Citroën’s Innovative New Suspension System

Published: June 6, 2016
Author: Dave Randle
Online version: https://www.wheels-alive.co.uk/citroens-innovative-new-suspension-system/

This slideshow requires JavaScript.

Citroën Springs Ahead…

by Dave Randle.

Above and beyond all its other innovations and achievements, Citroën is renowned for its ‘cushion of air’ ride quality. For over half a century it has developed and refined its ‘hydropneumatic’ and ‘hydractive’ systems until the late C6 and the still just present C5 represented the apotheosis of technical advancement in a world where it too often seems electronic correction is a substitute for sublime engineering.

Throughout its commercial career its apparent complexity has struck fear in as many hearts as it has won over, though the elegance of its basic principle is much easier to grasp and appreciate than the simplest electronic engine management system, and in an age when financial and political imperatives trump creativity and originality, we have long known that the days of the mechanical masterpiece are numbered.

Literally numbered in that the driving considerations of designers and manufacturers in these crass and decadent times are more often than not arbitrary figures dreamt up by unenlightened bureaucrats.

But, though the hydropneumatic system is justly the more famous example of Citroën’s ingenuity in the field, another such was conceived with comparative success at the other end of the spectrum – simplicity itself, and conceived for the cheapest and most basic models in the company’s post-war range.

Most cars at the time still depended on cart springs, especially at the rear – in some cases a single cart spring mounted transversely above the axle. Citroën had been among the first to employ ‘torsion bars’ – transverse metal bars mounted the width of the chassis with a leading or trailing arm to the wheel, which achieved its flexibility from the twisting potential (torque) of the torsion bar. This gave a pliant ride, and had the characteristic of ‘stiffening’ gradually as it approached the limits of torque, making it ideal as an ‘anti-roll bar’.

Although there were other systems such as rubber springs and ‘Hydrolastic’, the British Leyland system providing improved ride, but, without the self-levelling correction of the Citroën system, inclined to become unbalanced, and air-suspension arrangements that employed compressed air and inflatable cylinders which allowed some adjustment of response and height, most cars ended up with a leaf or coil spring and a hydraulic damper per strut.

Citroën’s engineers put each wheel of the 2CV on a hollow pivoted leading arm at the front and trailing arm at the rear, each acting on a connecting rod that ran horizontally along the side of the chassis. On each side of the car independently, the two rods met inside a cylinder and were interconnected by two coil springs and a separating solid buffer, so that each wheel was independent, but a shock or heightened activity at the front wheel would communicate to the rear by means of the tendency of the suspension cylinder to move toward the rear, preparing it for what was to come. As the rear wheel hit the same feature, it re-centred the cylinder.

On the earliest models, the only other feature of this wonderfully avant-garde set up was a friction damper, mounted usually only on each of the leading arms bearing the front wheels. This consisted of a hollow metal tube, rounded at the top and bottom, containing a sprung weight. As the wheel rose or dropped in response to the road surface, the weight tended to remain inert, so the springs above and below it would act on the arm, via the cylinder, to return it to optimum – to press it onto the road after a bump, and tend to lift it after a pothole.

The family 2CV – Ami, Dyane, Mehari – with this system were virtually unstoppable, on or off road. At the same time, Citroën was able to advertise a ride quality, borne of a brief to carry a carload of eggs across a ploughed field without breaking any, superior to almost anything on the road.

Nobody would recommend attempting the stunt with any current Citroëns. Although many embody the kind of design genius we expect from the marque and Cactus and Berlingo are as good as anything else on the road ride-wise, all are forced back upon the standardised model of McPherson Struts front and trailing arms at the rear – regular kit, with some variation possible in spring ratings and shock absorption. They also suffer from the strange fashion for low profile tyres and wheels like garden rollers.

When I drove my not-interested-in-cars brother to Devon in the rightly award-winning Grand C4 Picasso and enumerated its many virtues, he said: 'Hmpf! It doesn't ride like a Citroën.' Fortunately he didn't experience the C3 Picasso, which is a work of genius in every respect but seriously let down by its suspension. In happier days, when France was the undisputed master of comfort, a Gallic colleague of mine described the suspension on a Ford Transit as 'une véritable catastrophe.'

Ticket to Ride?

Are we doomed to put up with normal ride from now to eternity?

The joyous answer is no. Citroën has been at it again, and come up with an answer so ingenious and so simple that it will once more be available at the lowliest end of the range, and will be rolled out across that range without the need for specific new models built around it.

In many ways the new 'Citroën Advanced Comfort' arrangement echoes the inertia dampers of the 2CV. Coil springs, themselves reduced in diameter, are incorporated within the three-stage dampers which enable a very compliant initial response to a change in the road surface. As the spring compresses it offers greater resistance, but also acts against a

hydraulic chamber which cushions its arrival at the rubber bump-stop at the top of the strut. Even this last is now smaller and less rigid, much of the ‘bump’ having been taken out of it by the former stages of the process.

The removal of shocks from the process means that anti-roll bars can be reduced both in torque and diameter. These add-ons are often seen as a necessary evil. Suspension engineers work to achieve suppleness and precision, but simply because body roll is unfashionable, anti-roll bars are included to resist lateral motion of the body and centre of gravity. They can’t do that without compromising the compliance and travel of the suspension, and often reduce self-induced body roll at the expense of a tendency to lurch from side to side on uneven surfaces and adverse cambers.

If they offer too much resistance, they also compromise another Citroën virtue – directional stability. If you corner on a rough surface in a 2CV or a DS21, the front wheels on both sides of the car will continue to remain in contact with the surface without interrupting the free movement of the wheels or passing parasitic movements to the car. Try this in a standard car with so-called ‘sport’ suspension and ride, steering, braking and traction all suffer – even with ABS.

A further penalty of poor suspension is the number of shocks it transmits to the body of the car itself. Huge strides have occurred since the 1980s in torsional rigidity. Cars no longer twist visibly with the road surface or just the turning of the engine as they did back then. Citroën again pioneered the use of lightweight hardened foam to lend excellent rigidity to the chassis of the Xantia. But there are actually limits to rigidity, especially in the home of potholes, if violent shocks are being transmitted in this way.

By isolating those shocks and containing them within the suspension unit, engineers are able to further increase body rigidity, further removing the shocks from passengers and leading to even more precise steering and directional stability.

To complete the transformation of the running gear, electronic management systems have

also to be addressed, so the ESP (Electronic Stability Programme) will be perfectly mated to the new setup.

But it doesn't end there. Comfort doesn't end at the wheels or even the springs. The interior and the direct contact of the driver and passengers with the car is just as important, so as much work has gone into surfaces and materials as the oily bits below.

Standard across the range new seat architecture is also revolutionary, with seat casings able to accept various trims from cloth to leather and a new two-stage cushion set-up that employs the science of mattress design. One stage will ensure support, while the other acts as a further damper, absorbing any remaining movement that might otherwise trouble the bodies aboard.

This slideshow requires JavaScript.

Of course, there are certain people who find travelling on a cushion of air a bit disconcerting and this too has been addressed. By identifying the damping rates that seemed to bring on this 'floaty' effect in earlier hydropneumatic cars, the frequency was already lowered in C6 and C5. On the CAC prototype Cactus, it has been further reduced and in tests has eliminated the particular sensation of floatiness that seemed to cause it.



Prototype Cactus with Citroen Advanced Comfort.



So, while one end of it has been hived off – or promoted – to become the prestige DS range, very much living off Citroën's history and heritage, here is the birthright of the double-chevron returned, as it once more becomes the reference for those virtues for which it has been known throughout my career – ride, directional stability, active safety and being so original and different that its absorption into the 'norm' would be a motoring tragedy.