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A SURVEY ON SELF INFLATING TYRE SYSTEM

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ABSTRACT

Tire is the most essential part of automobile and it plays crucial role in ensuring safe driving. Even then, almost every automobile on the road run with either one or more under inflated tires. Detailed survey has come with result that drop-in tire pressure by just few psi leads to the reduction in gas mileage, tire life, safe driving and vehicle performance. Unawareness of exact pressure requirement, sudden environmental changes are also some of causes for tire running with improper pressure. Automatic tire pressure controlling and self-inflating system ensures correct pressure in the tire all the time. Drop in pressure is detected by hissing sound made by tire and system will starts refilling the tire automatically according to the requirement of the tire. This system is named automatic because it checks the tire pressure constantly using pressure gauge and accordingly gives alert signals to the driver. Aim of this project is to stabilize all automobile tires with ideal pressure, make system absolutely automatic, achieve satisfactory fuel efficiency, construct an affordable system, increase tire life and reduce accident rate has been achieved by installing the system in vehicle.

Keywords:*automatic control, safe driving, self-inflating system, tire pressure, vehicle etc.*

1.INTRODUCTION

A variety of tire monitoring strategies have been proposed to aware driver of low tire pressure. Under inflated tires run on the road due to unawareness of the fact that properly inflated tires can safe tire life up to 20% which is nine months more of its life span. It can also save fuel from 4% to 10%, increase braking efficiency up to 20%, and ease the self-steer. The research finding shows that the air pressure in the car drops 10 to 20 kpa a month which is equivalent of adding a 70kg person into the car. Inflating accurate tire pressure save the tire from extra heating, explosion and also help decrease maintenance cost, as shown in Fig. 1 [1].

Fig.1. Tire wear patters observed for different tire inflation pressures [1].

Compressor is used in this system to collect the air from atmosphere, compress it and deliver to the tire for inflation. Under inflated tires tend to wear at the edges more than at the center as the pressure is not sufficient at the center to bear the load. As against this for over inflated tires wear is higher at the center due to bulging of tires. Wearing of the threads causes the skidding of the tire hence leads to major danger accidents. All of related studies shows that under inflation from axle tires result in under steer tendencies while rear axle under inflation creates over steer behavior hence disturbing the car handling. This system is addressed to be automatic as it automatically checks the tire pressure by using pressure gauge and if tire pressure is decreased below ideal condition than the compressor starts to supply the air to refill the tire. It also predicts about the puncture when there is continuous reduction of its set optimal value. The advantage of the system is that it does not require any special attention from user side once after the system being installed. It discards the requirement of checking tire pressure manually, thus saving time and labor. With the recent oil price hikes and ever increasing environmental issues, the system addresses a potential development in a gas mileage, tire wear reduction, and an improvement in handling and tire performance in adverse condition. This kind of systems are all- ready being installed in military vehicles and commercial cars for safety purpose and to feel the luxury driving but this system is being introduced for all types of customer vehicles with the absolute motive to give safety assurance and comfort driving. Now with the installation of this system one can drive vehicle under all worst sudden varying environmental conditions like heavy rainfall, snowfall, deserts. Specially at remote places this kind of system proves to be most helpful as repairing devices for maintenance of the automobile are very critically available .At some crucial times like war conditions or any flood condition there is no time to refill the tire with air hence Automatic tire controlling and self- inflating tire system is very essential to be encouraged to install in every automobile to face all tire related issues and enjoy safe and comfort driving [5].

2. LITERATURE REVIEW

2.1 Burase et al. surveyed on automobile air inflating system. In this research paper, a new approach is encouraged for automobile a self-inflating tire that guarantees that tires will be properly inflated all the time. The system uses portable compressor that will supply air to all four tires 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 delivered to the required under inflated tire. This system acknowledges a essential improvement in gas mileage, tire wear reduction, and an increase in handling and tire performance in diverse conditions. [1]

2.2 S. Adakmol et al focused attention to the reasons due to which tires lose air and thus tried to develop the automatic system so that vehicle run safely on road all the time without attaining the under inflating condition ever hence avoiding the accidents. Centralized compressor system is applied over in this paper system. Under inflated tires overheat very rapidly then a well inflated tire which damages the tires within very short time span. In this system as soon as tire pressure goes under inflated state then a pressure sensor senses it and send it to all the controller which activates the solenoid valve and air is filled up to the exact pressure. [2]

2.3 Hemantsonihas studied for automatic tire inflation system and he introduced the centralized compressor-based system with the aim of improving gas mileage, tire life, car safety and working. 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 most beneficial project for society as the system automatically refills all the four tires whenever required under all environmental and road conditions [3].

2.4 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. The system uses the permanent connection between valve and hoses with only intention of providing tight connection during rotation of tire so that it can be lose only when substituting the tire by the driver. Other intention expressed through this paper is that the vehicle tire must never be either under inflated nor over inflated. Pressure in tires should be always idealized level as under inflation leads to wearing of tire, consumption of excess fuel and over inflation causes explosion of tires. This system also helps predict about the puncture in the tire when there is continuous reduction in pressure of its set threshold value. [4]

2.5 H. Soni et al. investigated the result of drop in tire pressure. Driven by their studies developed a compressor to obtain air from atmosphere, compress it and supply it to the tire for pressure regulation. The system automatically examines the tire pressure using pressure gauge. If the tire is under inflated then the compressor. [5]

3. PROBLEM STATEMENT

To develop an automatic air filling system, this recognizes and fills air in respective tyre when its pressure goes below the desired/required pressure (under inflated condition). Underinflated tyres overheat more quickly than properly inflated tyres, which cause damage to tyres. To reduce this problem, we are designing this system. As soon as a tyre Pressure goes under inflated, then a pressure sensor senses it and send it to the Controller which activates the solenoid valve and air is filled up to proper inflation.

4. OBJECTIVE

4.1. Maintains the required tyre pressure: The function of the system is to maintain and adjust the pressure in all the tyres of the system according to varying loading and driving conditions

4.2. An Automatic System: An automatic system further saves human energy & time in filling the air in tyres when they are in under inflated conditions.

4.3. Builds a Low-cost system: The installation of such a system in vehicles is a low-cost affair.

4.4. Improves fuel efficiency & tyre life: This system helps in less consumption of fuel and also improves tyre life by reducing chances of wear in tyre.

5. METHODOLOGY

After referring several papers, we got many ideas. 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, we will start making rough design and after that we will draw a 3-D model in Auto CAD. By referring this 3D model, we will buy the standard component required for the projects. After this we will start manufacturing work in workshop. Along with this electronics part will also be done. In electronics we 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.

5.1 STEPS: Figure 2 refers to the steps involved.

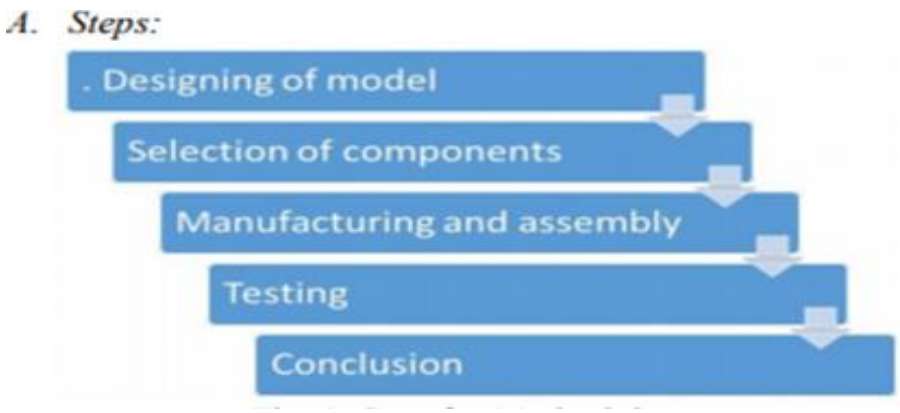

Fig.2. Step for Methodology.

5.2 System Design & Cad Model: The project work has been started with literature review as below. After referring several papers, we got many ideas. From these ideas we started developing a typical air inflation system as follows figure 3 & figure 4 .

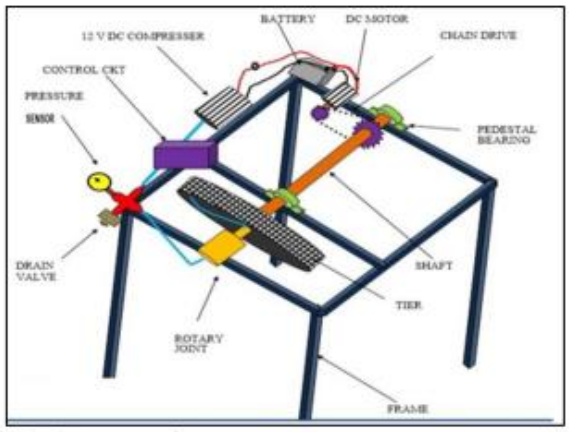

Fig.3. System Design

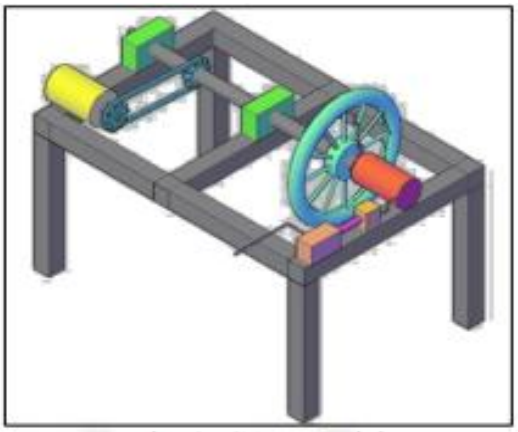

Fig.4. CAD Model

5.3 Integral Parts of the System:

5.3.1 Rotary Joint:

Rotary joint or a Rotary Union is a device that provides a seal between a stationary passage and a rotating part. Stationary passage may be a pipe or tubing; whereas rotating part can be a drum, spindle or a cylinder. Thus, it permits the flow of the fluid into and/or out of the rotating part. Generally, the fluids that are used with the rotary joints and rotating unions are steam, water, thermal oil, hydraulic fluids etc. A rotary union will lock onto an input valve while rotating to meet an outlet. During this time the liquid and/or gas will flow into the rotary union from its source and will be held within the device during its movement. This liquid and/or gas will leave the union when the valve openings meet during rotation and more liquid and/or gas will flow into the union again for the next rotation. Refer figure 5.

Fig.5 Rotary Joint.

5.3.2 Pressure Sensor:

A pressure sensor measures pressure of gases or liquids. It generates a signal as a function of the pressure imposed; in our system such signal is electrical. Pressure sensors can also be uses to measure other variables such as fluid/gas flow, speed and water level. Pressure sensors can alternatively be called pressure transducer, pressure transmitters, pressure senders, pressure indicators, piezometers and manometers among other names. Refer figure 6.

Fig.6. Pressure Sensor.

5.3.3 Compressor:

The system uses compressor to get the air from atmosphere & to compress it to a required pressure. A 12V DC compressor has being used in our system. It is perfect for cars, bikes and inflators. It operates from the cigarette lighter socket of a DC- 12V. Proper design has been set up for installing hose and cord. It is ideal for inflating all vehicle tires and other high-pressure inflatables. The following table shows the specification of our portable compressor. Operating Pressure Range (psi) 0-80 psi Voltage Supply 12 V DC Weight 336-gram Dimensions 10.8*4.7*9.5 cm Table 1 Specifications of our portable compressor. Refer figure 7.

Table 1: Specifications of our portable compressor.

Operating Pressure Range (psi)	0-80 psi
Voltage Supply	12 V DC
Weight	336 grams
Dimensions	10.8*4.7*9.5 cm

Fig.7. Portable Compressor.

5.4 Calculation:

5.4.1 Compressor Selection:

For tyre pressure of 30 psi Where, 1 psi = 0.06895 bar Therefore,

30 psi =30*0.06895 bar = 2.0685 bar = 2.1 bar (approx.)

Therefore, we are selecting 12V D.C., 5.5 bar compressor for tyre pressure of 30 psi.

5.5Specifications:

The specifications and material used for manufacturing of different components are as follows:

Table 2: Specifications/Material used for different components

Sr. No	Description	Specification
1.	Compressor	80 psi (5.516 bar) 12V D.C.
2.	Rotary Joint	Size= 1/2", Pressure= 10kg/cm2
3.	Pressure Sensor	Pressure range= 0-100 psi
4.	Bearing	Roller Bearing, Carbon Steel
5.	Chain Sprocket	No. of teeth =18, Carbon steel
6.	Shaft	Carbon Steel
7.	Frame	30" *20" *13", Mild Steel
8.	Wheel	Moped Vehicle (Honda Activa)
9.	Hoses	Polyvinyl chloride (PVC)
10.	DC Motor	12V DC ,100rpm

6. TYRE-INFLATION BASICS:

6.1 HOW TYRES SUPPORTS A CAR

You may have wondered how a car tyre with 30 pounds per square inch (psi) of pressure can support a car. This is an interesting question, and it is related to several other issues, such as how much force it takes to push a tyre down the road and why tyres get hot when you drive (and how this can lead to problems).

The next time you get in your car, take a close look at the tyres. You will notice that they are not really round. There is a flat spot on the bottom where the tyre meets the road. This flat spot is called the contact patch. If you were looking up at a car through a glass road, you could measure the size of the contact patch. You could also make a pretty good estimate of the weight of your car, if you measured the area of the contact patches of each tyre, added them together and then multiplied the sum by the tyre pressure. Since there is a certain amount of pressure per square inch in the tyre, say 30 psi, then you need quite a few square inches of contact patch to carry the weight of the car. If you add more weight or decrease the pressure, then you need even more square inches of contact patch, so the flat spot gets bigger.

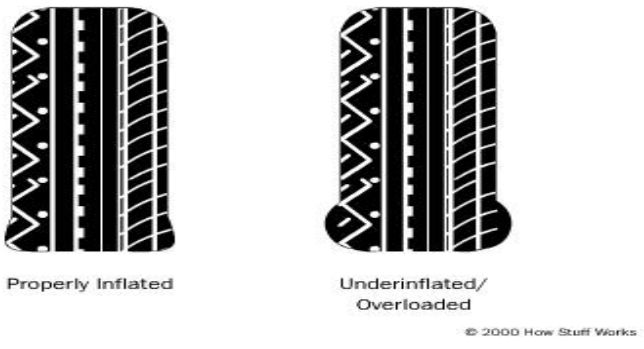

Fig.8. A properly inflated tyre and an under inflated or overloaded tyre.

You can see that the under inflated/overloaded tyre is less round than the properly inflated, properly loaded tyre. When the tyre is spinning, the contact patch must move around the tyre to stay in contact with the road. At the spot where the tyre meets the road, the rubber is bent out. It takes force to bend that tyre, and the more it has to bend, the more force it takes. The tyre is not perfectly elastic, so when it returns to its original shape, it does not return all of the force that it took to bend it. Some of that force is converted to heat in the tyre by the friction and work of bending all of the rubber and steel in the tyre. Since an under inflated or overloaded tyre needs to bend more, it takes more force to push it down the road, so it generates more heat.

Tyre manufacturers sometimes publish a coefficient of rolling friction (CRF) for their tyres. You can use this number to calculate how much force it takes to push a tyre down the road. The CRF has nothing to do with how much traction the tyre has; it is used to calculate the amount of drag or rolling resistance caused by the tyres. The CRF is just like any other coefficient of rolling friction: The force required to overcome the friction is equal to the CRF multiplied by the weight on the tyre. This table lists typical CRF for several different types of wheels.

Table 3: Refers to typical CRF for several different types of wheels.

TYRE TYPE	COEFFICIENT OF ROLLING FRICTION
Low rolling resistance car tyre	0.006 - 0.01
Ordinary car tyre	0.015
Truck tyre	0.006 - 0.01
Train wheel	0.001

7. SAFETY & RELIABILITY

Since levitation of air bearing produces excellent suspension, earthquakes cannot produce any damage to capsules. The supporting structures of tubes have foot print of size of telephone pole so they can sway in worst case and again without any possible damage to capsule. Besides, statistically, it is known that most of accident are caused by human factor but there is no human factor in hyperloop since everything is managed by computer system so accidents are next to impossible.

8. MERITS

8.1Safety: Properly inflated tires increase car stability and reduce the danger of Blowouts.

8.2 It also ensures a cars proper braking distance and overall vehicle handling and maneuverability.

8.3 Fuel efficiency: Correct tire pressure leads to lower rolling resistance, significantly improving fuel efficiency.

8.4 In United States alone, 1.24 Billion gallons of fuel per year can be saved by proper tire pressure.

8.5 TIRE LONGEVITY Proper inflation leads to improve the tires life span.

9. DEMERITS

9.1 The friction created is greater.

9.2 Friction creates heat and if enough heat is generated the rubber that holds the Tyre cords melts and Tyre trails.

9.3 As it effects mileage it can cause severe loss in the cost considerations.

10. FUTURE SCOPE

10.1 Michelin is working with several other companies to develop an active pressure-management system called TIPM (Tyre Intelligent Pressure Management).

10.2 This system has a compressor that automatically adjusts the pressure in each tyre while the vehicle is in operation to compensate for leaks and slow-leak punctures.

10.3 The driver will be able to adjust the pressure depending on the desired driving mode: comfort, sporty, all-terrain or over-obstacle.

10.4 The goal is to maintain a specific pressure.

11. COMPARATIVE RESULTS

Table 4: Refers to Comparative Results.

Sr.No	INVENTION YEAR	ACHIEVEMENTS
1	1970	Robert Thomson: Invented pneumatic tire in 19th century.The rubber doughnut tire inflated with air revolutionized tire technology, providing relief from the rough ride of the traditional hard wheels of the time.
2	2005	Michelin: Introduced tire and wheel combination called “Tweel.” in 20 centuries.It consisted of a thin band of rubber thread withcomposite- plastic belt reinforcement.

CONCLUSION

12.1 Self-inflating tyres help us to attain certain helpful criterions such as: -

12.1.1 It provides safe driving.

12.1.2 Improve fuel efficiency.

12.2 To control tyre pressure according to driving conditions.

12.2.1 Automatic centralized compressor self-inflating tyre system ensures that all tyres are always properly inflated and thus improves the tyre life, safety, reduction of gas mileage and vehicle performance by supplying air to all tyres via hoses and a rotary joint fixed between wheel spindleand wheel hub at each wheel whenever there is a pressure drop inside the tyre.

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