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(54) Title of the Invention: **Aircraft passenger seat and aircraft cabin arrangement**
Abstract Title: **Aircraft seat with reclining backrest segment and sleeping configuration**

(57) An aircraft passenger seat (1) comprising a seat pan (103), a back rest (105), and a seat shell structure (109). The back rest (105) is mounted to the seat shell structure (105). The seat shell structure (109) comprises a cavity (110). The aircraft passenger seat is configurable between an upright seating mode and a lie-flat bed mode. In the upright seating mode, the back rest (105) is in a first back rest position, in which the back rest conceals the cavity such that the cavity (110), and, in the lie-flat bed mod, the back rest (105) is in a second back rest position, in which the cavity (110) is exposed.

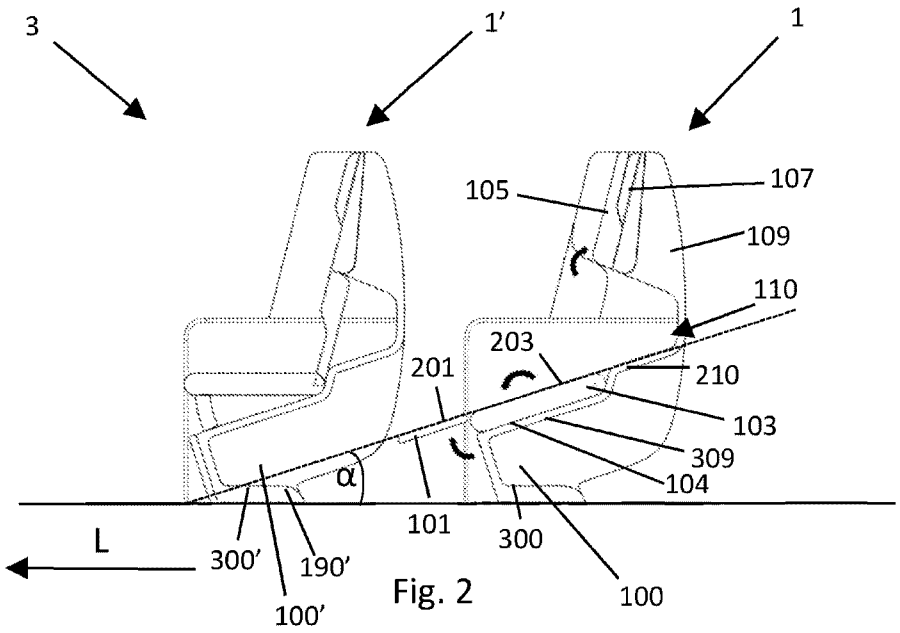

Fig. 2

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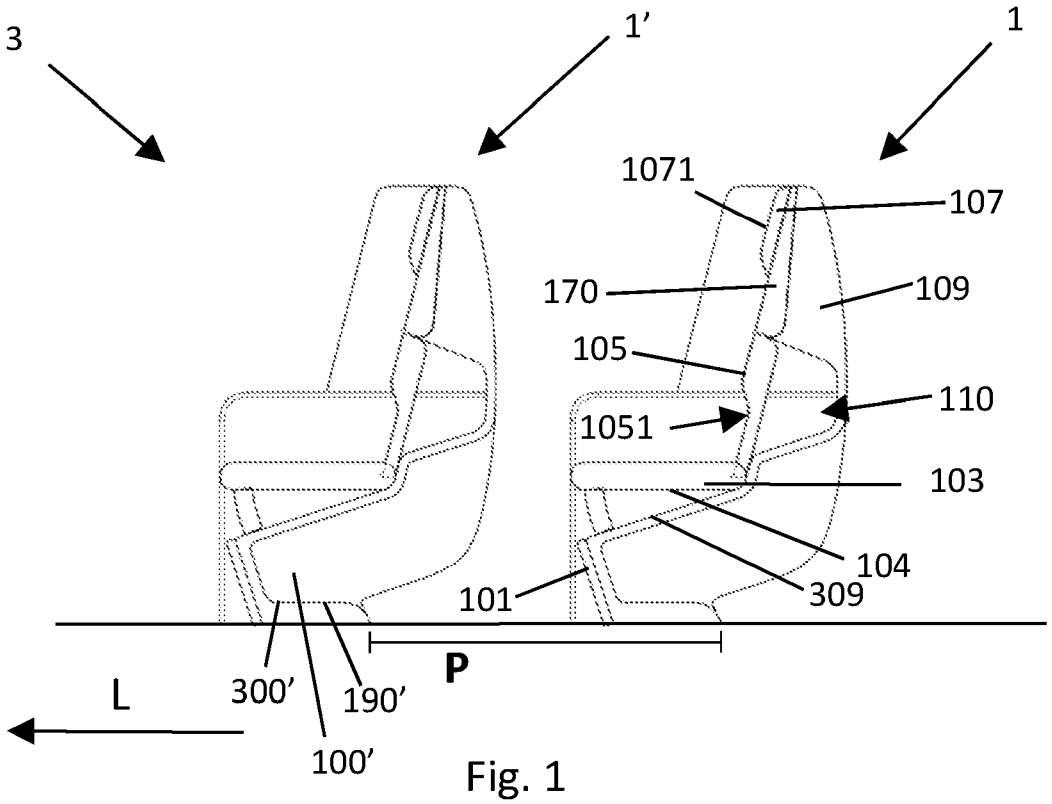
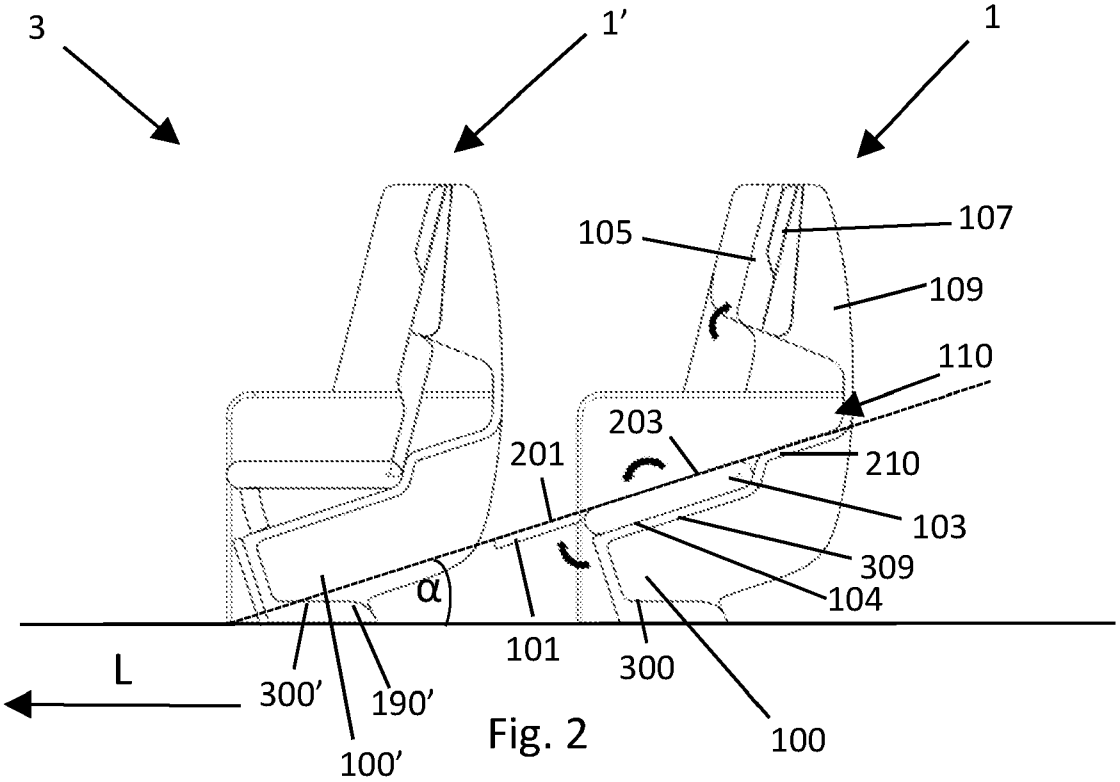

3
1'
1
1071
107
170
109
105
110
1051
103
104
309
101
P
L
300'
190'
100'

Fig. 1


3
1'
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105
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Fig. 2

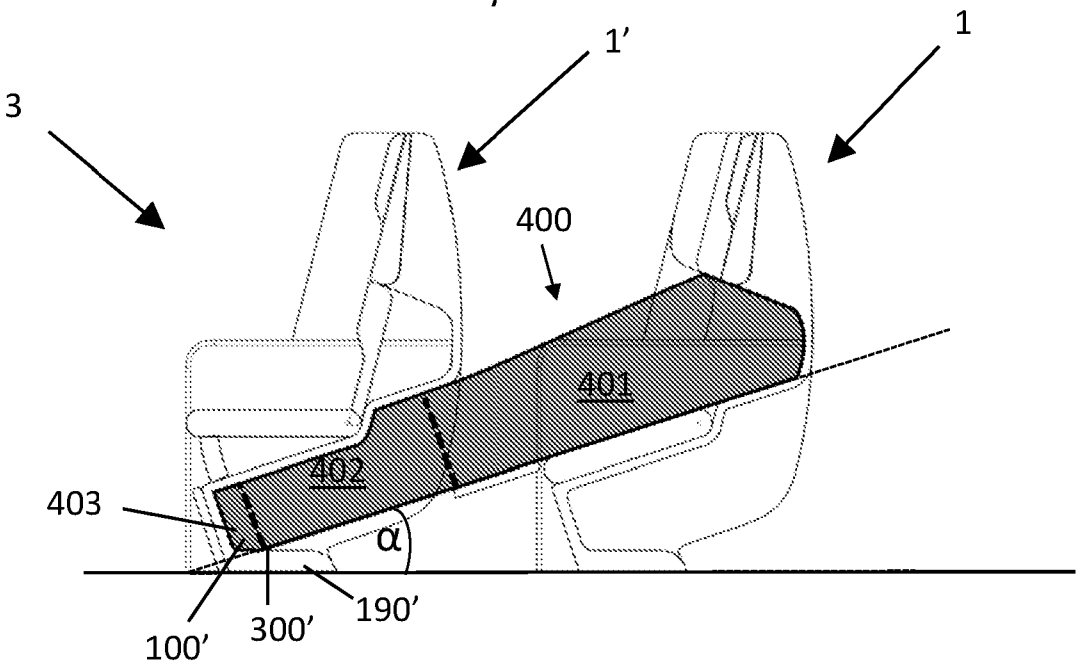

Fig. 3

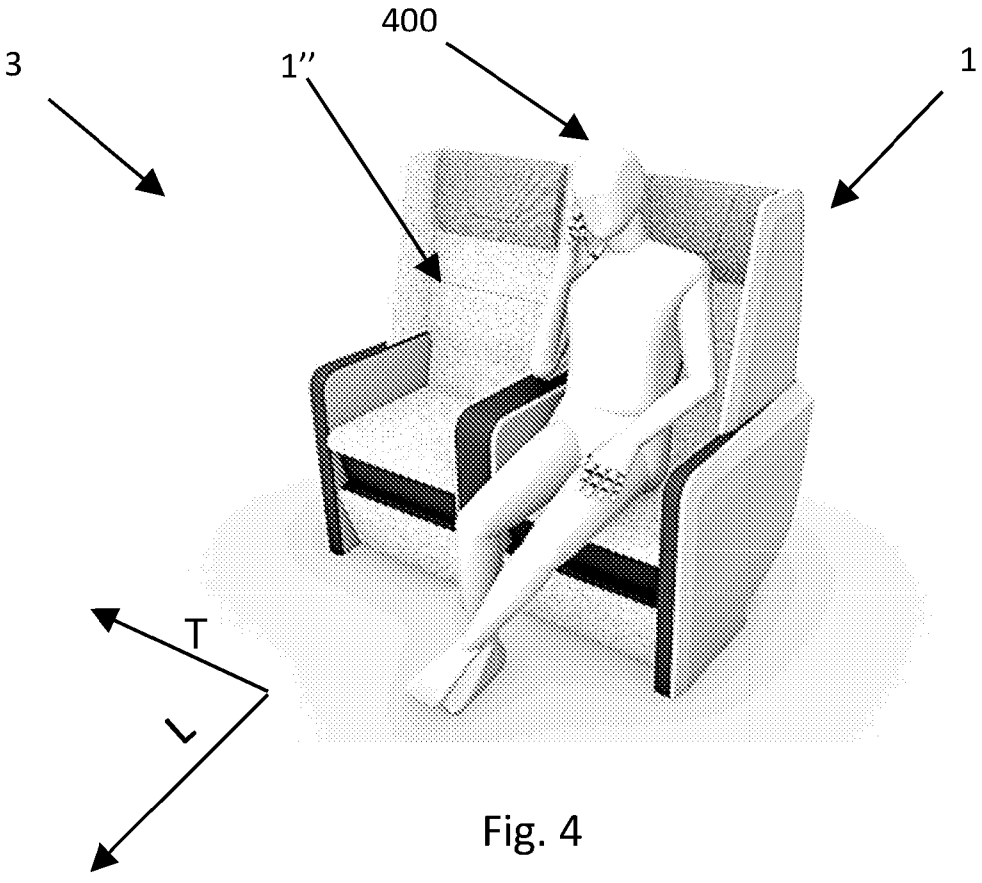

Fig. 4

AIRCRAFT PASSENGER SEAT AND AIRCRAFT CABIN ARRANGEMENT

Field of the Invention

The present invention concerns an aircraft passenger seat. More particularly, but not exclusively, this invention concerns an aircraft passenger seat configurable between an upright seating mode and a lie-flat bed mode. The invention also concerns an aircraft passenger seat unit and an aircraft cabin arrangement.

Background of the Invention

One of the main activities undertaken by a traveller during a flight is sleeping, particularly on long haul flights. One difficulty is in how to provide a comfortable space for a passenger to sleep in an aircraft passenger seat with a limited pitch, for example a premium economy aircraft passenger seat, typically having a seat pitch of substantially 96.5cm (38 inches).

Various aircraft passenger seat designs in the past have provided passengers with angle flat beds. Prior art business class aircraft passenger seats typically provide a traveller with an upright seating mode, that can be used for sitting, and a bed mode in which the aircraft passenger seat reclines to a horizontal, or near-horizontal position for sleeping. These prior art designs cannot be accommodated by the seat pitches typically accommodated in premium economy seating, for example, seat pitches of 96.5cm.

Innovation in aircraft passenger seating has been steadily increasing over recent years. Business class seating over recent years has seen huge passenger improvements such as increased privacy with suite doors. Premium economy seating has not evolved at the same pace as business class. As a result, the ability of premium economy to differentiate itself as an airline segment has somewhat declined.

An aircraft seating arrangement allowing a passenger to sleep is more desirable, especially during long haul flights where extended periods of time are spent on board.

An aircraft passenger seat which allows a passenger to turn the aircraft passenger seat into a lie-flat bed on which they can lie on is therefore desirable.

Furthermore, the most comfortable seating position may be dependent on a particular passenger's size and stature, as well as personal preference, which means that

an aircraft seating arrangement providing a variety of position options is more desirable to the passenger than a "one size fits all" arrangement.

The present invention seeks to mitigate the above-mentioned problems and/or provide an improved aircraft passenger seat.

Summary of the Invention

The present invention provides, according to a first aspect, an aircraft passenger seat comprising at least a seat pan, a back rest, and a seat shell structure, in which the back rest is mounted to the seat shell structure and the seat shell structure comprises a cavity, suitable for receiving the head of a passenger.

Moreover, the aircraft passenger seat is configurable between

- an upright seating mode, where the back rest is in a back rest first position, in which the back rest conceals the cavity, particularly such that the cavity cannot receive the head of a passenger sat in the aircraft passenger seat, and
- a lie-flat bed mode, where the back rest is in a back rest second position, in which the cavity is exposed, particularly such that the cavity can at least partially receive the head of a passenger lying on the aircraft passenger seat.

The term "upright" may correspond to a substantially vertical position, in which the back rest is substantially aligned with a vertical axis. However, it will also be understood by the skilled person to correspond to a position in which the back rest is oriented at an angle to the vertical axis, for example, if the back rest is slightly reclined.

The term "vertical" is used herein with reference to a floor of an aircraft cabin to which the aircraft passenger seat is mounted in use.

The term "horizontal" is used herein to refer to axes and planes that are perpendicular to the respective "vertical" axes and planes defined herein.

The term "lie-flat" may refer to a provision of a flat surface on which a passenger can lie. A "lie-flat" surface may be oriented at an angle to the horizontal.

The cavity may comprise an empty space or chamber within an object.

The "upright seating mode" may correspond to a mode of configuration that the aircraft passenger seat is set to be configured in during taxi, take-off and landing (TTL).

The aircraft passenger seat may be arranged, through use of electro-mechanical control means that would be well known to the skilled person, such that the aircraft passenger seat can only be in the upright seating mode during taxi, take-off and landing (TTL).

The aircraft passenger seat pitch can be defined as measurement of space between one point on an aircraft passenger seat to the same point on the aircraft passenger seat in front of it.

One of the key difficulties in developing innovations for the premium economy segment is the relatively limited pitch of the aircraft passenger seat, as compared to business class.

The present invention provides an aircraft passenger seat that is configurable between

- an upright seating mode, in which a passenger can sit upon the seat pan with his/her back against the back rest, and
- a lie-flat bed mode, in which the passenger can lie on the aircraft passenger seat.

In order to maximise a limited aircraft cabin space, the aircraft passenger seat makes use of a cavity located in the seat shell structure itself to provide a head space for the passenger when he/she is lying on the aircraft passenger seat, in the lie-flat bed mode.

The cavity is exposed by moving the back rest. The passenger can then place at least a substantial part of his/her head in the cavity, and rest their upper body on the seat pan. This arrangement allows for a flat sleeping surface providing a sufficient bed length for the passenger to lie flat, and at a tolerable and comfortable angle relative to the aircraft cabin floor, within a seat pitch of substantially 96.5cm (38 inches).

The aircraft passenger seat may further comprise a fixed back rest that is fixedly mounted to the seat shell structure.

The aircraft passenger seat may be a premium economy aircraft passenger seat. The lie-flat bed mode of the aircraft passenger seat is particularly advantageous for premium economy aircraft passenger seat. A premium economy passenger may enjoy being able to stretch their legs in the lie-flat bed mode and sleep, particularly during long-haul flights in which the time that is spent on board the aircraft is significant.

The back rest may be configured to move, particularly to rotate, between the first back rest position and the second back rest position.

The back rest may be configured to rotate between the first back rest position and the second back rest position though an angle greater than 90°. The back rest may be configured to rotate between the first back rest position and the second back rest position though an angle greater than 120°. The movable back rest may be configured to rotate between the first back rest position and the second back rest position though an angle of substantially 180°. This may allow for a space efficient mechanism of moving the back rest to reveal the cavity.

The back rest may be rotatably mounted to the seat shell structure.

In an alternative arrangement, the back rest may be slideable between the first back rest position and the second back rest position.

The back rest may be configured to be in contact, particularly in the second back rest position, with the head rest of the aircraft passenger seat.

The movable back rest may comprise a recess configured to mate contiguously with a protrusion of the head rest. This allows for the back rest, when in the back rest second position, to sit flush with the head rest, such that minimal space is wasted.

The head rest may be mounted to the fixed back rest. The head rest may be contiguously or integrally formed with the fixed back rest.

The seat pan may be

- in a first seat pan position, when the aircraft passenger seat is in the upright seating mode, and
- in a second different seat pan position, when the aircraft passenger seat is in the lie-flat bed mode.

The seat pan may be moveable between the first seat pan position and the second seat pan position by rotation.

The aircraft passenger seat may have a base surface for mounting the aircraft passenger seat to an aircraft cabin. The base surface may define a plane that corresponds to an aircraft cabin floor on which the aircraft passenger seat could be mounted.

The seat pan may comprise a plane approximating a top surface of the seat pan. In the upright seating mode, the plane approximating the top surface of the seat pan may be at an angle that is substantially parallel to the base surface and/or may be perpendicular to the vertical.

Throughout the specification, the skilled person will understand that reference may be given to a plane approximating a top surface of a seat pan. A plane

approximating a top surface of the seat pan may optionally be incorporated as a feature throughout this specification, wherever alignment with a seat pan is discussed.

The top surface of the seat pan may not be perfectly flat, and may have, for example, contoured regions. Therefore, a plane approximating a top surface of the seat pan can be useful when discussing the alignment of the seat pan with other components of one or more aircraft passenger seats.

The seat pan may be perfectly flat; in such an arrangement the plane approximating the top surface of the seat pan corresponds entirely to the top surface of the seat pan. Similar approximate planes can be considered for components of the aircraft passenger seat, such as the leg rest and foot well surface, as discussed below.

In the lie-flat bed mode, the seat pan is at an acute angle relative to the plane of the base surface of the aircraft passenger seat for mounting the aircraft passenger seat to the aircraft cabin.

In the lie-flat bed mode, the seat pan may be an angle of between 0° and 50°, between 5° and 25°, particularly between 10° and 20°, and more particularly between 16° and 18°, with respect to the plane of the base surface.

In the lie-flat bed mode, the seat pan may also be an angle of between 15° and 20°, particularly between 16° and 19°, more particularly between 17° to 18°, with respect to the plane of the base surface of the aircraft passenger seat.

The seat pan being at an acute angle relative to the plane of the base surface, and thus, the floor of the aircraft cabin when the aircraft passenger seat is mounted in the aircraft cabin, allows for the passenger lying on the aircraft passenger seat, in the lie-flat bed mode, to have part of their body, for example, their feet, located under the aircraft passenger seat in front of him/her, while at least part of his/her body rests on the seat pan, and at least a substantial part of his/her head rests inside the cavity.

This combination of features further allows for the passenger to lie-flat, in a non-horizontal position, more comfortably, even when the aircraft passenger seat pitch between aircraft passenger seats is relatively small, such as an aircraft passenger seat pitch typically found in a premium economy aircraft cabin.

The seat pan may be configured to be placed in at least one intermediate position between the first seat pan position and the second seat pan position, when the aircraft passenger seat is in the upright seating mode. It may be that the seat pan can be placed in a plurality of positions between the first seat pan position and the second seat pan position, when the aircraft passenger seat is in the upright seating mode.

Having the seat pan be adjustable in this way allows the passenger to adapt the aircraft passenger seat to a comfortable position, particularly when the passenger is sitting on the aircraft passenger seat in the upright seating mode.

The aircraft passenger seat may further comprises a leg rest, moveable between a retracted position and an extended position.

The leg rest may comprise a plane approximating a top surface of the leg rest.

The leg rest may be mounted to the seat shell structure.

In the upright seating mode, the leg rest may be in the retracted position, which may be substantially perpendicular to the seat pan, or the leg rest may be in any alternative between the retracted position and the extended position.

In the lie-flat bed mode, the leg rest may be substantially parallel to the seat pan, and optionally aligned with the seat pan.

In the upright seating mode, the approximate plane corresponding to the top surface of the leg rest may be in the retracted position and may be substantially perpendicular to the approximate plane corresponding to the top surface of the seat pan.

In the lie-flat bed mode, the approximate plane corresponding to the top surface of the leg rest may be substantially parallel to the approximate plane corresponding to the top surface of the seat pan, and optionally aligned with the approximate plane corresponding to the top surface of the seat pan.

The leg rest may therefore provide a further surface for the passenger to lie on when the aircraft passenger seat is in the lie-flat bed mode.

In this connection, the leg rest may provide support to an additional portion of the passenger's upper body, and/or support to the back, and/or upper leg of the passenger lying on the aircraft passenger seat.

It also allows for the passenger to comfortably lie-flat, while part of their leg remains unsupported. This advantageously saves weight, as less material is required because a lie-flat surface is not required to support the entire body of the passenger.

The leg rest may be mounted to the seat shell structure and moveable between the retracted position and the extended position, particularly by rotation of the leg rest with respect to the seat shell structure.

This makes it possible for the leg rest to provide a number of different positions to allow different comfortable sitting/lying positions for the passenger when the leg rest is deployed.

The leg rest may be configured to be fixed in a plurality of positions between the retracted position and the extended position. It may be that the leg rest can be fixed in a plurality of positions between the retracted position and the extended position.

Having the leg rest be adjustable in this way allows for the passenger to adapt the aircraft passenger seat to a comfortable position, particularly when he/she is sitting on the aircraft passenger seat in the upright seating mode.

The aircraft passenger seat may comprise a footwell located under the seat pan. The footwell is suitable for receiving the feet of a passenger located in a further aircraft passenger seat located behind the aircraft passenger seat. The footwell comprises a footrest surface, suitable for receiving the feet of said passenger.

Such a footwell may allow a passenger sat behind the aircraft passenger seat to rest their feet. The footwell may be configured such that it can be provide a footrest surface for the passenger sat behind the present aircraft passenger seat when this further aircraft passenger seat is in the lie-flat bed mode.

This arrangement allows for part of a passenger in a first aircraft passenger seat, in the lie-flat bed mode, behind the further aircraft passenger seat, to be located under the second aircraft passenger seat.

This further optimises space and allows for a passenger to be able to lie-flat, even if the aircraft passenger seat is arranged at a limited seat pitch, such as the seat pitch of a premium economy aircraft cabin.

The footrest surface may be configured to provide support to the feet of passenger in the first aircraft passenger seat behind.

The footrest surface may comprise a plane approximating the footrest surface.

The footrest surface may be configured such that the footrest surface is parallel to the seat pan, optionally parallel to the top surface of the seat pan of the aircraft passenger seat.

The footrest surface may be configured such that the footrest surface is parallel to the seat pan, optionally parallel to the top surface of the seat pan of the further aircraft passenger seat, according to the first aspect of the invention, located directly behind the aircraft passenger seat, when said further aircraft passenger seat is in the lie-flat bed mode.

Additionally, the footrest surface may be configured such that the footrest surface is parallel, in the lie-flat bed mode, to the leg rest, optionally parallel to the top surface of the leg rest, of the aircraft passenger seat.

Additionally, the footrest surface may be configured such that the footrest surface is parallel to the leg rest, optionally parallel to the top surface of the leg rest, of the further aircraft passenger seat, according to the first aspect of the invention located directly behind the aircraft passenger seat, when said further aircraft passenger seat is in the lie-flat bed mode.

According to a second aspect of the invention, there is provided an aircraft passenger seat unit comprising an aircraft passenger seat according to the first aspect of the invention.

In the present specification, "aircraft passenger seat unit" is used to refer to not only an aircraft passenger seat, but additionally other items, such as meal tables, arm rests, and screens and the like, that a passenger is likely to find in close proximity to the aircraft passenger seat, when they are sitting in the aircraft passenger seat.

According to a third aspect of the invention, there is provided an aircraft cabin comprising a plurality of aircraft passenger seats according to the first aspect of the invention, or a plurality of aircraft passenger seat units according to the second aspect of the invention.

According to a third aspect of the invention, there is provided an aircraft cabin comprising at least a first aircraft passenger seat and a second aircraft passenger seat according to the first aspect of the invention.

The footwell located under the seat pan of the second aircraft passenger seat is suitable for receiving the feet of a passenger located in the first aircraft passenger seat located behind the second aircraft passenger seat.

The footwell of the second aircraft passenger seat comprises a footrest surface for receiving the feet of the passenger.

The footrest surface on the footwell of the second aircraft passenger seat is configured such that the footrest surface is aligned with the seat pan of the first aircraft passenger seat, when the first aircraft passenger seat is in the lie-flat bed mode.

The footrest surface on the footwell of the second aircraft passenger seat may be configured such that the footrest surface is aligned with the plane approximating the top surface of the seat pan of the first aircraft passenger seat, when the first aircraft passenger seat is in the lie-flat bed mode.

The footrest surface of the footwell of the second aircraft passenger seat may be configured such that the footrest surface is also aligned with the leg rest of the first aircraft passenger seat, when the first aircraft passenger seat is in the lie-flat bed mode.

The alignment of the footrest surface of the second aircraft passenger seat with the seat pan, and optionally with the leg rest, of the first aircraft passenger seat allows for the flat surface to support the upper body of the passenger, and the footrest surface to support the feet of the passenger, where the feet would naturally rest if the passenger were to lie on said flat surface.

This allows for the passenger sat on the first aircraft passenger seat to lie flat, with their feet underneath the second aircraft passenger seat and at least part of his/her head in the cavity of the first aircraft passenger seat.

It also allows for the passenger to comfortably lie flat, while part of their leg remains unsupported. This advantageously saves weight, as less material is required because a lie-flat surface is not required to support the entire body of the passenger.

In the lie-flat bed mode, the seat pan of the first aircraft passenger seat may be an angle of between 0° and 50°, particularly between 5° and 25°, more particularly between 10° and 20°, particularly between 16° and 18°, and particularly of 16° or 18°, with respect to the base surface of the second aircraft passenger seat.

In the lie-flat bed mode, the seat pan may also be an angle of between 15° and 20°, particularly 16° and 19°, more particularly between 17° to 18°, with respect to the bottom surface of the second aircraft passenger seat.

The seat pitch between the first aircraft passenger seat and the second aircraft passenger seat may be between 75cm and 115cm, particularly between 85cm and 105cm, particularly between 85cm and 100cm, particularly between 90cm and 102cm and more particularly between 95cm and 98cm.

The seat pitch between the first aircraft passenger seat and the second aircraft passenger seat may be substantially 96.5cm.

The seat pitch between the first aircraft passenger seat and the second aircraft passenger seat may be less than 115cm, particularly less than 105cm, particularly less than 102cm, particularly less than 98 cm and more particularly 96.5 cm.

The aircraft cabin may comprise a longitudinal axis. The aircraft passenger seat may optionally be oriented to face the longitudinal axis. The first aircraft passenger seat may face in a direction aligned with the longitudinal axis of the aircraft cabin and/or the second aircraft passenger seat may face in a direction aligned with the longitudinal axis of the aircraft cabin.

The first aircraft passenger seat may be arranged to be directly behind the second aircraft passenger seat with respect to the longitudinal axis of the aircraft cabin.

The aircraft cabin may comprise a plurality of first aircraft passenger seats and of second aircraft passenger seats as previously described. The plurality of first aircraft passenger seats and second aircraft passenger seats may be arranged in rows that extend transverse to the longitudinal axis of the aircraft cabin. The aircraft cabin may comprise an aisle that interrupts said rows of aircraft passenger seats. The aisle may be substantially aligned with the longitudinal axis of the aircraft cabin.

It will be of course appreciated that the first aircraft passenger seats and/or the second aircraft passenger seats of the third aspect of the invention may alternatively or additionally comprise any features described in accordance with the first aspect of the invention.

According to a fourth aspect of the invention, there is provided a kit of parts suitable for forming an aircraft cabin as described in the third aspect of the invention.

According to a fifth aspect of the invention, there is provided a method of configuring an aircraft passenger seat, the aircraft passenger seat being in accordance with the first aspect of the invention, the method comprising changing the configuration of the aircraft passenger seat such that the configuration changes from the upright seating mode to the lie-flat bed mode, and/or such that the configuration changes from the lie-flat bed mode to the upright seating mode.

It will of course be appreciated that features described in relation to one aspect of the present invention may be incorporated into other aspects of the present invention. For example, the aircraft passenger seat according to the first aspect of the invention may incorporate any of the features described with reference to the aircraft passenger seat unit according to the second aspect of the invention, or aircraft passenger cabin according to the third or fourth aspect of the invention and *vice versa*.

Description of the Drawings

Embodiments of the present invention will now be described in detail, by way of non-limiting example, but the present invention is not limited to these disclosures, and will make it easy to understand what the invention consists of and how it can be embodied, with reference to the accompanying schematic drawings of which:

Figure 1 shows a seating arrangement comprising an aircraft passenger seat according to an embodiment of the invention wherein the aircraft passenger seat is configured in an upright seating mode;

Figure 2 shows the seating arrangement of Figure 1 with the aircraft passenger seat in a lie-flat bed mode;

Figure 3 is a schematic view of the seating arrangement of Figure 1 and Figure 2 in the lie-flat bed mode, with a passenger lying on the aircraft passenger seat;

Figure 4 is a three dimensional schematic view of an aircraft passenger seat in accordance with an embodiment of the invention arranged in a row in an aircraft cabin.

Detailed Description

Figures 1 and 2 show a seating arrangement comprising an aircraft passenger seat 1 according to an embodiment of the invention, where the aircraft passenger seat 1 is respectively configured in an upright seating mode and in a lie-flat bed mode.

The aircraft passenger seat 1 according to an embodiment of the invention is shown in Figure 1 and Figure 2 within an aircraft cabin 3.

The aircraft passenger seat 1 comprises at least a seat pan 103 and a back rest 105, in particular a movable back rest 105. The aircraft passenger seat 1 may also comprise a head rest 107.

According to the invention, the aircraft passenger seat 1 may also further comprise a footwell 100 and/or a leg rest 101.

The leg rest 101 may be moveable between a retracted position and an extended position.

These seat pan 103, the back rest 105 and the head rest 107 are all supported on a seat shell structure 109. The seat pan 103, the movable back rest 105, and the head rest 107 may all be independently mounted on the seat shell structure 109.

The head rest 107 may be contiguously formed with a fixed back rest 170.

The shell structure 109 has a base surface 190 for mounting the aircraft passenger seat 1 into the aircraft cabin 3, particularly onto a floor of the aircraft cabin 3.

The aircraft passenger seat 1 is located in the aircraft cabin 3, the aircraft cabin 3 having a longitudinal direction L. A second aircraft passenger seat 1', which is identical to the aircraft passenger seat 1, is located directly in front of the aircraft passenger seat 1 in with respect to the longitudinal direction L of the aircraft cabin 3. A

pitch P between the aircraft passenger seat 1 and the second aircraft passenger seat 1' in the aircraft cabin 3 that may be substantially 96.5cm (38 inches).

The aircraft passenger seat 1 is a lie-flat bed aircraft passenger seat that is moveable between:

- a lie-flat bed mode, in which the aircraft passenger seat 1 is configured so that a passenger can lie down, as shown in Figure 2 and Figure 3, and
- an upright seating mode, in which the passenger can sit, as shown in Figure 1 and Figure 4.

From the upright seating mode to the lie-flat bed mode, at least the seat pan 103 is moved, so that the passenger on the aircraft passenger seat 1 can lie down across the seat pan 103. In addition, from the upright seating mode to the lie-flat bed mode, the leg rest 101 may also be moved, particularly into the extended position, so that the passenger on the aircraft passenger seat 1 can lie down across both the seat pan 103 and the leg rest 101.

In order to create enough space for the passenger to lie on the aircraft passenger seat 1, the aircraft passenger seat 1 comprises a cavity 110.

According to the invention, the cavity 110 is provided behind the back rest 105. The cavity 110 comprises a concave void formed in the seat shell structure 109.

The cavity 110 is hidden from the passenger, when in the upright seating mode, and exposed, when the aircraft passenger seat 1 is in the lie-flat bed mode.

The cavity 110 is suitable for receiving at least the whole or part of the head of a passenger lying of the aircraft passenger seat 1 when in the lie-flat bed mode, which can be also designated by deployed mode.

According to the invention, the seat pan 103 and the back rest 105 are all movable. The leg rest 101 may also be movable.

Various actuators and actuation mechanisms are arranged to control movements of the seat pan 103, the back rest 105 and/or the leg rest 101, as would be well understood by the person skilled in the art. Therefore, no further description of the various actuators and actuation mechanisms are necessary.

When in the lie-flat bed mode:

- the leg rest 101 may provide a first exposed surface 201;
- the seat pan 103 may provide a second exposed surface 203; and/or
- the cavity 110 may provide a third exposed surface 210.

The first exposed surface 201, the second exposed surface 203 and the third exposed surface 210 are aligned, such that a continuous flat surface is provided for the passenger to lie upon.

This continuous flat surface may also be aligned such that the passenger can rest their feet on a footrest surface 300 of an identical second aircraft passenger seat 1' placed in front of the aircraft passenger seat 1.

To change configuration from the upright seating mode to the lie-flat bed mode, the seat pan 103 moves, particularly the seat pan 103 rotates, e.g. anticlockwise as shown in Figure 2, so that the second exposed surface 203 of the seat pan 103 moves downwardly and away from the back rest 105.

Alternatively, the seat pan 103 can slide, so that the second exposed surface 203 of the seat pan 103 moves downwardly and away from the back rest 105.

Moreover, the seat pan 103 comprises an underside 104, which faces the floor of the aircraft cabin 3 when the seat pan 103 is in the upright seating mode.

To change configuration from the upright seating mode to the lie-flat bed mode, the underside 104 of the seat pan 103 may move to a support surface 309 of the seat shell structure 109.

In the lie-flat bed mode, the second exposed surface 203 of the seat pan 103 therefore is at an obtuse angle relative to a plane defined by a surface of the head rest 107, as it can be seen in Figure 2.

Moreover, in the lie-flat bed mode, the second exposed surface 203 of the seat pan 103 is at an acute angle α relative to a plane defined by a surface of the base surface 190, as it can be seen in Figure 2. The angle α of the second exposed surface 203 of the seat pan 103 relative to the base surface 190 may be substantially 18°.

The seat pan 103 is configured to move between the lie-flat bed mode and the upright seating mode by moving, particularly rotating and/or sliding, the seat pan 103 downwards towards the floor of the aircraft cabin 3.

The leg rest 101 is configured to move between the lie-flat bed mode, where the leg rest 101 may be in the extended position, and the upright seating mode, where the leg rest 101 may be in the retracted position, by moving, particularly rotating and/or sliding, the leg rest 101 upwards, particularly such that it deploys from the seat shell structure 109.

The leg rest 109 is moved upwards by a predetermined amount such that both the first exposed surface 201 and the second exposed surface 203 are positioned at the

same acute angle α to the base surface 190, which is mounted onto the floor of the aircraft cabin 3. Preferably, the base surface 190 is parallel to onto the floor of the aircraft cabin 3, such as the angle α between the first exposed surface 201 and the second exposed surface 203 and the plane defined by the floor of the aircraft cabin 3 being the same as the angle between the first exposed surface 201 and the second exposed surface 203 and the plane defined by the base surface 190.

To change configuration from the upright seating mode to the lie-flat bed mode, the back rest 105 is moved, specifically after the seat pan 103 has moved, particularly the back rest 105 rotates, upwards in a direction away from the seat pan 103.

The back rest 105 moves such that the back rest 105 touches the head rest surface 107. Particularly, the back rest 105 may rotate by an angle of substantially equal to 180°.

According to a particular embodiment of the invention, a portion 1071 of the head rest 107 is configured to be mate contiguously and completely with a corresponding recess 1051 of the back rest 105, such that there is no void between the head rest 107 after having been moved and the back rest 105, when the aircraft passenger seat 1 is in the lie-flat bed mode.

Moving the back rest 105, in particular rotating and/or sliding the back rest 105, upwards reveals the cavity 110 in the seat shell structure 109 and the third exposed surface 210 on which a passenger can rest his/her head.

Once the leg rest 101 is deployed in the lie-flat bed mode, the first exposed surface 201 is aligned with the second exposed surface 203. The first exposed surface 201, the second exposed surface 203 and the third exposed surface 210 thus form a sleeping surface to support an upper body part 401 of a passenger 400 lying on the aircraft passenger seat 1.

The cavity 110 is large enough such that an averagely sized passenger 400 can fit him/her entire head inside the cavity 110.

Figure 3 is a schematic view of the seating arrangement of Figure 1 and Figure 2 in the lie-flat bed position, with the passenger 400 lying on the aircraft passenger seat 1. More particularly, Figure 3 shows a schematic representation of the passenger 400, and how the passenger 400 would lie on the aircraft passenger seat 1 when the aircraft passenger seat 1 is in the lie-flat bed mode. Like elements described in relation with Figure 1 and Figure 2 will not be described again for the sake of brevity.

When the passenger 400 lies on the aircraft passenger seat 1 in the lie-flat bed positon, their head, torso, and, depending on his/her size, at least a part of their upper leg, rests on the first exposed surface 201, the second exposed surface 203 and the third exposed surface 210.

The head, the torso and the upper leg form the upper body part 401 of the passenger 400, which is supported by the leg rest 101, the seat pan 103 and the cavity 110.

The passenger 400 can then support their feet 403 in the footwell 100' on the foot well surface 300' of the second aircraft passenger seat 1' placed in front of the aircraft passenger seat 1.

In the present description, elements being part of the second aircraft passenger seat 1' have same reference number with a prime symbol.

The foot well surface 300' provides further support to the passenger 400, by allowing a place for them to rest their feet 403. Thus, the passenger's lower leg region 402 is the only part of the body of the passenger 400 that is not directly supported by a support surface, such as the first exposed surface 201, the second exposed surface 203 and/ or the third exposed surface 210.

In the lie-flat bed mode, the first exposed surface 201, the second exposed surface 203 and the third exposed surface 210 respectively define a support surface.

In the lie-flat bed mode, the first exposed surface 201, the second exposed surface 203 and the third exposed surface 210 may be at an angle α of substantially 18° relative to the floor of the aircraft cabin 3 and thus the plane defined by the base surface 190.

Thus, the passenger 400, when on the aircraft passenger seat 1 in the lie-flat bed mode, lies at an angle α of substantially 18° from the horizontal.

In addition, the seat pan 103 may be rotatable with respect to the seat shell structure 109 at a pivot point located at a rear of the seat pan 103, so that a passenger sitting in the aircraft passenger seat 1 can tilt the seat pan 103 to move their knees upwards or downwards to a desired seating position.

Because the leg rest 101, the seat pan 103, and the back rest 105 are all independently moveable, as well as the upright seating mode and the lie-flat bed mode, the aircraft passenger seat 1 can be configured in a multiplicity of other modes that are in between the extremes of the upright seating mode and the lie-flat bed mode.

Figure 4 is a three dimensional schematic view of two aircraft passenger seats 1 of the invention arranged in a row in the aircraft cabin 3. More particularly, Figure 4 shows how the passenger 400 would sit on the aircraft passenger seat 1 when the aircraft passenger seat 1 is in the upright seating mode. Like elements described in Figure 1, Figure 2 and Figure 3 will not be described again for the sake of clarity.

An identical third aircraft passenger seat 1'' can be arranged to be directly adjacent to the aircraft passenger seat 1 in a transverse direction T of the aircraft cabin 3, which is perpendicular to the longitudinal direction L of the aircraft cabin 3. Thus, the aircraft passenger seat 1and the third aircraft passenger seat 1'' can be arranged in rows in the aircraft cabin 3.

Whilst the present invention has been described and illustrated with reference to particular embodiments, it will be appreciated by those of ordinary skill in the art that the invention lends itself to many different variations not specifically illustrated herein. By way of example only, certain possible variations will now be described.

In an embodiment described in the drawings, the back rest 105 rotates upwards to reveal the cavity 110. The skilled person will be able to readily envisage further embodiments where the back rest 105 moves in a different way to reveal the cavity 110.

In yet further embodiments, the back rest 105 can be

- removed from the aircraft passenger seat 1, instead of being rotated upwards,
- translated to reveal the cavity 110, and/or
- rotated away and to the side of the aircraft passenger seat, instead of being rotated upwards.

In yet further embodiments, the back rest 105 may alternatively be rotated downwards.

In an embodiment described in the drawings, the cavity 110 is concave. The skilled person would understand that any other shape cavity, for example a square or rectangular cavity, could be equally suitable in other embodiments.

In an embodiment described in the drawings, the back rest 105 can be rotated upwards by approximately 180° when moving to the tilted position. The skilled person would understand that any other degree of rotation and/or other movement, such as a translation movement, enough to reveal the cavity 110 would be sufficient.

For example, in other embodiments, the back rest 105 could be rotated upwards, downwards, or to the side by an angle having a value between 90° and 180°, for example

by 100°, 110°, 120°, 130°, 140°, 150°, 160° or 170°,when moving between the first back rest position and the second back rest position.

Alternatively, the back rest 105 could be rotated though reflex angle having a value between 180° and 360°, for example by 190°, 200°, 210°, 220°, 230°, 240°, 250°, 260° or 270°, or another angle having a value between 280° and 360°, when moving between the first back rest position and the second back rest position.

In the embodiment described in the drawings, the entire back rest 105 can be moved upwards. The skilled person would understand that, in other embodiments of the invention, the back rest 105 may be split into one or more parts. At least one of such parts of the back rest 105 may move, for example rotate, into the cavity 110, to reveal the cavity 110, when in the tilted position.

Optionally, part of a cushioned surface on such parts of the back rest 105 that moves into the cavity 105 can provide cushioning for the head of the passenger 400 when placed inside the cavity 110.

In the embodiment described in the drawings, the first exposed surface 201, the second exposed surface 203 and the third exposed surface 210 are at an angle α of substantially 18° relative to the floor of the aircraft cabin 3 or the base surface 190. However, the skilled person will appreciate that any other suitable angle which would allow a passenger to comfortably lie down in a given seating arrangement and seating pitch may be allowable.

In such alternative embodiments, the angle α may be between 0° and 50°, between 5° and 25°, between 10° and 20°, or between 16° and 18°, for example.

In the embodiment described in the drawings, the leg rest 101 is mounted to the seat shell structure 109 and rotates upwards from the seat shell structure 109. However the leg rest 101 could be mounted to any other suitable part of the seat shell structure 109, for example the seat pan 103 or the rear of a seat shell structure 109, so that the leg rest 101 deploys from the second aircraft passenger seat 1' located in front of the passenger 400, instead of from the aircraft passenger seat 1 on which the passenger 400 is currently sitting.

Where in the foregoing description, integers or elements are mentioned which have known, obvious or foreseeable equivalents, then such equivalents are herein incorporated as if individually set forth. Reference should be made to the claims for determining the true scope of the present invention, which should be construed, so as to encompass any such equivalents.

It will also be appreciated by the reader that integers or features of the invention that are described as preferable, advantageous, convenient or the like are optional and do not limit the scope of the independent claims. Moreover, it is to be understood that such optional integers or features, whilst of possible benefit in some embodiments of the invention, may not be desirable, and may therefore be absent, in other embodiments.

Claims

1. An aircraft passenger seat comprising at least a seat pan, a back rest and a seat shell structure,
wherein the back rest is mounted to the seat shell structure,
wherein the seat shell structure comprises a cavity; and
wherein the aircraft passenger seat is configurable between
- an upright seating mode, where the back rest is in a back rest first position, in which the back rest conceals the cavity,
and
- a lie-flat bed mode, where the back rest is in a back rest second position, in which the cavity is exposed.

2. An aircraft passenger seat according to claim 1, wherein the back rest is configured to move between the back rest first position and the back rest second position, particularly to rotate between the first back rest position and the back rest second position though an angle greater than 90 degrees.

3. An aircraft passenger seat according to any preceding claim, wherein in the second position, the back rest is configured to be in contact, particularly in the back rest second position, with a head rest of the aircraft passenger seat.

4. An aircraft passenger seat according to any preceding claim, wherein the seat pan is moveable, particularly by rotation, between
- a first seat pan position, in the upright seating mode,
and
- a second different seat pan position, in the lie-flat bed mode.

5. An aircraft passenger seat according to any preceding claim, wherein the aircraft passenger seat comprises a base surface, suitable for mounting the aircraft passenger seat to an aircraft cabin, and wherein, in the lie-flat bed mode, the seat pan is at an acute angle relative to a plane of the base surface.

6. An aircraft passenger seat according to claim 5, wherein, in the lie-flat bed mode, the seat pan may be an angle of between 5° and 25° with respect to the base surface, particularly between 10° and 20°, and more particularly between 16° and 18°.

7. An aircraft passenger seat according to any preceding claim, wherein, in the upright seating mode, the seat pan can be placed in at least one intermediate position between the first seat pan position and the second seat pan position.

8. An aircraft passenger seat according to any preceding claim, wherein the aircraft passenger seat further comprises a leg rest moveable between a retracted position and an extended position.

9. An aircraft passenger seat according to claim 8 wherein,

- in the upright seating mode, the leg rest is in the retracted position or any alternative between the retracted position and the extended position; and/or
- in the lie-flat bed mode, the leg rest is substantially parallel to, and optionally aligned with, the seat pan.

10. An aircraft passenger seat according to claim 8 or 9, wherein the leg rest is mounted to the seat shell structure and moveable between the retracted position and the extended position.

11. An aircraft passenger seat according to any proceeding claim, wherein the aircraft passenger seat comprises a footwell located under the seat pan.

12. An aircraft passenger seat according to claim 14, wherein, in the lie-flat bed mode, the footwell comprises a footrest surface parallel to the seat pan.

13. An aircraft cabin comprising at least a first aircraft passenger seat according to any of claims 1 to 12, and a second aircraft passenger seat according to any of claims 1 to 12, wherein the footrest surface of the second aircraft passenger seat is configured such that the footrest surface is aligned with the seat pan of the first aircraft passenger seat when the first aircraft passenger seat is in the lie-flat bed mode.

14. An aircraft cabin as claimed in claim 13, wherein the first aircraft passenger seat faces in a direction aligned with a longitudinal axis of the aircraft cabin and the second aircraft passenger seat faces in a direction aligned with the longitudinal axis of the aircraft cabin.

15. An aircraft cabin as claimed in claim 14, wherein the first aircraft passenger seat is arranged to be directly behind the second aircraft passenger seat with respect to the longitudinal axis of the aircraft cabin.

Intellectual Property Office

Application No:	GB2304081.9	**Examiner:**	Mr James Welsh
Claims searched:	1-15	**Date of search:**	7 September 2023

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-15	US 7108226 B2 (QUAN et al.) See Col. 4 line 36- 67; figure 8.
X	1-15	US 7997531 B2 (BETTELL) Col. 4 line 22-35; figures 5 and 6.
X	1-15	US 2022/0033083 A1 (CHAREYRE et al.) See paragraph [0057] - paragraph [0071]; figures 2C and 2D.
X	1-15	US 6692069 B2 (BEROTH et al.) See Col. 5 line 21 - 65; figures 5-7.
X	1-15	US 6209956 B1 (DRYBURGH et al.) See Col. 5 line 40 - col. 6 line 2; figures 9-11.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, Patent Fulltext

International Classification:

Subclass	Subgroup	Valid From
B64D	0011/06	01/01/2006