



Technical Torque #22

The Development of the Braking System; Part 2 - Steve Bullôt

In Part 1 we discussed the braking action at the wheel while in Part 2 we discuss the technologies used to transfer the operator's input to the braking mechanism at the wheel end.

Mechanical

Early brake systems were actuated by rods and levers however these were heavy and prone to failure whether with the rods bending or the connection between the rod and the actuating arm being subject to considerable force resulting in the joint becoming sloppy, thus the brake(s) losing efficiency or failing entirely.

Cable

As vehicles got faster and started carrying ever heavier loads the need for efficient braking became ever more important, so the rod and lever actuation was replaced by cable actuation. The advantage of cable operation was that it had only two connections, that between the operator's lever or pedal and the actuation lever and it was flexible and could go round corners. However, cable systems required constant maintenance as the cable would stretch thus limiting the brake force that could be applied.

Transmission Brake

In the early days of powered vehicles when brakes were rudimentary and often only used on a single axle some vehicles used a transmission brake, that is, a brake incorporated in the driveline that affected the driven wheels. The advantages of a transmission brake are that it operates ahead of the diff meaning that the braking torque is multiplied by the diff ratio. The disadvantages include the added stresses on the transmission when the brake is applied. This type of service brake has fallen out of favour even though some F1 cars such as the BRM P48 (pictured) used the system, nicknamed 'the bacon slicer', up to the early 1960s. The use of transmission brakes is now generally limited to use as a park brake (Cardan Shaft Park Brake) on mainly Japanese light duty trucks, but even here its deficiencies limit its effectiveness as vehicles fitted with CSPB are prone to rollaway and the manufacturers who use the system recommend wheel chocks also be used when stopped on a slope or when loading the vehicle.



Photo credit, hallandhall.com

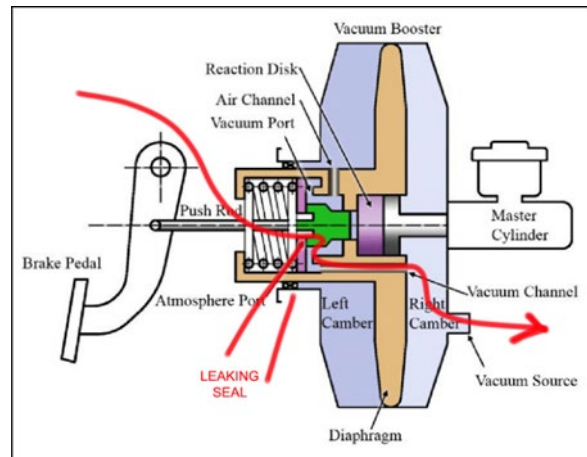
Hydraulic Brakes

A breakthrough came in 1917, when Malcolm Loughead, an American aeronautical Engineer who later changed the spelling of his name to Lockheed to match the pronunciation as he was sick of being called 'Log-head', patented hydraulic brakes. This style of brake was first invented by German engineer Hugo Meyer in 1895 and also developed by Frederick Duesenberg in the US in 1914 but didn't catch on until Lockheed developed and patented his system. Lockheed's brakes were the first mass-produced hydraulic brakes. The system used fluids to transfer force to the brake shoe when a pedal was pressed. Application of force utilising incompressible, hydraulic, fluid to transfer the force from the driver's foot to the brake shoes in a controlled and progressive manner was a step change in both safety and efficiency. Firstly, the braking force

was increased. Secondly, the problem of cables stretching or breaking was eliminated, and brakes became more convenient to use. However, while the first hydraulic brakes were notorious for leaks, they were still far more reliable than mechanical brakes and engineers rapidly solved the leaking problems by developing better and more secure jointing technologies. This braking system was adopted in nearly every vehicle by the late 1920's. This advance also saw the introduction of brakes to all wheels of vehicles.

Servo Assist

In 1928, a few years after the hydraulic brake had become the industry standard, an additional feature was added, brake servo assist. A brake servo uses negative pressure, a vacuum, generated in the inlet system to increase the braking force. After pressing the brake pedal the master cylinder is activated and a valve releases the negative pressure from the intake manifold. The pressure difference between the two parts of the membrane generates a force that adds additional force to the master cylinder piston.



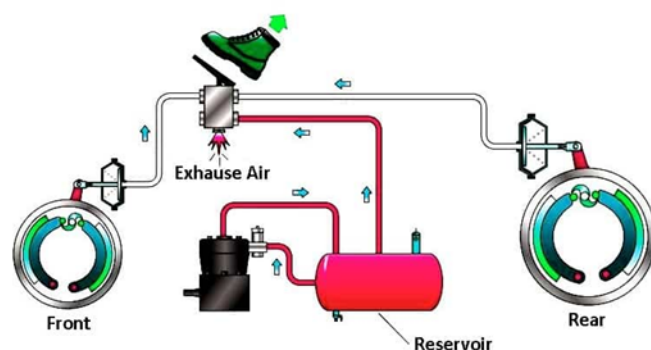
The force is directly proportional to the force used on the brake pedal (how far the pedal is depressed). This gave the driver even better control of the braking force, an essential safety feature as vehicles got heavier and faster.

Air over Hydraulic

Another form of assistance is air over hydraulic where compressed air is used to power an air cylinder with relatively large piston that, in turn, operates a smaller hydraulic piston in the same cylinder. This creates significantly more hydraulic pressure than the incoming air pressure and is then used to operate the service brake with minimal force required of the operator.

Air Brakes

Air brake systems were first developed by George Westinghouse in 1869 for use on trains. Knorr-Bremse, a German company that was manufacturing railway braking systems on the Westinghouse principle introduced a similar system for road vehicles in 1922, predominantly heavy vehicles such as trucks and buses, due to their ability to deal with heavy loads with reliable stopping power.



Brake Released

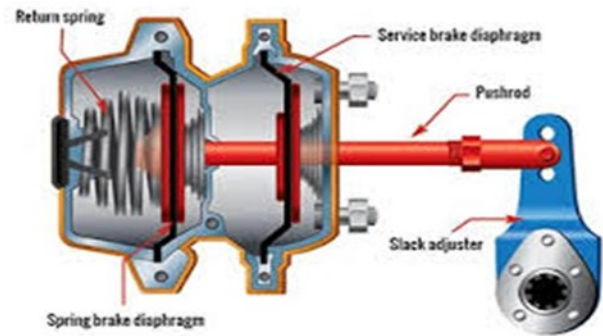
In air brake systems air is the control medium rather than hydraulic fluid. Air, the operating fluid, is compressed by an air compressor powered by the vehicle's engine. The compressed air is stored in one or more air tanks on the vehicle and used to apply the brakes via brake chambers activated by a driver operated treadle valve.



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For parking or emergency use the park braked axles have double acting chambers, spring brake chambers. Whereas the standard chambers apply the brakes with the application of air and the brake remains applied only as long as air is being released into the chamber by activation of the treadle valve, the spring brake operates in the opposite manner. In normal operation the spring brake chamber is fully charges with air and the brake is only applied when the chamber air is exhausted allowing the spring to overcome the pressure and apply the brakes. The brakes then remain applied until the air pressure in the spring chamber is built up again.

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In Part 3 of this series, we will look at the development of alternative and advanced brake operating and control systems