

Technical- Dampers

Dampers play a key role in a car's ability to ride well and to corner and brake efficiently. They have taken many forms over the years - here we look at some of the types used on Jaguars.

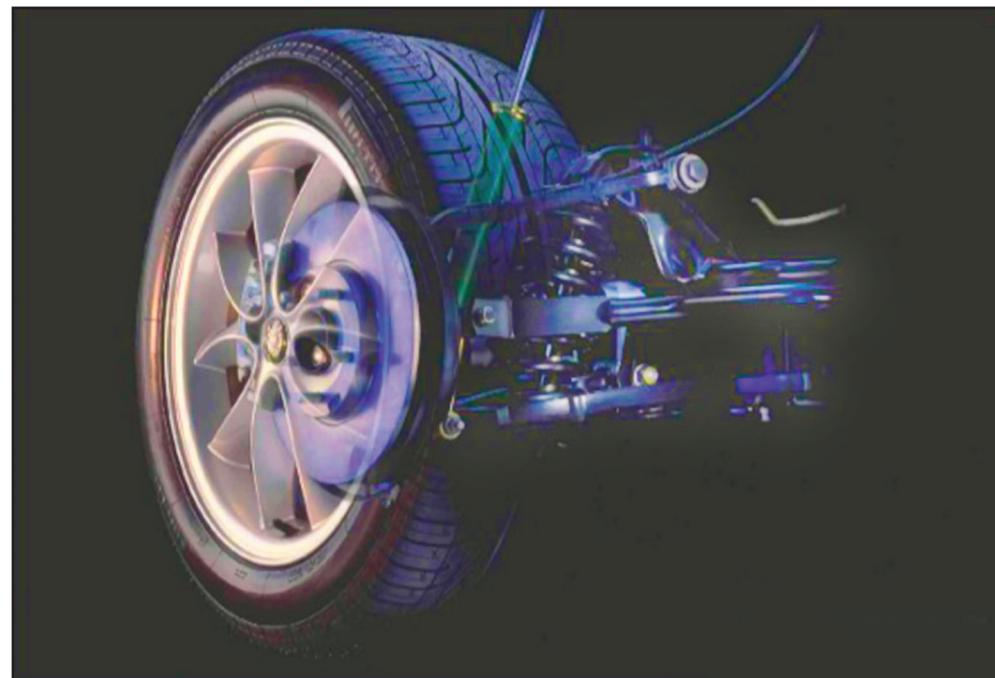
What Do Dampers Do?

Contrary to popular belief, a car's dampers do far more than help provide a comfy ride; in fact, their most important function is to ensure maximum grip between the tyres and the road under all conditions, but especially when braking and cornering.

Springs do a great job of soaking up the bumps in the road, but without an effective way of controlling that movement, not only would the passengers need sick bags, but the tyres would spend most of their time up in the air rather than gripping the road - the heavier the hub/wheel/tyre combination (unsprung weight) the more it wants to bounce around.

There is also the need during cornering to transfer as much force as possible to the outer wheels and resist the centrifugal force that wants the car to slide sideways.

Dampers allow the suspension to work in a controlled manner so that should a bump cause the wheel to rise and the



Shown here is a conventional damper (the green tube) in-situ as part of an X308 front suspension assembly. Picture: Jaguar Cars.

suspension compress, the car's weight is then able to push it straight back down as soon as possible. Similarly, when a car enters a corner, the dampers allow it to roll slightly and transfer weight, but also make sure that most of that force still acts on the tyre rather than being soaked up by the spring.

Under Breaking

Perhaps the most important function of the dampers, however, is to ensure maximum grip under braking, as the brakes are applied much of the car's weight is transferred forward (more than 80 per cent of braking is done with the front wheels).

It is vital that as much as possible of this weight bears down on the tyres - this is done by resisting both free compression of the front springs and the tendency of the wheel/tyre to bounce over irregularities in the road.

Damaged Dampers

Worn dampers may not be noticeable during normal driving but in event of an emergency stop they can, in fact, double the car's stopping distance, and so turn a near miss into something a lot worse.

Conventional dampers

Almost without exception the vast majority of modern dampers consist of a steel tube, usually linked to one of the suspension arms and filled with oil, in which a piston, mounted via a steel shaft to the chassis/body, moves up and down as the suspension compresses and then extends. A valve within the damper controls the rate at which the oil can



Computer Active Technology Suspension (CATS), introduced with the XK8, used dampers that could switch between hard and soft settings. Picture: Jaguar Cars.

Technical- Dampers (cont)

bypass the piston effectively restricting the speed with which the suspension can move. The shaft is usually made from polished hardened chrome and runs in a seal to prevent oil loss.

By varying the size of the fluid port, the degree of damping can be tuned to the needs of the car — It is even possible to have different damping rates for compression and rebound.

Gas Dampers

Gas dampers follow the same basic design but add a chamber filled with high pressure gas to exert force on the oil and prevent the formation of bubbles as can happen when a corrugated road causes the piston to cycle up and down at high speed - this is detrimental as the bubbles can then bypass the piston much faster than the oil would have done.

Self-levelling

For the high-end models of the original 3.6 litre XJ40 range, Jaguar elected to fit self-levelling suspension in order to maintain a constant vehicle height regardless of the total weight carried.

By fitting a height sensor, weaker coil springs and special dampers at the rear, charged with oil pressurised via an engine driven pump and accumulator, the ride height could be adjusted as necessary, though with the obvious drawback that the heavier the load the stiffer the suspension would be, so meaning a corresponding deterioration in ride quality.

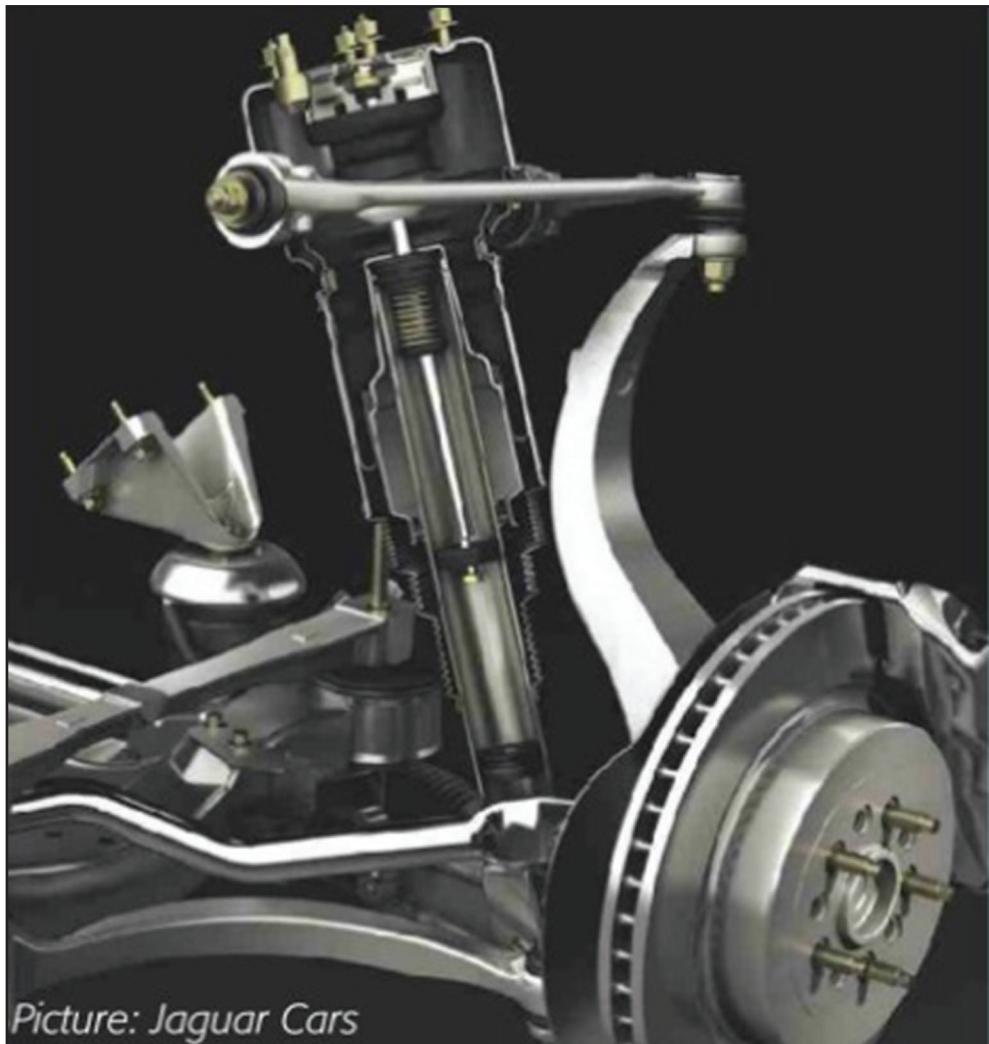
In the end, although the system worked reasonably well, reliability issues and the cost of replacement parts meant that virtually all of the SLS equipped cars still on the road have been converted back to standard suspension. The system did remain an option on post- 1989 cars but was rarely taken up, though it does seem to have been fitted to all VI2 XJ40s.

Computer Active Technology Suspension (CATS)

One of the biggest problems with conventional dampers, and for Jaguars especially, has been the inevitable compromise between crisp handling and a soft ride.



Unsure if your Jaguar has CATS? Just have a look at a suspension mount. If there is a lead from the top of the damper, CATS is fitted. *Jaguar Cars.*



Picture: Jaguar Cars

Computer Active Technology Suspension (CATS), introduced with the XK8, used dampers that could switch between hard and soft settings.

Technical- Dampers (cont)

Remotely adjustable dampers are by no means a new idea; Armstrong developed an aftermarket system back in the '60s, and by the late '80s several Japanese companies provided hard and soft settings via a dashboard switch, but invariably the driver would leave them permanently set one way or the other, negating any benefit.

What sets the Jaguar system apart from the rest (it was introduced with the XK8 in 1996, initially as an option on the coupe only) is the ability to switch automatically from soft to hard and back again as the driving conditions require.

The Computer Active Technology Suspension (CATS) system comprises four electronically switchable dual mode dampers, together with an ECU and various sensors (some shared with the ABS/stability control) to monitor acceleration, braking, engine revs, gear selection and even cornering forces via a sensor on the steering column.

During normal relaxed driving the dampers default to the soft setting but should the ECU determine that the

driver is pressing on they will instantly switch to the hard setting — for example when the front of the car drops under heavy braking or the car enters a corner at high speed.

Air Suspension

With the change to aluminium construction for the X350 in 2003, the chassis engineers faced a new challenge; with reduced bodyweight, the payload capacity of the car became a greater proportion of its overall weight when fully loaded. This would not be a problem on the forthcoming XK sports car, but in the XJ the combined weight of five passengers and a boot load of luggage would require conventional springs so stiff that the unladen ride would be ruined. The solution was to ditch the springs, take a conventional damper (standard or CATS) and encase it within an outer chamber filled with compressed air, the pressure of which can be adjusted to maintain a constant ride height. Unfortunately, the method of construction means that when one part of the airbag/damper fails the whole assembly must be replaced.

Adaptive Dynamics

For the 2010 Model Year, Jaguar re-engineered the CATS system with Bilstein dampers that are now continuously variable between hard and soft settings. The control system was updated and has the ability to predict roll and pitch (via the steering wheel, accelerator and brake), so that the internal valving can be adjusted in readiness to limit roll before the movement even takes place.

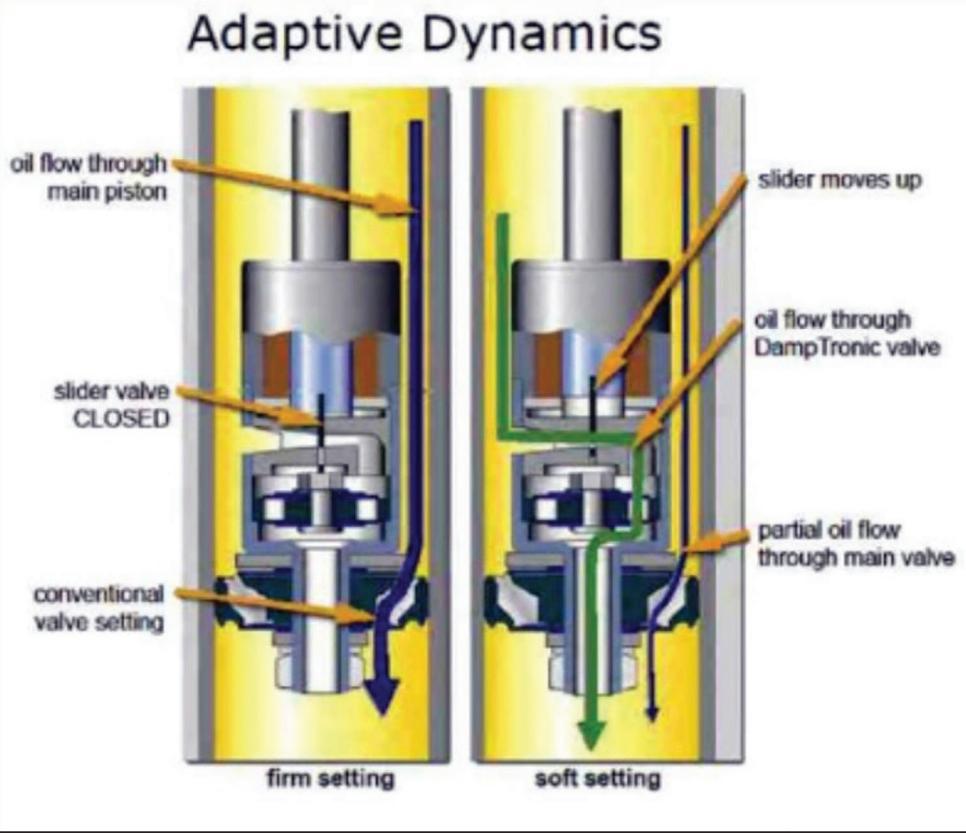
In addition, by monitoring each wheel position independently up to 500 times a second, road induced body motion can also be countered — for example to reduce pitching where there is a hollow in the road or when going over a hump-backed bridge.

Following criticism of the X350's low-speed ride, the new X351 XJ has conventional steel springs at the front and air-springs only at the rear where the greatest weight changes occur.

Testing

While there are sophisticated machines able to measure precisely the performance of conventional oil/gas dampers, a basic check-up can be performed at home whenever you service your car.

Start with a thorough visual inspection. Look for any signs of oil leakage, no matter how slight, as well as damage to the polished chrome shaft or deterioration of the mounting bushes. Then, with the car parked on level ground, pick a corner and use one knee to build up a rocking motion in the body, before letting go and counting how many oscillations occur before the car stabilises — ideally it should stop moving as soon as it has risen back to the normal ride height, though one full oscillation is acceptable. Anything more, especially when the car continues to rock in ever decreasing movements, means that the dampers are not working effectively and should be replaced. Repeat the procedure for each of the three remaining dampers. ■



Introduced with the 2010MY, initially on the XKR and XFR only, were Adaptive Dynamics dampers - unlike the CATS units, these can provide infinitely adjustable damping rates between too soft and hard extremes.

Editor: Information sourced from the Jaguar World (Garrett Coomber) and Jaguar Cars.