

RESTORING GAS-ASSISTED BETOR SHOCKS FITTED TO BULTACOS

By John Somerville

My previous article on restoring Betor shocks did not cover the gas-assisted Betor shocks as fitted to the late model Frontera Mk9, Frontera Mk10, Pursang Mk9, Mk10, late model Alpinas etc. Since then I have successfully stripped down and rebuilt several of the gas-assisted shocks and so far they work perfectly. This article will hopefully give you all the information you will need to completely rebuild your own Betor gas-assisted shocks. It does not cover the latter Betor gas shocks as fitted to the Frontera Mk11, Pursang Mk11 etc. which have the gas cylinders remotely mounted and attached to the main shock body with flexible tubes – although the theory may be the same.

The Betor gas-assisted shocks are an improvement over the earlier oil-only damped types which use a separate internal cylinder that contains the dampening oil and piston. On compression the oil is forced partly back through compression / rebound valves in the piston and also through valves in the base of the internal cylinder into the air space between the internal cylinder and the external shock body, where the air is compressed a little (by the volume of the shock shaft). On rebound the reverse happens, with the compressed air helping (a little) to push the piston back to its fully extended position.

There is not a lot of space inside these shocks for dampening oil (only 75cc ~ 85cc) which has to work very hard and as a result becomes hot, the viscosity rating drops and the shocks become under-damped and do not work optimally. The gas-assisted shocks overcome this problem by eliminating the internal cylinder for the piston and replacing it with a separate external gas cylinder mounted 'piggy-back' on the shock body. The main shock body is now completely full of oil, the piston sealing against the body itself. This results in three to four times as much oil being used in the shocks with the benefit of lower operating temperatures and better dampening. The piston contains all the compression / rebound valves.

On compression the oil in the shock body is forced mainly back through the piston but some (equating to the volume of the shock shaft) is pumped through a small tube in the base of the shock body, into the gas cylinder. Here it forces a free-floating alloy piston to move down the gas cylinder, which is charged with ~90 psi of nitrogen gas. On rebound this gas forces the piston back up the gas cylinder, which pumps the oil back into the shock body. The design of these gas-assisted shocks means they can be used in either 'right side up' or 'upside down' positions – the latter being preferred due to the reduction in unsprung weight (this cannot be done with the earlier oil-only Betors, which can only be used 'right side up').

To restore the gas shocks, firstly clean off all external grease and grime then clamp the shock in a vice, turn the spring preload adjusters to minimum, compress the springs and remove the cast alloy lock ring (under the top alloy shock mount). The springs can now be removed.

Next, invert the shocks in the vice and use an open-ended spanner on the lock nut on the shock shaft to unscrew the top cast alloy shock mount. The lock nut is probably well and truly corroded onto the shaft; this can be removed later with a bit of penetrating oil, heat, brute force and swearing!

Now unscrew the top steel plug on the shock body and **very** carefully remove the steel washer and oil seal below it (the oil seal may have to be re-used so don't damage it) then the alloy guide plug (below the oil seal). To do this temporarily screw the top shock mount back onto the shaft, then carefully wiggle / pull the shaft outwards, this will usually do the trick. If necessary a few light taps with a nylon hammer (directed away from the shock body) or pushing the shaft into the shock body (to pressurise the oil in the shock – if there is any!) will dislodge the guide plug. Once the alloy guide plug has been removed, remove a circlip from its groove about 1 inch down in the shock body (use circlip pliers with long, thin jaws bent at right angles to the hand grips that will reach the circlip), then the shaft / piston can be removed. Now drain all the oil out of the shocks (hopefully there is still clean oil in them and no water) and carefully clean and examine everything.

Make a careful note of any worn or damaged parts, there were apparently never any rebuild kits available for the gas-assisted shocks so replacement parts may have to be found or made. The main wear and tear seems to be on the shafts which may have become bent,

rusted / pitted and with worn or flaking chrome. You may be able to have the shafts straightened, re hard-chromed and precision ground but this can be expensive.

The Betor gas assisted shocks use an 11mm diameter shaft, so far I have not been able to find any 11mm chromed hydraulic steel rod that can be used to make new shafts with. If suitable replacement hard chromed hydraulic steel rod cannot be obtained then 11mm stainless steel rod can be bought from your local specialist metal supplier but it is not nearly as strong as genuine hydraulic steel rod and is more difficult to machine and is not recommended.

A better solution is to use hard-chromed 12mm hydraulic steel rod which can be purchased from specialty metal / hydraulic shops, various Bultaco dealers and maybe even auto wreckers for gas struts used to hold up tail gates on cars. Using 12mm shafts will require the external top steel plug and internal top alloy guide plug etc. to be reamed out a little to fit and 12mm oil seals etc. to be fitted.

Then all you need is a friendly machinist to cut the threads etc. on the new shafts. The outer shock body must not have any rust or dents in it or the piston will stick; if the body is lightly rusted inside a light hone may restore it otherwise it is useless – the piston will not seal properly, especially if the piston / ring is also badly worn or damaged - you will need to buy another pair of shocks in better condition! Perhaps your friendly local Bultaco dealer may be able to help with spare parts, or keep your eyes open on eBay.

There are three different designs of the top alloy guide plug that I have come across:

1. A short alloy guide plug 22mm long, as fitted to the shorter shocks as used on the late model Frontera Mk9 etc. On top of the plug is a 3mm thick flat steel washer above an oil seal which has a steel face on the bottom side (both are the same diameter as the I.D. of the shock body). The oil seal itself extends downwards 4mm below the steel bottom washer and is 18mm in diameter. Be very careful with this oil seal, you may have to re-use it, even if it is worn out, I have never come across another seal that even remotely looks like it. Under the oil seal is a recess machined in the top of the alloy guide plug for the main bottom part of the oil seal. Have this recess machined deeper and wider so a 22 x 11 x 7 oil seal can be pressed into it, directly below the original oil seal (a tight fit is required). If you fit a new 12mm shaft a 22 x 12 x 7 oil seal will of course have to be fitted and the original oil seal will need to be reamed out to fit the bigger shaft (this old oil seal becomes a scraper on top of the new oil seal). If the original oil seal is too badly damaged to be used, the hole in the top of the alloy guide plug only needs to be machined 7mm deep for the new oil seal. A new top washer can be made from suitable 3~4mm thick neoprene rubber sheet, over which the original top steel washer can be used. It only has to seal well against the outer wall of the shock body, the shock shaft is now sealed by the new oil seal in the top of the alloy guide plug. Alternately, an "O" ring can be fitted to a groove machined around the outside of the guide plug as per 3/ below.
2. A longer alloy guide plug 32mm long but in all other respects the same as 1/ above, as fitted to the Frontera Mk10 and Pursang Mk 9
3. A longer alloy guide plug 32mm long (same as 2/ above) which has an 'O' ring in a groove around it's outside. The top seal and washer are different too – the seal is 22mm in diameter and is much thinner than the previously described types. The washer (located on top of and same O.D. as the seal) is nylon on one side and steel on the other. A 6mm thick steel washer (with a recess machined underneath for the nylon / steel washer) and with a diameter the same as the I.D. of the shock body is on top of these and is held in place by the top steel screw-on plug. Machine the alloy guide plug as per 1/ above to fit a standard 22 x 11 x 7 oil seal under the original seal and washer. If a new 12mm shaft is being used, the top alloy guide plug, washer and oil seal will also have to be reamed out a little to fit the larger diameter shaft. If the original oil seal is too damaged to re-use it can be deleted (along with the steel washer above it), in which case the recess for the new oil seal does not have to be machined as deep, the top of the seal protruding up into the top 6mm thick steel washer. Or you could machine it even deeper to fit two new oil seals. I considered using and even bought genuine hydraulic oil seals / wipers but these are designed to work with a couple of thousand psi of pressure – far more than will ever be generated in the shocks and may not work as well as the standard replacement (rotational) oil seals due to a lack of pressure to ensure a constant seal. Consult your

local specialist hydraulic shop for advice (I use standard rotational type oil seals, which so far work perfectly).

The gas reservoir attached to the main shock body can be dismantled and checked / cleaned without too much trouble: Carefully tap off the end cap with a drift / hammer using a little heat if required. Inside you will see a screw-in steel plug with a hexagonal hole in its centre, and an air valve (same as on your car / bike wheels to pump up the tyres) screwed into another steel or alloy plug underneath it. If the shocks are still pressurised then take them to someone that can accurately measure the pressure – say an automotive air conditioning or suspension shop. Record the pressure (it should be ~90psi), this is a guide as to the pressure you should refill the shocks to. Use an extended reach socket to unscrew and remove the air valve, then make or buy an internal hex driver to fit and unscrew the top plug (again using heat / penetrating oil if required).

Under this screw plug is another alloy or steel plug (that the air valve screwed into) with an 'O' ring around its middle, that seals the gas into the cylinder. This plug can be removed by buying a long 8mm x 0.8mm pitch bolt (try a specialty fastener shop) screwed into the hole that the air valve used to be in and then pulling out the plug, using a little oil if necessary for lubrication. Next, screw the end plug (with the hex hole in it) back into the gas cylinder, gently clamp this end in a vice using alloy sheet on the vice jaws to protect the steel cylinder.

Heat up around the area where the bottom of the gas cylinder screws into the alloy casting and turn the main shock body to unscrew the gas cylinder. Once unscrewed (and cooled down) remove the 'O' ring and baffle plate from the bottom of the gas cylinder and clean everything. The alloy piston in the bottom of the gas cylinder can now be seen through the hole in the bottom, lubricate inside the cylinder with oil and then using a long drift or screwdriver carefully push the piston up the cylinder and out the top end – pushing out the top sealing plug at the same time if it is still in place.

There are two types of piston, a shorter style with one 'O' ring and a longer style with two 'O' rings. Clean the piston and plug and remove and replace the 'O' rings with new ones. I can't give the exact size of 'O' rings to use, there are so many different brands and sizes available, different ones from different suppliers; you will have to 'shop around' to find an exact fit. On some shocks there is a circular valve made of spring steel held in place by a nut on the bottom baffle plate below the gas cylinder.

If this is at all rusty, remove, clean and replace; otherwise simply clean out the cylinder, ensuring that the brass tube connecting it to the main shock body is not blocked and that the inside of the gas cylinder is free of rust and any damage. Don't forget to replace the tiny 'O' ring on the base of the air valves and also fit new valves if required.

The piston in the main shock body can now be disassembled, cleaned and checked for any wear and damage. Do not remove the piston ring (unless it is broken), you may risk breaking / bending it, simply clean out the ring groove and ensure the piston ring can rotate freely. Carefully reassemble the piston when you are satisfied that all is OK with it.

Now carefully remove the alloy and steel preload adjusters from the shock body, which are often corroded or jammed on with dirt. Soak in penetrating oil, use heat and a nylon drift and hammer to carefully loosen them and tap them off. File and sand smooth the inner face of the alloy casting so it will turn freely on the inner steel preload adjuster tube. Now clean all the external components of the shocks, I find a bead blaster does a great job (NOT a sand blaster which is too severe).

Before painting, the gas assisted shocks need to have the gas cylinder bottom baffle plate fitted in place with a new oil seal then the gas cylinder tightly screwed back into the casting, using a liquid Teflon pipe sealant to ensure there are no leaks. Screw the end cap back into the gas cylinder and clamp the end of the gas cylinder in a vice (with alloy sheet protectors on the vice jaws), then turn the main shock body a little at a time to screw the gas cylinder back in place (the reverse of screwing it out). Clean up any marks on the shock body / gas cylinder before painting. I use epoxy rust proof enamel spray paint for my shocks, it seems to work OK and dries very hard. Whatever you use though will still scratch and wear with use.

Now to rebuild the shocks.

Clamp the shocks in a vice, fit the spring preload adjusters then completely fill the gas cylinder with ~10 weight fork oil, place the bottom alloy piston in the gas cylinder (with the recessed side upwards) and carefully push it down to the bottom. The oil will be pumped through into the main shock body, eliminating any air bubbles in the process. Now add a few drops oil onto the top of the piston (for lubrication) and fit the top sealing plug and air valve and then the outer plug, doing it up tight (use a little grease on the thread so it won't rust on). Use a pump to pressurise the cylinder to ~50 psi then check for any air leaks – there must be absolutely none, either out of the top of the gas cylinder or down past the alloy piston through to the main shock body.

If there is a leak, replace the offending 'O' ring with a new one of slightly larger cross section; you may have to do this a few times to get it right. Now fill the main shock body with oil up to the level of the circlip groove, install the piston and shaft, pushing it all the way down into the shock body and then refit the circlip.

Now fit the top alloy guide plug and seals, washers etc. and ensure they seat inside the top lip of the shock body. Moving the shaft / piston up and down can help achieve this. Ensure there are no air bubbles in the shocks which will affect the dampening and that the shaft is all the way out when doing up the top steel plug (this is important). Approximately 250cc of oil is required to completely fill each of the shorter shocks, the longer shocks obviously require more.

Once the shocks have been refilled with oil you can re-pressurise the gas reservoir either with dry air or (preferably) nitrogen gas at ~90psi. A guide is that if you push the shock shaft all the way down into the shock and let it go, the pressure in the gas cylinder should just push it all the way out again. The shocks should compress with only a little effort but take more effort to extend them (do this without the springs fitted). You will probably need a few goes at this before you get it right – use dry air only until you get the dampening you want, then replace with nitrogen (if you want to). Once you are satisfied with the gas pressure, refit the black plastic air valve cover and steel end cap.

Next, refit the springs and spacer, rubber stop, lock nut etc. to the outside of the shocks and screw on the top alloy mount, doing everything up tight. The rubber stop on the shaft may be in poor condition and need replacing, if NOS rubbers are not available try the bike wreckers / auto suspension shops for suitable replacements.

The final thing to do is to check and if necessary replace the rubbers / galvanised steel tubes / washers in each shock mount at each end. The rubbers may be available from your friendly Bultaco dealer, local bike shop / wrecker or auto suspension shop, or may have to be made by machining suitable neoprene rubber rod to size. Suitable washers (if fitted) and seamed or seamless steel tube (hopefully of the correct I.D. and O.D.) can be obtained from steel suppliers, machined to size and galvanised.

Fit a small nylon cable tie tightly to the middle of the shock shaft, this will be pushed along the shaft when the shocks are compressed and will give an exact indication of the maximum travel of the shocks after use. If the cable tie has been pushed all the way to the end of the shaft then the preload is too light, you will need to increase the preload on the spring using the adjuster on the bottom of the main shock shaft (and vice-versa). Alternatively heavier weight oil can be used in the shocks.

A cable tie can similarly be used to measure travel on the front forks. The final thing to do is to fit a 30mm length of suitable inner tube rubber to the top end of the shocks covering the opening to the preload adjuster. This will keep out dirt / mud which will otherwise cement the adjusters in place, making adjustment very difficult.

Now to see how they work! Mount the shocks on your bike and adjust the preload on each, fire her up and go for a ride, re-adjusting the preload as required. After a good ride (longer if on the road), check the shocks for any visible oil leaks. It may well be a good idea to remove each shock separately to check for any air inside – take the spring off and push the rod in and out a few times; you will easily feel if there is any air and not enough oil inside.

Now is a good time to change the weight of the oil if required, drain the old oil out and refill with different weight oil to suit. Regularly replace the oil with use, more often if your bike is ridden on the dirt or raced, to keep the shocks in top condition.

The final step is to apply the appropriate 'BETOR GAS' decals to the shock gas cylinders, these are available from your Bultaco dealer.

The end result is a beautiful pair of shocks that will actually work well, be correct for your bike and save you a lot of money which you would otherwise spend on a new pair of aftermarket shocks.