A dynamic joint, to serve as part of a chair, where the dynamic joint is disposed between, and fixedly attached to, the seat and the base of the chair. The joint is operative to enable a person sitting on the chair to tilt the seat in any direction, over a substantial angle, by appropriate force from the person's pelvis and to similarly tilt the seat from any tilted position further in any direction. The Joint comprises a pair of attachment members and an elastomer body, structurally linked with them. The elastomer body is formed so as to include the tilting axes, close to the seat, and so as to control the dynamic tilting characteristics.

Also provided is a chair, comprising said joint, and an ergonomic seat for the chair, enabling the person to sit safely and comfortably while tilting the seat. Configuration of the chair as an exercise device is described.
NATURAL BALANCE ACTIVE CHAIR

[0001] This application claims priority from US Provisional Patent Application no. 61/381,979, filed 11 Sep. 2010, and from PCT application no. PCT/IL2011/000690, filed 29 Aug. 2011, whose disclosures are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates in general to seating devices and in particular—to tilting chairs and to fitness apparatus.

BACKGROUND ART

[0003] Accumulated sitting hours on chairs can cause health problems. The problems are mostly caused by technical disabilities of chairs to support adequate sitting postures for work in front of a desk or a computer, and to allow comfortable and safe body movement during long sitting periods. The term chair is to be understood hereunder to include any seating device, including a stool. With the changing industrial society and the increasing number of office jobs, where more employees transact business while sitting for long periods of time at desk and in front of computers, resultant health problems have become more common. Many past ergonomic chair designs tried to solve these problems, but the solutions were inherently limited by technologies. Most chairs for use in offices, desk work, factories and schools, both conventional chairs and ergonomic chairs, are designed for sitting upright with a fixed 90-degree angle between the upper body (also referred to herein as torso) and the thighs. Since the angle between the vertical axis of the pelvis and thighs at the hip joint can bend only 60 degrees, the rest of the 90 degrees bend, forced by the chair, is effected by commensurate rotation of the pelvis axis backwards, which strain the muscles of the back and causes asymmetric pressure on the inter-vertebrae discs. Therefore such a sitting posture over long periods of time may cause discomfort and back pain. In contrast a sitting position where the angle between the torso and the thighs is closer to 135-degrees is relaxing, allowing the spine to keep its normal curve, what is known as ‘natural lordosis’.

[0004] Thus there is a need for chairs that allow sitting at postures where the torso-thighs angles are over 90 degrees. One solution, available in many office chairs, is a back-tilting back-rest; however, the resultant posture does not allow working comfortably at a desk or in front of a computer.

[0005] Another solution, already applied in many devices and disclosed, for example, in U.S. Pat. No. 4,589,699 and U.S. Pat. Application 2009/0284064, has the seat of the chair tilted down, relative to the ground plane. If, for example the seat is tilted down by 25 degrees, and the user’s upper body is upright, the thighs will slope downward, creating an angle of 115 degrees with the upper body. Some of the designs of such chairs include knee rests and are therefore known as “kneeling chairs”. Sitting on such chairs for long periods is difficult since they require much energy to maintain the upright posture, they cause pressure on the knees, as well as on the sitting bones and spine, and they are not easy to use by the common users.

[0006] The two basic solutions for the torso-thigh angle problem, discussed above, have been shown to be unsatisfactory. They have, moreover, the disadvantage of forcing largely fixed postures, which cause additional discomfort to the user and distract from the alertness and vitality required in front of a desk or a computer. Solutions are therefore desired where the users can easily, dynamically and safely adjust the desired torso-thighs angle, either when the body is tilted back against a back support, or when the upper body remains upright.

[0007] Rocking chairs such as disclosed in U.S. Pat. No. 4,099,697, U.S. Pat. No. 5,921,628, or other dynamic seat devices such as disclosed in U.S. Pat. No. 2009/001788 or DE Pat. 4301734, act as rocking chairs, allowing the seat to tilt about a pivot at the base of the chair. However, since such a pivot is located far below the seat surface, the seat concurrently moves over a relatively long range, which is undesirable. Moreover, such tilting is activated mostly by the legs, creating movements of the whole body together, rather than, as is more desirable, involving only the middle body, i.e. the pelvis and/or the lower spine and their relevant muscles. Such activation can be achieved only if the pivot of tilting is close to the surface of the seat.

[0008] Another active dynamic chair is disclosed in U.S. Pat. No. 5,570,929. Its tilting angle and feedback pressure is a function of the user’s weight; however, its pivot is far from the seat making it difficult to maintain balance. U.S. Pat. No. 5,590,930 discloses a sitting chair in which the seat has a shell shape that is placed on a bearings mechanism, tilts about a pivot above the seat and cradles the user’s hips. Here the middle body is constrained to move about a pivot more upwards the spine rather than at the lower back. Such a chair, moreover, requires the seat to have a shell form, limiting the possibility to shape it for ideal sitting posture.

[0009] Another group of patents, such as U.S. Pat. No. 5,113,851 or DE Pat. 19507458, disclose dynamic tilting mechanisms that allow only predefined limited or automated movements, rather than free movements that are driven by the user with full flexibility and in all directions. These mechanisms have the additional disadvantages of being essentially heavy, large and expensive to produce and, moreover, cannot be produced as self-contained joint units, to be assembled with available seats and chair bases.

[0010] Chairs with a seat that can swing around one horizontal axis, such as are described in U.S. Pat. No. 5,261,723, allow the user to tilt the seat down, relative to the ground plane without knee support. Such devices are limited to tilting about one axis. Furthermore, the largest tilt angle the user can bear without sliding down, or without exerting extra force, is limited, since the shape of the seat is not ideal for resisting the user from sliding down at sharp forward angles.

[0011] Other adjustable dynamic chairs, such as disclosed in U.S. Pat. application 2008/0191525 or U.S. Pat. No. 5,044,587, feature a multi axes elastomeric joint, coupling between the seat and the base. However these joints have a carriage bolt running through the elastomer and engaging a rigid plate fixedly attached to the seat or the base. This causes the mechanism to have limited tilting angles and is more suitable to function when the seat is parallel to the ground, with only momentary tilting movements. It is, moreover, not built to be tiltable in directions other than the combination of the two base axes, nor to maintain its natural flexibility when tilted down, to allow small movements about a tilted position. Furthermore, it is not built to withstand constant tear forces that result from large tilt angles.

[0012] Other patent applications such as U.S. Pat. No. 2002/00486, DE102005033052 or DE202009017844, disclose seat joints with an elastic body that buffers between
rigid top and bottom plates, allowing tilting movements of the seat about a pivot point about two horizontal axes. However these elastomer buffers are not designed to maintain their functionality under constant forward or backward tilting, or to ensure linkage of the plates to the elastomer under aggressive or repetitive tilting, or to insure long lifetime of the buffer when used for tilt. Those joints use elastomer buffering appropriate for small tilt angles and short time durations, rather than tilting as required herein. The functionality of such joints mainly relies on pressing on elastomer against two hard plates, so like the joint in the citations of the previous paragraph, they may be sufficient for use in a chair where the seat remains largely parallel to ground, with occasional and relatively small tilting motions.

The motion limitations on the tilting joints disclosed in some of the last citations are also due to the manner in which the elastomer is joined to each of the plates. In the case of large, constant or aggressive tilt angles, not only shear forces are applied to the joint, but pull forces as well, since pivoting loads cause parts of the elastomer to go into tension; such pull forces, can tear the elastomer away from the plate. Usually elastomeric buffers are subject to compression and shear forces of vibrations, but they are not built to cope with forces caused by tilt tension, since the tensile strength of the elastomer and its merely adhesive links to the plates are not sufficient for long life time, or for such tilting angles. Some patents cited above may suggest an implementation wherein the elastic body of the joint is fixed into a corresponding penetration or recess in the plate, to secure them together, but such an arrangement is not likely to help much.

SUMMARY OF THE INVENTION

The Technical Problem

There are technical limitations and constraints on a dynamic joint between the base and the seat of a chair that can fulfill the totality of requirements as follows. The dynamic joint mechanism must allow the user freedom to dynamically select and adjust the seat angle without any special handles and controls and to do so independently from any back support. The same mechanism should allow the user to move the seat dynamically about any axis and from any tilt angle at which it is currently set, rather than only from its origin position. This mechanism should allow the user to easily move his pelvis and lower spine, while relaxing the muscles of other parts of the body, in order to effectually relax or strengthen the lower back. The same mechanism should allow the user to sit for long time periods in any tilt angle that the joint enables, while supplying the appropriate feedback for the user to feel safe and without a sensation of falling. It should, moreover, enable substantial, relatively large, tilt angles, relative to the ground, while keeping the joint intact, safe and reliable. ‘Substantial’, or ‘substantially large’ angles, in the present context, mean tilt angles of at least 15 degrees, preferably 45 degrees or more.

There is also a need for a complementary seat that will allow the user to tilt the seat, as well as to stay in the desired tilt angle, with no effort to hold the body in that position or to arrest it from sliding or falling. The latter requirement should be achieved with no physical barriers that may cause pressure on other parts of the body.

Any solution to the above requirements should be inexpensive, have an essentially small footprint, have a light weight and be easily adaptable to existing chairs. Dynamic joints and seats of the prior art are not capable, nor are designed to be capable, of supporting a plurality of the requirements mentioned above, let alone—their totality.

Elastomer materials, which are an essential component of the dynamic joint being disclosed herein, function in prior-art devices under compression and vibrational shear forces only. They inherently do not withstand tensile forces, such as may be caused by tilt in such a joint. Nor is the tensile strength of conventional adhesive links of the elastomer to metal- or other attachment members sufficient for long life operation of such a joint.

Solutions to the Problem

The principle purpose of the present invention is to provide a dynamic joint mechanism that can tilt in all directions progressively, and that enables sitting on a chair at various postures where the torso-to-thigh angle is larger than 90 degrees—either when leaning against a back support, or with the upper body upright and the seat tilted forward at any angle, relative to the ground plane. This purpose is advantageously served in the present invention by a dynamic seat joint that is implemented with a flexible member, such as an elastomer or rubber, that buffers and links between two rigid attachment members, which are attached or attachable to the seat and the base of the chair, respectively. The flexible member is joined with each attachment member in an interlocking structure, which ensures the integrity of the joint in face of the greatest shear- and tensile forces that may be caused by any tilting action. Preferably the elastomer is bonded to the attachment members also by special glue, applied during the elastomer injection process, as part of production. Preferably the elastomer is the only member connecting between the two metal plates, thus allowing full flexibility of the joint movements. It can be designed with various compounds of the elastomer, providing various degrees of resilience, as well as a feedback force that progressively grows as a function of stretching length. Furthermore, the flexibility, movement characteristics, as well as the pivot of movement, can be controlled by designing the shape of the elastomer body and by the volume of the elastomer, as described here below.

Another purpose of the present invention is to provide a dynamic joint with captive links that drastically reduce the chances that parts of the joint will fail or disconnect from each other owing to tensile and shear forces caused dynamically or statically by large tilts. Such links would ensure long operating life, as well as safety. A joint that serves such a purpose should also be inexpensive to produce. This purpose is advantageously served in the present invention by a dynamic joint that includes an elastomer body that meshes with the two coupling plates in three dimensional structures, such that allow better grip between the elastomer and the plates. In one configuration, for example, structured elements of each plate are partly buried inside the injected elastomer. In another configuration, for example, plate structures are provided that enable tightening of the elastomer to the plates by external forces, such as external tightening screws.

Another purpose of the present invention is to provide a dynamic joint such that the pivot of tilt of the joint is located below its upper surface (which is attachable to the seat) and as close to it as desired by the manufacturer of the chair—thus enabling user movements with the seat that are effected largely by the pelvis and the lower spinal vertebrae. This purpose is advantageously served in the present invention by a dynamic joint with an elastomer formed so as to
have, in a vertical cross section a profile that is asymmetric along the vertical axis, with a waist essentially high up (i.e. essentially closer to the upper surface of the joint than to its lower surface), thus creating a high pivot location.

Another purpose of the present invention is to provide an ergonomic seat that may be tilted forward at essentially large angles while enabling the user to remain sitting and arrest the user from sliding down without the need for any additional support, such as a knee support. Yet another purpose of the present invention is to provide a seat that distributes the pressure evenly over the user’s buttocks and allow the pelvis to rest largely on the muscle tissue, instead of mostly on the sitting bones singular areas, thus to reduce pressure from the spinal cord. Both the latter purposes are advantageously served in the present invention by a seat with certain proposed shapes, using a combination of a moderate saddle shape with a lengthwise convex curve which lowers the thighs and a protrusion at the middle front of the seat, which may be embraced by the user with his thighs, altogether with additional structures, such as side portions of the seat that are raised and form sloping supporting sides, allowing the user to press his thighs towards them, thus increasing friction. While the dynamic joint disclosed in this invention can be used without the ergonomic seat presented in the current paragraph, wherein other types of seat can be used instead, using the seat presented here allows the user larger tilt angles without sliding off the seat, and supplies better load pressure distribution at any angle.

Another purpose of the present invention is to provide integration between the proposed dynamic joint, the seat and the chair frame, such that creates a ‘natural balance’—meaning that the user feels natural and easy when shifting into forward or backward tilt postures, including such where the angle between torso and thighs is over 90 degrees. This purpose is advantageously served in the present invention by the ability to locate the proposed dynamic joint relative to the chair frame, as well as the proposed seat relative to the dynamic joint, at the desired balance location. For example, if the center of mass of the seat, with the user sitting thereon, is directly above the pivot axis of the joint, the seat will be naturally and easily balanceable by the user; if that center of mass is slightly in front, or slightly back, of the pivot axis, the seat will let the user flow naturally with the it into tilted forward when the center of mass is at the front of the joint, or tilted back angle when the center of mass is behind the joint. This, along with the feedback characteristics of the joint, which are provided by the proposed elastomer shapes, will let the balancing process be controlled safely and easily by the user, rather than forced on the user by the chair.

Another purpose of the present invention is to provide a physical exercise device that can strengthen the inner layers of lower and upper back muscles, as well as inner layers of abdominal muscle. These muscles are otherwise ‘hard to reach’ and their strengthening is important to maintain upright posture, as well as to prevent back pain, especially in the lower back, damage caused to the back from long durations of static sitting. This purpose is advantageously served in the present invention by the proposed dynamic joint and, preferably, the ergonomic seat with the addition of elastic straps, where those straps are connected to the frame of the chair. The straps, together with the seat and the joint, allow the chair to function as a fitness device. While tilting the seat in various directions with the pelvis, the user may use his hands or legs to engage the elastic straps so as to create counter pressure and balance between the different body parts. This enables exercising in a controlled and easy manner, due to the user’s ability to sit firmly and safely while moving the upper, middle and lower body separately as desired, while having the support of the seat, the leg control on the ground and the counter pressure of the elastic straps. This exercise ability may be augmented with the addition of a swivel plate between the seat and the dynamic joint, or between the join and the frame. This swivel plate leverages the effectiveness of the fitness activity with this device by integrating circular movement close to the seat surface. Together with the combination of the active joint it allows pelvis movements on the axis of the spinal cord in any tilt angle. That allows more body movements that mainly enhance the ability to activate the transverse abdominals and the lower back muscles. The swivel plate can have a free rotation, or it can have auto return functionality using internal compression or expansion springs. The auto return functionality can further enhance the effectiveness of the fitness exercises.

Another purpose of the present invention is to provide a dynamic joint that can be mounted on top of any existing office chair mechanism, as well as integrated with any existing or new chair design. This purpose is advantageously served in the present invention by a joint with a technology that enables its production with a small footprint relative to the seat and frame, as well as by its being manufacturable with any desired mounting drill locations and any desired mounting plate size—to adapt to any chair. Alternatively, it can be provided with an adapter mounting plate that will easily adapt the joint structure to fit any chair.

Another purpose of the present invention is to provide a device as proposed above with automatic capabilities to force fast or slow small-amplitude tilt movements of the seat in one or more axes. Such externally driven automatically induced vibration can reduce momentary pressure of back and body in order to relieve pain, induce blood flow, or awaken the user. This purpose is advantageously served in the present invention by an optional automatic vibrating, or tilling, engine that can be added to the proposed mechanism. Vibration engines can be added, for example, to the bottom of the seat—to induce therein small or large vibrations. Alternatively, a small motion engine can be mounted to the dynamic joint itself.

There is thus provided, according to the present invention, a dynamic joint to serve as part of a chair, the chair including also a seat and a base, the joint being fixedly attachable to the seat and to the base, wherein the chair, when comprising the joint, is operable to enable a person, while sitting thereon, to tilt the seat in any direction, definable in terms of two orthogonal horizontal pivot axes, over a substantial angle by appropriate force from the person’s pelvis and/or lower spine. The pivot axes of the tilting are between an upper surface of the joint, attachable to the seat, and a lower surface, attachable to the base, and essentially closer to the upper surface than to the lower surface. Preferably, the chair, when comprising the joint, is further operative to enable the person, while the seat is in any tilted position, to dynamically tilt the seat from that position in any direction by appropriate action of the person’s pelvis and/or lower spine.

In preferred embodiments of the invention, the joint comprises a rigid upper member, directly or indirectly attachable to the seat,
a rigid lower member, directly or indirectly attachable to the base, and
a flexible member, solely disposed between the upper and lower members and fixedly attached thereto,
wherein the pivot axes for all tilting movements are within the flexible member.
Preferably, each of the rigid members is interlocked with the flexible member.
Also preferably, the flexible member is made of at least one elastomer and the joint is fabricated wholly by injection of one or more of the elastomers, so as to contact the upper and lower members.
Further in preferred embodiments of the invention, the structure of the flexible member is designed to control one or more of—
the force required to tilt the seat in any direction,
the progressive variation of the force with the tilting angle and
the location of the tilting pivot axes.
Preferably the outline shape of the flexible member is formed so as to have a waist in at least one vertical cross-section and, more preferably—in a plurality of vertical cross-sections, of various azimuthal directions.
According to features of these configurations, the vertical location of the waist in any vertical cross-sectional plane determines the vertical location of the tilting pivot axis in that plane and the outline shape affects the required force, with respect to tilting in any direction, as a function of the tilting angle.
In some configurations of the invention, any of the upper and lower members is formed so that a part thereof serves as an anchor within the flexible member, preferably formed as one or more plates, both faces of each plate being in contact with corresponding portions of the flexible member. According to a further feature, any of the plates includes one or more holes there across, the holes being filled with an elastomer that forms an integral part of the flexible member.
According to the present invention there is provided a chair, comprising:
(a) a seat,
(b) a base and
c) a dynamic joint, directly or indirectly attached to the seat and to the base, the chair being operative to enable a person, while sitting thereon, to tilt the seat in any direction over a substantial angle by appropriate force from the person's pelvis and/or lower spine.
Preferably the joint is as described here above.
Also according to the present invention there is provided an ergonomic seat, to serve as part of a chair, wherein the seat is tiltable in any direction by substantially large angles, the seat being formed so as to resist a person sitting thereon from sliding off when the seat is tilted and so as to distribute the weight of the person essentially evenly at any tilt position or when not tilted.

Advantageous Effects of the Invention

The dynamic joint and the seat herein disclosed enable a person (the user) to sit in any desired posture while the angle between the torso and the thighs can be naturally set by the user to be at values above 90 degrees. The user can change the angle dynamically to any other comfortable angle, inter alia, to relieve stresses, to exercise the muscles or to allow blood flow in a body part that feels numb. The user can achieve this by tilting the seat by any desired angle, exploiting the capabilities of the disclosed joint and seat, with no efforts, with minimum stress and pressure and without sliding. The advantageous results are capabilities to (a) sit and work for long time periods with improved vitality and less pain and stress; (b) avoid accumulated body damage that long sitting periods may produces; (c) practice and strengthen the muscles and the blood vessels needed to support a healthy back and a healthy body. This invention allows people to use it on any existing chair with very cheap adapting plate to mount the joint with.

The herein disclosed techniques for design of the joint and, possibly, of the chair allow accurate control of the location of the pivot of tilting and the characteristics of the tilting motions (such as their progressiveness), reduced tension on the elastomer. Proper values for such location and characteristics ensure stability and allow the user to sit still or to move the seat as desired. Locating the pivot as close to the seat surface as desired enables user movements with the seat that are derived from the pelvis and the lower vertebrae, allowing pressure relief, better blood circulation in lower back, vitality and alertness while sitting.

Progressive force feedback from the joint enables easily controlled continuous shift between, and combination of, fast small movements of the pelvis and larger body movements. It also provides stability and safety for the user.

A technology that insures a captive linkage between the rigid attachment members and the elastomer buffer, such that will not fail under static and dynamic tensile and shear forces produced by the tilting of the seat, even if the tilting is aggressive or repetitive.

A seat with the disclosed characteristics distributes pressure evenly over the user's buttocks and to support the person's buttocks tissue so as to allow the pelvis to rest on that tissue. It further enables the user to sit with the seat tilted at large angles in any direction, without sliding off it and without the need for any additional support, such as a knee support.

The dynamic chair disclosed herein creates a "natural balance", wherein the user feels natural and able to easily tilt the seat forward and backward—to achieve comfortable postures, where the angle between torso and thighs is over 90 degrees.
The dynamic chair with added straps, disclosed herein enables a user to exercise the back and abdominal muscle so as to strengthen them, to immunize them from back pain or to prevent damage caused to the back from long duration static sitting.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIGS. 1A and 1B are perspective views of a chair with the dynamic joint and ergonomic seat, wherein FIG. 1A is a side view and FIG. 1B is a top front view
FIG. 2A is a perspective view of a dynamic joint according to the invention,
FIG. 2B is a vertical cross-sectional view of the joint of FIG. 2A in a particular configuration.
FIGS. 2C-2F are vertical cross-sectional views of alternative configurations of the joint of FIG. 2A.
FIGS. 3A and 3B are a perspective view and a vertical cross-sectional view, respectively, of another embodiment of a dynamic joint according to the invention
FIG. 4 is a wire frame model drawing of one conceptual embodiment of an ergonomic seat according to the invention.

FIGS. 5A and 5B illustrate, in a perspective view, attachment of the dynamic joint to the bottom of the seat at two different locations.

FIG. 6 illustrates, in corresponding multiple perspective views, various tilt positions of the seat in the chair of FIGS. 1A and 1B.

FIGS. 7A and 7B consists of perspective views of the chair of FIGS. 1A and 1B, with the backrest in leaned back position, wherein FIG. 7A shows the seat in forward tilt position and FIG. 7B shows the seat in backward tilt position.

FIG. 8 is a perspective view of exercise apparatus that comprises a dynamic joint and an ergonomic seat according to the invention.

FIG. 9 is a perspective view of a swivel plate that can be mounted above or below the dynamic joint of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

FIGS. 1A-1B are perspective views of a chair according to the invention. As seen in FIG. 1A, the chair is equipped with a dynamic joint 101 that links between the seat 102 and a frame 103 of a chair. The seat 102 is an ergonomic seat and the dynamic joint 101 allows the user to tilt the seat to any side as well as forward and backward whereas the seat 102 is an ergonomic seat that resists the user from sliding out of it. This chair can be equipped also with any other chair tilt mechanism where the dynamic joint 101 can be mounted on top of such mechanism. The same structure, using the dynamic joint and the optional seat can be applied to different frame styles and shapes, for any use.

FIGS. 2A-2F depict a dynamic joint in some embodiments of the invention, wherein FIG. 2A shows it generally in a perspective view, while FIGS. 2B-2F are vertical cross-sectional views of corresponding embodiments. As seen in FIG. 2A, the joint consists of an elastomer body 201, whose horizontal cross section has a cylindrical, oval or any polygonal shape, and upper and lower attachment members 202, made of metal or any other rigid material. The attachment members 202 are provided with drill holes 203 that allow attaching them, respectively, to the base or frame of the chair and to the seat or to a swivel plate on which the seat may be mounted. The structure of the elastomer body 201 is controlled to determine its pivot axes and the progressive tilting characteristics where the feedback force, which is equal to the force that the sitting person must exert (from his pelvis and/or lower spine) to effect the tilting, grows with the tilt angle—as explained below. In addition, the structure of the elastomer body 201 and of attachment members 202 is jointly designed to effect strong captive coupling, between them, where the link of metals and elastomer will not fail and disconnect—as also explained below.

FIG. 2B is vertical cross-sectional drawing of the joint in one embodiment, as an example, depicting structural details of its components. Upper plate 202 (FIG. 2A) is seen to be formed as an external plate 205, used for the attaching, and an internal plate, or anchor, 206, of smaller size ‘D’; the two plates are rigidly joined to each other at a certain mutual distance ‘H3’. The plates may be made of metal or any other strong and rigid material. Internal plate 206 is locked inside the injected elastomer and is preferably covered with elastomer glue before the injection; it acts as a captive link to the external plate, and it insures that the elastomer will not fail to hold the two attachment members together. It is used to insure better link under shear and tensile forces on the elastomer caused by large or aggressive tilts and adds durability and longer lifetime to the link. Anchor (inner plate) 206 can have any desired shape, such that will interlock with the elastomer, that is—the shape of the anchor and the resultant complementary shape of the injected elastomer are such as to keep the elastomer from slipping out from the space between the anchor and the external plate even under the most extreme shear and tensile forces caused by the tilting. A simplified preferred structure for the anchor 206 is a round plate without sharp edges and with several holes there through, which are subsequently filled by the injected elastomer—in permanent locking bond with the elastomer injected to between plates 205 and 206.

Profile outline 207 of the elastomer body includes two curves, ‘R1’ and ‘R2’, shaped so as to—

(a) impart extra flexibility to the joint for small movements,

(b) allow better progressive characteristics for the joint in which as the larger the angle between the plates the larger the force needed to apply to it and the stronger the feedback force and—

(c) reduce or adjust the tension within the elastomer when the joint is tilted.

The convergence of the curves ‘R1’ and ‘R2’ forms a circumferential ‘waist’, at height ‘H2’ from the lower attachment plate.

Two parameters mainly affect the tilting characteristics of the joint—the diameter of the waist and its height ‘H2’. The waist diameter 208 is shown to have different possible values, as, for example ‘D1’ to ‘D4’. Each diameter value determines the amount of elastomer at this location when injected into the mold during joint fabrication. Different diameter values create different types of joints, with different flexibility and strength. Moreover, the waist diameter may generally vary with the azimuth of the vertical cross-sectional plane—preferably forming a generally elliptical outline, wherein, for example, the diameter lengthwise (front-to-back) is larger than the diameter crosswise; this creates different tilt characteristics between front- and back tilts and sideways tilt. The waist outline may be further adjusted to effect asymmetric tilt characteristics—for example between forward and backward tilts.

The height ‘H2’ of the waist determines the vertical location of the pivot of tilt movement. The higher the location, the closer is the pivot to the seat, which allows faster movements. Also, the closer the pivot to the seat, the closer they are to the user’s pelvis and lower vertebrae.

The vertical outline curves ‘R1’ and ‘R2’ of the elastomer within any azimuthal plane can each be chosen to have various radius values, both positive and negative, to further control the characteristics of the joint movements, such as the force required progressively for tilting to, or the force required to tilt about, any tilt angle in that plane or in any other plane (i.e. in any direction), as a function of the tilt angle. In the configuration of FIG. 2C, for example, curve ‘R2’ 209 and ‘R1’ 210 have, both, positive radii; in the configuration of FIG. 2D ‘R2’ 212 is has a positive radius and ‘R1’ 211 has a negative radius; in the configuration of FIG. 2E ‘R1’ 213 and ‘R2’ 214 have, both, negative radii. In the configuration of FIG. 2E there is illustrated, as an example an optional addition 215 of elastomer at the waist, to further control the tilting resilience of the structure; this feature may
be combined with any other configuration, such as those discussed above, to affect the listed tilt characteristics. In the configuration of FIG. 2f the curves ‘R2’ and/or ‘R1’ 216 have a radius of zero, i.e. —are straight lines.

[0071] The term “waist” is to be understood, throughout, as denoting the profile shape of the elastomer body in a vertical cross-sectional plane of any given azimuthal direction, which shape generally includes the curves R1 and R2. Dimensional waist parameters, such as diameter or vertical location of the waist, refer to the deepest incursion points of the profile shape in that plane. The profile shape generally varies with the azimuthal direction and so does the waist diameter and possibly also its height.

[0072] In the configuration of FIG. 2f there is also shown, by way of example, an alternative structure 217 for the implementation of the anchor (internal plates). It is constructed of several internal layers, or plates, fixed to each other and to the external plate. Such structure can improve the linkage of the elastomer to the attachment members.

[0073] Optionally the internal plates may be covered with special adhesive that sticks the elastomer to the metals when the elastomer is injected. The elastomer compound can be selected for each production for extra control of joint flexibility and characteristics; for example, the same joint shape can be produced in 40 ‘Shore A’, or 70 ‘Shore A’ hardness.

[0074] The details of the shape and composition of the elastomer body, which may be regarded collectively as defining its structure, have been shown here above to control its mechanical characteristics—primarily the locations of the tilt axes and the progressive-resistance tilt characteristics. The dynamic joint disclosed herein and its salient characteristics are therefore occasionally referred to herein as being ‘structurally controlled’.

[0075] FIGS. 3A and 3B show, in perspective view and vertical sectional view, respectively, another embodiment of a dynamic joint 301 according to the invention. It, again, includes an elastomer body, having generally a cylindrical shape, preferably with a circular or elliptical cross section, and a circumferential waist profile, which is closely linked with two attachment members. This embodiment is similar to that depicted in FIGS. 2A-2F in all that pertains to the elastomer body, namely the structure (i.e. composition and form) of the elastomer that controls its tilting pivot location and its progressive tilt characteristics, as well as the interlocking structure between it and the two attachment members. This embodiment, again, includes optional ‘H2’ and ‘H3’ parameters that further define the shape and waist location of the elastomer body. The embodiment of FIG. 3 differs, however, from that of FIG. 2 in the form and structure of the attachment members that serve to attach the joint, at one end, to the frame, or base, of the chair and at the other end—to the seat. Here, as illustrated in FIG. 3B, each attachment member is a rigid structure that includes an anchor, such as plate 304, located inside, and meshed with, the elastomer and a fastener, such as threaded bolt 302 (306 in FIG. 3B), or internally threaded nut 305. The anchor (e.g. internal plate 304) acts, as explained above insures that the elastomer will remain tightly joined with the two attachment members for a long time and in the face of aggressive tilting of the seat. The internal plate is fixedly connected with the respective fastener by any strong bonding means known in the art, or they may be produced as a single piece by any suitable process. Either a bolt or a nut can be deployed independently in each attachment member as required for optimal attachment to the frame or the seat, respectively, during assembly of the chair. Clearly, the frame and the seat must be provided each with a matching fastener, e.g. a bolt, threaded to match the nut in the dynamic joint, or a nut, threaded to match the bolt in the dynamic joint. Preferably the surface of the attached part of the chair that comes in contact with the corresponding face of the dynamic joint (which is the outer face of the elastomer member) is hard and flat, so that, when the corresponding fasteners are tightened, the flat face presses the elastomer onto the internal plate, thus further strengthening the link between the attachment member and the elastomer.

[0076] In an alternative configuration of the embodiment of FIG. 3, an attachment member may be provided additionally with an external metal plate, which would serve the function of holding tightly the outer elastomer layer onto the internal plate. In alternative configurations there may be a plurality of fasteners in each attachment member, rather that the single central fastener shown. It is noted that there may be other configurations of the attachment member, with similar or different means of attaching or fastening to corresponding parts of the chair—all being within the scope of the present invention.

[0077] FIG. 4 depicts a seat that integrates the shape concepts presented in this invention. The seat is characterized by a continuous doubly-curved upper surface, conceptual portions of which are described as follows: 401 is largely convex along the front-to-back axis and this contributes to the resistance of sliding when the seat is tilted forward, as it allow the user to lower the thighs to form an angle larger than 90 degrees between torso and thighs, while naturally shifting the center of mass area of contact backward (toward a less inclined portion of the surface). The convex shape contributes as well to an even pressure distribution of the user’s body on the seat. The side portions of the seat, 404, 402 and 407, are raised and form sloping supporting sides. The middle-rear side portion 402 is shaped so as to contribute to an even pressure distribution on the user’s buttocks, lifting the pelvis off the sitting surface and to support the person’s buttocks tissue to allow the pelvis to rest on those tissues, instead of mostly on the sitting bones. Portion 402 also prevents the user from sliding out from the seat while it is tilted sideways, thus contributing to the user’s safety. The middle-front side portion 404 helps further to resist the user from sliding; moreover, the user can push his thighs the legs towards outwards to press against the side surface 404, thus increasing friction therewith to resist sliding forward. Rear side portion 407 acts as a chute that guides the user to sit at the appropriate location on the seat, in order to achieve best fit and even pressure distribution. It also prevents the user from sliding backwards when the seat is tilted backward.

At the middle of its back the seat has an opening 405, which allows the buttocks to have better grip of the seat to resist sliding in a forward tilt. It also aids in fitting different buttocks sizes to the same seat and it allows the user to freely lean back on the chair’s backrest. 408 is largely convex side-to-side along a cross axis, this contributes to lowering the thighs further, as well as allowing to embrace the seat by the thighs, to further resist sliding while the seat is in a forward tilt. Optionally, a protrusion 403 is formed at the front of the seat, which may be embraced by the user with his thighs, to further resist sliding while the seat is in a forward tilt. The bulge 405 may have any of many shapes, as long as it provides the same functionality, namely—being embraceable by the thighs; one of these shapes may be, for example, a pair of protrusions—
one at the inner side of each thigh. Optionally, a pair of cavities 406 are provided, located under the sitting bones so as to divert pressure off them. This is especially effective when sitting upright in a forward tilt posture, when more pressure is accumulated on the sitting bones.

The joint described here above is but one of many embodiments for implementing the concepts mentioned above. The size and depth of the seat and of each portion thereof can be adjusted to fit different users, or user groups (e.g. male vs. female and old vs. young); they may also be adjusted to match or complement the feel and functionality of various dynamic joints.

[0078] FIGS. 5A and 5B show, by way of example, two different relative positions for attaching the dynamic joint to the seat. In FIG. 5A the joint is located closer to the center of the seat 501; this will enable the user to sit naturally balanced largely parallel to the ground, will create a more natural feel and movement of the seat and will enable easier tilting backwards or sideways. In FIG. 5B the joint is located closer to the back of the seat 502; this will enable the user to sit naturally balance at a larger forward tilt of the seat. For the most natural feeling the attachment location should be closer to center of weight of the user when seated. Optionally, a user-adjustable location mechanism is provided, enabling the user to manually adjust the location of the seat relative to the joint.

[0079] FIG. 6 depicts, in multiple perspective views, a chair based on the dynamic joint mechanism and the ergonomic seat, disclosed herein, in various tilting angles. The dynamic joint can tilt in any direction, allowing the user to set his forward or backward tilt angle of the seat as desired, or to make momentary movements to reduce pressure and induce blood flow, or to exercise the lower back and abdominal muscles in order to strengthen them. View 601 shows the seat in a natural angle parallel to the ground, without tilting, were c1 angle is 90 degrees. View 602 shows a tilted forward posture, were c2 angle is larger than 90 degrees that can be set by the user when seated. View 603 shows a steeper angle of forward tilting than the previous view, were c3 angle is larger than c2. View 604 shows a backward seat position, were c1 angle is smaller than 90 degrees, which can be used, for example, when leaning back onto the backrest. View 605 shows a side tilt position, were β1 is an angle in an orthogonal axis to α and is smaller than 90 degrees. View 606 shows a combination of side and front tilt position, were β2 angle is smaller than 90 degrees and α is larger than 90 degrees. The user can force the seat to tilt in any direction—allowing him the ability to draw movements like circle tilting or any kinds of movement desired to relieve pain or to train his muscles. This chair can be equipped with any other components, such as back cushion, armrest, or various frame shapes of any material.

[0080] FIGS. 7A and 7B depict a chair that uses the dynamic joint as a leaning-back tilt mechanism to enable a user to easily lean onto the backrest. The dynamic joint can replace any tilting mechanisms that exist in chairs, or it can be mounted on top of any existing mechanism to further improve sitting postures. FIG. 7A shows a leaned-back posture where the seat is tilted forward, allowing the user to lean back in an open posture, where the body is stretched out. FIG. 7B shows a leaned-back posture where the seat is tilted backward, allowing the user to lean back in a 'cradled' posture.

[0081] FIG. 8 depicts a chair according to the invention, configured as a fitness, or exercise, apparatus. This chair comprises a dynamic joint and, preferably, an ergonomic seat with all the capabilities explained above and may as well be equipped with a backrest (not shown). It is generally equipped with any of a variety of auxiliary parts, such as straps, elastic straps, bars or handles. In the configuration shown, the chair is equipped with elastic straps 801, which can be made of elastomer, or any other flexible material. The elastic straps 801 are attached, for example, to end-points 802 on the base of the chair; any type of base or frame, aside from that shown, can be used for the chair and the mounting locations can be changed. Optional handles 803 are provided for the user to easily hold the elastic straps and stretch them while exercising. The user can sit on the chair and hold the elastic straps by his hands, or other parts of the body, while the elastic straps act as counter force to any of the user's movements, which are done with the aid of the tilting seat—thus allowing further strengthening of the muscles that are activated by the movement. The elastic straps may be of various types and have various values of strength and length, so as to adjust the load and force of the straps. With a specific set of exercises, the user can use this fitness apparatus to easily strengthen his lower back muscles and inner abdominal muscles, so as to be able to hold his back straight, to reduce pain and to immunize the lower back from injuries due to back health problems. Some possible exercises, performed while seated on the fitness apparatus, include, for example, pushing the seat to the left with the right leg while pushing/stretching the elastic band with the right hand in a counter direction; or pushing/stretching the straps with the hands upward while tilting the seat in any direction; or rotating the seat; or crossing hands close to the body and forcing the seat to tilt or turn with the pelvis. It is possible to connect additional elastic straps to other parts of the chair's frame, in order to provide counter force to movements in several different directions.

[0082] FIG. 9 shows a swivel plate that can be mounted between the dynamic joint and the seat, or between the frame and the dynamic joint. It can be any standard swivel plate produced as a generic product and available in the markets. It generally comprises a bottom metal plate 901, and an upper metal plate 902, connected to each other by a rotational bearing 903. Either or both of the plates may optionally be provided with mounting holes 904. Such a swivel plate allows the seat to have circular rotations movement around the vertical axes at any tilted position of the dynamic joint. Integrating such a circular movement of the seat surface with the tilting of the dynamic joint enables pelvis movements on the axis of the spinal cord in any tilt angle. Such functionality allows additional body movements and enhances the ability to activate the deeper muscles of the back and the abdomen.

INDUSTRIAL APPLICABILITY

[0083] The dynamic joint and ergonomic seat presented in this invention can be assembled to any chair or frame. For example, any chair that is built with any of the self mechanisms and ensembles can be equipped with the herein-presented joint, and optionally with the herein-presented seat. The joint and the seat can also be integrated into any new design of a chair. The chair can be of any type, such as an office chair, a school chair, a bar stool, etc. The greatest benefits are for chairs that are used for work in front of a desk or a computer, but also any other type of chair may benefit.

[0084] The joint can be attached to any existing chair by a simple adapter plate, using any fastening means.
The ergonomic seat presented here can replace the seat of an existing chair—to allow better pressure distribution on the seat. It can as well be integrated with the presented dynamic joint, allowing effortless and easy dynamic movements and extended possible sitting postures for work or comfort.

The dynamic joint and ergonomic seat presented in this invention, with additional elastic straps mounted to a chair’s frame, can perform as a fitness apparatus. The elastic straps together with the dynamic joint allow the chair to act as a fitness device. Moving the seat with the pelvis while the hands or legs use the elastic straps to create counter pressure between the different body parts. Such fitness apparatus can be used indoor or outdoor and can strengthen all body muscles, with special capabilities to strengthen back and inner abdominal muscles to support strong and healthy back. The dynamic joint and, optionally, the ergonomic seat presented herein can be assembled to any fitness equipment, existing or under design or fabrication, replacing the conventional seat therein. This would allow the user to sit in postures with less stress on the spine and cartilages, as well as to improve his capabilities to activate more muscles while practicing.

The joint disclosed herein can be easily produced by any elastomer injection process, or vulcanization process. Due to the innovative design disclosed here, a wide variety of elastomer compounds, as well as variety of adhesives between elastomer and plates members, can be used, enabling the required functionality at low production costs.

The seat disclosed herein can be produced with various types of materials and by various fabrication processes, such that will allow it to maintain its shape under the pressure of human weight and the pressure created by the mounting joint feedback when tilted. Such materials and processes are well known in the art.

1. A dynamic joint serving as part of a chair, the chair including a seat and a base, the joint being attachable to the seat and to the base and comprising:
   a rigid upper member, directly or indirectly attachable to the seat;
   a rigid lower member, directly or indirectly attachable to the base; and
   a single flexible member, solely disposed between said upper and lower members and fixedly attached thereto, wherein said upper member is tiltable with respect to said lower member over a substantially tilt angle about a horizontal pivot axis locatable below the upper member and above the lower member.

2. The joint as in claim 1, wherein said tilting is variable in at least one direction, said pivot axis definable by two orthogonal horizontal axes.

3. The joint as in claim 2, wherein the direction of said tilting is dynamically varied.

4. (canceled)

5. The joint as in claim 3, wherein said flexible member is made of at least one elastomer and contacts said upper and lower members.

6. The joint as in claim 3, wherein any of said rigid members is formed to interlock with said flexible member.

7. The joint as in claim 3, wherein the structure of said flexible member is configured to affect, with respect to any tilting direction, one or more of—
   a force required to tilt said upper member,
   a progressive variation of said force with the tilting angle and
   a vertical location of said pivot axis.

8. The joint as in claim 3, wherein said flexible member has a single circumferential surface, defining a waist, which has a diameter, in at least one vertical cross-section, and said surface further formed to have said waist positionable in a plurality of vertical cross-sections of a plurality of azimuthal directions.

9. (canceled)

10. The joint as in claim 8, wherein said diameter is generally variable with the azimuthal direction and said waist has a vertical location in a vertical cross-sectional plane, said vertical location defining a vertical position of the pivot axis when said joint is tiltable in the respective vertical cross-sectional plane, and said waist configurable in any vertical cross-sectional plane to affect a force required to tilt said upper member as a function of said tilt angle.

11. (canceled)

12. (canceled)

13. The joint as in claim 3, wherein at least one of said rigid members is further formed so that a part thereof serves as an anchor within said flexible member.

14. The joint as in claim 13, wherein said part that is formable as at least one plate having at least one face contacting corresponding portions of said flexible member.

15. The joint as in claim 14, wherein at least one said plate includes at least one hole therein, the at least one hole fillable with an elastomer forming an integral part of said flexible member.

16. (canceled)

17. (canceled)

18. (canceled)

19. (canceled)

20. (canceled)

21. (canceled)

22. (canceled)

23. (canceled)

24. (canceled)

25. (canceled)

26. An ergonomic seat, adapted to serve as part of a chair, wherein the seat is tilttable in at least one direction by a substantially tilt angle, the seat formable to arrest a person sitting thereon from sliding thereoff when the seat is tilted and to distribute the weight of the person substantially evenly when the seat is tilted and when not tilted.

27. (canceled)

28. (canceled)

29. (canceled)

30. (canceled)

31. (canceled)

32. (canceled)

33. (canceled)

34. (canceled)