

Heaven is going up and down

Classic cars are often noteworthy for their ride comfort, but the passing of time takes its toll on the suspension system. Geoff McAuley look at how the various components work and explains how to maintain a smooth ride.

Basic suspension principles have changed little in the past 70 years, but subtle improvements have enhanced handling and comfort by a considerable degree.

In many ways, the suspension design of older cars falls into the 'golden period' which lies between the crudity of very early types, and the need for cheapness found in many recent examples.

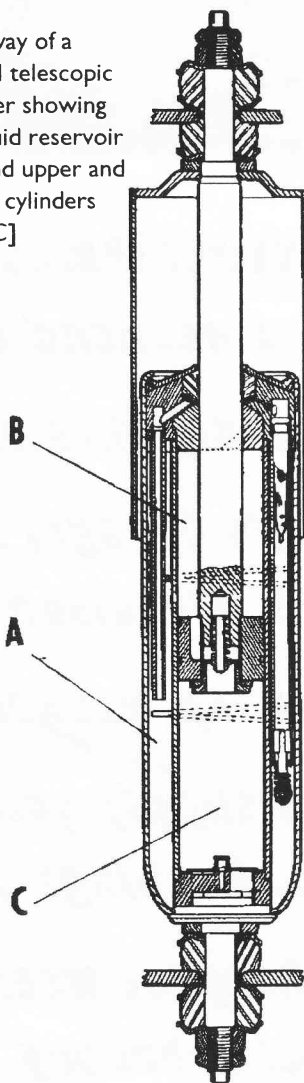
The perfect compromise between cost, simplicity, comfort, and handling is most elusive, the first two elements often giving grace to the later two on cars of character.

Basic Principles

Clearly, the primary function of a car's suspension is to insulate the occupants from noise and undulations of the road surface.

The theoretical requirement is to absorb road shocks in such a way that the energy therein can be spread out over a relatively long period of time. Rather like a bank loan, the pain of the cost of an item is spread out and so becomes less intense.

Cutaway of a typical telescopic damper showing the fluid reservoir [A] and upper and lower cylinders [B & C]



Of course, our bank loan lasts for a period of months [Well, years. Ed.], and that would hardly do for our car's suspension, because every few seconds another bump [or purchase] comes along, and, ideally the first bump needs to be paid off before the second arrives.

So we are talking in fractions of seconds here, but the principle is the same.

When a car hits a bump, the spring absorbs most of the shock, which it then dissipates gradually, either by lifting the car, or by forcing the wheels down the other side of the bump.

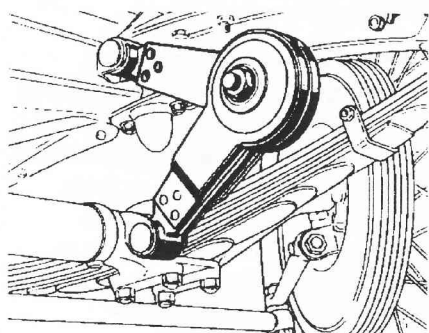
Over an indentation, the opposite occurs, ie the car body is gently lowered, or the spring is re-compressed as the wheel climbs out of the hole.

So what is complicated about designing a good suspension system? Well, for a start, after a spring has been released from being either compressed or extended, it will not immediately return to its original shape, but will tend to overshoot beyond its *status quo*.

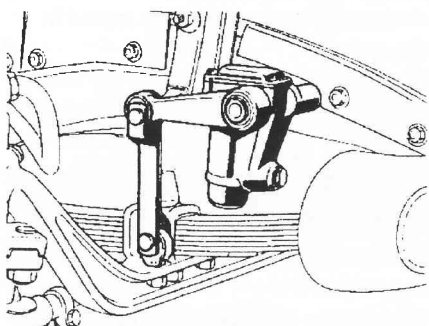
In fact, if left to its own devices, it will 'twang' several times before settling down, a condition known as hysteresis.

Furthermore, all springs have what is called a 'resonant frequency', that is, once excited, they tend to twang at a certain rate which is determined by their material of manufacture, size and design.

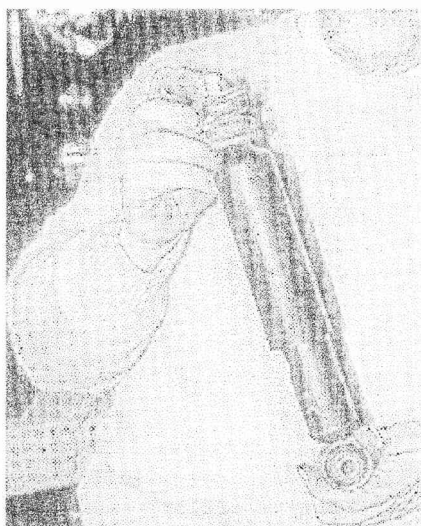




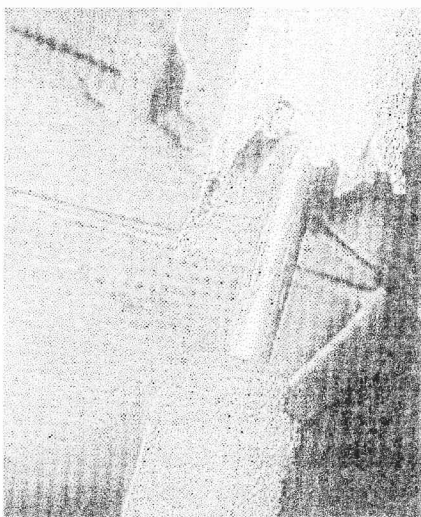
Friction shock absorbers are common on pre-war cars



Lever-arm shock absorbers can still be found on MGBs [Pathetic when you think about it! Ed.]



Telescopic shock absorbers are more efficient than other types...



...but can suffer from neglect like any other component

This in itself could cause a bouncy ride, but if the frequency of resonance happens to coincide with meeting a series of bumps in the road, the whole car may start to bounce uncontrollably, possibly lifting the wheels clear of the road. [This is getting better and better, and I had never realised the possibilities! Ed.]

Shock Absorbers

The cure for this resonant catastrophe is to fit a device known as a shock absorber, effectively between both ends of the spring. This controls the 'overshoot' and lowers the overall resonant frequency to a point where it is no longer a problem.

Today, dampers are often referred to as shock absorbers. Although, in fact, it is the spring which absorbs the shock, not the damper.

Shock absorbers fall into three categories: friction, lever and telescopic.

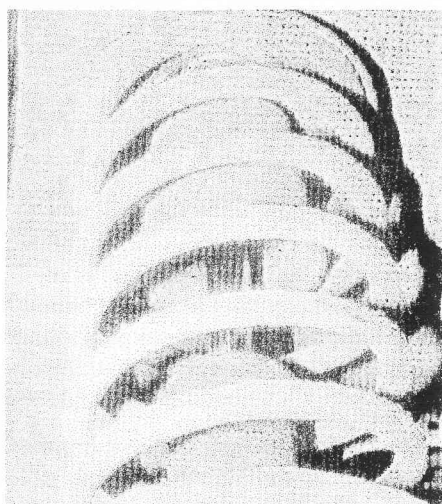
Friction Shock absorbers

These are essentially a pre-war design which relies on a series of friction material pads held together under pressure. As the suspension, and therefore the shock absorber arm, moves, the friction between adjacent pads provides a damping action.

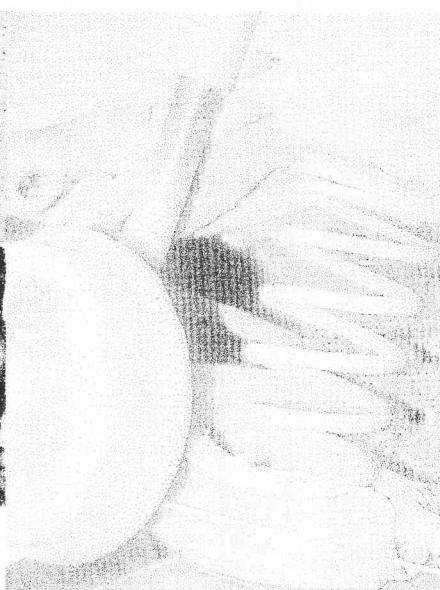
Unfortunately, friction shock absorbers offer the greatest resistance when static and the least when in motion, which is



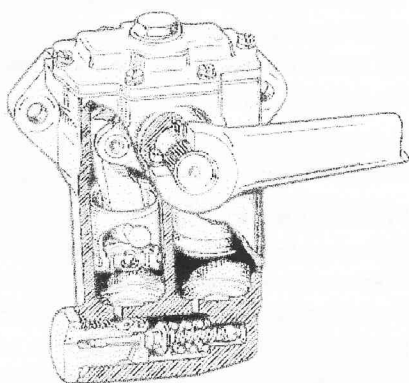
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Coil units are standard fare on many classics fitted with independent wishbone front suspension



An independent rear suspension system with coil springs



Cutaway of an Armstrong hydraulic shock absorber showing the twin piston arrangement and the arm connected to the suspension arm

the opposite to the ideal requirements. Their advantage lies in their simplicity and ease of overhaul.

Lever Shock absorbers

This version relies on the reluctance of a fluid to be squeezed through a small orifice. The shock absorber is mounted solidly on the car's chassis or body, while a lever is connected from a moving part of the suspension to an internal piston which forces oil through one or more small holes.

The effort of forcing the oil through these holes creates heat, and so dissipates unwanted energy stored in the spring.

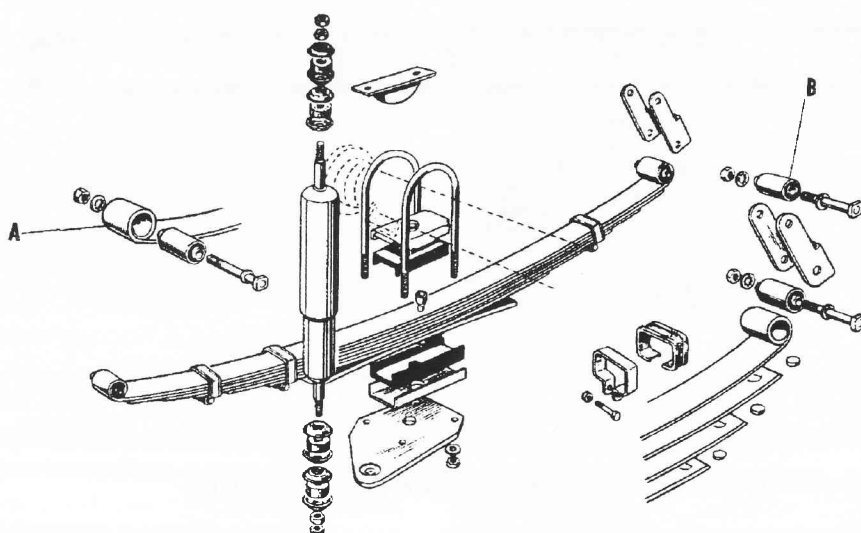
Telescopic Shock absorbers

Using much the same principles as the lever type, telescopic versions are 'direct acting', and are therefore rather more accurate in their control of the springs, because the amount of spring movement is more or less faithfully followed by the internal components of the shock absorber.

Most telescopic shock absorbers these days are 'variable double acting': that is to say, they present resistance to bounce and rebound direction [ie when they are extended].

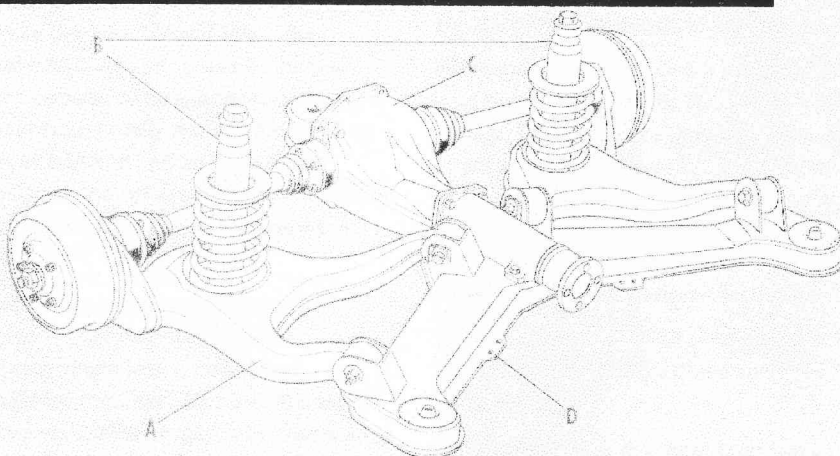
Modern gas shock absorbers still use the 'squeezed fluid' principle, but merely have a gas chamber between the pressure faces and the fluid chamber.





Typical leaf spring layout showing the spring, damper mounts, fixed shackle [A] and swinging shackle [B]. Both lateral and longitudinal driving forces can be absorbed by this simple arrangement.

SEMI-TRAILING ARM AND COIL SPRING SUSPENSION



Independent rear suspension set-up with semi-trailing arms [A], coil over damper units [B] and fixed differential [C] bolted to subframe [D]

Faults

Friction shock absorbers are amenable to overhaul because of their simplicity, and repair is usually limited to stripping and thorough cleaning. But they do tend to suffer from dirt, rust and corrosion and performance suffers quite rapidly if they are neglected.

Many types of lever shock absorber can be overhauled, which is just as well, because they can be unreliable.

Leading seals can cause loss of fluid and the fluid itself can deteriorate with time, although it can usually be replenished. Also, physical wear can cause sloppiness in the units.

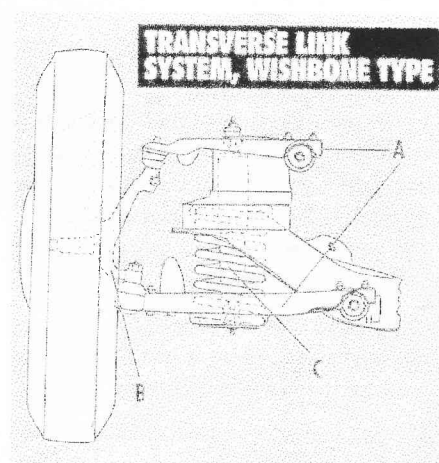
Telescopic shock absorbers are completely sealed, so do not suffer from dirt ingress. Their direct action means the fluid is subjected to less stress than the lever type, and so longevity is far better, however only a few early models can be stripped for overhaul.

Wear of the internal seals and valves will show up as a gradual sponginess, and will signal the need for replacement. The eyes of the shock absorber usually house rubber bushes which, although very durable, will soften or wear with age. Replacement bushes are cheap.

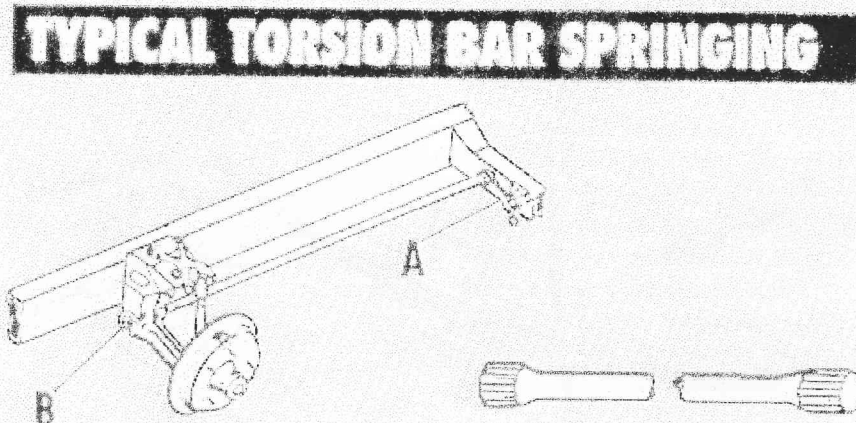
Fluid shock absorbers, whether lever or telescopic, will rapidly lose their efficiency if the fluid overheats during exceedingly heavy use. For this reason, lever types are rarely used for competition motoring and telescopic versions are often replaced with uprated models.



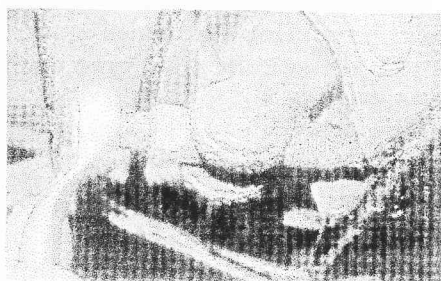
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Independent front suspension unit with unequal length wishbones [A], stub axle [B] and coil over damper units [C].



Adjustable torsion bar frame mounting [A] and suspension arm [B].

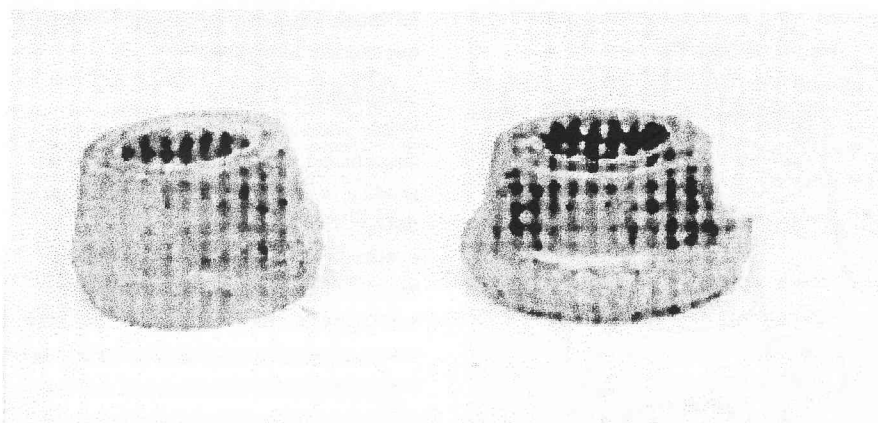


Above: Torsion bar tension can usually be adjusted by a screw to vary the car's ride height

Top Right: Regular greasing is a must for early suspension components. Properly maintained they can outlast modern 'sealed units'.

Bottom Right: Anti-roll bars come in all shapes and sizes, but are essentially transverse torsion bars





Although they are extremely durable, rubber suspension bushes eventually deteriorate. Here, a worn damper bush, left, is compared with a brand new one.

Adjustment is possible on some telescopic types such as Koni and Spax so that allowance can be made for wear, or stiffening up can be effected for racing, etc.

Types of Spring

Before the First World War, the elliptical [cart] spring was by far the most popular choice, a narrow spring steel blade, usually mounted on a pivot bolt at one end and an articulated shackle at the other, with the car chassis fastened somewhere in between the two.

There were many varieties on this theme — semi-elliptical, quarter elliptics, single leaf, multiple leaf, cantilever mounted, etc. But the basic spring was, quite simply, a bendable strip of steel.

Most cars had opposite pairs of wheels mounted on solid beam axles, but during

the thirties, many manufacturers began to appreciate the advantages of isolating each wheel from its opposite partner, particularly at the front of the car where undesirable wheel movements could adversely affect the cars' steering. And so was born 'independent suspension'.

Independently suspended wheels did not lend themselves well to the use of leaf springs, because there was now no axle to act as a mounting point, and although a few manufacturers such as BSA with their Scout employed a complex multiple leaf arrangement, most car makers turned to torsional springs.

Torsion Bar

The purest form of torsional spring is the torsion bar.

Quite simply, this is a steel bar with a radius arm attached to each end. One arm is permanently secured against the car chassis and the other is attached via

locating components to the wheel. As the wheel rises or falls, so the bar twists.

A popular variation of the torsion bar is the so-called coil spring, a strong steel coil located between the chassis/body and the wheel locating components. As a wheel is deflected, the coils of the spring TWIST, so the coil spring is in reality a compact form of torsion bar!

To prove the point, cut out a long thin strip of paper and form it into a coil around a pencil, taking one end in each hand, remove it from the pencil and squeeze it like a concertina. You will see how the paper actually twists, rather than bends.

Other Types

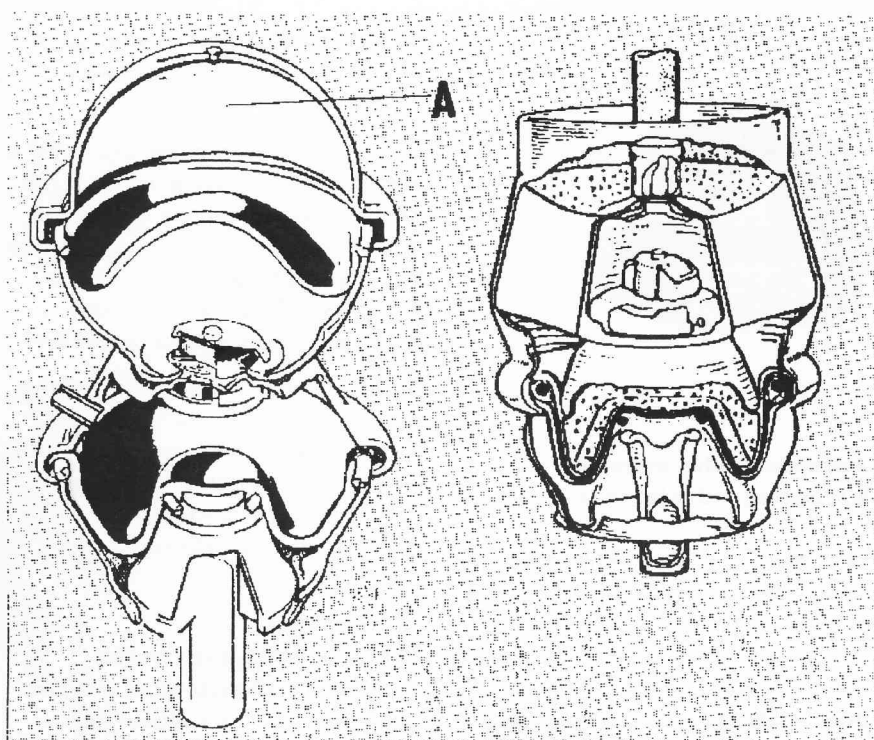
Most other designs rely on the compressible characteristics of rubber, but despite some very elaborate versions the good old torsion bar/coil spring systems are difficult to beat for reliability, simplicity and performance. [A neat dismissal of both hydrolastic and hydropneumatic concepts. Ed.]

Some manufacturers, notably Citroën and British Leyland, have introduced the interconnection of the wheels' suspension by means of fluid lines, with varying degrees of success. [For the really knowledgeable, Citroën introduced the interconnection of front and rear suspension in 1948 with the 2CV — without fluid line. Ed.]

The results have produced mixed reactions and it is fair to say that interconnected suspension systems,



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although eloquent by design, are not to everyone's liking.

Suspension Faults

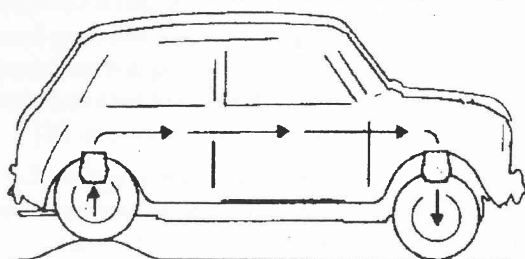
Wear will slowly take its toll of any suspension system and because of its gradual nature, may be quite difficult to detect. Coil and leaf springs will eventually become 'set' under the weight of the car, while worn bushes will cause 'clonks' and rattles and may cause a lack of steering directness and excessive tyre wear.

Coil springs can sometimes break, but the effect may not be immediately obvious, so periodic visual checks should be made.

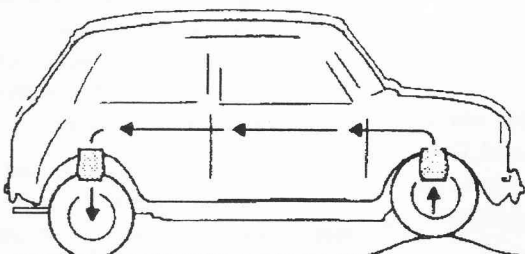
A broken torsion bar will cause a total suspension collapse and may be due to minor surface damage to the bar such as might be caused by careless welding — a MIG welder should never be earthed through a torsion bar.

Pneumatic suspension can suffer from fluid loss because of corroded pipework or faulty seals in the suspension units, but the rubber components are quite durable.

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Above: Hydrgas, left, and hydrolastic suspension units. The sphere [A] accommodates the gas suspending medium.



Left: The compensating effect front to rear of hydrolastic suspension units: linking pipes connect the units longitudinally.

