Title: AIRBAG DEVICE WITH REDUCED SOUND LEVEL

Fig. 1

Abstract: The present invention relates to an airbag inflator (1) comprising a gas generating unit (2) and a diffuser (5) through which gas is communicated to the airbag cushion. The airbag inflator (1) further comprises an expansion chamber (3) that receives high pressure gas from the gas generating unit (2) and a converging-diverging nozzle (4) connected downstream the expansion chamber (3) in order to reduce high sound levels in the environment generated by the high velocity gas flow.

Inventors: SCHNEIDER, Roland [DE/DE]; Enzensperger Strasse 4, D-81669 Munchen (DE); SVEDEJSAN, Stefan [SE/SE]; Drottninggatan 54 C, S-441 31 Alingsas (SE); LINDQVIST, Johan [SE/SE]; Vintergatan 3F, S-441 36 Alingsas (SE); MAGNUSSON, Ulf [SE/SE]; Furulundsvagen 20, S-441 92 Alingsas (SE); HOLGERS, Alf [SE/SE]; Fagelvagen 24, S-441 40 Alingsas (SE).
AIRBAG DEVICE WITH REDUCED SOUND LEVEL

Technical field
The present invention relates to airbag inflators comprising a gas generating unit and a diffuser through which the gas is communicated to the airbag cushion.

Background of the invention
Airbag inflators are well known in the art of motor vehicles for protecting the vehicle occupants in the case an accident occurs. Generally, the airbag is filled with a gas flow, which is released at a high velocity from an inflator chamber. Airbag inflators normally generate high sounds, with peak values of 120dB or higher, which may be harmful for a vehicle occupant. Especially, high sounds are generated if many airbag devices are activated at the same time. The sound is generated as a result of pressure and velocity differences in the streaming fluids. The released high velocity gas from the inflator chamber creates shearing forces and turbulence, which in turn leads to high sound levels.

It is known to have arrangement in airbag devices that reduce high sounds. US 3807755 discloses an arrangement where the sound from a gas generator is reduced by using a manifold having a first converging-diverging nozzle, a passage portion and a second converging nozzle. This arrangement, however, with at least two nozzles with an elongated passage portion in-between makes the airbag inflator rather complex, bulky and heavy.

Summary of the invention
An object of the present invention is to provide an airbag inflator, which reduces at least some of the above problems.
In one aspect of the present invention according to the introduction the airbag inflator is characterised in that the airbag inflator further comprise an expansion chamber that receives high pressure gas from the gas generating unit and a converging-diverging nozzle connected downstream the expansion chamber, in order to reduce high sound levels in the environment generated by the high velocity gas flow.

The expansion chamber and the converging-diverging nozzle are adapted to reduce high sounds generated by the gas generator. In the expansion chamber the pressure of the gas released from the combustion chamber is reduced and consequently the speed of the gas is reduced. By reducing the gas velocity the sound level in the environment is reduced. The sound level is further reduced in the passage through the converging-diverging nozzle. A short nozzle can be used since the sound level is reduced in the expansion chamber. By introducing an expansion chamber for reduction of high sounds the length of the nozzle that receives the gas can be shorten. Thus, the complete airbag inflator can be made more compact and less complex.

The expansion chamber cross section may be circular. This is an advantage since circular cross section results in equal pressure reduction in all directions in the plane defined by a cross sectional cut, which leads to better and smoother pressure reduction. Furthermore generation' of turbulences due to sharp corners is avoided.

The expansion chamber inlet may be circular. Thus generation of turbulences due to sharp corners is avoided. The expansion chamber outlet may be circular. Thus generation of turbulences due to sharp corners is avoided.

The expansion chamber outlet may be of the same size or larger as the expansion chamber inlet. If the outlet size is too small the pressure' of the streaming gas may
rise which is unfavourable. By having an outlet size equal to or larger than the inlet size this can be avoided.

In designing the expansion chamber, the length of the chamber, the cross sectional area of the chamber and the cross sectional area of the expansion chamber inlet and outlet are important to adapt the chamber to reduce high sound levels generated by the airbag inflator. Furthermore, the ratio between the inlet cross sectional area and the chamber cross sectional area is important to adapt the chamber to reduce high sound levels.

The length of said expansion chamber is preferably between 1-6 cm, more preferably between 2-5 cm and most preferably between 2.7-4 cm. Thus the expansion chamber length may correspond with the frequency of airbag deployment sound, which may result in an effective reduction of the sound level.

The airbag inflator may comprise at least one additional expansion chamber, in order to further reduce the high sound level generated by the gas generator.

The expansion chambers are then preferably linked to each other in a series.

**Brief description of the drawings**

The present invention will now be described in more detail with reference to the accompanying schematic drawings which show a preferred embodiment of the invention and in which:

Fig. 1 shows a sectional view of a an airbag inflator according to an embodiment of the present invention.

Fig. 2 shows a sectional view of a an airbag inflator according to another embodiment of the present invention.
Detailed description of preferred embodiments

Figure 1 shows an airbag inflator 1 according to a first embodiment of the present invention. The inflator 1, which preferably is made of metal, comprises a gas-generating unit 2, an expansion chamber 3, a converging-diverging nozzle 4 and a diffuser 5. The gas-generating unit 2 comprises a combustion chamber 6 in which a gas-generating medium, for instance a propellant charge, and/or compressed air is stored. Such compressed gases can be stored in liquid form, or as a mixture of gas and liquid. In this specific embodiment a propellant charge and compressed gas is stored in the combustion chamber 6. The gas-generating unit 2 further comprises an igniter 7 having a pyro charge, which is activated upon a signal from the sensor system (not shown) via a cable 8. The expansion chamber 3 has an inlet 9 through which the high-pressure gas is received from the combustion chamber 6, and an outlet 10 which is connected to the converging-diverging nozzle 4. Alternatively the expansion chamber may have several inlets and/or outlets. The expansion chamber 3 is adapted to reduce high sounds generated by the high velocity gas flow. That is, the size of an expansion chamber inlet 9, the length and shape of the expansion chamber 3 and the size of a expansion chamber outlet 10 are designed to reduce the sound level to the environment. In this embodiment the expansion chamber cross-section, inlet and outlet are circular. However the expansion chamber cross-section, inlet and outlet may have other shapes such as rectangular, polygonal or oval. The length of the expansion chamber is preferably between 1-6 cm, more preferably between 2-5 cm and most preferably between 2,7-4cm. For a cylindrical expansion chamber the diameter is preferably between 20-β0mm, more preferably between 25-50 mm and most preferably between 32-40 mm. For a circular expansion chamber inlet the diameter is preferably between 5-20mm, more preferably between 6-15 mm and most preferably between 8-12mm. The
ratio of the expansion chamber diameter and the chamber inlet diameter is preferably between 2-7, more preferably between 3-6 and most preferably between 4-5. The inlet 9 to the expansion chamber 3 is covered by a burst disc 11, which prevents the material stored inside the combustion chamber 6 from entering the expansion chamber 3 until the gas generator is activated. An outflow unit 12 comprises a converging-diverging nozzle for further reduction of the sound level and a diffuser 5 through which the gas is communicated to the airbag cushion (not shown).

Upon a signal from the sensor system (not shown) a pyro charge is activated by an igniter 7, whereby the propellant generates gas inside the combustion chamber 6. Consequently, the pressure in the combustion chamber 6 increases and at a certain level the burst disc 11 is broken whereby the gas flows through the expansion chamber 3, the converging-diverging nozzle 4 and the diffuser 5 into the airbag cushion (not shown).

Figure 2 shows a second embodiment of the present invention where the airbag inflator 1 has a second gas generating unit 13 comprising a combustion chamber 14, a burst disc 15 covering an inlet 16 to the expansion chamber 3 and an igniter 17, which is activated via a cable 18 upon a signal from the sensor system (not shown). Upon activation of the second gas generating unit 13 the burst disc 15 is broken and gas passes through the expansion chamber 3 and the converging-diverging nozzle 4 before communicated to the airbag cushion via the diffuser 5. Depending on the crash severity one or both gas generating units 2, 13 may be activated. The burst discs 11 and 15 are positioned with an offset to each other in a direction perpendicular to the length extension of the airbag inflator 1, see figure 2. Thus the expansion chamber inlets 9 and 16 are facing each other having an offset as seen in figure 2. This offset orientation prevents that one burst disc is affected by
the gas flow from the other combustion chamber when only one gas generated unit is activated.

Due to the design of the inflator in this embodiment the gas flow changes direction when passing through the expansion chamber 3. Changing of the gas direction generates sound. Therefore, in this specific embodiment the length of the expansion chamber 3 may be at least eight times the diameter of one of the expansion chamber inlets. The outlet diameter may be of the same size or larger than the inlet diameter.

There are different types of gas generating media that can be used in an airbag inflator according to the present invention. A propellant medium can be used to generate high-pressure gas. The propellant medium can for instance be a selected gas generating reactant material, for example in the form of pellets, wafers or grains. An initiator device preferably ignites the propellant material. Such device is preferably a squib.

Furthermore, instead of, or in combination with, using propellant, compressed gas can be stored in the inflator and released upon activation of the inflator.

It will be appreciated that the described embodiments of the invention can be modified and varied by a person skilled in the art without departing from the inventive concept defined by the claims.
1. Airbag inflator (1) comprising a gas generating unit (2) and a diffuser (5) through which gas is communicated to the airbag cushion, characterized in that the airbag inflator (1) further comprises an expansion chamber (3) that receives high pressure gas from the gas generating unit (2) and a converging-diverging nozzle (4) connected downstream the expansion chamber (3) in order to reduce high sound levels in the environment generated by the high velocity gas flow.

2. Airbag inflator according to claim 1 where the expansion chamber cross section (3) is circular.

3. Airbag inflator according to claim 1-2 where the expansion chamber inlet' (9) is circular.

4. Airbag inflator according to claim 1-3 where the expansion chamber outlet (10) is circular.

5. Airbag inflator according to claim 1-4 where the expansion chamber outlet (10) is at least of the same size as the expansion chamber inlet (9).

6. Airbag inflator according to claim 1-5 wherein the length of said expansion chamber (3) preferably is between 1-6 cm, more preferably between 2-5 cm and most preferably between 2,7-4cm.

7. Airbag inflator according to claim 1-6 where the ratio of the expansion chamber cross sectional area and the chamber inlet cross sectional area preferably is between 5-45, more preferably between 7-35 and most preferably between 15-25.
8. Airbag inflator according to claim 1-7 where the airbag inflator comprise at least one additional expansion chamber, in order to further reduce the high sound levels generated by the gas generator.

9. Airbag inflator according to claim 8 where the expansion chambers are linked to each other in a series.
# INTERNATIONAL SEARCH REPORT

**International application No.**
PCT/SE2007/000206

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC:** see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC:** B60R

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

SE, DK, FI, NO classes as above

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

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**Name and mailing address of the ISA/Authorized officer**
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Hans Nordstrom / JA A
Facsimile No. + 46 8 666 02 86
Telephone No. + 46 8 782 25 00

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**B60R 21/26** (2006.01)

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