Dampers – or shocks or shockers, whichever you prefer – are obviously important contributors to the handling of your car and the more sophisticated models are highly tuneable, some offering separate adjustments for high- and low-speed bump and rebound, although a combined adjustment for bump and rebound is more common. But you can can go further: **Stuart Woolley** *describes fine-tuning his Nitrons by revising the composition of the shim stacks.*

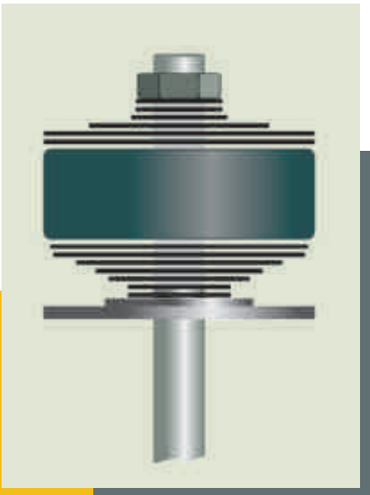

Fig 1
hardest valve stack

MANY INTERNET VIDEOS and write-ups discuss how to swap valve-stacks in a shock absorber to achieve a different ride, but there is very little public knowledge on the theory of changing shims within the valve stacks themselves to customise your suspension setup.

The original set-up on my Nitron shocks was unsuitable for my needs, and the cost of having them shipped back to the UK from Africa where I live, have them re-valved was a bit high – so I decided to have a go at doing it myself. Luckily, I've been re-valving suspension for motocross and enduro bikes for a few years, so I had some prior experience and knowledge. And I can say that the process was quite straightforward, and I am extremely happy with the results. With a bit of effort and the aid of this guide, you should be able to achieve the same!

SHOCK TACTICS

Let's start with the back-to-school basics before we get to the shock absorbers themselves, as certain things need to be right for the shocks to do their job correctly. The movement of the suspension arms needs to be as friction-free as possible for good suspension movement. Spherical bearings are the best, but nylon bushes can be very good and last for a long time, as dirt cannot make its way into the bushes very easily. With rubber-bonded bushes you are never going to have an ideal set-up. Also, your ideal spring rates will differ depending on your usage and your car weight. It's not good practice to have very soft springs and then try to compensate for a soft ride with stiff shocks, as the ride will feel harsh. On the other hand, having springs that are too stiff and shocks set too soft will result in a bouncy, uncontrolled ride. When set up correctly, you should be using all the suspension travel and on a fast blat the suspension should bottom out occasionally.

SHIM THEORY

Rather than being overly-specific about re-valving, this article will be more general – to keep it shorter – and will take you through how to change a valve stack to make it stiffer or softer, and how to adjust rebound and compression. It will also go over two-stage valve stacks for softer rides and more suited to lower speeds, harder rides for higher speeds, and how to pre-load shims in the valve stack.

Gaining a softer or harder set-up will require the shims in the valve stack to be replaced by shims of different diameter or thickness, or to add or remove shims to or from the valve stack.

Figure 1 is a schematic side-view sketch of the internals of a Nitron shock absorber. From the top, we have the nut and the rebound valve stack (each horizontal line representing a shim), then the main valve body (or piston), followed by the compression valve stack and the main bump stop plate. Both valve stacks essentially act as one way valves – allowing fluid to flow past in one direction, but providing much resistance to flow in the opposite direction. The main valve body will normally have four holes for oil to pass through for rebound, and eight holes to pass oil for compression.

Figure 1 will be very close to what a standard valve stack will look like in your shock. The many shims in the compression and rebound valve stacks result in a firm ride.

Figure 2 differs from Figure 1 in that the compression valve stack has an annulus near the valve, which pre-loads the first shim onto the valve. This will only allow oil to pass once it has reached a critical pressure, making the ride very firm over little bumps in the road and helps to stop the car from diving under braking, but it will act as normal over larger bumps.

The valve stack shown in **Figure 3** can be achieved by removing some large diameter

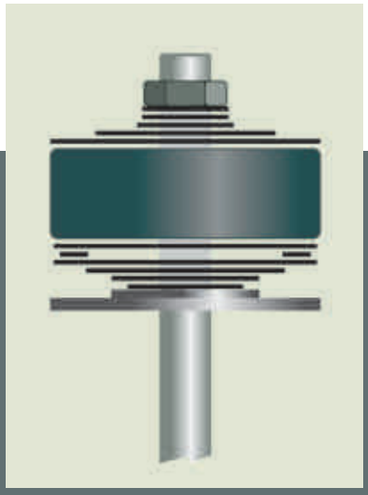

Fig 2
hard valve stack with pre-load

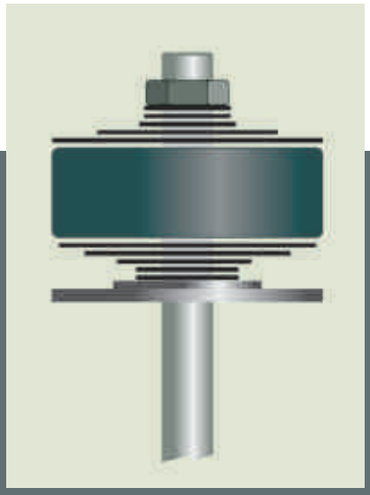

Fig 3
soft valve stack

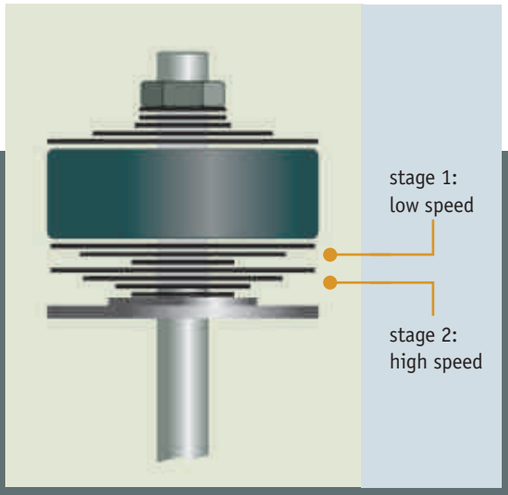

Fig 4
two-stage valve stack

Fig 5
Typical examples of shim stacks
with shim thicknesses shown in mm

relative stiffness	1st shim	2nd shim	3rd shim	4th shim	5th shim
hardest stack	**0.2**	**0.2**	**0.2**	—	—
harder	**0.2**	**0.2**	**0.1**	**0.1**	**0.1**
medium	**0.2**	**0.2**	**0.1**	**0.1**	—
softer	**0.2**	**0.2**	**0.1**	—	—
softest stack	**0.2**	**0.2**	—	—	—

shims, if there are more than one, and one or two intermediate shims. The resulting ride will be much softer. In the case that there is only one large shim and you want a softer ride, the shim can be replaced by a thinner one.

Figure 4 depicts what is known as a two-stage valve stack. This configuration can give the best of both worlds, as one stage is responsible for low-speed damping and the other deals with the high-speed damping. In the first stage, two or three shims are followed by one to three small diameter shims, and then the second stage can start with two or three large shims. The idea is that the first stage shims bend for slow-to-medium speed until they come into contact with the second stage – suddenly increasing the resistance to flow – at which point greater high-speed loads are required to bend the shims in the second stack. Changing the number of small shims in the centre will change the point at which the second stage comes into effect. When set up well, the two-stage valve stack will result in a smooth ride but with good resistance to bottoming out.

NOTES

It is very important to note that your first shim (the shim closest to the valve body) completely covers the holes on the main valve body to create a seal.

In all of the figures here, the small diameter shims next to the large bump stop washer on the shaft side, affect the high-speed compression. The compression shim stack should bend enough to contact it, and fitting more small shims will make high-speed action softer.

When removing shims from the compression stack to make it softer, you will have to make the rebound stack softer to keep the ratio balanced.

When replacing shims, you have to bear in mind that the thickness of a shim plays a major roll in the resistance to oil flow. For example, the resistance caused by a single shim of 0.2mm thickness is greater than two shims of 0.1mm thickness – it is actually more nearly equivalent to three 0.1mm shims. And the resistance of two 0.1mm shims is less than that of a 0.15mm shim.

To point you in the right direction towards getting a softer setting on a shim stack, I have drawn up a table, **Fig 5** (above) of shim stacks, with each stack being one step softer than the previous one:

Bear in mind that these will be for the main part of the shim stack which is located against the piston and do not include the several shims of reducing diameters that are also part of the valve stack.

Obviously the number of possible shim stack combinations – when you start to include shims of 0.15mm thickness and start varying the outer diameters of the shims – can be quite immense, but you will quickly

find that there is only a narrow region of combinations which will suit your car and your needs. To give you a true example, I'm using my front shocks with 300 lb/inch springs and the valve stacks I'm currently running with are shown in the second table, **Fig 6**.

My car is used on the road as well as track-days and gymkhanas (*something akin to our slaloms or autosolos in the* UK) and to me, this feels much better than the standard set-up. When I get some thinner shims, of 0.15mm thickness which allow even finer adjustment, I will dabble a bit more and see if I can improve things further.

Fig 7 shows the shock absorber adjustment valve, which is controlled by the adjustment knob on the bottom of the shock. When screwed all the way in, it will cut off the oil flow through the shaft bypass holes. When fully opened some oil can bypass the valve stack, resulting in a softer ride than when the adjustment valve is closed. If the valve stack set-up is too hard and the adjustment valve is open, the shocks will behave better at slow speeds, but will still feel stiff at high speeds.

The type of oil that you use is another tuning variation available to you. Most shocks will use shock oil on the range from 2.5w to 7.5w. Most motorcycle shops will sell good quality shock oils, which are where I get my products from. I only use 2.5w oil, as thinner oils move through the valve stack quicker, resulting in a more responsive and less harsh action.

If your shocks have a separate nitrogen canister, you will have to release the pressure before you strip them. As a tip, once your shocks are assembled and bled, you can use a small pump sold for mountain bike shocks to pump the canister pressure up to 10 bar for testing; once you are happy with the set-up, you can purge them with nitrogen.

I'm sure there will be a few places willing to sell you shims, but to save you some time, try out Racetech in the USA who can supply you with shims, shaft seals and bump-stop rubbers. You can see their range of shims and products at *www.racetech.com*

Note that Nitron shock absorbers use shims with a 12mm inside diameter.

DISMANTLING

If your car has been corner-weighted, mark the shocks so you know which one goes where when reassembling, and measure and record the spring lengths. Unwind the adjusting nut and remove wire clip. You should then be able to remove the spring seat and the spring from the shock.

Clamp the bottom of the shock in a vice–fitted with soft jaws, so that you don't damage anything. Use the tool shown in the **Fig 9** (a pin spanner–for my Nitrons I needed one with 6mm pins) to unwind the shock nut. Proceed to carefully remove the internal shaft.

Drain the oil and clean the chamber out with benzene, or a similar substance, which will remove any oil and anything suspended in the oil.

Remove the top nut from shaft, making sure the shaft remains upright. Using a long screwdriver or a thick wire, slide all the shims and piston off of the shaft, taking note of how the piston was mounted–as it will only work when mounted one way–and place, in order, on a paper sheet, **Fig 11**.

Fig 6
Example: shim stacks currently used by the author
Nitron front shocks with 300 lb/in springs, mixed road/track use
see text

compression stack	rebound stack
1 shim of 35 x 0.2mm	1 shim of 35 x 0.3mm
1 shim of 32 x 0.3mm	1 shim of 32 x 0.3mm
1 shim of 24 x 0.2mm	1 shim of 20 x 0.2mm
2 shims of 18 x 1.0mm	

Fig 8

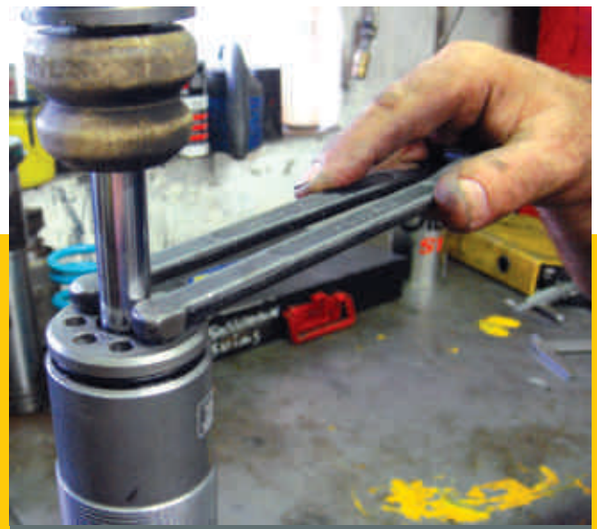

Fig 9
using a pin spanner to unwind the piston nut

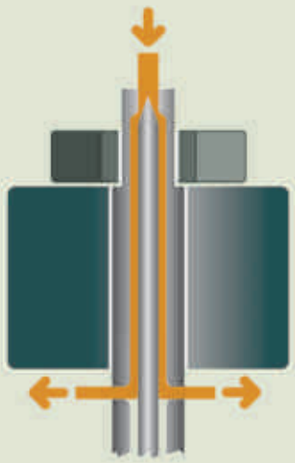

Fig 7
adjustment valve
see text

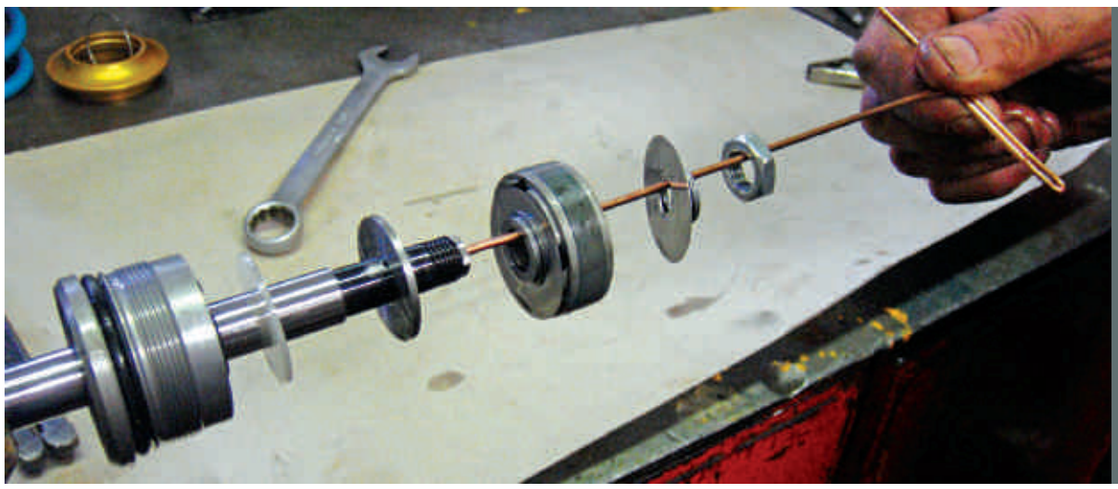

Fig 10
unthreading the components from the shaft onto a piece of wire or long screwdriver

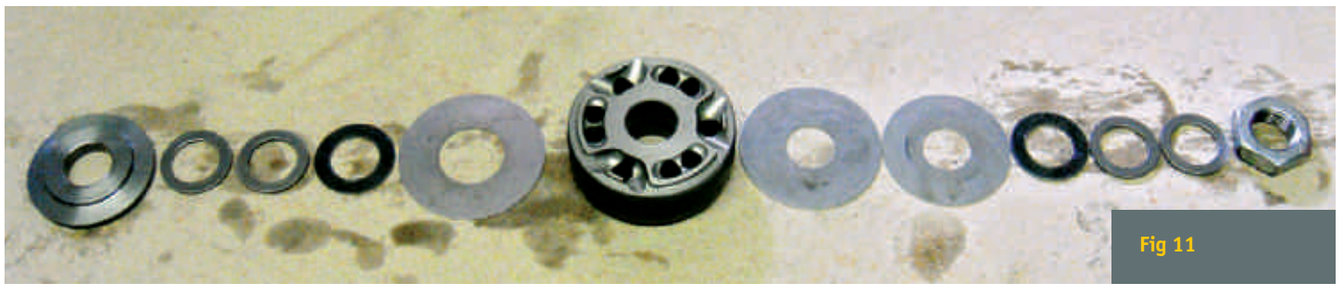

Fig 11

Fig 12
close-up view of the shims and spacers above and below the piston

Fig 13
tapping the shaft and piston assembly with a non-marking hammer to expel any trapped air from the oil

Fig 14
when raising the piston again within the body, take care not to allow air to sucked back in

Do not remove the piston seal nut from the shaft unless you are changing the shaft seal.

Laying all the shims and the piston in order simply helps you keep track of the sequence in which everything is placed, and makes it easier to identify where shims should be added or removed. In **Fig 11**, from left to right we have the bump-stop plate, spacer shims, compression shim stack, piston, rebound shim stack, spacer shims, and the nut that keeps the valve stack altogether. Make a list of the shims in each stack for reference at a later stage.

REASSEMBLY

In the correct order, slide the spacers, shims and piston on to shaft, followed by the nut, with one drop of blue Loctite.

For Nitron shocks, the nut should be tightened to a torque value of 18 Nm (13.3 lb.ft).*

Fill the body with new oil. Slide the piston into the oil, moving it up and down a few times with a bit of force to release any air bubbles. Raise the piston near to the surface of the oil, but do not let it come out of the oil as it will suck air into the system. Make sure the shock adjuster screw is turned all the way out.

Hold the shaft and tap the end of the shaft with a rubber hammer. This action forces oil through the valve stack and displaces any air that is trapped between the shims and within the piston. You will need to continue tapping the shaft until all the all of the air has been expelled from the system, while topping up the oil level when necessary (**Fig 13**).

Once all the air has been expelled, fill the oil up to the top of the chamber and slowly raise piston so it is level with the threads – about 20 mm down the bore (**Fig 14**). Be careful not to raise the piston too much or it will suck air into the system and you will need to purge it again, tapping with the hammer.

Still holding the shaft, slide the shock nut down the shaft and screw it into the threads. Oil should bleed out from the groove on the side of nut, which indicates that the system is completely full of oil, and does not contain any air. Do not over-tighten the nut, as it's the o-ring that seals the shock.

Place the bottom of the shock on a rag and push down hard to compress it until it hits the bump stop; then release it and let it return under rebound. Now do the same with the adjusting screw all the way in, and there should be a noticeable resistance under rebound and compression. If that checks out, adjust the adjustment valve to a position that will suit your needs; or try setting it halfway between fully-opened and fully-closed, then use it to fine-tune the shocks on the car.

A word of caution

This article is intended as a general guide only, and although it is based around Nitron dampers, the concepts should be common to many damper makes.

As always, before undertaking any DIY task on your car, **please ensure** that you are comfortable with undertaking it safely as we cannot accept any liability for problems which you may encounter.

*

We did take the opportunity to pass this text via Nitron's technical department for feedback. They made a couple of comments which should be taken into account when reading this advice…

"The torque value stated in this article for the piston nut is too soft at 18 Nm. We use 33 Nm (24 lb.ft).
Also the article does not mention what gas pressure to use – this is crucial whether for air or nitrogen."

Of mirrors and missing handbags

Mike Harley *recounts a tale of lost-and-found, the kindness of strangers – and a useful gadget…*

On a Club event a couple of years ago, I spotted a Caterham with a small additional mirror mounted on the windscreen. I spoke to the owner, who told me that he spends a lot time in southern France and that on returning to this country, often find himself struggling with a blind-spot when driving on motorways. He told me that this wide-angle mirror resolves the problem and has the added benefit of not vibrating as much as the door mounted ones do.

I traced the make, Stadium, and found that it is sold at Halfords for just over £4. It's meant to clip onto a sun visor to help you keep an eye on the children! After a year's use, I can say it's a great item – it helps you see who's in the outside lane, although it does takes a while to get used to estimating distances due the mirror's wide-angle curve. It is also a great help when reversing.

When I found the most useful mounting position, I fixed a piece of insulation tape to the screen as a reference, and this also prevents any permanent marks on the glass. As I had been told, the mirror does indeed remain stable at speed and the only real limitation I have found is that it can only be used when the hood is off.

The picture shows it fitted – you will need to accept my apologies for the filthy windscreen and the range of dead wildlife, but there is a story and a justification for this…

We had just had a very fast 40-mile run though the small vineyard roads around Chablis, much to the delight of the vineyard workers who had clearly heard us coming and were out on the roadsides, waving furiously.

Why the speedy run? Well, following a leisurely lunch beside the river, Kate had left her handbag – which contained our passports, documents and money – on the back of the car when she climbed into the passenger seat. Of course, it fell off onto the road as we left.

Luckily, it was found by a local lady, who took it to the restaurant, guessing we had eaten there. It was only when we arrived back at the campsite that Kate had what can only be described as 'One of Those Moments".

"My bag, where's my bag? Oh my God! – you'll have to go back. Go fast. Very fast. My life is in that bag!" So I did.

Much to our relief, the restaurateur had the bag and everything was intact. In the meantime, he had also contacted the Police, explained what the bag contained, given them our registration