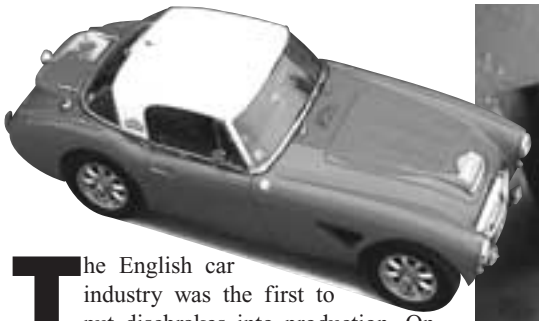
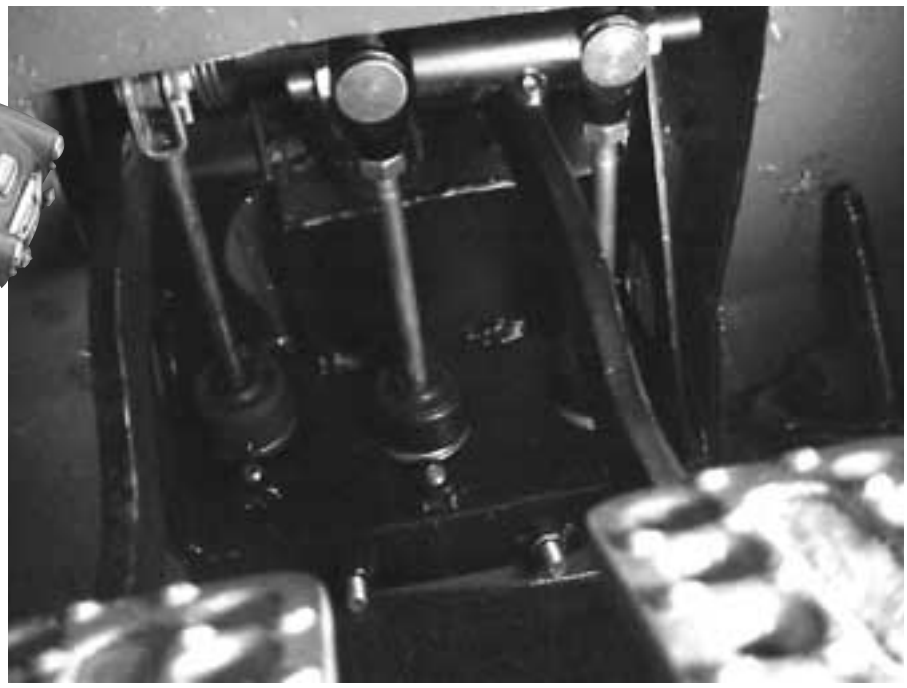
An article by Magnus Karlsson
e-mail 492karlsson@telia.com

UPRATED Brakes

This article is about 3000 brakes in general and how to modify them in particular.





Brake balance bar photographed in place. At the left in the photo the clutch master cylinder can be seen, then the pair of brake master cylinders and the balance bar adjusted with the longest stroke to the master cylinder of the rear circuit.

The English car industry was the first to put discbrakes into production. On the lOOS, discs were used on all four wheels as early as in 1955 but that was on a limited special series. The production model of the Healey got front discs starting with the launch of the 3000 MKI in 1959. The drum-brakes were being retained at the rear. The calipers used at the front were Girling type 14. To begin with there was no servo option. Starting with chassis no.15104 a BT7 MK II, a servo was listed as an option. Included in this option was a master cylinder with a larger bore. Beginning with chassis no.25315, the first BJ8, the servo was listed as standard. On the early BJ8: s the same calipers, servo and master cylinder, as on the early cars with this option, were being used. This was changed when production of the fully developed BJ8 was started , commencing with chassis no. 26705. Now Girling type 16 calipers, incorporating pistons of a larger diameter, were being used. At the same time the front stub axles were changed into handed pairs, with integral caliper adapters, which is of some importance for this article. The earlier stub axles were the same on each side with a seperate adapter for the caliper.

It is of course possible to modify the brakes, eventhough they are quite good to begin with. A simple form of modification is to use uprated pads. Up until now it has not been possible to get uprated pads for the type 14 calipers. The simple solution for this has been to get some uprated type 16 pads and reshape them with an angle grinder, so that they will fit the early calipers. AH Spares in England has recently started to market uprated type 14 pads. Uprated and racing pads has a much higher coefficient of friction than standard ones, which will

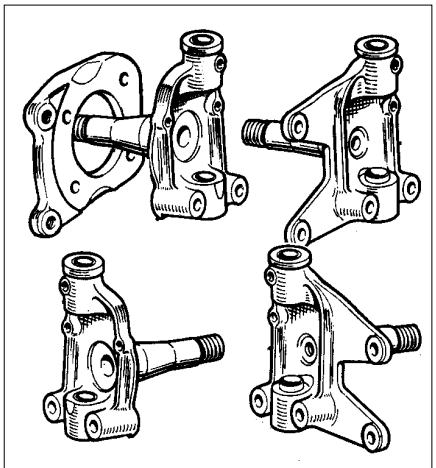
increase the braking force. For ordinary road use it is suitable to fit uprated pads only, since they don't require such a high temperature as racing pads in order to be effective. If full racing pads were mounted on a road car the braking would actually be less effective than with standard pads, since the correct working temperature would never be reached. There are more and further reaching possible modifications. On the early cars it is a good idea to change the calipers into Girling type 16. With these calipers an increased braking force is attained, thanks to the larger diameter pistons

Front caliper Girling type 14.

and the larger sweep area of the pads. Now it is important to keep the difference in stubaxles between the early and the late models in mind. When one goes out looking for the Girling type 16 calipers, one will find that they are not only quite hard to come buy but also quite expensive. Furthermore a pair of BJ8 stubaxles must be found, since the distance between the mounting points on the

Front brake pads. Early type to the left. Late type to the right.

caliper adapters are larger on the BJ8, than on the early stubaxles. -Lots of trouble and expensive! Now it happens to be so luckily arranged that there is one caliper with the same function and appearance as the BJ8 caliper, with the only exception that they fit perfectly on the mounting points of the early adapters. The caliper in question is the Girling type 16 Metric and it can be found rebuilt at various Healey specialists at a hefty price. Rebuilt ones can be found much cheaper at ordinary auto suppliers. The cheapest and in my opinion best way to get them is at a breaker. I have tried all three alternatives myself and found that the rebuilt ones both from specialists and ordinary suppliers were so poorly rebuilt that they had to be rebuilt again anyway. One caliper from a specialist was cracked and one from an ordinary supplier lacked the internal seal between the two caliper halves! If you go looking for the calipers at the breakers they were fitted to early seventies European Fords such as Capri, Consul and Granada. Keep in mind that they must come from models with unvented discs. On the early cars the discs themselves must be swapped into BJ8 discs. The early discs are to thin for this type of caliper. If you are the owner of a BJ8 and wish to upgrade further, you can obtain the Girling four pot calipers that were fitted to the Volvo 164. These fit the adapters on the BJ8 stub axles perfectly and the original disc can be retained. Another far-reaching modification is to fit discs to the rear. This modification is actually a little superfluous on the ordinary road car. There are some factors that speak for this modification though, among them our deeply hidden desire to own that really hot sportscar or the actual need for really good brakes that arises if the car is supposed to be driven hard at competitive events. Suitable are the Girling calipers that were fitted at the rear on Jaguar E-types and early XJ6: s. There are kits available on the market comprising of discs and mounting brackets, these are quite expensive. Unfortunately I haven't yet been able to figure out the make of these discs, they can probably be bought much cheaper and the brackets would be quite easy to make.



Early stubaxles to the left. They are the same on both sides. Seperate caliper adapters, same on both sides.

BJ8 stubaxles to the right. Handed with integral caliper adapters.

Early type front piston to the left, diameter 48 mm. Metric type 16 piston to the right, diameter 54 mm. Observe the different grooves for the rubber gaiter. The later type piston to the right, has a newer and more effective type of grove, that will neither fit with the original gaiter nor original caliper.

The change of the front calipers are done as follows. Dismantle the front calipers and the front hubs with the discs. Install the BJ8 discs on your old hubs. The new discs and the old hubs are a perfect match. The new discs are necessary, since they are thicker and that thickness is what the new calipers require. The thicker disc has its advantages, like being mechanically more durable and stable and able to dissipate the heat much better. For some reason Healeys that are driven hard seem to suffer more from overheated front brakes than other cars. When you are reinstalling the hubs make sure to check the splines and the hub bearings. Make sure that the play in the bearings is set to zero when the nut is tightened at the correct torque. The hub must rotate freely under these conditions. Trial fit the calipers, with the pistons in their innermost position. Often these calipers do not centralise correctly over the discs, the outer halves locates too far away from the disc. Measure the distance between each piston and the disc. Add the measurements and divide by two. Subtract the result from the largest measurement (the outer one) and you have the thickness of two shims that have to be made. The shims are ground to the correct thickness and placed between the caliper adapter and the mounting points of the caliper itself. When the shims are made the caliper can be permanently installed. After this it's time to make up new brake pipes that go between the calipers and the brake hoses. Keep the two female nipples and get two new male nipples of the dimension 3/16" and M10 xl fine thread. The female nipples fit your existing brake hoses and the male nipples fit your new calipers.

To install the rear discs, start by removing the hubs, drums, driveshafts, inner hubs, brake shoes and brake shields. The brackets for the calipers goes onto the same mounting points that carried the brake shields. In order to give enough place for the calipers these mounting points have to be ground off a little. When the brackets are in their place, the inner hubs and drive shafts can be refitted. The calipers have to be split before the inner halves are installed onto their brackets. The

disc and hub goes onto the five original wheel studs. The outer caliper halves are the last parts to install. The procedure with split calipers is necessary due to the fact that the disc covers the mounting points for the calipers and thus it would be impossible to assemble the parts without splitting the calipers. Among the few drawbacks with rear discs are that the above procedure calls for bleeding of the brakes everytime the discs have to be changed and that the handbrake becomes less efficient thanks to the mechanical calipers that it now operates.

Rear caliper from Jaguar E-type and early XJ 6.

If you now choose to take the car for a test drive, you will discover that the balance between front and rear brakes are messed up and thus makes driving the car quite lethal. The fact is that the rear brakes will lock up way before the front ones. -Not a very good situation. The same phenomenon that will be experienced by someone who has changed to rear discs and retained the early smaller front calipers. The only difference being that with large front calipers the symptoms will be worse. -Strange, how can this be? According to the laws of physics the braking force is supposed to be greater with larger diameter pistons. The force equals the pressure times the area, F = p * A. I have no good explanation for this. Only an empirical experience of what happens in reality. This does not mean that there is anything wrong with the formula above rather that other factors have to be taken into account. The readers with more knowledge in physics than me can probably provide a good answer. Myself I suppose that it has to do with the greater swept area of later pads, which would require a higher force in order to grip the disc. The larger volume of brake fluid that has to be moved may also play a part. The fact that the Healey is very heavy at the front may have an influence. Different brake pad materials clearly play a part. An example that deserves to be mentioned, is the new rear brake shoes that can be bought from certain suppliers. These shoes work perfectly with the early small caliper but not with the late ones. With the late calipers the same phenomenon with rear brakes locking first is resurrected. Something to watch out for, you BJ8 owners about to change your rear brake shoes. How does one deal with the faulty brake balance then? Preferably by first converting from a single circuit brake system, into a dual circuit system. Something that will facilitate, with the help of certain additional parts, the manual adjustment of the brake balance. It will also increase the general safety of the car. No car manufacturer today would even dream of putting a car equipped with a single circuit on the market. If you are about to convert to a dual circuit system it will be a good idea to replace all the old brake pipes at the same time. The original brake pipes were made out of steel and it can be very dangerous to drive around with these old pipes today. On a single circuit system it's enough with one pipe rusted thru somewhere and all of the braking power will disappear. Many brake pipe sets that are marketed today are made out of copper, they do not rust which is fine but they can become self-hardened. The self-hardening process takes place if the pipes are allowed to move or vibrate and this eventually leads to cracks in the copper. The best solution is to get a brake pipe set made out of steel as original. Make sure that the nipples also are made out of steel, since the ones made out of brass are too soft and can be turned round or easily loose their threads. What additional parts are used in order to set the brake balance manually? -Well you either go for a dual circuit master cylinder and a brake bias valve or you rebuild the pedal box to incorporate a brake balance bar. Let's take a look at the first alternative: The dual circuit master cylinder and brake bias valves are quite simple to install and they require no real alterations of the chassis. One drawback with this type of master cylinder is that if one circuit fails the other one remains but with a reduced degree of effectiveness. In theory this reduced degree of effectiveness shall be sufficient enough to bring the car to a halt. Use of the brake bias valve has the added drawback of restraining the flow to, in this case, the rear circuit, which results in the case of a fallout of the front circuit, in a further reduced rear braking capability. Reduced effectiveness by the fact that the dual circuit master cylinder only works on one circuit, plus an already restrained rear circuit will not give a very good result. I have myself experienced the loss of the rear circuit in a car equipped with this system. The remaining braking power in the front circuit was way too small to be able to stop the car safely. I have not been able to fully investigate the reason for this, but the fact that it happened is enough to keep me away from this solution. It is of course quite possible to install a brake bias valve for the rear brakes, on a single circuit system as well, but taking the reasoning above into consideration it is nothing that I would recommend. Now lets take a look at the other system with a brake balance bar, which will require some fairly big alterations to the chassis, especially on a LHD car. The biggest advantage is that it will in practice create two different brake systems in the car, one for the front and one for the rear. No system will be restrained as in the case with the brake bias valve. If one system fails the other will still operate with full effectiveness regardless of if it's the front or the rear system that fails. Each system has its own master cylinder, which implies that it can be looked upon as two systems instead of two circuits. This statement is not entirely true though, since both systems share the same brake pedal. The

construction of the brake balance bar allows the force that is transferred from the brake pedal to the master cylinders to be adjusted in accordance to the specific requirements of car and driver. In our case this implies an adjustment of the balance bar that distributes the longest stroke to the master cylinder of the rear circuit. If the bar is set as far as possible in this direction, one will find that it's not enough to compensate for the faulty brake balance, with the large type of front calipers. The next trick is to fit master cylinders of different sizes for the two circuits. I have found that a size of 0.75" for the front circuit is suitable and the standard size, for non-servo master cylinders, of 0.625" to be suitable for the rear circuit. With these cylinders a correct brake balance can be set. One rule of thumb says that the balance should be adjusted to give about 60% of braking power to the front and 40% to the rear. It is somewhat a question of trial and error before a suitable balance that will work is attained. With this system differences in pad material can also be adjusted for. In general it can be said that the balance never must be set so that the rear locks first, eventhough some rally drivers might choose such a setting for short and twisty special stages. If the braking power would be set higher than 60% at the front, one would not risk the same uncontrollable slides as when the power is set to high at the rear, but the braking distance will increase considerably, which can be just as dangerous.

Modified pedal box for LHD 3000. The picture depicts a pedal box without balance bar but modified to be used in conjunction with Webers. The pedal box with balance bar should be "cut" the same way.

How can a system incorporating a brake balance bar, best be installed? On a RHD car the process is quite straightforward. First you have to remove the pedal box and modify it. The modification comprises of widening it so that an additional master cylinder can be fitted. The shaft that the pedals attach to, is lengthened. The balance bar housing is welded to the pedal lever, in such a fashion that when the rods protruding out from the mastercylinders are connected to the bar, they will be 90° to the pedal lever and still aligned with the centre of the bore of the master cylinders. It´s an advantage to align the housing to the left of the pedal shaft, thus creating an inbuilt bias for the front circuit. This provides of course that the left master cylinder is used for the rear circuit. The brake box in the chassis also needs a slight modification. The sheetmetal surrounding the master cylinders are cut out. An additional notch for a master cylinder is added and the metal is adjusted to fit with the modified pedal box, before being welded back in place. On a LHD car the incision will reach even further. The brake box of the chassis is much narrower on the left-hand side than on the right-hand side, because of the cool air duct that passes on the left of the box. The box has to be widened by as much as the pedal box itself and the cool air ducting has to be removed permanently. The widening of the box is made in direction of the left-hand fender. The pedal box and brake box has to be cut in the front portion, in order for Webers to fit. The original pedal return springs will not fit the "cut" pedal box. New ones have to be manufactured When the modified pedal box has been reinstalled it's time for some new steel brake pipe plumbing. It is advisable to route the pipe for the rear through the firewall and on top of the inner sill, where the aluminium finisher will cover it. Drill a hole in the rear bulkhead and use the hole as a transmission point between brake pipe and hose. Move the brake pipe union from the right to the left. Attach it to the bracket that originally served to clamp the brake pipe. Use the threaded hole that held the union, to clamp the pipe on the other end. Route the front pipe as original but with the exception that it is attached to the top portion of the frame instead of, to the sides. This routing inside of the car and on top of the frame, is made for safety reasons. It is advisable to change all rubber hoses into ones braided with stainless steel as these have a greater resistance to abrasion and do not swell under high brake pipe pressures, thus giving a firmer pedal feel. If you don't already have a servo, now is the time to install one. It shall be installed only to operate on the front circuit. Suitable is the Lockheed "high knee point" type. Don't forget to test drive and adjust the brake balance after installation of the servo. The servo increases the pressure in the front circuit and therefore alters the balance. It is possible to run the car without a servo but the pedal will become very firm and one has to push the brakes really hard if something is supposed to happen.

Pedal box with balance bar for RHD car. Two master cylinders one for each circuit. One master cylinder for the clutch.

Brake balance bar assembly as seen from the engine compartment.