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Automatic tyre pressure inflation and Bumper system with Jack

C.Jayabalan
R.M.K Engineering College, Kaveraipettai

CH.Babu Aravind
R.M.K Engineering College, Kaveraipettai

CH.Tejavenkatasai
R.M.K Engineering College, Kaveraipettai

CH.Lokesh
R.M.K Engineering College, Kaveraipettai

Abstract **- Project is concerned about and to develop an "Automatic tyre pressure inflation and Bumper system with Jack". As we are aware that by drop of few pressure units in vehicle its results in the reduction in mileage, tyre life, safety and performance.**

This system can be placed in every in automobile under any operating condition, this will not only maintain the correct tyre pressure but also increase tyre life, mileage and safety so we have fabricated this system to inflate and deflate the tyre automatically by using control units. This system is named automatic because it checks the tyre pressure continuously using built control device to the driver about the tyre condition.

In this Project, The design and develop a control system based intelligent electronically controlled automotive bumper activation Before Collision and Pneumatic Jack also placed for lifting the axle to change the tyre after punchier.

Index Terms - Automatic tyre pressure inflation, tyre inflation system, Automatic Bumper, Jack

INTRODUCTION

According to a study, approximately 80% of the vehicles on the road are driven with one and more tyre under inflated. Tyre looses air during normal driving (especially after hitting pot holes or curbs) and seasonal changes in temperature.

The vehicle can also lose one or two psi each month in winter and even more in the summer and you can't feel if they are properly inflated just by looking at them [2]. This is a system which is installed on the vehicle that enables the operator to adjust the inflation pressure of individual tyre of the vehicle.

This system has three general goals: a) TO DETECT: -If the air pressure in tyre has dropped (Continuously check the air pressure in each tyre). b) TO NOTIFY: -If there is any dropped in the air pressure in any tyre. c) TO INFLATE\DEFLATER -In case of over pressure or under pressure the tyre pressure is maintained inflate the tyre to the required level if there is a drop in the tyre pressure and there has to be an air supply as well as check wall that opens only when needed.

It was first introduced in the American DUKW amphibious trucks in 1942. Nowadays it is a standard in Czech's heavy military Tatra trucks and also common in Soviet and Russian military trucks. Apart from military trucks it was also introduced in civilian Hummer H1, [7]. It is most important in them because the military vehicle have to go to remote places like mountains, deserts and snowy areas where no fuel pump or tire pressure refilling system is available. Tires are the 2nd highest costly part for trucking industries. According to the AAA (American Automobile Association), 80% of the vehicles have at least 1 underinflated tire also their stats shows that when the pressure of tire is below 2 psi than the ideal pressure the fuel efficiency is reduced by 10% [8]. Also the researches done by the NACFE (North American Council for Freight Efficiency) in 2013 shows that an improperly inflated tire leads to vehicle consuming more than necessary fuel. The pressure also decreases due to natural passage of air through elastic rubbers present in tires. When there is a decrease in 10 degree Fahrenheit of Surrounding temperature, 1 psi pressure of tire decreases. When tire comes in contact with ground due to friction heat is generated which melts the rubber of tire and underinflated tires gets overheated easily. In an underinflated tire engine has to work harder thus taking more fuel to run the vehicle. As the environmental conditions are also not similar everywhere so it becomes essential to maintain ideal tire pressure in order to improve the fuel economy as petrol or diesel are non-renewable sources of energy and many countries imports fuel/oil from Dubai and Oman due to abundance. Generally there is a decrease of 0.5 to 1 psi tire pressure per month under normal atmospheric conditions. The vehicle and its passenger's safety, fuel economy, improving tire life, reducing tire blowouts chances are the most essential aspects in a vehicle, fortunately Automatic tire inflation system substantially helps in taking care of these aspects. As it regularly compensates the lost air in the tire thus reducing human effort by not regularly checking the tire pressure manually. Another aim of introducing this system is to improve handling and control over vehicle thus reducing the

chances of accidents. System consists of a compressor which supplies air to rotor assembly and inflating tire via flexible ducting and rotary bearing. By maintain ideal pressure in tires braking and handling works at its best. Once the system is installed there no need for driver or any passenger to check the pressure manually thus reducing time and drudgery.

PROBLEM DEFINITION

As we are aware that maintenance of correct tyre pressure is extremely important for the enhancement of tyre life. Due to drop in the pressure the tyre goes underinflated and reduces fuel economy, quickest tyre wear, not proper rolling, discomfort ride etc. So to solve out all problems we make an automatic tyre inflation system, which will properly inflate the tyre all times.

Objectives:

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

LITERATURE REVIEW

Over a period of 12 weeks in 2013 a trial was conducted involving two cement tankers in NSW, Australia. For the first 6 weeks this system was turned on in both tankers and for another 6 weeks this system was turned off and graphs are prepared which shows that trucks with this system was in good condition like average vehicle idle time, average vehicle time spent using power take off, Avg. Emission and fuel combustion. We also carried out a survey of different people and asked them when they inspect their tyre pressure, the report is as follows:- The problems they were facing were tyre wear, time and efforts to check as well as fill the correct air pressure. Also, some unprofessional guys do not fill the correct pressure in the tyre which leads to over inflation or under inflation on the tyre. To overcomes all these our system is the best suitable system also, in summer days, when we drive, the temperature of the tyre increases rapidly, consequently, the heated air inside the tyres expands and its pressure rises quickly, which can lead to a tyre blowout with disastrous consequences. So, therefore, to maintain the correct tyre pressure in any weather condition, we must enable this system

COMPONENT WITH SPECIFICATION

These are the components and specification used for the Fabricate of the project a) Flexible air hose b) Wheel c) Quick release coupling d) Pressure switch e) Solenoid valve f) Power supply g) Rotary Joints h) Pneumatic cylinder (double acting) for Jack and Pumper I) Hand Lever Valve (DCV)It is kind of hollow tube which is used to transport air from the compressor to the tyre and it is flexible due to which it can easily transport. B) Wheel It is a circular component that is intended to rotate on an axle bearing.

Quick release coupling

A quick connect fitting, also called a quick disconnect or quick release coupling, is a coupling used to provide a fast, make-or-break connection of fluid transfer lines. Operated by hand, quick connect fittings (Fig. 1.1) flanged connections, which require wrenches. When equipped with self-sealing valves, quick connect fittings will, upon disconnection, automatically contain any fluid in the line.

Figure 1.1

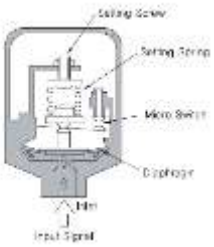

Figure 1.2

Pressure switch

It is a device (Fig.1.2) which is used to sense the pressure and transmit the signal (on\off) to the solenoid valve depending upon the current pressure. In this switch a piston is present with the calibrated spring. One end of the piston of the pressure is excreted which is the current pressure and the other end is connected to the switch. Whenever there is a change in the pressure the signal is transmitted. When the pressure of the tyre is dropped the switch transmit the signal to the solenoid valve and valve opens and start Inflated the tyre upto calibrated level when the pressure sense that it achieve the calibrated level switch give the signal and the solenoid valve will stop inflating the tyre.

Solenoid valve

It is an electromechanical controlled device which is used to allow or restricted the flow of air to pass through them from the compressor. It is attached between the compressor and the Flexible air hose. The coil\solenoid casing which is hollow and has a metallic finish in outer, in the hollow part the coil winding is present, which is energized and reenergized by the lead wire. The plunger is present at the centre of the casing with the calibrated spring, which is above the plunger.
Solenoid valve got the signal from the pressure switch through the lead wires and it electrically energized the electric coil which is positioned around the plunger and magnetic field is created which pulls the plunger up towards the centre of the coil. This opens the valve and air start flowing and it again got the signal from the pressure switch. It de-energized the electric coil and magnetic field ruined and plunger goes down and closes the valve, or stop flowing.

Fig. 1.3

Pneumatic Double Acting Cylinder:

Pneumatic cylinder consist of
A) PISTON
B) CYLINDER
The cylinder is a Single acting cylinder one, which means that the air pressure operates forward and spring returns backward. The air from the compressor is passed through the regulator which controls the pressure to required amount by adjusting its knob. A pressure gauge is attached to the regulator for showing the line pressure amount by adjusting its knob. A pressure gauge is attached to the regulator for showing the line pressure. Then the compressed air is passed through the double acting 5/3 solenoid valve for supplying the air to one side of the cylinder. Then the compressed air is passed through the double acting 5/3 solenoid valve for supplying the air to one side of the cylinder.

Fig. 1.4

DCV direction control Valve

Hand Lever Valves are used to operate **Pneumatic** Cylinders. The functioning is the same, however, the solenoid coil is replaced by a **hand lever**, which controls the movement of the spool inside the **valve**, thereby allowing the **air** to pass. In this project hand lever valve is used to operate the Pneumatic Jack to change the Punchier Tyre.

Fig. 1.5

CONSTRACTION AND WORKING PRINCIPLE

In this one end of the Solenoid valve is attached to the compressor and another to the air hose. This hose is connected to the wheel and the switch, solenoid valve and switch also connected with each other to transmit the signals. The wheel and the components are assembled to the frame.

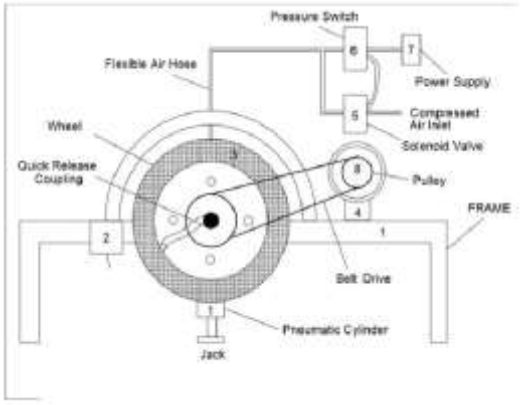

Fig. 1.6

WORKING PRINCIPLE

Whenever there is a pressure drop in the tyre this pressure is a sense of the pressure sensor which is pre-calibrated, this switch gives the signal to the valve and the solenoid will energize and valve open. The compressed air will start flowing and inflating the tyre and when the calibrated pressure is obtained the sensor will give the signal and the solenoid will de-energized and valve close. With this we obtained the calibrated pressure and vehicle will run smoothly.

- The project consists of pressure switch and Receiver circuit, Control Unit, Pneumatic bumper system.
- The pressure sensor senses the pressure.
- There is any tyre pressure low and high, the control signal is given to the bumper activation system by make a T joint in Tyre Inflation System.
- In This Project Additionally used the pneumatic Jack to change the tyre after tyre got puncher. And it operated by Hand lever Valve.

Advantages

There are many important positive points of this system as explained below;
1. The main advantage is that you don't require checking tyre pressure daily, it saves the time of air filling.
2. This will reduce the tyre wear because of uniform pressure in the tyres.
3. The cost of the system is optimized, but increases safety, comfort and efficiency.
4. System able to increase the pre-crash safety.
5. System able to provide more safety to the passengers.
6. With this you don't have to stop in that area, which is not safe for you, when a tyre gets punctured.

DESIGN PROCEDURE

We should design this bumper piston cylinder assembly according to the stroke length and weight of bumper which has to be lift. Weight and area calculation for bumper:
Double acting pneumatic cylinder
Stroke length : Cylinder stoker length 160 mm = 0.16 m ,Quantity: 1 ,Seals : Nitride (Buna-N) Elastomeric ,End cones: Cast iron, Piston: EN – 8 Media : Air ,Temperature : 0-80 º C ,Pressure Range: 8 N/m².

Frame of bumper has 3 flanges as follows:
2 flanges of 260mm×20mm
2flanges of 70mm×20mm
Area of bumper = (2×area of horizontal flange) +(2×area of vertical flange)
= (2×(260×20)) + (2×(70×20))
= 2×5200+2×1400
=10400+2800
=13200mm2
Weight of bumper= 3.5 kg.
So we have to design cylinder piston which can pull 3.5 kg load.

Specifications of bumper as follows:

1. Weight of bumper: 3.5 kg

2. Required stroke length must be up to: 20 mm
Now we should design piston cylinder as it fulfills above requirement.

Cylinder piston design

Cylinders are used to convert fluid power into mechanical motion. A cylinder consists of a cylindrical body, closures at each end, movable
piston, and a rod attached to the piston.
When fluid pressure acts on the piston, the pressure is transmitted to the piston rod, resulting in linear motion. The piston rod thrust force developed by the fluid pressure acting on the piston is easily determined by multiplying the line pressure by the piston area.

FORCE = PRESSURE x AREA or F = PA
First we select the air compressor which has capacity of 3bar pressure.
For this project according to factor of safety we should design the piston cylinder which can apply pull force load of 3.5 kg.
So for trail we select 25mm
diameter piston with 25 mm stroke.

Further calculations as follows:

The piston area has to be determined first to solve this problem. The area of a circular surface is r2, where "r" is the radius.
In the case of a 25 mm diameter piston, the area equals 490.87 square mm(r2). Since a pressure of acts 3bar on each square mm,
The total thrust force will be
= 490.87*10-6 * 3*105
=147.361 N.
To convert it into kg.devide by 9.81
147.361/9.81= 15.01 kg.
Thus the piston cylinder can lift up 15 kg load at 3 barthrough out 25 mm stroke length.
Hence we select
Piston cylinder specification:
Stroke length : 25 mm diameter
Diameter : 25 mm
Pull force capacity: up-to 15 kg
Direction control valve specification:
5*2 DCV
Actuation:
solenoid operated DC coil
Coil voltage ratings: 12 volt (0.5 amp to 2 amp)
Specification of compressor:
Type: Rotary air compressor
Input voltage: 12volt 2.5 amp
Output pressure: 3bar capacity
Discharge: 25 cm3 / s
Material used for chassis:
Square mild steel pipe of 20mm×20 mm

i) Design of Piston Rod:
Dia of the Piston = 15mm
Area of the Cylinder = π d2 /4
=(π*0.015*0.015)/4
=0.0001767m^2
Force acting on the rod(P)
= p x Area
= 600000 N/ m2 x 0.0001767
= 106.02N

ii)Length of Piston Rod:
Approach stroke =140mm
Length of Threads =2x20 =40mm
Extra length due to front cover = 12mm
Extra length of accumulated head = 20mm
Total length of the piston rod
=140+40+12+20mm = 212mm

Impact Force Calculation
Force, F = mass (m) x acceleration (a)
Mass of the vehicle m= 25kg
By motion Equation, 2as = v2-u2
Where, v= Final velocity = 5.55m/s
a= acceleration, s = braking distance (Db=2.24m) u= Initial velocity = 0
2xax2.24 = 02 – 5.552 = -6.87m/sec2
Force, F = mxa =25x (-6.87)=-171.75N
The Final impacting force value F = 171.75N.
Fabrication

CONCLUSION

In order to serve efficiently and increase the vehicle performance, tire life and overall safety of the vehicle or society as a whole, it becomes essential to implement these techniques. This system doesn't exist in majority of passenger vehicles till date so it will be a boom to the automobile industry. As discussed earlier it will lead to thrifty fuel consumption, better vehicle mobility due to better traction and the vehicle vibrations lessens thus ameliorating cargo safety as it is capable of retaining ideal tire pressure by providing sufficient air flow with minimum leakage, taking care of the loads transferred on rotary joints simultaneously. In this project, for the safety purpose we are added pneumatic pumper will automatically release in vehicle running condition after tyre punchiered. In this project we are also implement the Pneumatic jack to easily remove the tyre and change the tyre quickly.

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