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Fabrication of Automatic Tire Pressure Inflation System

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ABSTRACT

Since the discovery of tires, modifications are being done in tires of a vehicle on a regular basis for its improved life and its role in increasing vehicular safety. The air pressure in the tires needs to be maintained at ideal level for better running of vehicle and for its safety purposes. So, this system was introduced keeping in mind the fuel consumption, vehicular safety and comfort.

This inflation system can be done by using components such as compressor, solenoid valve, pressure switch and rotary joint etc. It maintains the required tire pressure of vehicle to an ideal value. Solenoid valve will be used to control the air movements and pressure switch controls the solenoid valve. Hence, if there is any change in pressure inside car tires, the pressure switch intimates the solenoid valve and then solenoid valve takes in or takes out the air in system.

The aim of introducing this system is to maintain ideal pressure in car tires. The proposed system is already existed in Military vehicles. When the pressure of tire goes below ideal vale pressure gauge monitors it and the tire is inflated again. This increases fuel efficiency and reduces tire wear thus increasing their life and reducing the tire replacement time and cost.

This project provides a better understanding for others on the working, advantages and limitations of the "automatic tire pressure inflation system" used in tires of a vehicle.

List of Abbreviations

1. Psi — Pounds Per Square Inch.
2. RMA — Rubber manufacturing association.
3. NHTSA — National Highway Safety Administration.
4. CTIS — Central Tire Inflation System.
5. OEM — Original Equipment Manufacturer.
6. PSI — Public Service International.
7. TIPS — Tire Pressure Control System.
8. ECU — Electronic Control Unit.

INTRODUCTION

Tire-Inflation Basics

The "Automatic tire inflation and deflation system" is a Mechanical device. Its demand is increasing widely in automobile works. The manual work increases the effort of the man power (operator) during the air checking in vehicles. The Air Maintenance Technology system developed through this project replenishes lost air and maintains optimal tire cavity pressure whenever the tire is rolling in service, thus improving overall fuel economy by reducing the tire's rolling resistance. Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources; pneumatics type is an attractive medium for low- cost automation. Today automobile sector plays a big role in the economics of all the countries in the world and lots of researches have been carried out to improve the efficiency of the vehicle one the techniques to improve the efficiency of an automobile is inflate the tire regularly.

As its well-known, one of the most serious problems that the large motor vehicles whether they are for the transportation of passenger or cargo and especially those used for middle or longer distance travel, resides the ensuring the correct performance of the tires. According to data about 80 percent of the cars on the road are driving with one or more tires under inflated. Tires lose air through normal driving (especially after hitting pot holes or curbs), permeation

and seasonal changes in temperature. They can lose 13789.52 Pascals (2 pounds per square inch) each month in the winter and even more in the summer.

You can't tell if they're properly inflated just by looking at them. You have to use a tire pressure gauge. Not only is under inflation bad for your tires but it's also bad for your gas mileage, affects the way your car handles and is generally unsafe. When tires are under inflated, the tread wears more quickly. According to Goodyear, this equates to 15 percent fewer miles you can drive on them for every 20 percent that they're under inflated. Under inflated tires also overheat more quickly than properly inflated tires, which cause more tire damage.
The faded areas below indicate areas of excessive tread wear.
The most important factors in tire care are:

- Proper Inflation Pressure
- Proper Vehicle Loading
- Proper tire Wear
- Regular Inspection
- Vehicle condition

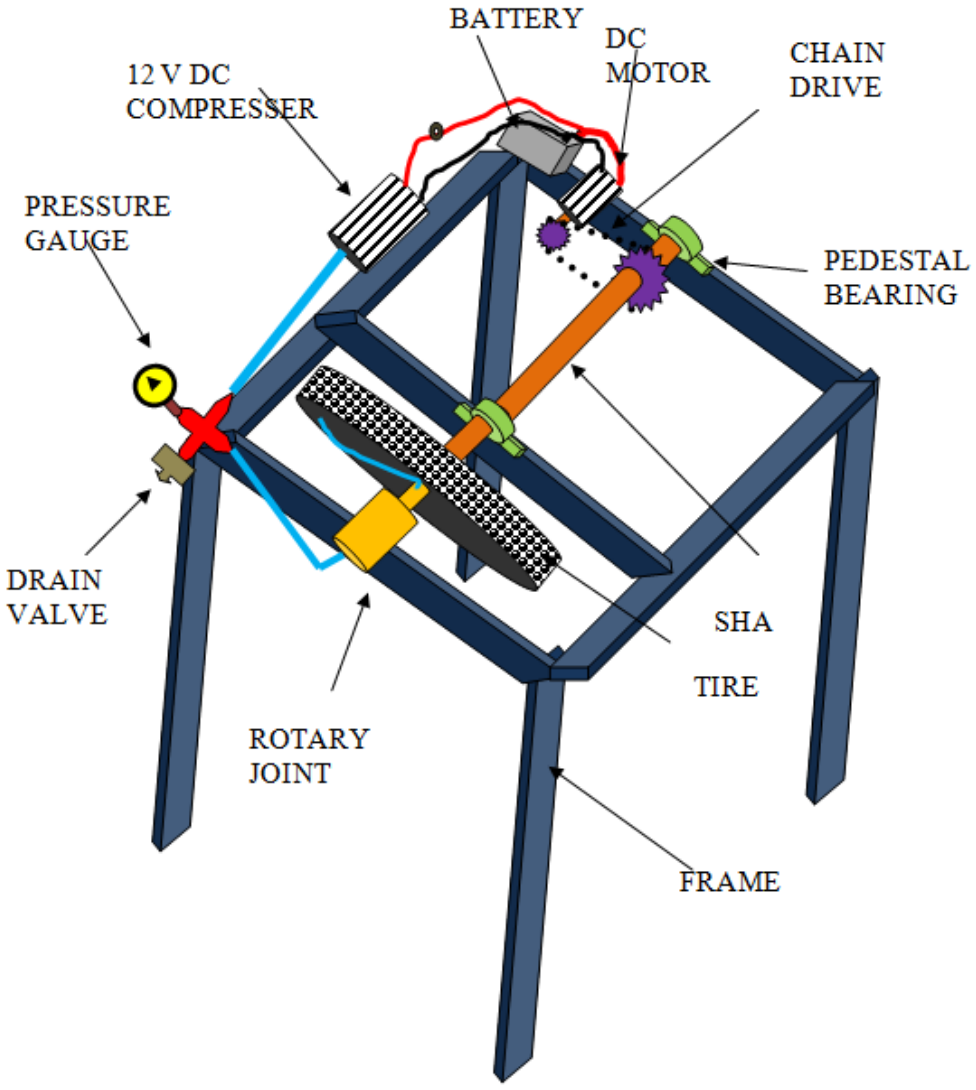


Fig.1 Construction Diagram of Inflation System

The Benefits of Proper Inflation With the right amount of air pressure; you will achieve optimum tire performance. This means your tires wear longer, save fuel and help prevent accidents. The "right amount" of air is the pressure specified by the vehicle manufacturer, which may be different on the front than the rear tires on your particular model car or light truck. The correct air pressure is shown on the tire placard (or sticker) attached to the vehicle door edge, door post, glove box door or fuel door. If your vehicle doesn't have a placard, check the owner's manual or consult with the vehicle manufacturer, tire manufacturer or your local tire dealer for the proper inflation. The tire placard tells you

the maximum vehicle load, the cold tire air pressures and the tire size recommended by the vehicle manufacturer. If you don't take proper care of your tires, the results can be serious.

Most tire companies are either supplying a handbook or are molding a safety warning right onto the tire sidewall. Motorists are strongly advised to follow the vehicle owner's manual or the tire placard in the vehicle for proper inflation and loading. Only specially trained persons should mount or demount tires. An explosion of a tire and wheel assembly can result from improper or careless mounting procedures.

Persons who do mount tires must have the right equipment, the right training and the right information before proceeding. Never exceed 40 psi to seat the beads. Always use a restraining device when mounting a tire on a rim, and be sure to stay back from the tire when inflating it. Remember, mounting and demounting tires and wheels should be left to skilled professionals who are aware of the safety hazards involved and who have the proper tools and equipment to do the job safely.

Because tires are flexible, they flatten at the bottom when they roll. This contact patch rebounds to its original shape once it is no longer in contact with the ground. This rebound creates a wave of motion along with some friction. When there is less air in the tire, that wave is larger and the friction created is greater -- and friction creates heat. If enough heat is generated, the rubber that holds the tire's cords together begin to melt and the tire fails. See how tire works to learn more. Because of the extra resistance an under inflated tire has when it rolls, your car's engine has to work harder.

AAA statistics show that tires that are under inflated by as little as 2 psi reduce fuel efficiency by 10 percent.

LITERATURE REVIEW

Bezuidenhout in discuss The South African Sugar cane industry has identified central tire inflation (CTI) as a technology that could improve vehicle performance and reduce costs. This specific need is due to the fact that transport comprises up to 20 % of a cane grower’s production costs because of poor vehicle utilization. Consequently, it is important that transport costs should be reduced in order for the sugarcane industry to maintain profitability concluded by [1].

Central tire inflation technology offers benefits such as improved mobility and savings in road maintenance costs, but more importantly can also reduce the two largest operational expenses on a transport vehicle namely fuel and tires explained by Oberholzer [2].

As per Kaczmarek during World War II the mobility requirements in the former Soviet Union and Warsaw pact countries were extremely demanding due to poor road and highway quality. Consequently, a considerable effort was made by these countries to develop systems to improve mobility, including primary suspensions and central tire inflation systems [3].

Kaczmarek (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, where after most of the military tactical vehicles produced in the United States were equipped with CTI discussed by Adams [4].

Sturoset al. Say’s Tire deflection is the key to understanding the use of CTI technology. Tire deflection is defined as the change in tire section height from the freestanding height to the loaded the height. The percentage deflection is the ratio of that change to the freestanding section height. At the lowered inflation pressures (increased tire deflection), the tire’s imprint or contact the area is greatly increased and the load is applied over a substantially larger area explained by [5].

Foltz and Elliot discuss that A CTI system permits a vehicle operator to optimize tire and vehicle performance by varying inflation pressures in response to changing operating conditions (load, road and vehicle speed) while the vehicle is moving [6].

In this study, the air pressure of tire is maintained by using automatic tire inflation system. Case Study on Automatic Tire Inflation Management: The aim of this study is to design and fabricate a system in which there is proper inflation in the tire at all times which produce fuel savings of 1-4% and increase tire life by up to 10%. A trial was done in this case paper involving two cement tankers in NSW Australia operated over a period of 12 weeks in 2013. For first 6 weeks central inflation system was turned ON in both tankers and for another 6 weeks central inflation system was turned OFF in the both and graphs are prepared showing trucks with central inflated system is good in conditions like average vehicle idle time, average vehicle time spent using power take off, average vehicle GHG emissions, average vehicle fuel consumption across the trial period. [7]

METHODOLOGY

Compressed air is given to the 2/2 solenoid valve inlet. The pressure switch is used to sense the tire pressure. The required tire pressure is set by the pressure switch reading. This pressure switch is used to sense the current pressure and this output signal is given to the solenoid valve.

Whenever the tire pressure is below the set valve the pressure switch activate the solenoid valve. The compressed air is goes to the tire with the help of quick release coupling which is used to rotating the wheel freely. The required pressure is filled then the pressure switch will be deactivated the solenoid valve so that the tire pressure will be maintained in constant level.

Fig.2 Fabrication

Ability to Provide Proper Tire Pressure
The ideal functional objective of our design is its capability to adjust the pressures in all four tires of a Passenger vehicle to obtain the proper pressure for varying road/driving conditions. Specifically, it is desired that:
• Cold tire pressure is maintained during vehicle use to account for slow leaks and Fluctuating tire temperatures
• As vehicle speed increases, tire pressures increase.
• As vehicle speed decreases, tire pressures decrease.
• As vehicle load increases, tire pressures increase.
• As vehicle load decreases, tire pressures decrease.

Based on more detailed research on the components necessary for the system, it was discovered that a specialized rotary joint must be designed to support this process. This design consideration required additional product development time that was not originally anticipated. Therefore, the ideal functional objectives have been modified to account for this design requirement. Specifically, the new objectives require that:

• Cold tire pressure 241290 Pascals (35 pounds per square inch) is maintained by ensuring that the rotary joint-shaft system does not fail structurally, 1pound per square inch = 6894.757 pascals
• Cold tire pressure (35 psi) is maintained by ensuring that the rotary-joint shaft system does not leak excessively
• Cold tire pressure (35 psi) is maintained by ensuring that the entire system (compressor, Air tubes, rotary joint, etc.) can provide sufficient flow rate.

Because of the detailed level of explanation required for these items, these objectives are described

Minimize Negative Visual Aesthetics
Another design objective is to ensure that the product will not have a negative effect on current vehicle Aesthetics. All components should be located as inconspicuously as possible and should only be seen When servicing the unit. However, in the case of the rotary joints, which may still be visible through the Wheel rims, an attempt must be made to minimize its visibility around the brake disks. Specifically, it is desired that Where Visible is the visible area of the rotary joint and Disk is the visible area of the brake disk.

Ability to Provide Automatic System
A third objective is to provide all of the said benefits to the user through an automatic system, thus minimizing user intervention. Specifically, it is desired that the system automatically increases or decreases the tire pressures for the given road conditions. However, since this objective is closely linked with the ideal objectives in maintaining the proper tire pressure, and thus unattainable due to time constraints, this objective will not be pursued.

Low-Cost Device
For both the original equipment manufacturer (OEM) and end user (vehicle owner), it is imperative to keep the price of the device as low as possible. Considering the potential benefits and cost savings that this design has to offer and the

prices of optional equipment for passenger vehicles with similar complexity, the target price range for this device has been identified as. This is the price for both the OEM and vehicle owner, assuming that the OEM does not mark up the price. In addition, this price range should be able to support the costs of components of the system, manufacturing, and any necessary installation.

Layout of tire inflation system:

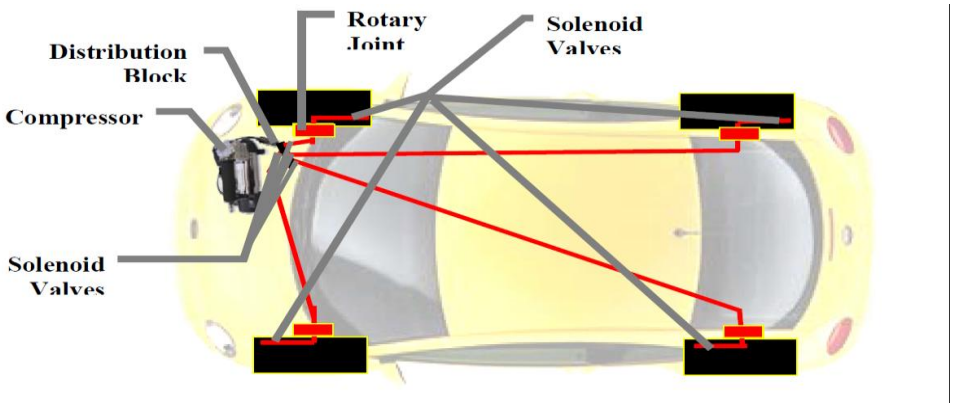


Fig: 3 Tire Inflation System Configurations

Portable Compressor

12V Car Electric Air Compressor Tire Pump - Tire Inflator also for Bikes, Cycles, Boats, Inflatable Toys100% Brand New 12V Air Compressor/Tire Infiltrator Simply use this for fast & easy inflation of car tires" No strength required for pumping air as it is all electronic & is powered directly from your car battery Perfect for anyone who wants a ease while inflating a tire Time saving as compared to mechanical pump .Quick operation, very Compact and easy to store in car dickey suitable for:- Auto tires, Car/ bike tires, rubber rafts balls Inflates car tires, bicycle tires, rafts and sports equipment such as Basketball, Soccer fast and easily. Also inflates boats, pools, air bed, balloon, etc.

Fig:4 Portable Compressor

Solenoid Valves

2/2 air solenoid valves are direct acting solenoid valves and do not require a minimum operating differential pressure. As shown below when the coil is energized (right diagram), it lifts the solenoid plunger, which normally rests on the valve seat and lifts it to open the main valve orifice. When the coil is de-energized (right diagram), the spring force the plunger returns to the valve seat to close the valve orifice.

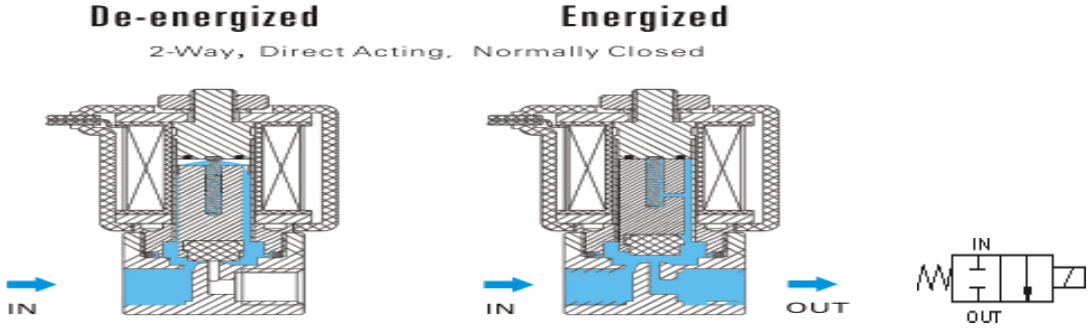


Fig:5 Solenoid Valves

Pressure Sensor

A pressure sensor measures pressure, typically of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed.

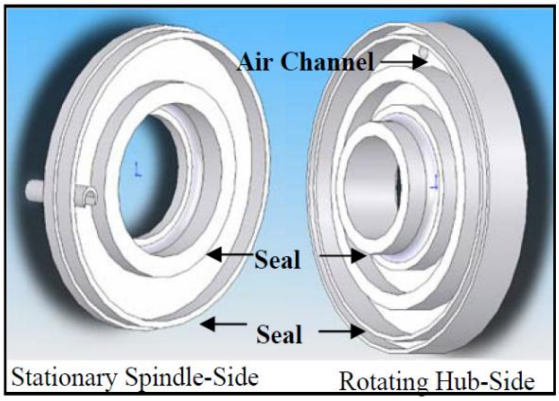
For the purposes of this article, such a signal is electrical.

Pressure sensors are used for control and monitoring in thousands of everyday applications. Pressure sensors can also be used to indirectly measure other variables such as fluid/gas flow, speed, water level, and altitude. Pressure sensors can alternatively be called pressure transducers, pressure transmitters, pressure senders, pressure indicators and pyrometers, manometers, among other names. Pressure sensors can vary drastically in technology, design, performance, application suitability and cost. A conservative estimate would be that there may be over 50 technologies and at least 300 companies making pressure sensors worldwide.

Fig:6 Pressure Sensor

Rotary Joint

We are designing this device for common passenger vehicles, and the main challenge is the presence of the axle shaft that runs straight into the centre of the wheel forcing us to find an alternative method of routing the air. Our proposed solution to this challenge is to place rotary joint that has one half spinning with the drive axle hub and the other half stationary with the spindle. Within this rotary joint will be an air chamber that will allow air to pass from the stationary half of the joint into the half that is rotating.



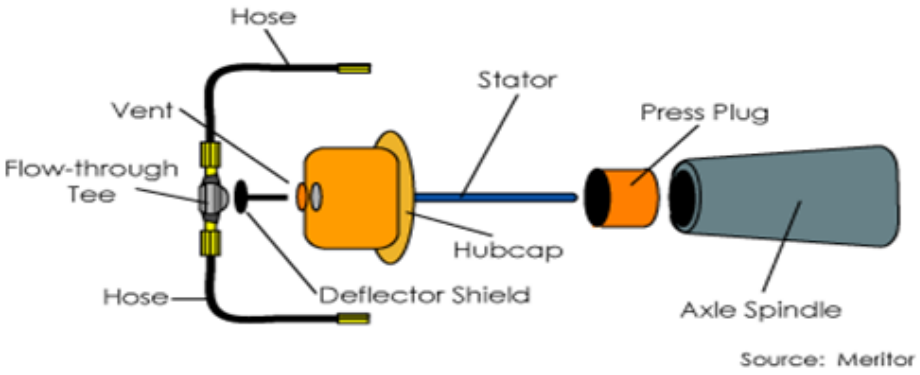


Fig: 7 Rotary Joint

The main criteria for our rotary joint design were the following:

- Must have approx. 40mm hole in the centre to allow for the axle to either pass through or support the joint.
- Air inlets and outlets must be located at the outer radius to allow the hoses on the outside of the joint to clear the vehicle spindle and hub.
- Overall thickness of the joint must be no greater than 25mm to so as not to interfere with the
- Vehicle drives line or suspension components.
- Ball bearing system must be used to reduce contact friction between the two rotating halves both axial and planar.

Pressure Switch

A pressure switch is a form of switch that makes electrical contact when a certain set pressure has been reached on its input. This is used to provide on/off switching from a pneumatic or hydraulic source. The switch may be designed to make contact either on pressure rise or on pressure fall

CAR BATTERY 12V

Fig: 8 Car Battery 12v

An automotive battery is a type of rechargeable battery that supplies electric energy to an automobile. Usually this refers to an SLI battery (starting, lighting, and ignition) to power the starter motor, the lights, and the ignition system of a vehicle's engine.

CONCLUSIONS

It can be concluded that this automatic centralized compressor self-inflating tire system ensures that all tires are always properly inflated and thus improves the tire life, safety, reduction of gas mileage and vehicle performance by supplying air to all tires via hoses and a rotary joint fixed between wheel spindle and wheel hub at each wheel whenever there is a pressure drop inside the tire.

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