DISC BRAKES

The Motorcycle Designer's Point of View

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DISC brakes have been big news in the car world ever since Jaguars had such a resounding success in the 24-hours' race at Le Mans in 1953, their win being largely attributable to the excellent combination of stopping power and endurance afforded by the Dunlop disc brakes fitted to all four wheels. Since that time, there has been a gradual swing-over to this type of brake for fast cars here, though their additional cost, compared with drum brakes, has been something of a deterrent towards their general adoption.

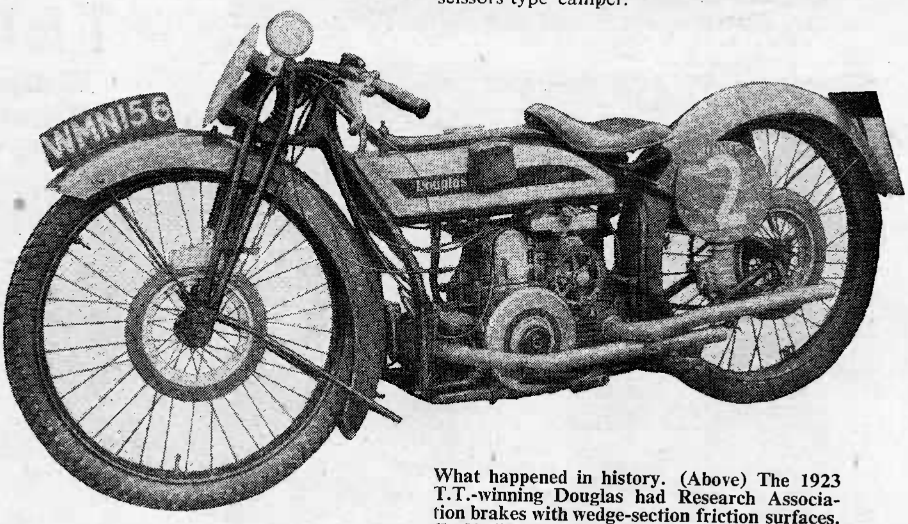
Not that the disc brake is in any sense new-fangled. Dr. Lanchester patented one form of it as far back as 1902, and it has been used intermittently in various applications ever since—chiefly, in recent times, on aeroplanes.

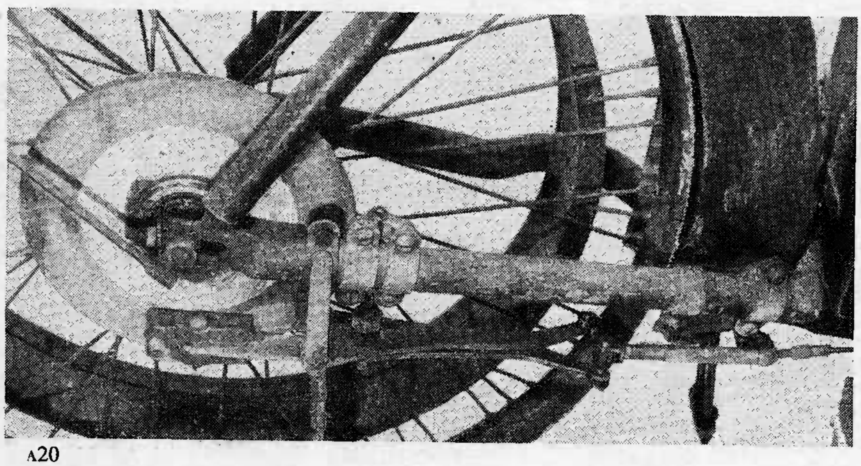
Broadly, two forms are possible—one with continuous circular plates and friction discs rather like a plate-clutch, and the other the "spot type," in which the rim of the rotating disc is gripped between relatively small pads, rather like grasping the edge of a plate between finger and thumb. In the latter form, about 85% of the disc is directly exposed to the air and heat generated on the surface can thus be dissipated to air directly, instead of having to be conducted through a finite thickness of metal before dissipation can occur; the future of the disc brake appears to lie with this type.

In view of its outstanding performance on four wheels, it seems odd that so little attention has been given to the idea where two wheels are concerned. Isolated examples have been built from time to time, one of the earliest known being fitted to a model made by the Imperial Motor Co., of Brixton Hill, and now owned by Mr. P. A. Clare, of Norwood. A quarter of a century later, the revolutionary Douglas which was paramount in the racing world at the time was fitted fore and aft with brakes, designed by an organization known as the Research Association, which could in a sense be called disc brakes. They were not drums, certainly, but consisted of rings of frictional material of triangular section, on to which aluminium shoes were pressed by mechanical linkage, the triangular section giving a wedging action which increased the unit pressure still further. The illustration shows the general system, including the parallel links on each shoe which prevented them from tilting or digging-in, although the wedge section is not very apparent.

About three years ago, a rider in West Australia grafted a single spot-disc brake from a racing car onto a pair of Vincent forks and attached the lot to an outfit which managed to win several races against faster machines because it was able to run past them before braking for corners. Last year, and again this year, spot-disc brakes of private manufacture appeared in the Sidecar T.T. and seemed to perform very well.

The rear brake on a sidecar outfit gets much more of a hiding than it does on a solo, because, with so much more weight on the wheel, the brake can be (and, in fact, must be) applied with much greater vim. The picture of the example used on G. Deakin's T.T. outfit shows it to be remarkably similar to the old Imperial design, the main difference lying in the method of actuation—hydraulic in the modern brake, via the small-bore pipe in the foreground, and mechanical in the oldster, by means of a scissors-type calliper.

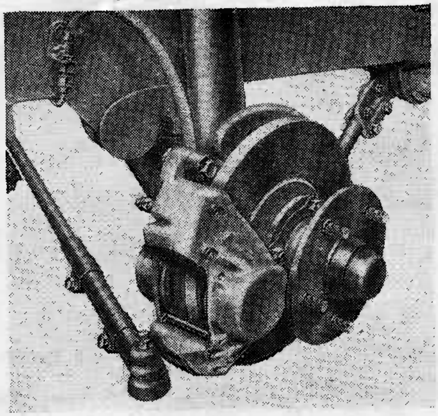




What happened in history. (Above) The 1923 T.T.-winning Douglas had Research Association brakes with wedge-section friction surfaces. (Left) The remarkable Imperial design of 1905 had true calliper action with mechanical operation.

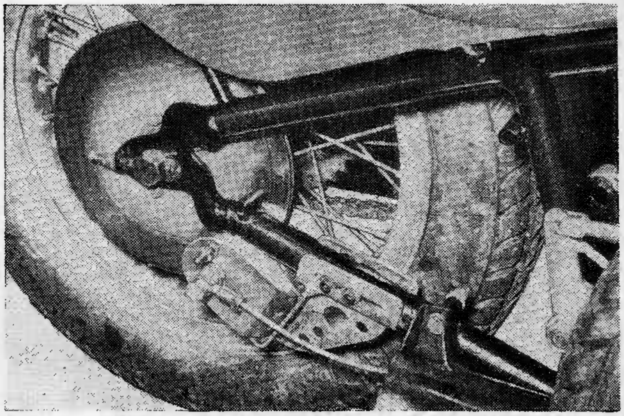
In fact, the Imperial was a very well conceived design. The pads are pivoted to allow full face contact, the calliper arms are very deep and stiff in cross-section near the point of maximum bending stress, and a very large mechanical advantage is gained by the toggle action of the links which pull the ends of the levers together.

Because of the complete absence of the self-energizing effect which is provided by the leading shoe in a drum brake, very high pressure is required with just a pair of pads pressing on each side of the disc. It might be thought that a better effect could be obtained with several pairs, grouped in one calliper, but this scheme was tried by Dunlops and abandoned because it was found that the wear was unequal, the last (and therefore the hottest) pair wearing



(Left) A modern example of disc car brake: note the thickness of the disc and rigid calliper construction.

(Right) Disc brake of the Deakin-Sheldon sidecar outfit entered in this year's T.T., a hydraulically operated "one-off."



away at a much greater rate than the others. With a single pair, the local heat generated is very high, but the pads, due to their simple shape, can be made of very heat-resistant material.

The heat is, naturally, generated on the surfaces of the disc, whence it can be dissipated directly into the air and the less the disc is shrouded by the pad mechanism the better. Even if the disc runs very hot indeed —and on one occasion, at Goodwood, discs were seen at night to be glowing—the thermal expansion does no harm, whereas it causes a drum to expand away from the shoes and gives the effect of loss of adjustment, especially if the shoes are of steel and not aluminium.

In order to get high pad pressure without the use of some leverage system, car-type discs utilize very high hydraulic pressure, and this means that the pedal travel is great in relation to pad movement.

Some of this travel is absorbed in taking up initial clearance, and some in "spring," partly of the mechanism and partly through dilation of the flexible pipes. To minimize this effect, the pads are made self-adjusting to run only just clear of the disc surfaces, and the calliper housing is very robust, as shown in the illustration of a type now in current production and coming into increasing use on high-performance cars.

One of the big assets of such modern designs is that changing the pads is but a matter of minutes. It can be done in little more time than it takes to change a wheel.

Whether this type of brake has any outstanding advantages over the drum for motorcycle use is debatable. Our drums are usually shallow in relation to diameter, and suffer less from distortion or bell-mouthing than wide drums; they are not tucked away inside small disc wheels. Also, by adopting two leading shoes, very great retardation can be obtained with only finger-pressure on a lever with less than 3 in. of movement.

Under touring conditions, an exposed disc would be continually spattered with mud and water from passing vehicles and, while it is true that most of this is immediately thrown off by centrifugal action at higher speeds, it would stay there at low speed and might lead to very erratic and unpredictable effects. Shielding could be added to arrest most of the stuff, but it is difficult to introduce any enclosure without interfering with cooling.

The difficulty of obtaining pressure could, of course, be overcome by adopting hydraulic operation throughout, as is already done on B.M.W. racing outfits, with all brakes applied by one pedal. One-pedal operation is not very popular on solo machines, most riders preferring to have the front brake applied separately and with rather more delicacy by means of a hand lever, but Rudges employed the "proportional braking" system with one pedal for many years. In this system, both brakes were applied with equal pressure up to a certain point, and after that a preloaded spring in the rear mechanism commenced to compress, so that further pedal pressure applied the front brake harder and harder without much increase in pressure on the rear.

This system is now being applied to cars with hydraulic brakes and permits equal braking at low rates of retardation. as dictated by wet surfaces, but piles a lot of extra power on the front brakes when road conditions are good and much of the vehicle weight is transferred to the front wheels by the braking action. Applied to single-trackers, this might give better results than separate control in the hands of an inexperienced rider.

The Editor of *Motor Cycling* has put forward a disc-brake scheme which might well be worth consideration. In this, the disc is located centrally in a large-diameter hub, so that it is a ring rather than a disc, and the pressure pads are held in brackets extending radially from a large-diameter axle, which is drilled to act as a pipe for the hydraulic fluid. Brake reaction can be taken up equally on both fork blades by splining the axle to each, thereby halving the loads and distributing them equally at the same time, and the weight would be equally disposed about the centre-line, a point which is more important than is sometimes appreciated.

Of course, there are snags in the scheme. Cooling of the disc would be difficult unless scoops or turbine-blades were built in to create a draught through the hub, and the hub itself would have to be in at least three pieces in order to gain access to the pads. The pad mounting would need to be very well engineered to avoid flexure and lost motion. Nevertheless, it is an interesting idea and one which some readers may care to play around with on paper.