Design and Manufacturing of Self Inflating Tire System

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ABSTRACT

This paper presents the methods for self inflating tires. Nowadays every part of an automobile sector is getting automated. Automation relaxes a person to do manual work. Now a day a lot of automation has taken place in inflating tires. To inflate a tire a driver has to take his vehicle to the gas station or by using a manual hand pump. These involve human interference and labor work. Tires lose air through normal driving i.e. after hitting pot holes or curbs, permeation and seasonal changes in temperature. Due to less pressure in tires it will lead to low efficiency of fuel, time for filling the air in tires, less safety, cost for filling of air. With addition to this if there is sudden puncture can cause the driver to lose control, heading towards an accident. Self inflating systems are designed to constantly maintain tire pressure at the proper level.

Keywords –Self inflating tires , Automatic Tire monitoring system.

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1. INTRODUCTION

Automobiles have become an important part of human life. The usage of automobiles is increased rapidly in last few decades. Accidents related to it has encouraged the automobile companies to provide for safety. Every part is automated to an extend except tires. In last few years automation for inflating tires is given a concern due to various factors that cause due to low pressure in tires viz. accidents, more fuel consumption, speed etc. Tire-inflation systems have three goals Tire-inflation systems have to detect when the air pressure in a particular tire has dropped - This means they have to constantly check the air pressure in tires or in interval of time. Indicate the problem to the driver. Inflate that tire back to the proper level by supplying required air pressure to the tire.

2.0METHODOLOGY:

This system includes the three main procedure which are as follows,

- It senses the pressure of air of running tire with the help of pressure sensor system.
- Then feedback sent to the program control
- and it actuates the inflator to fill the desired air pressure

2.1COMPONENTS :

2.1.1 Rotary joint / rotary union:A rotary union is a union that allows for rotation of the united parts. It is thus a device that provides a seal between a stationary supply passage (such as pipe or tubing) and a rotating part (such as a drum, cylinder, or spindle) to permit the flow of a fluid into and/or out of the rotating part. Fluids typically used with rotary joints and rotating unions include various heat transfer media and fluid power media such as steam, thermal oil, hydraulic fluid. 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.[3]

2.1.2 Pressure Sensor:

Pressure sensor is used in the system is used to detect the pressure of fluid / air .when the pressure of air drops sensor detects and which in terms actuates the system similarly when required pressure is achieved sensor detects the pressure cut off the supply**. [3]**

2.1.2Arduino

Arduino is an open-source project that created microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices.The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog input/output (I/O) pins that can interface to various expansion boards (termed *shields*) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a programming language named *Processing*, which also supports the languages C and C++.Arduino boards are available commercially in preassembled form, or as do-it-yourself kits. The hardware design specifications are openly available, allowing the Arduino boards to be produced by anyone. Adafruit Industries estimated in mid-2011 that over 300,000 official Adriano's had been commercially produced, and in 2013 that 700,000 official boards were in users' hands.[3]

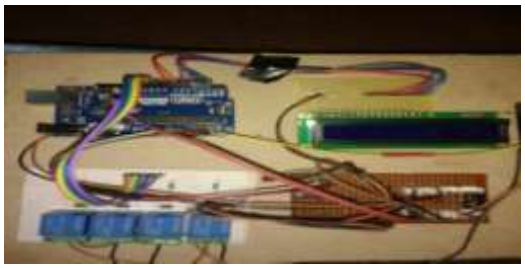

Fig 1 arduino

2.1.4 .Inflator

Inflator is a device used to pump the compressed air inside tire. This device can works on 12 V DC supply. The work of inflator is to have input from system and will acts when information send to him to fill the air through circuit.

2.1.5Chain Drive

chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles..[3]

2.1.6Sprocket

A sprocket or sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. Sprockets are used in bicycles, motorcycles, cars, tracked vehicles, and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc. [3]

2.1.7 Dc motor

DC motors are part of the electric motors using DC power as energy source. These devices transform electrical energy into mechanical energy.

2.1.8LCD display

A liquid-crystal display (LCD) is a flat-panel display or other electronic visual display that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly.[3]

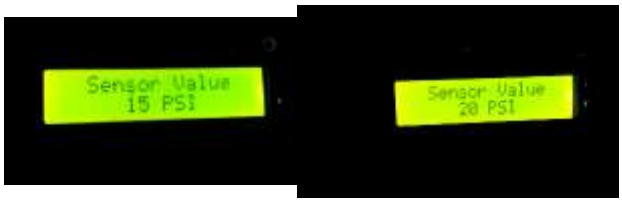

Fig 2 lCD display

3.0:- APPARATUS

0. Frame
1. Electric motor 12 volt dc 1 amp
2. Inflator 2 amp 12 volt
3. Pressure sensor 70 psi
4. Inflator 40 psi
5. Sprocket 18 teeth
6. Chain 6B
7. Tire (90 100 10)
8. Pedestrian bearing
9. Battery 12 volts
10. LCD display

4 CALCULATIONS:-

4.1 Chain design

chain -06 B

pitch -9.525mm

roller diameter,d1=6.35 mm

width, b1=5.72 mm

transverse pitch p_t=54.85 mm

approximate center distance,

a=40p

=40*9.525

=381mm

4.2 Design of sprocket

Used chain no.06B

For Z=18

Pitch ,P=9.525

Width between inner plates , b1=5.72

Roller diameter, d1=6.35

Transverse pitch p_t=10.24

1.pitch circle diameter

D =54.85 mm

4.3 **Shaft calculations**

P = 0.25 KW =250 W

K1 = 1.75

N= 100 rpm

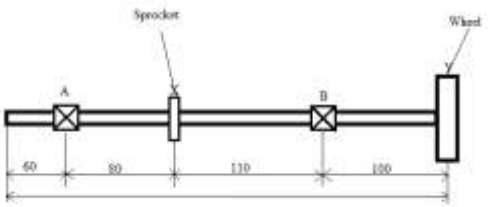

fig. 3 shaft calculation

T_d = 60*P*kt/2 π n

P=0.25 Kw=253W

N=100 rpm

T_d = (60*10^6*0.25*1.75) / (2*π*100)

T_d = 41778.17256 Nmm

T_d = 41.77817256 Nm

Maximum Stress

T_{max} = (16/πD^3) (m^2+Td^2)

T_{max} = 0.30* Syt

For Shaft SAE 1030 (Mild steel)

Syt = 296 Mpa

Take F.S = 2

Tmax = 0.30 * Syt = 0.30 * 296 = 88.8 N/mm^2

Mass of Sprocket,

W = 2.943 N

Mass of wheel

W = 42.183 N

Reactions at Support

Moment at A

2.943 * 80 – R_B * 190 + 42.183 * 290 = 0

R_B = 65.62 N

Resultant force in vertical

R_A + R_B - 2.943 - 42.183 = 0

R_A + 65.62 - 2.943 - 42.183 = 0

R_A = -20.494 N

Shear Force Calculation

SF_{AL} = 0 N

SF_{AR} = -20.494 N

SF_{XL} = -20.494 N

SF_{XR} = -20.494 - 2.943 = -23.437 N

SF_{BL} = -23.437 N

SF_{BR} = -23.437 + 65.62 = 42.183 N

SF_{YL} = 42.183 N

SF_{YR} = 42.183 - 42.183 = 0 N

Bending moment Calculations

Bending moment at A

BM_A = 0

Bending moment at X

BM_X = 20.494 * 80 = 1639.52 N mm

Bending moment at B

BM_B = 20.494 * 80 -2.943 * 110 = 1315.79 N mm

Bending moment at Y

BM_Y = 0

Bending moment is maximum at point X

Therefore, Resultant **Bending moment** = M_b = 1639.52 N mm

T_{max} = (16/ πD^3) (Mb^2 + Td^2)

D = 13.38 mm

Selecting Diameter = 20 mm for safe loading and to affix rigidly in pedestal bearing and also for fixing air valves and rotary coupling on it.

5. CONSTRUCTION:-

Electric motor drives the shaft via chain and sprocket mechanism Shaft is supported by two pedestrian bearing .Rotary coupling is mounted on shaft which is embedded inside tire rim. Inflator is mounted on the frame. The output of inflator is connected to flexible hose. This hose is connected to shaft. Shaft has hole in two different planes by which air can be passed through it to the rotary coupling. One part of the rotary coupling is stationary and it is mounted outside the rim. Moving part is embedded inside the rim to which shaft is connected. Pressure sensor's one end is connected to three way valve. 3 way valve is used whose one end is connected to the pressure sensor, second to the inflator and third to the tire air filling tube. The output of sensor is connected to the aurdino which is programmable microcontroller. Aurdino has input and output ports

6. Working principle:-

Motor rotates the chain & sprocket mechanism which intern rotates the shaft, tire, rotary coupling. When the pressure inside the tire drops below the desired pressure it will besensed by pressure sensor. It will give its output to the comparator where the desired pressure and actual pressure of the tire will be compare, if it is less than the desire pressure of the tire will be compare. If it is less than the desired pressure it will send a signal to the display board and alarm will be signal. It will also send a signal to actuate the inflator via electronic controller. Inflator will send the compressed air via flexible hoses to the shaft. Since the shaft has two holes drilled in two perpendicular planes whose one point is connected to the hose and other to the rotary coupling rotary part. Then the air from the inflator enters the rotary coupling from where it enters the tire.

6.1Actual working:-

Single phase electric supply is provided to the electric motor via adapter of 1 amp. Electric motor starts rotating which intern rotates the tire through chain and sprocket mechanism. Tire rotates at the speed of 100 rpm.

Pressure sensor is continuously sensing the pressure of air inside the tire and its output is connected to the LCD display. When the tire pressure falls below the desired pressure (in our case it is 15 psi) the inflator will start compressing and the air will be supplied to the rotary coupling via flexible hoses. The air reaches the stationary part of the coupling and comes out from the rotating part of the coupling which is joined to the shaft. Since shaft has two holes drilled in perpendicular directions the air from rotary coupling enters into the shaft and comes out from the other hole which is in perpendicular direction. The air from then enters 3 way valve and then enters the tire.

3 way valve is used whose one end is connected to the pressure sensor, second to the inflator and third to the tire air filling tube.

Once the desired pressure is attained (in our case it is 20Psi) the signal to stop the inflator will be given to the relay via electronic circuit and hence inflator will stop.

This cycle will again take place if the pressure falls below 15 psi.

Cad Models :

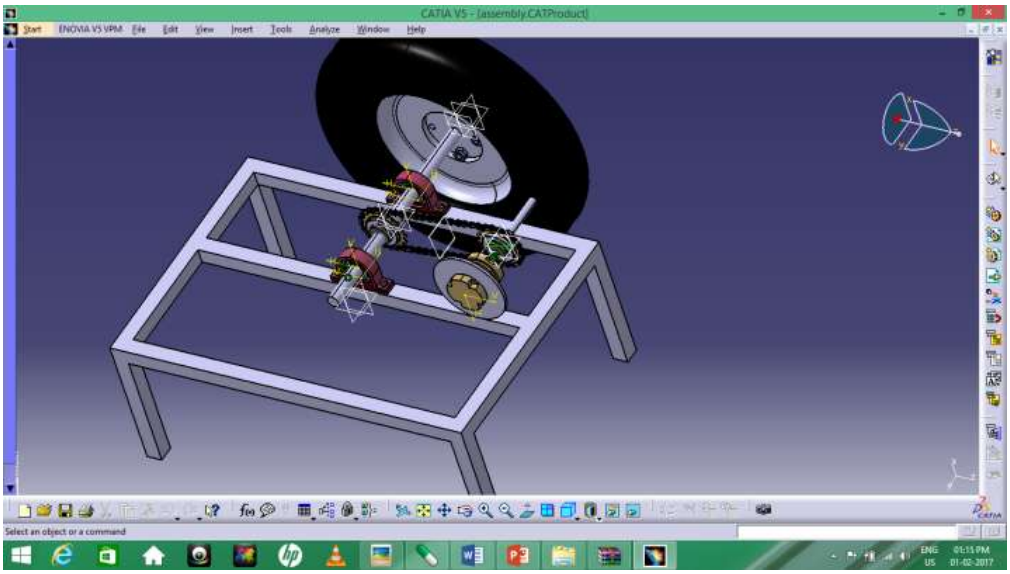

Fig 4 : - CAD model (Assembly)

Fig 5 Actual model

7.CONCLUSION:-

This system will improve safety, automation of filling air in tires, reduced human labor for filling the air at fuel stations, control of driver over vehicle, comfort, control over vehicle. This system will help avoid accidents due to tire bursting.

8. REFERENCE-

[1] "Mechanized Air Filling System", P.Omprakash, T.Senthil Kumar, Vol.4, No.3, May 2014, International Journal of Information Sciences and Techniques.
[2] "Tire Pressure Monitoring and Air Filling System",Ajas.M.A,Aiswarya.T.G,Adersh Vinayak , Surya Balakrishnan , Janahanlal P.S., v2, Issue 2, April-May 2014, International Journal of Research & Advanced Technologys
[3] www.wikipedia.com