Design and Development of Automatic Tyre Inflation System

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Abstract— In today's world scenario of automobile new technologies have developed and still developing to prevent accident of vehicles. A some of accidents are almost take place because of tyres fault system. So to overcome that automatic tyre inflation system is effective method. It shows that the a drop in tyre pressure by just a few PSI can result in the reduction of gas mileage, tyre life, safety, and vehicle performance, Development of an automatic, self-inflating tyre system that ensures the tyres are properly inflated at all times. Our design proposes and successfully implements the use of a centralized compressor that will supply air to all tyres via hoses and a rotary joint fixed between the wheel spindle and wheel hub at wheel. The rotary joints effectively allow air to be channel to the tyres without the tangling of hoses. With the recent oil price hikes and growing concern of environmental issues, this system addresses a more improvement in gas mileage; tyre wear reduction; and an increase in handling and tyre performance in diverse conditions.

Key words: Inflation, Rotary Joint, Compressor, Air, Safety, Tyre

I. PROJECT MOTIVATION

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 40% 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 that is either over-inflated or under-inflated. According to the Rubber Manufacturing Association (RMA) survey, 80% of people are unsure of how to check their tyre pressures. 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.

II. PROBLEM DEFINITION

By studying various papers and searching we found that now a days, inflation of air in tyre is became challenge when vehicle is in motion. Moreover accident of vehicle also takes place because of under or overinflated tyre system. Thus in our design we have made automatic tyre inflation system that will help to fill the air in tyre while car is in motion. Therefore we have planned to fill air automatically in the tyre while vehicle is running. Because tyre's 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 tyre, that waviness larger and the friction created is greater and friction creates heat. If enough heat is generated, the rubber that holds the tyre's cords together begin to melt and the tyre fails.

III. INTRODUCTION

It is observed that, generally about 80 percent of the vehicles on the road are driving with one or more tyres under inflated. Tyres loose air through normal driving (especially after hitting pot holes or curbs), permeation and seasonal changes in temperature. It may lose one or two psi (pounds per square inch) each month in winter and even more in the summer. And, we cannot tell if they're properly inflated just by looking at them. We have to use tyre pressure gauge to check pressure in tyre. As safety point of view under inflated tyre bad but it's also bad for your gas mileage, affects the way your vehicle handles and is generally unsafe. When tyres are inflated, the tread wears more quickly. According to Goodyear, this equates to 15 percent fewer miles we can drive on them for every 20 percent that they're under inflated. Under inflated tyres also overheat more quickly than properly inflated tyres, which cause more tyre damage.
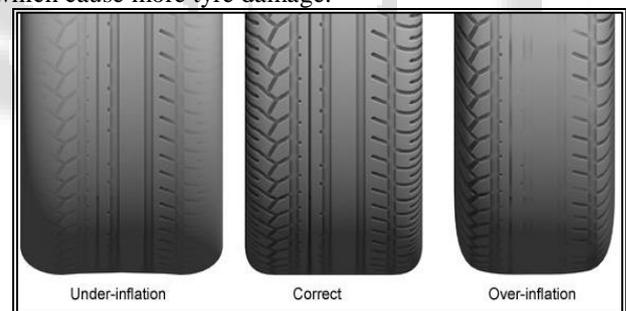

Fig. 1.1: Tyre wear pattern observed for different tyre inflation pressures

IV. EFFECT OF TYRE PRESSURE ON VEHICLE PERFORMANCE

Improperly inflated tyres are directly affect on vehicle performance such as mileage, speed, average as well as passenger safety. Proper air pressure in a tyre helps to distribute the weight of a vehicle evenly across the tyre's tread pattern, so the tyre (and the vehicle) is at its most stable. When a tyre is under-inflated or over-inflated, it loses stability, negatively affecting handling, cornering, and stopping. Eventually the tyre will also start to wear unevenly. Under-inflated tyres tend to show wear on the outside edges of the tread, while overinflated tyres show wear down the middle of the tread. With incorrect inflation pressure more tyre wear and thus there is a need to change tyre quickly.
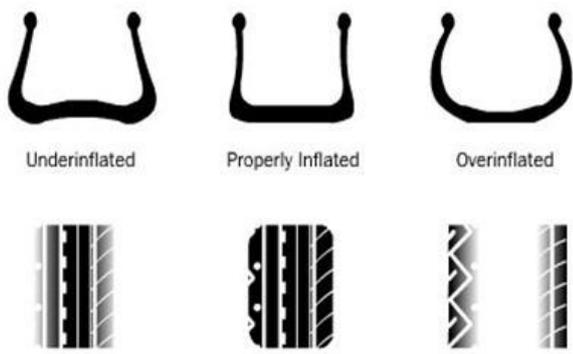
Fig. 1.2: Various tyre pattern

V. METHODOLOGY

This project is started with discussion with our project guide about automobile. During that discussion covering project overview and sheared a opinion that related about title of project. Then started to make and decide the new idea about the title. Before that, literature review and research about title is the important point to get the best idea. Then studied and made a investigation about conventional air filling system. That includes a study about concept of conventional air filling system, process to fabricate. This task have been done through study on the internet, research paper, and others information. After collecting all title related information and obtained new idea and knowledge about the title, the project continued with the design process. After several design sketched, we selected the best design. Then the selected design transferred to engineering drawing using solid works software for analysis process. After that selection of components is confirmed initially. After all the detailed drawing and material preparation done the next step carried out is a fabrication process. This process based on dimension has been determined from drawing. Analysis stage has been implemented before fabrication stage.
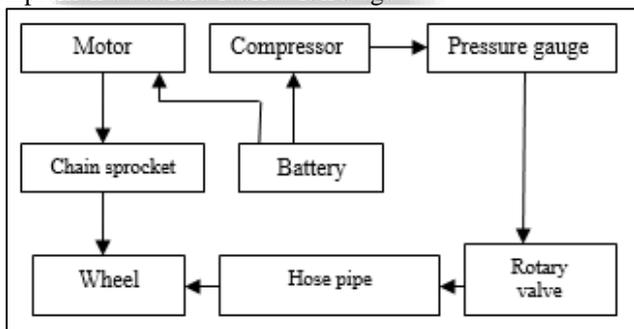

Fig. 1.3: Block Diagram Of Automatic Tyre Inflation System

A. Working:

This mechanism works on the principle that the compressor supplies air to the tyre when the vehicle is running. The air from the compressor is supplied to the rotary joint, from where the air is supplied to the tyre which is under-inflated. Because of the implementation of rotary joint the air is easily supplied to the tyre without tangling the hoses. In the process of automatic tyre inflation system. the compressor is used to compress the air. The air is taken from the atmosphere and compressed it at required pressure. There is small pipe which is used connect to the compressor outlet port and one end of the rotary joint. The compressed air is supplied to the rotary

joint through the small pipe. Two Pedestal bearings are used to support the axle of the assembly. Bearings are fixed to the rigid supports via nuts and bolts. The axle is rotate on which wheel or rim is mounted on one end. One end of coupler is connected to axle and other end is connected to rotary joint. When a system start compressed air from compressor is filled in tyre through rotary joint and hose pipe. Drain valve is provided to relief excessive air.

B. Components of system:

1) Compressor
An air compressor is provided to supply compressed air for inflation of tyre through rotary joint.
2) Rotary joint
The most critical component of the system is the rotary joint that enables the air to travel from the fixed components of the vehicle to the rotating vehicle tyres. The rotary coupling is attached to the wheel hub at the end of each axle and is connected to the air system. The airlines connecting the rotary coupling are usually very strong stainless steel hoses due to the fact that they are exposed and vulnerable to being damaged. The rotary joint is comprised of air and oil seals and bearings and connects the air hose from the non-rotating axle to the rotating hubcap.
3) Motor:
An electric motor is required to drive compressor unit as well as chain sprocket mechanism which is used to rotate the tyre. 12 volt DC motor is used to drive compressor unit.
4) Battery:
As to run entire system, power source is required which will be given from battery. A 12 volt dry cell automobile battery is used that supply power to DC motor.
5) Pedestal Bearings
6) Tyre
7) Hoses and pipes
8) Nut and bolt
Advantages:
1) Increase vehicle efficiency.
2) Increase life span of tyre.
3) Avoid accidents and fatality.
4) Reduced tyre blowout since tyre remain at the proper inflation level.

VI. THEROTICAL CALCULATIONS

Motor:
Power of motor = 0.5 H.P = 746 x 0.5 = 373 N- m /s
Rpm of motor= 1800 rpm
Output rpm required = 8 rpm
Calculation of final speed & torque of motor:
Power of motor (P)= 0.5 hp = 0.5 x 746 =373 watt

$$P = \frac{2\pi NT}{60} \quad [\text{ where, } N \rightarrow \text{Rpm of motor} = 1800]$$

$T \rightarrow$ Torque transmitted

$$373 = \frac{2\pi \times 1800 \times T}{60}$$

T = 1.97N-m
T = 1979.8 N-mm
Calculation of torque obtain by motor:
Input torque of gear box = 1980 N- mm
Input rpm of gear box = 1800 rpm
For speed reduction we use chain drive
Teeth 1 = 12
Teeth 2 = 40

Reduction Ratio = 3.3

$$N_2 = \frac{N_1}{3.3}$$

$$N_2 = \frac{24}{3.3}$$

$N_2 = 7.2$ rpm

$N_2 \approx 8$ rpm

Torque at gear box out put

$$\frac{N_1}{N_2} = \frac{T_1}{T_2}$$

$$\frac{24}{7.2} = \frac{T_1}{178.09}$$

$T_1 = 593.63$ N-m

Shaft design:

Shaft design based on maximum shear stress theory

$T_1 = 593.63$ N-m

$$T_1 = \frac{\pi}{16} \times \tau \times Ds^3$$

$$593.63 = \frac{\pi}{16} \times 36 \times (Ds)^3$$

Ds = 43.17 mm

D_S =45 mm.

Design of chain & sprocket:

We know,

Transmission ratio = $\frac{Z_2}{Z_1} = \frac{40}{12} = 3.33$

For this transmission ratio number of teeth on pinion sprocket is in the range of 21 to 10, so we select number of teeth on pinion sprocket as 12 teeth.

So, $Z_1 = 12$ teeth

Selection of pitch of sprocket:

The pitch is decided on the basis of rpm of sprocket.

rpm of pinion sprocket is variable in normal condition = 7.2 rpm

For this rpm value we select pitch of sprocket as 9.52mm

Pitch= 9.52 mm.

Transmission ratio = $\frac{Z_2}{Z_1} = \frac{40}{12} = 3.33$

VII. TESTING AND RESULTS

This project is completely based on demonstration purpose as the ideal objective of project is to fill the proper air pressure in under inflated tyre while vehicle is in motion which we have achieved. If such system is implemented in vehicles, the mileage of the vehicle is increased and tyre wear is reduced.

Tyre pressure (PSI)	Reading 1 (in sec)	Reading 2 (in sec)	Average (in sec)
5	62	69	65.2
8	102	116	109
10	167	180	173.5
12	410	426	418
15	645	662	653.5

TABLE 1: AVERAGE TIME FOR VARIOUS PSI

VIII. CONCLUSION

This self-inflating tyre system is capable of succeeding as a new product in the automobile engineering industry. This system specifically addresses the needs of the consumers by maintaining appropriate tyre pressure conditions for Reducing tyre wear, increasing fuel economy, Increasing overall vehicle safety. Automatic tyre inflation system help in monitoring tyre pressure constantly as well as it provide inflation or deflation of tyre while vehicle is running. Because such a product does not currently exist for the majority of passenger vehicles, the market conditions would be favourable for the introduction of a self-inflating tire system. The reduction in tyre disposal in landfills and decrease the rate of consumption of natural resources will truly benefit society.

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