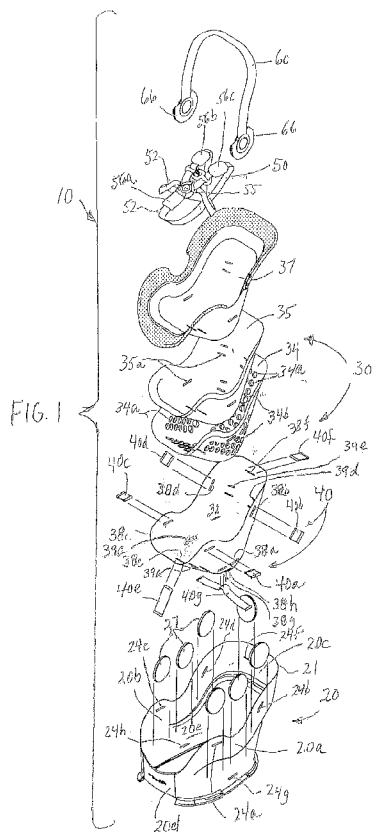




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[Continued on next page]

(54) Title: CAR SEAT



(57) Abstract: Embodiments of a car seat include an outer protective shell, an inner seat, a suspension system connecting and permitting relative movement between the inner seat and the outer protective shell for shock isolation, and a harness adapted to hold an occupant to the inner seat and not attached to the outer protective shell. In an accident, regardless of the direction in which the seat is facing and regardless of whether the result is a sudden acceleration and/or deceleration, the inner seat will move inside the frame, and the suspension system will absorb some, much, or all of the energy. Energy not absorbed by the suspension system may be absorbed by the inner seat itself and/or an anchor system used to connect the car seat to a vehicle. The frame of the seat will remain structurally intact in almost all circumstances thereby protecting the occupant of the car seat.

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CAR SEAT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is related to co-owned U.S. Patent Application No. 13/785,555 (Cohen et al.) filed March 5, 2013, the entire contents of which are hereby incorporated herein by reference.

BACKGROUND

1. Field

[0002] The present disclosure relates to car seats. More particularly, the present disclosure relates to safety car seats. The safety car seats may be for infants or children, although this application is not limited thereto.

2. State of the Art

[0003] The most common cause of death for children aged 1-5 in developed countries is by accident, and the leading cause of death by accident is due to car accidents. When properly installed in passenger cars, child safety seats have been reported to reduce fatal injury by about 71% for children under age one and by about 54% for toddlers aged 1-4. Nonetheless, in the U.S. alone, over 250 children aged 0-4 are fatally injured every year while properly restrained in their car seats.

[0004] In addition, to the fatalities, every year, thousands of children who are properly restrained in car seats still sustain incapacitating injuries resulting from car accidents. By far the most common severe injuries are head injuries, including cerebrum injuries (contusions or lacerations), concussions, skull vault and skull base fractures, subarachnoid hemorrhages, and subdural hematomas. Other common severe injuries are thoracic (lung and rib), abdominal (bowel, liver, spleen, kidney), spine, and upper extremity (clavicle, humerus, radius/ulna) and lower extremity (pelvis, femur, tibia/fibula) injuries. The injury outcome in children can be worse than similar injuries sustained by adults, and children who suffer traumatic brain injuries can experience lasting or late-appearing neuropsychological problems. For example, frontal lobe functions develop relatively late in a child's growth, so that injury to the frontal lobes may not become apparent until the child reaches adolescence.

[0005] According to the U.S. National Highway Traffic and Safety Administration (NHTSA), children under the age of one should always ride in a rear-facing car seat that has a harness. While it is recommended that rear-facing seats be used as long as possible, it is recognized that children aged 1 and over will wish to face forward. NHTSA recommends that children aged 1-3 (and older if they have not reached a certain height and weight) use a

forward-facing car seat with a harness and tether that limits the child's forward movement during a crash.

[0006] There are many types of car seats available for purchase. Infant seats recommended for children under age 1 are typically rear-facing. Many include a base that is belted or tethered into the car and a seat that can latch into the base. The seat often includes a handle so that the seat may be carried when it is unlatched from the base (i.e., from the car). A popular car seat option for infants as well as children is a "convertible" car seat that may be oriented in a rear-facing position and then "converted" to a front-facing position. Some convertible car seats may even convert into a booster seat for children weighing up to 100 pounds. Typically the convertible car seats are strapped into the car using the car seat-belt, or are anchored to the car frame directly using a LATCH (Lower anchors and Tethers for children) system. All car seats offer a harness for strapping the child into the seat. The usual harness is a five-point safety harness. The car seats tend to be formed from injection molded plastic, typically at least 5mm thick, and the seats (with base in the case of the infant seats) typically weigh 7 kgs or more.

[0007] ISOFIX (ISO standard 13216) is the international standard for attachment points for child safety seats in passenger cars. The system has various other regional names including LATCH ("Lower Anchors and Tethers for Children") in the United States and LUAS ("Lower Universal Anchorage System") or Canfix in Canada. It has also been called the "Universal Child Safety Seat System" or UCSSS.

[0008] ISOFIX relates to the anchoring system for Group 1 child safety seats. It defines standard attachment points to be manufactured into cars, enabling compliant child safety seats to be quickly and safely secured. ISOFIX is an alternative to securing the seat with seat belts. Seats are secured with a single attachment at the top (top tether) and two attachments at the base of each side of the seat. The full set of anchor points for this system were required in new cars in the United States starting in September 2002.

[0009] In the EU the system is known as ISOFIX and covers both Group 0/0+ and Group 1 child safety seats. The mechanism for attaching the seat to the Lower Anchors is quite different from that in the United States. In the EU two "alligator-like" clips connect the seat to the Lower Anchors rather than the open clip style connectors commonly used in the United States. However, some carseat manufactures are beginning to offer true ISOFIX type attachments in the U.S. In the European standard, there are also various installation categories: "universal", "vehicle-specific" and "semi-universal". The main difference is that "Universal" represents use of a top tether strap with the ISOFIX anchorage, "vehicle-specific" represents the usage of the ISOFIX anchorage without the TopTether in specified vehicles only, while

"Semi-Universal" represents usage of the ISOFIX anchorage together with a "foot-prop".

SUMMARY

[0010] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0011] A car seat includes an outer protective shell or frame, an inner seat, a harness, and a suspension system. The protective shell or frame is adapted to be strapped or anchored to the car frame. The inner seat is connected to the protective shell or frame by the suspension system for shock isolation such that the inner seat can move (float) a small amount relative to the protective shell. The harness is not attached to the outer protective shell or frame, but extends through slots in the inner seat and keeps the passenger in the inner seat.

[0012] In one embodiment, the suspension system is a seven-point suspension system. The seven-point suspension system may include seven webs or belts, most or all of which are between .75 and 3 inches long that are used to suspend the inner seat relative to the outer frame. The webs or belts can be made from various materials including, but not limited to, ABS, plastic, fabric webbing such as car seatbelt webbing, and ULTEM® 292a, 292b, or similar material. In one embodiment, respective slots are provided in the outer frame and the shell of the inner seat through which the webs extend, and the respective ends of each web are either sewn on themselves or sewn around a stick or other object so that the end is too thick to pull through the slots.

[0013] In one embodiment, the outer protective shell or frame is a multilayered construction of strong, light material.

[0014] In one embodiment, the inner seat is a protective seat made from a multi-layered construction. In one embodiment the multi-layered construction of the inner seat includes (from outside to inside) a flexible hard outer shell, a cushioning spacer layer, a uniform foam layer, and an optional fabric or leather layer. The cushioning spacer layer does not cover the entire inside of the hard outer shell nor the entire outside of the uniform foam layer. The inner seat construction is arranged to redirect energy transmitted from the outer shell along a circuitous path.

[0015] In one embodiment, the multiple layers of the inner seat have slots through which harness belts extend. In one embodiment a five-point harness has several belts that are attached to each other and wrap around the inner seat.

[0016] In one embodiment, a removable fabric cover may be used to cover the inside of the inner seat and the space between the inner seat and the outer frame.

[0017] In one embodiment, the car seat extends in a major direction along a longitudinal axis and the outer protective shell includes a plurality of anchor boxes that extend at an angle with respect to the longitudinal axis. The angle can be a ninety-degree angle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Fig. 1 is an exploded view of a car seat.

[0019] Fig. 2 is a perspective, partially broken view of the car seat of Fig. 1 without the removable fabric cover and inner seat layers.

[0020] Fig. 3 is a front view of the car seat of Fig. 1.

[0021] Fig. 4 is a cross-sectional view of the car seat of Fig. 1 taken at A-A of Figure 3.

[0022] Fig. 5 is a perspective view of the car seat of Fig. 1.

[0023] Fig. 6 is a perspective, partially cut-away, partially transparent view of another embodiment of a car seat.

[0024] Fig. 7 is a perspective view of another embodiment of a car seat.

[0025] Fig. 8 is a view of the bottom of the car seat shown in Fig. 7.

[0026] Fig. 9 is a perspective view of the side and bottom of the outer shell of the car seat shown in Fig. 7 with a tether connector in one anchor box.

[0027] Fig. 10A is a perspective view of an anchor box and tether connector shown in Fig. 7.

[0028] Fig. 10B is a side elevation view of the anchor box and tether connector shown in Fig. 10A.

[0029] Fig. 10C is a cross-sectional view of the anchor box and tether connector of Fig. 10A taken at C-C of Figure 10B.

[0030] Fig. 10D is an elevation view of the anchor box and tether connector shown in Fig. 10A with a cover of the anchor box removed.

[0031] Fig. 10E is schematic representation of an alternate anchor box construction from that shown in Fig. 10D.

[0032] Fig. 11 is an elevation view of an embodiment of a car seat in a front facing orientation in a vehicle.

[0033] Fig. 12 is an elevation view of an embodiment of a car seat in a front facing orientation in a vehicle.

[0034] Fig. 13 is an elevation view of an embodiment of a car seat in a rear facing orientation in a vehicle.

[0035] Fig. 14 is an elevation view of an embodiment of a car seat in a rear facing orientation in a vehicle.

[0036] Fig. 15 is a top plan view of the car seat shown in Fig. 7.

[0037] Fig. 16 is a perspective view of a strap of the car seat shown in Fig. 15.

[0038] Fig. 17 is an exploded assembly view of the car seat shown in Fig. 7 and an optional compressible material.

DETAILED DESCRIPTION

[0039] One embodiment of a car seat 10 is seen in Figs. 1-5. Car seat 10 includes an outer protective shell 20, an inner seat 30, a suspension system 40 and a harness 50. The protective shell 20 is adapted as described below to be strapped or anchored to a car frame (not shown). The inner seat 30 is connected to the protective shell 20 by the suspension system 40 such that the inner seat can move (float) a small amount relative to the protective shell 20 as described below. Thus, the outer shell 20 provides support for the seat 30 (via the suspension system 40) but is not rigidly attached thereto. The harness 50 extends through and around the inner seat 30 and is not attached to the outer protective shell 20. A handle 60 connected to the shell 20 is optionally provided.

[0040] In one embodiment, the outer protective shell or frame 20 is made from a strong, light material such as carbon fiber or an aramid fiber such as KEVLAR (a trademark of DuPont, Wilmington, Delaware), or any other strong, light material. In one embodiment, the shell 20 is constructed of multiple layers of carbon fiber, aramid fiber or a composite material. In another embodiment, the outer protective shell is formed from two separated layers of carbon fiber, aramid fiber or composite material (as seen, e.g., in Fig. 4) sandwiching a honeycomb, foam, or corrugated material (not shown). In other embodiments, the shell 20 is constructed of one or more of polycarbonate, polypropylene, ABS resin, and fiberglass. One function of the shell 20 is to provide support for the seat 30 via the suspension system 40. Another function of the shell 20 is to provide protection from intrusion by exterior objects.

[0041] In one embodiment the shell 20 provides side and back walls 20a-20c and a front wall 20d that connects the side walls 20a, 20b at the front of the car seat. The back wall 20c provides a high back compared to the front wall 20d, which is low. The side walls are contoured to extend from the back to the front. The front, back and side walls provide an upper edge 21 to which or over which a seat cover may be attached as described hereinafter. All walls may be rounded to eliminate edges so there may be no exact delineation of the front, side, and back walls.

[0042] As seen in Figs. 1-5, the side walls 20a, 20b define fore and aft slots 22a, 22b (two more slots not shown) for receiving a seat belt therethrough, thereby permitting the car seat 10 to be strapped in facing forwards or backwards. If desired a belt (not shown) may be provided having one end attached to the shell 20 and a hook (not shown) located at the other end. The

hook may be used to connect to the frame of the car (not shown) located under the car's seat cushion (not shown). In another embodiment, the shell 20 may be adapted to rigidly connect to a separate base that can be strapped or anchored in place in the car. In another embodiment, the shell 20 may be adapted so that hooks from the car (not shown) can attach to the shell 20.

[0043] Shell 20 also defines a series of slots 24 for receiving the belts 40a-40g of the suspension system 40. In the embodiment shown, eight slots 24a-24h are provided, including two slots each (24a-24d) towards the top of side walls 20a, 20b, a single slot 24e in the bottom of the front wall 20d of the car seat (see Fig. 4), a single slot 24f in the top of the back wall 20c, and a single slot each 24g, 24h toward the bottom of the side walls 20a, 20b. Belts 40a-40g, as described in more detail below, couple the shell 20 to the inner seat 30. It will be appreciated that if it is desired that the belts not be seen from the outside, the slots are built into the inner side of the wall as shown for slot 24e of Fig. 4. Otherwise, the slots may extend through the walls of the shell 20 as seen with respect to slots 24a-24d, 24f-24h. For purposes herein, a "slot" in a wall may be considered a through-slot, or a hook or catch that allows attachment for the belt or attachment device to the shell 20.

[0044] In one embodiment, shell 20 also defines holes or slots (not shown) for receiving a connection mechanism or support 66 for a handle 60.

[0045] In one embodiment, a plurality of optional padding elements 27 are spaced around the inside surface 20e of the shell 20. The padding elements 27 are located such that should the shell 20 be subjected to significant forces and movement relative to the seat 30, the padding elements 27 will contact the seat 30 and largely prevent the inside surface 20e of the shell 20 from contacting the seat 30. In one embodiment, the padding elements 27 are thick enough so that they extend from the inside surface 20e and contact the seat 30 so that should the shell 20 be subjected to significant forces and movement relative to the seat 30, the padding elements 27 will already be in contact with the seat 30 to absorb energy from the moving seat 30. The padding elements 27 may be formed from an elastomeric, cellular foam or any other desirable foam. In another embodiment, the padding elements are comprised of thermoplastic polyurethane (TPU). In another embodiment, the pads 27 are comprised of open-cell polyurethane. In another embodiment, the pads are comprised of closed cell polyolefin foam. In another embodiment, the pads are comprised of polyethylene foam which may be a high density polyethylene foam. In one embodiment the padding elements 27 are formed as a single pad defining multiple cut-outs (i.e., the equivalent of multiple connected pads). Regardless, the single pad with the cut-outs or the multiple pads 27 are arranged in a desired configuration and are affixed to the inner surface 20e of the shell and the outer surface of inner seat 30. Affixation can be done with glue, Velcro or any other affixation means. By

way of example, and not by way of limitation, the innermost cushioning pads may have a density of between 3.4 lbs/ft³ (approximately 0.016 g/cm³) and 25 lbs/ft³ (approximately 0.4 g/cm³), although they may be more dense or less dense.

[0046] The outer dimensions of the shell 20 may vary widely. The shell 20 may be between 40 and 70 cm wide, or even narrower or wider, and between 20 and 60 cm deep, or even shallower or deeper, and between 50 and 80 cm high, or even shorter or taller. In one exemplary embodiment the outer dimensions of the shell is 50 cm wide (plus or minus 5 cm), 28 cm deep (plus or minus 3 cm), and 68 cm high (plus or minus 7 cm).

[0047] The inner seat 30 is scooped in shape with a relatively high back, a deep seat area (for the buttocks), and a slightly rising surface for the thighs and legs. In one embodiment, the inner seat 30 is a protective seat made from a multi-layered construction. In one embodiment the inner seat includes a flexible hard outer shell layer 32, a cushioning spacer layer 34, and uniform foam layer 35, and an attached fabric or leather layer 37. The cushioning spacer layer 34 does not cover the entire inside of the hard outer shell layer 32 nor the entire outside of the uniform foam layer 35. The fabric or leather layer 37 can extend beyond the inner seat 30 and attaches to the edge 21 of the shell 20 but does not inhibit seat 30 from moving relative to the shell 20. In another embodiment the multi-layered construction of the inner seat includes (from outside to inside) a hard outer shell layer 32, a cushioning spacer layer 34, and a uniform foam layer 35. An optional plastic, leather, or fabric layer (not shown) may be provided over the foam layer 35. A separate removable seat cover can be provided that extends over the seat 30 and attaches to the edge 21 of the shell 20. Again, the separate removable seat cover would not inhibit seat 30 from moving relative to the shell 20. The inner seat construction is arranged to redirect energy transmitted from the outer shell along a circuitous path so as to absorb the energy. The inner seat 30 also defines a plurality of (e.g., eight) slots 38a-38h for receiving belts 40a-40g of the suspension system 40, and a series of slots 39a-39e for receiving belts 52 of harness 50.

[0048] In one embodiment, the hard outer shell layer 32 of inner seat 30 is comprised of a polycarbonate shell. In another embodiment, the hard outer shell 32 is comprised of a different hard plastic such a polypropylene. In another embodiment, the hard outer shell 32 is comprised of ABS resin. In another embodiment, the hard outer shell layer 32 is made of carbon fiber or fiberglass.

[0049] In one embodiment, the cushioning spacer layer 34 of inner seat 30 includes multiple spaced pads. In another embodiment, the cushioning spacer layer 34 comprises a single pad defining multiple cut-outs 34a (i.e., the equivalent of multiple connected pads). In one embodiment the cushioning spacer layer 34 is comprised of foam. The foam may be an

elastomeric cellular foam or any other desirable foam. In another embodiment, the cushioning spacer layer is comprised of thermoplastic polyurethane (TPU). In another embodiment, the cushioning spacer layer is comprised of open-cell polyurethane. In another embodiment, the cushioning spacer layer is comprised of closed cell polyolefin foam. In another embodiment, the cushioning spacer layer is comprised of polyethylene foam which may be a high density polyethylene foam. In another embodiment, the cushioning spacer layer 34 has multiple layers formed from different materials. By way of example and not by way of limitation, the cushioning spacer layer may be between 3mm and 26mm thick, although it may be thinner or thicker. As another example, the cushioning spacer layer may be between 6 and 13mm thick. By way of example, and not by way of limitation, the cushioning spacer layer may have a density of between 3.4 lbs/ft³ (approximately 0.016 g/cm³) and 25 lbs/ ft³ (approximately 0.4 g/cm³), although it may be more dense or less dense.

[0050] According to one embodiment, the cushioning spacer layer 34 covers approximately fifty percent of the inner surface area of the hard outer shell 32. In another embodiment, the spacer layer 34 covers between twenty percent and eighty percent of the inner surface area of the hard shell 32. In these embodiments, the spacer layer defines air gaps located between said hard outer shell 32 and said foam layer 35. The spacer layer 34 should cover sufficient area between the hard shell 32 and the foam layer 35 so that upon external impact to the inner seat 30, the shell 32 does not directly come into contact with the foam layer 35. Regardless of the material and arrangement of the cushioning spacer layer 34, in one embodiment the cushioning material is affixed to the hard shell layer 32 and to the foam layer 35. Affixation can be done with glue, Velcro or any other affixation means.

[0051] Cushioning spacer layer 34 is also provided with a series of slots 34b corresponding to slots 39a-39e of the flexible hard outer shell layer 32 for receiving the harness straps.

[0052] In one embodiment the foam layer 35 is a substantially continuous uniform layer interrupted only by slots 35a for the belts of the harness 50. The foam may be an elastomeric, cellular foam or any other desirable foam. In one embodiment, the foam layer 35 is comprised of closed cell polyolefin foam. In another embodiment, the foam layer is comprised of polyethylene foam which may be a high density polyethylene foam. By way of example and not by way of limitation, the foam layer may be between 3mm and 13mm thick, although it may be thinner or thicker. By way of example, and not by way of limitation, the foam layer may have a density of between 3.4 lbs/ft³ (approximately 0.016 g/cm³) and 25 lbs/ ft³ (approximately 0.4 g/cm³), although it may be more dense or less dense.

[0053] All dimensions of the inner seat 30 are generally chosen to be smaller than the dimensions of the shell 20. Thus, inner seat 30 is suspended substantially within the shell 20

and generally protected by the shell 20.

[0054] The suspension system 40 functions to suspend the inner seat 30 relative to the outer shell 20 and to thereby act as a shock absorber/isolator between the shell 20 and the seat 30. In one embodiment, the suspension system 40 is a seven point suspension system with seven webs or belts 40a-40g. Some or all of the webs or belts 40a-40g may be the same length. Thus, by way of example only, belts 40a-40f may each be between approximately 2cm and 5cm in length, while belt 40g may be between 30cm and 50cm in length. Belt 40g is shown as extending through slots 38g and 38h in the buttocks area of the outer seat layer 32 and attaching to sides 20a and 20b of the shell 20 at slots 24g, 24h. Of course, other lengths may be used. If desired, belt 40g may be attached to the back wall 20c of the shell 20. In one embodiment, the belts extend through the slots 24a-24h in the shell 20 and the slots 38a-38h in the inner seat 30 and are doubled over at each end and sewn at each end to prevent removal. In another embodiment, the ends of each belt extend around a stick or other object and are sewn so that the ends are too thick to remove through the slots. The webs or belts may be formed from a thick web of strong material such as polyester or nylon.

[0055] In one embodiment the harness 50 is a five-point harness as is known in the art. The harness 50 includes belt(s) 52 such that a central (crotch) belt or strap extends through slot 39a of seat 30, a lap belt extends through slots 39b, 39c of the seat 30, and shoulder belts extend through slots 39d and 39e of seat. Buckles and latches 54 may be provided with a push button 55 that permits release of the buckles. Guard pads 56a, 56b, 56c may be provided on the crotch and shoulder belts, and a clip 58 coupling the shoulder belts may be provided. The entire harness system 50 may be formed from standard materials and may constitute a standard five-point harness system that acts to keep the passenger in the seat 30. As will be appreciated, the belt(s) of the harness extend through slots in the layers of seat 30 and extend around the front and backside of the seat 30, but are not attached directly to the seat 30. The belt(s) 52 are optionally adjustable in length.

[0056] Optional handle 60 is attached by support mechanisms 66 to respective sides 20a, 20b of the shell 20. Handle 60 may swivel relative to support mechanisms 66 as is known in the art.

[0057] The embodiments of the car seat described with reference Figs. 1-5 provide a highly protective, safe, and strong car seat system. In particular, because of the suspension system, in case the car in which the car seat is anchored is in an accident that causes sudden acceleration and/or deceleration of the car, force that is applied to the shell which is anchored to the car is not transferred to the inner seat and is therefore not applied to the occupant of the seat. More particularly, in the case of an accident, regardless of the direction in which the seat

is facing and regardless of whether the result is a sudden acceleration and/or deceleration, the inner seat will move inside the shell, and the suspension system will absorb some, much, or all of the energy. The inner seat will swing inside the shell to the extent allowed by the belts of the suspension system (it being appreciated that the fabric or leather covering will easily comply). In addition, should the force be significant enough to cause the inner seat and shell to contact each other (at the optional foam pads on the inside of the shell), the construction of the inner seat with its foam spacer layer located between a hard outer layer and an inside foam layer is energy absorbing. Thus, some, most, or all of the energy that is transferred from the shell to the inner seat will be absorbed by the seat itself rather than transferred to the occupant of the seat. Furthermore, should the accident cause dislocation of the interior of the car or should an object hit the shell of the car seat, the shell is of extremely high strength and will remain structurally intact in almost all circumstances. Thus, the occupant of the car seat will not be crushed and will be protected by the foam padding of the seat. Further yet, it should be appreciated that the described car seat system will be light in weight (e.g., under 4 kg; and possibly around 3 kg).

[0058] Figure 6 provides an alternate embodiment of a car seat 110 that is similar to car seat 10 of Figs. 1-5, with similar elements numbered similarly but increased by "100". Car seat 110 includes an outer protective shell 120, an inner seat 130, a suspension system 140 and a harness 150. The protective shell 120 is adapted as described below to be strapped or anchored to a car frame (not shown). The inner seat 130 is connected to the protective shell 120 by the suspension system 140 such that the inner seat can move (float) a small amount relative to the protective shell 120 as described below. Thus, the shell 120 provides support for the seat 130 (via the suspension system 140) but is not rigidly attached thereto. The harness 150 is attached to the inner seat 30 and not to the outer protective shell 120. A handle 160 connected to the shell 120 is optionally provided.

[0059] The outer protective shell 120 can be made from the same material as shell 20 of Figs. 1-5. Shell 120 provides side and back walls 120a-120c and a front wall or slat 120d that connects the side walls 120a, 120b at the front of the car seat. The back wall 120c provides a high back compared to the front wall 120d which is low and short. The side walls are contoured to extend from the back to the front. The front, back and side walls provide an upper edge 121 to which or over which a seat cover may be attached as described hereinafter.

[0060] As seen in Figs. 1-5, the side walls 120a, 120b define fore and aft slots 122a, 122b, 122c (one more slot not shown) for receiving a seat belt therethrough, thereby permitting the car seat 110 to be strapped in facing forwards or backwards. In addition, or alternatively, a belt 162 is provided having one end attached to the shell 120 and a hook 163 located at the

other end. The hook 163 may be used to connect to the frame of the car (not shown) located under the car's seat cushion (not shown). In another embodiment, the shell 120 may be adapted to rigidly connect to a separate base that can be strapped or anchored in place in the car.

[0061] Shell 120 also defines a series of slots 124 for receiving the belts 140 (belts 140a-140f shown; one belt not shown) of the suspension system 140. Seven slots are provided, including two slots each in side walls 120a, 120b, a single slot in the front wall 120d of the car seat, a single slot in the top of the back wall 120c, and a single slot in the bottom of the back wall 120c. Belts 140 couple the shell 120 to the inner seat 130.

[0062] Shell 120 also defines holes, slots, or surfaces for receiving a connection mechanism or support 166 for a handle 160. Also, a plurality of padding elements 127 are spaced around the inside surface 120e of the shell 120. The padding elements 127 are located such that should the shell 120 be subjected to significant forces and movement relative to the seat 130, the padding elements 127 will contact the seat 130 and largely prevent the inside surface 120e of the shell 120 from contacting the seat 130. The padding elements 127 may be formed from the same materials discussed above with reference to padding elements 27 of Figs. 1-5.

[0063] The inner seat 130 is scooped in shape with a relatively high back, a deep seat area (for the buttocks), and a slightly rising surface for the thighs and legs. The inner seat 30 is a protective seat made from a multi-layered construction. The inner seat includes a hard outer shell 132, and an attached fabric or leather layer 139 that incorporates foam pillows 135a therein. The fabric or leather layer 139 extends beyond the inner seat 130 and attaches to the edge 121 of the shell 120 but does not inhibit seat 130 from moving relative to the shell 120. The inner seat 130 also defines a plurality of (e.g., seven) slots 138 for receiving belts of the suspension system 140, and a series of slots 139 for receiving belt(s) 152 of the harness system 150. The hard outer shell 132 of inner seat 130 may be formed from the same materials discussed above with reference to shell 32 of Figs. 1-5.

[0064] The suspension system 140 functions to suspend the inner seat 130 relative to the outer shell 120 and to thereby act as a shock absorber/isolator between the shell 120 and the seat 130. The suspension system 140 is a seven-point suspension system with seven webs or belts (six shown 140a-140f). The belts may be configured and formed in a manner such as belts 40a-40g of Figs. 1-5.

[0065] The harness 150 is a five-point harness system with belt(s) 152 that include a central (crotch) belt attached through slot 139a of seat 130 and shoulder belts and lap belts attached through similar slots of the seat. The entire harness system 150 may be formed from

standard materials. As will be appreciated, the belt(s) of the harness extend through slots in the layers of seat 130 and extend around the front and backside of the seat 130, but are not attached directly to the seat 130. The belt(s) 152 are optionally adjustable in length.

[0066] Optional handle 160 is attached by support mechanisms 166 to respective sides 120a, 120b of the shell 120. Handle 160 may swivel relative to support mechanisms 166 as is known in the art.

[0067] The embodiments described with reference to Fig. 6 provides a highly protective, safe, and strong car seat system similar to that of the embodiments described with reference to Figs. 1-5, although it is noted that the inner seat of Fig. 6 itself is not as energy absorbent as the inner seats described with reference to Figs. 1-5.

[0068] Figure 7 shows an alternate embodiment of a car seat 210 that is similar to car seat 10 of Figs. 1-5, with similar elements numbered similarly but increased by “200”. Car seat 210 includes an outer protective shell 220, an inner seat 230, a suspension system 240 (Fig. 15). The protective shell 220 is adapted as described below to be strapped or anchored to a car frame (not shown). The inner seat 230 is connected to the protective shell 220 by the suspension system 240 such that the inner seat can move (float) a small amount relative to the protective shell 220 as described below. Thus, the shell 220 provides support for the seat 230 (via the suspension system 240) but is not rigidly attached thereto. The harness 250 is attached to the inner seat 230 and not to the outer protective shell 220. A handle (not shown), like handle 60 shown in Fig. 1, connected to the shell 220, is optionally provided.

[0069] The outer protective shell 220 can be made from the same material as shell 20 of Figs. 1-5. Shell 220 provides side and back walls 220a-220c and a front wall or slat 220d that connects the side walls 220a, 220b at the front of the car seat. The back wall 220c provides a high back compared to the front wall 220d, which is low and short. The side walls are contoured to extend from the back to the front. The front, back and side walls provide an upper edge 221 to which or over which a seat cover may be attached as described hereinafter.

[0070] As shown in Figs. 7 and 8, side wall 220a defines fore and aft anchor boxes 222a and 222b for receiving corresponding tether connectors 223a and 223b, while side wall 220b defines fore and aft anchor boxes 222c and 222d for receiving corresponding tether connectors 223c and 223d, thereby permitting the car seat 210 to be connected to the vehicle in either a forward-facing or a rear-facing orientation. The tether connectors 223a-223d can be LATCH or ISOFIX connectors, which are well known. The anchor boxes 222a-222d are generally located proximate to the “corners” of the outer shell 220 as shown in Figs. 7 and 8. Though not shown in Fig. 8, optional anchor boxes can be located in the front wall 220d and/or the back wall 220c.

[0071] As shown in Fig. 8, anchor boxes 222a-222d receive respective tether connectors 223a-223d (e.g., LATCH or ISOFIX connectors) in a direction that is at an angle with respect to a longitudinal axis 225 of the car seat 210. Specifically, in the embodiment shown in Fig. 8, the tether connectors 223a-223d extend substantially perpendicular to the longitudinal axis 225.

[0072] In one embodiment anchor boxes 222a-222d are constructed exactly the same and, therefore, to simplify the following discussion only a description of anchor box 222a will be given as representative of the other anchor boxes 222b-222d. Likewise, in one embodiment the tether connectors 223a-223d are constructed exactly the same and, therefore, to simplify the following discussion only a description of tether connector 223a will be given as representative of the other tether connectors 223b-223d.

[0073] The construction of anchor box 222a is best understood with reference to Figs. 9 and 10A-10D. The anchor box 222a includes a housing 280 (Figs. 9, 10A, 10C), a sleeve 282 (Fig. 10C) coupled to the housing 280 with a pin 284 (Figs. 10C, 10D), and inserts 286 (Figs. 10C and 10D) interposed between the housing 280 and the sleeve 282. The housing 280 includes a base 280a and a cover 280b which attach together, although the cover 280b (as well as the sleeve 282, pin 284, and inserts 286) of anchor box 222a is shown removed in Fig. 9 for illustrative purposes. The base 280a has an outer flange 280c (Figs. 10C and 10D) that surrounds a cutout formed along the bottom edge of side 220a. The base 280a has an inner portion 280d (Figs. 10C and 10D) that extends inward from the outer flange 280c at an angle with respect to axis 225, and in one embodiment in a direction generally perpendicular to axis 225. The inner portion 280d defines a channel 280e (Figs. 10C and 10D) rectangular in cross-section, in which the sleeve 282, the pin 284, and inserts 286 are disposed. In one embodiment the channel 280e has a square cross section having dimensions of about 2 inches by 2 inches. The base 280a may be integrally formed with wall 220a of the outer shell 220 or may be a separate piece that is attached to the wall 220a.

[0074] As shown in Fig. 10D, the sleeve 282 is pinned to the inner portion 280d by pin 284 and is spaced from the surface of the channel 280e by inserts 286 (286a-286c). Pin 284 extends through sleeve 282 and through sides of inner portion 280d in a direction parallel to the axis 225. The sleeve 282 is constructed to receive tether connector 223a. The portion of pin 284 inside the sleeve 282 is constructed to permit a latch mechanism of tether connector 223a to attach to the pin 284 when the tether connector 223a is fully inserted into the housing 280. Preferably, the tether connector 223a is removably attachable to the pin 284. Such removably attachable tether connectors 223 are well known and include LATCH and ISOFIX connectors.

[0075] The inserts 286 shown in the embodiment of Figs. 10C and 10D are generally ring-like, having an inner surface that surrounds and contacts the outer surface of sleeve 282 and having an outer surface that contacts the wall of channel 280e. In the embodiment shown in Figs. 10C and 10D the inner and outer surfaces of the inserts 286 define a square profile corresponding to the square profiles of the sleeve 282 and the channel 280e. It is to be understood, however, that the inserts 286 may have other profiles to conform to the geometries of the sleeve 282 and channel 280e. For example, in one alternate embodiment shown in Fig. 10E, an anchor box 322a in wall 220a includes a housing 380 having an outer cover 380b connected to an inner portion 380a. The inner portion 380a defines a channel 380e which is tapered inwardly from the side of the outer shell 220 (not shown) and is trapezoidal in cross-section. Each insert 386a-386c in Fig. 10E has an outer surface that is tapered to conform to the tapered profile of channel 380e. Thus, it is to be understood that all of the inserts 386a-386c may have different profiles and dimensions based on their relative position along sleeve 382 within the anchor box 322a. Moreover, instead of a plurality of separate, spaced-apart inserts 386a-386c, a unitary elongated insert (not shown) may be employed which occupies some or all of the space between sleeve 282 (382) and channel 280e (380e). For example, such the unitary elongated insert may take the form of a sleeve or jacket in which sleeve 282 (382) is received and which has openings for pin 284 (384). In one embodiment, the inserts 286 (386) are formed of a compressible material, such as a foam. More specifically, in one embodiment inserts 286 (386) are formed of a foam having a density between 580 pounds per square inch and 2,900 pounds per square inch, manufactured by Sorbothane Inc. of Kent, Ohio.

[0076] Although the sleeve 282 (382) is coupled to the housing 280 (380) by pin 284 (384), the sleeve 282 (382) has some freedom of motion relative to the housing 280 (380). The sleeve 282 (382) can rotate and translate longitudinally about an axis along pin 284 (384). In addition, the sleeve 282 (382) can rotate about an axis 287 (Fig. 10D) (387, Fig. 10E) through and perpendicular to the axis along pin 284 (384). Such motion about axis 287 (387) can be accomplished by forming through holes in sleeve 282 (382) (through which pin 284 (384) extends) slightly larger than the outer diameter of pin 284 (384).

[0077] The relative movement of sleeve 282 (382) with respect to housing 280 (380) is limited by the inserts 286a-286c (386a-386c), which are constructed to compress or expand in response to the relative movement between the sleeve 282 (382) and the housing 280 (380). The relative movement between the sleeve 282 (382) and the housing 280 (380) occurs as a result of force and torque transmitted by the tether connector 223a to the sleeve 282 (382) during impact of the vehicle, as discussed more fully below.

[0078] As shown in Figs. 11 and 12, where the car seat 210 is placed in a forward-facing

orientation in the vehicle, tether connectors 223c and 223d are connected, respectively to tether straps 249c and 249d, which also have second tether connectors 251c and 251d at opposite ends of the tether straps 249c and 249d for attachment to anchor points 255c and 255d of the vehicle. In one embodiment, the tether straps 249c and 249d are adjustable to facilitate vehicle installation. Preferably, tether connectors 251c and 251d are LATCH or ISOFIX connectors and anchor points 255c and 255d are LATCH or ISOFIX anchor points. In particular, anchor box 222c connects to a corresponding anchor point 255c of the vehicle located in front of the vehicle seat, and anchor boxes 222d connects to a corresponding anchor point 255d of the vehicle at the rear of the vehicle seat, such as at an intersecting location between the seat back and the seat bottom. While not shown in Figs. 11 and 12, the connections of anchor boxes 222a and 222b to the vehicle would be mirror images to that shown in Figs. 11 and 12. In addition, in the embodiment shown in Fig. 11, an upper tether strap 249e is connected between an upper anchor point 255e of the vehicle and the back side 220c of the outer shell 220.

[0079] As shown in Figs. 13 and 14, where the car seat 210 is placed in a rear-facing orientation in the vehicle, tether connectors 223a and 223b are connected, respectively to tether straps 249a and 249b, which also, preferably, have second tether connectors 251a and 251b at opposite ends of the tether straps 249a and 249b for attachment to anchor points 255d and 255c of the vehicle. In one embodiment, the tether straps 249a and 249b are adjustable to facilitate vehicle installation. Preferably, tether connectors 251a and 251b are LATCH or ISOFIX connectors and anchor points 255d and 255c are LATCH or ISOFIX anchor points. In particular, anchor box 222b connects to a corresponding anchor point 255c of the vehicle located in front of the vehicle seat, and anchor box 222a connects to a corresponding anchor point 255d of the vehicle at the rear of the vehicle seat, such as at an intersecting location between the seat back and the seat bottom. While not shown in Figs. 13 and 14, the connections of anchor boxes 222c and 222d to the vehicle would be mirror images to that shown in Figs. 13 and 14. In addition, in the embodiment shown in Fig. 13, the upper tether strap 249e is connected between the upper anchor point 255e of the vehicle and the front side 220d of the outer shell 220.

[0080] When the anchor boxes 222a-222d are connected to the vehicle, as described above in connection with Figs. 11 to 14, the aforementioned tether straps (e.g., 249a-249d) will extend generally parallel to the longitudinal axis 225 of the car seat 210. Therefore, for example, any load applied to anchor box 222a via tether connector 223a and strap 249a (Fig. 13) during impact is not applied in a direction along the longitudinal axis 225. Instead, owing to tether connector 223a (Fig. 13) extending at an angle relative to the longitudinal axis 225, the tether connector 223a creates a moment arm at which the load from impact will act to

advantageously transmit a torque to anchor box 222a, as discussed more thoroughly below.

[0081] Anchor box 222a is intentionally structurally inefficient so that it can absorb the force and torque from the tether connector 223a during impact of the vehicle. Referring back to Figs. 10D and 10E, the inserts 286a-286c (386a-386c) are constructed to absorb at least some of the energy transmitted through the tether straps to the car seat 210 during impact. Specifically, when the tether strap 249a extends parallel to the longitudinal axis 225 of the seat 210, as shown in Figs. 13 and 14, and the force in the tether strap 249a is applied through the tether connector 223a, the tether connector 223a in the sleeve 282 (382) will exert a moment on sleeve 282 (382) about axis 287 (387). The moment applied to sleeve 282 (382) will tend to rotate the sleeve 282 (382) about the axis 287 (387), which will tend to compress the inserts 286a-286c (386a-386c) against the channel 280e (380e), thereby absorbing some of the energy from the impact. Moreover, in the alternate embodiment shown in Fig. 10E, the width of insert 386a is greater than insert 386b, which has a width greater than insert 386c. In comparison to the arrangement of sleeve 282 about axis 287 shown in Fig. 10D, the arrangement shown in Fig. 10E allows more rotation of sleeve 382 about axis 387 and therefore absorbs more energy for the same amount of insert material. In addition, to further absorb energy from the impact, the moment exerted on the sleeve 282 (382) will also be partially transmitted through the pin 284 (384) and the base 280a (380a) of the housing 280 (380) to the side 220a of the outer shell 220. Owing to the energy absorbed by inserts 286a-286c (386a-386c), the force exerted on the base 280a (380a) can be reduced. Consequently, the force exerted on side 220a and the deflection of the housing 280 (380) with respect to the side 220a can be reduced. Thus, the construction and orientation of anchor box 222a (323a) reduces the amount of energy transmitted to the outer shell 220 and, therefore, to the occupant of the car seat 210.

[0082] As shown in Fig. 15, shell 220 also defines a series of eight slots 224a-224h for receiving seven belts 240a-240g of the suspension system 240. Seven slots are provided, including three slots each in side walls 220a, 220b, a single slot in the front wall 220d of the car seat, and a single slot in the top of the back wall 220c. Belts 240a-240g couple the outer shell 220 to the inner seat 230.

[0083] The inner seat 230 is scooped in shape with a relatively high back, a deep seat area (for the buttocks), and a slightly rising surface for the thighs and legs. The inner seat 230 is a protective seat made from a multi-layered construction which is identical to seat 30, described above. The inner seat 230 also defines a plurality of (e.g., eight) slots 238a-238f (Fig. 15), 238g (Fig. 8), and 238h (Fig. 8) for receiving the belts 240a-240f (Fig. 15) and 240g (Fig. 8) of the suspension system 240, and a series of slots 239 for receiving belt(s) 252 of the harness system 250. The hard outer shell 232 of inner seat 230 may be formed from the same

materials discussed above with reference to shell 32 of Figs. 1-5.

[0084] The suspension system 240 functions to suspend the inner seat 230 relative to the outer shell 220 and to thereby act as a shock isolator between the shell 220 and the seat 230. The suspension system 240 is a seven-point suspension system with seven webs or belts (six shown 240a-240f in Fig. 15 and one shown 240g in Fig. 8). The belts 240a-240g may be configured and formed as described below.

[0085] In the embodiment shown in Figs. 8 and 15, all of the belts 240a-240g share the same construction. Accordingly, to simplify the discussion, a description of belt 240a is provided below as representative of the construction and function of all of the belts 240a-240g.

[0086] As shown in Fig. 16, belt 240a includes a generally flat web or strap 290. The strap includes ends 292a and 292b. Ends 292a and 292b are tapered outwardly so that they have a thinner profile at their outer sides than at their inner sides. Ends 292a and 292b can be formed from various materials including, but not limited to, ABS, plastic, webbing such as car seatbelt webbing, and ULTEM® 292a, 292b, or similar material. Belt 240a also includes two washers 294a and 294b located between the ends 292a and 292b. The ends 292a and 292b are relatively thicker than the washers 294a and 294b and the strap 290. The ends 292a and 292b retain the washers 294a and 294b on the strap 290. End 292a is constructed to be received through slot 224a in outer shell 220 while end 292b is constructed to be received through slot 238a in inner seat 230.

[0087] Washers 294a and 294b are formed of a compressible material, such as a foam manufactured by Sorbothane Inc. of Kent, Ohio. Washer 294a has an outer flange 296a, an inner flange 298a, and a web 300a connecting between the outer flange 296a and the inner flange 298a. A groove 302a is defined between the outer flange 296a, the inner flange 298a, and the web 300a. Groove 302a is formed around the periphery of the washer 294a. The washer 294a is constructed to be received in opening 224a of shell 220. The groove 302a is constructed so that the edge that defines opening 224a is seated in the groove 302a so that the shell 220 is sandwiched between the outer flange 296a and the inner flange 298a of the washer 294a. With the washer 294a so seated in the shell 220, relative movement of the washer 294a, such as due to movement of the strap 290 during impact of the vehicle, can cause compression and/or tension on the flanges 296a and 298a and the web 300a to absorb some of the energy imparted to the strap 290. For example, during an impact of the vehicle to which the car seat 210 is attached, tension in strap 290 can cause end 292a to contact and apply pressure to outer flange 296a of washer 294a, which will compress the outer flange 296a against the outer side of shell 220, thereby absorbing some of the energy of the impact.

[0088] Washer 294b has an outer flange 296b, an inner flange 298b, and a web 300b

connecting between the inner and outer flanges. A groove 302b is defined between the outer flange 296b, the inner flange 298b, and the web 300b. Groove 302b is formed around the periphery of the washer 294b. The washer 294b is constructed to be received in opening 238a of inner seat 230. The groove 302b is constructed so that the edge that defines opening 238a is seated in the groove 302b so that the inner seat 230 is sandwiched between the outer flange 296b and the inner flange 298b of the washer 294b. With the washer 294b so seated in inner seat 230, relative movement of the washer 294b, such as due to movement of the strap 290 during impact of the vehicle, can cause compression and/or tension on the flanges 296b and 298b and the web 300b to absorb some of the energy imparted to the strap 290. For example, during an impact of the vehicle to which the car seat 210 is attached, tension in strap 290 can cause end 292b to contact and apply pressure to outer flange 296b of washer 294b, which will compress the outer flange 296b against the side of inner seat 230, thereby absorbing some of the energy of the impact.

[0089] The harness 250 is the same as harness 50, described above and, therefore, a description of harness 250 is omitted for sake of brevity.

[0090] Fig. 17 shows an exploded assembly view of the car seat 210 with optional compressible material 308, such as foam, constructed for attachment to the bottom side of outer shell 220. The compressible material 308 is attached to the bottom edge 310 of the outer shell 220 and acts to provide additional shock absorbency between the outer shell 220 and the vehicle seat (not shown). In one embodiment, the foam is about 1 inch thick when uncompressed. The foam can be made from various materials including, but not limited to Poron XRD foam (manufactured by Rogers Corporation of Rogers, Connecticut) or similar materials.

[0091] Thus, it will be appreciated that the various embodiments of car seats described above employ layered shock absorbing/isolating arrangements, which together, act as a shock absorber/isolation system that can reduce the forces exerted on an occupant of the car seat during a vehicle collision. The outer shell is of extremely high strength and will remain structurally intact in almost all circumstances thereby further protecting the occupant of the car seat.

[0092] There have been described and illustrated herein several embodiments of a car seat. While particular embodiments have been described, it is not intended that the claims be limited thereto, as it is intended that the claims be as broad in scope as the art will allow and that the specification be read likewise. Thus, while particular materials for shell have been disclosed, it will be appreciated that other materials may be used as well provided they supply sufficient strength for the suspension system and structural integrity for the system. Similarly, while

particular types of materials have been disclosed for the inner seat layers, it will be understood that other materials can be used. Further, while the suspension system has been described as being comprised of belts or webs, it will be appreciated that other or additional suspension elements may be utilized. It will therefore be appreciated by those skilled in the art that yet other modifications could be made without deviating from the spirit and scope of the claims.

WHAT IS CLAIMED IS:

1. A car seat for an occupant, comprising: an outer protective shell; an inner seat; a suspension system coupling and permitting relative movement between said inner seat and said outer protective shell, said suspension system suspending said inner seat substantially within said outer protective shell; and a harness adapted to hold the occupant in the inner seat and not attached to the outer protective shell.
2. A car seat according to claim 1, further comprising: a handle connected to said outer protective shell, wherein said outer protective shell has two side walls, a back wall and a front wall and said handle is connected to said two side walls.
3. A car seat according to either claim 1 or claim 2, wherein: said outer protective shell comprises at least one of polycarbonate, polypropylene, ABS resin, fiberglass, carbon fibers, and aramid fibers.
4. A car seat according to claim 3, wherein: said outer protective shell has a plurality of layers, at least two of said plurality of layers comprised of said at least one of polycarbonate, polypropylene, ABS resin, fiberglass, carbon fibers and aramid fibers.
5. A car seat according to any previous claim, wherein: said outer protective shell defines a plurality of slots for receiving a seat belt in at least two different locations.
6. A car seat according to any previous claim, further comprising: an anchor connected to said outer protective shell, said anchor including a web.
7. A car seat according to any previous claim, further comprising: a plurality of padding elements wherein, said outer protective shell has an inner surface and said plurality of padding elements are located on said inner surface of said outer protective shell.
8. A car seat according to claim 7, wherein the plurality of padding elements extend from the inner surface of the outer protective shell to the inner seat and at least one of the padding elements always contacts the inner seat.

9. A car seat according to any previous claim, wherein: said suspension system comprises a plurality of webs.
10. A car seat according to claim 9, wherein: said outer protective shell has two side walls, a back wall and a front wall, and said plurality of webs includes two webs extending from a first of said two side walls to said seat, two webs extending from a second of said two side walls to said seat, one web extending from said front wall to said seat, and two webs extending from said back wall to said seat.
11. A car seat according to claim 10, wherein: said two webs extending from each of said two side walls are between 2mm and 5mm in length.
12. A car seat according to any previous claim, wherein: said inner seat is scooped in shape and has a relatively high back, a deep seat area extending from said back, and a slightly rising forward surface extending from said deep seat area, and said harness includes at least one belt including a central belt portion extending from said slightly rising forward surface, and two shoulder belt portions each extending from said relatively high back.
13. A car seat according to any previous claim, wherein: said inner seat comprises a plurality of layers including a hard outer layer with an inner surface, a substantially uniform inner foam layer with an outer surface facing said inner surface of said hard layer, and a cushioning spacer layer between said inner surface of said hard outer layer and said outer surface of said cushioning spacer layer, wherein said cushioning spacer layer covers substantially less than the entire of said inner surface of said hard outer layer and substantially less than the entire of said outer surface of said inner foam layer and defines a plurality of air gaps between hard outer layer and said inner foam layer.
14. A car seat according to claim 13, wherein: said plurality of layers of said inner seat comprises a cover layer extending over said inner foam layer and attached to said protective shell.
15. A car seat according to any previous claim, further comprising: a seat cover extending over said inner seat and at least a portion of a rim of said outer protective shell.

16. A car seat according to any previous claim, wherein: said shell is between 40 and 70 cm wide, 20 and 60 cm deep, and 50 and 80 cm high.

17. A car seat according to any previous claim, further comprising: a handle connected to side walls of said outer protective shell.

18. A car seat according to any previous claim, wherein: said car seat weighs less than 4 kg.

19. A car seat according to any previous claim, wherein the car seat extends in a major direction along a longitudinal axis and wherein the outer protective shell includes a plurality of anchor boxes that extend at an angle with respect to the longitudinal axis.

20. A car seat according to claim 19, wherein the anchor boxes extend perpendicular to the longitudinal axis.

21. A car seat according to claim 20, wherein the anchor boxes are constructed to receive and attach to at least one of a LATCH connector and an ISOFIX connector.

22. A car seat according to claim 9, wherein each web includes a first washer seated in the inner seat and second washer seated in the outer protective shell.

23. A car seat according to claim 23, wherein each of the first and second washers each is comprised of an inner flange, an outer flange, and a web between the inner and outer flanges forming a groove surrounding the periphery of the washer, the inner seat being seated in the groove formed in the first washer and the outer protective shell being seated in the groove formed in the second washer.

24. A car seat according to claim 23, wherein the first and second washer are formed of a compressible material.

25. A car seat according to claim 24, wherein the compressible material includes foam.

26. A car seat for an occupant, comprising: an outer protective shell having a major dimension extending along a longitudinal axis; a plurality of anchor boxes connected to said protective shell, extending at an angle with respect to said longitudinal axis and adapted to receive a tether connector; and an inner seat coupled to the outer protective shell.
27. A car seat according to claim 26, further comprising a harness coupled to said inner seat adapted to hold the occupant in said inner seat.
28. A car seat according to either of claims 26 or 27, wherein said anchor boxes extend perpendicular to the longitudinal axis.
29. A car seat according to any of claims 26-28, wherein said anchor boxes are constructed to receive and attach to at least one of a LATCH connector and an ISOFIX connector.
30. A car seat according to any of claims 26-29, wherein said anchor boxes include a housing, a sleeve coupled to said housing, and at least one insert interposed between the sleeve and the housing.
31. A car seat according to claim 30, wherein: said at least one insert has a first cross-sectional area at a first location relative to said longitudinal axis and a second cross-sectional area different than said first cross-sectional area at a second location removed from said first location relative to said longitudinal axis.
32. A car seat according to claim 31, wherein the at least one insert is formed of a compressible material.
33. A car seat according to claim 32, wherein the compressible material includes foam.
34. A car seat according to any of claims 26-33, further comprising: a suspension system coupled to said inner seat and to said outer protective shell, said suspension system suspending the inner seat substantially within the outer protective shell and permitting relative movement therebetween and shock-isolating said inner seat from said outer protective shell.

35. A car seat system for removably coupling a car seat to a vehicle having at least one car seat anchor, the system comprising: a car seat having at least one anchor; and a tether strap having a first connector at a first end of said tether strap and having a second connector at a second end of said tether strap, wherein said first connector is removably attached to the at least one car seat anchor of the vehicle and said second connector is removably attached to the at least one anchor of the car seat.

36. A car seat system according to claim 35, wherein: said car seat includes an inner seat, a shock isolation apparatus coupling the inner seat and said outer protective shell and permitting relative movement therebetween, and a harness adapted to hold the occupant in the inner seat and not attached to the outer protective shell.

37. A car seat shock isolation system for a car seat having a wall and connected to a vehicle, the system including: a shock absorbing washer seated in the wall of the car seat and a strap extending through said washer and coupled to the car seat, said strap having an end portion adjacent to said washer that is constructed to apply pressure to said washer in response to movement of said strap.

38. A car seat shock isolation system according to claim 37, wherein: said washer has an inner flange disposed on an inner side of the wall of the car seat, an outer flange disposed on an outer side of the wall of the car seat, and a web extending between the inner flange and the outer flange, wherein the end portion of the strap is adjacent to the outer flange.

39. A car seat shock isolation system according to claim 38, wherein: said washer is formed of foam.

AMENDED CLAIMS

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1. A car seat for an occupant, comprising: an outer protective shell; an inner seat; a suspension system coupling and permitting relative movement between said inner seat and said outer protective shell, said suspension system suspending said inner seat substantially within said outer protective shell; and a harness adapted to hold the occupant in the inner seat and not attached to the outer protective shell, wherein said suspension system comprises a plurality of webs.
2. A car seat according to claim 1, further comprising: a handle connected to said outer protective shell, wherein said outer protective shell has two side walls, a back wall and a front wall and said handle is connected to said two side walls.
3. A car seat according to either claim 1 or claim 2, wherein: said outer protective shell comprises at least one of polycarbonate, polypropylene, ABS resin, fiberglass, carbon fibers, and aramid fibers.
4. A car seat according to claim 3, wherein: said outer protective shell has a plurality of layers, at least two of said plurality of layers comprised of said at least one of polycarbonate, polypropylene, ABS resin, fiberglass, carbon fibers and aramid fibers.
5. A car seat according to any previous claim, wherein: said outer protective shell defines a plurality of slots for receiving a seat belt in at least two different locations.
6. A car seat according to any previous claim, further comprising: an anchor connected to said outer protective shell, said anchor including a web.
7. A car seat according to any previous claim, further comprising: a plurality of padding elements wherein, said outer protective shell has an inner surface and said plurality of padding elements are located on said inner surface of said outer protective shell.
8. A car seat according to claim 7, wherein the plurality of padding elements extend from the inner surface of the outer protective shell to the inner seat and at least one of the padding elements always contacts the inner seat.

9. A car seat according to any previous claim, wherein said webs are flexible.
10. A car seat according to claim 9, wherein: said outer protective shell has two side walls, a back wall and a front wall, and said plurality of webs includes two webs extending from a first of said two side walls to said seat, two webs extending from a second of said two side walls to said seat, one web extending from said front wall to said seat, and two webs extending from said back wall to said seat.
11. A car seat according to claim 10, wherein: said two webs extending from each of said two side walls are between 2mm and 5mm in length.
12. A car seat according to any previous claim, wherein: said inner seat is scooped in shape and has a relatively high back, a deep seat area extending from said back, and a slightly rising forward surface extending from said deep seat area, and said harness includes at least one belt including a central belt portion extending from said slightly rising forward surface, and two shoulder belt portions each extending from said relatively high back.
13. A car seat according to any previous claim, wherein: said inner seat comprises a plurality of layers including a hard outer layer with an inner surface, a substantially uniform inner foam layer with an outer surface facing said inner surface of said hard layer, and a cushioning spacer layer between said inner surface of said hard outer layer and said outer surface of said cushioning spacer layer, wherein said cushioning spacer layer covers substantially less than the entire of said inner surface of said hard outer layer and substantially less than the entire of said outer surface of said inner foam layer and defines a plurality of air gaps between hard outer layer and said inner foam layer.
14. A car seat according to claim 13, wherein: said plurality of layers of said inner seat comprises a cover layer extending over said inner foam layer and attached to said protective shell.
15. A car seat according to any previous claim, further comprising: a seat cover extending over said inner seat and at least a portion of a rim of said outer protective shell.

16. A car seat according to any previous claim, wherein: said shell is between 40 and 70 cm wide, 20 and 60 cm deep, and 50 and 80 cm high.

17. A car seat according to any previous claim, further comprising: a handle connected to side walls of said outer protective shell.

18. A car seat according to any previous claim, wherein: said car seat weighs less than 4 kg.

19. A car seat according to any previous claim, wherein the car seat extends in a major direction along a longitudinal axis and wherein the outer protective shell includes a plurality of anchor boxes that extend at an angle with respect to the longitudinal axis.

20. A car seat according to claim 19, wherein the anchor boxes extend perpendicular to the longitudinal axis.

21. A car seat according to claim 20, wherein the anchor boxes are constructed to receive and attach to at least one of a LATCH connector and an ISOFIX connector.

22. A car seat according to claim 9, wherein each web includes a first washer seated in the inner seat and second washer seated in the outer protective shell.

23. A car seat according to claim 23, wherein each of the first and second washers each is comprised of an inner flange, an outer flange, and a web between the inner and outer flanges forming a groove surrounding the periphery of the washer, the inner seat being seated in the groove formed in the first washer and the outer protective shell being seated in the groove formed in the second washer.

24. A car seat according to claim 23, wherein the first and second washer are formed of a compressible material.

25. A car seat according to claim 24, wherein the compressible material includes foam.

26. A car seat for an occupant, comprising: an outer protective shell having a major dimension extending along a longitudinal axis; a plurality of anchor boxes defined in a wall of said outer protective shell, said anchor boxes extending at an angle with respect to said longitudinal axis and adapted to receive a tether connector; and an inner seat coupled to the outer protective shell.

27. A car seat according to claim 26, further comprising a harness coupled to said inner seat adapted to hold the occupant in said inner seat.

28. A car seat according to either of claims 26 or 27, wherein said anchor boxes extend perpendicular to the longitudinal axis.

29. A car seat according to any of claims 26-28, wherein said anchor boxes are constructed to receive and attach to at least one of a LATCH connector and an ISOFIX connector.

30. A car seat according to any of claims 26-29, wherein said anchor boxes include a housing, a sleeve coupled to said housing, and at least one insert interposed between the sleeve and the housing.

31. A car seat according to claim 30, wherein: said at least one insert has a first cross-sectional area at a first location relative to said longitudinal axis and a second cross-sectional area different than said first cross-sectional area at a second location removed from said first location relative to said longitudinal axis.

32. A car seat according to claim 31, wherein the at least one insert is formed of a compressible material.

33. A car seat according to claim 32, wherein the compressible material includes foam.

34. A car seat according to any of claims 26-33, further comprising: a suspension system coupled to said inner seat and to said outer protective shell, said suspension system suspending the inner seat substantially within the outer protective shell and permitting relative movement therebetween and shock-isolating said inner seat from said outer protective shell.

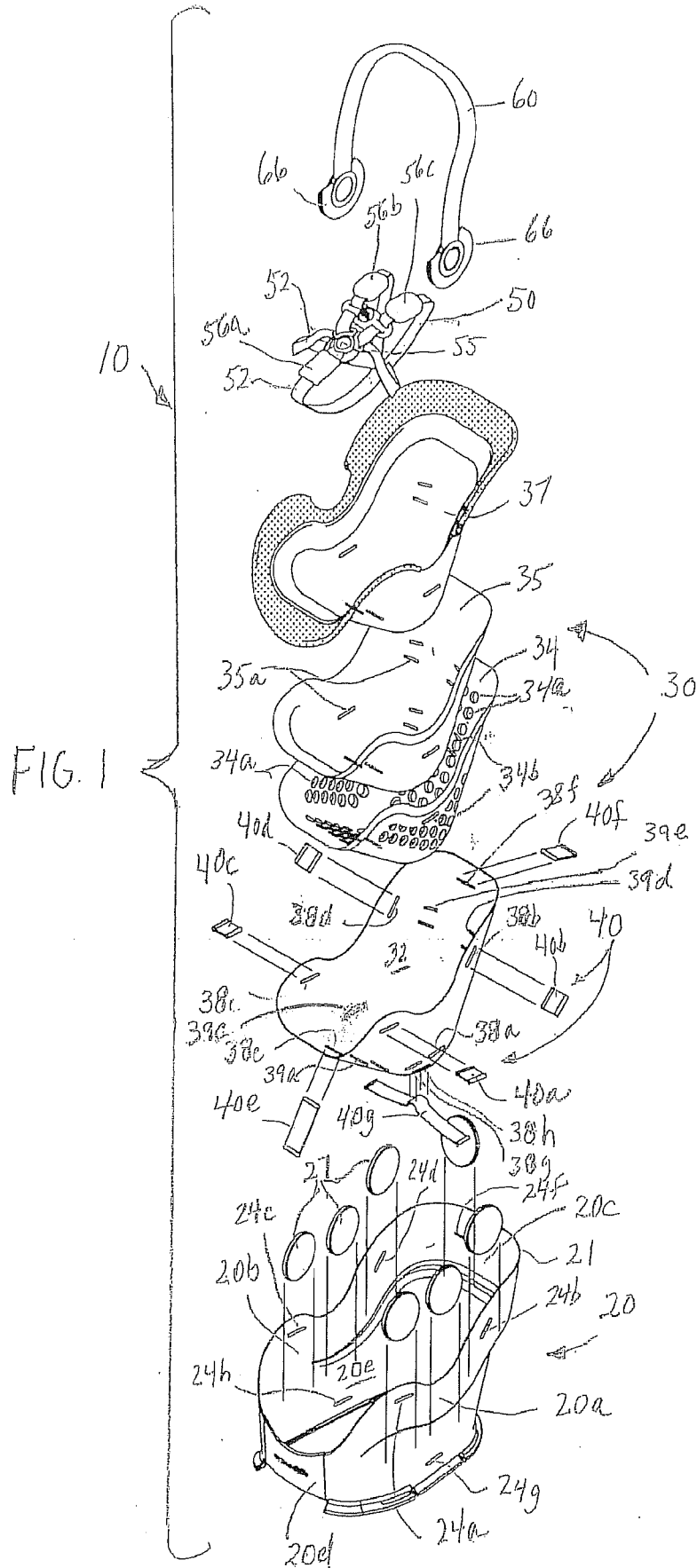
35. A car seat system for removably coupling a car seat to a vehicle having at least one car seat anchor, the system comprising: a car seat having at least one anchor; and a tether strap having a first connector at a first end of said tether strap and having a second connector at a second end of said tether strap, wherein said first connector is removably attached to the at least one car seat anchor of the vehicle and said second connector is removably attached to the at least one anchor of the car seat.

36. A car seat system according to claim 35, wherein: said car seat includes an inner seat, a shock isolation apparatus coupling the inner seat and said outer protective shell and permitting relative movement therebetween, and a harness adapted to hold the occupant in the inner seat and not attached to the outer protective shell.

37. A car seat shock isolation system for a car seat having a wall and connected to a vehicle, the system including: a shock absorbing washer seated in the wall of the car seat and a strap extending through said washer and coupled to the car seat, said strap having an end portion adjacent to said washer that is constructed to apply pressure to said washer in response to movement of said strap.

38. A car seat shock isolation system according to claim 37, wherein: said washer has an inner flange disposed on an inner side of the wall of the car seat, an outer flange disposed on an outer side of the wall of the car seat, and a web extending between the inner flange and the outer flange, wherein the end portion of the strap is adjacent to the outer flange.

39. A car seat shock isolation system according to claim 38, wherein: said washer is formed of foam.



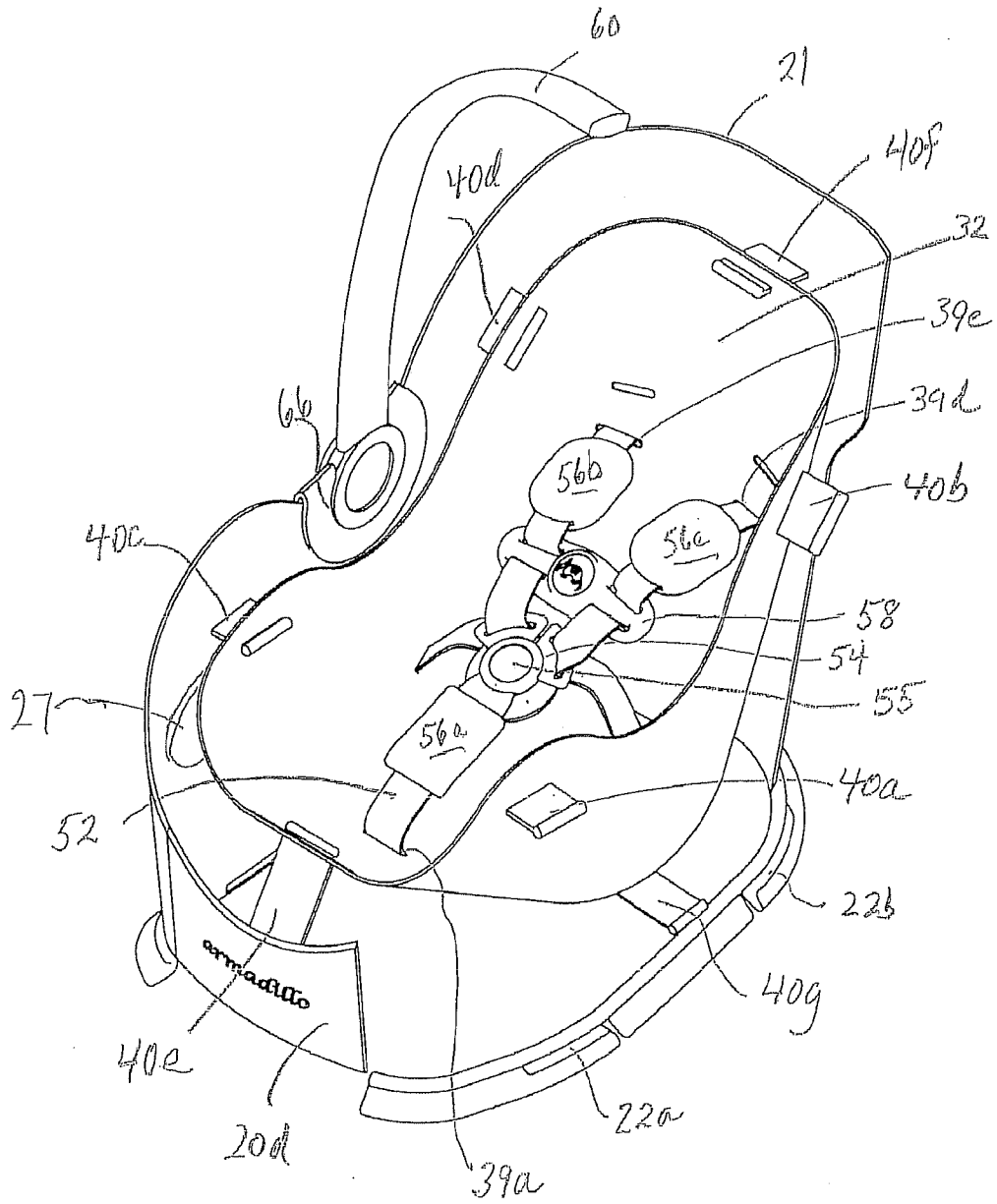


FIG 2

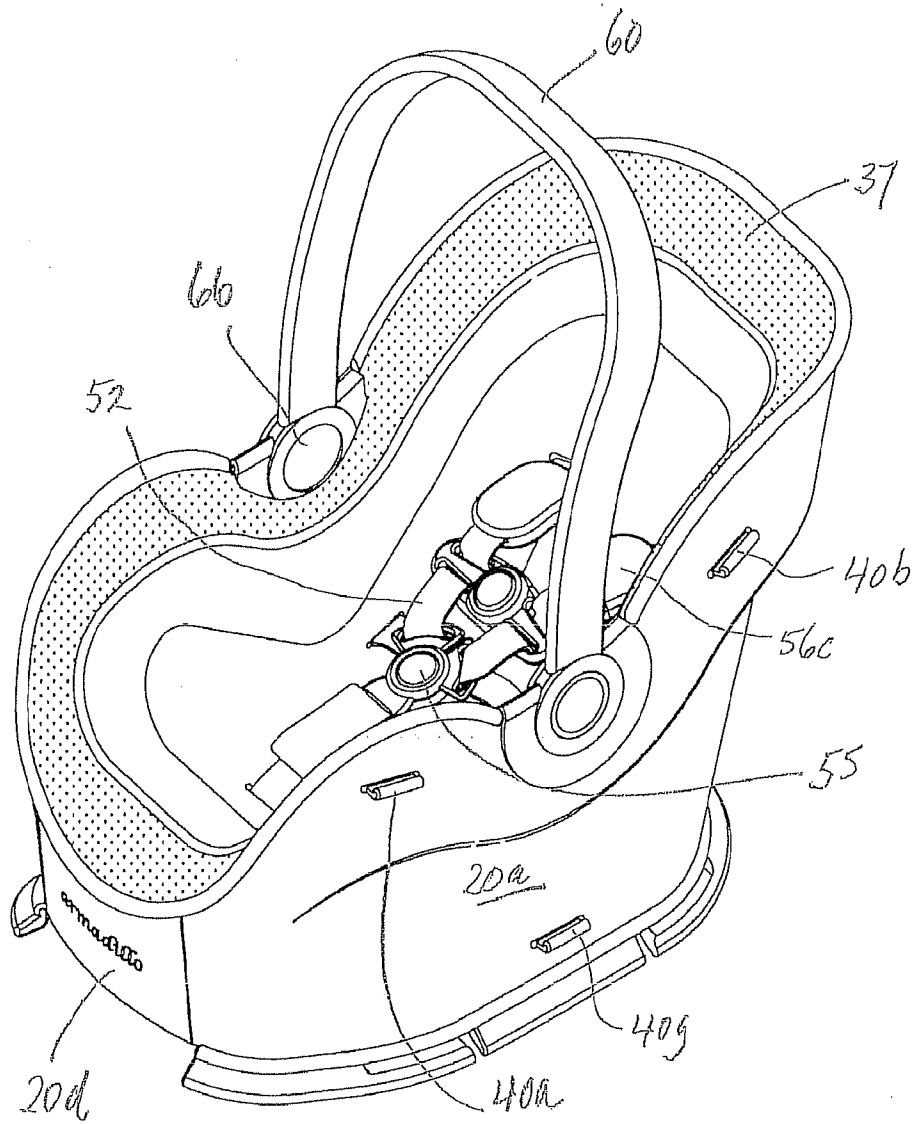
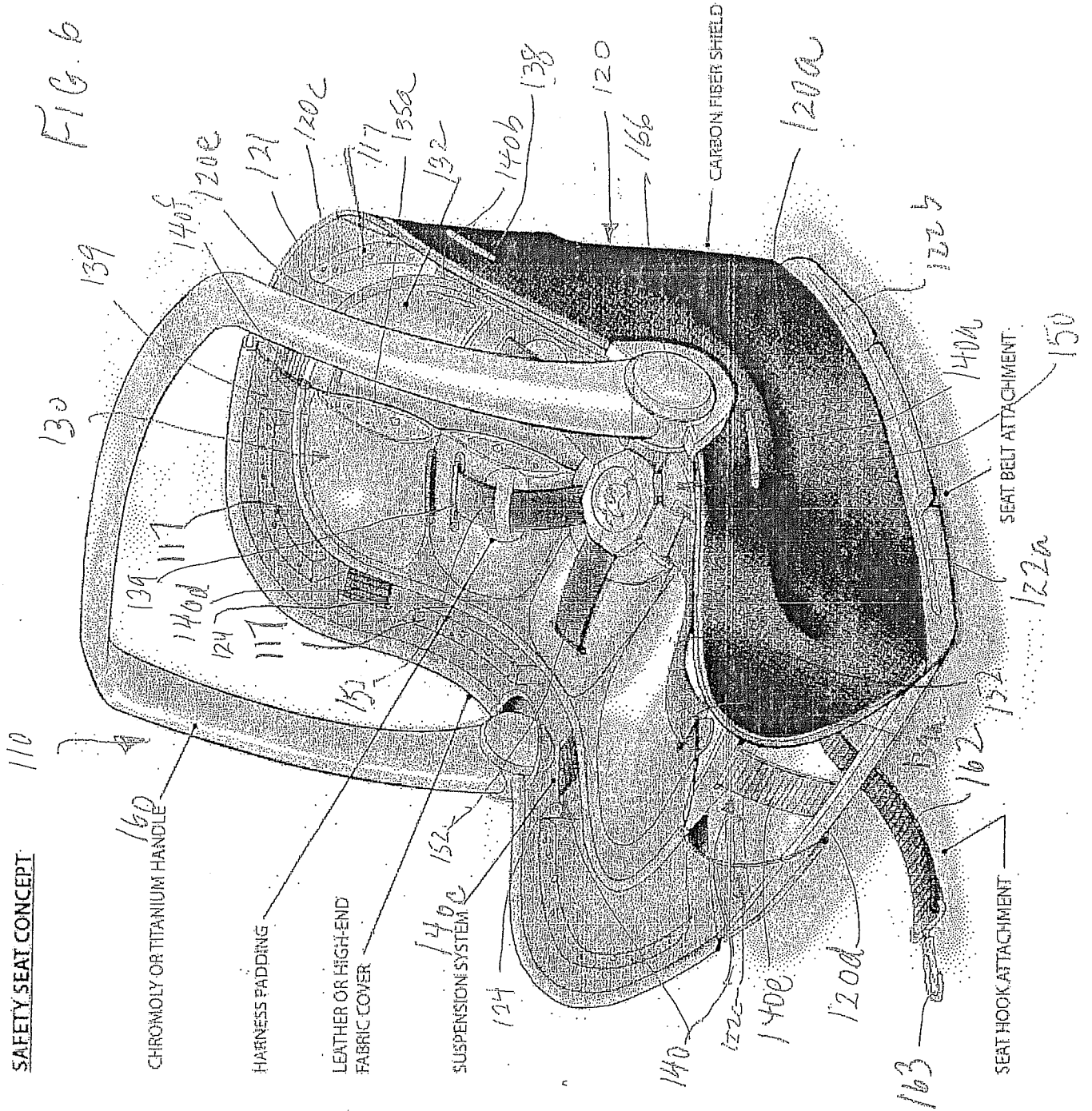


FIG. 5



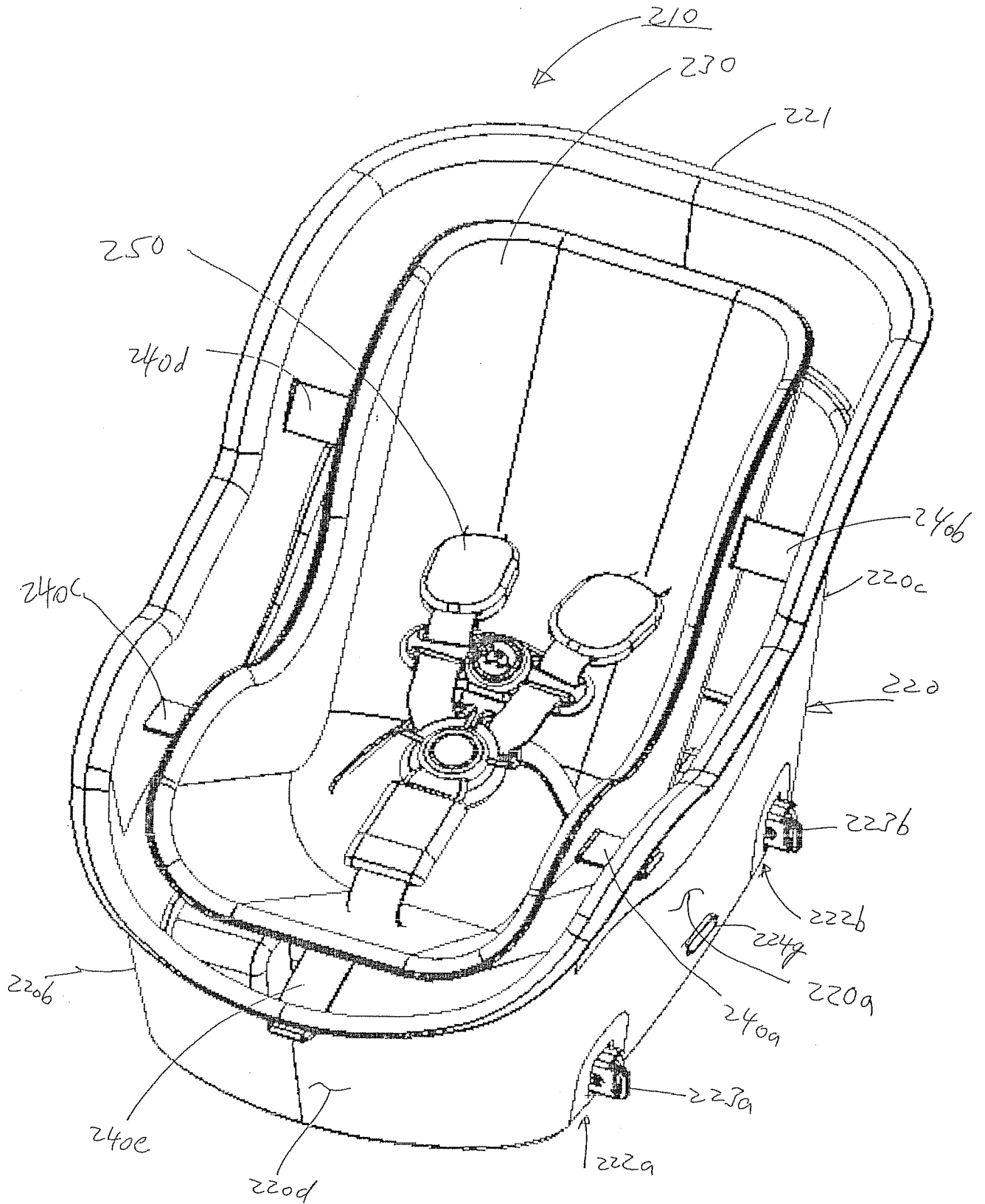


FIG. 7

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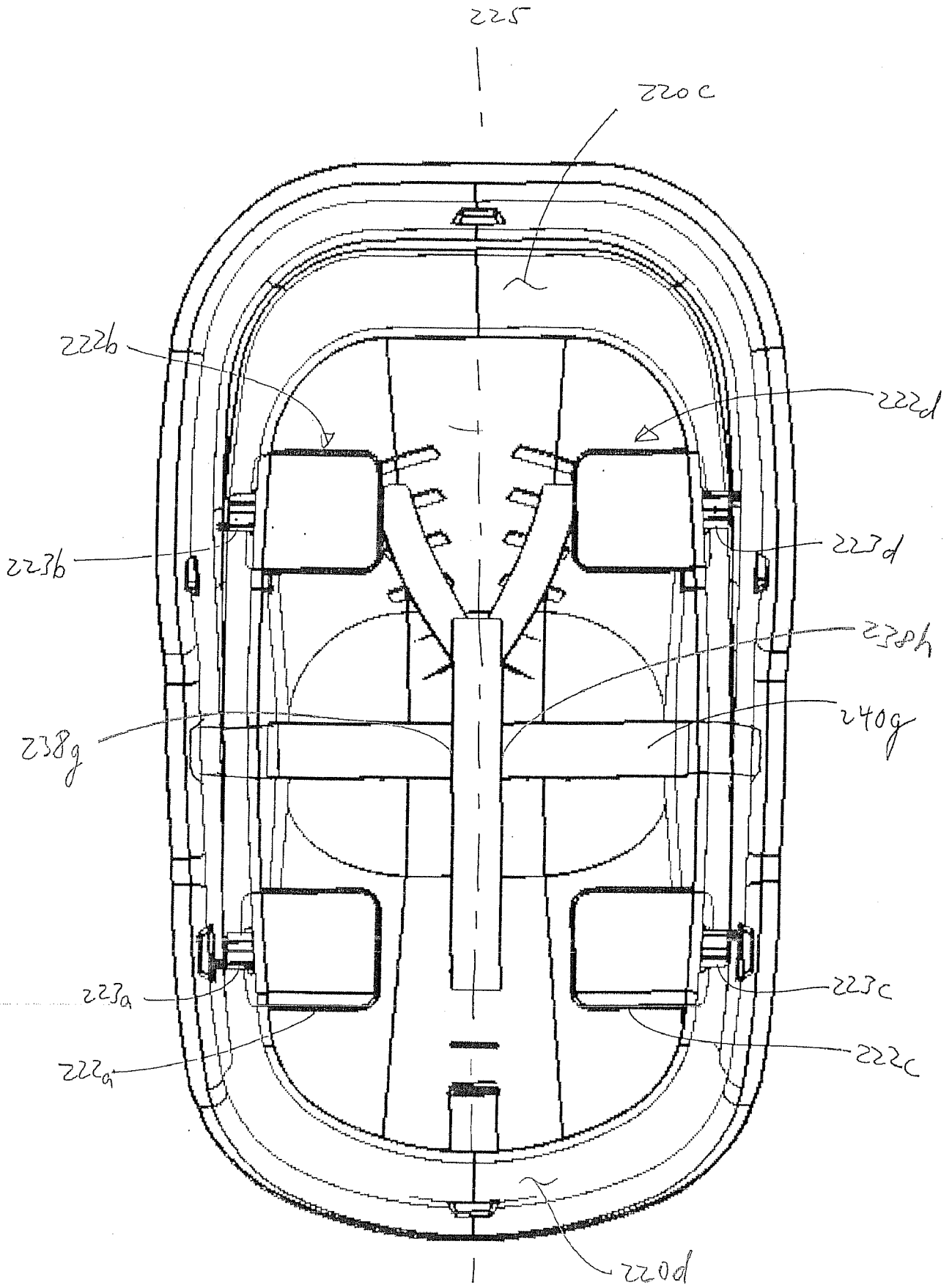


FIG. 8

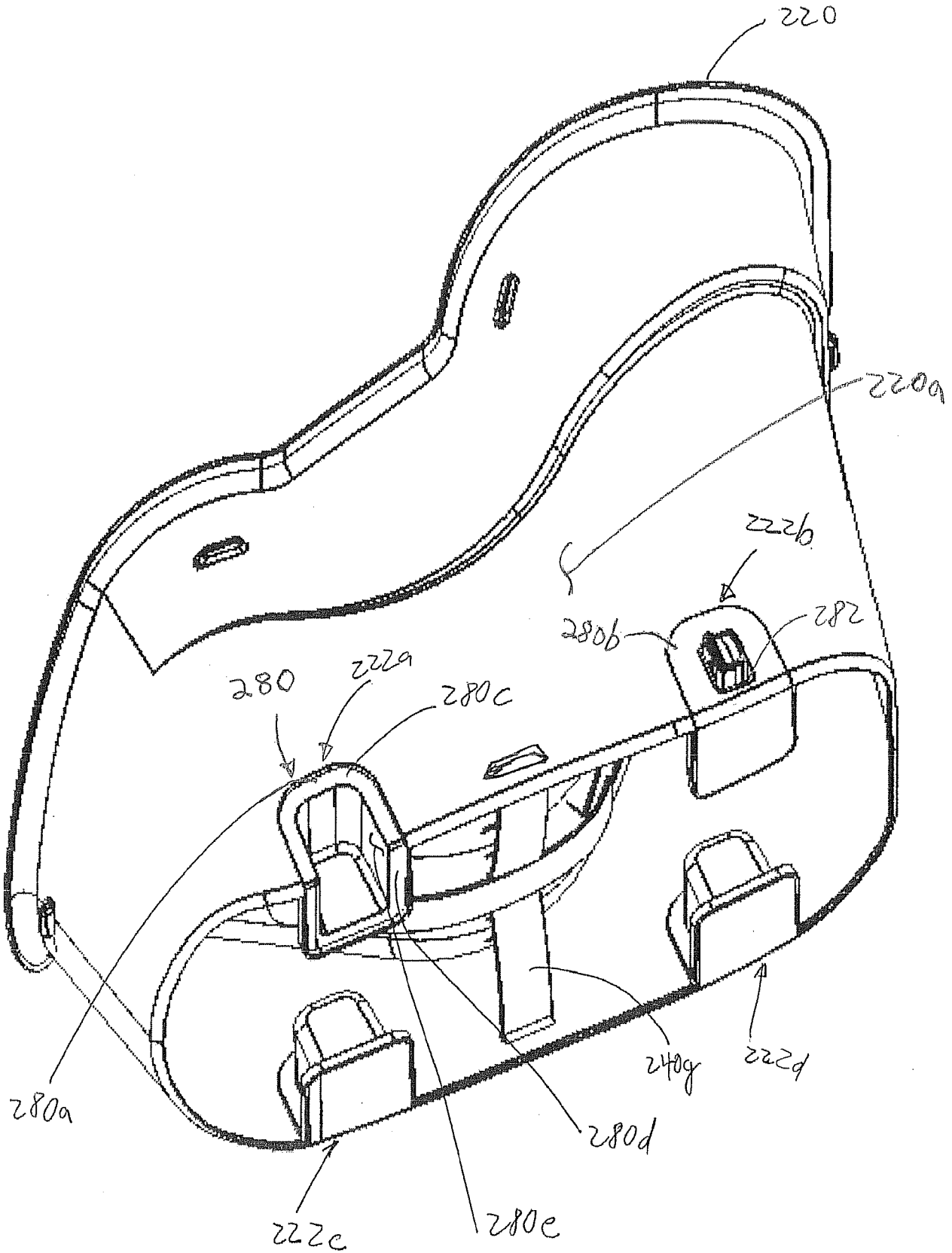
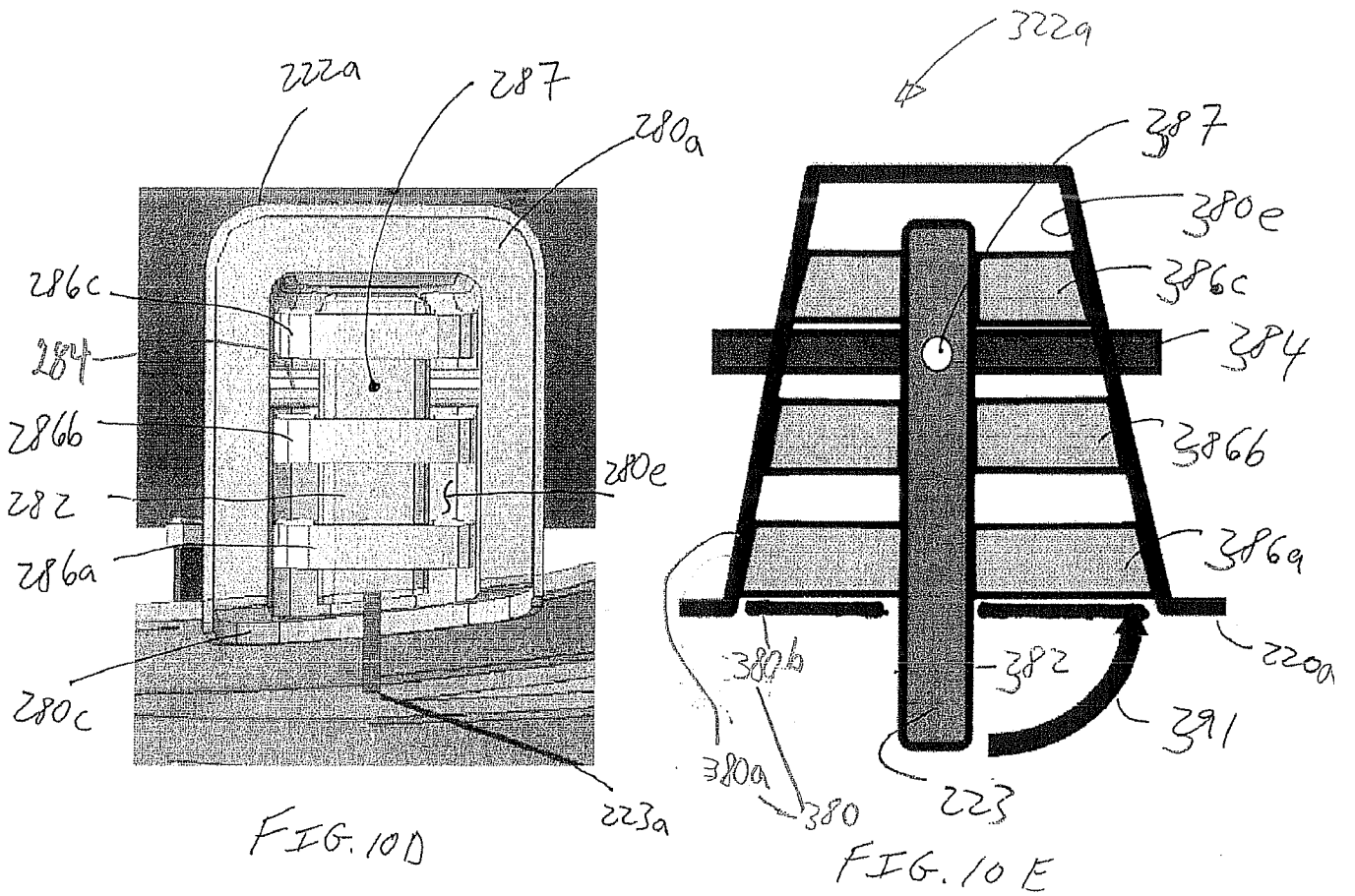


Fig. 9



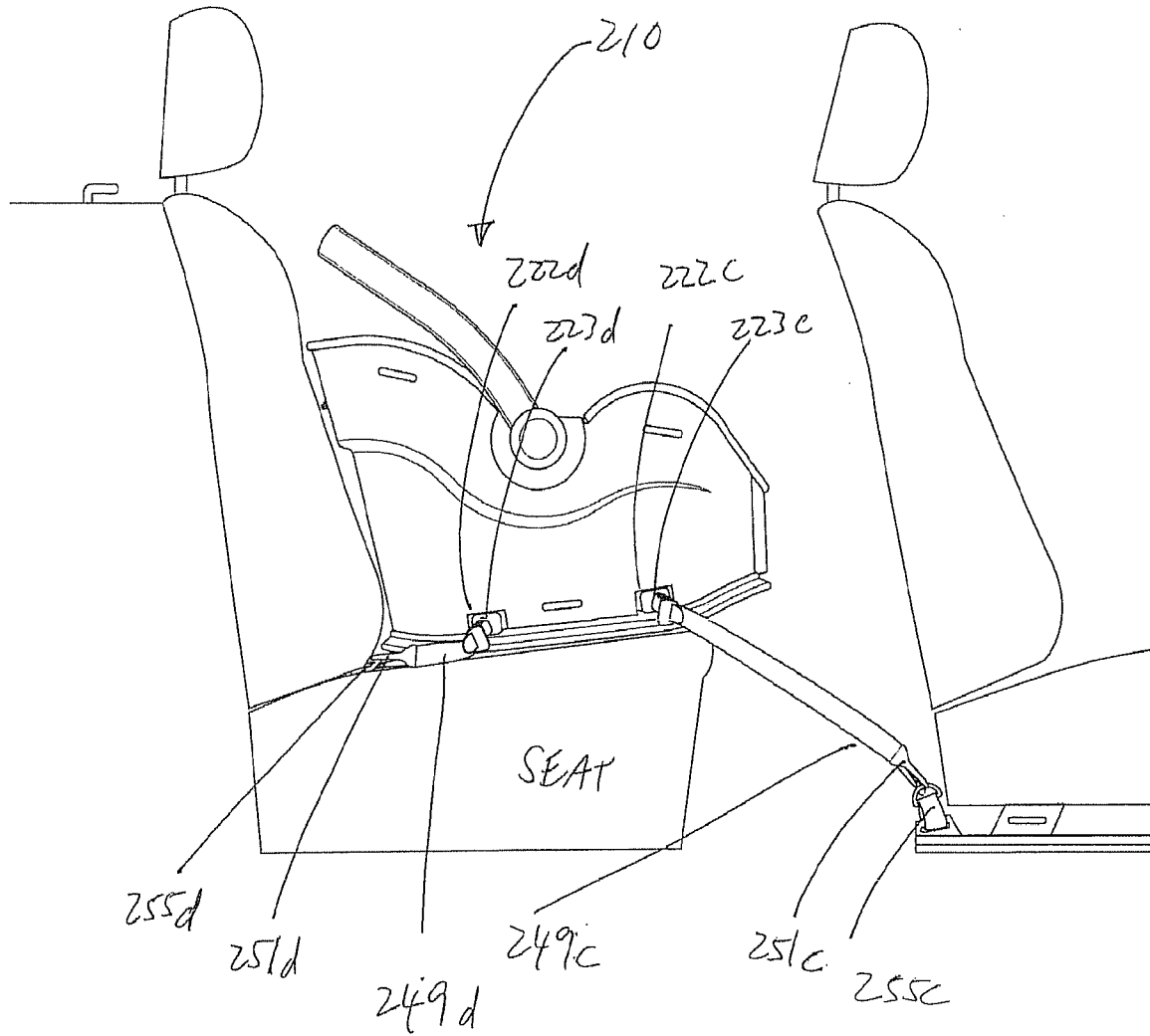


FIG. 12

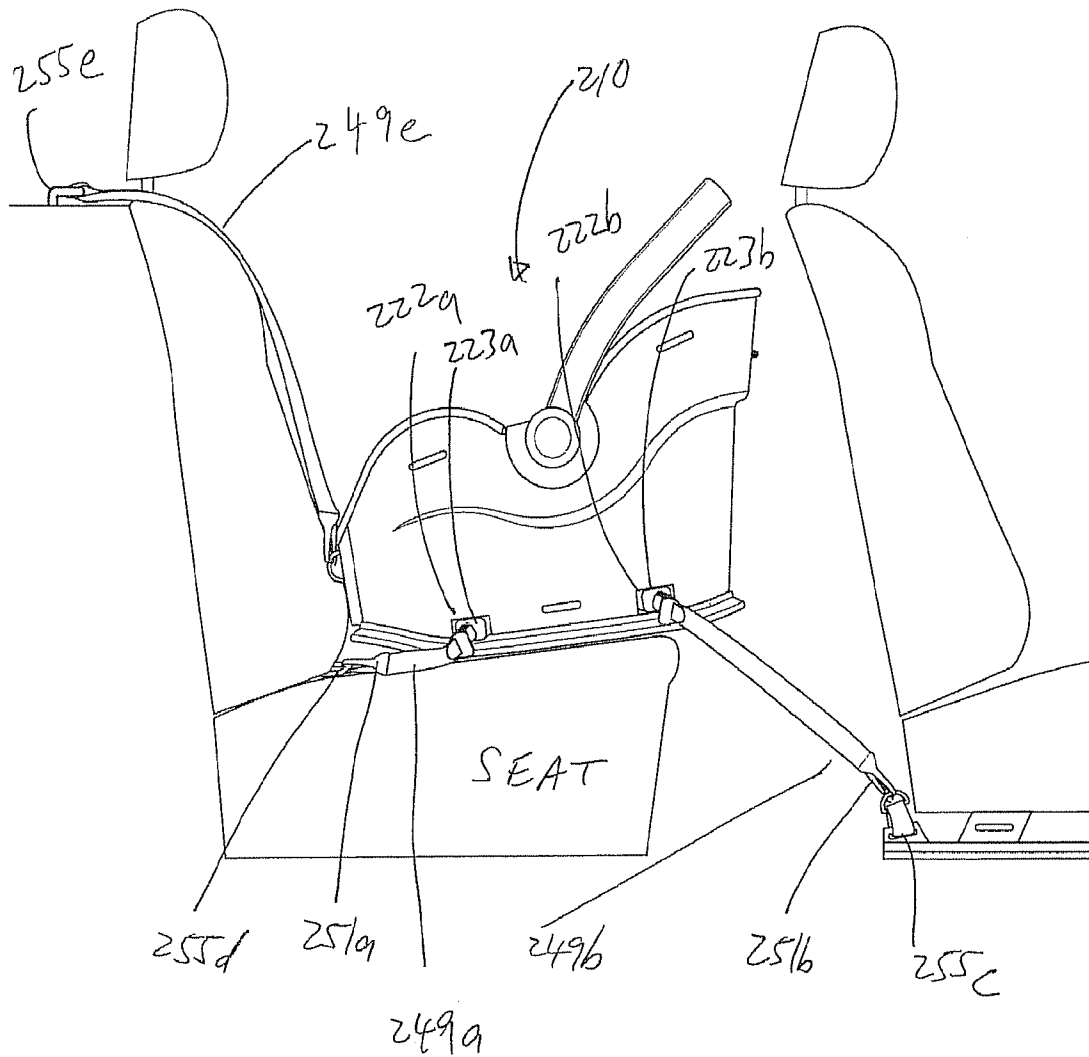


FIG. 13

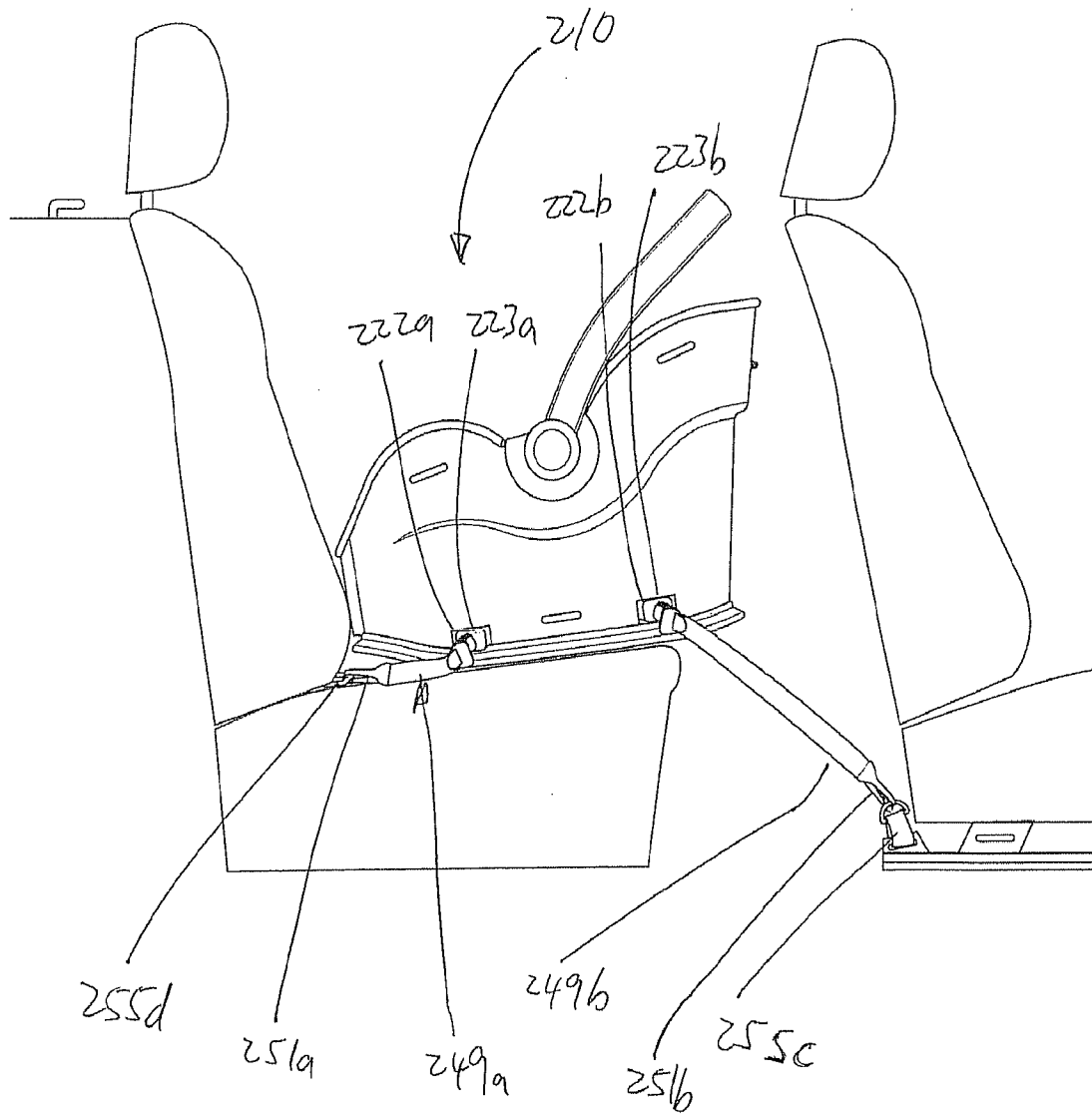


FIG. 14

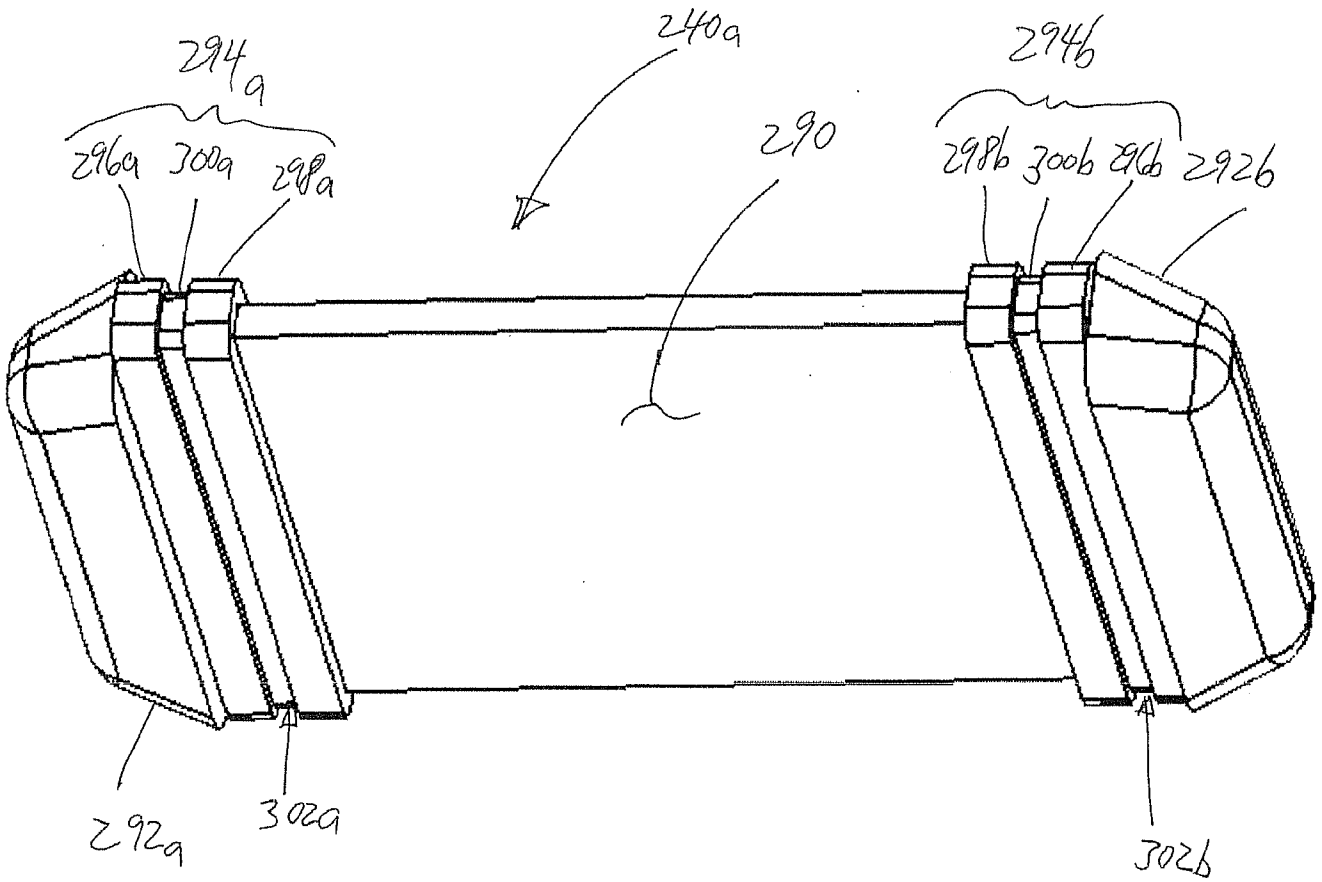


FIG. 16

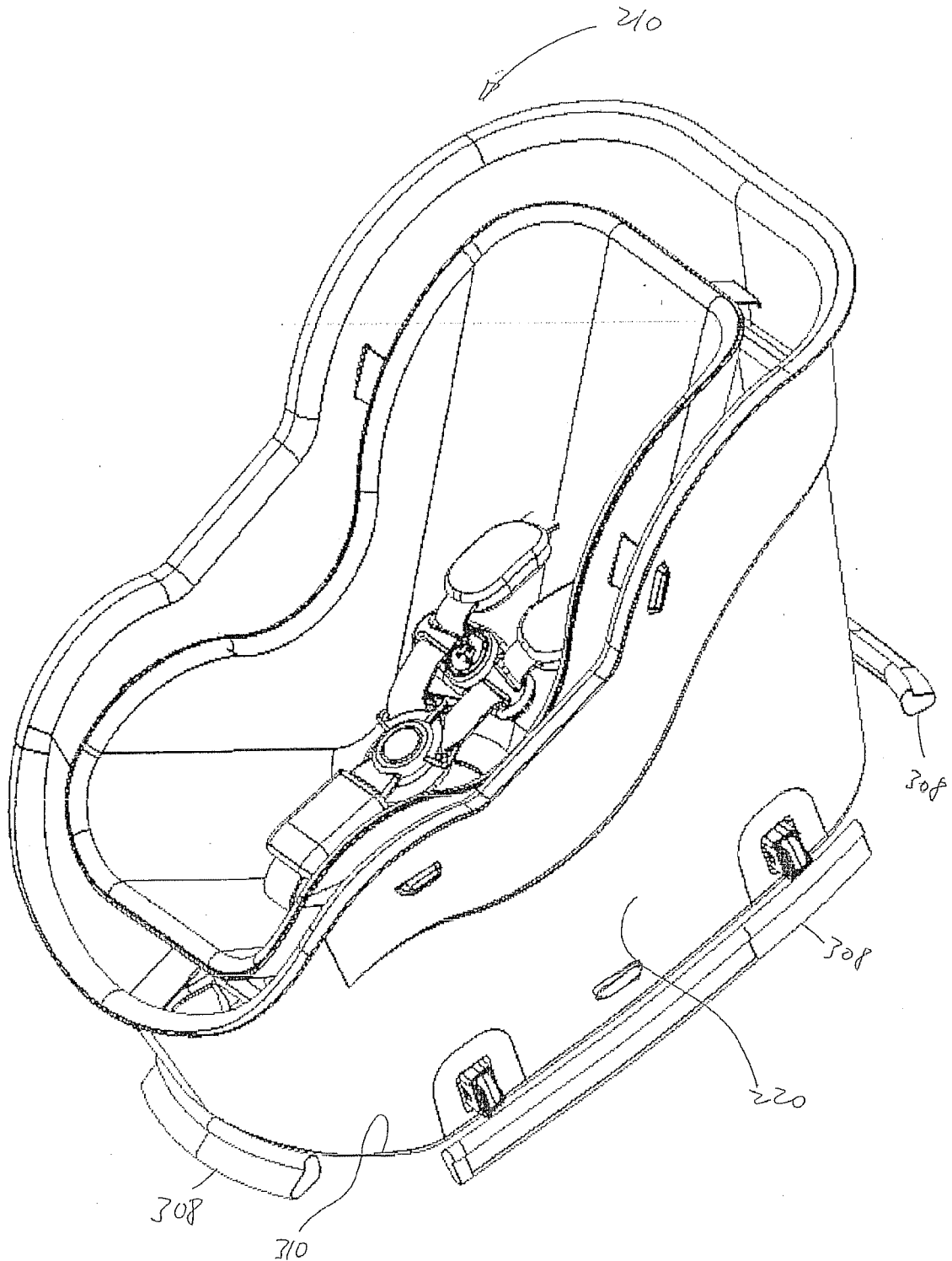


FIG. 17

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2014/020527

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B60N 2/427 (2014.01)

USPC - 297/216.11

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - A47D 1/10; B60N 2/26, 2/28, 2/42, 2/427; B60R 22/10 (2014.01)

USPC - 297/216.1, 216.11, 216.13, 216.15, 216.16, 250.1, 256.13, 256.14, 256.16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

CPC - B60N 2/26, 2/28, 2/2806, 2/2812, 2/2821, 2/286, 2/2863, 2/2884; B60R 22/105 (2014.02)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Google Patents, Google, YouTube

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---	EP 1 953 035 A2 (SAKUMOTO) 06 August 2008 (06.08.2008) entire document	1, 26-28
Y		2-4, 36
X ---	US 6,450,576 B1 (RHEIN et al) 17 September 2002 (17.09.2002) entire document	35
Y		36
X	US 2009/0026815 A1 (AMESAR et al) 29 January 2009 (29.01.2009) entire document	37-39
Y	US 2012/0013157 A1 (KEEGAN et al) 19 January 2012 (19.01.2012) entire document	2-4

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

05 June 2014

Date of mailing of the international search report

24 JUN 2014

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/020527

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

- 1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

- 2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

- 3. Claims Nos.: 5-25, 29-34
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

- 1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
- 2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
- 3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

- 4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

- Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
 - The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
 - No protest accompanied the payment of additional search fees.