Title: DRIVER SIDE AIRBAG MODULE WITH IMPROVED VENT

Abstract: A driver side airbag module (10) mounted on a steering wheel (68) has a housing or base (12), an inflator (20) and an airbag cushion (30). The airbag cushion (30) has a driver facing outer portion (36) and a steering wheel facing inner portion (33) with a vent opening (32). A tether (50) is affixed to an inside surface (37) of the outer portion (36) at a first end (53) and extending rearwardly to a second end (51) affixed to the inner portion (33). A tether cover (40) is sewn to the inner surface (31) of the inner portion (33). The tether (50) covers the vent opening (32) on inflation and while under tension blocks and seals the vent opening (32). When the occupant or driver (2) rides into the airbag (30) and upon the front portion contacting the driver (2), the tether (50) slackens and is pushed outward the vent opening (32).
DRIVER SIDE AIRBAG MODULE WITH IMPROVED VENT

Field of the Invention
[001] This invention relates to a driver side airbag module assembly, more particularly to an improved venting of the airbag cushion.

Background of the Invention
[002] Airbag cushions are designed to inflate rapidly when activated to provide occupant protection. Driver side airbag module assemblies protect the driver by a rapid generation of inflation gases to fill the airbag cushion. To further protect the occupant, vent openings are often provided. These openings allow gases to escape to reduce the pressure inside the cushion.

[003] Often to offset the gases lost due to venting, more propellant is required in the inflator. This increases the cost of the device. It therefore would be desirable to have an airbag cushion that can be vented while also reducing the lost gases caused by venting. The present invention described as follows achieves this objective.

Summary of the Invention
[004] A driver side airbag module mounted on a steering wheel assembly has a module housing, an inflator and an airbag cushion. The airbag cushion has a driver facing outer (or front portion) portion and a steering wheel facing inner portion with a vent opening. A tether is affixed to an inside surface of the outer portion at a first end and extends rearwardly to a second end affixed to the inner portion. The second end is located and fixed past the vent opening so a portion of the tether overlays the opening. A tether vent cover is sewn to the inner surface of the inner portion. The vent cover is sewn adjacent to at least two sides of the tether. The vent cover has an opening overlying the tether and the vent opening of the inner portion. The tether covers the vent opening on inflation and while under tension blocks and seals the vent opening. When the driver rides into the inflating cushion and upon the front portion contacting the driver, the tether slackens and is pushed outward the vent opening by the inflation gases to open the vent to exhaust the inflation gases. The driver side airbag module preferably includes a single stage inflator.
The tether preferably is a one-piece structure having a wide portion under the tether vent cover. The tether vent cover is stitched to the inner surface of the inner portion adjacent to three sides of the tether.

In a preferred embodiment, the tether vent cover is stitched to the inner portion adjacent to four sides of the tether and has a slit opening through which a portion of the tether passes. The tether is sandwiched between the vent cover and inner surface of the inner portion forming three layers of material and the expanding inflation gases seal the respective layers as the tether exerts tension between the fixed first and second ends. The tether can be constructed having a narrow portion between the wide portion and the first end. The narrow portion upon relaxation of tension slides through the slit as the inflation gases push the portion of the tether overlying the vent outside the airbag vent opening, where the tether outside the opening forms a hood over the vent opening deflecting the escaping gases when the vent is opened.

The first end of the tether is affixed internally at a location on the outer portion along a centerline of the airbag between 12 o'clock and 6 o'clock between a driver's chest and head. The vent opening on the inner portion lies on a position less than 12 o'clock to 3 o'clock, wherein 12 o'clock is the top center of the steering wheel and 3 o'clock is the mid location toward the passenger compartment. Preferably, the vent opening is located at about 1 and 2 o'clock. Most preferably, the vent opening is located at 2 o'clock. The vent opening extends radially outward of the steering wheel rim. The vent opening is located between an outer diameter of the inflated cushion and the rim of the steering wheel. The vent opening is closer to the outer diameter of the inflated cushion. In one embodiment, the vent opening is located offset from the driver and inward toward the passenger compartment. The vent opening is located in an upper quadrant of the cushion toward the passenger compartment. Alternatively, the vent opening can be located in an upper quadrant of the cushion toward the driver door, the vent opening is located offset from the driver and inward toward the driver door, preferably at 10 o'clock in this alternative embodiment. In some regions the steering wheel may be on opposite side of the vehicle relative to other regions, therefore the 10 o'clock location may be directed toward the passenger compartment. In any event, the center top of the steering location should be avoided.
**Brief Description of the Drawings**

The invention will be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is a side or plan view of the inflated deployed airbag module assembly of the present invention.

FIG. 2 is a half cross sectional view of the airbag module assembly shown mounted on a steering wheel.

FIG. 3A is an enlarged view of an exterior portion of the airbag cushion showing the tether covering the vent opening; the tether and vent location of the inner portion of the airbag cushion is shown surrounded by a stitched seam which secures the internal vent cover.

FIG. 3B is an enlarged view of the interior of the airbag cushion, the airbag cushion being turned inside out, showing the tether cover, the tether and vent location on the inner portion of the airbag, the vent cover being stitched to the inner portion having a slit through which the tether can slide.

FIG. 3C is an enlarged view of the tether cover, the tether and vent location of the exterior surface of the inner portion of the airbag, showing how the tether can be pushed out through the vent open and extended out of the airbag.

FIG. 3D is a view of the exterior of the inner portion showing an inflator opening and the vent of the airbag cushion.

FIG. 4 is a cross sectional schematic view of the inflated airbag showing the tether under tension sealing the vent opening.

FIG. 5 is a view of an occupant inwardly deflecting the airbag to create a slack in the tether allowing the tether to be pushed through the vent opening thereby opening the vent.

FIG. 6 is a sequence of high speed photos showing the deployed airbag with the vent location oriented at 2 o'clock.

FIG. 7 is a sequence of photos showing the vent opening when positioned at 12 o'clock being obstructed by the driver.

FIG. 8 is a second set of sequential photos showing the vent opening when positioned at 12 o'clock obstructed by the rim of the steering wheel.
Detailed Description of the Invention

[009]  With reference to figure 2, a driver side airbag module 10 is illustrated mounted onto a steering wheel assembly 68. The steering wheel assembly 68 has a mounting post 70 for locating and centering the airbag module 10 relative to an opening 14 on a base plate or housing 12. The airbag cushion 30 is shown enveloping the inflator 20, the inflator 20 has a plurality of openings 22 through which inflation gases pass to fill the airbag cushion 30. As shown, the airbag module 10 in this exemplary embodiment has the airbag cushion 30 mounted to the base plate or housing 12 occupying a space 64. Alternatively, the airbag cushion 30 can be mounted such that the inflator 20 rests inside the airbag cushion 30 sandwiching the cushion between the inflator and the base plate when mounted to the module housing or base plate 12. The module housing or base plate 12 can include a cover 72 that encases the entire assembly. As shown, this assembly is only one exemplary example of how the driver side airbag module 10 assembly can be constructed. Alternative shapes and configurations can be used.

[010]  It is important to note that the inflator 20 can be of a small size with a significantly reduced amount of propellant due to the unique construction of the airbag cushion 30. As illustrated the inflator 20 is a single stage inflator greatly reducing the amount of propellant needed to inflate the airbag due to the unique construction of the airbag cushion 30.

[011]  In figure 1, the airbag cushion 30 is shown in its inflated deployed condition with a simulated driver occupant 2 seated in front of the airbag cushion 30 and the steering wheel 68 and prior to the head coming into contact with the airbag cushion 30 on deployment and the airbag cushion is fully inflated in the absence of any venting until the occupant's upper body impinges directly into the outer portion 36 of the airbag cushion 30. As further described below in this condition, an internal tether 50 is maintaining a vent opening 32 in a sealed and closed condition.

[012]  The vent opening 32, as shown in figures 3A-3C, has a vent cover 40 that is encircling 360 degrees around the tether 50. The vent cover 40 is secured directly to the inner surface 31 of the inner portion 33 of the airbag cushion 30 along the seam 41 or some other joinder technique such as welding. This enables the vent cover 40 to sandwich a wide portion 52 of the tether 50 between a vent opening 32 on the inner portion 33 and the vent cover 40. Under this construction, three layers of material are overlaid. The vent cover 40 having an opening 42 as illustrated allows the inflation gases to pass and push on the tether 50 during deployment. This pushing on the tether 50 will not release the tether 50 from the closed vent
condition, but will rather tightly seal the opening 32 on the inner portion 33 of the airbag cushion 30 as the internal pressures push against the vent cover 40 the tether 50 and the underlying portion 33 tensioning all of them against the other sealing them tightly. As shown in figure 3B, a narrow portion 54 of the tether 50 is shown extending through a slit 44 in the tether vent cover 40. This narrow portion 54 of the tether 50 extends outward from the vent cover 40 and is integrally attached or a part of the wide portion 52 of the tether 50. Some of tether 50 is fixed along sides at widest portion 52. The wide portion 52 of the tether 50 is fixed at the second end 51 by the portion of the seam 41 extending past the vent opening 32, but is free to move along the sides under the cover 40.

[0013] With reference to figure 3A, the external portion of the airbag cushion 30 is shown. The stitching seam 41 around the periphery of the inner portion shows the vent opening 32 as a square opening. The wide portion 52 of the tether 50 is inside and under the cover 40. The stitching 41 holding the vent cover 40 to the inner surface 31 of the airbag is shown on the exterior portion of the inner portion 33 of the airbag cushion 30. An opening 24 into which an inflator 20 can be positioned is also shown. In figure 3C, the tether 50 is shown extending out of the vent opening 32 illustrating a vent open condition. As shown, the inner portion 33 and outer portion 36 can be stitched together along seam 35. In figure 3D, a large opening 24 into which an inflator can pass is surrounded by a plurality of adjacent holes 25 in which mounting bolts on the inflator 20 can be passed. The inflator 20 when positioned internal of the airbag can then have the airbag cushion 30 folded about it and folded into the module housing and cover during final assembly.

[0014] With reference to figures 4 and 5, when the airbag cushion 30 is deployed and the inflation gases from the inflator 20 fill the airbag cushion, the airbag cushion 30 expands rapidly outwardly and the tether 50 which is attached at a first end 53 to the inner surface 37 of a front outer portion 36 of the airbag cushion 30 is tensioned as the gases expand the inside of the airbag cushion 30 to its fully inflated condition. The opposite second end 51 of the tether 50 is stitched to the interior surface 31 of the inner portion 33 of the airbag 30 and can also be stitched along this edge through the cover at seam 41 such that all three layers are tightly secured together at the second end 51. It is understood the sides of the tether 50 are not fixed and are free except along sides which are partially fixed at wide portion of tether. As the occupant 2 impacts the airbag 30 as shown in figure 5, the driver's head 4 impacting the airbag cushion 30 causes a release in tension in the tether 50 such that the tether 50 is free to move and is pushed by the inflation gases outward of the vent opening 32 in such a fashion that the second fixed end 51 holds the tether 50 at one end as the slackness of the tether 50 is
created by the deflection of the airbag cushion 30. A hood shaped arch is created by the tether 50 extending out the vent opening 32 as the inflation gases pass from the tether 50 as it is pushed external of the airbag cushion 30. This construction is unique in that the entire tether 50 and vent cover 40 are internal of the airbag cushion 30 until the tether 50 is deflected, slackened and allowed to push outside of the airbag cushion 30. When this occurs, the vent is fully opened at the vent opening 32 and the airbag cushion 30 will continue to vent, preventing further increases in pressure in the airbag.

**[0015]** An important aspect of the present invention is shown in figure 6 wherein a photographic sequence under high speed is taken showing airbag deployment as the dummy simulated driver 2 is shown impacting the inflated airbag cushion 30. As shown, the vent opening 32 is positioned at approximately the 2 o'clock position. It is noted that it is less than the 12 o'clock position; the 12 o'clock position being the top of the steering wheel 68. The 3 o'clock position is at a horizontal or midline of the steering wheel 68 extending in toward the passenger compartment in the illustrated embodiment. As the occupant 2 impinges into the airbag cushion 30, the tether 50 is shown bulging outward of the inner portion 33 of the airbag cushion 30 creating an exhaust and venting condition.

**[0016]** With reference to figures 7 and 8, it has been noted that when the tether 50 according to the present invention was positioned at the 12 o'clock position under the rim 69 of the steering wheel 68 the occupant's head 4 could impact the vent opening 32 and actually obstruct the release of gases in such a fashion that an inferior venting or exhaust condition could occur. In figure 8, another scenario of deployment is shown wherein the occupant 2 is impacting the airbag cushion 30 early on during the inflation and the vent opening 32 when positioned at the 12 o'clock position would actually be positioned under the steering wheel rim 69 and the rim 69 itself would prevent the vent opening 32 from opening and operating effectively. This is important because vent locations positioned in this precise 12 o'clock location should preferably be avoided. In the present design, it has been found that it is most beneficial to move the vent to the 2 o'clock position, preferably between 1 and 2 o'clock, most preferably at the 2 o'clock position. When this occurs the vent opening 32 is proximately at the shoulder region of the driver 2 and is allowed to open without any interference due to any obstruction. Alternatively, it is possible that this vent opening 32 location could be positioned on the opposite side at the 10 o'clock position, preferably between 11 and 10 o'clock. In this condition, the vent opening 32 would then be positioned towards the driver's door on American made vehicles. On British vehicles, it would also be extending into where the driver is located on the opposite side of the vehicle, also would be
extending toward the passenger compartment. It being understood that either of these locations are perfectly acceptable, however it is important to avoid any region where the head 4 or steering wheel rim 69 can impede the progress of the venting action.

[0017] As shown, the airbag cushion 30 is constructed with only one single vent. There are no additional openings. This insures that the inflation gases on initial deployment are completely contained within the airbag; this is maintained throughout the activation of the airbag and deployment until the driver or an out-of-position passenger impedes the forward projection of the airbag cushion such that it releases the tension on the tether 50. Once the tension is released by the driver impacting the airbag, the vent will open automatically and will remain open during this deployment and activation of the airbag cushion. This is quite unique from other airbag systems wherein multiple vents or vents that are positioned so that the airbag is normally vented on deployment which greatly increases the amount of gas propellant needed to make up for the lost gases. All of these issues are avoided with the present invention.

[0018] Variations in the present invention are possible in light of the description of it provided herein. While certain representative embodiments and details have been shown for the purpose of illustrating the subject invention, it will be apparent to those skilled in this art that various changes and modifications can be made therein without departing from the scope of the subject invention. It is, therefore, to be understood that changes can be made in the particular embodiments described which will be within the full intended scope of the invention as defined by the following appended claims.
What is claimed is:

1. A driver side airbag module (10) mounted on a steering wheel assembly, comprising:
   a housing or base (12);
   an inflator (20);
   an airbag cushion (30), the airbag cushion (30) having a driver facing outer portion (36) and a steering wheel facing inner portion (33) with a vent opening (32);
   a tether (50) affixed to an inside surface (37) of the outer portion (36) at a first end (53) and extending rearwardly to a second end (51) affixed to the inner portion (33);
   a tether vent cover (40) sewn to the inner surface (31) of the inner portion (33), the vent cover (40) is sewn adjacent to at least two sides of the tether (50); the vent cover (40) having an opening (42) overlying the tether (50) and the vent opening (32) of the inner portion (33); and
   wherein the tether (50) covers the vent opening (32) on inflation and while under tension blocks and seals the vent opening (32) and upon the front portion contacting the driver (2), the tether (50) slackens and is pushed outward the vent opening (32) by the inflation gases to open the vent to exhaust the inflation gases.

2. The driver side airbag module (10) of claim 1 wherein the inflator (20) is a single stage inflator.

3. The driver side airbag module (10) of claim 1 wherein the tether (50) has a wide portion (52) under the tether vent cover (40).

4. The driver side airbag module (10) of claim 3 wherein the tether vent cover (40) is stitched to the inner portion (33) adjacent to three sides of the tether (50).

5. The driver side airbag module (10) of claim 3 wherein the tether vent cover (40) is stitched to the inner portion (33) adjacent to four sides of the tether (50) and has a slit opening (44) through which the tether (50) passes.

6. The driver side airbag module (10) of claim 5 wherein the tether (50) is sandwiched between the vent cover (32) and inner surface (31) of the inner portion (33) forming three
layers of material and the expanding inflation gases seal the respective layers as the tether (50) exerts tension between the fixed first (53) and second ends (51).

7. The driver side airbag module (10) of claim 6 wherein the tether (50) has a narrow portion (54) between the wide portion (52) and the first end (53).

8. The driver side airbag module (10) of claim 7 wherein the narrow portion (54) upon relaxation of tension slides through the slit (44) as the inflation gases push the wide portion (54) outside the airbag vent opening (32).

9. The driver side airbag module (10) of claim 8 wherein the wide portion (52) forms a hood over the vent opening (32) deflecting the escaping gases when the vent is opened.

10. The driver side airbag module (10) of claim 1 wherein the first end (53) of the tether (50) is affixed at a location on the outer portion along a centerline of the airbag between 12 o'clock and 6 o'clock between a driver's chest and head (4).

11. The driver side airbag module (10) of claim 10 wherein the vent opening (32) on the inner portion (33) lies on a position less than 12 o'clock to 3 o'clock, wherein 12 o'clock is the top center of the steering wheel and 3 o'clock is the mid location toward the passenger compartment.

12. The driver side airbag module (10) of claim 11 wherein the vent opening (32) is located at about 1 and 2 o'clock.

13. The driver side airbag module (10) of claim 12 wherein the vent opening (32) is located at 2 o'clock.

14. The driver side airbag module (10) of claim 11 wherein the vent opening (32) extends radially outward of the steering wheel rim (69).

15. The driver side airbag module (10) of claim 14 wherein the vent opening (32) is located between an outer diameter of the inflated cushion and the rim (69) of the steering wheel (68).
16. The driver side airbag module (10) of claim 15 wherein the vent opening (32) is closer to the outer diameter of the inflated cushion.

17. The driver side airbag module (10) of claim 16 wherein the vent opening (32) is located offset from the driver (2) and inward toward the passenger compartment.

18. The driver side airbag module (10) of claim 17 wherein the vent opening (32) is located in an upper quadrant of the cushion (30) toward the passenger compartment.

19. The driver side airbag module (10) of claim 16 wherein the vent opening (32) is located offset from the driver (2) and inward toward the driver door.

20. The driver side airbag module (10) of claim 19 wherein the vent opening (32) is located in an upper quadrant of the cushion (30) toward the driver door.

21. A driver side airbag module (10) mounted on a steering wheel assembly, comprising:

   a housing or base (12);
   an inflator (20);
   an airbag cushion (30), the airbag cushion (30) having a driver facing outer portion (36) and a steering wheel facing inner portion (33) with a vent opening (32); and
   wherein the vent opening (32) on the inner portion (33) lies on a position at 2 o'clock, wherein 12 o'clock is a top center of the steering wheel and 3 o'clock is a mid-location toward the passenger compartment.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. B60R21/2338   B60R21/239

ADD.

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):

B60R

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

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

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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