Drum brake

A **drum brake** is a brake in which the friction is caused by a set of shoes or pads that press against a rotating drum-shaped surface.

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 conventional disk brake, it is sometimes called a "pinch drum brake", although such brakes are relatively rare. A related type of brake uses a flexible belt or "band" wrapping around the outside of a drum, called a band brake.

A drum brake with the drum removed as used on the rear wheel of a car or truck. Note that in this installation, a cable-operated parking brake uses the service shoes.

History

The modern automobile drum brake was invented in 1902 by Louis Renault, though a less-sophisticated drum brake had been used by Maybach a year earlier. In the first drum brakes, the shoes were mechanically operated with levers and rods or cables. From the mid-1930s the shoes were operated with oil pressure in a small wheel cylinder and pistons (as in the picture), though some vehicles continued with purely-mechanical systems for decades. Some designs have two wheel cylinders.

The shoes in drum brakes are subject to wear and the brakes needed to be adjusted regularly until the introduction of self-adjusting drum brakes in the 1950s. In the 1960s and 1970s brake drums on the front wheels of cars were gradually replaced with disc brakes and now practically all cars use disc brakes on the front wheels, with many offering disc brakes on all wheels. However, drum brakes are still often used for handbrakes as it has proven very difficult to design a disc brake suitable for holding a car when it is not in use. Moreover, it is very easy to fit a drum handbrake *inside* a disc brake so that one unit serves as both service brake and handbrake.

Early type brake shoes contained asbestos. When working on brake systems of older cars, care must be taken not to inhale any dust present in the brake assembly. The United States Federal Government began to regulate asbestos production, and brake manufacturers had to switch to non-asbestos linings. Owners initially complained of poor braking with the replacements; however, technology eventually advanced to compensate. A majority of daily-driven older vehicles have been fitted with asbestos-free linings. Many other countries also limit the use of asbestos in brakes.

Self-applying characteristic

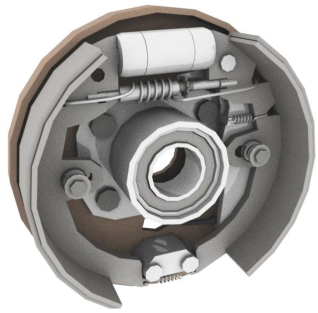
Drum brakes have a natural "self-applying" characteristic.[1] The rotation of the drum can drag either or both of the shoes into the friction surface, causing the brakes to bite harder, which increases the force holding them together. This increases the stopping power without any additional effort being expended by the driver, but it does make it harder for the driver to modulate the brake's sensitivity. It also makes the brake more sensitive to brake fade, as a decrease in brake friction also reduces the amount of brake assist.

Disc brakes exhibit no self-applying effect because the hydraulic pressure acting on the pads is perpendicular to the direction of rotation of the disc.[1] Disc brake systems usually have servo assistance ("Brake Booster") to lessen the driver's pedal effort, but some disc braked cars (notably race cars) and smaller brakes for motorcycles, etc., do not need to use servos.[1]

Note: In most designs, the "self applying" effect only occurs on one shoe. While this shoe is further forced into the drum surface by a moment due to friction, the opposite effect is happening on the other shoe. The friction force is trying to rotate it away from the drum. The forces are different on each brake shoe resulting in one shoe wearing faster. It is possible to design a two-shoe drum brake where both shoes are self-applying (having separate actuators and pivoted at opposite ends), but these are very uncommon in practice.

Drum brake designs

Drum brakes are typically described as either leading/trailing or twin leading.[1]


Rendering of a drum brake

Rear drum brakes are typically of a leading/trailing design(For Non Servo Systems), or [Primary/Secondary] (For Duo Servo Systems) the shoes being moved by a single double-acting hydraulic cylinder and hinged at the same point.[1] In this design, one of the brake shoes will always experience the self-applying effect, irrespective of whether the vehicle is moving forwards or backwards.[1] This is particularly useful on the rear brakes, where the footbrake must exert enough force to stop the vehicle from travelling backwards and hold it on a slope. Provided the contact area of the brake shoes is large enough, which isn't always the case, the self-applying effect can securely hold a vehicle when the weight is transferred to the rear brakes due of the incline of a slope or the reverse direction of motion. A further advantage of using a single hydraulic cylinder on the rear is that the opposite pivot may be made in the form of a double lobed cam that is rotated by the action of the parking brake system.

Front drum brakes may be of either design in practice, but the twin leading design is more effective.[1] This design uses two actuating cylinders arranged so that both shoes will utilize the self-applying characteristic when the vehicle is moving forwards.[1] The brake shoes pivot at opposite points to each other.[1] This gives the maximum possible braking when moving forwards, but is not so effective when the vehicle is traveling in reverse.[1]

The optimum arrangement of twin leading front brakes with leading/trailing brakes on the rear allows for more braking force to be deployed at the front of the vehicle when it is moving forwards, with less at the rear. This helps to prevent the rear wheels locking up, but still provides adequate braking at the rear when it is needed.[1]

The brake drum itself is frequently made of cast iron, although some vehicles have used aluminum drums, particularly for front-wheel applications. Aluminum conducts heat better than cast iron, which improves heat dissipation and reduces fade. Aluminum drums are also lighter than iron drums, which reduces unsprung weight. Because aluminum wears more easily than iron, aluminum drums will frequently have an iron or steel liner on the inner surface of the drum, bonded or riveted to the aluminum outer shell.

Advantages

Drum brakes are still used in some modern cars and smaller (and less-expensive) dirt bikes and ATV's, such as the Honda CRF80F, because of some engineering and cost advantages. Drum brakes allow simple incorporation of a parking brake. They are often applied to the rear wheels since most of the stopping force is generated by the front brakes of the vehicle and therefore the heat generated in the rear is significantly less. Drum brakes are also occasionally fitted as the parking (and emergency) brake even when the rear wheels use disk brakes as the main brakes. In this situation, a small drum is usually fitted within or as part of the brake disk also known as a banksia brake.

In hybrid vehicle applications, wear on braking systems is greatly reduced by energy recovering motor-generators (see regenerative braking), so some hybrid vehicles such as the GMC Yukon hybrid and Toyota Prius (except the third generation) use drum brakes.

Disadvantages

Drum brakes, like most other types, are designed to convert kinetic energy into heat energy via the process of friction.[1] This heat is intended to be further transferred to atmosphere, but can just as easily transfer into other components of the braking system.

Brake drums have to be large to cope with the massive forces that are involved, and they must be able to absorb and dissipate a lot of heat. Heat transfer to atmosphere can be aided by incorporating cooling fins onto the drum. However, excessive heating can occur due to heavy or repeated braking which can cause the drum to distort, leading to vibration under braking.

The other consequence of overheating is brake fade.[1] This is due to one of several processes or more usually an accumulation of all of them.

1. When the drums are heated by hard braking, the diameter of the drum increases slightly due to thermal expansion, this means the brakes shoes have to move farther and the brake pedal has to be depressed further.

2. The properties of the friction material can change if heated, resulting in less friction. This is usually only temporary and the material regains its efficiency when cooled,[1] but if the surface overheats to the point where it becomes glazed the reduction in braking efficiency is more permanent. Surface glazing can be worn away with further use of the brakes, but that takes time.

3. Excessive heating of the brake drums can cause the brake fluid to vapourise, which reduces the hydraulic pressure being applied to the brake shoes.[1] Therefore less retardation is achieved for a given amount of pressure on the pedal. The effect is worsened by poor maintenance. If the brake fluid is old and has absorbed moisture it thus has a lower boiling point and brake fade occurs sooner.[1]

Brake fade is not always due to the effects of overheating. If water gets between the friction surfaces and the drum, it acts as a lubricant and reduces braking efficiency.[1] The water tends to stay there until it is heated sufficiently to vapourise, at which point braking efficiency is fully restored. All friction braking systems have a maximum theoretical rate of energy conversion. Once that rate has been reached, applying greater pedal pressure will not result in a change of this rate, and indeed the effects mentioned can substantially reduce it. Ultimately this is what brake fade is, regardless of the mechanism of its causes.

Disc brakes are not immune to any of these processes, but they deal with heat and water more effectively than drums.

Drum brakes can be grabby if the drum surface gets light rust or if the brake is cold and damp, giving the pad material greater friction. Grabbing can be so severe that the tires skid and continue to skid even when the pedal is released. Grabbiness is the opposite of fade: when the pad friction goes up, the self-assisting nature of the brakes causes application force to go up. If the pad friction and self-amplification are high enough, the brake will stay on due to self-application even when the external application force is released.

Re-arc'ing

Before 1984, it was common to re-arc brake shoes to match the arc within brake drums. This practice, however, was controversial as it removed friction material from the brakes and caused a reduction in the life of the shoes as well as created hazardous asbestos dust. Current design theory is to use shoes for the proper diameter drum, and to simply replace the brake drum when necessary, rather than perform the re-arcing procedure.

Adjustment

Early drum brakes (before about 1955) required periodic adjustment to compensate for drum and shoe wear. If not done sufficiently often long brake pedal travel ("low pedal") resulted. Low pedal can be a severe hazard when combined with brake fade as the brakes can become ineffective when the pedal *bottoms out*.

Self adjusting brakes may use a mechanism that engages only when the vehicle is being stopped from reverse motion. This is a traditional method suitable for use where all wheels use drum brakes (most vehicles now use disc brakes on the front wheels). By operating only in reverse it is less likely that the brakes will be adjusted while hot (when the drums are expanded), which could cause dragging brakes that would accelerate wear and increase fuel consumption.

Self adjusting brakes may also operate by a ratchet mechanism engaged as the hand brake is applied, a means suitable for use where only rear drum brakes are used. If the travel of the parking brake actuator lever exceeds a certain amount, the ratchet turns an adjuster screw that moves the brake shoes toward the drum.

The manual adjustment knob is usually at the bottom of the drum and is adjusted via a hole on the opposite side of the wheel. This requires getting underneath the car and moving the clickwheel with a flathead screwdriver. It is important and tedious to adjust each wheel evenly so as to not have the car pull to one side during heavy braking, especially if on the front wheels. Either give each one the same amount of clicks and then perform a road test, or raise each wheel off the ground and spin it by hand measuring how much force it takes and feeling whether or not the shoes are dragging.

Use in music

A brake drum can be very effective in modern concert and film music to provide a non-pitched metal sound similar to an anvil. Some have more resonance than others, and the best method of producing the clearest sound is to hang the drum with nylon cord or to place it on foam. Other methods include mounting the brake drum on a snare drum stand. Either way, the brake drum is struck with hammers or sticks of various weight.

It is also commonly used in steelpan ensembles, where it is called "the iron."

See also

- Balancing machine
- Brake lining
- Brake bleeding
- Hydraulic Disc Brakes

References

[1] The AA Book of the car, 1976