

On the down side, disc brakes were more expensive to manufacture because of the added cost of the caliper assembly ... the part that applies hydraulic force to press the brake pads against the rotor. Adding a parking brake to a disc brake was also more complicated because it required either a locking caliper or a "mini-drum" inside the rotor. And because there was no self-energizing effect when the brakes were applied, disc brakes required more pedal effort (which meant power brakes were usually required). Yet in spite of these drawbacks, disc brakes eventually replaced drums up front because their performance advantages outweighed their disadvantages.

EARLY DISC DESIGNS

The first disc brake for an automotive application was invented by Elmer Sperry for an electric car in 1898. The car had disc brakes on the front wheels, and used an electromagnet to press a friction pad against one side of the disc. The first mass-production application of a disc brake system that was similar to what we use today was on the 1949 Crosley. In 1956, the British-made Triumph and Jaguar offered disc brakes as standard equipment, and by the early 1960s disc brakes were used on many other European cars.

Until the early 1970s, however, disc brakes weren't used much on American-made cars (the Chevrolet Corvette being one exception) because of their higher cost. When they were adopted, most vehicles only used them up front where they provided the most good. Using drums in the rear saved cost and allowed the use of a simpler (less expensive) parking brake. Even today, most domestic as well as many import vehicles still use the front disc/rear drum arrangement because it provides the best compromise between cost and performance. Four-wheel disc brake systems tend to be limited to sporty models and high-end luxury sports sedans. Disc brakes are detailed in Learning Unit 3.

HYDRAULIC VS. MECHANICAL BRAKE ACTUATION

Prior to the 1920s, all brake systems were mechanically operated rather than hydraulic. The cams or wedges that operated the brake shoes or brake bands were actuated by levers connected to rods or cables that linked them to the brake pedal. The "Bowden cable" (a hollow flexible steel cable with a sliding wire inside) allowed mechanical drum brakes to be used on the front wheels as well as the rear.

For many years, most vehicle manufacturers didn't appreciate the value of having brakes on all four wheels. So most of the early vehicles only had brakes on the rear wheels. Those who did attempt to put brakes on all four wheels found it wasn't easy. A complex arrangement of equalizer yokes and pulleys were needed to even out the braking forces when the brakes were applied, otherwise the rear brakes would lock up and cause the car to skid.

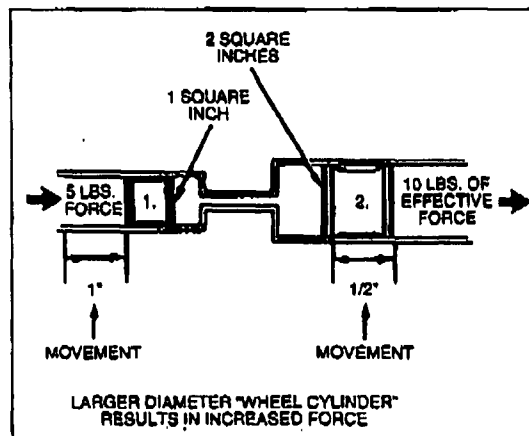


Figure 1.4, Hydraulics can reduce pedal effort by multiplying the input force (courtesy of NAPA United).

The first hydraulic brake system was patented in 1918 by Malcom Loughead, who went on to found the Lockheed Company. Though