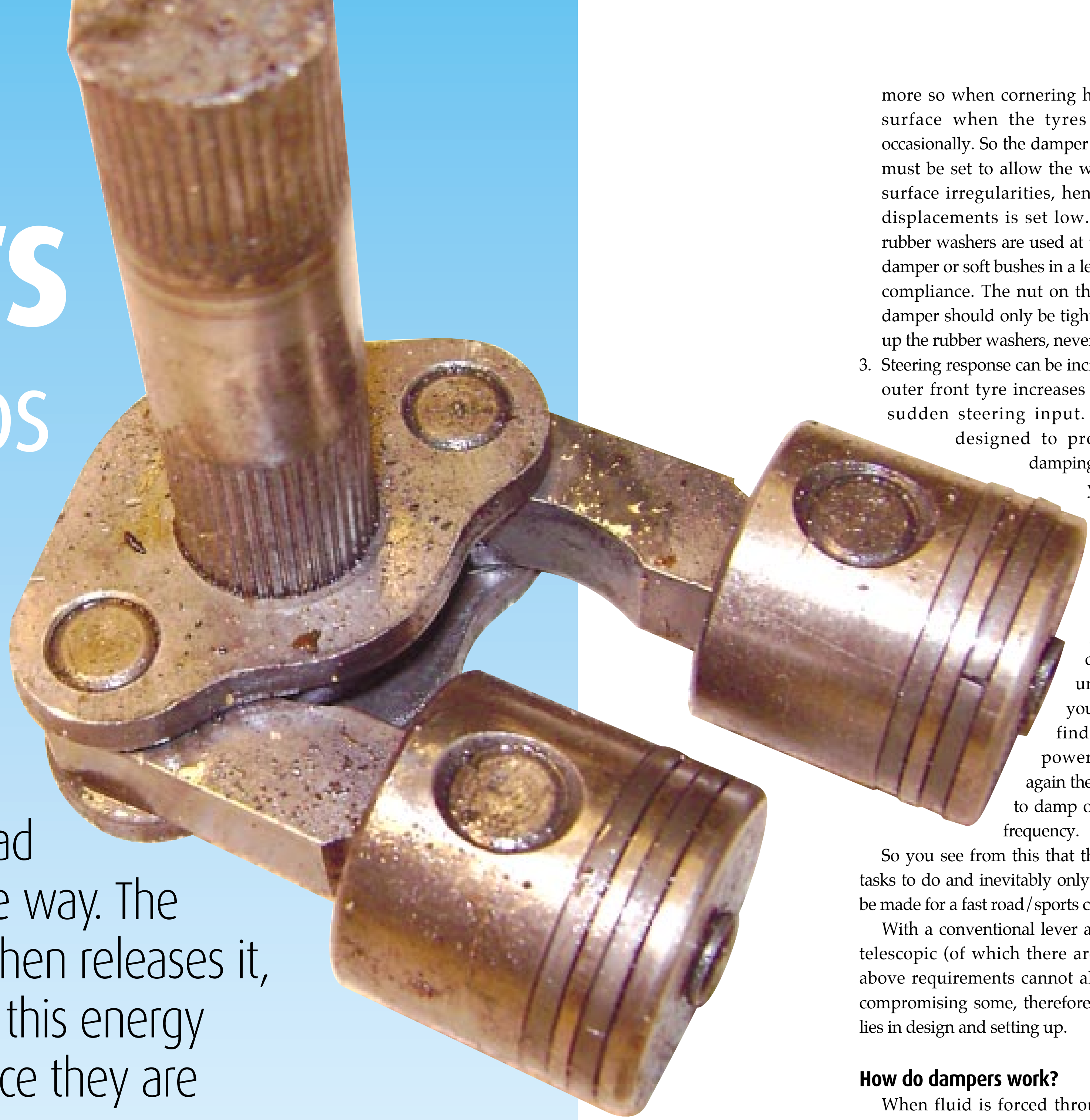
Dampers

...or what stops you bouncing



Many of you will know dampers as *shock absorbers* or *shocks* or *shockers*, but it is the springs that absorb the road shocks by deflecting out of the way. The spring stores the energy and then releases it, the damper converts some of this energy from the bump into heat, hence they are called dampers.

Dampers perform many tasks, four of them are:

1. To manage the continuation of bounce or pitch of the car after going over a bump or pothole, thus the car does not oscillate much after the event.
2. To maintain the tyre in good contact with the road.
3. To manage the increase in load on the outer front tyre as one 'piles' into a corner assertively.
4. To manage roll motion in fast lane change manoeuvres.

So what is required to accomplish these tasks?

1. Oscillation of the car after a bump or pothole is uncomfortable and can induce "sea sickness." While less so in a Morgan, it can still be quite unpleasant if the rear end continues to bounce after a bump. One feels these suspension inputs primarily through the seat. The road forces the axle up and the mass inertia of the car resists it. The input can be very large, so if the bump rate is too high one will really feel it through the seat, whilst the loads on the damper and its mounts can be so high as to risk failure. The return of the axle after a bump is only achieved by the springs, so even if the damping on rebound is high the forces will always be less than in bump. Thus dampers are set with the rebound/extension rate around three times greater than the bump/compression rate.
2. Tyre contact with the road is obviously essential, no more so when cornering hard on a very uneven surface when the tyres may skip sideways occasionally. So the damper (and springs and tyres) must be set to allow the wheel to quickly follow surface irregularities, hence damping for small displacements is set low. Often soft or voided rubber washers are used at the top of the telescopic damper or soft bushes in a lever system to allow this compliance. The nut on the top of the telescopic damper should only be tightened sufficiently to nip up the rubber washers, never to compress them.
3. Steering response can be increased if the load on the outer front tyre increases rapidly when there is sudden steering input. Thus the damper is designed to provide high levels of damping at the rate of roll when you apply steering at speed.
4. Roll damping is important and undamped roll would show up as wallowing going into or out of a corner. This can be very unsettling for the car as you are either working to find grip in the corner or powering your way out. So again the dampers need to be set to damp out these modes at their frequency.

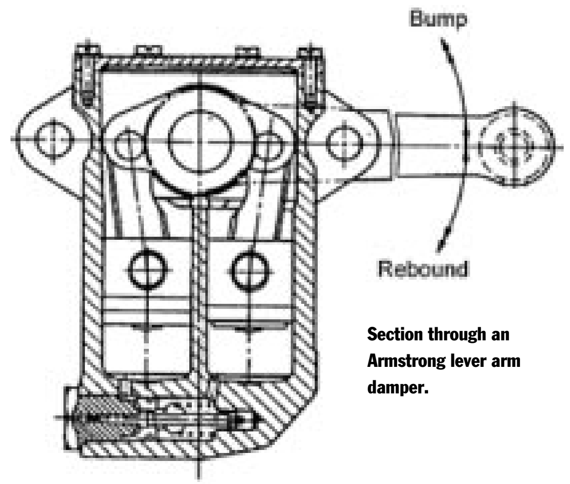
Valve assembly removed and complete

So you see from this that the dampers have many tasks to do and inevitably only good compromises can be made for a fast road/sports car or for a race car.

With a conventional lever arm (e.g. Armstrong) or telescopic (of which there are many) dampers, the above requirements cannot all be achieved without compromising some, therefore, this is where the skill lies in design and setting up.

How do dampers work?

When fluid is forced through an orifice there is resistance, and the smaller the orifice the more resistance. Fluid has many properties; the two of most relevance and use are viscosity and density.



Section through an Armstrong lever arm damper.

Viscosity is easy to understand. Consider how thick oil is compared with water.

Density is also easy to understand. Oil floats on water so is less dense than water.

Both these fluid properties are made use of in dampers, but both have their own benefits and down sides.

For low flow rates the fluid property that is important here is viscosity. The fluid resistance then is in direct proportion to the flow rate. However, viscosity changes with temperature. It gets thinner as it warms up and thicker in cold temperature and hence the damping would vary with temperature and use, not good!

For high flow rates the fluid property that is important here is density. The fluid resistance is proportional to the 'square' of the flow rate. So double the rate and the resistance goes up four fold. Density of oil changes very little with temperature so it is useful to make use of this property.

Dampers are designed to make use of both these properties, indeed they have to be. The density related property is used as much as possible to ensure consistent performance over wide operating temperature ranges but then the fluid viscosity property can not be avoided so also has to be incorporated in the design. In some older damper designs the fluid viscosity was relied on almost entirely so that changing the oil from thin to thick could increase the damping.

Dampers resist compression and extension by forcing oil through small orifices. At certain preset pressures relief valves open to allow more fluid to flow to slow the force build up particularly during bump. However at ever increasing bump velocities the relief valves can no longer cope and the forces build again resulting in a back jarring thump. The resistance before the relief valves open is preset by most manufacturers except, at least, Koni.

Damper Types

There are two types of dampers fitted to 'traditional' Morgans, 'lever arm' and telescopic.

The 'lever arm' dampers were made by Armstrong and supplied to many British cars. Morgans used them as rear fitments into the 21st Century. When in good condition these dampers work quite well. They can overheat with race use but their big failings are leakage and wear. The shaft that joins the lever to the internal pistons is carried by the casting and so this can wear and also the seal that keeps the oil in and muck out weeps thus lowering the oil level and causing the bearing to run dry. The biggest problem that limits their life though is internal wear. There is about a 10:1 ratio between rear axle movement and damper piston movement. Thus with stiff springs and normal driving the internal pistons only move by 0.1 inches, thus the bores wear locally and allow oil to bypass them, thus reducing the damping effect. This can be checked on and off the car. To check on car, remove the short rubber bushed link. Work the lever over its full range in both directions repeatedly. If you can feel a soft section about where they normally operate then this is the sign of wear, and one may try to compensate for this wear, buy rebuilt units, or succumb to fitting adjustable telescopic dampers. Self rebuilding is for most of us out of the question, as the lever is very difficult to remove from the shaft without damage. However there are a couple of ways to extend the life if the level of damping has dropped off:

1. Replace the hydraulic fluid. Drain the fluid and then flush out with 'white spirit'. From new, the hydraulic fluid was SAE20, but trying one grade more viscous, e.g. SAE30 will partially negate some of the effects of the worn bores. Obtain suitable oil from a motorcycle shop as many motorcycle dampers are rebuildable and designed to be predominantly sensitive to viscosity rather than density.
2. Adjust the bump and rebound damping. As per the diagram below, the valve assembly can be removed. Once the damper is removed from the car it is possible to orientate the unit so that when the valve assembly is removed no oil is lost. Both the bump and rebound relief valve blow off pressures are set by compression coil springs. Since the compression damping is adjusted by the thickness of the shims under the larger coil spring, adding a shim or two will produce a noticeable effect on the bump damping, and will control the severity and frequency of the impact of the top of the differential on the parcel shelf. The rebound damping is set by the nut on the end of the longer, smaller diameter spring. This nut is prevented from rotating by a blob of soft solder, easy to remove enough to free the nut and easy to redo, but one must degrease first. A turn on this nut will give a noticeable effect on rebound damping. Make sure you adjust both sides the same. A good comparison is to clamp both in a vice back to back, then pull hard on the levers simultaneously with a hand on each and feel how matched they are, I set up a pulley system with a 56 lb weight so that equal load could be applied to both so I could observe the differences.

There were two special Armstrong lever arm dampers made: *Adjustaride,* that enabled adjustment on the unit and *Selectaride,* that enabled remote damping selection from the dashboard – both versions sought after by the race boys.

Telescopic dampers have been fitted for decades for the front suspension and to the rear suspension by the factory for a decade or so, though earlier by the race boys. Telescopic dampers to fit Morgans are available from many, including: Spax, AVO, Bilstein, GAZ, Sach, Leda and Koni. Depending on the manufacture these are either nonadjustable or adjustable. For up to fast road use single adjustables that soften or firm both bump and rebound damping together are mostly favoured, though for racing dampers whereby the bump and rebound damping can be adjusted independently are often used.

Basics for setting dampers.

As stated earlier, rebound damping is typically set around three times harder than bump damping and in most telescopic dampers these have to be adjusted at the same time. Set bump damping sufficiently hard to prevent the differential hitting the parcel shelf and the front bottoming out over the sort of big bumps one can expect. Then set the rebound damping to control oscillations after a bump or pothole. One way of getting close before a road test is to kneel on the rear bumper or rack to compress the suspension, and then get off. The rear of the car will rise and should only just go beyond normal ride height. With occupants and luggage it will then oscillate a bit more, but this is a good initial setting. If there is too much rebound damping there is a risk that the rear of the car will jack itself down over a series of bumps as the rear suspension will not have enough time to return before the next compression. Avoid this!

This then covers the basics. Well selected and correctly set dampers can provide a good ride and good handling and just takes a bit of nerve to have a go!

Peter J Ballard. BSc. (Automotive) CEng MIMechE.

Valve assembly 'exploded' (Don't lose the shims when you remove the assembly from the body – easy!)