A safety seat for vehicles which incorporates a head-restraining member comprising a sheet of flexible material which is yieldable or stretchable but generally non-elastic. The head-restraining sheet is secured to the safety seat so as to extend downwardly in front of the passenger's head. The sheet gradually absorbs the momentum of the passenger's head and provides a progressively increasing contact area with the passenger's head and face to minimize the peak unit load.
SAFETY DEVICE FOR RESTRAINING PASSENGERS

This invention relates to a safety device for restraining passengers of fast-moving vehicles (such as automobiles, buses, airplanes, etc.) to prevent injuries to the vehicle passenger's head in the event of a rapid acceleration or deceleration of the vehicle, as might happen in the case of an accident or an emergency stop.

Many safety devices have been proposed for vehicle seats (such as seat belts, shoulder straps or harnesses, vests, etc.) to minimize injury to a vehicle passenger in the event of an accident or an emergency stop. In my prior U.S. Pat. No. 3,232,665 there is provided a shield with a large padded impact area for absorbing the kinetic energy of the body of a passenger. In U.S. Pat. No. 3,424,497 the shield is extended upwardly and forwardly for the purpose of absorbing the energy of not only the passenger's body but also the passenger's head. While such constructions obviously provide some degree of safety, nevertheless these devices provide inadequate protection for the passenger's head and face.

The primary object of the present invention is to provide a restraining device which is designed and constructed to absorb the forward momentum of the head in a gradual manner and to provide for a large contact area for the head and face of a passenger. The restraining device of the present invention is also designed to avoid rebound forces which usually occur in the case of sudden stops.

Although not limited thereto, the device of the present invention is particularly suitable as a safety device for infants and small children. The head of an infant is relatively larger and heavier relative to its body in comparison with an adult's head. In infants the boney structure of the skull is not completely closed, the fontanelles are relatively soft and the neck is very delicate. Therefore, it is very important in the case of infants that the restraining device provide a gradual deceleration over a large area of contact so as to avoid injury to the infant's head and neck.

An important feature of the present invention resides in the utilization of a restraining device for a vehicle passenger's head in the form of a sheet of a flexible, yieldable, generally non-elastic material (such as netting) which is admirably suited to provide excellent distribution of the contact forces over the facial and forehead areas of the passenger. By utilizing a restraining member of this type, the head contacts the sheet, the sheet progressively yields to provide a progressively increasing contact area. Thus, with this arrangement the dissipation of the momentum energy is initiated quickly and the total energy is dissipated progressively (as distinguished from suddenly) and over a relatively longer time period.

Other objects and features of the present invention will become apparent from the following description and drawings, in which:

FIG. 1 is a perspective view of the body shield shown in FIG. 2;
FIG. 2 is a perspective view of the rear side of the head-restraining device;
FIG. 6 is a fragmentary perspective view of the anchoring means for the restraining sheet in the stretched condition;
FIGS. 7 and 8 are views illustrating the function and operation of the restraining device of the present invention;
FIG. 9 is a perspective view of a modified form of the safety seat frame according to the present invention;
FIG. 10 is a fragmentary perspective view of the rear side of the seat frame illustrated in FIG. 9;
FIG. 11 is a fragmentary perspective view of one end of the head-restraining device adapted for use with the seat frame shown in FIG. 9;
FIG. 12 is a perspective view of the modified form of seat frame shown in FIG. 9 and illustrating a modified form of head-restraining device;
FIG. 13 is a perspective view of the safety seat illustrated in FIG. 12 in the completely assembled form and anchored to a vehicle seat by a seat belt;
FIG. 14 is a fragmentary view, partly in section, illustrating the manner in which the body shield of the modified form of construction is anchored to the seat frame and taken along the line B—B in FIG. 15;
FIG. 15 is a sectional view along the line A—A in FIG. 14 with the body shield removed;
FIG. 16 is a vertical sectional view of a modified form of safety seat adjustable to the size of the passenger;
FIGS. 17 and 18 are views showing the function and operation of the device illustrated in FIGS. 9 through 16.

Referring first to FIGS. 1 through 6, the embodiment of the invention shown includes a safety seat frame consisting of a pair of side walls and a rear wall which merges with a curved bottom wall so as to provide a seat (such as for an infant). The forward edges of side walls extend upwardly and rearwardly from the forward portion of bottom wall as at 18 to an arcuate concave portion 20. At the upper end of the concave portion 20 the forward edges of side walls extend upwardly and then rearwardly as at 22 to the upper edge of rear wall 14. Seat frame 10 is formed as a relatively rigid structure and may be molded, for example, from plastic material as an integral unit. At least the concave portions 20 of the forward edges of the side walls are enlarged as illustrated.

Seat frame 10 is provided on the rear side of rear wall 14 with suitable members adapted for interconnection with wire brace 26 for positioning frame 10 on a vehicle seat, such as illustrated at 28 in FIG. 7. A body shield 30 is preferably mounted on seat frame 10 for restraining forward movement of the passenger's body midsection. Body shield 30 comprises a curved rigid panel 32 which is padded on the inner side thereof as at 34. The opposite ends of panel 32 of body shield 30 are provided with rigid end walls 36 formed with curved channels 38 at the edges thereof. Channels 38 conform in shape with the enlargements at the edges of the concave portions 20 on side walls 12 so that channels 38 can be telescoped in an arcuate fashion into and out of engagement with the arcuate enlarge-
ments to mount the body shield on the seat frame preferably after the passenger is seated therein. As shown in FIGS. 7 and 8, body shield 30 has a portion 40 which overlies the passenger's lap and a second portion 42 which extends upwardly and forwardly in front of the passenger's chest. Shield 30 terminates at its upper end at a level below the neck of the passenger. Rear wall 14 is dimensioned to extend upwardly above the head of the passenger.

The head restraining member of the present invention is generally designated 44 and comprises a sheet of flexible material which is yieldable or stretchable, but generally non-elastic. For example, member 44 can be formed from a sheet of transparent stretchable plastic. Preferably, however, sheet 44 is formed of a netlike material (such as strong mosquito netting or the like). As shown in FIG. 3, the head-restraining sheet 44 is dimensioned to extend downwardly from the upper end of rear wall 14, around the front edge portions 22 of side walls 12 and over at least a portion of the front face of body shield 30.

At its upper end sheet 44 has attached thereto a wire loop 46. Loop 46 comprises a first straight laterally extending portion 48 retained within hem 50 formed at the upper end of the sheet. Wire loop 46 includes a second straight laterally extending portion 52 adapted to be secured to the seat by means of hooks 54 on the rear side of rear wall 14 as shown in FIG. 7. The two straight portions 48,52 of wire loop 46 are interconnected by inwardly bent legs 56.

The lateral side edges of sheet 44 are formed as flanges 58 adapted to overlap and snugly embrace the outer face of side walls 12. At its lower end sheet 44 has attached thereto a strong flexible panel 60, the extreme end of which is reinforced by a rod 62. In the embodiment illustrated in FIGS. 1 through 8 the restraining seat of the present invention is adapted to be positioned on a vehicle seat as shown in FIGS. 7 and 8 and anchored thereto by means of a conventional seat belt 64. Belt 64 extends over and across the concave outer portion of body shield 30. However, before seat belt 64 is secured, the reinforcing panel 60 of sheet 44 is arranged to overlies body shield 30 so that the rod 62 will form an enlargement extending beyond said belt 64 to thus firmly anchor the lower end of sheet 44 to seat frame 10.

Referring now to FIGS. 7 and 8, the function and operation of the restraining device of the present invention is illustrated. In these drawings a child 66 is shown seated in the device with the body shield 30 overlying the child's lap and extending upwardly and slightly away from the child's chest. It will be observed that the yieldable sheet 44 is anchored at its lower end on the seat frame 10 by seat belt 64 and extends upwardly around the forward edge portions 22 of side walls 12 to the upper end of rear wall 14. The upper end of sheet 44 then extends downwardly over the upper end of rear wall 14 and is anchored to the seat frame by interengagement of wire loop 46 with hooks 54. In FIG. 7 the child's head is shown in solid lines in the position that it would normally occupy and in broken lines in the position to which it would be thrust immediately after an emergency stop or sudden deceleration. It is apparent from FIG. 7 that in the event of sudden deceleration of the vehicle the passenger's head would be thrust forwardly through the space F before the forehead encounters the restraining influence of sheet 44. The distance F is preferably on the order of 2 to 10 inches. In most instances under conditions of rapid deceleration the energy of the momentum of the passenger's head will not be dissipated completely as the head is thrust forwardly through the free distance F. The momentum will be sufficient to thrust the child's head forwardly a further extent so that the passenger's forehead slides along the inside of the screen from the point A to the point B through the distance S. Since sheet 44 is made of a yieldable or a stretchable material, as the forehead slides along the inside of the sheet it gradually increases the tension of the sheet and gradually increases the contact area between the passenger's head and the inside of the sheet until point B is reached where substantially the entire forehead and face of the passenger contacts sheet 44. At the same time the chest area of the passenger has contacted the portion 42 of the body shield and compressed the padding thereon. However, before the passenger's head reaches point B, the tension on the sheet due to the forward momentum of the passenger's head is sufficient to at least partially straighten the inwardly bent legs 56 of wire loop 46 as shown in FIG. 4 so that the two straight portions 48,52 become more remotely separated and enable the sheet 44 to yield to a greater extent than it otherwise would. Thus the passenger's head is gradually brought to a complete stop with the peak unit load at the area of contact being maintained at a relatively low and constant value by reason of the yielding of sheet 44, the straightening of legs 56 and the progressively increasing area of contact between the child's head and sheet 44. Thus, during the final period of forward motion of the passenger's head the passenger's face has maximum surface contact with the sheet which tends to minimize injury. It is particularly true in the case of infant passengers which are much more readily susceptible to skull fractures.

In a rear end collision in a forwardly facing safety device of the present invention the first impact period is taken by the back wall of the seat which may be padded to minimize such injury. In the rebound period the passenger's head is thrust forwardly and the impact thereof is taken by sheet 44 in the manner illustrated in FIGS. 7 and 8. It will be appreciated that if the safety device is arranged on a seat so as to face rearwardly the direction of movement for the initial impact and later rebound periods will be the opposite as described above for front end and rear end collisions. However, in either event, the sheet 44 will absorb the impact of the passenger's head in the fashion described either during the initial impact period or the following rebound period.

In FIGS. 9 through 18 a somewhat modified form of invention is illustrated. In this form the safety seat frame 68 is provided with side walls 70 which may be padded, if desired, and with a rear wall 72 and bottom wall 74 as in the previous embodiment illustrated. However, in the arrangement illustrated in FIGS. 9 through 18 the body shield 76 comprises a rigid panel 78 which is padded at its inner side as at 80 and provided with a pivot support 82 at its lower end. As shown in FIG. 14, pivot support 82 comprises a sleeve 84 fixed to the lower end of panel 78. Within sleeve 84 there is
arranged a shaft consisting of two sections 86, 88. Shaft section 86 is axially slideable in shaft section 88 and is biased outwardly thereof by a compression spring 90. Shaft section 86 is releasely locked in its outwardly extended position by a spring detent 92. Thus, shaft sections 86, 88 are designed to normally project outwardly beyond the adjacent side edges of panel 78. Each side wall 70 of seat frame 68 is provided with axially aligned apertures 94 therein. These portions of side walls 70 may be reinforced if desired by a metal plate 96 secured to the side walls as by rivets 98. In the arrangement illustrated body shield 76 is adapted to be pivotally mounted on seat frame 68 by inserting the projecting end portion of shaft section 88 into one of the openings, axially retracting shaft section 86 to permit its alignment with the other opening 94 and then permitting shaft section 86 to project outwardly through the other opening 94 by reason of compression spring 90. In this manner body shield 76 is rigidly supported on seat frame 68 so that it is permitted to tilt in a forward and rearward direction at its upper end.

As is the case with the previous embodiment described, the modified form of safety device also incorporates a head-restraining member 99 formed of sheet of material that is flexible, yieldable or stretchable, but generally non-elastic. Sheet 99 is shaped and dimensioned so as to extent from the upper end of rear wall 72 downwardly over the forward edges of side walls 70 in the manner described with respect to the previous embodiment. However, in this form of the invention sheet 99 is firmly anchored or secured in some suitable fashion at its lower end to body shield 76. The upper end of sheet 99 may be connected to the seat frame in the same manner that the upper end of sheet 44 is connected. However, in FIGS. 10 and 11 a modified form of connection is shown. The upper end of sheet 99 has connected thereto a wire loop 101 generally similar to the wire loop 46 previously described. Wire loop 101 has laterally inward bent legs 100 and a tubular sleeve portion 102 secured thereto. The rear side of rear wall 72 is fashioned at the upper end thereof with a generally cylindrical bore forming a laterally extending socket 104 which is slotted as at 106. The upper end of sheet 99 is adapted to be anchored to the back side of rear wall 72 by inserting the portion of wire loop 101 having sleeve 102 thereon axially into and through socket 104, slot 106 accommodating the wire at either side of wire loop 101. The axial length of socket 104 is slightly less than the width of wire loop 101 at the sleeve 102 so that when the wire loop is pivoted upwardly against the rear face of rear wall 72 the wire loop is locked in place and the upper end of sheet 99 is firmly anchored to rear wall 72. Preferably wire loop 101 is interengaged with socket 104 and thereafter sheet 99 is extended forwardly and downwardly over the forward edges of side walls 70. Finally body panel 78 is interengaged with the seat frame in the manner illustrated in FIGS. 12 and 13 and the entire assembly is anchored to the vehicle seat by seat belt 108. With the arrangement described in FIGS. 9 through 16 the function and operation of sheet 99 is generally the same as described in connection with FIGS. 7 and 8. However, as shown in FIGS. 17 and 18, upon sudden deceleration the passenger's body is thrust forwardly so that body shield 76 pivots forwardly about pivot support 82 simultaneously with the extension of sheet 99. Body shield 76 is normally retained in a generally upright position by the tension of seat belt 108 and its forward tilting movement is somewhat restricted by the seat belt (see FIG. 18). However, sheet 99 yields and gradually absorbs the impact of the passenger's head substantially in the same manner as described previously in connection with the embodiment illustrated in FIGS. 1 through 8.

While seat frame 68 may be padded as desired, there is illustrated in FIG. 16 a particular pad construction for enabling the seat to be adjusted to infants or children of different sizes. In FIG. 16 there is shown a seat pad 110 dimensioned in length to substantially completely overlie rear wall 72 and bottom wall 74. However, about the lower one-third portion of pad 110 (the portion designated 112) is substantially thicker than the upper two-thirds portion 114 of the pad. Pad 110 has one or more plugs 116 on the under side thereof adapted to project into suitably located apertures in the rear and bottom walls of the seat frame to prevent shifting of the pad. When the pad is arranged in the position illustrated in FIG. 15, the effective height of seat formed by bottom wall 74 is at a maximum so that the head of a child will be located adjacent the upper end of the unit as shown in FIG. 17. In the event of a slightly larger child, pad 110 can be reversed end to end in a position so that the child is sitting on the thinner portion 114 of the pad. In the event that a child is even longer, pad 110 can be completely removed from the unit. In any event, the child's head will be properly located approximately at the position shown in FIG. 17 so that upon sudden deceleration or in the event of an accident the forward thrust of the child's head and body will be absorbed by sheet 99 and also by the straigthening of the wire loops 100 of the anchoring member 98.

FIG. 16 also shows the provision of a second set of apertures 118 in the side panels of the seat frame for receiving the body shield in a second position for further accommodating the seat to the child's size.

I claim:

1. A safety restraining seat for vehicles comprising a rigid frame adapted to be positioned on and anchored to a vehicle seat and in which a passenger is adapted to be seated, said frame having a pair of generally vertically extending, laterally spaced side walls which permit only limited lateral movement of the passenger seated in said frame, a body shield, means for anchoring the body shield relative to said frame so that the shield is adapted to restrain forward movement of the passenger's body in the area upwardly from the passenger's lap to an elevation below the passenger's head and neck, and a head restraining member comprising flexible sheet of a generally non-elastic material, said sheet extending downwardly in front of the passenger's head and being secured to said frame whereby, upon sudden acceleration of the vehicle, the forward momentum of the passenger's body is absorbed by said body shield and, as the passenger's head is displaced forwardly into engagement with said sheet, the sheet progressively yields to provide a progressively greater area of contact with the passenger's head to gradually decelerate the passenger's head while absorbing the forward momentum thereof and maintaining the peak unit contact load on the passenger's head at a minimum value.
2. The combination set forth in claim 1 wherein said frame includes a back and bottom wall extending between the side walls, said back wall extending upwardly to a level generally above the head of a passenger seated in the frame.

3. The combination set forth in claim 2 wherein said sheet extends upwardly from said body shield in front of the passenger's head and to the upper end of said back wall.

4. The combination set forth in claim 3 wherein said sheet extends laterally across said frame to each of said side walls.

5. The combination set forth in claim 2 including yielding, generally non-elastic anchoring means securing said sheet to said frame, said last-mentioned means being adapted to yield under the tension applied thereto by said sheet as the result of the forward momentum of the passenger's head resulting from sudden deceleration.

6. The combination set forth in claim 5 wherein said sheet is adapted to yield under a lesser force than is required to produce yielding of said non-elastic anchoring means.

7. The combination set forth in claim 7 wherein said last-mentioned means includes a wire element having bends therein to foreshorten the length thereof, said bends being adapted to at least partially straighten under the tension applied thereto by said sheet as a result of the forward momentum of the passenger's head upon sudden deceleration.

8. The combination set forth in claim 7 wherein said wire element is detachably connected to said seat back.

9. The combination set forth in claim 5 wherein said last-mentioned means comprises a member having a laterally extending first portion connected with the upper end of said sheet and a laterally extending second portion spaced from said first portion and connected with said seat back, said laterally extending portions being connected by laterally bent wire portions which are adapted to at least partially straighten out and thus increase the spacing between said lateral portions in response to the tension applied by said sheet member to said non-elastic anchoring means.

10. The combination set forth in claim 3 wherein said side walls extend forwardly beyond the head and face of a passenger seated in the frame so that the passenger's head is capable of moving forwardly prior to encountering said sheet.

11. The combination set forth in claim 10 wherein said sheet is dimensioned laterally to overlap and extend around the forward edges of said side walls.

12. The combination set forth in claim 10 wherein said sheet is dimensioned to snugly embrace the laterally outer sides of said side walls adjacent the forward edge portions thereof.

13. The combination set forth in claim 1 wherein said body shield is anchored on said frame, extends upwardly from the passenger's lap and is spaced slightly forwardly of the passenger's chest.

14. The combination set forth in claim 13 wherein the lower end of said sheet is connected with said body shield.

15. The combination set forth in claim 13 wherein said body shield comprises a panel connected to said frame for forward tilting movement at its upper end.

16. The combination set forth in claim 15 wherein the lower end of said sheet is anchored on said body shield and is displaced by the tilting movement thereof.

17. The combination set forth in claim 1 wherein said frame includes a back and bottom wall extending laterally between and connected to said side walls and including a seat pad extending over said back and side wall, said pad being substantially thicker along generally one-third of its length than along the other two-thirds of its length, said pad being adapted to be reversely positioned for end on said back and side wall to vary the effective height of the bottom wall relatively to said side walls.

18. The combination set forth in claim 17 including means for detachably anchoring said pad to said frame.

19. The combination set forth in claim 1 wherein said head-restraining member comprises a sheet of stretchable mesh material.

20. The combination set forth in claim 1 wherein said head-restraining member comprises a net material.

21. A safety restraining seat for vehicles comprising a rigid frame adapted to be positioned on and anchored to a vehicle seat and in which a passenger is adapted to be seated, said frame having a pair of generally vertically extending, laterally spaced side walls which permit only limited lateral movement of the passenger seated in said frame, a body shield panel, means for anchoring the body shield panel on said frame so that the panel is adapted to extend upwardly from the area of the passenger's lap to an elevation in front of the passenger's chest and terminating below the passenger's head and neck, and a head-restraining flexible sheet of generally non-elastic material, said sheet extending downwardly in front of the passenger's head, means anchoring said sheet to said frame, said anchoring means being yieldable but generally non-elastic whereby, upon sudden acceleration of the vehicle, the forward momentum of the passenger's body is absorbed by said body shield and, as the passenger's head is displaced forwardly into engagement with said sheet, said last-mentioned anchoring means progressively yield to gradually decelerate the passenger's head while absorbing the forward momentum thereof and maintaining the peak unit load on the passenger's head at a minimum value.

22. The combination set forth in claim 1 including means for anchoring the body shield on said seat frame in a plurality of different positions to accommodate passengers of different sizes.