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(54) SECURING DEVICE, MEASURING DEVICE AND MEASURING METHOD

(57) The invention relates to a securing device (10) for securing a ball game racquet (220), including an engaging device (12) configured to engage the ball game racquet to fixate the ball game racquet (220). The engaging device (12) includes a first engaging interface (24) configured to engage with the ball game racquet (220), when an axis of the ball game racquet (220) is arranged in a predetermined first orientation, to fixate the ball game racquet (220) in the first orientation and a second engaging interface (26) configured to engage with the ball game racquet (220), when the axis of the ball game racquet (220) is arranged in a predetermined second orientation, to fixate the ball game racquet (220) in the second orientation, the second orientation being different from the first orientation. The invention also relates to a measuring device for measuring at least one parameter of a ball game racquet (220) and a method for measuring a mass moment of inertia of a ball game racquet (220).

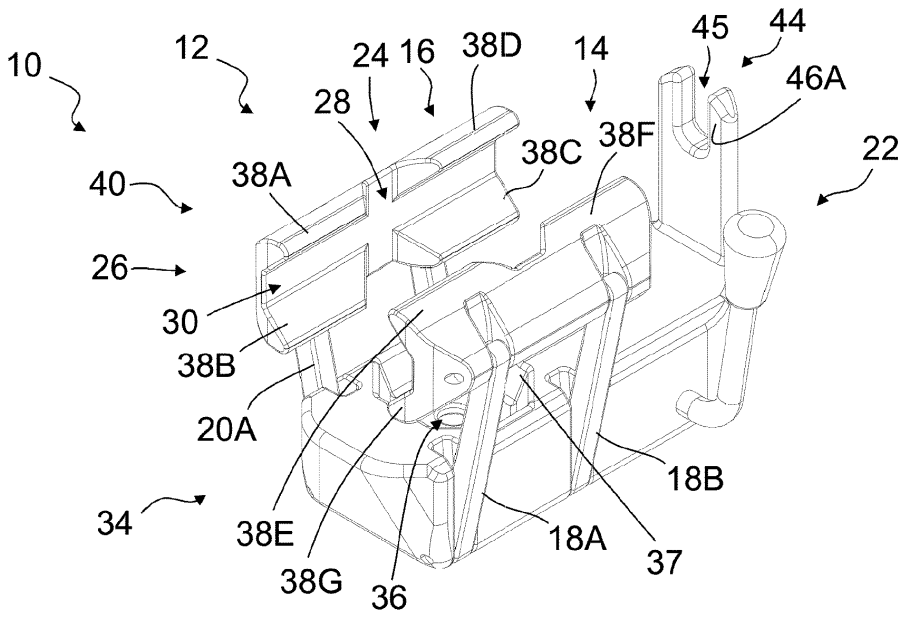

Fig. 1

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Description

[0001] Ball game racquets are available for a wide range of different leisure activities and/or sports. For instance, there is a relatively large market for tennis racquets with a broad selection of different available tennis racquets. Other leisure activities and/or sports, such as, but not limited to, badminton, squash, padel tennis, and table tennis, also form sizable markets with a variety of different ball game racquets available for users to choose from.

[0002] Ball game racquets, in particular tennis racquets, may have a variety of different configurations and/or may be made from a variety of different materials. Simple, relatively low-priced ball game racquets are typically made of plastic or metal, such as aluminum. High-performance ball game racquets, on the other hand, are often made of more sophisticated and/or expensive material, such as carbon fiber, and/or have a more sophisticated construction.

[0003] Several factors, such as a plurality of physical parameters, may affect a ball game racquet's performance. For instance, the weight of a ball game racquet may influence the ball game racquet's performance. A plurality of further parameters may also influence the ball game racquet's playing characteristics. Hence, determining one or more physical parameters of a ball game racquet, such as its weight and moment of inertia about one or more axes of rotation of the ball game racquet, may help identify and indicate a ball game racquet's playing characteristics. This may allow a user to select a ball game racquet which is best suited for the user's playing style and/or degree of skills.

[0004] Several measuring systems for measuring various parameters of a ball game racquet, which may indicate one or more playing characteristics of the ball game racquet, are known from the prior art. However, conducting the measurements by means of the measuring systems is often tedious and time-consuming based on the equipment known from the prior art.

[0005] It is therefore an object of the present invention to provide means for improving the measurement process of a ball game racquet.

[0006] This object is achieved by a securing device for securing a ball game racquet as defined by the features of claim 1. Preferred variations and further developments are defined by the features of the dependent claims.

[0007] The securing device includes at least one engaging device configured to engage at least a portion of the ball game racquet to substantially fixate the ball game racquet at least against rotation relative to the engaging device. The securing device may be configured to engage and substantially fixate the ball game racquet at least against rotation relative to the engaging device by providing a frictional connection and/or a form fit connection between a section of the engaging device and at least a portion of the ball game racquet.

[0008] The securing device may be configured to substantially fixate the ball game racquet at least against rotation about one, two or more, preferably all, axes of rotation of the ball game racquet relative to the engaging device. Optionally, the securing device may also be configured to substantially fixate the ball game racquet against translational movement in one, two or more, preferably all, directions relative to the engaging device. Further optionally, the securing device may be configured to allow translational movement of the ball game racquet relative to the engaging device along at least one moving direction, the moving direction preferably coinciding or extending parallel to an axis of the ball game racquet about which the securing device is configured to prevent rotation of the ball game racquet relative to the engaging device. The engagement between the engaging device and the ball game racquet may be effected and released selectively on demand, e.g., via actuation by the user.

[0009] Preferably, the engaging device is configured to engage a portion of a handle of the ball game racquet, the handle of the ball game racquet being configured to be gripped by a user. This may allow the handle of the ball game racquet to be gripped by the engaging device in a number of rotational and/or translational positions relative to the engaging device, e.g., to measure one or more physical parameters of the ball game racquet by a corresponding measuring device and/or to service the ball game racquet in a number of different rotational and/or translational positions relative to the engaging device. Alternatively, the engaging device may be configured to engage any other portion of the ball game racquet, such as a section of a head portion of the ball game racquet.

[0010] The engaging device includes a first engaging interface configured to engage with at least a portion of the ball game racquet, when an axis of the ball game racquet is arranged in a predetermined first orientation relative to the engaging device, to substantially fixate the ball game racquet at least against rotation relative to the engaging device in the first orientation. The first engaging interface may be configured to engage with at least a portion of the ball game racquet by providing a frictional connection and/or a form fit connection between a section of the first engaging interface and at least a portion of the ball game racquet. Preferably, the first engaging interface is configured to engage a portion of a handle of the ball game racquet. Alternatively, the first engaging interface may be configured to engage any other portion of the ball game racquet, such as a section of a head portion of the ball game racquet.

[0011] The engaging device further includes at least a second engaging interface configured to engage with at least a portion of the ball game racquet, when the axis of the ball game racquet is arranged in a predetermined second orientation relative to the engaging device, to substantially fixate the ball game racquet at least against rotation relative to the engaging device in the second orientation, the second orientation being different from the first orientation. The second engaging interface may

also be configured to engage with at least a portion of the ball game racquet by providing a frictional connection and/or a form fit connection between a section of the second engaging interface and at least a portion of the ball game racquet. Preferably, the second engaging interface is configured to engage a portion of a handle of the ball game racquet. Alternatively, the second engaging interface may be configured to engage any other portion of the ball game racquet, such as a portion of a head section of the ball game racquet.

[0012] The axis of the ball game racquet, which can be positioned in the predetermined first orientation and the predetermined second orientation, may be any reference axis of the ball game racquet, provided it is the same axis of the ball game racquet, i.e. that it has the same orientation relative to the ball game racquet, in the first orientation and the second orientation. Preferably, the axis of the ball game racquet is a longitudinal axis of the ball game racquet. However, any axis of the ball game racquet can be used as said reference axis.

[0013] The securing device may be configured to be securably, preferably releasably, attachable to one or more measuring devices configured to measure one or more parameters of the ball game racquet. For instance, the one or more measuring devices may be configured to determine a moment of inertia about one or more axes of rotation, a weight, a center of mass and/or one or more other physical parameters of the ball game racquet which can be detected by a corresponding measuring device. Due to the ability of the securing device to fixate the ball game racquet in at least two different predetermined orientations, the securing device may enable one or more physical parameters of the ball game racquet to be measured in at least two different orientations. In the prior art devices, separate measuring devices are used to measure one or more physical parameter of the ball game racquet in different orientations of the ball game racquet. Thus, the securing device described herein may alleviate at least some of the trouble in the measuring process of a ball game racquet, e.g., by reducing the number of measuring devices for measuring physical parameters in a plurality of different orientations of the ball game racquet. This may provide an increased flexibility in measuring physical parameters of the ball game racquet and/or may reduce the total equipment required and/or the costs for the required equipment and/or the space required for setting up the measuring equipment.

[0014] Besides providing a securing means for measuring physical parameters of a ball game racquet, the securing device described herein is not limited thereto and may also be configured to generally fixate the ball game racquet in different orientations, e.g., to enable the ball game racquet to be examined, serviced and/or analyzed in said fixed orientations.

[0015] The securing device may be configured as an adapter for providing a connection interface between a respective external device, such as a measuring device, and a ball game racquet. Preferably, the securing device may be attachable, and thus adaptable, to a plurality of different external devices, e.g., measuring devices.

[0016] For instance, the securing device may be configured to be attachable to and rotatably driven by a measuring device for measuring a moment of inertia of the ball game racquet. Thus, by being able to change the orientation of the ball game racquet between the first orientation and the second orientation, a moment of inertia about at least two axes of rotation of the ball game racquet, preferably about at least two principle axes of the ball game racquet may be determined, e.g., a moment of inertia about a swing axis of the ball game racquet, also known as the swing weight, a moment of inertia about a twist axis of the ball game racquet, also known as the twist weight and/or a moment of inertia about a spin axis of the ball game racquet, also known as the spin weight.

[0017] Preferably, the first orientation and the second orientation of the axis of the ball game racquet are angularly offset from each other, preferably by 30° to 150°, more preferably 40° to 140°, more preferably 50° to 130°, more preferably 60° to 120°, more preferably 70° to 110°, more preferably 80° to 100°, most preferably by substantially 90°. Optionally, the first orientation and the second orientation of the axis of the ball game racquet may be translationally offset from each other. This may allow one or more parameters of the ball game racquet to be determined in different orientations of the ball game racquet which are offset by the above-identified values.

[0018] The first orientation and the second orientation being "predetermined" may mean that the first engaging interface and the second engaging interface may include one or more features configured to align, or facilitate alignment of, the axis of the ball game racquet to the first orientation and/or the second orientation or at least assist in achieving the first orientation and/or the second orientation. Alternatively, the engaging device may include one or more indicating features which identify and indicate the first orientation and the second orientation to the user. Thus, an arbitrary orientation of the axis of the ball game racquet relative to the engaging device, is not to be understood as being a predetermined first orientation and a predetermined second orientation within the context of the present disclosure.

[0019] The engaging device may be configured to fixate the ball game racquet relative to the engaging device in more than two predetermined orientations of the axis of the ball game racquet, e.g., three, four or five predetermined orientations.

[0020] Preferably, the engaging device includes at least two engaging elements which are movable relative to each other to engage and disengage the ball game racquet therebetween in the first orientation and the second orientation, respectively. The engaging elements may be rotatably and/or translationally moveable relative to each other. Preferably, the engaging elements include the first engaging interface and/or the second engaging interface. Preferably, a first section of the first engaging

interface and a first section of the second engaging interface is provided on one engaging element and a second section of the first engaging interface and a second section of the second engaging interface is provided on the other engaging element, respectively. The respective engaging interface may be brought into engagement with the ball game racquet by rotatably and/or translationally moving the engaging elements towards each other. The engaging elements may be urged towards and/or away from each other, e.g., by one or more preloading elements, such as one or more spring elements.

[0021] Preferably, the securing device further includes at least one actuating device configured to be actuated by a user to trigger a movement of the engaging elements relative to each other. The actuating device may be a manual device, e.g., such that the movement of the engaging elements is performed manually by the user, such as by means of a lever. Alternatively, or additionally, the actuating device may be an electric device, such as an electric motor which can be controlled by a control device, and/or a pneumatic device and/or a spring force driven device.

[0022] Preferably, the engaging device includes a clamping device configured to, in the first orientation and/or the second orientation, clamp at least a portion of the ball game racquet to substantially fixate the ball game racquet at least against rotation relative to the engaging device in a clamped position and unclamp from the ball game racquet to release the ball game racquet in an unclamped position. The clamping device may include the first engaging interface and/or the second engaging interface. In the clamped position, the clamping device may be configured to provide a frictional connection and/or a form fit connection between a section of the clamping device and at least a portion of the ball game racquet.

[0023] Preferably, the first engaging interface and the second engaging interface at least partially overlap such that at least one of the first engaging interface and the second engaging interface engages at least a portion of the ball game racquet in the first orientation and the second orientation. Thus, at least a section of the first engaging interface and/or the second engaging interface may be utilized for fixating the ball game racquet in the first orientation and the second orientation. This may allow the first engaging interface and/or the second engaging interface to share structural features and to be used efficiently, which may reduce the size of the engaging device. Preferably, the first engaging interface and/or the second engaging interface is/are configured to at least partially receive at least a portion of the ball game racquet in the first orientation and the second orientation.

[0024] Preferably, the first engaging interface includes a first channel configured to at least partially receive at least a portion of the ball game racquet, preferably at least a portion of a handle of the ball game racquet, in the first orientation and the second engaging interface includes at least a second channel configured to at least partially receive at least a portion of the ball game racquet, preferably at least a portion of a handle of the ball game racquet, in the second orientation. The first channel and/or the second channel may provide a frictional connection and/or a form fit connection between a section of the respective channel and at least a portion of the ball game racquet.

[0025] Preferably, the first channel and the second channel at least partially intersect, when the ball game racquet is engaged by the engaging device in the first orientation and/or the second orientation. Hence, a section of the engaging device, in the intersection portion of the first channel and the second channel, is configured at least partially as the first channel and the second channel. This may further allow the first channel and the second channel to share structural features and to be used efficiently, which may reduce the size of the engaging device.

[0026] Preferably, the first channel and the second channel at least partially intersect at an angle from 45° to 135°, preferably from 55° to 125°, more preferably from 65° to 115°, more preferably from 75° to 105°, most preferably from 85° to 95°.

[0027] Preferably, the engaging device includes at least two engaging elements which are movable relative to each other to engage and disengage the ball game racquet in the first orientation and the second orientation, respectively. Preferably, at least one of the first channel and the second channel, preferably the first channel and the second channel, is at least partially defined by the engaging elements. For instance, a first section of the first channel and/or a first section of the second channel may be provided on one engaging element and a second section of the first channel and/or a second section of the second channel may be provided on the other engaging element. For instance, the engaging elements may be moved towards each other to receive a section of the ball game racquet in the first channel or the second channel. By moving the engaging elements away from each other, the ball game racquet may be released from the first channel or the second channel.

[0028] Preferably, the first engaging interface extends in a first direction and the second interface is arranged at an end of the engaging device, with respect to the first direction. Preferably, the second interface is arranged at a proximal end of the engaging device, with respect to a position of the user when operating the securing device.

[0029] Preferably, the securing device further includes at least one orientation assistance mechanism configured to urge the ball game racquet into, or at least towards, the first orientation and/or the second orientation. This may decrease the risk of a deviation of the axis of the ball game racquet from the first orientation and/or the second orientation.

[0030] Preferably, the orientation assistance mechanism includes at least one opening which is configured to at least partially receive at least a portion of the ball game racquet, preferably at least a portion of a handle of the ball game racquet, preferably an end of the handle

of the ball game racquet. Preferably, the opening is at least partially tapered, preferably conically tapered, in a direction in which the ball game racquet is insertable into the opening. As a portion of the ball game racquet is introduced into the opening, the tapered feature of said opening may urge the ball game racquet into a desired predetermined direction, e.g., by centering the ball game racquet toward a central axis of the opening. This may decrease the risk of a deviation of the axis of the ball game racquet from the first orientation and/or the second orientation.

[0031] Preferably, the securing device includes at least two orientation assistance mechanisms, wherein a first of the orientation assistance mechanisms is configured to urge the ball game racquet into, or at least towards, the first orientation and a second of the orientation assistance mechanisms is configured to urge the ball game racquet into, or at least towards, the second orientation. This may decrease the risk of a deviation of the axis of the ball game racquet from the first orientation and the second orientation, respectively.

[0032] Preferably, the securing device includes at least two orientation assistance mechanisms, wherein a first of the orientation assistance mechanisms is configured to align the axis of the ball game racquet to the first orientation, and a second of the orientation assistance mechanisms is configured to align the axis of the ball game racquet to the second orientation.

[0033] Preferably, the securing device includes at least two orientation assistance mechanisms, wherein a first of the orientation assistance mechanisms is configured to center the axis of the ball game racquet with respect to the first engaging interface, and a second of the orientation assistance mechanisms is configured to center the axis of the ball game racquet with respect to the second engaging interface.

[0034] Preferably, a longitudinal axis of the ball game racquet extends in a first direction in the first orientation and in a second direction in the second orientation, wherein the first direction and the second direction extend at an angle to each other from 45° to 135°, preferably from 55° to 125°, more preferably from 65° to 115°, more preferably from 75° to 105°, most preferably from 85° to 95°.

[0035] Preferably, the securing device further includes at least one locking device configured to lock the engaging device such that the engaging device maintains engagement of the ball game racquet in the first orientation and/or the second orientation, preferably until the locking device is unlocked. This may ensure that the ball game racquet remains in the first orientation or the second orientation, respectively, e.g., until the measurements and/or any other work being performed on the ball game racquet is/are completed. This may increase the reliability of the securing device.

[0036] Preferably, the engaging elements each include a plurality of protrusions, wherein adjacent protrusions of each engaging element are flared away, in at least a section of the protrusions, from each other.

[0037] Preferably, the engaging elements each include a plurality of protrusions, wherein adjacent protrusions of each engaging element form a V-shaped shape channel therebetween, respectively, to at least partially receive a section of the ball game racquet therein.

[0038] The object mentioned at the beginning is also solved by a measuring device for measuring at least one parameter of a ball game racquet, preferably at least one mass moment of inertia about at least two different axes, preferably at least three different axes, of a ball game racquet.

[0039] The measuring device includes at least one securing device according to any of the configurations described herein. The measuring device further includes at least one drive device operatively connected to the securing device and configured to rotatably drive the securing device to rotate the ball game racquet about at least one axis of rotation, when the ball game racquet is substantially fixated by the engaging device of the securing device. The measuring device further includes at least one detection device configured to detect the mass moment of inertia about the axis of rotation as the ball game racquet is being rotated.

[0040] The configurations and advantages described above with respect to the securing device also apply to the measuring device accordingly.

[0041] Preferably, the securing device is releasably connected to the measuring device.

[0042] Preferably, the securing device is configured as an adapter which is retrofittable to the measuring device.

[0043] The object mentioned at the beginning is also solved by a method for measuring a mass moment of inertia about at least two different axes, preferably at least three different axes, of a ball game racquet by means of at least one measuring device, preferably a measuring device according to any configuration described herein.

[0044] The method includes the steps of:

providing a securing device having at least one engaging device configured to engage at least a portion of the ball game racquet to substantially fixate the ball game racquet at least against rotation relative to the engaging device;

engaging at least a portion of the ball game racquet by means of the engaging device, when an orientation axis of the ball game racquet is arranged in a predetermined first orientation relative to the engaging device, to substantially fixate the ball game racquet at least against rotation relative to the engaging device in the first orientation;

rotating the securing device and the ball game racquet about a first axis of rotation by means of at least one drive device operatively connected to the securing device;

performing at least one measurement of a mass moment of inertia about the first axis of rotation;

disengaging the engaging device to release the ball

game racquet from the engaging device; rearranging the ball game racquet such that the orientation axis of the ball game racquet is arranged in a predetermined second orientation relative to the engaging device, the second orientation being different from the first orientation;
engaging at least a portion of the ball game racquet by means of the engaging device to substantially fixate the ball game racquet at least against rotation relative to the engaging device in the second orientation;
rotating the securing device and the ball game racquet about a second axis of rotation by means of the drive device, the second axis of rotation being different from the first axis of rotation; and
performing at least one measurement of a mass moment of inertia about the second axis of rotation.

[0045] The following list of aspects provides alternative and/or further features of the invention:

1. A securing device for securing a ball game racquet, including:

at least one engaging device configured to engage at least a portion of the ball game racquet, preferably at least a portion of a handle of the ball game racquet, to substantially fixate the ball game racquet, preferably at least against rotation, relative to the engaging device;
wherein the engaging device includes:

a first engaging interface configured to engage with at least a portion of the ball game racquet, when an axis of the ball game racquet is arranged in a predetermined first orientation relative to the engaging device, to substantially fixate the ball game racquet, preferably at least against rotation relative to the engaging device in the first orientation; and
at least a second engaging interface configured to engage with at least a portion of the ball game racquet, when the axis of the ball game racquet is arranged in a predetermined second orientation relative to the engaging device, to substantially fixate the ball game racquet, preferably at least against rotation relative to the engaging device in the second orientation, the second orientation being different from the first orientation.

2. The securing device according to aspect 1, wherein the engaging device includes at least two engaging elements which are movable relative to each other to engage and disengage the ball game racquet therebetween in the first orientation and the second orientation, respectively.

3. The securing device according to aspect 2, further including at least one actuating device configured to be actuated by a user to trigger a movement of the engaging elements relative to each other.

4. The securing device according to any of the preceding aspects, wherein the engaging device includes a clamping device configured to, in the first orientation and/or the second orientation, clamp at least a portion of the ball game racquet to substantially fixate the ball game racquet at least against rotation relative to the engaging device in a clamped position and unclamp from the ball game racquet to release the ball game racquet in an unclamped position.

5. The securing device according to any of the preceding aspects, wherein the first engaging interface and the second engaging interface at least partially overlap such that at least one of the first engaging interface and the second engaging interface engages at least a portion of the ball game racquet in the first orientation and the second orientation.

6. The securing device according to any of the preceding aspects, wherein the first engaging interface includes a first channel configured to at least partially receive at least a portion of the ball game racquet, preferably at least a portion of a handle of the ball game racquet, in the first orientation and the second engaging interface includes at least a second channel configured to at least partially receive at least a portion of the ball game racquet, preferably at least a portion of a handle of the ball game racquet, in the second orientation.

7. The securing device according to aspect 6, wherein the first channel and the second channel at least partially intersect, when the ball game racquet is engaged by the engaging device in the first orientation and/or the second orientation.

8. The securing device according to aspect 7, wherein the first channel and the second channel at least partially intersect at an angle from 45° to 135°, preferably from 55° to 125°, more preferably from 65° to 115°, more preferably from 75° to 105°, most preferably from 85° to 95°.

9. The securing device according to any of aspects 6 to 8, wherein the engaging device includes at least two engaging elements which are movable relative to each other to engage and disengage the ball game racquet in the first orientation and the second orientation, respectively, and wherein at least one of the first channel and the second channel, preferably the

first channel and the second channel, is at least partially defined by the engaging elements.

10. The securing device according to any of the preceding aspects, wherein the first engaging interface extends in a first direction and the second engaging interface is arranged at an end of the engaging device, with respect to the first direction.

11. The securing device according to any of the preceding aspects, further including at least one orientation assistance mechanism configured to urge the ball game racquet into, or at least towards, the first orientation and/or the second orientation.

12. The securing device according to aspect 11, wherein the orientation assistance mechanism includes at least one opening which is configured to at least partially receive at least a portion of the ball game racquet, preferably at least a portion of a handle of the ball game racquet, preferably an end of the handle of the ball game racquet, wherein the opening is at least partially tapered, preferably conically tapered, in a direction in which the ball game racquet is insertable into the opening.

13. The securing device according to aspect 11 or 12, wherein the securing device includes at least two orientation assistance mechanisms, wherein a first of the orientation assistance mechanisms is configured to urge the ball game racquet into, or at least towards, the first orientation and a second of the orientation assistance mechanisms is configured to urge the ball game racquet into, or at least towards, the second orientation.

14. The securing device according to any of aspects 11 to 13, wherein the securing device includes at least two orientation assistance mechanisms, wherein a first of the orientation assistance mechanisms is configured to align the axis of the ball game racquet to the first orientation, and a second of the orientation assistance mechanisms is configured to align the axis of the ball game racquet to the second orientation.

15. The securing device according to any of aspects 11 to 14, wherein the securing device includes at least two orientation assistance mechanisms, wherein a first of the orientation assistance mechanisms is configured to center the axis of the ball game racquet with respect to the first engaging interface, and a second of the orientation assistance mechanisms is configured to center the axis of the ball game racquet with respect to the second engaging interface.

16. The securing device according to any of the preceding aspects, wherein a longitudinal axis of the ball game racquet extends in a first direction in the first orientation and in a second direction in the second orientation, wherein the first direction and the second direction extend at an angle to each other from 45° to 135°, preferably from 55° to 125°, more preferably from 65° to 115°, more preferably from 75° to 105°, most preferably from 85° to 95°.

17. The securing device according to any of the preceding aspects, further including at least one locking device configured to lock the engaging device such that the engaging device maintains engagement of the ball game racquet in the first orientation and/or the second orientation, preferably until the locking device is unlocked.

18. The securing device according to any of aspects 2 to 17, wherein the engaging elements each include a plurality of protrusions, wherein adjacent protrusions of each engaging element are flared away, in at least a section of the protrusions, from each other.

19. The securing device according to any of aspects 2 to 18, wherein the engaging elements each include a plurality of protrusions, wherein adjacent protrusions of each engaging element form a V-shaped shape channel therebetween, respectively, to at least partially receive a section of the ball game racquet therein.

20. A measuring device for measuring at least one parameter of a ball game racquet, preferably at least one mass moment of inertia about at least two different axes, preferably at least three different axes, of a ball game racquet, the measuring device including:

at least one securing device according to any of the preceding aspects;
at least one drive device operatively connected to the securing device and configured to rotatably drive the securing device to rotate the ball game racquet about at least one axis of rotation, when the ball game racquet is substantially fixated by the engaging device of the securing device; and
at least one detection device configured to detect the mass moment of inertia about the axis of rotation as the ball game racquet is being rotated.

21. The measuring device according to aspect 20, wherein the securing device is releasably connected to the measuring device.

22. The measuring device according to aspect 20 or 21, wherein the securing device is configured as an

adapter which is retrofittable to the measuring device.

23. A method for measuring a mass moment of inertia about at least two different axes, preferably at least three different axes, of a ball game racquet by means of at least one measuring device, preferably a measuring device according to any of aspects 20 to 22, the method including the steps of:

providing a securing device having at least one engaging device configured to engage at least a portion of the ball game racquet to substantially fixate the ball game racquet at least against rotation relative to the engaging device;
engaging at least a portion of the ball game racquet by means of the engaging device, when an orientation axis of the ball game racquet is arranged in a predetermined first orientation relative to the engaging device, to substantially fixate the ball game racquet at least against rotation relative to the engaging device in the first orientation;
rotating the securing device and the ball game racquet about a first axis of rotation by means of at least one drive device operatively connected to the securing device;
performing at least one measurement of a mass moment of inertia about the first axis of rotation;
disengaging the engaging device to release the ball game racquet from the engaging device;
rearranging the ball game racquet such that the orientation axis of the ball game racquet is arranged in a predetermined second orientation relative to the engaging device, the second orientation being different from the first orientation;
engaging at least a portion of the ball game racquet by means of the engaging device to substantially fixate the ball game racquet at least against rotation relative to the engaging device in the second orientation;
rotating the securing device and the ball game racquet about a second axis of rotation by means of the drive device, the second axis of rotation being different from the first axis of rotation; and
performing at least one measurement of a mass moment of inertia about the second axis of rotation.

[0046] Preferred embodiments of the present invention are further elucidated below with reference to the figures. The described embodiments do not limit the present invention.

Fig. 1 shows, in a perspective view, a securing device according to an embodiment of the invention, wherein an engaging device of the securing device is in an opened position;

Fig. 2 shows a further perspective view of the securing device shown in Fig. 1;

Fig. 3 shows, in a perspective view, the securing device shown in Fig. 1, wherein the engaging device is in a closed position;

Fig. 4 shows a further perspective view of the securing device shown in Fig. 3;

Fig. 5 shows, in a side view, the securing device shown in Figs. 1 and 2, wherein the engaging device is in an opened position;

Fig. 6 shows the securing device of Fig. 5, wherein the engaging device is in a closed position;

Fig. 7 shows, in a top view, the securing device of Figs. 1 and 2;

Fig. 8 shows, in a top view, a measuring device according to an embodiment of the invention.

[0047] Figs. 1 to 7 show a securing device 10 for securing a ball game racquet according to an embodiment of the invention. The securing device 10 includes an engaging device 12 configured to engage at least a portion of a handle of the ball game racquet to substantially fixate the ball game racquet at least against rotation relative to the engaging device 12.

[0048] The engaging device 12 includes two engaging elements 14, 16 which are movable relative to each other to engage and disengage the ball game racquet therebetween in a first orientation and at least a second orientation, respectively. Each engaging element 14, 16 is mounted to a pair of arms 18A, 18B and 20A, 20B, respectively, the pair of arms 18A, 18B and 20A, 20B, respectively, in turn being movable relative to each other to move the engaging elements 14, 16 into and out of engagement with the ball game racquet. Movement of the arms 18A, 18B, 20A, 20B relative to each other may be actuated by an actuating device 22, which is configured as a manual lever in Figs. 1 to 7. However, the lever is only shown as an exemplary configuration. For instance, instead of being manually operable, the actuating device 22 may be powered, e.g., electrically and/or pneumatically and/or via a preloading mechanism, e.g., such as by including an electric motor which may be controlled by at least one controller to move the arms 18A, 18B, 20A, 20B or the engaging elements 14, 16, relative to each other.

[0049] The engaging elements 14, 16 may be configured to be releasable from the arms 18A, 18B, 20A, 20B to replace and/or exchange the engaging elements 14, 16. The securing device 10 described herein may be configured to be operable with a wide range of ball game

racquets, e.g., having different dimensions and/or shapes and/or weights and/or materials. Optionally, for instance, a variety of differently configured and/or dimensioned engaging elements 14, 16 may be available and employable with the securing device 10, e.g., in order to adapt to ball game racquets having various dimensions and/or shapes and/or weights and/or materials. This may provide a modular configuration of the securing device 10 to increase the range of applications of the securing device 10 and/or to more individually adapt the securing device 10 to various ball game racquets.

[0050] In order to provide engagement between the engaging device 12 and the ball game racquet and fixate the ball game racquet in at least two different orientations, the engaging device 12 includes a first engaging interface 24 configured to engage with at least a portion of the handle of the ball game racquet, when an axis of the ball game racquet is arranged in a predetermined first orientation relative to the engaging device 12, to substantially fixate the ball game racquet at least against rotation relative to the engaging device 12 in the first orientation.

[0051] The engaging device 12 further includes a second engaging interface 26 configured to engage with at least a portion of the handle of the ball game racquet, when the axis of the ball game racquet is arranged in a predetermined second orientation relative to the engaging device 12, to substantially fixate the ball game racquet at least against rotation relative to the engaging device 12 in the second orientation. The second orientation is different from the first orientation.

[0052] In the example shown in Figs. 1 to 7, the first engaging interface 24 is configured to fixate the ball game racquet in an orientation in which a longitudinal axis of the ball game axis extends substantially vertically, when the securing device is in an operating position. This corresponds to the predetermined first orientation according to the example shown in Figs. 1 to 7. The second engaging interface 26 is configured to fixate the ball game racquet in an orientation in which the longitudinal axis of the ball game axis extends substantially horizontally, when the securing device is in an operating position. This corresponds to the predetermined second orientation according to the example shown in Figs. 1 to 7.

[0053] The first engaging interface 24 includes a first channel 28 which extends through at least a section of the first engaging interface 24. The first channel 28 is configured to at least partially receive at least a portion of the handle of the ball game racquet in the first orientation. The second engaging interface 26 includes at least a second channel 30 configured to at least partially receive at least a portion of the handle of the ball game racquet in the second orientation.

[0054] As can be seen in the example shown in Figs. 1 to 7, the first channel 28 and the second channel 30 at least partially intersect. Per the example shown in Figs. 1 to 7, the first channel 28 and the second channel 30 intersect at an angle of approximately 90°. However, the angle of intersection may vary, e.g., depending on the desired and/or required angular offset of the first orientation and the second orientation. The first channel 28 and the second channel 30 may at least partially intersect at an angle from 45° to 135°, preferably from 55° to 125°, more preferably from 65° to 115°, more preferably from 75° to 105°, most preferably from 85° to 95°.

[0055] The securing device 10 further includes at least one orientation assistance mechanism 34 configured to urge the ball game racquet, or at least a section thereof, into, or at least towards, the first orientation. The orientation assistance mechanism 34 includes an opening 36 which is configured to at least partially receive at least a portion of the handle of the ball game racquet, preferably an end or butt of the handle of the ball game racquet. The opening 36 is defined by a wall 37 which is at least partially tapered, preferably conically tapered, in a direction in which the ball game racquet is insertable into the opening 36. The wall 37 may be shaped to substantially match and/or accommodate a shape of an end or butt of the handle of the ball game racquet. A through-hole 39 is provided in the opening 36 (see Fig. 7), e.g., which may allow an element attached to the respective ball game racquet, preferably to an end or butt of the handle of the ball game racquet, such as a loop, string or other element, to be inserted therethrough. This may enable a more secure and reliable abutment of the ball game racquet within the opening 36.

[0056] Thus, the tapered configuration of the opening 36 may urge the ball game racquet towards the first orientation which may decrease the risk of a deviation of the axis of the ball game racquet from the first orientation.

[0057] The orientation assistance mechanism 34 further includes protrusions 38A-38H provided on the engaging elements 14, 16, wherein adjacent protrusions of each engaging element 14, 16 are flared away, in at least a section of the protrusions 38A-38H, from each other. In particular, ends of the protrusions 38E and 38F which face each other substantially form a V-shape to provide a V-shaped channel therebetween. Similarly, pairs of adjacent protrusions 38A and 38D, 38B and 38C, and 38G and 38H also provide a V-shaped channel therebetween, respectively. The respective V-shaped channels may contribute to the first channel 28. The above-described configuration of the protrusions 38A-38H may assist with the alignment of the axis of the ball game racquet in the first orientation, e.g., by urging the axis of the ball game racquet towards the first orientation.

[0058] Alternatively, or additionally, the protrusions 38A-38H are tapered towards a distal end of each protrusion 38A-38H and in a direction which extends substantially perpendicular to the first channel 28. This may also urge the ball game racquet towards the first orientation which may decrease the risk of a deviation of the axis of the ball game racquet from the first orientation.

[0059] The securing device 10 includes a further orientation assistance mechanism 40 to assist with aligning the axis of the ball game racquet in the second orientation. For instance, the orientation assistance mechanism

40 may be configured to urge the ball game racquet into, or at least towards, the second orientation.

[0060] The orientation assistance mechanism 40 functionally shares the above-identified protrusions 38A-38H, wherein adjacent protrusions of each engaging element 14, 16 are flared away, in at least a section of the protrusions 38A-38H, from each other. In particular, ends of the protrusions 38C and 38D which face each other substantially form a V-shape to provide a V-shaped channel therebetween. Similarly, pairs of adjacent protrusions 38E and 38G, 38F and 38H, and 38A and 38B also provide a V-shaped channel therebetween, respectively. The V-shaped channels may contribute to the second channel 30. The configuration of the protrusions 38A-38H may assist with the alignment of the axis of the ball game racquet in the second orientation, e.g., by urging the axis of the ball game racquet towards the second orientation.

[0061] Alternatively, or additionally, the protrusions 38A-38H are tapered towards a distal end of each protrusion 38A-38H and in a direction which extends substantially perpendicular to the second channel 30. This may also urge the ball game racquet towards the second orientation which may decrease the risk of a deviation of the axis of the ball game racquet from the second orientation.

[0062] The securing device 10 further includes a limiting feature 44 configured to limit a position of the ball game racquet relative to the securing device 10. In particular, the limiting feature 44 provides one or more abutting surfaces 46A, 46B against which the ball game racquet may abut, at least in the second orientation. This may assist in positioning the ball game racquet at least in the second orientation. The limiting feature 44 includes a slot 45 formed therein which may allow an element attached to the respective ball game racquet, preferably to an end or butt of the handle of the ball game racquet, such as a loop, string or other element, to be inserted therethrough. This may enable a more secure and reliable abutment of the ball game racquet against the limiting feature 44.

[0063] The securing device 10 may be configured to be securably, preferably releasably, attachable to one or more measuring devices configured to measure one or more parameters of the ball game racquet. For instance, the one or more measuring devices may be configured to determine a moment of inertia about one or more axes of rotation, a weight, a center of mass and/or one or more other physical parameters of the ball game racquet which can be detected by a corresponding measuring device.

[0064] For instance, the securing device 10 may be configured to be attachable to and rotatably driven by a measuring device for measuring a moment of inertia of the ball game racquet. Thus, by being able to change the orientation of the ball game racquet between the first orientation and the second orientation by means of the securing device 10, as described above, a moment of inertia about at least two axes of rotation of the ball game racquet, preferably about at least two principle axes of the ball game racquet, may be determined, e.g., a moment of inertia about a swing axis of the ball game racquet, also known as the swing weight, a moment of inertia about a twist axis of the ball game racquet, also known as the twist weight, and/or a moment of inertia about a spin axis of the ball game racquet, also known as the spin weight.

[0065] Besides providing a securing means for measuring physical parameters of a ball game racquet, the securing device 10 described herein is not limited thereto and may also be configured to generally fixate the ball game racquet in different orientations, e.g., to enable the ball game racquet to be examined, serviced and/or analyzed in said fixed orientations.

[0066] The securing device 10 may be configured as an adapter for providing a connection interface between a respective external device, such as a measuring device, and a ball game racquet. Preferably, the securing device may be attachable, and thus adaptable, to a plurality of different external devices, e.g., measuring devices.

[0067] Figs. 3, 4 and 6 show the securing device 10, in which the engaging device 12 has been brought into a closed position by actuating, i.e., rotating, the actuating device 22. The ball game racquet may be engaged by the first engaging interface 24 or the second engaging interface 26 in said closed position.

[0068] To operate the securing device 10, the user may first place a section of the handle of the ball game racquet in the first engaging interface 24. In particular, an end or butt of the handle of the ball game racquet may be inserted into the opening 36 of the orientation assistance mechanism 34. Next, the user may actuate the actuating device 22 by rotating the lever such that the engaging elements 14, 16 are moved towards each other to engage the handle of the ball game racquet in the first engaging interface 24 in the first orientation. At least a section of the handle of the ball game racquet is thereby received in the first channel 28. The user may then, e.g., perform one or more measurements of one or more physical parameters by a corresponding measuring device to which the securing device 10 is coupled, e.g., one or more moments of inertia about a first axis of rotation of the ball game racquet, e.g., about a swing axis of the ball game racquet.

[0069] Next, the user may change the orientation of the ball game racquet by actuating the actuating device 22 to release the ball game racquet from the engaging device 12. The user may then reorient the ball game racquet and place a section of the handle of the ball game racquet in the second engaging interface 26. In particular, an end or butt of the handle of the ball game racquet may be abutted against the limiting feature 44. Next, the user may reactuate the actuating device 22 by rotating the lever such that the engaging elements 14, 16 are again moved towards each other to engage the handle of the ball game racquet in the second engaging interface 26

in the second orientation. At least a section of the handle of the ball game racquet is thereby received in the second channel 30. The user may then again perform one or more measurements of one or more physical parameters by a corresponding measuring device to which the securing device 10 is coupled, e.g., one or more moments of inertia about a second axis of rotation of the ball game racquet, e.g., about a spin axis of the ball game racquet.

[0070] Hence, the securing device 10 described herein may provide a flexible and efficient device for securing a ball game racquet in a number of different orientations, e.g., to measure one or more physical parameters of the ball game racquet in the various orientations.

[0071] Fig. 8 shows a measuring device 210 including at least one securing device according to any of the configurations described herein, e.g., the securing device 10 as shown in Figs. 1 to 7, respectively. The measuring device 210 is configured for measuring at least one parameter of a ball game racquet 220, preferably at least one mass moment of inertia about at least two different axes of rotation, preferably at least three different axes of rotation, of a ball game racquet 220.

[0072] The measuring device 210 further includes a drive device 212 operatively connected to the securing device 10 and configured to rotatably drive the securing device 10 to rotate the ball game racquet 220 about at least one axis of rotation, when the ball game racquet 220 is substantially fixated by the engaging device 12 of the securing device 10.

[0073] The measuring device 210 further includes at least one detection device 216 configured to detect the mass moment of inertia about the axis of rotation as the ball game racquet is 220 being rotated.

Claims

1. A securing device (10) for securing a ball game racquet (220), including:

at least one engaging device (12) configured to engage at least a portion of the ball game racquet (220) to substantially fixate the ball game racquet (220) at least against rotation relative to the engaging device (12);
wherein the engaging device (12) includes:

a first engaging interface (24) configured to engage with at least a portion of the ball game racquet (220), when an axis of the ball game racquet (220) is arranged in a predetermined first orientation relative to the engaging device (12), to substantially fixate the ball game racquet (220) at least against rotation relative to the engaging device (12) in the first orientation; and
at least a second engaging interface (26) configured to engage with at least a portion of the ball game racquet (220), when the axis of the ball game racquet (220) is arranged in a predetermined second orientation relative to the engaging device (12), to substantially fixate the ball game racquet (220) at least against rotation relative to the engaging device (12) in the second orientation, the second orientation being different from the first orientation.

2. The securing device (10) according to claim 1, wherein the engaging device (12) includes at least two engaging elements (14, 16) which are movable relative to each other to engage and disengage the ball game racquet (220) therebetween in the first orientation and the second orientation, respectively.

3. The securing device (10) according to any of the preceding claims, wherein the first engaging interface (24) and the second engaging interface (26) at least partially overlap such that at least one of the first engaging interface (24) and the second engaging interface (26) engages at least a portion of the ball game racquet (220) in the first orientation and the second orientation.

4. The securing device (10) according to any of the preceding claims, wherein the first engaging interface (24) includes a first channel (28) configured to at least partially receive at least a portion of the ball game racquet (220), preferably at least a portion of a handle of the ball game racquet (220), in the first orientation and the second engaging interface (26) includes at least a second channel (30) configured to at least partially receive at least a portion of the ball game racquet (220), preferably at least a portion of a handle of the ball game racquet (220), in the second orientation.

5. The securing device (10) according to claim 4, wherein the first channel (28) and the second channel (30) at least partially intersect, when the ball game racquet (220) is engaged by the engaging device (12) in the first orientation and/or the second orientation, preferably wherein the first channel (28) and the second channel (30) at least partially intersect at an angle from 45° to 135°, preferably from 55° to 125°, more preferably from 65° to 115°, more preferably from 75° to 105°, most preferably from 85° to 95°.

6. The securing device (10) according to claim 4 or 5, wherein the engaging device (12) includes at least two engaging elements (14, 16) which are movable relative to each other to engage and disengage the ball game racquet (220) in the first orientation and the second orientation, respectively, and wherein at least one of the first channel (28) and the second

channel (30), preferably the first channel (28) and the second channel (30), is at least partially defined by the engaging elements (14, 16).

7. The securing device (10) according to any of the preceding claims, further including at least one orientation assistance mechanism (34, 40) configured to urge the ball game racquet (220) into, or at least towards, the first orientation and/or the second orientation.

8. The securing device (10) according to claim 7, wherein the orientation assistance mechanism (34) includes at least one opening (36) which is configured to at least partially receive at least a portion of the ball game racquet (220), preferably at least a portion of a handle of the ball game racquet (220), preferably an end of the handle of the ball game racquet (220), wherein the opening (36) is at least partially tapered, preferably conically tapered, in a direction in which the ball game racquet (220) is insertable into the opening (36).

9. The securing device (10) according to claim 7 or 8, wherein the securing device (10) includes at least two orientation assistance mechanisms (34, 40), wherein a first of the orientation assistance mechanisms (34) is configured to urge the ball game racquet (220) into, or at least towards, the first orientation and a second (40) of the orientation assistance mechanisms is configured to urge the ball game racquet (220) into, or at least towards, the second orientation.

10. The securing device (10) according to any of claims 7 to 9, wherein the securing device (10) includes at least two orientation assistance mechanisms (34, 40), wherein a first (34) of the orientation assistance mechanisms is configured to align the axis of the ball game racquet (220) to the first orientation, and a second (40) of the orientation assistance mechanisms is configured to align the axis of the ball game racquet (220) to the second orientation.

11. The securing device (10) according to any of claims 7 to 10, wherein the securing device (10) includes at least two orientation assistance mechanisms (34, 40), wherein a first (34) of the orientation assistance mechanisms is configured to center the axis of the ball game racquet (220) with respect to the first engaging interface (24), and a second (40) of the orientation assistance mechanisms is configured to center the axis of the ball game racquet (220) with respect to the second engaging interface (26).

12. The securing device (10) according to any of the preceding claims, wherein a longitudinal axis of the ball game racquet (220) extends in a first direction in the first orientation and in a second direction in the second orientation, wherein the first direction and the second direction extend at an angle to each other from 45° to 135°, preferably from 55° to 125°, more preferably from 65° to 115°, more preferably from 75° to 105°, most preferably from 85° to 95°.

13. A measuring device (210) for measuring at least one parameter of a ball game racquet (220), preferably at least one mass moment of inertia about at least two different axes, preferably at least three different axes, of a ball game racquet (220), the measuring device (210) including:

at least one securing device (10) according to any of the preceding claims;
at least one drive device (212) operatively connected to the securing device (10) and configured to rotatably drive the securing device (10) to rotate the ball game racquet (220) about at least one axis of rotation, when the ball game racquet (220) is substantially fixated by the engaging device (12) of the securing device (10); and
at least one detection device (216) configured to detect the mass moment of inertia about the axis of rotation as the ball game racquet is (220) being rotated.

14. The measuring device according to claim 13, wherein the securing device (10) is releasably connected to the measuring device.

15. A method for measuring a mass moment of inertia about at least two different axes, preferably at least three different axes, of a ball game racquet (220) by means of at least one measuring device, preferably a measuring device (210) according to claim 13 or 14, the method including the steps of:

providing a securing device (10) having at least one engaging device (12) configured to engage at least a portion of the ball game racquet (220) to substantially fixate the ball game racquet (220) at least against rotation relative to the engaging device (12);
engaging at least a portion of the ball game racquet (220) by means of the engaging device (12), when an orientation axis of the ball game racquet (220) is arranged in a predetermined first orientation relative to the engaging device (12), to substantially fixate the ball game racquet (220) at least against rotation relative to the engaging device (12) in the first orientation;
rotating the securing device (10) and the ball game racquet (220) about a first axis of rotation by means of at least one drive device (212) operatively connected to the securing device (10);

performing at least one measurement of a mass moment of inertia about the first axis of rotation;
disengaging the engaging device (12) to release the ball game racquet (220) from the engaging device (12);
rearranging the ball game racquet (220) such that the orientation axis of the ball game racquet (220) is arranged in a predetermined second orientation relative to the engaging device (12), the second orientation being different from the first orientation;
engaging at least a portion of the ball game racquet (220) by means of the engaging device (12) to substantially fixate the ball game racquet (220) at least against rotation relative to the engaging device (12) in the second orientation;
rotating the securing device (10) and the ball game racquet (220) about a second axis of rotation by means of the drive device (212), the second axis of rotation being different from the first axis of rotation; and
performing at least one measurement of a mass moment of inertia about the second axis of rotation.

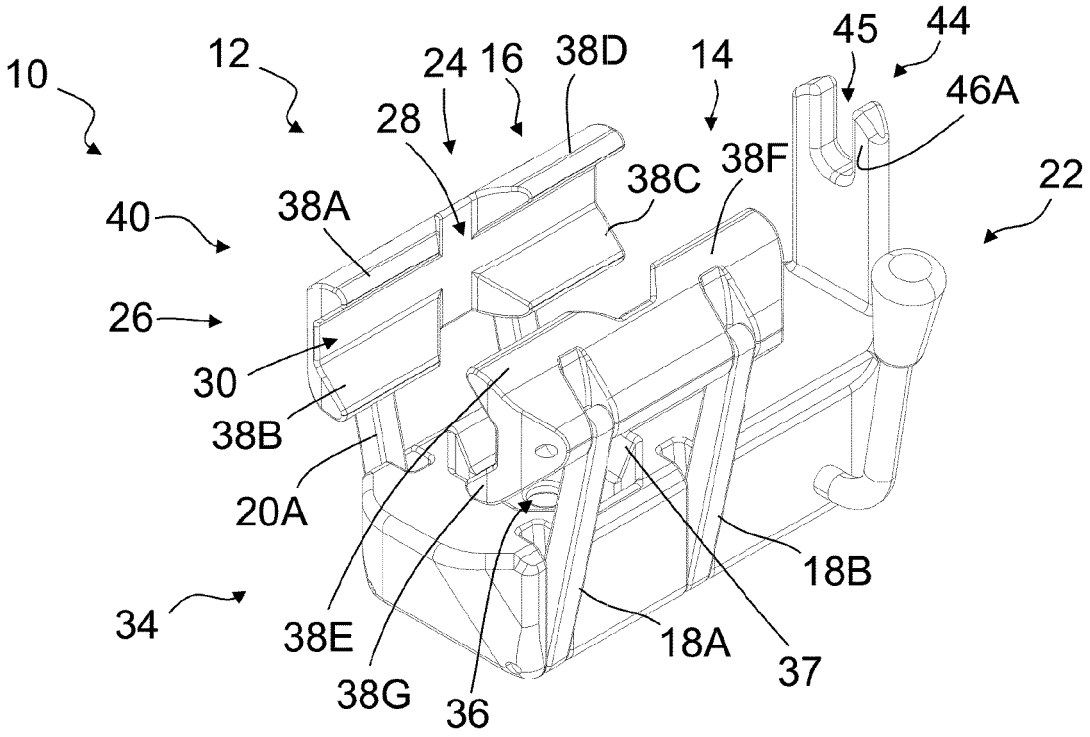
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Fig. 1

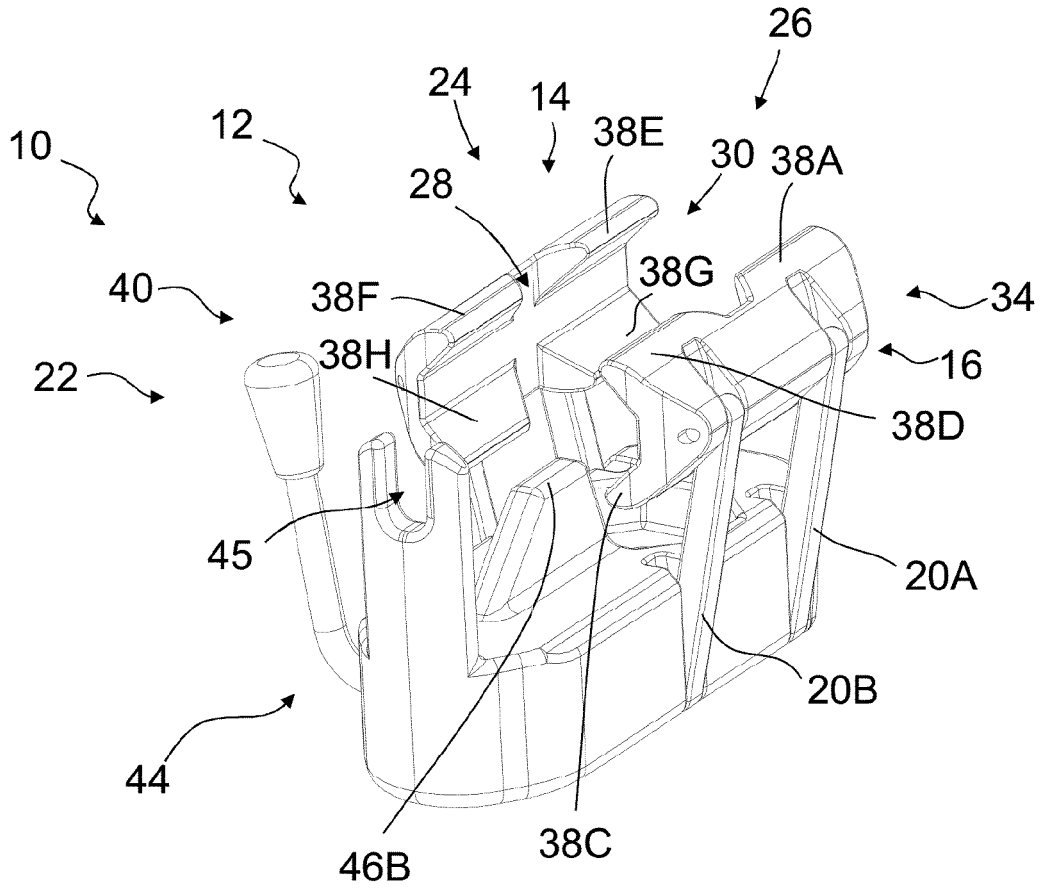
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Fig. 2

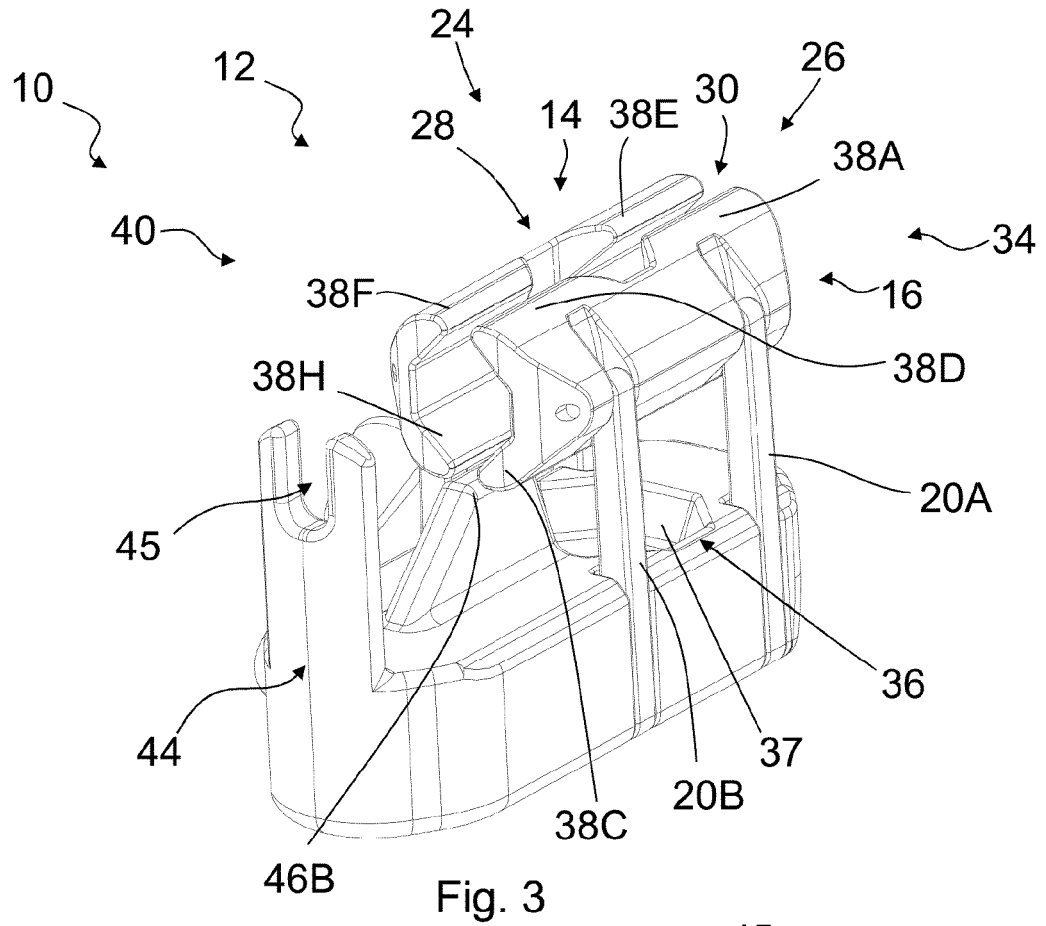
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Fig. 3

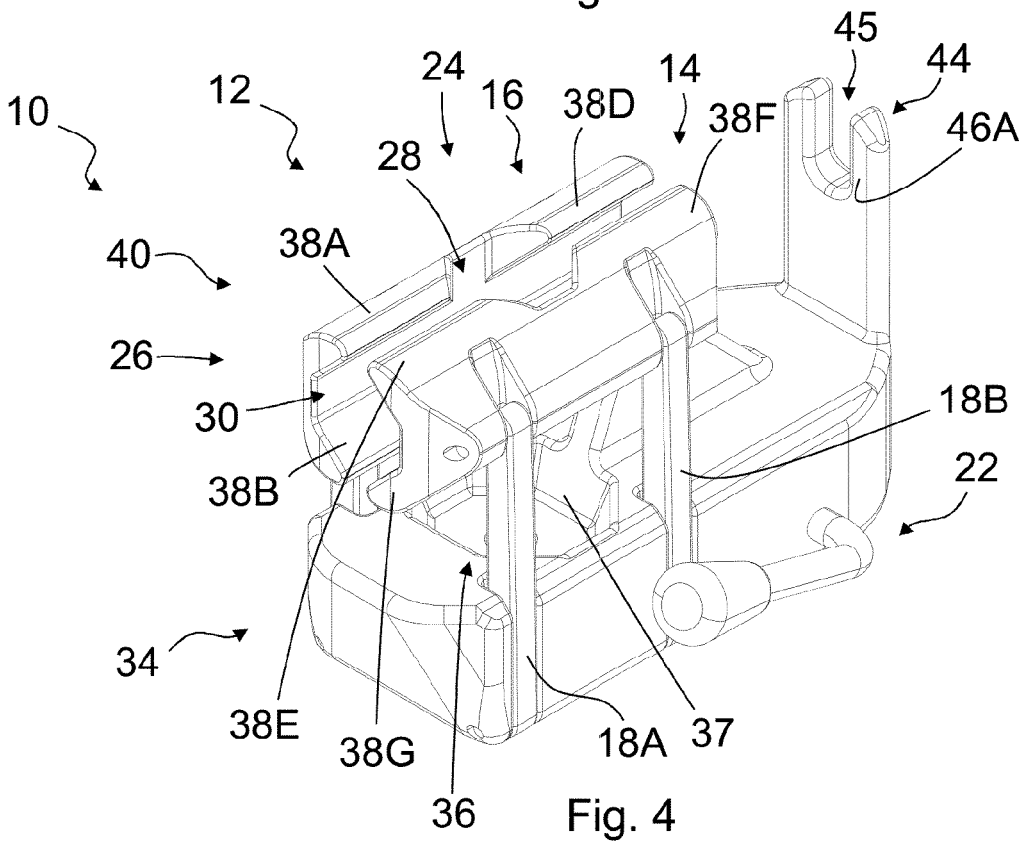
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Fig. 4

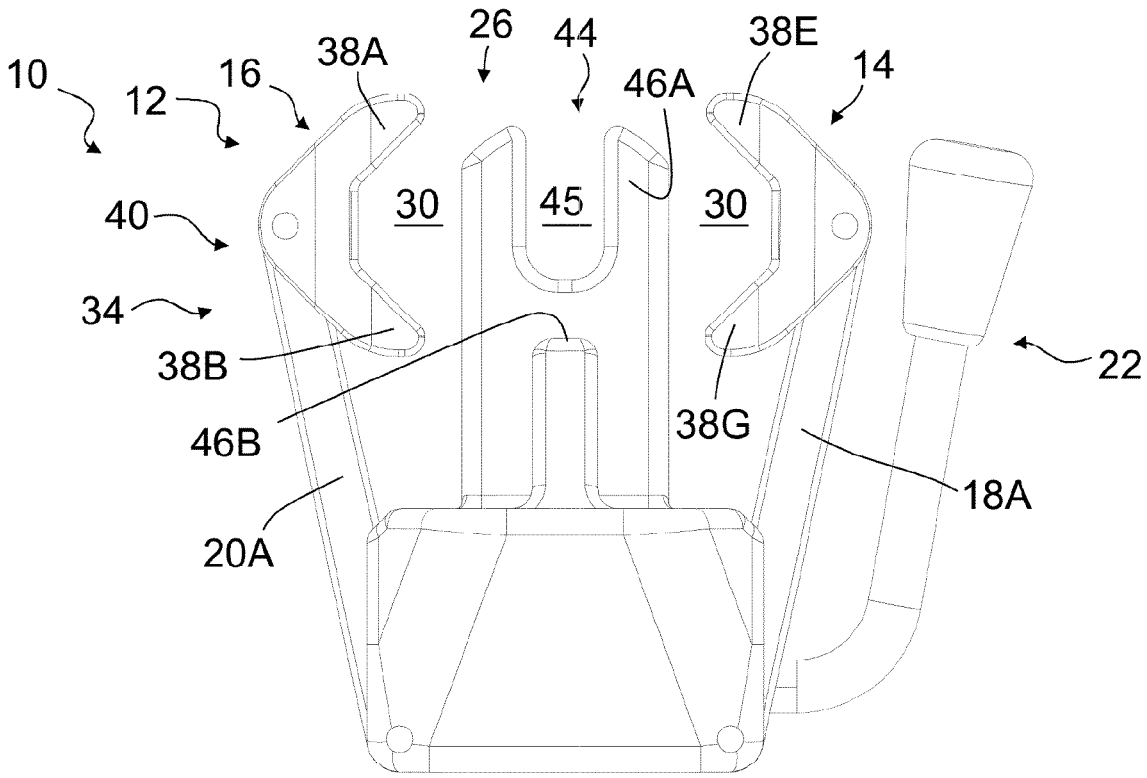
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Fig. 5

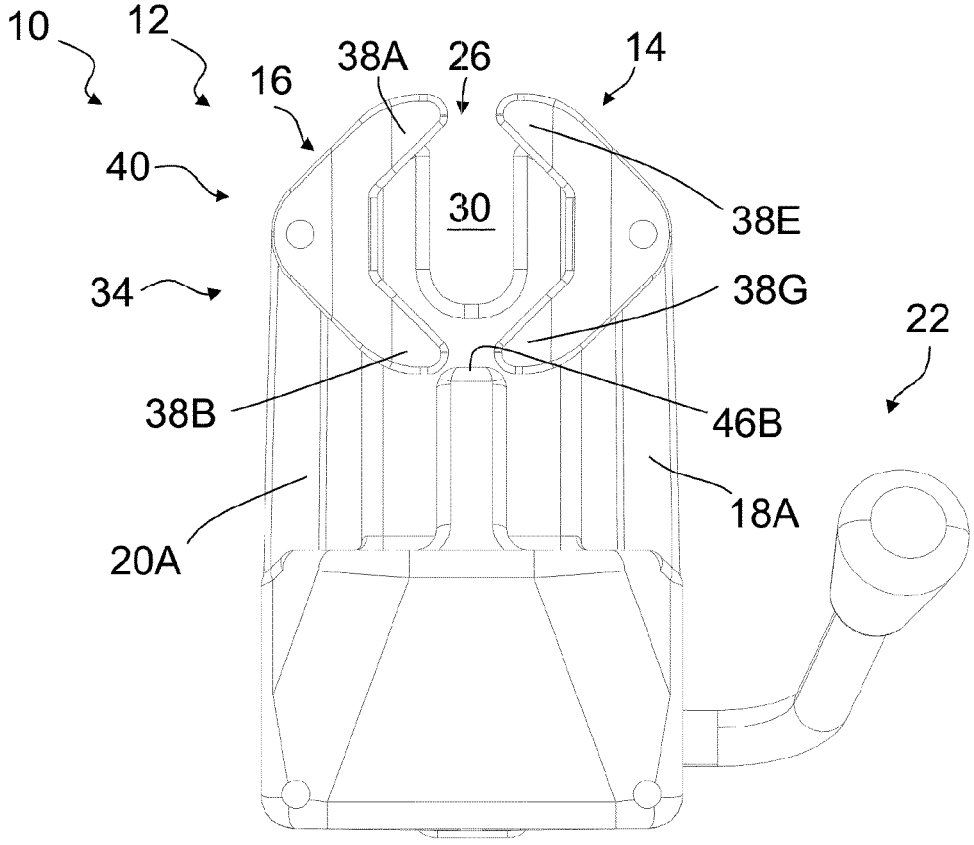
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Fig. 6

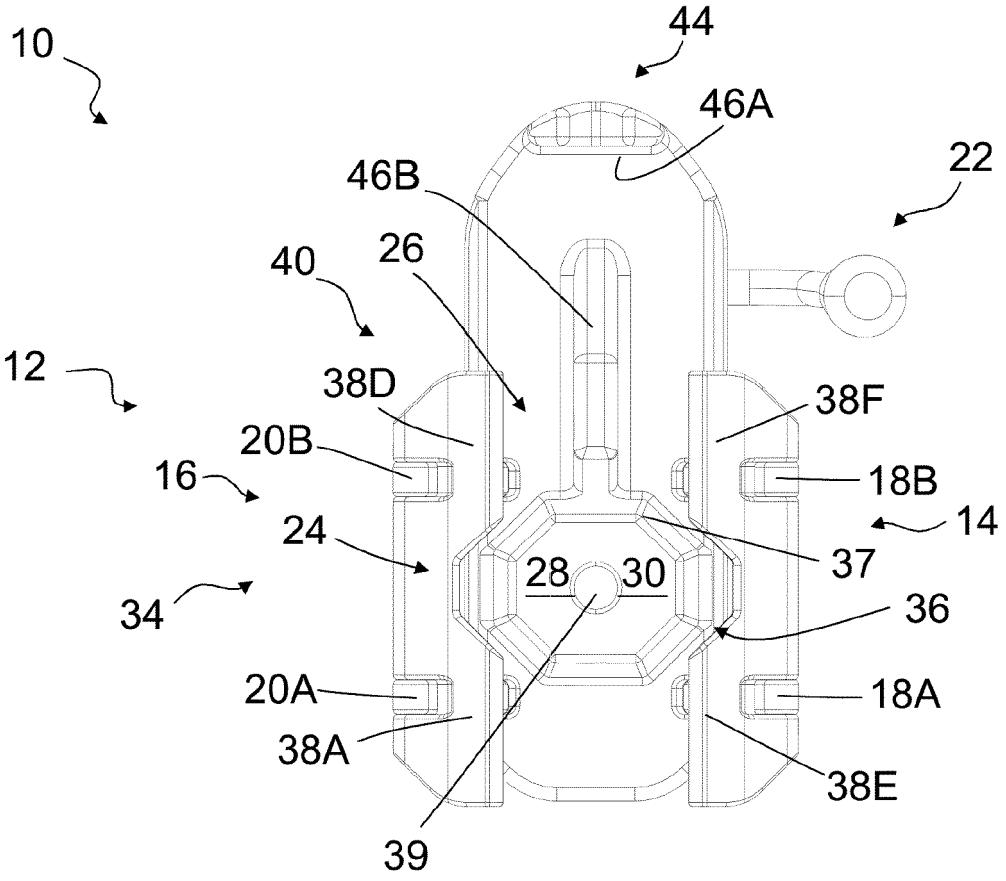
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Fig. 7

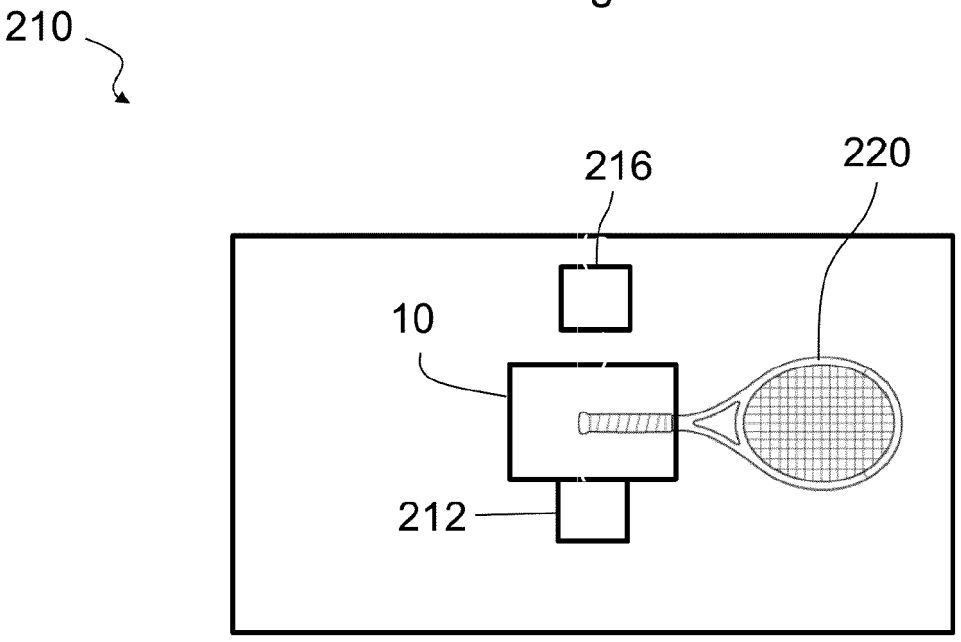
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Fig. 8

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 22 15 8722

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2007/113626 A1 (SILVEY STEVE [US]) 24 May 2007 (2007-05-24) * paragraph [0021] - paragraph [0031]; figures 1-5 *	1,2,4,6, 12 13,14	INV. A63B60/42 A63B102/02 G01B5/00 G01L3/00
Y	WO 2018/050998 A1 (E RE CA [FR]) 22 March 2018 (2018-03-22) * page 2, line 24 - page 8, line 10; figures 1-11 *	13,14	
A	DE 88 07 436 U1 (SKIS ROSSIGNOL S.A.) 21 July 1988 (1988-07-21) * paragraph [0035] - paragraph [0062]; figures 1-5 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			A63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 August 2022	Jekabsons, Armands

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 15 8722

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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24-08-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007113626 A1	24-05-2007	NONE	
WO 2018050998 A1	22-03-2018	FR 3056293 A1	23-03-2018
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82