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System for Automatic Tyre Inflation

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ABSTRACT

Since the invention of tyres, improvements are routinely made to a vehicle's tyres for a longer lifespan and their contribution to increased vehicle safety. As is common knowledge, a car is the most significant aspect of our lives because it allows us to cover great distances quickly. For the vehicle to run more efficiently and safely, the tyre pressure needs to be kept at the recommended level. Therefore, this technology was introduced with consideration for fuel consumption, vehicle comfort, and safety. It keeps the vehicle's tyres at the proper pressure, improves fuel efficiency, and lessens tyre wear, extending tyre life and cutting down on the frequency and cost of tyre replacement. Maintaining optimal tyre pressure is a major goal of this system's introduction. When a tire's pressure dips below ideal levels, a pressure gauge monitors it and the tyre is inflated once again. This essay helps researchers and novice students comprehend the benefits and drawbacks of the "Automatic tyre inflation system" used in automobile tyres.

INTRODUCTION

In 1942, it was initially used in American DUKW amphibious trucks. It is now a standard in Russian and Soviet military trucks, as well as in large Tatra trucks used by the Czech military. Along with military trucks, the civilian Hummer H1 was the first vehicle to use it. They need it the most because military vehicles must go to distant locations like mountains, deserts, and cold regions where there is no fuel pump or tyre pressure replenishment system. The second most expensive component for the transportation industry is tyres. The American Automobile Association (AAA) reports that 80% of vehicles have at least one underinflated tyre, and that 10% less fuel efficiency results from tyres that are underinflated by less than 2 psi from the recommended pressure. Additionally, studies conducted by the North American Council for Freight Efficiency in 2013 demonstrate that an incorrectly inflated tyre causes a vehicle to use more gasoline than is necessary.

Additionally, the pressure drops as a result of air naturally passing through the elastic rubbers found in tyres. 1 psi of tyre pressure is lost for every 10 degrees Fahrenheit drop in ambient temperature. Underinflated tyres rapidly overheat when they come into contact with the ground because of the friction that causes heat to be produced, which melts the rubber of the tyre. An underinflated tyre forces the engine to work harder, using more fuel to power the car.

Due to the fact that environmental conditions vary greatly from place to place and since petrol and diesel are non-renewable energy sources, it is crucial to maintain optimal tyre pressure. Due to their availability, many nations import fuel and oil from Dubai and Oman. Under normal atmospheric circumstances, tyre pressure typically decreases by 0.5 to 1 psi every month. The most important characteristics of a vehicle are safety for the driver and passengers, fuel efficiency, increased tyre life, and less risk of tyre blowouts. Fortunately, automatic tyre inflation systems significantly assist in taking care of these factors. Because it adjusts for lost air in the tyre on a regular basis, avoiding the need to manually check tyre pressure on a regular basis reduces human effort. The introduction of this system has the additional goal of enhancing vehicle control and handling, which lowers the risk of accidents. The system comprises of a compressor that feeds air through flexible ducting and a rotary bearing to the rotor assembly and tyre inflation. Braking and handling are optimized by maintaining appropriate tyre pressure. Once the technology is deployed, neither the driver nor any passengers will need to manually check the pressure, saving time and eliminating drudgery.

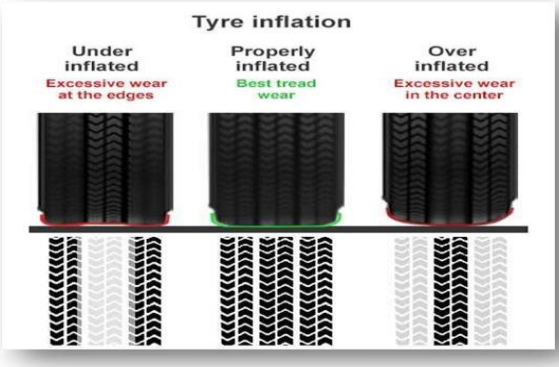

Figure 1- Various types of inflated tires

WORKING PRINCIPLE

The automatic tyre inflation system has a compressor that is used to pump air through hoses into the rotary joint, which provides the rotation of the wheel assembly and is fixed between the wheel spindle and wheel hub at each wheel. Without tangles from the hoses, air is directed through the rotary joint. The tyre inflates when pressure drops below the desired level. The battery provides electricity to the compressor. This process is done while the car is driving because the tyres need to be inflated because their pressure is low.

COMPONENTS AND THEIR WORKING

The Wheel-end assembly and a control module make up the bulk of the entire system. The flexible hose with check valves that makes up the wheel-end assembly. The check valves only allow air to enter the tyres while checking for air leaks. This system's fundamental mechanism is a rotary joint that distributes air to nozzles installed in the rim and permits rotation of the wheel assembly.

Rotary Union: The air chamber that the rotary union is made of allows air to move along the shaft's revolution. Figure 2 depicts the rotary union in more detail

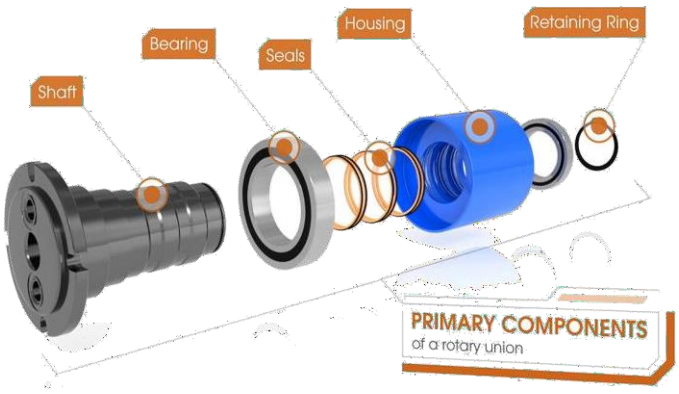

Figure 2- Rotary union and its components

It also has the components discussed below:

a) Housing- The housing holds everything else in the rotary union together. It has a threaded intake port with a housing that supplies medium attached to it. The housing doesn't move. From the inside, it is composed of a shaft, bearing, and mechanical seal.

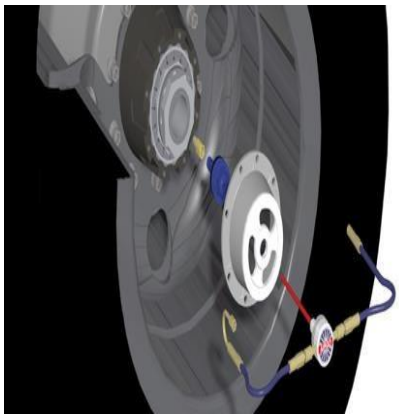

Figure 3- Closer view of the Housing

b) Compressor- A mechanical tool called a gas compressor lowers the volume of air while raising its pressure. A pump is used to raise water pressure, specifically in fluids, which is a tiny distinction between a compressor and a pump. Due to the compressor's reciprocating nature, the desired pressure is achieved. The rotary joint's rotation provides simultaneous air supply. Since a compressor frequently becomes overloaded, a secondary power source is used instead of a battery-powered 12 Volt DC supply. Its position is crucial since it must continue to provide all of the wheels with the necessary pressurized air. In automobile vehicles, a 300 psi compressor is typically utilized.

Figure 4- A Compressor

c) Air delivery system- It consists of pipes which carries the pressurized air as sent by the compressor after being sensed by the pressure gauge sensors. The parts of the air delivery system is generally short made and softer (strong enough to withstand the air pressure) so that it can fit into the wheels, avoiding any damage to it. These pipes are joined to small tubes which will join to tires and delivering air from compressor. This system contains self-actuating valves which ensures safe and required pressure delivery of air. To prevent the backflow, kill switches are installed for constant pressure supply to the tire. A diagram (Figure 5) is shown for the better understanding of air delivery system and its components.

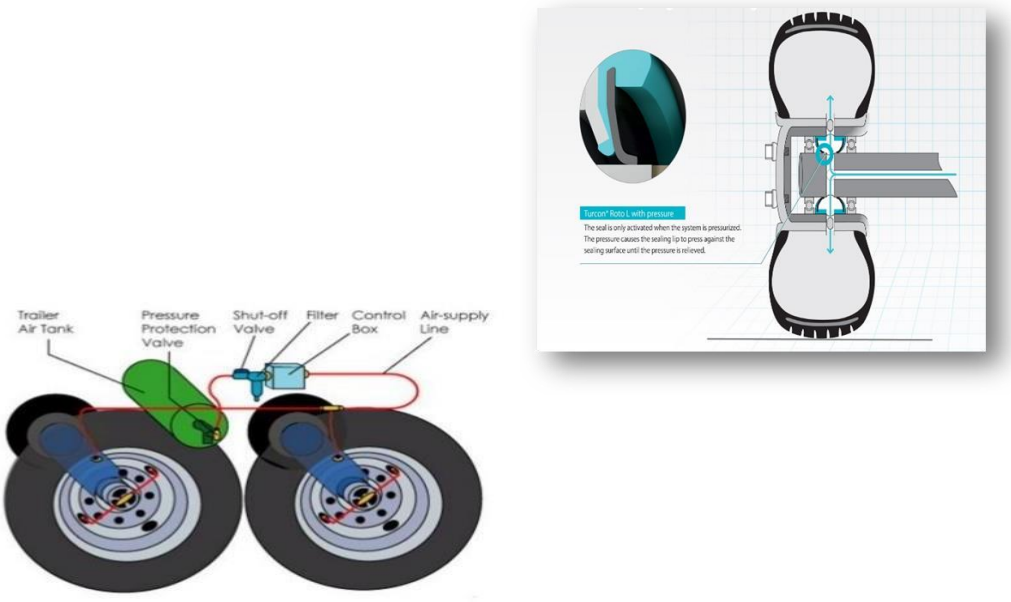

Figure 5 - Components of an Air delivery system

d) Pressure Gauge and sensors- The pressure gauge and sensors are the most crucial pieces of equipment since they are responsible for measuring the real tyre pressure and determining how much additional air is actually required to be delivered in order to re-inflate the tyres. The sensors find the lowest and highest pressure levels. When the pressure level drops below the minimum optimum pressure boundary, it will be in the ON position; conversely, when the pressure level rises above the maximum ideal pressure limit, it will be in the OFF position. In the housing of the pressure gauge, there is sticky oil. The oil filling has many benefits, including reducing pointer vibrations and preventing ambient air from entering the system, which prevents condensation of water. Since the reading provided by the gauge is entirely digital, it is exceedingly accurate and simple for the user to understand. The accuracy of pressure gauges is categorized based on precession, with grade D having a 5% inaccuracy and grade 4A having a 0.1% error. Figure 5 shows how seals open when there is pressure applied, and they stay open until the pressure is released.

ADVANTAGES OF AUTOMATIC TIRE INFLATION SYSTEM

Although it is very economical, this system also serves a very important purpose: it ensures the safety of the driver and passengers as well as the vehicle itself. Although this kind of system is uncommon in passenger cars, it can add significantly to the value of the automotive industry and capture a sizeable share of the market. Except these valuable points it has some more advantages-

- Since a properly inflated tyre doesn't wear out very much, tyre wear will be greatly reduced.
- Less fuel will be used by the vehicle.
- Air will be delivered in the ideal quantity without experiencing negative leakage.
- There will be less effort for the driver or passenger, and there won't be any time wasted in routine tyre pressure checks.
- Even while it is expensive to install, it can last longer without needing to be changed, which lowers the cost of air replenishment.
- Because it is user-friendly, there is no special need for a technically proficient person.
- The ideal stopping distance for the vehicle. When the tyre is properly inflated, the coefficient of rolling resistance is lower, allowing for proper motion and less heat buildup in the tyres, which causes the vehicle to stop at the suggested distance. Chart 1 depicts a graph that illustrates how tyre pressure and coefficient of rolling resistance are influenced by vehicle speed

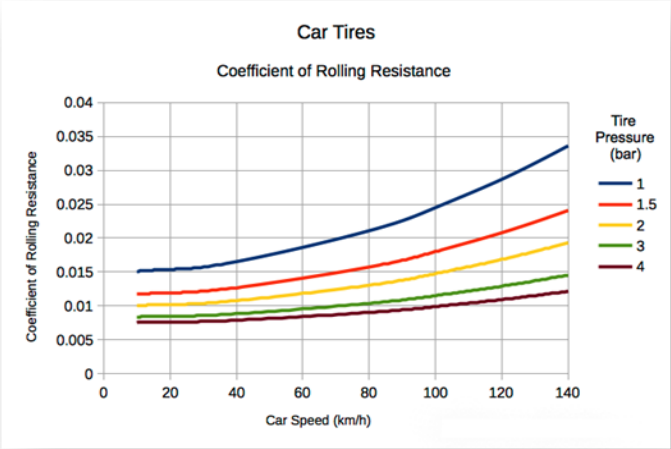

Figure-6 Dependence of Tyre Pressure and Coefficient of Rolling Resistance on Vehicle Speed

LIMITATIONS

The disadvantages of automatic tyre inflation systems are limited, although they do exist:

- The rotary joint's life is limited because it is always in motion; however, with good maintenance, it can last for a longer period of time.
- To achieve the best effects, seals must frequently be replaced.
- It is necessary to occasionally inspect pipes and tubes.

CONCLUSION

It becomes crucial to use this strategy if you want to fulfil your purpose effectively and improve vehicle performance, tyre life, and general vehicle or societal safety. Since most passenger cars do not already have this mechanism, it will be a boon to the auto industry. In mining operations, vehicles often encounter different types of terrain. Automatic Tyre Inflation Systems can adapt to these changes by adjusting tire pressure based on the specific needs of the terrain. This adaptability enhances the vehicle's performance and minimizes the risk of getting stuck or encountering difficulties in challenging conditions. As was already mentioned, it will result in less fuel consumption, improved vehicle mobility due to better traction, and reduced vehicle vibrations, improving cargo safety. It can maintain ideal tyre pressure by supplying enough air flow with minimal leakage while simultaneously caring for the loads transferred on rotary joints.

REFERENCES

[1] Inderjeet Singh, Bhupendra Pratap Singh, Hari Shankar Sahu, Raunak Chauhan, Novel Kumar Sahu. “To Study on Implementation of Tyre Inflation System for Automotive Vehicles” Volume 5, pp-226-231, 2016.

[2] Ajas.M.A, Aishwarya.T.G, Adersh Vinayak, Surya Balakrishnan, Janahanlal P.S. Tire Pressure Monitoring and Air Filling System International Journal of Research in Engineering and advanced Technology.2, 457-461, 2014.

[3] Hemant Soni, Akash Lahurgade, Sourabh Relkar, Sourabh Badhulkar Automatic Tire Inflation System, Golden Research Thoughts. 3,125-130, 2014.

[4] T Pletts, Literature Review on Central Tyre Inflation System. 3, 2249-8001, 10007-10018, 2006.

[5] Kunjan Shinde, Sagar Asari, Vighnesh Nayak, Pranav Kadam and Anand Dalvi (Project on Vehicle Automation) Automatic Tire Inflation System , 725–736, 2018.

[6] Tawanda Mushiri, Allan T.Muzhanje, Charles Mbohwa A Literature review on Design of an automatic tyre pressure inflation for small vehicles. 299-303, 2214-7853, 2020.

[7] Harshal Junankar, Vishnusagar Bihare, Nishant Giradkar, Chetal Gupta. A review: Automatic Tire Inflation System, International Journal for Scientific Research and Development. 3, 167-172, 2015.