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History and Evolution of Airbags in Automotive Vehicles

Academic Skills (ACHA4005)

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1. Introduction

This report is going to go into the history and evolution of Airbags in automotive vehicles. Safety in vehicles is one of their most important attributes currently as cars get bigger, faster and more dangerous. Because of this, airbags have become one of the most vital safety features in modern vehicles. However, airbags have come a long way since they were first invented with basic designs and patents to what we know them as today, with high-tech sensors and crash detection. This assignment will highlight the beginnings of the airbags and how they transformed into their modern-day counterparts.

2. Contextual/Background

As cars have developed so have their safety measures. The first mass produced automobiles were well known for having minimal safety features due to the new technology. One of these important safety features was the airbag. The rough idea of an airbag was initially designed in 1951 by Linderer and patented in 1953. (Viano, D. C. 2024 'History of airbag safety benefits and risks', *Traffic Injury Prevention, Airbag concepts*) The device was described as an "inflatable container" that would either be triggered automatically or manually in the event of a crash. It would inflate in front of the occupant of the vehicle to minimise the injuries they would sustain. Alongside this in 1953, Hetrick would patent his version of the airbag (Viano, D. C. 2024 'History of airbag safety benefits and risks', *Traffic Injury Prevention, Airbag concepts*). His patent was built off Linderer's initial design but also incorporated compressed air technology that was used by the U.S Navy. (Sawyer, C.A., 2012. *DEVELOPING AIRBAGS. Automotive Design & Production, Paragraph 2*) . Hetrick's design involved the inflatable cushion to be integrated into the steering wheel. This integrated system would automatically inflate with air using a fast-opening valve and stored air during the crash to offer protection to the driver. Hetrick was the first person to use the term "airbag" for the name of his invention which has carried on for its later designs. Sadly, despite interest from several different automobile manufacturers, none decided to purchase the licence to enable them to use it. (Sawyer, C.A., 2012. *DEVELOPING AIRBAGS. Automotive Design & Production, Paragraph 2*). Later, during 1958, Bertrand would patent his take on the airbag (Viano, D. C. 2024 'History of airbag safety benefits and risks', *Traffic Injury Prevention, Airbag concepts*). Bertrand's designs were an inflating bag that would inflate downwards from an attached roof rail with an attached high-pressure air tank to give the occupant a way to deflate the bag after the crash. Bertrand designed two separate versions of the design which shared the same roof-based design. The main difference with the two patents is that one was an attached device and the second was integrated into the roof itself.

These early patents eventually developed into what is now standard in every vehicle. The first sensor to make the airbag viable wasn't patented until 1968 by Allen Breed.

(Sawyer, C.A., 2012. *DEVELOPING AIRBAGS*. *Automotive Design & Production*, Paragraph 3). His design would allow airbags to deploy within 30 milliseconds of a crash which meant that airbags were now a viable option for vehicle safety. His design has now been rendered obsolete; however, it helped greatly in how they would develop in the years after.

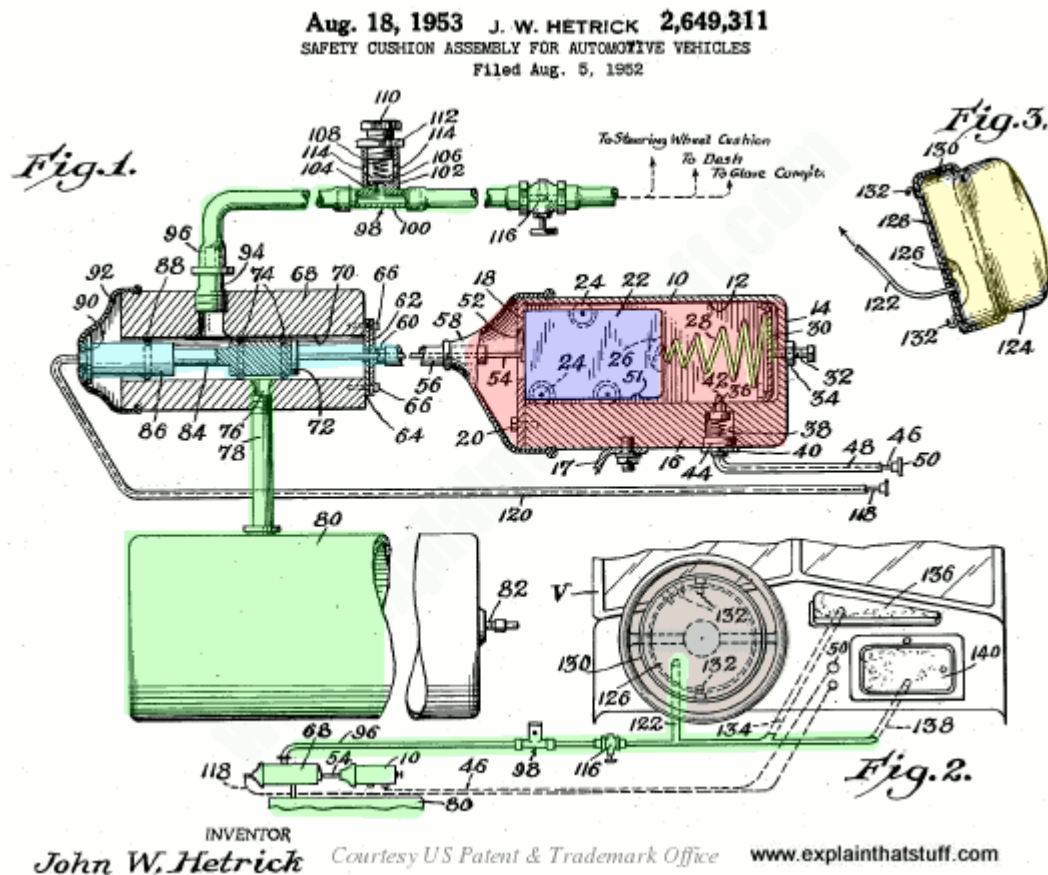


Figure 1: Hetrick airbag design 1953 (Woodford, C 2022)

3. Discussion

Despite early developments, airbags only started to become more widely available during the late 80's and early 90's. The safety of these airbags was however mixed as they could be unsafe for children. In 1991, Evans found that on its own, the airbag was found to be 17% effective with a margin of error of $\pm 4\%$ at preventing death in front facing seats. This increased to 46% (± 4) with the inclusion of a seatbelt. (Viano, D. C. 2024 '*History of airbag safety benefits and risks*', *Traffic Injury Prevention, Airbags as standard equipment*). However, airbags raised separate safety concerns. In 1917, Braver et al discovered that despite airbags reducing fatalities by 18% in full frontal crashes and 11% in all crashes they posed a separate risk. It was found out that they increased the risk of a fatality in children under 10 by 34% in frontal crashes. It is believed that this is caused by the airbags being deployed so close to the children. (Viano, D. C. 2024 '*History of airbag safety benefits and risks*', *Traffic Injury Prevention, Airbags as standard equipment*).

In 2001 an advanced airbag rule was introduced by NHTSA. (Viano, D. C. 2024 '*History of airbag safety benefits and risks*', *Traffic Injury Prevention, Airbags as standard equipment*). NHTSA is the National Highway Traffic Safety Administration whose objective is to "save lives, prevent injuries, and reduce costs due to road traffic crashes, through education, research, safety standards, and enforcement". (NHTSA 2024). This rule was implemented to address and resolve the safety risks that apposed children and small adults specifically. This rule made 3 required changes for every airbag. These changes were that airbags had to be adjustable based on multiple factors, the testing of airbags had to include a wider range of crash test dummy sizes which needed to include young children in different seat positions and seatbelt locations, and that in certain situations the airbag must reduce how much they inflate as not to harm children or small adults. (Viano, D. C. 2024 '*History of airbag safety benefits and risks*', *Traffic Injury Prevention, Airbags as standard equipment*). It also added the requirement of 25mph barrier impact tests and 30 mph frontal crash tests. These were implemented to ensure that airbags would still deploy and at a lower velocity to ensure that they helped more than raise the mortality rates as this was an issue with the first generation of airbags.

The implementation of the rule was deemed controversial with multiple safety organizations suing the NHTSA; however, the NHTSA was covered by the courts. By 2007 the rule was fully implemented with the requirement of all cars needing to have the second generation of airbags fitted by law. The advanced airbags have introduced multiple benefits over their predecessors. Due to their design improvements the number of avoided deaths from 80 per 100 million vehicles to just 1 per 100 million.

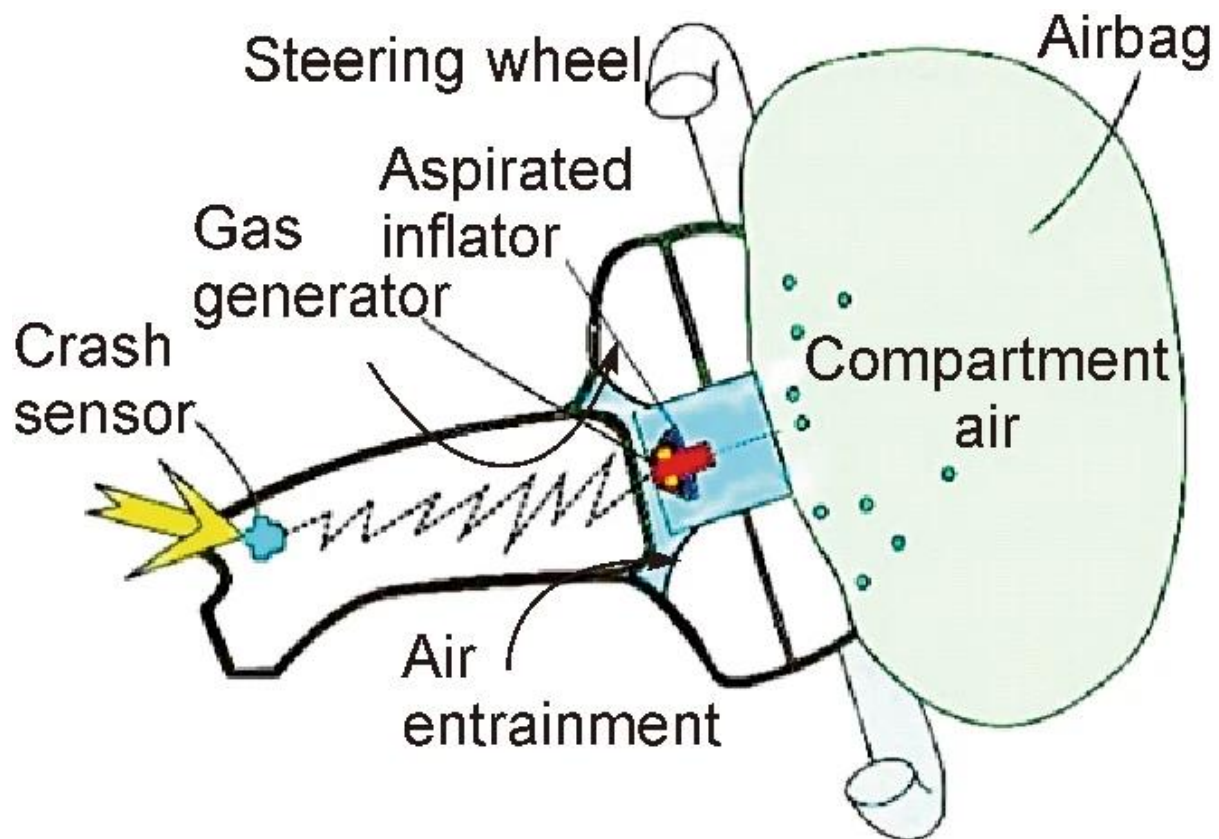


Figure 2: Second generation airbag (Yurchenko, N.F 2021)

In recent years the crash detection and deployment systems of airbags have evolved further. One example of these is the “Mercedes Benz’s Pre-Safe system”. This system allows the car to detect if a crash might happen and deploys the airbag early to ensure that it can deploy safely and reduce fatalities. (Azuma, T 2022 *The Evolution of Airbags in Automobiles: From 1941 to Today. The Revolutionary Pre-Safe System*).

Almost all airbags have a standardized base design, but different continents have different specific requirements, however they use the same base shape. This allows manufacturers to adapt their shape and size depending on the vehicle it will be fitted to. They are designed through various methods which include CAD (computer assisted

design), sketches and simulations. These different design approaches allow different airbag types such as single stage, dual stage and different vent hole designs. Despite different regions having different designs the fundamental design is used universally. The shape and size of the airbag stays similar across all designs; however, they can vary in their vent and inflation systems. It's important for manufacturers to use a standardized baseline design that can be easily adapted to the global market. (Sawyer, C.A., 2012. *DEVELOPING AIRBAGS. Automotive Design & Production, Paragraph 6+7*).

4. Conclusions

In conclusion, it is obvious that airbags have evolved a lot over the years. From a basic patent of a bag filled with air to the developments of pre-crash warnings systems they have come a long way in the means of vehicle safety. However, it is best kept in mind that they are not the only forms of vehicle safety and multiple factors play into that role such as; seatbelts, crumple zones and general safety equipment. Despite this, airbags have saved countless lives and shall continue to improve and prevent multiple deaths in the future. Frontal airbags alone have been recorded to have saved over 50,000 lives between 1987 to 2017 alone (*NHTSA (2024) Air Bags, Overview*), this is without factoring the many other types that reside in vehicles currently. This proves that they have now become an invaluable part of life and automobiles.

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