Secondary tire inflation system for blown out tire

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Abstract. Automobile is one of the greatest inventions of mankind which helps people to migrate from one place to another in a short span of time with comfort. In the last few decades, many innovative technologies have been emerging. One such technology is Self Tire Inflation System. This system will monitor the tire pressure continuously and inflates or deflates the tire depending upon the road conditions. But there are many chances for the tire to get blown out, hence the plan of implementing an additional tire-tube setup in the tire has been brought up, which will act as a secondary tube until the primary tube gets blown out. This tube setup makes use of the Self Tire Inflation System and immediately inflates when the primary tire-tube setup gets damaged. This will act as an immediate remedy for reducing the accidents that are caused due to sudden blown out of tire, especially for the Off-Road vehicles and military vehicles that roll their wheels on tough terrain and extreme weather conditions.

Keywords: tire pressure, secondary tire inflation system, butterfly valve and nozzle

1. Introduction

Automobile has become an integral part of our life today. Humans are completely reliable on automobiles for the transportation purposes. The demand for automobiles has been increasing day by day. Many automobile industries are competing with each other to launch new and advanced vehicles focusing more on safety and comfort of the customers. There are many innovative technologies to improve the safety system in a vehicle. One such upcoming technology is the Automatic Tire Inflation system. This system will continuously monitor the tire pressure and also inflate or deflate the tire depending upon the road condition. In the situations where the tire suddenly gets blown out, making the driver lose the control over the steering wheel and ultimately leading to accident. So, to avoid this risk an additional feature has been implemented along with the tire inflation system. This additional feature helps in reducing the time to repair the tire and simultaneously reduces the manual effort. This system helps in improving fuel economy of the vehicle as well.

The best application of such automatic tire inflation system is used in military vehicles, where the land conditions keep continuously changing and the probability of tire damage is very high. Such vehicles are designed to operate in extreme weather condition such as heavy rainfall, snowfall, deserts storms, etc.

- Rathi et al (2017) states that the only part of a vehicle which is not getting automated is tires. From this research work it was known that a slight drop in pressure, will affect the tire wear, safety, gas mileage and whole vehicle’s performance. In order to neglect the unwanted stress and time spent for inflating the tires, an Automatic Air Inflation system
was designed. The system states that the tires are optimally inflated at all running conditions.[1]

• Ibrahim savas et al. (2016). This research is aimed to develop an automatic tire pressure control system for control over the slippage in order to achieve better the tractive efficiency of tractors. The developed design of the system was a flexible structure which could be adapted to all brand and their model of tractors. With the help automatic tire pressure control system, it is aimed, to reduce fuel consumption, to increase the efficiency of drawbars and to rule out negative traffic effects which will occur on the field.[2]

• Kaczmarek et al. (1984) stated that “One of the most effective and well proven systems that have been adapted to wheeled tactical vehicles to improve the overall vehicle mobility is CTI”. However, after World War II no serious consideration of the benefits of CTI occurred until the early 1980’s, the period when most of the military vehicles produced in the United States were equipped with CTI. [3]

• Burase et al. surveyed on Automobile Air Inflating System. This research paper comprises of a new approach for automobile, a self-inflating tire that guarantees the tires to be properly inflated at all times. This system uses portable compressor that will supply air to all the four tires through hoses and a rotary joint fixed between the wheel spindle and wheel hub at each wheel. The rotary joints effectively allow air to be delivered to the required under-inflated tire. This system acknowledges an essential improvement in gas mileage, tire wear reduction, and an increase in handling and tire performance in diverse conditions.[4]

• Hemantsoni and S. Adakmol et al focused on automatic tire inflation system and he introduced the centralized compressor-based system with the aim of improving mileage, tire life and car safety. Using this system air is delivered to all four tires of the vehicle using hoses and a rotary joint constrained between the wheel spindle and wheel hub at every wheel. This is one of the most beneficial project for society as the system automatically re-inflates all the four tires whenever required under all environmental and road conditions. [5]

• P. Omprakash et al. worked on the mechanism for air refilling system. The aim of this project was to introduce a system that can be used in any type of tire either tube or tubeless. With the intention of providing tight connection during rotation of tire, the system uses the permanent connection between valve and hoses so that it can be lose only when substituting the tire by the driver.[6]

The above Literatures served as an eye opener for new safety systems for automotive vehicles.

2. Materials and methods

2.1 Design of secondary tire-tube setup

• The design in this system is quite easy to understand and this setup has been made with very few and intricate modifications which has been theoretically out shown a good result. The former method of Automatic Tire Inflation System, had proven to be a good solution for few decades.
But for the wheels to roll normally in any extreme situations, the changes can be adapted to the system by providing a Secondary Tire-Tube setup inside the original tire with a lesser dimension. The pressure is maintained at a pre-set amount by the usage of the air compressors. A pair of nozzles, a pair of butterfly valves, pressure sensors and the pressure regulators are used to support this new setup. This system can even help in car to move in extreme terrains, even after the damage of the outer tire. This system is of high advantage for the Off- Road vehicles, providing the traveller no worry about the tire and the terrain.

![Design of complete secondary tire-tube setup](image)

**Figure 2.1 Design of complete secondary tire-tube setup**

### 2.1.1 Components required
1. Air Compressor - Pressurises the air
2. Pressure Sensor - Monitors the pressure changes and signals ECU
3. Two Nozzles - To change the velocity of feed air
4. Two Butterfly Valves - Closing and opening of air passage
5. Secondary Tire-Tube setup
6. Rubber material - Silica or Carbon Black
Figure 2.2 Air compressor with nozzle and butterfly valves, pressure sensor at the end points

Figure 2.3 External and internal tire with nozzle position

Figure 2.4 External tire and tube setup
2.2 Working

The working or the workflow can be categorized depending upon their condition

i. Pressure Reduction

ii. Puncture in the external tire-tube setup

2.2.1 Pressure reduction:

This phenomenon is quite familiar, where the pressure in the tubes go down the pre-set or the recommended level. The pressure decrease in the tube is sensed by the pressure sensor which send the data to the ECU, which in turn signals and activates the air compressor to feed the compressed air into the tube. The air compressor takes in atmospheric air and compresses it to the required pressure that has to be fed into the tube, thus ensuring proper tire pressure and this is achieved by the movement of the butterfly valves and the nozzles which are in the flow path of air.

2.2.2 Puncture in the external tire-tube setup:

This situation has higher chances to occur in the Off-Road and military vehicles whose wheels rolls on tough terrains and extreme weather conditions. When travelling in such tough terrains, the spokes or the rocks or any obstacle may tend to damage the external tube thus leading to the sudden fall in pressure which is sensed by the pressure sensor and signalled to the ECU.

This action is followed by the closing of the butterfly valve at the external tube, thus causing the air to flow to the external tube. Due to the position of butterfly valve in the inner side in open condition, the compressed air is let into the secondary tube setup which is raised to the pressure little lesser than the recommended value of pressure. The punctured tube shrinks to stick on to the inner side of the external tire, simultaneously the inner tire expands along with the tube and makes contact with the external tire’s inner surface. This system of using a Secondary Tire-Tube inflation system can serve as a temporary solution but for a quite longer period, until the original tube and tire is replaced.

2.3 Conditions to be maintained

1. The outer tube must be maintained at a pressure (-5 psi) than the recommended value
2. The inner tube must be maintained at a pressure three-fourth of the pre-set value of pressure
3. The proper working of the valves must be ensured
4. The Aurdino coding must be precise to achieve accurate results
2.4 Components and Design Setup:

Figure 2.5 Design flow of secondary tire inflation system
3. Results and conclusion

The tire pressure is an important parameter in any automobile. This pressure also decides the mileage of the vehicle. Any variation in the tire pressure may lead to lack of control over stability of the vehicle and ultimately leading to accident. However, to avoid such accidents, the idea of Self Tire Inflation System has been brought up. In the situations where tire gets blown out, there is a need for immediate solution. The Secondary Tire Inflation system, which is the solution, will inflate the secondary tube when the primary tire-tube blown out and feeds air pressure to the wheel, thus ensuring instant stability to the vehicle. Thus, this system acts as an immediate remedy to avoid the accidents or loss of life due to tire blown outs, also reduces the manual work and avoids the necessity to repair the blown-out tire. Hence, this system can be applied especially to the Off-Road vehicles and also to military vehicles.

4. Future scope: The present research work can be extended by employing the design of experiment (DOE) testing along with Internet of Things (IoT).

5. References

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