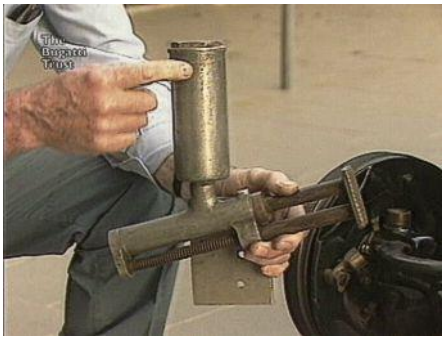
More about Roadster brakes and brake bleeding by Paul Alting van Geusau

In Nigel Maude's [TRM 1946-49] internet blog, roadster brakes and brake fluid bleeding are issues attracting great interest. Still a number of Roadster owners complain about very unreliable brakes and many owners report of having great difficulties in getting all the air out of the brake system when bleeding the system. Since some Roadster owners do not encounter any problems with their brakes while for others the brakes are a continuous source of trouble, a follow-up on the 2006 December-January Brake Special Feature would appear appropriate to discuss probable causes for these problems.

Some history

The Girling Roadster brakes are so-called "hydrastatic" brakes. As was also explained in the Review Brake Special Feature this term relates to the self-adjusting property of the brakeshoes which allows a small displacement master cylinder to be used. Consequently the ratio of master cylinder diameter to wheel brake cylinder diameter can be very low and, in principle, results in a powerful brake combined with a very light pedal effort.
As to the origin of the design, Bob Wyatt refers in the December 2009/January 2010 Review to information given by Jim Sills at the classic car show:
"Bugatti developed a system like this with linings in contact with the brake drums and a large mechanical advantage from the pedal before the second world war specifically for use on racing cars (However, I also found information that a certain Scott Ivason patented the basic concept in 1927, so further search is necessary to settle the issue). The seals were leather and were replaced for each race. Girling bought the idea and the first application was to Triumph cars, Roadsters and Razor Edge saloons. It was deemed so successful that it was never repeated! "
Nevertheless advertisements found on the Internet show that the Girling system was continued and used on small and medium size airplanes in the 1950's, but of course airplanes have different service intervals!



This unique picture is taken from the DVD "Bugatti" by HG (Hugh) Conway (1914-1989), the founder of the Bugatti Trust. It shows the Bugatti "direct action" master cylinder and Mr Conway commented that it "worked quite well but was always giving trouble".

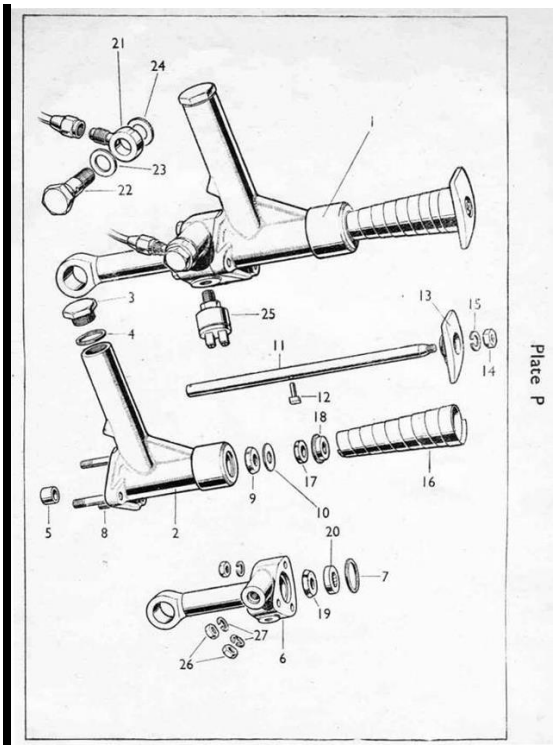
Girling Hydrastatic brakes have been used on a number of cars. In addition to the Triumph Roadster and Saloon, also the postwar AC 2-litre saloon, Jowett Javelin, Landrover and even early Rolls Royce Silver Cloud models used hydrastatic Girling brakes.

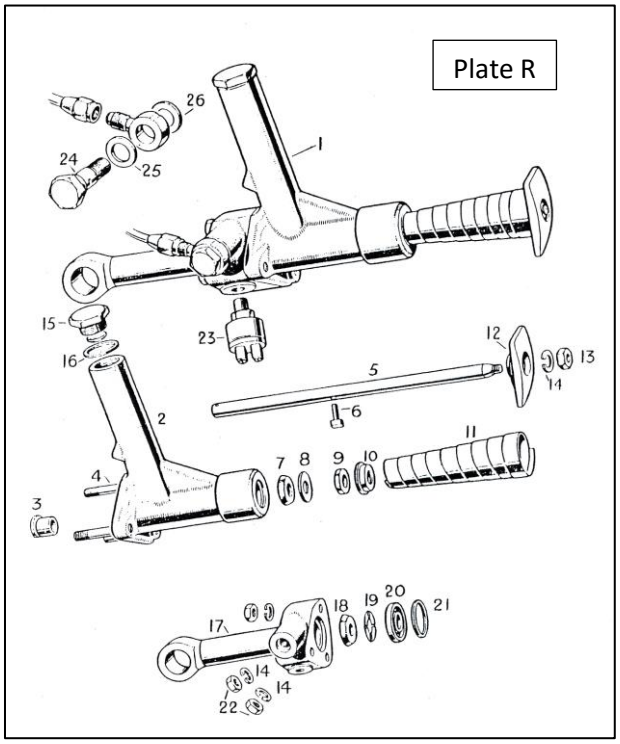
However, apparently it proved difficult to keep the brake system in good working order and later models of these cars had modified hydraulic brake systems. In this relation it is interesting to see that the 1950 *Instruction for the Maintenance and Overhaul of Girling Hydro-Mechanical Brakes* (http://jowett.net/Parts/TechNotes-Part26-Miscellaneous.htm) mentions brake adjusters for a system that originally had been advertised as self-adjusting (and looking at the November 2007 issue of the Review such an adaptation was made by Bob Wyatt too!). The AC web page acknowledges that the earlier Girling Hydrastatic front brakes were more "prone to seizing".
Rolls Royce tried to improve the system by providing a "shake back stop" and explained: "The tension of the brake shoe return springs (or more correctly 'bias springs') is such that the shoes are in equilibrium with the springs in the wheel cylinders. These exert a slight pressure on the back of the operating rubber cup and piston in the expanders. In consequence, there must be sufficient friction between the shake-back stop and the brake shoe web to prevent the shoe being shaken back by the vertical forces imposed on it when traversing rough roads".
Nevertheless the system was quickly abandoned.
So apparently, in particular the self-adjusting properties could not be guaranteed to work properly under all circumstances and clearly the problem is related to the sensitive balanced set-up of the brake shoes. Generally speaking, when new, the system works well but when getting older more friction is encountered and proper balance is affected. The system is very sensitive to sticking pistons which lead to seizing of the brakes. It cannot be emphasized enough that the brake cylinders must be kept in as-new condition otherwise constant brake problems will be the result.
Furthermore, a problem related to the self-adjusting property is that when the drum develops an internal wear ridge it becomes very hard to remove the drum.

The drums and shoes
In order to ensure only minimal brake contact movement of the brake shoes, the drums and shoes have to be manufactured to very close limits. This means that when replacing friction linings it should be ensured that the inner radius of the drum is exactly the same as the outer radius of the new linings, otherwise there is a risk of bending of the shoes during application of the brake, which results in a spongy brake pedal or, worse, in an increase of the stroke of the brake pedal. The brake specialist has friction lining grinding machines available for achieving this goal.

The Girling Direct Acting Master Cylinder (Plates P and R)
The Triumph Roadster and Renown master brake cylinder is a brake pressure source of quite unique construction. This master cylinder was developed for the hydrastatic brake system in which the extremely small movement of fluid permitted a master cylinder of small displacement to be designed. But this also means that even small air bubbles or a brake shoe not touching the brake drum will lead to failure of the brakes because the stroke of the master cylinder plunger rod cannot give sufficient volume displacement to make up for the brake fluid volume needed to exert pressure in the wheel brake cylinders. When the plunger rod or ram is pressed into the pressure chamber (17 in Plate R) it does not touch the walls of the pressure chamber and thus acts as a fluid displacement plunger rather than a piston in the usual sense.

Pictures of the Roadster master cylinder are shown below. Quite surprisingly it was found that the master cylinders shown in the different plates published by Girling or Triumph are not identical.





You will see from the above pictures that in Plate P (left) the corrugated washer 19, shown in Plate R, is missing. Nowhere is there an explanation to be found in the relevant literature about the function of this washer.
It was argued that the corrugated washer must be in position to protect the rubber seal. Without it, the seal would become perforated by the holes in the brass bush.

This surely appears to be a valid reason but why use a corrugated washer for this purpose instead of a more logical plain washer and why are there axial holes in the guide 20 anyway?
Considering the operation of the master cylinder more in detail let us have a look at the path to be followed by the brake fluid for keeping the pressure chamber (17 in Plate R) filled with fluid. Brake fluid must pass through the radial holes in the end of the plunger rod. In its fully withdrawn position these holes are just behind the lip seal 18 (see plate R above) so as to provide a passage between the inside of the pressure chamber and the space connected to the reservoir.

Plate P comes from the “Standard Triumph Service Instruction Manual” and the manual explains that “The pressure chamber is kept replenished with fluid by the provision of internal splines cut in the guide bearing 20 through which the ram (plunger rod) passes”. It continues by stating that “The extreme end of the ram is recessed and two small ports are provided behind the base of the cup washer to register with the channels of the guide when the ram is in the off-position”. How such “registering” is ensured is difficult to see because the guide 20 is mounted in a bore and there is no information derivable if it can be mounted in only one registered position with respect to the holes in the plunger rod.

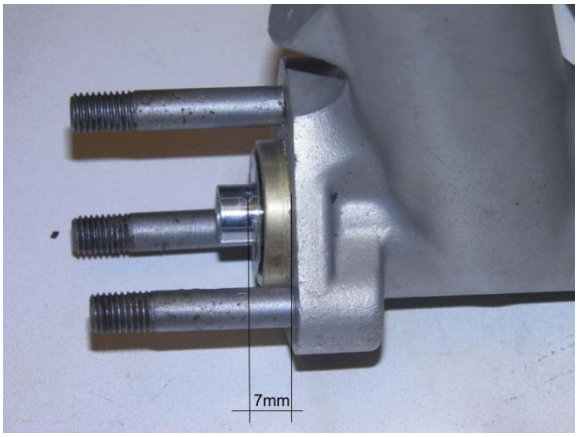
Apparently Girling improved its initial design shown in Plate P by replacing the guide 20 with internal splines by a combination of corrugated washer and plain guide bearing 20 provided with axial holes, as shown in Plate R above. Due to these holes brake fluid

freely enters the space between the guide bearing 20 and washer 19. It will be clear that as an effect of its corrugations, the washer keeps a free space filled with brake fluid and fluid also has free access to a small chamber formed in the recuperating seal. When the plunger rod is in its fully withdrawn position the holes in the plunger rod are exactly at the position of this chamber filled with brake fluid. Since the corrugations are on both sides of the washer it does not matter in which way it is inserted between the seal and guide.

The combination of the guide bearing 20 with its axial holes and the corrugated washer 19 is thus essential for the correct functioning of this type of master cylinder as regards free brake fluid flow to and from the pressure chamber 17. In this respect it is also essential that the holes in the plunger rod are located at the position of the chamber of the recuperating seal when the rod is retracted. It is important to check this position because dirt in the runway for the guide block (12 in Plate P and 6 in Plate R) and/or a weak return spring may prevent the plunger rod to arrive at its correct end position (see also Ron Cromar's article in the March 2009 Review).
It will be clear from the operation as explained above that not only does bleeding become extremely difficult when there is no free fluid access to the master cylinder bore but also braking can under certain circumstances be affected. This might occur (a) if the brake cylinder is not sufficiently (re)filled with brake fluid, or (b) when the fluid cannot escape, the brakes may seize as a result of expansion of the brake fluid when it gets hot. These may well be the reasons for the problems encountered by some Roadster owners!

To make checking easier I have taken my spare master cylinder apart and have measured how far the holes in the plunger rod stick out of the housing in the fully retracted position of the plunger rod (7mm see Picture 1). There the plunger rod sticks out 112mm from the other end of the master cylinder housing.

Picture 1



Picture 2

Picture 2 shows that the recuperating seal comprises a small recess forming a chamber around the holes in the plunger rod when it is in its retracted position. So brake fluid can freely flow through the holes in the bronze guide passing the corrugated washer and into the chamber in the recuperating seal and from the chamber through the holes in the plunger rod into the pressure chamber 17.
Bob Cakebread experienced that the guide pin in the rod can be a source of trouble when the corners of the guide pin are not rounded: "On one car I attempted to drive the brakes worked fine when the pedal was pressed slowly but when pressed quickly the pedal would jam. I traced this fault to the guide pin

which had one end squared off so on pressing the pedal it swung to one side enough to jam on the rough cast groove in the body. That little pin is so important both to ensure that it can run smoothly in the groove but also to ensure that it does not restrict the return travel of the plunger rod."

Leakage problems

The outer seal sometimes is a source of leakage and mostly the cause is a damaged recess in the master cylinder housing. Picture 3 below shows what corrosion can do to the recess walls and without machining and insertion of a bush, so as to provide a new sealing outer surface for the outer seal, good sealing cannot be assured.

Picture 3

Bob Cakebread experienced leakage from the outer seal due to wear in the top bush such that even a new seal could not prevent leakage. Considering the high loads placed on this bush one wonders why Girling never supplied this bush in their repair kits.

Bleeding the brakes

When the master cylinder is assembled in the correct manner there is no reason why bleeding should give a problem. The holes in the plunger rod are quite small so some pressure might help to ease the bleeding operation. Triumph Roadster Manual recommends using the Eezi Bleed system with 30 psi pressure.

My experience is that such a pressure might be too much for the outer seal and this was confirmed by Nigel Maude: "the rear seal (pedal end) always tends to leak, and I should imagine a 30psi pressure on it would be overdoing because in normal operation there are only 2/3 inches head of brake fluid in the reserve cylinder".

I found a 10 psi pressure sufficient to do a proper job and in fact I found that a brake fluid supply bottle hanging about 1 metre above the car bonnet for feeding the master brake reservoir via a plastic tube gives the wanted result as well. Do not try the usual "pumping" procedure (pumping by means of repeated actuation of the brake pedal) for bleeding the brakes!

However, Ron Cromar, who has an 1800 Roadster, commented: "I find I really do need a good pressure [30psi] to get decent bleeding. I raise the car up on jack stands, remove all four wheels and put four containers in place with four bleed tubes. I go round from wheel to wheel, bleeding and re-bleeding until I can find no trace of air bubbles. My 5th Bleed nipple always contributes some small bubbles, so I think air does get trapped close to the banjo take-off point to the rest of the braking system".

By fitting a 5th bleeding nipple to the Roadster's Braking System (see the article written by Ron Cromar in the October 2011 Review) pushing air bubbles forward through the whole system can be avoided and I warmly recommend this addition.

The Eezibleed set comes with a number of adapters for connecting the pressurised Eezibleed reservoir to the master cylinder reservoir. Unfortunately none of the adapters fit the Roadster master cylinder but thanks to Mick George (see page 22 of the October 2012 issue of the Triumph Roadster Review) connectors made in aluminium are available at a reasonable price, in particular when considering the quality! So now all Roadster users can use the Eezibleed set for bleeding their Hydrastatic Roadster Brake system!

The Eezi Bleed set

and Mick George's adapter

With thanks to Ron Cromar for the prooffreading and some of the pictures!