Braking system

A **brake** is a mechanical device that inhibits motion by absorbing energy from a moving system.It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction. Most brakes commonly use friction between two surfaces pressed together to convert the kinetic energy of the moving object into heat, though other methods of energy conversion may be employed. For example, regenerative braking converts much of the energy to electrical energy, which may be stored for later use. Other methods convert kinetic energy into potential energy in such stored forms as pressurized air or pressurized oil. Eddy current brakes use magnetic fields to convert kinetic energy into electric current in the brake disc, fin, or rail, which is converted into heat. Still other braking methods even transform kinetic energy into different forms, for example by transferring the energy to a rotating flywheel.

Brakes are generally applied to rotating axles or wheels, but may also take other forms such as the surface of a moving fluid (flaps deployed into water or air). Some vehicles use a combination of braking mechanisms, such as drag racing cars with both wheel brakes and a parachute, or airplanes with both wheel brakes and drag flaps raised into the air during landing.

Since kinetic energy increases quadratically with velocity (an object moving at 10 m/s has 100 times as much energy as one of the same mass moving at 1 m/s, and consequently the theoretical braking distance, when braking at the traction limit, is 100 times as long. In practice, fast vehicles usually have significant air drag, and energy lost to air drag rises quickly with speed.

Almost all wheeled vehicles have a brake of some sort. Even baggage carts and shopping carts may have them for use on a moving ramp. Most fixed-wing aircraft are fitted withwheel brakes on the undercarriage. Some aircraft also feature air brakes designed to reduce their speed in flight. Notable examples include gliders and some World War II-era aircraft, primarily some fighter aircraft and many dive bombers of the era. These allow the aircraft to maintain a safe speed in a steep descent. The Saab B 17 dive bomber andVought F4U Corsair fighter used the deployed undercarriage as an air brake.

Friction brakes on automobiles store braking heat in the drum brake or disc brake while braking then conduct it to the air gradually. When traveling downhill some vehicles can use their engines to brake.

When the brake pedal of a modern vehicle with hydraulic brakes is pushed against the master cylinder, ultimately a piston pushes the brake pad against the brake disc which slows the wheel down. On the brake drum it is similar as the cylinder pushes the brake shoes against the drum which also slows the wheel down.

Factor governing braking: • There are four basic factors determine the braking power of the system. – Pressure Pressure – amount of friction generated between moving surfaces contacting pp one another depends in part on the pressure exerted on the surfaces. The hydraulic hydraulic force is used to move brake pads or brake shoes brake shoes against spinning spinning rotors or drums mounted on the wheels. – Coefficient of Friction Coefficient of Friction – In automotive brakes, the COF expresses the frictional relationships between pads and rotors or shoes and drums and is carefully engineered to ensure maximum performance. [COF 0.25 to 0.55] Frictional Contact surface It is the amount of surface or area M.S Ramaiah School of Advanced Studies - Bangalore A.C.Meti MSRSAS 6 – Frictional Contact surface – It is the amount of surface, or area, that is in contact. Bigger brakes stop the car more quickly. – Heat Dissipation Heat Dissipation – A large amount of heat is produced in brakes. The weight and the speed of the vehicle determine the braking mechanism.

TYPES OF BRAKES

 MECHANICAL BRAKES
•DRUM BRAKES

•DISC BRAKES
HYDRAULIC BRAKES

POWER BRAKES
•AIR BRAKES

•AIR HYDRAULIC BRAKES

•VACCUM BRAKES

•ELECTRIC BRAKES

DRUM BRAKES

A **drum brake** is a brake that uses friction caused by a set of shoes or pads that press outward against a rotating cylinder-shaped part called a brake drum.

The term *drum brake* usually means a brake in which shoes press on the inner surface of the drum. When shoes press on the outside of the drum, it is usually called a *clasp brake*. Where the drum is pinched between two shoes, similar to a conventionaldisc brake, it is sometimes called a *pinch drum brake*, though such brakes are relatively rare. A related type called a band brake uses a flexible belt or "band" wrapping around the outside of a drum.

A Drum brake components include the backing plate, brake drum, shoe, wheel cylinder, and various springs and pins.

Backing plate

The backing plate provides a base for the other components. The back plate also increases the rigidity of whole set-up, supports the housing, and protects it from foreign materials like dust and other road debris. It absorbs the torque from the braking action, and that is why back plate is also called the "Torque Plate". Since all braking operations exert pressure on the backing plate, it must be strong and wear-resistant. Levers for emergency or parking brakes, and automatic brake-shoe adjuster were also added in recent years.

Brake drum

The brake drum is generally made of a special type of cast iron that is heat-conductive and wear-resistant. It rotates with the wheel and axle. When a driver applies the brakes, the lining pushes radially against the inner surface of the drum, and the ensuing friction slows or stops rotation of the wheel and axle, and thus the vehicle. This friction generates substantial heat.

Wheel cylinder

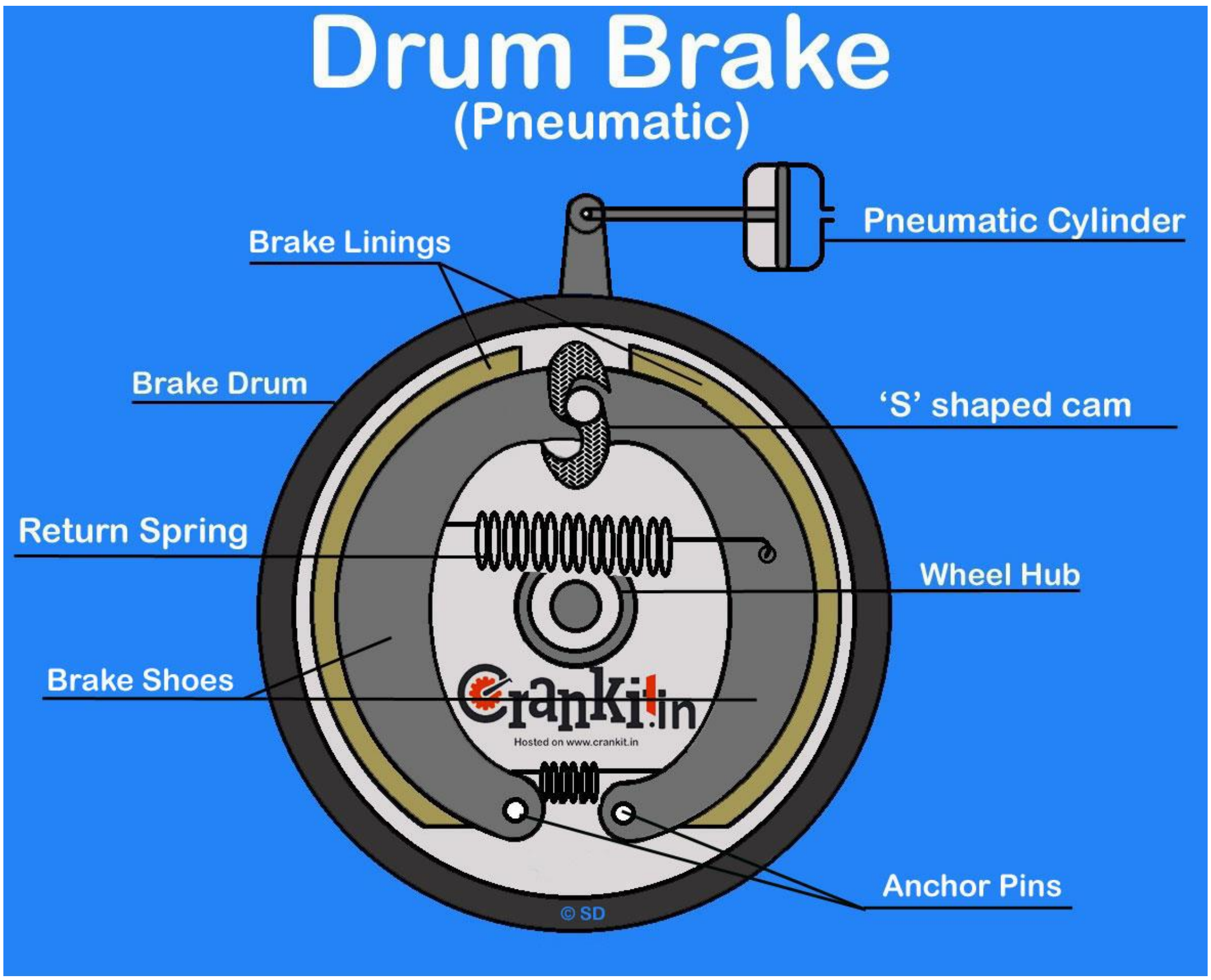
One wheel cylinder operates the brake on each wheel. Two pistons operate the shoes, one at each end of the wheel cylinder. The leading shoe (closest to the front of the vehicle) is known as the primary shoe. The trailing shoe is known as the secondary shoe. Hydraulic pressure from the master cylinder acts on the piston cup, pushing the pistons toward the shoes, forcing them against the drum. When the driver releases the brakes, the brake shoe springs restore the shoes to their original (disengaged) position. The parts of the wheel cylinder are shown to the right.

Brake shoe

Brake shoes are typically made of two pieces of steel welded together. The friction material is either riveted to the lining table or attached with adhesive. The crescent-shaped piece is called the Web and contains holes and slots in different shapes for return springs, hold-down hardware, parking brake linkage and self-adjusting components. All the application force of the wheel cylinder is applied through the web to the lining table and brake lining. The edge of the lining table generally has three “V"-

shaped notches or tabs on each side called nibs. The nibs rest against the support pads of the backing plate to which the shoes are installed. Each brake assembly has two shoes, a primary and secondary. The primary shoe is located toward the front of the vehicle and has the lining positioned differently from the secondary shoe. Quite often, the two shoes are interchangeable, so close inspection for any variation is important.

Linings must be resistant to heat and wear and have a high friction coefficient unaffected by fluctuations in temperature and humidity. Materials that make up the brake shoe lining include, friction modifiers (which can include graphite and cashew nut shells), powdered metalsuch as lead, zinc, brass, aluminium and other metals that resist heat fade, binders, curing agents and fillers such as rubber chips to reduce brake noise.



In the UK two common grades of brake shoe material used to be available. DON 202 was a high friction material that did not require a brake power servo. The disadvantage was that the lining was prone to fading on steep hills. A harder lining, the famous VG95 was produced but this required a brake servo. The other snag was that the parking brake would often fail the annual MOT test unless the high friction linings were installed just for the test.

HYDRAULIC BRAKES

▶Hydraulics is the use of a liquid under pressure to transfer force or motion, or to increase an applied force.

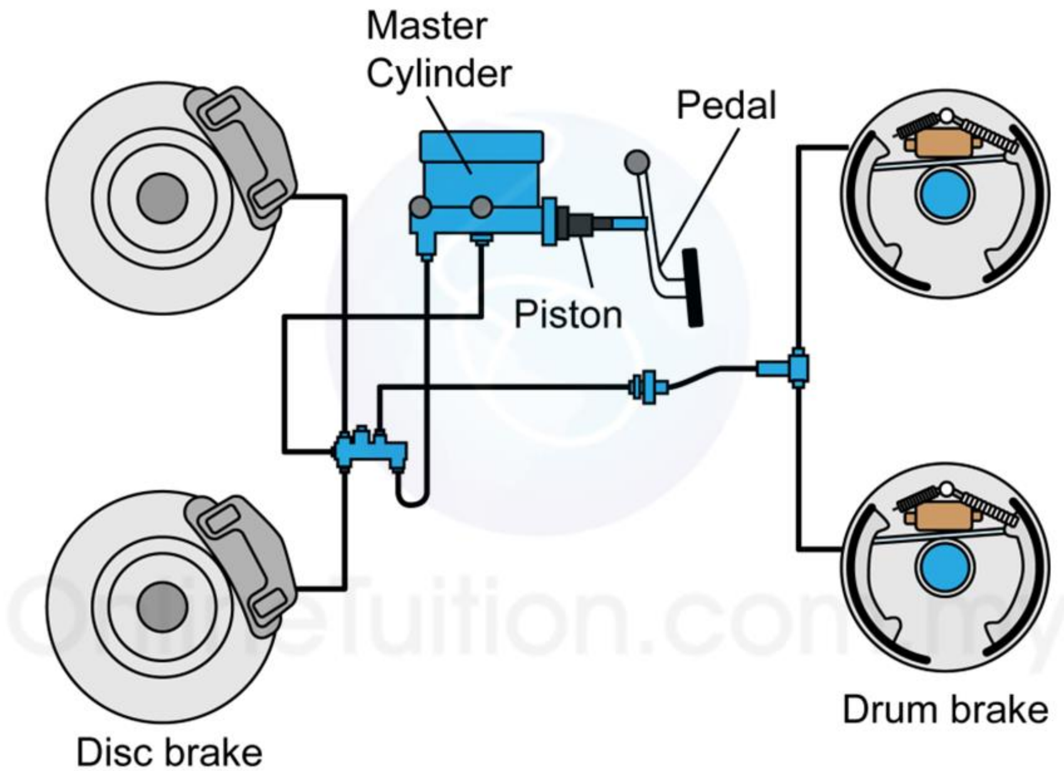
▶The pressure on a liquid is called HYRAULIC PRESSURE.

▶And the brakes which are operated by means of hydraulic pressure are called HYDRAULIC BRAKES.

▶These brakes are based on the principle of Pascal's law.

PASCAL'S LAW

➢The pressure exerted anywhere in a mass of confined liquid is transmitted undiminished in all directions throughout the liquid. Applied in hydraulic lifts, hydraulic brakes etc. Also, fluid pressure does not diminish when transferred within a closed system. That means that if there is no leak in a system, the pressure at the wheels will be the same as the pressure from the master cylinder.



Brake Pedal: To slow down or stop the movement of a vehicle, the driver will apply force on a pedal. This component where the driver presses with his/her foot is called the brake pedal. It is connected to the master cylinder through a mechanical cord or linking rod.

Master Cylinder: An important unit of every braking system that converts the applied force on the pedal to hydraulic pressure. The basic functions of master cylinder include developing pressure, equalizing the required pressure for braking, preventing contaminants like air and water, etc… Master cylinder components are housing, reservoir, piston, rubber cup, pressure check valve and more.

Wheel cylinder: Wheel cylinders are responsible for converting hydraulic pressure to mechanical pressure used for pushing brake shoes towards the drum. The stepped wheel cylinder and the single-piston wheel cylinder are the two major categories of wheel cylinders.

Brake Lines & Hoses: Brake lines or hoses are used for transferring high-pressure fluid between different components. In these two, brake lines are rigid and are constructed using double-wall steel tubings. Whereas the brake hoses are flexible that can be moved.

Brake Fluid: Brake fluids are the medium that transfer pressure to the wheel cylinders. Low freezing point, water tolerance, lubrication, non-corrosiveness, proper viscosity and high boiling point are the required properties for hydraulic brake fluids.

Drum Brake: It is a small round drum containing a set of brake shoes inside it. The brake shoes are supported on a back-plate that is bolted to the axle-casing. This will rotate along with the wheels and when the driver applies the brake, the shoes will come closer to the drum and will resist the rotation of wheel.

Disk Brake: It contains a disc-shaped metal rotor bolted to the wheel hub. So, this metal rotor will spin within the wheel. While pressing the brake pedal, the brake pads will be squeezed against the disk and slow down the vehicle.

AIR BRAKES

An **air brake** or, more formally, a **compressed air brake system**, is a type of friction brake for vehicles in which compressed air pressing on a piston is used to apply the pressure to the brake pad needed to stop the vehicle. Air brakes are used in large heavy vehicles, particularly those having multiple trailers which must be linked into the brake system, such as trucks, buses, trailers, and semi-trailers, in addition to their use in railroad trains.

Design and function

Air brakes are typically used on heavy trucks and buses. The system consists of service brakes, parking brakes, a control pedal, and an air storage tank. For the parking brake, there is a disc or drum 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 100–120 psi or 690–830 kPa or 6.89–8.27 bar) to the brake chamber, causing the brake to be engaged. Most types of truck air brakes are drum brakes, though there is an increasing trend towards the use of disc brakes. The air compressor draws filtered air from the atmosphere and forces it into high-pressure reservoirs at around 120 psi (830 kPa; 8.3 bar). 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. A mechanical "wig wag" that automatically drops down into the driver's field of vision when the pressure drops below a certain point is also common. Setting of the parking/emergency brake releases the pressurized air in the lines between the compressed air storage tank and the brakes, thus allowing the spring actuated parking brake to engage. A sudden loss of air pressure would result in full spring brake pressure immediately.

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.).

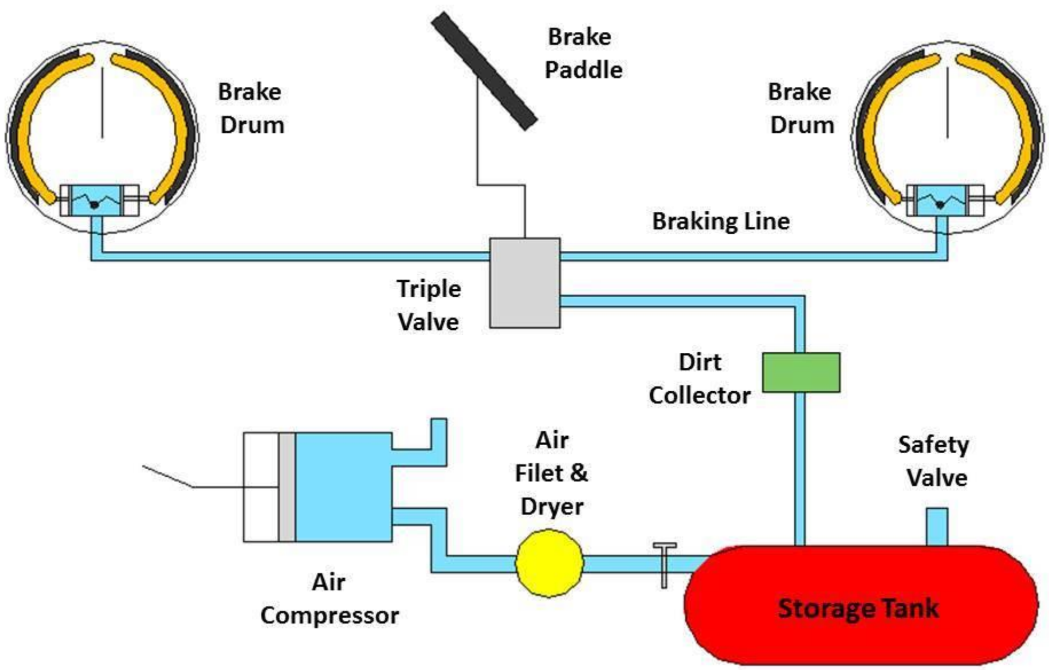
Supply system

The air compressor is driven by the engine either by crankshaft pulley via a belt or directly from 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 anair dryer which removes moisture and oil impurities and also may include a pressure regulator, safety valve and 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 supply reservoir (also called a wet tank) from which it is then distributed via a four-way protection valve into the primary reservoir (rear brake reservoir) and the secondary reservoir (front/trailer brake reservoir), a parking brake reservoir, and an auxiliary air supply distribution point. The system also includes various check, pressure limiting, drain and safety valves.

Air brake systems may include a wig wag device which deploys to warn the driver if the system air pressure drops too low.

Control system

The control system is further divided into two service brake circuits, the parking brake circuit, and the trailer brake circuit. The dual service brake circuits are 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 a 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 theprime 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 local heavy vehicle legislation) and the prime mover park brake handcontrol



Air Brake System

Air assisted hydraulic brakes

1. In this type, compressed air is converted into hydraulic pressure.

2. It consists of following parts:

   - AIR COMPRESSOR
   - AIR TANK
   - AIR PRESSURE REGULATOR
   - FOOT CONTROL VALVE
   - LEVER TYPE SERVO

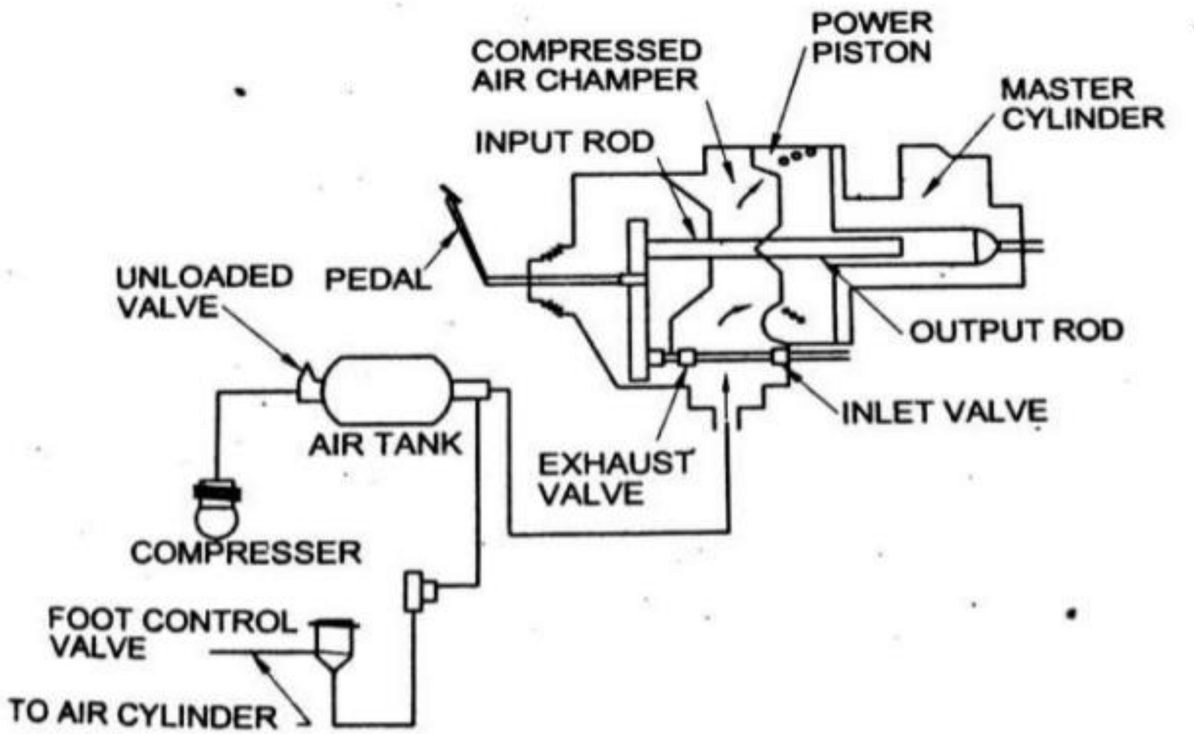
3. The air compressor delivers compressed air to air tank that is connected to lever type servo.

4. When the driver presses the pedal the input rod moves towards right.

5. The lower arm helps to close the exhaust valve but opens the inlet valve.

6. Compressed air flows from the air tank into air chamber.

Air assisted hydraulic brake



VACUM BRAKES

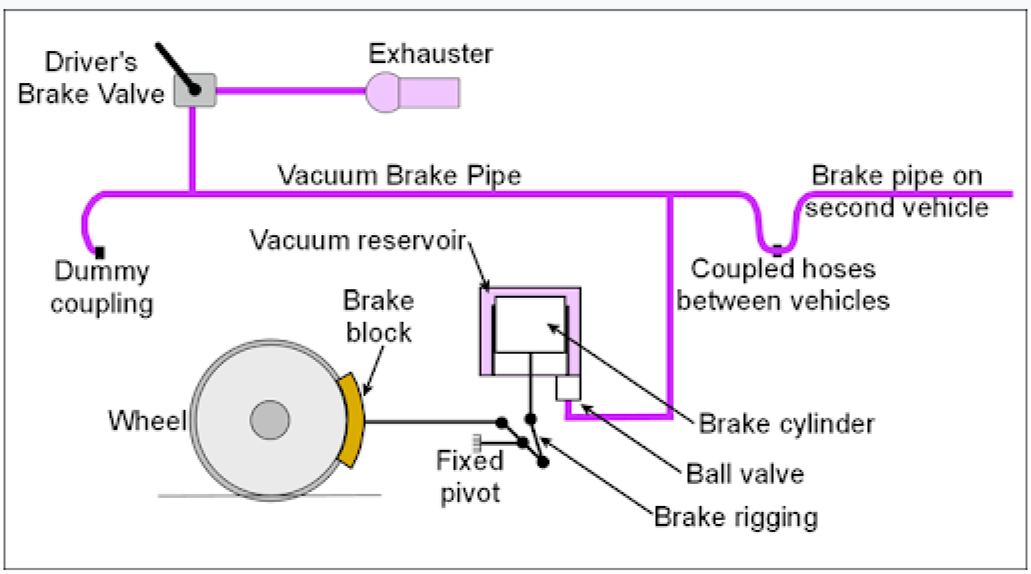
In the earliest days of railways, trains were slowed or stopped by the application of manually applied brakes on the locomotive and in brake vehicles through the train, and later by steam power brakes on locomotives. This was clearly unsatisfactory, given the slow and unreliable response times (each brake being separately applied by a member of the train crew in response to signals from the driver, which they might miss for any number of reasons, and necessarily in sequence rather than all at once where there were more brakes than crew members, making emergency braking extremely hit-and-miss) and extremely limited braking power that could be exerted (most vehicles in the train being wholly unbraked, and the power of all but the locomotive's own brakes relying on the strength of a particular crewmember's arm on a screw handle), but the existing technology did not offer an improvement. A chain braking system was developed, requiring a chain to be coupled throughout the train, but it was impossible to arrange equal braking effort along the entire train.

A major advance was the adoption of a vacuum braking system, in which flexible pipes were connected between all the vehicles of the train, and brakes on each vehicle could be controlled from the locomotive. The earliest scheme was a simple vacuum brake, in which vacuum was created by operation of a valve on the locomotive; the vacuum actuated brake pistons on each vehicle, and the degree of braking could be increased or decreased by the driver. Vacuum, rather than compressed air, was preferred because steam locomotives can be fitted with ejectors; venturi devices that create vacuum without moving parts.

The simple vacuum system had the major defect that in the event of one of the hoses connecting the vehicles becoming displaced (by the train accidentally dividing, or by careless coupling of the hoses, or otherwise) the vacuum brake on the entire train was useless.

Operation

Vacuum brake cylinder in running position: the vacuum is the same above and below the piston.Air at atmospheric pressure from the train pipe is admitted below the piston, which is forced up In its simplest form, the automatic vacuum brake consists of a continuous pipe—the train pipe—running throughout the length of the train. In normal running a partial vacuum is maintained in the train pipe, and the brakes are released. When air is admitted to the train pipe, the air at atmospheric pressure acts against pistons in cylinders in each vehicle. A vacuum is sustained on the other face of the pistons, so that a net force is applied. A mechanical linkage transmits this force to brake shoes which act on the treads of the wheels.



The fittings to achieve this are:

- a train pipe: a steel pipe running the length of each vehicle, with flexible vacuum hoses at each end of the vehicles, and coupled between adjacent vehicles; at the end of the train, the final hose is seated on an air-tight plug;
- an ejector on the locomotive, to create vacuum in the train pipe;
- controls for the driver to bring the ejector into action, and to admit air to the train pipe; these may be separate controls or a combined brake valve;
- a brake cylinder on each vehicle containing a piston, connected by rigging to the brake shoes on the vehicle; and
- a vacuum (pressure) gauge on the locomotive to indicate to the driver the degree of vacuum in the train pipe.

The brake cylinder is contained in a larger housing—this gives a reserve of vacuum as the piston operates. The cylinder rocks slightly in operation to maintain alignment with the brake rigging cranks, so it is supported in trunnion bearings, and the vacuum pipe connection to it is flexible. The piston in the brake cylinder has a flexible piston ring that allows air to pass from the upper part of the cylinder to the lower part if necessary.

When the vehicles have been at rest, so that the brake is not charged, the brake pistons will have dropped to their lower position in the absence of a pressure differential (as air will have leaked slowly into the upper part of the cylinder, destroying the vacuum).

When a locomotive is coupled to the vehicles, the driver moves the brake control to the "release" position and air is exhausted from the train pipe, creating a partial vacuum. Air in the upper part of the brake cylinders is also exhausted from the train pipe, through a non-return valve.

If the driver now moves his control to the "brake" position, air is admitted to the train pipe. According to the driver's manipulation of the control, some or all of the vacuum will be destroyed in the process. The ball valve closes and there is a higher air pressure under the brake pistons than above it, and the pressure differential forces the piston upwards, applying the brakes. The driver can control the amount of braking effort by admitting more or less air to the train pipe.