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STUDY OF SELF INFLATING TYRE SYSTEM

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Abstract

Driven by studies that show that a drop in tyre pressure by just a few PSI(pound per square inch) can result in the reduction of gas mileage, tyre life, safety, and vehicle performance, this study developed an automatic, self-inflating tyre system that ensures that tyres are properly inflated at all times. The design proposes and successfully implements the use of a centralized compressor that will supply air to all four tyres via hoses and a rotary joint fixed between the wheel spindle and wheel hub at each wheel. The rotary joints effectively allow air to be channeled to the tyres without the tangling of hoses. With the recent oil price hikes and growing concern of environmental issues, this system addresses a potential improvement in gas mileage; tyre wear reduction; and an increase in handling and tyre performance in diverse conditions.

I. Introduction

Improperly inflated tyres are fairly common problems on passenger vehicles. In fact, 80% of passenger vehicles on the road have at least one under-inflated tyre and 36% of passenger cars have at least one tyre that is 20% or more under-inflated. Often pressure loss in tyres is a result of natural permeation of the gas through the elastic rubber, road conditions (such as potholes), and seasonal changes in temperature. Most vehicle owners are unaware of the fact that their tyres are not at the correct pressures because it is difficult to determine the tyre pressure visually; a tyre that is properly inflated to the correct pressure looks very similar to one

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that is either over-inflated or under-inflated. Thus, from the viewpoint of passenger vehicle owners, they are losing money due to increased tyre wear and decreased fuel efficiency, and a solution needs to be found to correct this issue. From the viewpoint of the designers, however, the root cause of improperly-inflated tyres is due to vehicle owners not knowing proper tyre pressures for certain conditions, difficulty finding an air pump, lack of pressure measuring device, and a general lack of concern.

Tyre Wear, Fuel Economy, Performance, and Safety.

An under-inflated tyre can have dramatic effects on tyre wear. Since the contact patch of the tyre has a larger wave pattern, friction and heat increase cause the contact patch to wear out more quickly than if the tyre was inflated properly. "Goodyear estimated that a tyres average tread life would drop to 68 percent of the expected tread life if tyre pressure dropped from 35 PSI to 17 PSI and remained there". Doran Manufacturing offers more statistics regarding the effects of under-inflated tyres:

1. 20% under-inflation can reduce tyre life by 30%
2. 20% under-inflation can increase tyres wear by 25%

Fuel economy is also greatly affected by under- inflated tyres. According to fueleconomy.gov, an under-inflation of 1 PSI in all four tyres on a passenger vehicle reduces efficiency by 0.4%.

As vehicle speeds increase, the tyre pressures should also increase accordingly to reduce rolling resistance (which improves fuel economy) and to limit damage due to the increased frequency of tyre profile deflections. Since highways are typically smoother than local roads, increasing the tyre pressure will not negatively impact ride quality in terms of noise and vibrations.

II. Literature Survey

This study administered a 10 question survey to potential users for this dynamically self-inflating tyre system to gain an understanding of their knowledge regarding the topic as well as to observe their preferences for certain aspects that this study can incorporate with this system. Below is a list of the main points discovered from the results.

1. Only 4.3% of those surveyed check their tyre pressures on a weekly basis. [1]

2. Only 5.3% of survey participants check their tyre pressures for fuel economy. [2]

3. Most participants check their tyre pressures for safety reasons instead of tyre wear. [3]

4. Those that do not check their tyre pressures either do not care or do not know the correct pressures. [4]

5. Roughly half of those surveyed have had their tyres replaced in the 3-4 year timeframe. [5]

6. Almost half of those surveyed never check their tyre tread depth [6].

7. Those that do check their tread depths mostly check it for safety concerns. [7]

8. Those that never check their tread depths either do not know the correct depth or do not care. [8]

9. 70% of those surveyed drive on the highway a moderate amount (50% of all driving done on highways) [9].

10. 48% of survey participants drive over the legal speed limit. [10]

III. Methodology

This system consists of centralized compressor, rotary joint, pressure sensor, electronic control circuit, battery, wheel and a motor to run that wheel. After getting ideas of different components needed, as you will start making rough design and after that you will draw a 3-D model in Solid works. By referring this 3D model, you will buy the standard component required for the projects. After this you will start manufacturing work in workshop. Along with this electronics part will also be done. In electronics you will have to build controller circuit to get signal from pressure. After this, assembly of different components will be done. Later testing will be started for getting various results.

IV. Working

The Automatic tyre inflation system contains a compressor which is used to pass air through the rotary joint (which is fixed between wheel spindle and wheel hub at each wheel) via hoses, providing the rotary motion of wheel assembly. Air is channeled through rotary joint without entangling the hoses. When pressure goes below the desired level it pumps air and tyre inflates. The compressor gets power from the battery. This operation takes place when the vehicle is moving and there is a requirement of inflation of tyre due to reduced tyre pressure level.

Working Components

- Compressor 150 psi 12V D.C.
- Rotary Joint Size= 1/2", Pressure= 10kg/cm2
- Pressure Sensor Pressure range= 0-100 psi
- Roller Bearing, Carbon Steel
- Chain Sprocket No. of teeth =18, Carbon steel
- Shaft is of Carbon Steel
- Frame 30" *20" *13", Mild Steel
- Wheel Moped Vehicle (Honda Activa)
- Hoses Polyvinyl chloride (PVC)
- DC Motor 12V DC ,100rpm

Project Description

This system is capable of automatically maintaining tyre pressure in a passenger vehicle. This has been achieved through use of a centralized air compressor that is placed in the engine compartment of a vehicle. This compressor is attached to a distribution block which houses (4) solenoid valves used to control which tyres receive inflation pressure. From this distribution block, the air travels via ¼" dia. hoses to a rotary joint located at each wheel. This rotary joint allows our system to pass air from the vehicle chassis to the rotating tyre. The system that we have developed is to be integrated with the tyre pressure monitoring systems currently found on vehicles to provide our microprocessor with tyre pressure data. To reduce tyre pressures, our system also incorporates solenoid valves at each tyre valve which plan to be operated either through wireless technology or electrical contacts in each rotary joint.

The main focus of our project is to show how we plan on getting the air to the tyre. By running the tube from the compressor into the end of the rotary joint that is stationary and then from the end of the rotary joint that is spinning out to the tyre valve, we are able to avoid tangling the hose. We also want to show how we plan on using an air distribution block controlled by solenoid valves to manage the flow of air into the tyres. Thus, our project shows that our design will "work" in a sense that we will be able to control the tyre pressures in each individual tyre and route the air from the centralized compressor to the rotating tyre without tangles and without negatively affecting vehicle aesthetics.

Rotary Joint

A rotary joint, also referred to as a rotary union or rotating union, is a rotary sealing device that connects rotating equipment to fixed piping for the transfer of steam, water, thermal oil, coolant, hydraulic oil, air, and other media. In our project we used rotary joint for the air supply to the wheels through hoses.

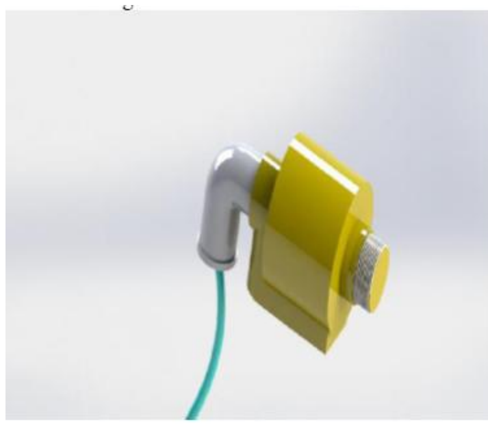

Figure 1. Rotary joint.

Compressor

A gas compressor is a mechanical device that increases pressure of same air and reduces its volume. There is a slight difference between a compressor and pump is that a pump is used to increase the pressure of water especially in fluids. The desired pressure is achieved due to the reciprocating nature of compressor. Simultaneous air supply is given by the rotary joint's rotation. A compressor generally gets overloaded so it is provided with a secondary power source except from a 12 Volts DC supply from a battery. Since it has to maintain the required pressurized air to all the wheels, its position is very critical. Generally a 300PSI compressor is used in automotive vehicles.

Figure 2. 12 V DC Compressor.

Design of self inflating tyre system

Figure 3. Isometric view of tyre self-inflating tyre system.

Figure 4. Top view of tyre self-inflating tyre system.

V. Conclusion

The dynamically-self-inflating tyre system would be capable of succeeding as a new project in the automotive supplier industry. It specifically addresses the needs of the consumers by maintaining appropriate tyre pressure conditions for:

- Reduced tyre wear
- Increased fuel economy
- Increased overall vehicle safety.

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