GETTING TECHNICAL:

» 1. The best place to invest your money, is in a good quality rear shock.

WORDS: Dave Stewart
PHOTOS: Courtesy of Ohlins

SHOCK TREATMENT

» 2. The business end of a set of Superbike forks.

» SUSPENSION ON A RACE BIKE IS THERE FOR JUST ONE REASON, KEEPING THE TYRE CONTACT PATCHES IN A STATE OF OPTIMUM FRICTION CO-EFFICIENT WITH THE TRACK SURFACE. WE DON'T CARE ABOUT COMFORT, OR WHETHER THE SHOPPING IN THE (NON-EXISTENT) PANNIERS IS MANGLING ITSELF BEYOND ALL RECOGNITION, WE JUST WANT TO LAP A GIVEN STRETCH OF TARMAC AS FAST AS POSSIBLE.

Of course, there's a little more to it than that, such as giving us good feedback so that we have the confidence to use all of the available grip, but in essence we just want to go as fast as possible.

Many new racers think nothing of handing over thousands of pounds to sometimes dubious looking men with riffler files, cam dials and a pile of kit gaskets for an engine tuning job that is unlikely to make much difference to their results. However, if you suggest that they might be better advised to spend even half of that budget on decent quality suspension, they look at you as though you're ready for the special extra long sleeved jacket and a padded cell. I'm not suggesting that you won't be visiting the engine tuner at a later stage, but it's just a case of getting your priorities right.

You'll only use maximum throttle openings for around 40% of a lap at the very most on any circuit you'd care to mention, but the suspension works for 100% of every lap, at every circuit – therefore the gains to be had are much bigger. Good suspension will also ensure that you get the best performance out of your engine, tyres and brakes too, so it should be a complete no-brainer that your first investment should be in this area.

I know a lot of riders shy away from fiddling about with suspension, as they consider it to be some kind of 'black art' but to be honest

that's just a load of bull. If you are smart enough to fill in an ACU Licence application form, you're smart enough to understand suspension. You don't even really need to know exactly how it works (internally that is), you just need to understand what effect the changes you make have on your bikes handling and feel.

At the front end, unless you own a Bimota Tesi or a VT Britten, you'll find a fairly conventional set of front forks. Despite engineers banging on about the gross inefficiencies of the standard style front fork set up, no one has managed to better the basic design in over 100 years of trying. Hossack front ends and hub-centre steering are both theoretically better, but you only need to look at the front end on the most expensive race bike on the planet (Hondas RCV212) to see for yourself what the greatest engineers in the world decided was the best solution. It doesn't matter whether yours are upside down forks or the old style conventional ones, they all perform exactly the same basic function.

The internal springs allow movement of the fork tubes whilst the fluid and valves control the springs inherent desire to oscillate. If we start with the springs, these need to hold the weight of the bike and rider at a controlled and predetermined height, as we outlined in "Sharp as a Razor" in the last issue. Deciding on the correct springs, oil and air gap for you and your machine is pretty basic stuff. You want the bike to use as much of the available suspension travel as possible, but only at the absolute extremes of the bike (and your) performance envelope.

ALWAYS fit a 'witness ring' to one fork stanchion so that you know exactly how much travel you are using in each track session. As your riding improves you will inevitably need to change your suspension, as you will be pushing the limits much harder. At first those changes will be adjustments of your original set up, but later you will need to upgrade the actual components to deal with the extra forces that you are generating as your speed improves.

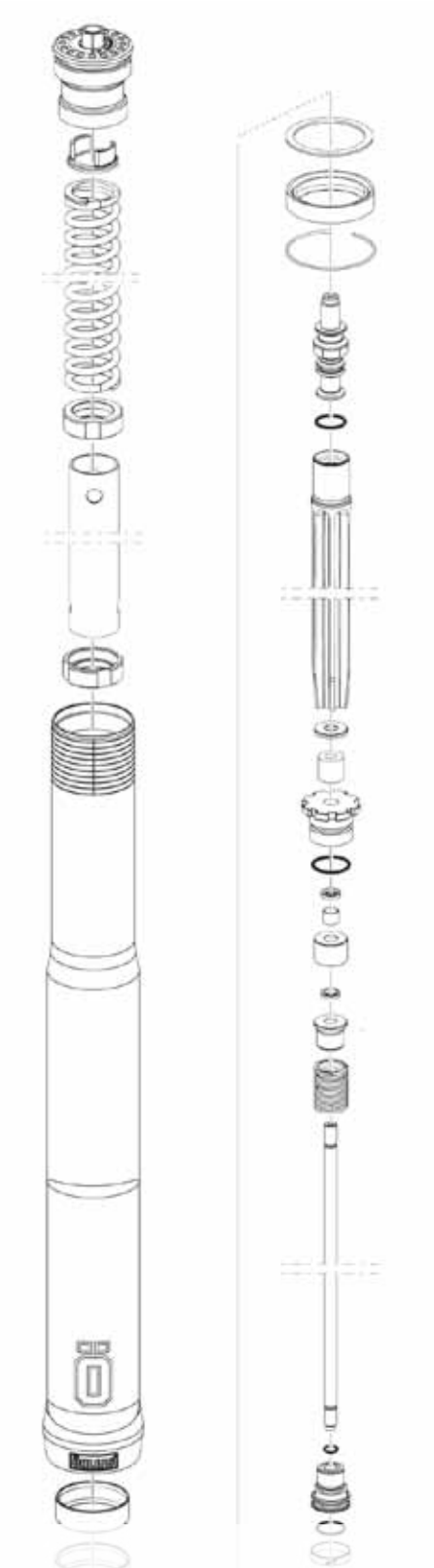
HOW IT WORKS

Every fork leg is a sealed system in its own right. A damper rod is connected to a piston that seals very neatly to the walls of the tube to create two sealed chambers – one above the piston and one below. In order to allow movement of the piston, there are apertures in the piston that allow the oil to flow from one chamber into the other as the fork is compressed or extended, in the same way as in the diagram of an Emulsion Shock Absorber. It is the control of this movement of oil that gives the 'damping' effect.

Once you have damping, you have to find a way of controlling it within the desired parameters. The very simplest way of doing this is by controlling the size of the holes in the piston and choosing the 'weight' and amount of oil that you are going to fill the tube with. When I say "fill" the tube, you never actually completely fill a tube, as a very important part of any standard front fork is the 'air' gap. The air gap is the amount of free space that is sealed in above the surface of the oil, this gives an extra element of compressibility, compliance and heat expansion room to the fork that oil alone cannot give. It was this presence of air that caused hydraulic fluid manufacturers to develop 'anti-frothing' agents that were added to suspension fluids to maintain their efficiency. As the technology moved forwards, air was replaced with inert gas as this is more resistant to heat expansion. Keeping the fluid in the correct heat range is key to having good suspension, so you often won't get optimum performance until 2 to 3 laps into any given session.

Even with the most basic suspension that has no external rebound or compression damping, there are things you can do to change the way your forks perform. The oil inside each fork leg has a specific "weight" which is an indicator of its viscosity. Viscosity is simply a measure of any fluids resistance to flow. Imagine that water is 1 and treacle is 25 on a sliding scale and you'll get an idea of how it works. Fill a bicycle pump with water and then compress the pump and it will take very little effort to expel the water through the small outlet, whereas if you try the same trick with treacle the effort will be far greater. It's exactly the same with oil as it increases in viscosity. Five weight oil is far less viscous than ten weight oil, which in turn is far less viscous than twenty weight oil. The oil has to go through valves inside the fork (just like the little hole in the end of the bicycle pump) and it is this oil flow that controls the progression of the fork tubes moving up and down in response to the bumps, cornering and braking forces applied to the front tyre.

So you see, there are two distinctly different ways of increasing or decreasing the damping in even the most basic model. You can make the control holes smaller (or bigger if you want to reduce damping) or you can leave the holes alone and increase the viscosity of the oil – thus slowing down the fluid flow. This is the basic tenet of all damping and although it has become a very refined science, it all boils down to closely controlling that oil flow to make the fork extend or compress in the manner required to keep the tyre in constant contact with the tarmac.



3. Don't drop this lot on the workshop floor!

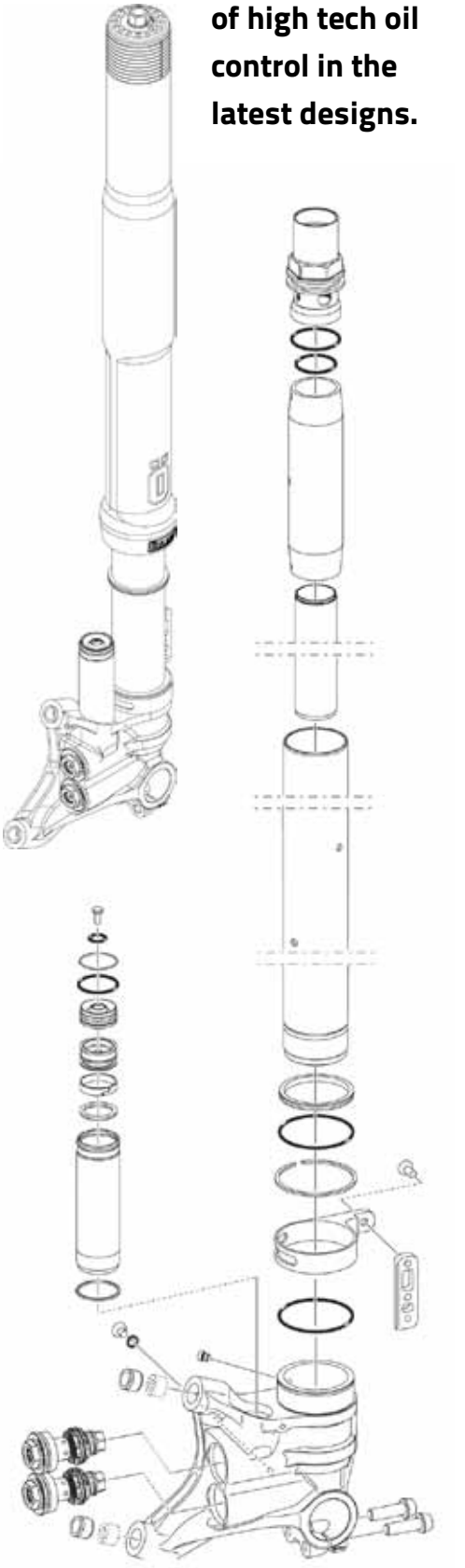
The next step was obviously to build in a means of adjustment without having to constantly dismantle the whole fork leg. Tapered needles sitting in the holes with fine screw threads were the first step in that direction. Screw the tapered needle into the hole to reduce the aperture thus increasing the damping effect, or unscrew the needle to increase the aperture thus decreasing the damping effect. That crude idea served to make an equal adjustment on both compression and rebound damping, because the same primary hole was being used in both directions. However, if you wanted to allow more damping in one direction than the other you would have to separate those functions and thus have one way valves or valves that flowed more easily in one direction than the other. It was at that point that the original shim stack was created. Early shim stacks distorted conically under higher pressures to let oil flow around the outside edges thus giving a secondary form of damping, now referred to as 'high speed' damping. Shim stacks and other internal control devices have now become extremely sophisticated, as demonstrated by the exploded diagram from the Ohlins manual. By separating all of those functions, you also enabled completely separate adjustment of compression and rebound damping and the modern 3 way fork was born.

You will see from the pictures of the latest Superbike forks kindly supplied by Ohlins, that the control and adjustment of every aspect of this oil flow has been analysed by technicians far cleverer than us, but you don't really need to know the intricacies of how it works, just have a basic understanding of why any particular change works in order to become competent at making your own adjustments.

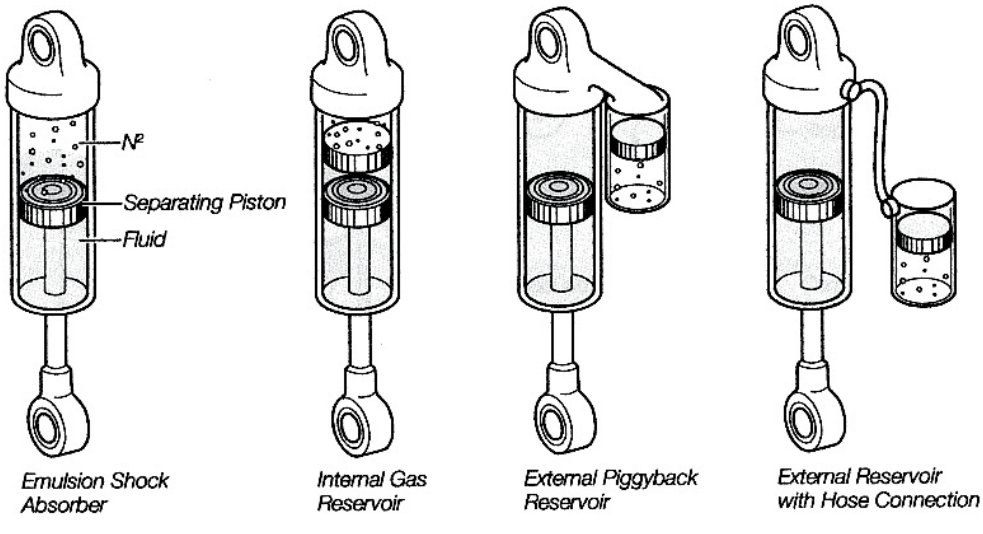
What you really need to know is how to identify the symptom and accurately relay that information to a technician, or to be able to make the correct adjustment yourself. Remember that once you have a set of good base settings, you should only be making one adjustment at a time and you should always write down exactly what you have adjusted.

The whole of the motorcycles setup can affect the front forks. So a perceived problem with the front end could be generated by a rear end problem. For example, front end 'patter' or 'chatter' – where the tyre feels as though it is hopping sideways as you enter the corner, perhaps trailing a little front brake – can be caused by the rear ride height being too high. You see the symptom in this case is probably related to the fact that the front fork is working too low in its travel and has reached the firmer part of its range too soon, but your task is to find out why that is happening.

4. There's an awful lot of high tech oil control in the latest designs.



5. Compression and Rebound adjustment made easy...



TROUBLESHOOTING

Symptom	Potential Solutions
The front wheel 'chatters" entering a corner, the problem goes away, as soon as you let the brakes off, or when you get on the power. **Possible Problem** The fork is working too low in the travel and reaches the progressive, hard part at the end of the travel. **Possible Problem** Rear ride height is too high, too much rear spring preload.	**Potential Solutions** - Increase preload. - Change to a harder spring. - If a lot of stroke remains after riding, drop the oil level. See oil level chart. - Make sure the front fork has no friction. **Potential Solutions** - Lower the rear end by taking off preload from rear shock spring. - Or by adjusting the rear ride height.
The front wheel is jumping during the last part of braking.	**Potential Solutions** - If a lot of stroke remains, the oil level is too high. Lower the oil level. - If the fork is bottoming, install harder springs and keep the same oil level.
The front end feels unpredictable and unsafe in the middle of the corner (between braking and getting on power).	**Potential Solutions** - Not enough rebound damping. Add more damping. - Too much rebound damping. If it at the same time feels harsh, reduce rebound damping. - Too much compression damping. Also gives a harsh feeling. - Reduce compression damping.
The front end loses grip coming out of a corner.	**Potential Solutions** - Not enough rebound damping. Add more rebound damping. - Too much preload. Reduce preload. - Rear end is too soft. Install harder rear spring. - Front end is too high. Lower the front end by pulling the fork legs through the yokes.

It could equally be that the fork springs are slightly too soft or that the air gap is incorrect, or that the compression damping is too soft but you have to start with changing one single thing. Once you've changed that single thing, write it down and ride the bike again. If the problem persists, put that setting back where it was and make a different adjustment, in this instance that could be increasing the front forks preload (remember to write it all down) and then ride the bike again. You need to work through your full range of potential solutions in order to find out the best resolution and that best resolution could involve more than one element of adjustment, so it is vital to keep written track of the changes you make and the effects that each one has.

Rear shock absorbers work on exactly the same principles as forks, but the units themselves look very different. Because most motorcycles are primarily made for road use, the rear end is generally much more of a compromise than the front end and is therefore where you will find the biggest immediate gains in performance if you change to a bespoke racing shock. For racing purposes you are looking at a much narrower window of performance and you don't have to worry about a pillion passenger, top box or luggage, all of which inevitably make any road-going shock absorber the Achilles heel of a modern bike. Your number one investment should be a good quality, well set up rear shock absorber. Anything between £350 & £800 for a new unit may seem like a hefty price tag, but that item will save you money on tyre wear every time you ride the bike and it will also make you more competitive as it will allow you to tune the handling of your bike to suit your particular style.

There is a seemingly baffling range of rear units available ranging from the very simple Hagon twin shock units as fitted to many of the Thundersport 500 machines, right through to the latest Ohlins TTX MkII multi-adjustable mono-shock. A nice quality rear unit should be equipped with 3 way damping and a variable length option. Beware! – very small changes in the shock length make big differences in both ride height and weight bias, so be very careful when making adjustments. A centrally mounted mono-shock is generally considered to be the best engineering solution, but every now and again you will see alternative thinking, such as Brian Crightons Norton NR588 rotary racer, which had an outboard mono-shock to get it into the cooling airstream. As strange as that set up may have looked, it actually worked surprisingly well. Some of the best modern front fork cartridge kits often have compression adjustment on one leg and rebound adjustment on the other leg, so just because something appears at first glance to be an oddity, it doesn't mean it won't be extremely effective.

As mentioned above, every change to one part of the suspension or geometry will affect the whole set up. The whole art of setting up a road race motorcycle is in getting the whole machine to work as a harmonious unit, giving good grip and feel on corner entry, stability mid-corner, good drive on the exit and giving an overall feeling of confidence in the rider.

We have inserted a small table of common problems and possible remedies here, but this is only a wide view starting point and as you get a feel for what effect each adjustment has on your machine, you will expand it exponentially. Remember there is always help at hand in the Thundersport GB paddock, so if you come across a problem you can't solve a visit to the trade area where you will find the JHS suspension service will no doubt assist you.

» 6. A rider looking down at these poking through his top yoke, knows he has the best in the business.