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Hubbard

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[45] **Date of Patent: Jan. 4, 2000**

[54] **HEAD AND NECK SUPPORT FOR RACING**

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[22] Filed: **Jan. 27, 1999**

Related U.S. Application Data

[60] Provisional application No. 60/072,957, Jan. 29, 1998.

[51] **Int. Cl.**[7] **A42B 3/00**; A41D 13/00

[52] **U.S. Cl.** **2/468**; 2/421; 280/290

[58] **Field of Search** ..... 2/410, 411, 421, 2/422, 425, 455, 459, 461, 468; 280/290; 244/122 AG

[56] **References Cited**

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5,267,708	12/1993	Monson et al. .	
5,272,770	12/1993	Allen et al.	2/468
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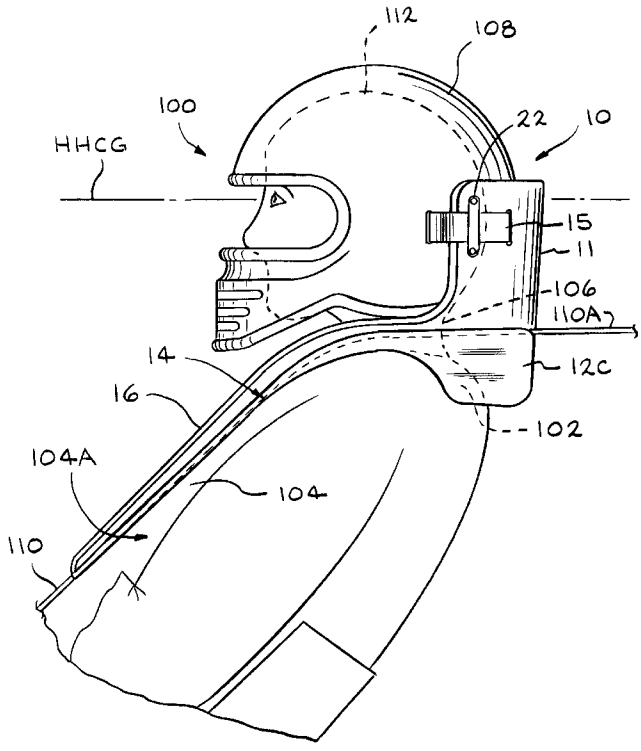
Primary Examiner—Michael A. Neas

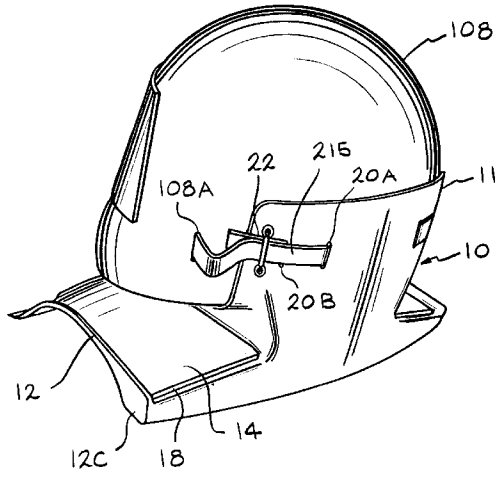
Attorney, Agent, or Firm—Mary M. Moyne; Ian C. McLeod

[57] **ABSTRACT**

An improved head and neck support device (**10**) for occupants (**100**) of high performance vehicles, is described. The device includes a restraining yoke (**12**) and a collar (**11**). The restraining yoke has two front portions (**12**A and **12**B) which extend down from the shoulders (**102**) of the occupant along the torso (**104**) of the occupant. The restraining yoke also includes a rear portion (**12**C) which extends behind the neck (**106**) and the shoulders of the occupant. The collar of the device extends upward from the rear portion of the restraining yoke behind the head (**112**) of the occupant. The collar of the device is connected by tethers (**15** or **215**) to the helmet (**108**) of the occupant. The shoulder belts (**110**A) of the shoulder harness (**110**) of the vehicle extend over the front portions and rear portion of the restraining yoke when the device is mounted on the occupant such that the device is between the shoulder belts and the occupant. The collar acts to transfer the forces from the helmet through the tethers to the collar of the restraining yoke which transfers the forces to the shoulder harness thereby reducing the forces being transmitted to the neck of the occupant.

17 Claims, 8 Drawing Sheets





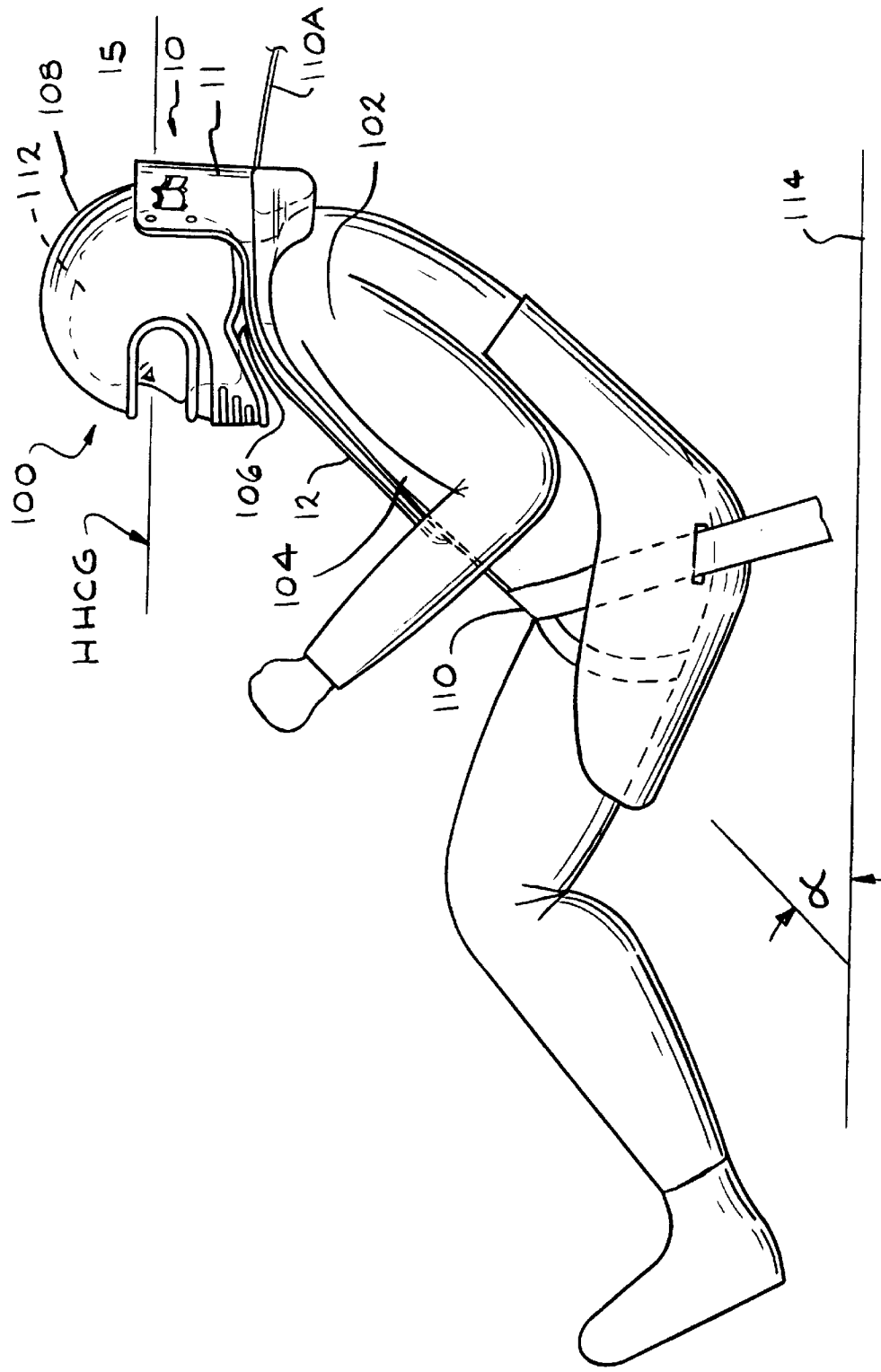


FIG. 1

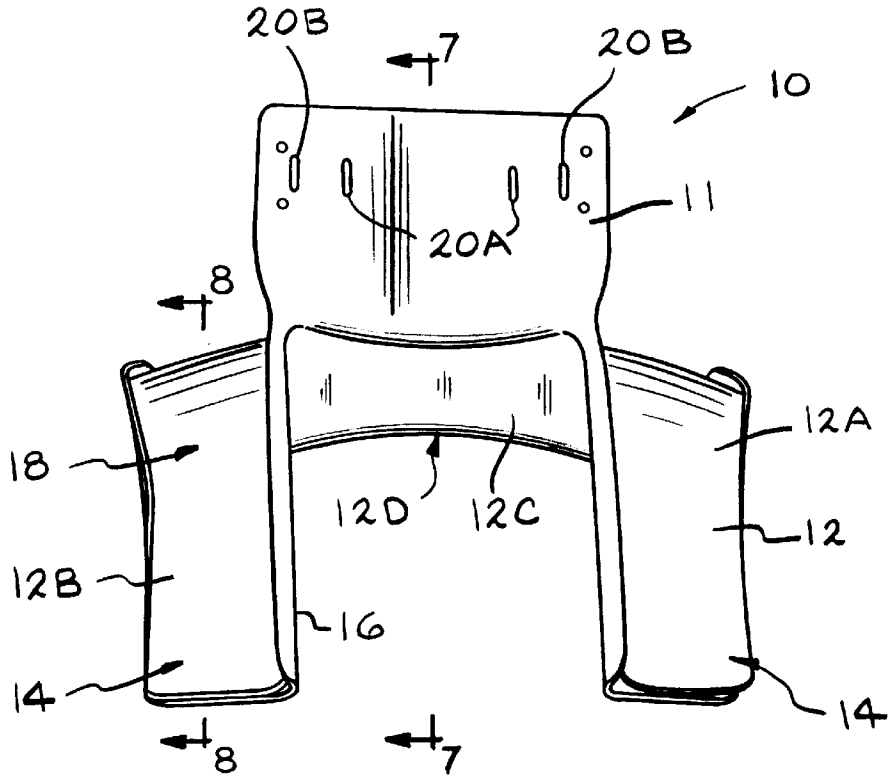

20B
7
20B
10
11
20A
8
18
12A
12D
12C
12
12B
16
14
14
8
7

FIG. 2

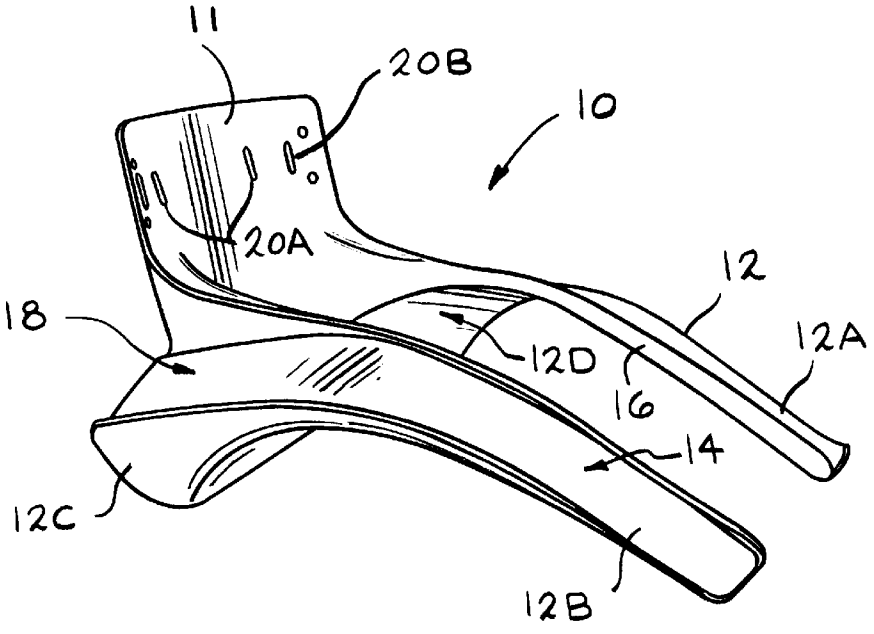

11
20B
10
20A
12
18
12D
12A
16
14
12C
12B

FIG. 3

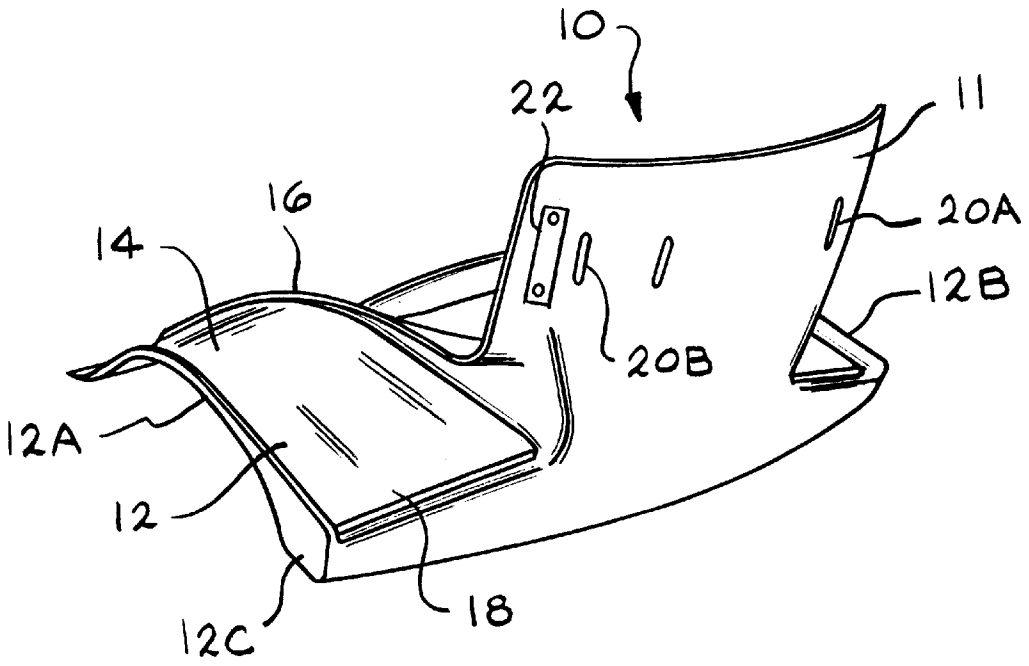

10
22
11
16
14
20A
12B
20B
12A
12
12C
18

FIG. 4

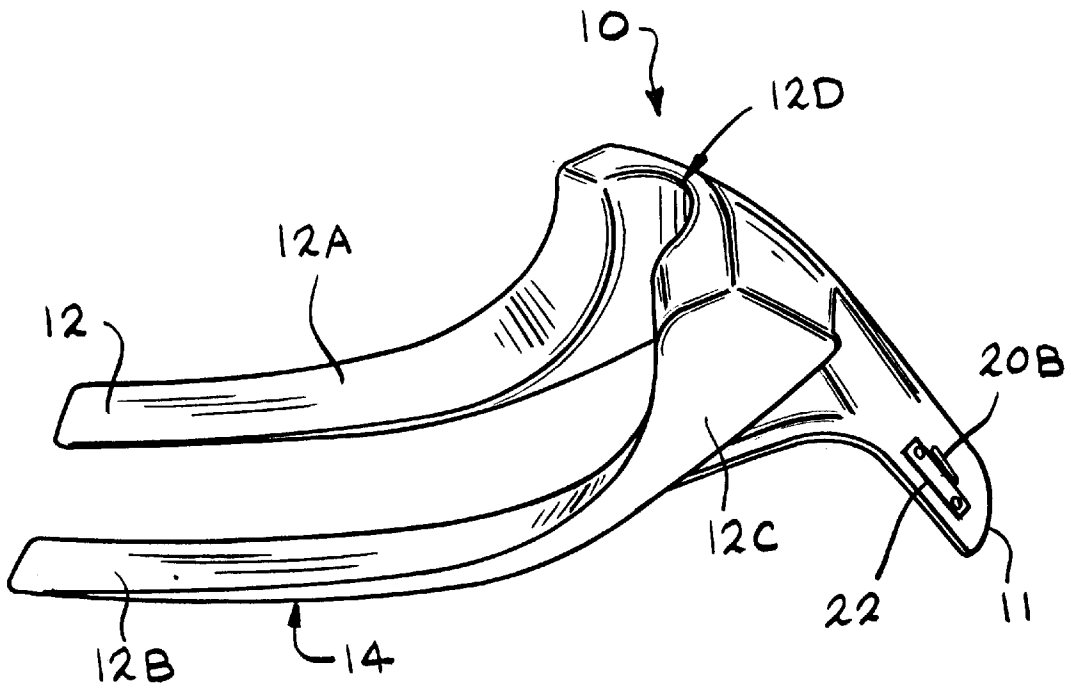

10
12D
12A
12
20B
12C
22
11
12B
14

FIG. 5

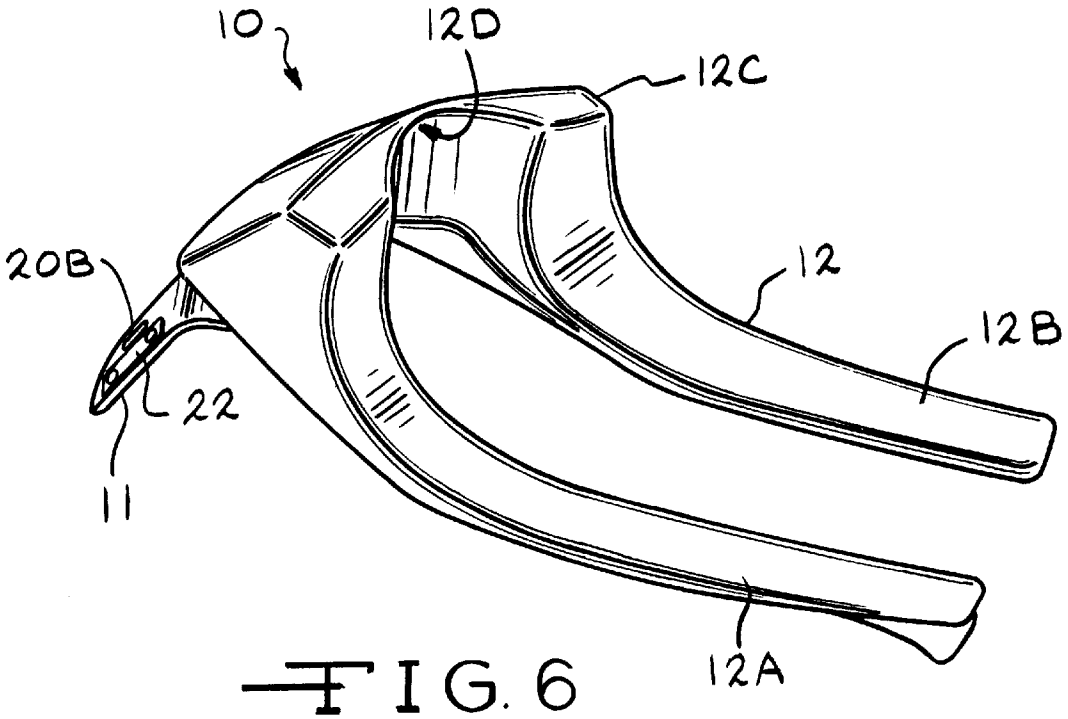


FIG. 6

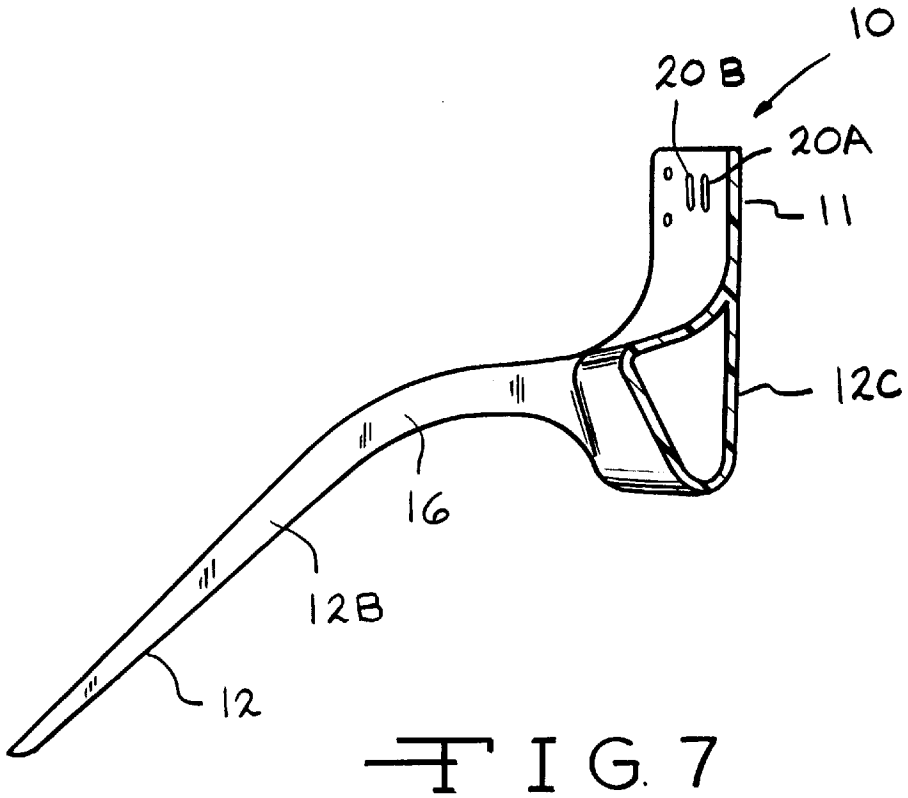


FIG. 7

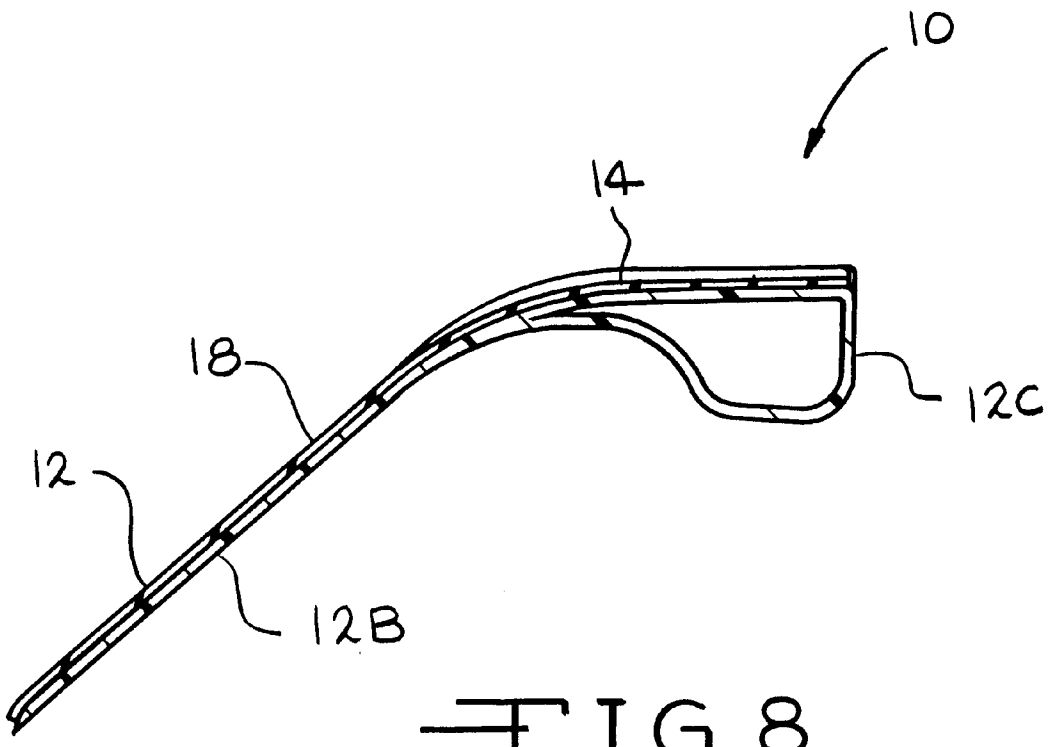


FIG. 8

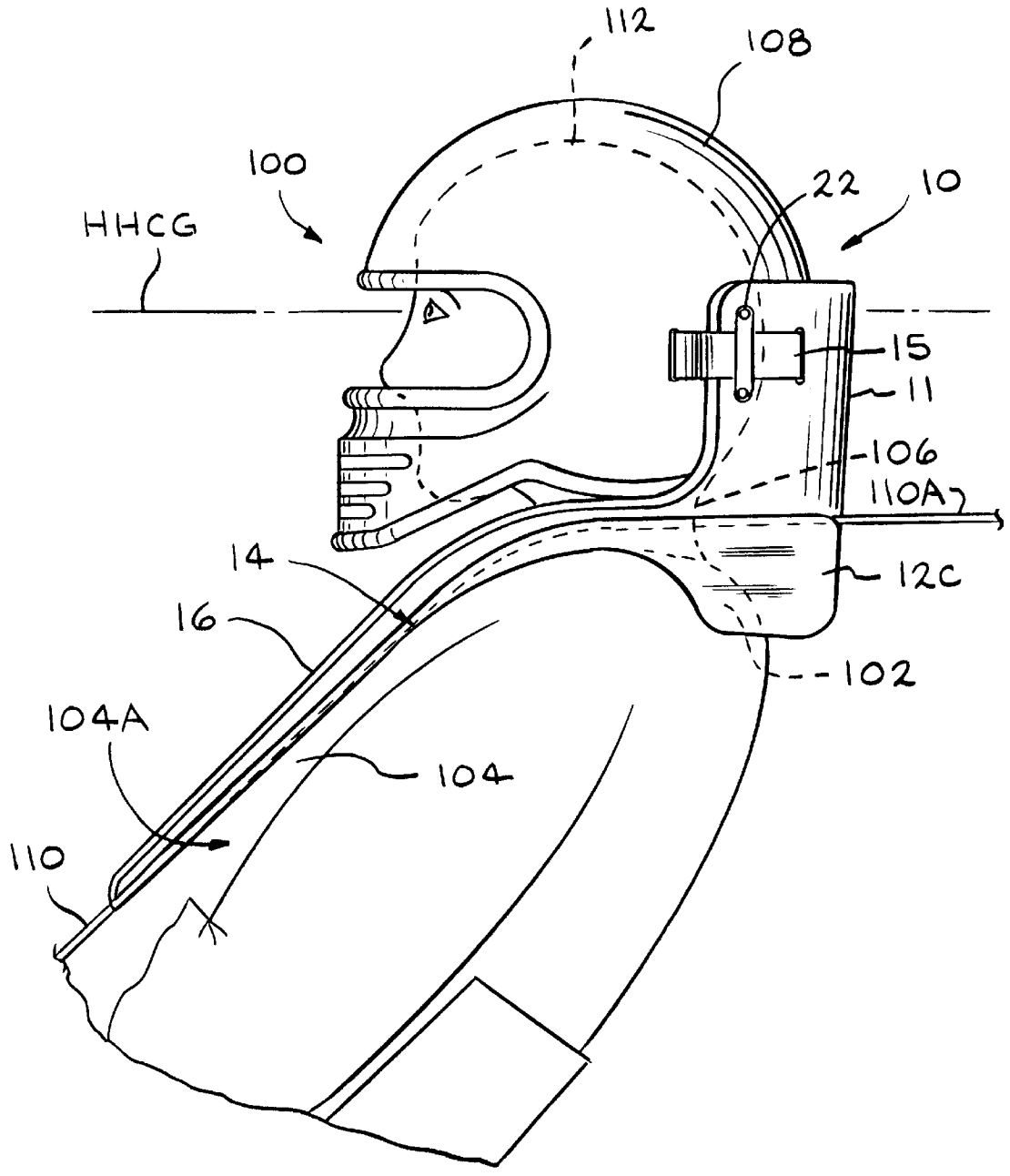


FIG. 9

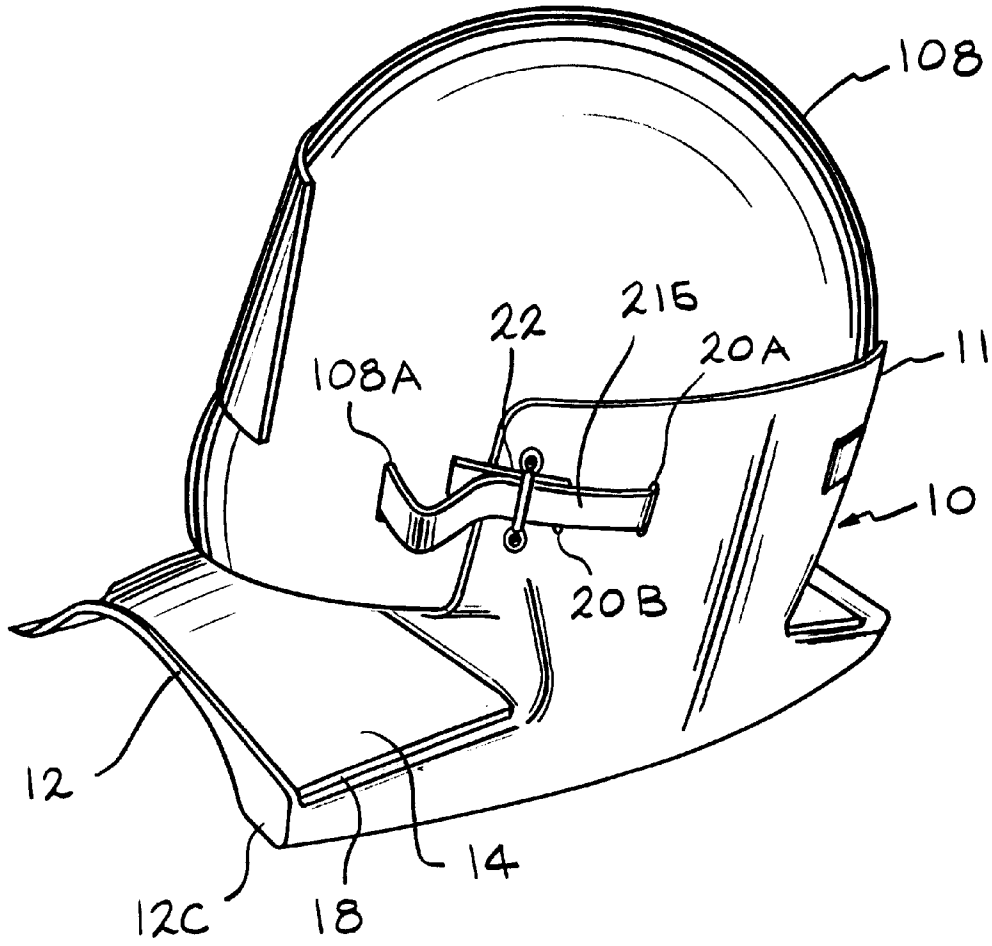


FIG. 10

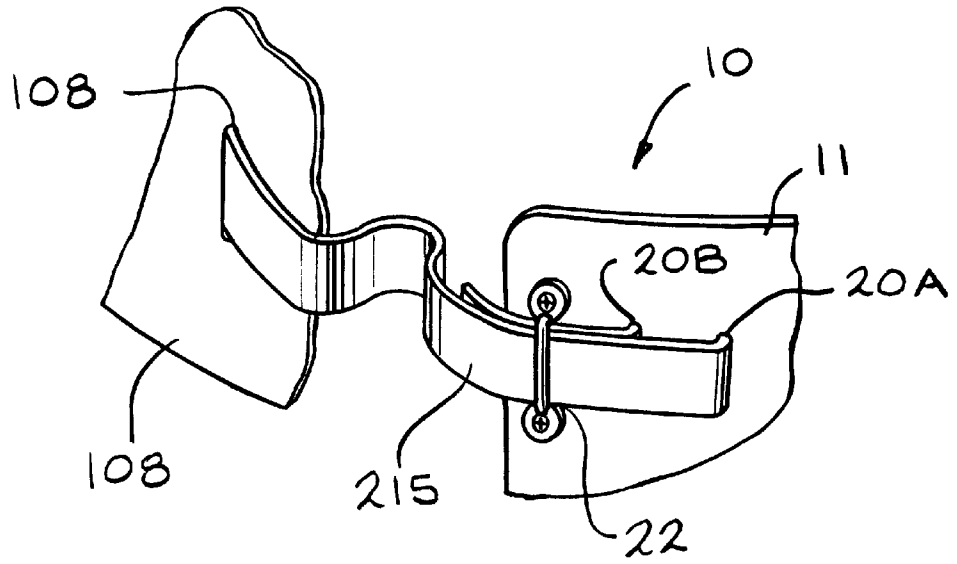


FIG. 11

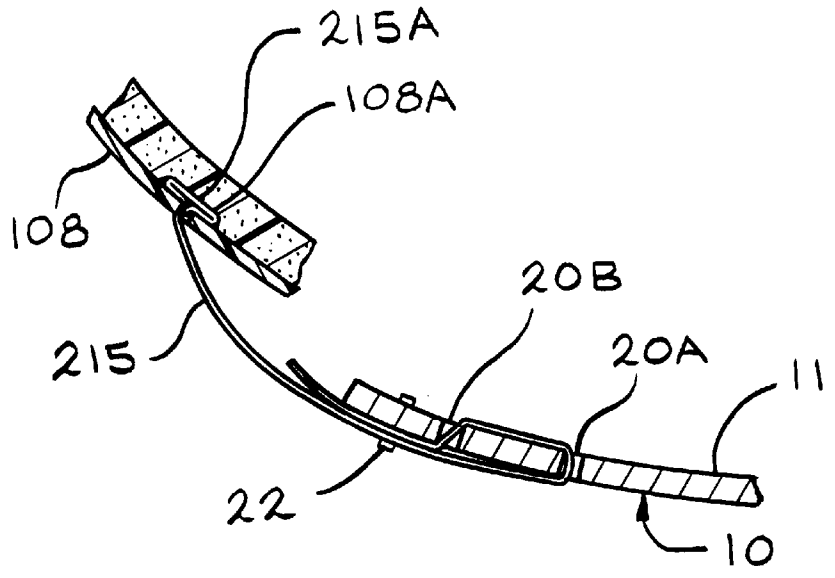


FIG. 12

HEAD AND NECK SUPPORT FOR RACING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application Ser. No. 60/072,957, filed Jan. 29, 1998.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

REFERENCE TO A "MICROFICHE APPENDIX"

Not Applicable

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention relates to an improved head and neck support device for use in high performance vehicles. In particular, the present invention relates to an improved head and neck support device which is mounted on the shoulders of the occupant of the vehicle and acts to transfer force away from the neck of the occupant through the device to the shoulder harness of the vehicle.

(2) Description of the Related Art

The present invention is an improvement of Applicant's earlier head and neck support device as described in U.S. Pat. No. 4,638,510 to Hubbard. Hubbard '510 describes a head and neck support device with tethers that are attached between the driver's helmet and the collar of the head and neck support device. The head and neck support device has a yoke integral with the collar that fits around the back of the occupant's shoulders, adjacent the neck, and on the front of the occupant's chest. The yoke has an opening so that the occupant can mount the head and neck support device by placing his head through the opening. In another embodiment of Applicant's original device, the yoke is provided with a slot in the front so that the occupant can put on the device from behind by sliding the device around his neck. The original head and neck support device has been made for approximately **300** occupants of race cars and boats. Several of these occupants have crashed and have not reported that they suffered significant head or neck injuries. Many of these occupants credit their head and neck support device with reduction or elimination of head and neck injuries.

The main problem with the original head and neck support device is that the loading from the tethers must be resisted by bending of the collar and yoke of the head and neck support device. This requires a substantial collar and yoke structure which occupies space between the bottom of the occupant's helmet and torso. Although the original head and neck support device functions effectively to reduce neck loads and head accelerations, it often interferes with the bottom of the occupant's helmet.

The related art has also shown various types of head support devices for use for occupants of a vehicle. Illustrative are U.S. Pat. No. 4,909,459 to Patterson; U.S. Pat. No. 4,923,147 to Adams et al and U.S. Pat. No. 5,267,708 to Monson et al.

Patterson describes a head restraint device which connects the helmet of the occupant to the vehicle seat. The head restraint has a restraining strap which applies a single force to the head to restrain the head from horizontal forward motion and a strap assembly on the helmet to hold the head upright. The restraining strap pulls the head directly back near the middle of the head and helmet. The restraining strap only applies the force when the deceleration forces are above a predetermined level. The attachment of the strap to the helmet allows the helmet to rotate about a vertical axis approximately 180°. The restraint can also be connected to the torso of the occupant to simultaneously retract the head and the torso. The restraint must be detached for the occupant to exit the vehicle.

Adams et al describes a seat insert for a vehicle which maintains an occupant of the vehicle in a forward position during high G acceleration. The seat insert has a head support member for supporting the occupant's head during a forward, leaning posture. A head support member restraint cord is provided to restrain the movement of the head support member during an occupant's forward lean. The top and bottom of the helmet are restrained to the head support member which is behind and above the top of the helmet. The head support member tends to resist motions of the occupant's head which are downward due to accelerations. The seat insert also includes a back plate assembly connected to the head support member for supporting the spine in its natural curvature. The back plate assembly is able to pivot forward relative to the seat of the vehicle. The seat insert is able to transfer G-induced weight from the spine to the back plate assembly and ultimately to the existing seat of the vehicle. The seat insert restrains the occupant relative to the seat and must rely on restraint of the torso to be compatible with the head restraint for restraining the head relative to the torso.

Monson et al describes a head support apparatus which can be attached to a body support device. The apparatus includes a beam housing attachable to the body support device such as to be rigid in the y-z plane but to be rotatable about an x-axis. The x-axis is defined as extending through the subject's face to the back of the head. The y-axis is defined as extending laterally from ear to ear and the z-axis is defined as extending vertically from the top of the head through the subject's chin. A U-shaped rigid beam is mountable in a channel of the beam housing such that the beam is rigidly supported within the x-y plane but is able to be rotated about the x-axis. Helmet attachments are provided for supporting the helmet relative to the rigid beam within the x-z plane but allowing rotation of the helmet about the y-axis.

There remains the need for a head and neck support device which is lightweight and easily mounted on the occupant without interfering with the occupant's mobility or comfort and which transfers force away from the head and neck of the occupant to the support harness of the vehicle.

SUMMARY OF THE INVENTION

The present invention is an improved head and neck support device for use in high performance vehicles. The device includes a restraining yoke and a collar. The restraining yoke has two front portions which extend down from the shoulders of the occupant along the torso of the occupant. The restraining yoke also includes a rear portion which extends behind the neck and the shoulders of the occupant. The collar of the device extends upward from the rear portion of the restraining yoke behind the head of the occupant and is connected by tethers to the helmet of the occupant. The front portions and rear portion of the yoke are provided with load bearing surfaces. The shoulder belts of the shoulder harness of the vehicle extend over the front portions and rear portion of the restraining yoke on the load

bearing surfaces when the device is mounted on the occupant such that the device is between the shoulder belts and the occupant. The collar acts to transfer the forces from the helmet through the tethers to the collar of the restraining yoke which transfers the forces through the load bearing surfaces to the shoulder belts of the shoulder harness thereby reducing the forces being transmitted to the neck of the occupant.

The substance and advantages of the present invention will become increasingly apparent by reference to the following drawings and the description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of the head and neck support device **10** mounted on the shoulders **102** of an occupant **100** and connected by tethers **15** to a helmet **108**.

FIG. **2** is a front view of the head and neck support device **10** showing the restraining yoke **12** and the collar **11**.

FIG. **3** is a side perspective view of the head and neck support device **10** showing the restraining yoke **12** and the collar **11**.

FIG. **4** is a back perspective view of the head and neck support device **10** showing the restraining yoke **12** and the collar **11**.

FIG. **5** is a bottom right side perspective view of the head and neck support device **10** showing the restraining yoke **12** and the collar **11**.

FIG. **6** is a bottom left side perspective view of the head and neck support device **10** showing the restraining yoke **12** and the collar **11**.

FIG. **7** is a cross-sectional view along the line **7**—**7** of FIG. **2** showing the rear portion **12**C of the restraining yoke **12**.

FIG. **8** is a cross-sectional view along the line **8**—**8** of FIG. **2** showing the front portion **12**B of the restraining yoke **12** with the friction material **18** on the load bearing surface **14**.

FIG. **9** is a side view of the head and neck support device **10** mounted on the occupant **100** having the positioning of the shoulder belts **110**A of the shoulder harness **110** on the load bearing surfaces **14**.

FIG. **10** is a perspective view of the head and neck support device **10** connected to the helmet **108** by an alternate tether **215**.

FIG. **11** is a partial view showing the alternate tether **215** connected between the head and neck support device **10** and the helmet **108**.

FIG. **12** is a cross-sectional view showing the alternate tether **215** connected between the helmet **108** and the head and neck support device **10**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to a head and neck support device for an occupant of a vehicle with a shoulder harness over shoulders of the occupant and a helmet on a head of the occupant and with a horizontal level center of gravity of the head and helmet combined at about eye level of the occupant, which comprises: a stiff restraining means including front portions and a rear portion relative to the occupant, the front portions contoured to fit a torso and shoulders of the occupant and the rear portion contoured to fit behind a neck and the shoulders of the occupant, the front and rear portions having load bearing surfaces on a side opposite the occupant wherein shoulder belts of the shoulder harness are in contact with the load bearing surfaces of the front and rear portions of the stiff restraining means when the occupant is secured in the vehicle; a stiff high collar mounted on the restraining means which extends upward from the rear portion of the restraining means to at least adjacent the horizontal level center of gravity of the head and helmet combined and adjacent the neck of the occupant which allows movement of the head to provide forward and lateral fields of view for the occupant; and tethering means attached between the collar and the helmet wherein the tethering means provides a restraint between the helmet and the collar which is in a substantially horizontal plane and wherein during normal vehicle operation or in a crash, the collar transmits forces to the restraining means from the tethering means and the load bearing surfaces of the restraining means transmit forces from the restraining means to the shoulder belts of the shoulder harness to allow the shoulder harness to provide resistance to the tethering means through the restraining means and collar thereby reducing the motions of the head relative to the torso and forces being transmitted to the neck of the occupant which may cause fatigue and injury in vehicle operation or in a crash.

Further, the present invention relates to a method for providing neck protection for an occupant of a high performance vehicle, the vehicle having a shoulder harness with shoulder belts for securing the occupant into the vehicle, which comprises: providing a helmet for a head of the occupant; providing a head and neck support device having a stiff restraining means including front portions and a rear portion relative to the occupant, the front portions contoured to fit a torso and shoulders of the occupant and the rear portion contoured to fit behind a neck and shoulders of the occupant, the front and rear portions having load bearing surfaces on a side opposite the torso of the occupant; a stiff high collar mounted on the restraining means which extends upward from the rear portion of the restraining means to at least adjacent a horizontal level center of gravity of the head and helmet combined and adjacent the neck of the occupant; and tethering means attached between the collar and the helmet; positioning the neck support device on the shoulders of the occupant such that the front portions of the restraining means are adjacent the torso of the occupant and the rear portion of the restraining means is adjacent the neck and shoulders of the occupant; positioning the helmet on the head of the occupant; attaching the tethering means between the collar of the neck support device and the helmet, wherein the tethering means provides a restraint between the helmet and the collar which is in a substantially horizontal plane; and securing the shoulder harness around the occupant such that the shoulder belts of the shoulder harness are adjacent and in contact with the load bearing surfaces of the front and rear portions of the restraining means of the neck support device, wherein during normal vehicle operation or in a crash, the collar transmits forces to the restraining means from the tethering means and the load bearing surfaces of the restraining means transmit forces from the restraining means to the shoulder belts of the shoulder harness to allow the shoulder harness to provide resistance to the tethering means through the restraining means and collar thereby reducing the motions of the head relative to the torso and forces being transmitted to the neck of the occupant which may cause fatigue and injury in vehicle operation or in a crash.

FIGS. **2** to **8** show the head and neck support device **10** of the present invention. FIGS. **1** and **9** show the neck support device **10** of the present invention mounted on a driver or other occupant **100** of a vehicle (not shown). The

device **10** includes a restraining yoke **12** and a collar **11** formed together as an integral piece. The restraining yoke **12** is U-shaped and has a pair of front portions or legs **12**A and **12**B extending outward from a rear portion **12**C. The front portions **12**A and **12**B extend forward from the rear portion **12**C. The bottom surface of the restraining yoke **12** is contoured such as to conform to the shoulders **102** and a front **104**A of the torso **104** or chest of the occupant **100** (FIGS. **5** and **6**). The inner surface of the rear portion **12**C of the restraining yoke **12** has a notch **12**D between the front portions **12**A and **12**B to accommodate the occupant's neck **106**. The rear portion **12**C of the restraining yoke **12** has a thickness such that a bottom of the rear portion **12**C extends down behind the shoulders **102** along the back of the occupant **100** while a top of the rear portion **12**C is spaced above the shoulders **102** (FIG. **1**). The rear portion **12**C of the restraining yoke **12** is preferably hollow such as to reduce the weight of the device **10** (FIGS. **7** and **8**).

The upper surface of the restraining yoke **12** along the front portions **12**A and **12**B and on the rear portion **12**C adjacent the front portions **12**A and **12**B is provided with load bearing surfaces **14** in the form of channels on the top surface of the restraining yoke **12** (FIGS. **2** and **3**). The load bearing surfaces **14** follow the shape of the upper surface of the yoke **12** along the front portions **12**A and **12**B and at the rear portion **12**C adjacent the front portions **12**A and **12**B above the shoulders **102** of the occupant **100**. The thickness of the rear portion **12**C of the restraining yoke **12** enables the load bearing surfaces **14** adjacent the rear portion **12**C of the restraining yoke **12** to be behind and essentially at a vertical level with the shoulders **102** of the occupant **100** (FIGS. **1** and **9**). The inner edge of the load bearing surfaces **14** is preferably provided with a raised lip **16** such as to prevent the shoulder belts **110**A of the shoulder harness **110** from slipping off the load bearing surfaces **14** toward the neck **106** of the occupant **100**. The width of the load bearing surfaces **14** is preferably greater than the width of the shoulder belts **110**A of the shoulder harness **110**. The load bearing surfaces **14** are preferably provided with a friction material **18** which resists the shoulder belts **110**A from slipping on the load bearing surfaces **14** and provides for better transference of force from the load bearing surfaces **14** to the shoulder harness **110**. The belt bearing surfaces **14** are preferably flat in cross-section.

The collar **11** extends upward from the rear portion **12**C of the restraining yoke **12** between the front portions **12**A and **12**B such that the collar **11** extends behind the head **112** of the occupant **100**. The collar **11** extends upward to at least the horizontal level center of gravity of the head and helmet combined (HHCG) of the occupant **100** (FIG. **1**). The collar **11** is preferably curved to follow the shape of the head **112** and helmet **108** of the occupant **100**. The collar **11** is provided with a pair of inner and outer openings **20**A and **20**B on the left and right sides of the collar **11** adjacent the shoulders **102** of the occupant **100**. The openings **20**A and **20**B allow for tethers or straps **15** to be connected between the collar **11** of the head and neck support device **10** and the helmet **108** positioned on the occupant **100**. The openings **20**A and **20**B are preferably elongate and have a length and width only slightly greater than the width and thickness of the tethers **15**. In the preferred embodiment, a loop **22** is provided on the left and right sides of the collar **11** adjacent the openings **20**A and **20**B on the outer surface of the collar **11** opposite the helmet **108**. The loop **22** allows for securing the tether **15** on the collar **11**. The tethers **15** extend from the openings **108**A on the left and right side of the helmet **108** through the pair of openings **20**A and **20**B on the left and right sides of the collar **11** such that the tether **15** is wrapped around the openings **20**A and **20**B and secured in the openings **20**A and **20**B.

In another embodiment as shown in FIGS. **10** to **12**, the tethers **215** extend through the opening **108**A in the helmet **108**, along the outer surface of the helmet **108** and under the loop **22** and along the outer surface of the collar **11**. The tethers **215** then extend into the inner opening **20**A of the collar **11** and back along the inner surface of the collar **11** and out through the outer opening **20**B of the collar **11** and under the loop **22**. The first end **215**A of the tether **215** is enlarged such that the first end **215**A does not move through the opening **108**A in the helmet **108** (FIG. **12**).

Tethers **15** or **215** are provided on the left and right side of the helmet **108**. The tethers **15** or **215** are preferably identical. The tethers **15** or **215** are connected in such a way as to allow side to side turning motion of the head **112** of the occupant **100**. In the preferred embodiment, the tethers **15** or **215** have a fixed length. The length of the tethers **15** or **215** is such as to allow some mobility of the head **112** while preventing fatigue and potentially injurious head motions. The length of the tethers **15** or **215** preferably allows the occupant **100** to have the ability to rotate his head **112** to increase his sight area. The occupant **100** is preferably able to move his head **112** such as to have forward and lateral fields of view. The tethers **15** or **215** preferably restrict turning motion of the head **112** to about 45° on either side of center. The tethers **15** or **215** are securely but somewhat flexibly secured to the collar **11**. The tethers **15** or **215** are preferably constructed of a relatively inextensible, fibrous strap material. The tethers **15** or **215** are connected between the collar **11** and the helmet **108** so that the tethers **15** or **215** are essentially in a horizontal plane at or adjacent the horizontal level of the center of gravity of the head and helmet combined (HHCG). The restraining yoke **12** and collar **11** are preferably constructed of a lightweight, durable, stiff and inflexible material such as a carbon fiber composite or a high impact resistant plastic material.

In Use

The device **10** of the present invention is mounted on the occupant **100** such that the front portions **12**A and **12**B of the restraining yoke **12** extend down along the chest or front **104**A of the torso **104** of the occupant **100**, the rear portion **12**C of the restraining yoke **12** extends behind the neck **106** and shoulders **102** of the occupant **100** and the collar **11** extends upward essentially vertically behind the head **112** of the occupant **100**. In the preferred embodiment, the collar **11** is spaced apart from the helmet **108** of the occupant **100**. The device **10** is mounted such that the neck **106** of the occupant **100** is adjacent the notch **12**D of the rear portion **12**C of the restraining yoke **12**. In the preferred embodiment, the front portions **12**A and **12**B of the restraining yoke **12** adjacent the front **104**A of the torso **104** of the occupant **100** are positioned such that an angle α with the horizontal as defined by the horizontal axis **114** of the vehicle is approximately 30° to 50° when the device **10** is securely held in place on the occupant **100** and the occupant **100** is sitting in the vehicle (FIG. **1**).

The device **10** is securely held in place by the shoulder belts **110**A of the shoulder harness **110** when the occupant **100** is securely belted into the vehicle. The device **10** is only secured to the occupant **100** of the vehicle by the shoulder belts **110**A. This allows the occupant **100** to exit the vehicle without having to remove the device **10**. The shoulder belts **110**A of the shoulder harness **110** extend along the load bearing surfaces **14** of the restraining yoke **12** such that the restraining yoke **12** is between the shoulder belts **110**A and

the occupant **100** and the load bearing surfaces **14** are above and behind the occupant's shoulders **102** and between the occupant's shoulders **102** and the seat back (not shown) (FIGS. **1** and **9**). The load bearing surfaces **14** of the restraining yoke **12** at the rear portion **12**C are positioned such that the shoulder belts **110**A of the shoulder harness **110** adjacent the rear portion **12**C are substantially parallel with the horizontal level of the top of the shoulders **102** of the occupant **100**. The shoulder belts **110**A of the shoulder harness **110** hold the restraining yoke **12** securely in contact with the front **104**A of the torso **104** and the shoulders **102** of the occupant **100** during both normal vehicle operation and during a crash. The collar **11** of the device **10** is connected by the tethers **15** or **215** to the helmet **108** on the head **112** of the occupant **100**. The connection of the tethers **15** or **215** to the helmet **108** tends to pull the entire device **10** forward and the rear portion **12**C and collar **11** of the device **10** upward. In addition, since the forces exerted by the tethers **15** or **215** are near the top of the head and neck support device **10** and above the shoulder harness **110** which is holding the head and neck support device **10** to the torso **104** of the occupant **100**, the rear portion **12**C of the head and neck support device **10** tends to rotate upward and forward which is resisted by downward and rearward forces from the shoulder belts **110**A on the load bearing surfaces **14** at the rear portion **12**C of the yoke **12**. During a crash, the tethers **15** or **215** carry tension forces from the helmet **108** to the collar **11** of the head and neck support device **10**.

In rearward vehicle acceleration or frontal crash (such as in applying the brakes or striking something with the front of the vehicle) with forward head motion relative to the torso **104**, the restraining yoke **12** will tend to move forward relative to the vehicle and rotate with the top of the collar **11** moving forward relative to the bottom due to the head/helmet restraining forces. The tendency for the restraining yoke **12** to move forward will be restrained by the shoulder belts **110**A in much the same way as normally occurs without the device **10** present. The tendency for the top of the device **10** to rotate forward such that the rear of the device **10** moves up will be restrained by the shoulder belts **110**A acting downward and rearward on the load bearing surfaces **14** of the restraining yoke **12** adjacent the top of and to the rear of the shoulders **102**. This constraint of rotation will also reduce the tendency of the front, lower part of the restraining yoke **12** to load the lower part of the rib cage. The body of the occupant **100** also tends to move forward relative to the vehicle. The torso **104** of the occupant **100** is restrained by rearward force from the shoulder harness **110** and the restraining yoke **12**. The shoulder harness **110** includes shoulder belts **110**A over his shoulders **102**, around his lap and between his legs. The head and neck support device **10** is held in place on the torso **104** of the occupant **100** by the shoulder harness **110**. The head **112** tends to continue moving forward but is restrained to move with the torso **104** as a result of the forces applied through the tethers **15** or **215**. Thus, the vehicle is accelerated rearward, the head **112**, torso **104** and restraining yoke **12** move forward relative to the vehicle, the torso **104** and restraining yoke **12** are restrained by the shoulder harnesses **110** and the head **112** and helmet **108** are restrained to move with the torso **104** by the device **10**. The forces to restrain the head **112** and helmet **108** will be predominately carried through the device **10** to the shoulder belts **110**A. The tether forces restraining the head **112** reduce the loading of the neck **106**. Thus, these tether forces reduce the fatiguing demands on the neck **106** and the potential for injury from the loads that would be present without the device **10**. The tethers **15** or **215** also protect the occupant **100** from extreme head and neck motion relative to the torso **104**. The loads from the tethers **15** or **215** are transmitted through the collar **11** and restraining yoke **12** to the torso **104** and shoulder belts **110**A of the shoulder harness **110**. The friction material **18** attached to the load bearing surfaces **14** increases the frictional forces acting rearward on the load bearing surfaces **14** from the shoulder belts **110**A. In this way, the load bearing surfaces **14** effectively restrain the head and neck support device **10** to carry the tether forces which restrain the head **112** of the occupant **100** to move with the torso **104**.

In a frontal crash, the acceleration forces and the restraint forces on the occupant **100** are primarily horizontal. The horizontal tethers **15** or **215** restrain the motions of the occupant's head **112** such that the occupant's head **112** moves with the occupant's torso **104** which reduces the forces applied to the occupant's neck **106** that may cause injuries to the head **112** and neck **106**. The tethers **15** or **215** also reduce head motions and accelerations that are due to head rotations in side view. The shoulder belts **110**A apply downward and rearward loads on the load bearing surfaces **14**, adjacent to and behind the shoulders **102** of the occupant **100** to counteract the tether forces acting between the collar **11** of the head and neck support device **10** and the helmet **108** of the occupant **100**. The loads from the shoulder belts **110**A on the load bearing surfaces **14** act through the device **10** and the tethers **15** or **215** to resist the forward motions of the head **112** of the occupant **100** relative to the torso **104** of the occupant **100**. Because the head and neck support device **10** is between the occupant's torso **104** and the shoulder harness **110**, the forces that restrain the helmeted head **112** are transmitted through the head and neck support device **10** to the occupant's torso **104** and the shoulder harness **110**.

In a rear crash with forward acceleration, the occupant **100** tends to move rearward and upward because of the angle of the seat back. The structure that supports the head **112** moves rearward with the front **104**A of the torso **104**. The friction with the shoulder belts **110**A of the shoulder harness **110** slows the occupant **100** as the torso **104** of the occupant **100** moves forward relative to the shoulder harness **110**. The device **10** is between the occupant's shoulders **102** and the shoulder belts **110**A to increase the forces from the shoulder belts **110**A and to create more downward force as the occupant **100** slides up the seat back. Thus, the head and neck support device **10** improves the restraint of the occupant's upper torso **104** in a rear crash.

In sideways acceleration (such as in striking an object with the side of the vehicle), assume, for the sake of illustration, that the vehicle is accelerated to the left as would occur in turning toward the left or striking an object with right side of the vehicle and that forces and motions are expressed relative to the vehicle. The torso **104** is restrained by the seat and harness **110**. The helmet **108** and head **112** are restrained to accelerate to the left with the torso **104** by tension in the tethers **15** or **215** on the left side and by contact with the collar **11** on the right side. The tethers **15** or **215** are configured so that with sidewards motion the helmeted head **112** also moves rearward into the collar **11**. In sideways acceleration, the loads on the collar **11** from the helmeted head **112** tend to rotate the top of the restraining yoke **12** away from the direction of the acceleration (top toward the right in the current example). The restraining yoke **12** tends to move downward onto the right shoulder **102** and upward off of the left shoulder **102**. This tendency to rotate is resisted by the forces between the restraining yoke **12** and the right shoulder **102** and between the restraining yoke **12** and the shoulder harness **110** on the left side. The head **112**,

helmet **108** and device **10** also tend to move to the right. This motion is resisted by the shoulder harness **110** on the right and, to some extent, by the shoulder belt **110**A on the load bearing surfaces **14** on the left side of the restraining yoke **12** and the contact between the collar **11** and the upper shoulders **102** and neck **106**.

Thus, the accelerations of the head **112**, helmet **108**, neck **106** and torso **104**, with components in forward, rearward or sideward directions, are restrained as combinations of the mechanical responses described above.

The load bearing surfaces **14** extend rearward from the top of the occupant's shoulders **102** so that, when racing, these load bearing surfaces **14** lie below the shoulder belts **110**A of the shoulder harness **110**. Since the shoulder belts **110**A can be secured to the vehicle below the edge of the load bearing surfaces **14** at the rear portion **12**C of the device **10**, the load bearing surfaces **14** of the head and neck support device **10** will be loaded by the shoulder belts **110**A while the occupant **100** is racing and this loading of the head and neck support device **10** is transmitted to the occupant's shoulders **102** to help hold the occupant **100** down in the seat.

The load bearing surfaces **14** provide a load path for the forces from the tethers **15** or **215** through the head and neck support device **10** to the shoulder belts **110**A. This loading path through the head and neck support device **10** makes possible the removal of material from the head and neck support device **10**, between the helmet **108** and the shoulder belts **110**A that was needed in the original head and neck support device for bending resistance (U.S. Pat. No. 4,638, 510). The head and neck support device **10** of the present invention is small and easy to handle which enables occupants **100** to wear the device **10** with very little interference between the head and neck support device **10** and the helmet **108**.

It is intended that the foregoing description be only illustrative of the present invention and that the present invention be limited only by the hereinafter appended claims.

I claim:

1. A head and neck support device for an occupant of a vehicle with a shoulder harness over shoulders of the occupant and a helmet on a head of the occupant and with a horizontal level center of gravity of the head and helmet combined at about eye level of the occupant, which comprises:

(a) a stiff restraining means including front portions and a rear portion relative to the occupant, the front portions contoured to fit a torso and shoulders of the occupant and the rear portion contoured to fit behind a neck and the shoulders of the occupant, the front and rear portions having load bearing surfaces on a side opposite the occupant wherein shoulder belts of the shoulder harness are in contact with the load bearing surfaces of the front and rear portions of the stiff restraining means when the occupant is secured in the vehicle;

(b) a stiff high collar mounted on the restraining means which extends upward from the rear portion of the restraining means to at least adjacent the horizontal level center of gravity of the head and helmet combined and adjacent the neck of the occupant which allows movement of the head to provide forward and lateral fields of view for the occupant; and

(c) tethering means attached between the collar and the helmet wherein the tethering means provides a restraint between the helmet and the collar which is in a substantially horizontal plane and wherein during normal vehicle operation or in a crash, the collar transmits forces to the restraining means from the tethering means and the load bearing surfaces of the restraining means transmit forces from the restraining means to the shoulder belts of the shoulder harness to allow the shoulder harness to provide resistance to the tethering means through the restraining means and collar thereby reducing the motions of the head relative to the torso and forces being transmitted to the neck of the occupant which may cause fatigue and injury in vehicle operation or in a crash.

2. The head and neck support device of claim **1** wherein the front and rear portions of the restraining means have channels which form the load bearing surfaces and accommodate the shoulder belts of the shoulder harness.

3. The head and neck support device of claim **2** wherein the channels have an inner lip which prevents the shoulder belts of the shoulder harness from moving inward toward the neck of the occupant.

4. The head and neck support device of claim **1** wherein in normal vehicle operation, the collar is spaced apart from the helmet of the occupant.

5. The head and neck support device of claim **1** wherein the restraining means and the collar are an integral piece.

6. The head and neck support device of claim **1** wherein the tethering means is attached between the collar and the helmet adjacent the horizontal level center of gravity of the head and helmet combined.

7. The head and neck support device of claim **1** wherein the tethering means is two straps connected to opposite sides of the collar adjacent each shoulder of the occupant.

8. The head and neck support device of claim **7** wherein the straps are of such a length as to allow side to side turning movement of the head of the occupant.

9. The head and neck support device of claim **7** wherein the straps extend through openings in the helmet along an outside of the helmet and an outside surface of the collar and in through a first opening in the collar and along an inside surface of the collar and back through a second opening in the collar.

10. The head and neck support device of claim **9** wherein a first end of the straps has an enlarged portion which prevents the first end of the straps from moving through the openings in the helmet.

11. The head and neck support device of claim **1** wherein the rear portion has a thickness such that a bottom of the rear portion contacts a back of the occupant adjacent the shoulders and a top of the rear portion having the load bearing surfaces is spaced above the shoulders of the occupant.

12. The head and neck support device of claim **11** wherein the rear portion of the restraining means is hollow such as to reduce the weight of the device.

13. The head and neck support device of claim **1** wherein the load bearing surface of the rear portion is positioned such that the shoulder belts of the shoulder harness on the load bearing surfaces of the rear portion are substantially parallel with the horizontal level of a top of the shoulders of the occupant.

14. The head and neck support device of claim **1** wherein an inner side of the rear portion has a notch to accommodate a neck of the occupant.

15. The head and neck support device of claim **1** wherein the load bearing surfaces are provided with a friction material which increases frictional forces between the load bearing surfaces and the shoulder belts.

16. The head and neck support device of claim **1** wherein there are two front portions which extend from the rear

portion down a front of the torso of the occupant on each side of the neck.

17. A method for providing neck protection for an occupant of a vehicle, the vehicle having a shoulder harness with shoulder belts for securing the occupant into the vehicle, which comprises:

(a) providing a helmet for a head of the occupant;

(b) providing a head and neck support device having a stiff restraining means including front portions and a rear portion relative to the occupant, the front portions contoured to fit a torso and shoulders of the occupant and the rear portion contoured to fit behind a neck and shoulders of the occupant, the front and rear portions having load bearing surfaces on a side opposite the torso of the occupant; a stiff high collar mounted on the restraining means which extends upward from the rear portion of the restraining means to at least adjacent a horizontal level center of gravity of the head and helmet combined and adjacent the neck of the occupant; and tethering means attached between the collar and the helmet;

(c) positioning the neck support device on the shoulders of the occupant such that the front portions of the restraining means are adjacent the torso of the occupant and the rear portion of the restraining means is adjacent the neck and shoulders of the occupant;

(d) positioning the helmet on the head of the occupant;

(e) attaching the tethering means between the collar of the neck support device and the helmet, wherein the tethering means provides a restraint between the helmet and the collar which is in a substantially horizontal plane; and

(f) securing the shoulder harness around the occupant such that the shoulder belts of the shoulder harness are adjacent and in contact with the load bearing surfaces of the front and rear portions of the restraining means of the neck support device, wherein during normal vehicle operation or in a crash, the collar transmits forces to the restraining means from the tethering means and the load bearing surfaces of the restraining means transmit forces from the restraining means to the shoulder belts of the shoulder harness to allow the shoulder harness to provide resistance to the tethering means through the restraining means and collar thereby reducing the motions of the head relative to the torso and forces being transmitted to the neck of the occupant which may cause fatigue and injury in vehicle operation or in a crash.

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