left-hand pad 14B by the weight/physiology of a person (not illustrated) sitting on the seat.

30 Figure 12 particularly shows the tilting (rolling/seesawing curved arrows S) nature of the seat pads by virtue of the leaf spring 22 wherein, as one pad lowers, the other rises.

The linked articulated movement can be incorporated into a seat independently of the optimum sitting angle provided by the contoured pads because it addresses variations in pelvic shapes that are not solved by the
5 sitting thigh angle alone.

The leaf spring 22, being resilient, also allows springing movement of the seat back 16 via its pivotal connection 17, a movement that helps in the treatment of
10 pain in the back muscles provided by the series of "back balls" 18 located on a seat back portion. As mentioned, the pads have a silicon mounting bush within the lug at the front and between the mountings at the back, which allow for a controlled amount of roll in the seat pad.

15 A more conventional seat back (as in an office chair) may be incorporated with the seat which is not necessarily pivotally linked to the seat pads, e.g. it could extend from elsewhere on the base/pedestal and be movable or
20 adjustable independently.

While a leaf spring is illustrated in the presently preferred embodiment of the invention, such biased movement could be provided by other spring types or
25 pneumatic cylinders.

Preferably the back portion 16 is self adjusting in response to a user sitting on the contoured pan 14. The self adjusting back component of the invention can be
30 used to treat pain in the postural back muscles or for the general accommodation thereof. Furthermore, it should be noted that the seat is preferably manually adjustable in height only; with the result that many

superfluous and wasteful manual adjustment mechanisms (as found in the prior art) can be discarded.

Preferably, when loaded with the weight of a person, seat pads 14 should accommodate and support a user's thighs at an angle selected to be substantially 27° below the horizontal while the curved and contoured nature of the seat pads 14 comfortably prevent a user from sliding forward.

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It will be appreciated that the pivot mechanism of the seat back 16 connected via the leaf spring could take several forms or, in the case of a stool-type design, be removed completely. In such a device the two seat pads

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14 can be at a fixed angle of approximately 27°. Guidance for the use of the invention recommends that the users feet are flat on the floor when in the final sitting position, or at least in a position which allows the muscles thighs and legs to be relaxed. There could also be occasions when the occupier might want to use a foot rest on the lower part of the chair so that lower legs could be angled backwards or in the case of the invention being used on a higher seat such as a bar stool a higher foot rest could be incorporated to support the feet.

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It should be noted that, because the two seat pads 14 are contoured to the buttocks of the user, explicit cushioning on said pads 14 can be relatively thin.

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General principles of the seat according to the invention can be adapted for use in a wheelchair or other seat designs such as a bicycle or motorcycle seat. Operation is otherwise the same as described above

In all cases the seat pads (or integrated single seat pan) include a concave portion or equivalent to cup and support each ischial tuberosity of a user in a way which
5 does not put undue pressure on the perineum and also avoids muscle tightening which would otherwise result from a user attempting to prevent slipping forward.

The seat of the invention, in all forms, can be moulded
10 in relatively few parts, e.g. all major elements of the office chair of Figures 1 to 4 can be moulded from aluminium such that it can be particularly lightweight.

What I Claim Is:

1. A seat with a contoured pan adapted to direct the thighs of a user to be supported at a position
5 between 22 and 32 degrees to the horizontal plane.
2. The seat of claim 1 wherein in use, when a user is seated, the seat will direct and maintain the user's spine to substantially emulate a standing position.
- 10 3. The seat of claim 1 or 2 wherein the position is substantially 27 degrees to the horizontal plane.
4. The seat of any preceding claim with a contoured pan
15 adapted to support each ischial tuberosity of a user and enabling the thighs of a user to be supported.
5. The seat of any preceding claim wherein the contoured pan is adapted to support each ischial
20 tuberosity by a portion that is concavely shaped about at least two axes.
6. The seat according to any preceding claim wherein the seat pan is comprised of two at least partially
25 concavely shaped seat pads adapted to support each ischial tuberosity of a user.
7. The seat according to claim 6 wherein the seat pads of the invention have a degree of movement about
30 four axes and two fulcra.
8. The seat according to claim 6 or 7 wherein a rear side of each seat pad is linked to the other for (roll) movement, such that lowering a rear side of

one pad will cause a corresponding raising of the rear of the other pad.

- 5 9. The seat according to claim 8 wherein the link is provided by a resilient element spanning between the rear side of the pads.
- 10 10. The seat according to claim 9 wherein the seat pads are attached to the resilient element by a resilient connection, enabling yaw movement of the respective pads.
- 15 11. The seat according to claim 10 wherein the resilient element is a leaf spring and the resilient connection is a rubber bush.
- 20 12. The seat according to any of claims 6 to 11 wherein a frontal portion of each pad is mounted for pivotal (pitch) movement to a seat support structure.
13. The seat according to any of the preceding claims, further including a back portion, pivotally mounted in relation to the seat pan.
- 25 14. The seat according to claim 13 wherein the back portion is pivotally mounted at a distal end thereof to a resilient element spanning between a rear side of two seat pads, there being a second pivotal connection from the back portion toward a seat support structure, wherein each seat pad is mounted at a front side thereof for pivotal (pitch) movement to the seat support structure.
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15. The seat according to claim 13 or 14 wherein, in use, the back portion is arranged to pivot toward the spine of a seated user in response to a force applied to the contoured pan.
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16. The seat according to any preceding claim wherein the seat pan is cushioned by a relatively thin layer of padding.
- 10 17. The seat according to any of the preceding claims wherein the contoured pan is functionally substituted or complimented by a ridge, non-slip rubber surface, adhesive or strap means.
- 15 18. The seat of any preceding claim, further including a height adjustment mechanism.
19. The seat of any preceding claims wherein a seat support structure includes a ground contacting leg or legs.
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20. A seat including two seat pads mounted on a support structure wherein a rear side, relative to a user's sitting direction, of each seat pad is linked to the other for roll movement, such that lowering a rear side of one pad will cause a corresponding raising of the rear of the other pad.
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21. The seat of claim 20 wherein the link is provided by a resilient element spanning between the rear side of the pads.
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22. The seat according to claim 20 wherein the seat pads are attached to the resilient element by a resilient connection.
- 5 23. The seat according to claim 22 wherein the resilient element is a leaf spring and the resilient connection is a rubber bush.
- 10 24. The seat according to any of claims 20 to 23 wherein a front side of each pad is mounted for pivotal, pitch, movement to a seat support structure.
- 15 25. The seat according to any of preceding claims 20 to 24, further including a back portion, pivotally mounted in relation to the seat pan.
- 20 26. The seat according to claim 25 wherein the back portion is pivotally mounted at a distal end thereof to a resilient element spanning between a rear side of the two seat pads, there being a second pivotal connection from the back portion toward the support structure, wherein each seat pad is mounted at a front side thereof for pivotal (pitch) movement to the seat support structure.
- 25 27. The seat according to any of claims 20 to 26 wherein the two seat pads provide a surface for supporting each buttock of a user and the seat pads are integrated into a single pan forming the support surface.
- 30 28. The seat of any preceding claim 20 to 27 wherein the seat pads are mounted to provide an incline between 22 and 32 degrees below horizontal such that, when a

user is seated, the seat will direct the user's spine to substantially emulate a standing position.

29. A wheelchair incorporating a seat according to any
5 preceding claim.

30. The wheelchair according to claim 29 wherein the seat is height adjustable relative to a footrest.

10 31. A bicycle or motorcycle incorporating a seat according to any of claims 1 to 28.

32. Use of a seat according to any preceding claim wherein the seat is configured to enable a user to
15 sit with feet flat on a ground surface.