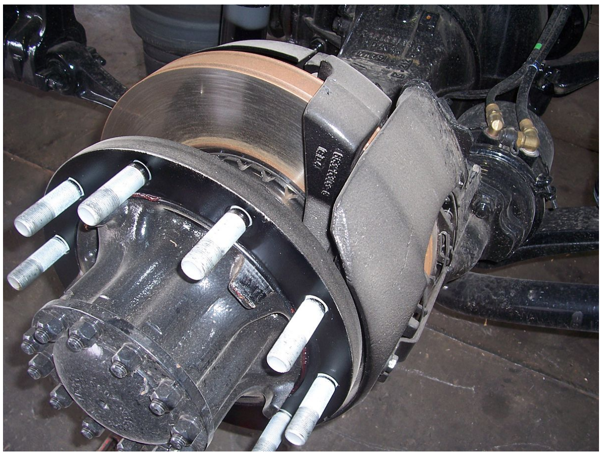
Air brake (road vehicle)

Air brakes are used in trucks, buses, trailers, and semi-trailers. George Westinghouse first developed air brakes for use in railway service. He patented a safer air brake on March 5, 1872. Originally designed and built for use on railroad train application, air brakes remain the exclusive systems in widespread use. Westinghouse made numerous alterations to improve his air pressured brake invention, which led to various forms of the automatic brake and the subsequent use on heavier road vehicles.


Truck air actuated disc brake.

Compressed air brake system

Compressed air brake systems are typically used on heavy trucks and buses (Note the difference between pneumatic brakes and pneumatic/hydraulic). The system consists of service brakes, parking brakes, a control pedal, an engine-driven air compressor and a compressed air storage tank. For the parking brake, there is a disc or drum brake arrangement which is designed to be held in the 'applied' position by spring pressure. Air pressure must be produced to release these "spring brake" parking brakes. For the service brakes (the ones used while driving for slowing or stopping) to be applied, the brake pedal is pushed, routing the air under pressure (approx 100-125psi) to the brake chamber, causing the brake to reduce wheel rotation speed. Most types of truck air brakes are drum units, though there is an increasing trend towards the use of disc brakes in this application. The air compressor air draws filtered air from the atmosphere and forces it into high-pressure reservoirs at around 120 PSI. Most heavy vehicles have a gauge within the driver's view, indicating the availability of air pressure for safe vehicle operation, often including warning tones or lights. Setting of the parking/emergency brake releases the pressurized air pressure in the lines between the compressed air storage tank and the brakes, thus actuating the (spring brake) parking braking hardware. An air pressure failure at any point would apply full spring brake pressure immediately.

In the Florida CDL Handbook [1] , this process is described. Here is the section describing the service brake:

5.1.7 - The Brake Pedal

Brakes are applied by pushing down the brake pedal. (It is also called the foot valve or treadle valve.) Pushing the pedal down harder applies more air pressure. Letting up on the brake pedal reduces the air pressure and releases the brakes. Releasing the brakes lets some compressed air go out of the system, so the air pressure in the tanks is reduced. It must be made up by the air compressor. Pressing and releasing the pedal unnecessarily can let air out faster than the compressor can replace it. If the pressure gets too low, the brakes won't work.

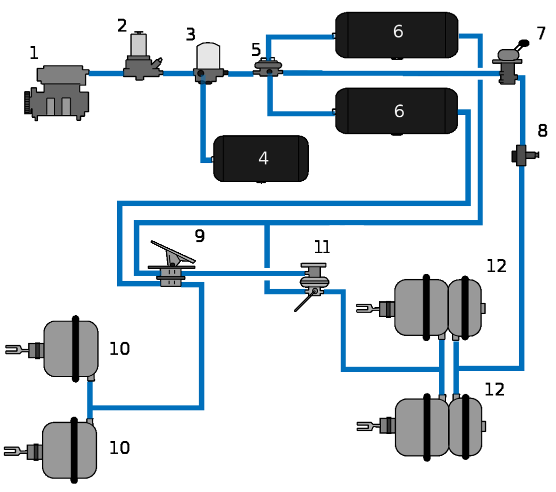
These large vehicles also have an emergency brake system, in which the compressed air holds back a mechanical force (usually a spring) which will otherwise engage the brakes.[2] Hence, if air pressure is lost for any reason, the brakes will engage and bring the vehicle to a stop.

Design and function

A compressed air brake system is divided into a supply system and a control system. The supply system compresses, stores and supplies high-pressure air to the control system as well as to additional air operated auxiliary truck systems (gearbox shift control, clutch pedal air assistance servo, etc.).

Supply system

The air compressor is driven off of the engine either by crankshaft pulley via a belt or directly off of the engine timing gears. It is lubricated and cooled by the engine lubrication and cooling systems. Compressed air is first routed through a cooling coil and into an air dryer which removes moisture and oil impurities and also may include a pressure regulator, safety valve and a smaller purge reservoir. As an alternative to the air dryer, the supply system can be equipped with an anti freeze device and oil separator. The compressed air is then stored in a reservoir (also called a wet tank) from which it is then distributed via a four way protection valve into the front and rear brake circuit air reservoir, a parking brake reservoir and an auxiliary air supply distribution point. The system also includes various check, pressure limiting, drain and safety valves.



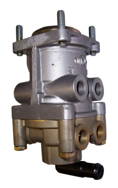
" Over simplified" air brake diagram on a commercial road vehicle (does not show all air reservoirs and all applicable air valves).

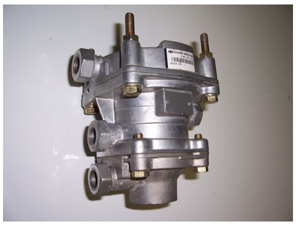
Control system

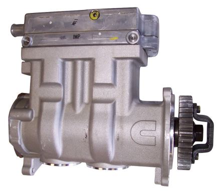
The control system is further divided into two service brake circuits: the parking brake circuit and the trailer brake circuit. This dual brake circuit is further split into front and rear wheel circuits which receive compressed air from their individual reservoirs for added safety in case of an air leak. The service brakes are applied by means of a brake pedal air valve which regulates both circuits. The parking brake is the air operated spring brake type where its applied by spring force in the spring brake cylinder and released by compressed air via hand control valve. The trailer brake consists of a direct two line system: the supply line (marked red) and the separate control or service line (marked blue). The supply line receives air from the prime mover park brake air tank via a park brake relay valve and the control line is regulated via the trailer brake relay valve. The operating signals for the relay are provided by the prime mover brake pedal air valve, trailer service brake hand control (subject to a country's relevant heavy vehicle legislation) and the prime mover park brake hand control.

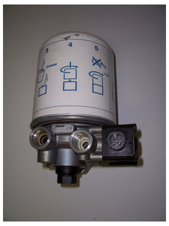

Park brake valve

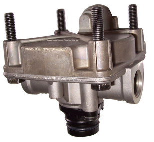

Spring brake cylinder


Air brake foot valve


Trailer brake relay valve


Truck air compressor


Air dryer


Air brake relay valve


Four way protection valve

Exposed Physical Structure

This example of the air brake consists of a physical structure on the exterior of a vehicle that will increase the vehicle's drag coefficient, and therefore slow it down. Air brakes of this sort are ineffective at normal road vehicle speeds, and therefore are reserved for vehicles which need to quickly decelerate from high speeds, such as race and high performance sports cars.


The Bugatti Veyron's hydraulic rear spoiler/air brake in the wing position.

The Bugatti Veyron, the fastest production car in the world, [3] features a rear spoiler which, at speeds above 200 km/h (120 mph), also acts as an air brake, snapping to a 55° angle in 0.4 seconds once the brake pedal is pressed, providing an additional 0.68 g (6.66 m/s^2) of deceleration (equivalent to the stopping power of an ordinary hatchback). [4] Top Fuel Dragsters and other drag racing cars that routinely reach speeds greater than 150 miles per hour use a physical air brake via a parachute(s) after the completion of a race.

In 1994, NASCAR introduced roof flaps to the cars, which are designed to keep cars from becoming airborne and possibly flipping. Following Rusty Wallace's crash at Talladega, Penske Racing designed the original roof flaps.[5] NASCAR team owner Jack Roush helped improve on the design of the roof flaps, in conjunction with Embry-Riddle Aeronautical University, Daytona, Florida, USA.[6] During a spin, the car rotates it eventually reaches an angle where the oncoming air reacts with the profile of the vehicle in the same manner as a wing. If the speed is high enough, air flowing over this aerofoil shape will create sufficient lift to force the car to become airborne. To prevent this, NASCAR developed a set of flaps that are recessed into pockets on the roof of the car. As a car is turned around and reaches an angle where significant lift occurs, the low pressure above the flaps causes them to deploy. The first flap, oriented 140 degrees from the centerline of the car, typically deploys first. After flap deployment, higher pressure air is forced through an air tube which connects to a second flap, deploying it. This second flap ensures that, should the car continue to spin, no further lift will be created as the vehicle's angle changes. The deployment of these flaps eliminates most of the lift on the vehicle. The roof flaps generally keep the cars on the ground as they spin, although it is not guaranteed.[7]

References

[1] "Florida CDL Handbook 2009" (http://www.lowestpricetrafficschool.com/handbooks/cdl/en/5/1). . Retrieved 2009-10-27.
[2] "Florida CDL Handbook 2009" (http://www.lowestpricetrafficschool.com/handbooks/cdl/en/5/1). . Retrieved 2009-10-27.
[3] "Top 10 Fastest Production Cars in the World" (http://www.allfastcars.com/fastestcars.shtml) accessed December 4, 2010
[4] Adams, Eric (2006). "Inside a Street-Legal Land Rocket". *Popular Science* **269** (6): 73
[5] (http://www.jayski.com/past/050221.htm) Jayski's Silly Season Site
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[7] Howstuffworks.com (http://auto.howstuffworks.com/nascar-safety1.htm) Explanation of roof flaps.

State of California, Copyright 2003, California Commercial Driver Handbook, Sec. 5

North American Standard Inspection Program, Commercial Vehicle Safety Alliance (12 December 2005). *Tractor Protection Systems*. Retrieved 7 September 2006 from: Commercial Vehicle Safety Alliance (http://www.cvsa.org/resourcecenter/documents/2005_02_tractor_protection_systems_rev5.pdf#search="emergency brake, air, require")

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