North Asian International Research Journal of Sciences, Engineering & I.T.

ISSN: 2454-7514 Vol. 6, Issue-10 October -2020

IRJIF. I.F. : 3.821

Index Copernicus Value: 52.88 Citation Index

A Peer Reviewed Refereed Journal

ANALYSIS OF THE DRUM BRAKING SYSTEM

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Introduction

The drum brake is a type of braking system that was pivotal to the automotive industry. With the development of hydraulics and constant discoveries on friction materials, the Drum brake has contributed to making cars safer for everyday operation. The drum brake has may advantages that improve its safety and efficiency, such as its extra corrosion and wear protection due to the protection of the drum and the larger surface that the callipers occupy on the inside of the drum. Due to these advantages, the drum brake is considered to be superior and is used widely in the automotive industry. This Report will explore the history, the principles behind, mechanical prosperities and the materials used, along with its impacts on society and the environment.

History of the Drum Brakes

Automobile brakes come in many different styles and designs. Designs such as the disk and the drum brake have evolved over time parallel to the introduction of the automotive industry. In the 1800's, the first braking systems were developed in order to slow a vehicles momentum and to prevent its motion. From the early drum brakes to modern day disk brakes, over 100 years later, the braking system has developed into a complex feat of engineering designed to adapt to different road conditions, making most vehicles safer to operate. The mechanical drum brake was first developed in 1902 by a manufacturer named Louis Renault. This drum brake was considered the foundation for future braking systems. The first drum brake was an external design, with a flexible metal band that was wrapped around a drum on the rear axle. This prototype model was tested in a "brake race", where the drum brake was used in Ransom E. Olds' 'Oldsmobile' which competed against a Victoria horseless carriage and a four-horse coach. The Oldsmobile won the brake race by stopping in at a distance of 21 feet as opposed to the horseless carriage needing 37 feet and the four-horse coach needing 77.5 feet. This race caught the attention of car manufacturers everywhere and soon, the external drum brake was being fitted into all automobiles in 1903. The main problem with the external model was that the brake could unwrap easily on hills and many cars stopped on hills would roll back down and the car could only travel 200–300 miles between brake service. In 1904, the internal drum brake was introduced to the automotive industry. The internal design would allow the brake to stop the vehicle without giving way on a slope and because of the brake being sheltered from the elements; a car could

travel up to 1000 miles without a brake service.

Engineering Principles

A brake is a mechanical device which produces frictional resistance against a moving machine. It acts as a motion reduction apparatus. In order to perform this function, the brake shoe absorbs the kinetic energy produced by the momentum of the object, which is typically released in the form of heat. The hydraulic system used in the drum brake will be distributed throughout the system of tubing using pascals principle.

Pascals law states; “Pressure applied to any part of a confined fluid transmits to every other part of the vessel in equal distribution”. This principle is extremely important to the functionality of the braking system due to the incompressible liquid being pushed against all of the pistons in each brake module. According to Pascals law, the pistons extend into the brake shoes causing all brakes to turn on.

Advantages of the hydraulic system is that there is even braking effort to all four wheels, there is a lower rate of wear due to the absence of joints, and by changing the size of the piston’s cylinder, the amount of force exerted can be either increased or decreased depending on the size of the mechanism. Some disadvantages of the hydraulic system are that the fluid is very messy and can damage the brake if it leaks from the piston. The leaks can be difficult to locate. If the fluid comes into contact with the brake shoe, the brake will not function as desired, which can be extremely dangerous in most situations. Another disadvantage of this system is that if the hydraulic fluid leaks in close proximity to the engine or somewhere with a high heat, the fluid may catch fire and cause injury.

Materials

Friction materials are used in the development of the drum brakes. Friction material is pressed against the moving drum by the brake shoes, thus reducing the movement of the drum. Friction materials are usually made up of heat resistant materials in order to combat the inevitable loss of energy through heat.

The most common material used in the drum brake that conserves heat and is efficient in reducing the motion of the drum, ironically, is asbestos. However, due to health risks, ceramic is now more widely used as a friction material in drum brakes. Carbon ceramic is extremely durable under high friction and heat situations thus making it a fitting alternative to a brake shoe lining.

In addition, manufacturers made semi metallic brake materials using copper, and steel wool bonded by resin. These materials were used as they poses similar properties to ceramic in terms of durability. Hydraulic fluid is used as the oil based in which power and energy is transferred across a machine to execute a function.

Mechanical Properties

Drum brakes are generally used to decrease the motion on older and lower performance vehicles. A drum brake system consists of a break drum, hydraulic wheel cylinders, brake shoes and return springs. The drum is connected to either the rear axle or a wheel hub, which is bolted in a fixed position on the drum.

As the brake pedal is pressed in the vehicle, the pistons extend outward as a result of the brake fluid being pressurised. The pressure in the extending piston forces brake shoes against the inside surface of the break drum in order to stop the drum from spinning by creating friction. This friction causes the lining on the brake shoe to gradually wear away. As the driver takes their foot off the brake pedal, the hydraulic fluid in the piston recedes. This causes the piston to contract due to the lack of pressure. The return springs fitted into the drum brake, allow the brake shoes to pull away from the drum when the piston is contracting, allowing the vehicle to regain momentum.

A Common issue that the drum brake system faces are a worn-out brake shoe lining because to heat and friction due to repetitive use. Other, more serious issues that the braking system faces are a rusty return spring. The rusty spring is more brittle and weaker and can snap in pieces. This causes the brake shoes to be in constant contact with the drum causing damage to the shoes. An “out of round” brake drum occurs with ages and occurs when the brake drum is more oval shaped. This causes the brake pedal to pulsate and damage as the brake shoes do not have firm contact with the drum surface.

Drum Brakes in Society

The drum brake has arguably revolutionised the automotive industry and society as a whole. Drum brakes are present in most cars today and are responsible for keeping everyday drivers safe on roads. With the introduction of the hydraulic system with devices such as the Archimedes Screw, which used a screw like mechanism to transport water from a lower point to a higher point. Through the harnessing of pascals theory, drum brakes have improved drastically over time, becoming more efficient with every redevelopment. Hydraulics are now powerful enough to be used in aircraft, spacecraft, farming equipment, trains, machine tools, and automobiles.

One of the benefits of the Drum brake system to the automotive industry is that they possess higher corrosion resistance due to the components being sheltered by the drum housing. Due to this corrosion resistance, service of the drum brake is required less frequently because of the extra protection that the drum provides the housing. They can provide more braking force than a disk brake and have a longer lifespan due to the increased friction contact area of the brake shoe and the inside of the drum. The drum brake is also very cheap to manufacture and is widely used in most cars.

Although the Drum brake system has been proven to be very reliable and efficient, there is still a small chance that the hydraulic system could fail, by bursting and causing injury and broken brakes and leaking from the piston and wetting the brake shoe, which causes the friction material to lose friction. Brakes must be serviced often to ensure that there is no leak and that the braking system of the automobile will not fail.

Brake emissions are also negative impacts that this device produces which is bad for our health and the environment. Asbestos was a material used in brake pads in the late 80’s and early 90’s because of its friction properties. Many cars contained asbestos on the road. Every time a brake was activated, a layer of asbestos particles would separate from the brake pad and emit into the air. In areas which have high traffic density and therefore braking frequency meant unnecessary exposure to asbestos emissions. In areas with high traffic frequency, 55% of emissions by mass of non-exhaust related emissions can be attributed to brake wear. The emissions rate of non-

exhaust related emissions on freeway was at 22% by mass of particles, due to lower traffic density and brake frequency.

Asbestos disease often stemmed from brake service and auto repair and mechanics who were exposed to cars for extended periods of time had a higher risk of asbestos disease, with the substance being on their hands, in their lungs, lingering in the place they work, and on their clothes, before asbestos was over ruled by a newer, safer friction material. This long exposure to this cancerous material can prove to be detrimental to the mechanics health, increasing their risk of getting illnesses such as mesothelioma and asbestosis.

Conclusions and Recommendations

To conclude, the drum brake was key to the automotive industry as it revolutionised the industry and helped to evolve hydraulics. The brake utilises two drum shoes and a 'drum' where the two shoes expand outward into the spinning drum forcing it to stop. Inside the drum, on the shoes asbestos was used as a friction material as it was extremely efficient. This led to many issues and this example shows us how the drum brake evolved over time. The report covers key aspects such as the principles, mechanical properties behind the drum brake and hydraulic systems incorporated with it. The report also includes history and the materials used to manufacture these brakes. In the end the aim was to assess how the drum brake affected society and the impact it brought to the automotive industry. The drum brake changed how modern car breaks have evolved and shaped how the automotive industry used hydraulics. This aim was achieved when researching this complex braking system and learning how simple aspects from this brake were taken and applied to other brakes. The major findings when conducting the practical found that it required a solid build with accurate cuts and measurements to make it work smoothly and replicate a real drum brake. This helped with our understanding and linked to our research.

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