# M-100 Gas Suspension and the Passage of Time

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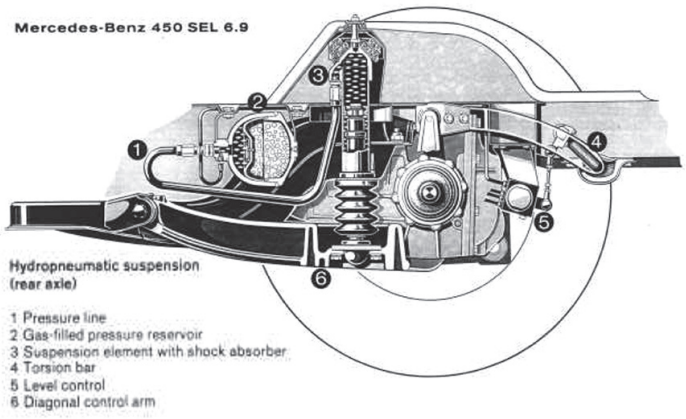
*Grounded? Read on…there is hope!*

You are probably familiar with the Mercedes models W109, W112 or the W100 from the 60s and early 70s. These models were designed with a 'legendary'Air Suspension system, legendary for the superbe ride - but also legendary for the complications and finally for its price. Very similar aspects are said to be true for the Hydraulic-Pneumatic Suspension (HPF ) that came with the W116, 6.9 in the mid 70s .Gas SuspensionPeople might think that the early air suspension is very different to the later hydraulic system used in the 6.9 and they are correct if you consider the vast differences in parts and technical details (using air vs oil). However looking at the M-100 cars ( 6.3, 600 and 6.9) through the lenses of the Gas Suspension Principle you may discover that both systems are members of the same family: Yes you heard it right. The M-100 cars not only share a similar engine but they also use the very same principle of Gas Suspension. The earlier M-100 cars have an air spring and the later 6.9 have the gas spheres. Both are working according to the gas laws (laws in physics).Why did Mercedes put so much effort into the designs of the gas suspension? The answers to that question might be many faceted. Back in the 1950s the time was ready for the gas suspension. The word is Zeitgeist. Cars, especially luxury cars back then were seen as spearheads of technical innovation, power and speed etc. Cars did follow and show the spirit and life style of its time and simply the fact that gas suspension was technically feasible created a strong momentum.Looking at the systems today-60 years later- the enormous efforts to keep a car up on gas springs instead of steel springs are honorable. However, at least for some people the efforts are also questionable let alone the higher maintenance and failure rate of the gas suspension. So why was there a gas suspension hype? Gas suspension was 'in the air', clearly, and Mercedes was not the first nor the only company to come up with a gas suspended car. If I am not mistaken a Cadillac in the mid 50s started with air suspension in a luxury car (it was not reliable). At about the same time Paul Mages, a French inventor developed the famous hydraulic -pneumatic suspension for Citroen in Europe while Borgward in Germany picked up the air suspension idea in the late 50s and developed with Bosch the precursor of the later Mercedes VNB axle valves for the



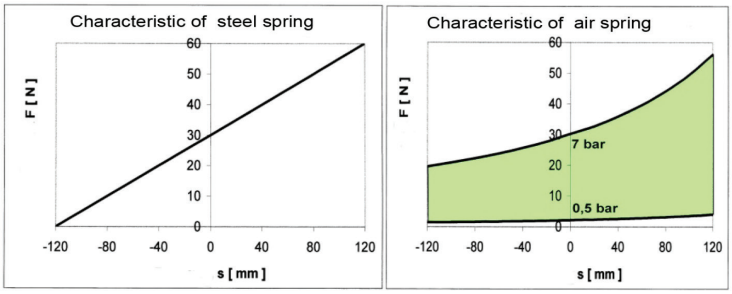



*Diagram 1a: Comparison - steel spring vs. air spring*

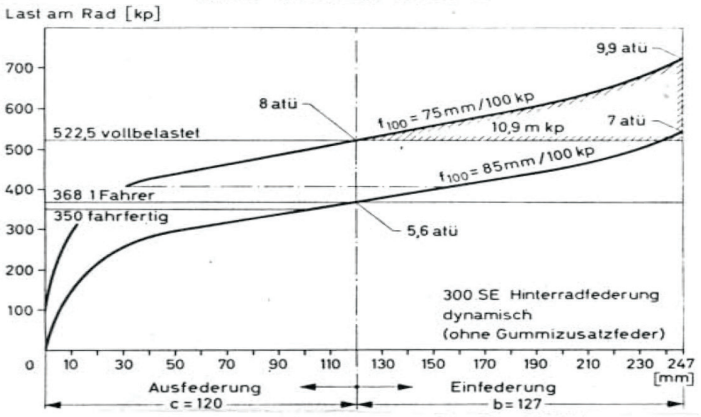



*Diagram 1b: Dynamic air spring characteristic, 300SE, rear axle (source: Article in magazine ATZ 1965 Heft 2, February 1963, Weller and Neuschaefer, Daimler-Benz-Luftfederung, page 38)*

W112 in the early 60s. The Mercedes air suspension was late in the game but superior in its design and technical finesse.

On the positive side and for the sake of arguments in favor of a gas spring car here are the arguments.

**Advantage #1:** The car can be kept on its ideal axle height independent of its variable load. This means that ideal axle geometry (castor, camber etc.) can be always maintained in the neutral height level. Driving safety is improved due to better road handling for example at night keeping the same headlight position.

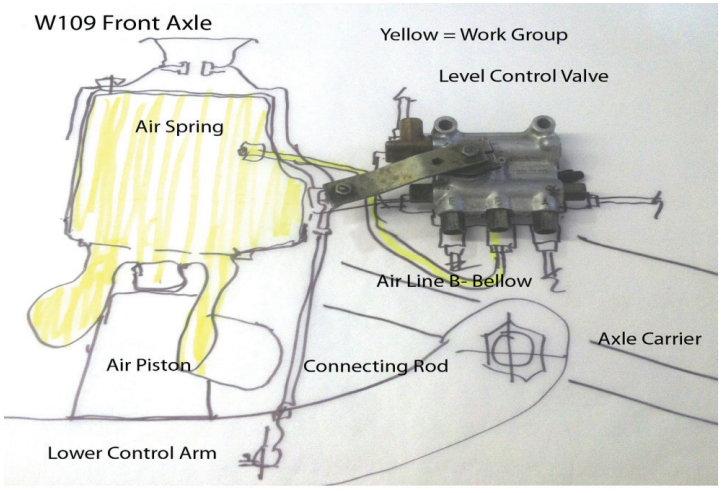



*Diagram 2: Work Group (Source: Martin Werminghausen)*

**Advantage #2:** Driving dynamics, road handling and comfort are improved: The spring characteristic of a gas spring is dynamic or progressive in nature (while a steel spring has a constant coefficient or a linear characteristic), therefore the suspension can better respond to driving: E.g. the suspension is soft and comfortable during slow driving and becomes noticeably stiffer during faster driving. The suspension responds to dynamic load as it reacts to live load.

**Advantage #3:** Better sound isolation of airbag and lower resonance frequency. This leads to a smoother and more comfortable ride.

**Advantage #4:** Higher ability to absorb energy which means better and safer handling in extreme(r) driving conditions. The gas spring has a higher ability to absorb energy (physical work) compared to a steel spring and is therefore considered a safety feature.

The fact that some cars today are using the air suspension shows that despite the greater costs a gas suspended car will provide the better riding quality.

I will not go into much technical detail of the systems but want to touch on the basics. Trying to explain the Ideal Gas Law P*V= nRT is maybe too much but there is a simplified and practical version of the gas laws known as the combined gas law: P*V/T = C (combining Boyle's law and Gay-Lussac's law). The gas law can be applied to the air suspension and the hydraulic suspension. Both gas springs work with the same principles. During the dynamic compression of gas (if you go over a bump for instance) the gas volume in the spring is reduced by the same factor as the pressure increases. This means simply that we are looking at a dynamic compression rate for the air spring versus a linear comprssion reat for a steel spring which provides the special ride.

Comparing the two gas spring systems the main differences are two things:

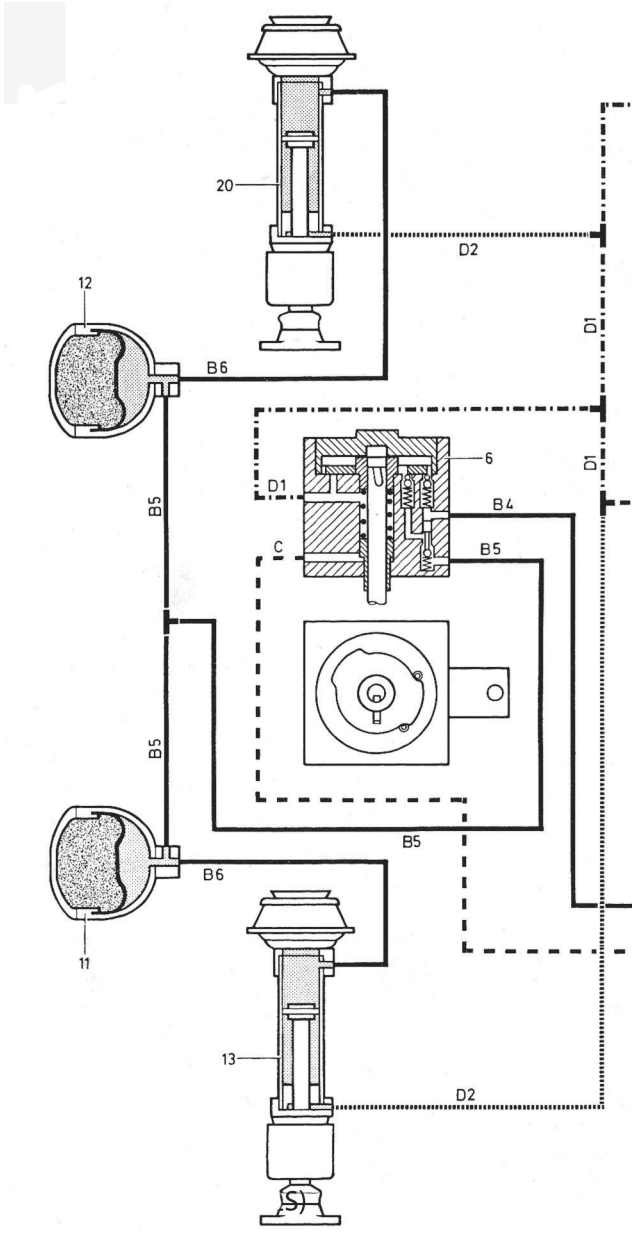
A) The air suspension is using straight air while the HPF is using oil as a medium to compress the gas spring.

B) Pressure and volume rates: The air suspension springs are under a working pressure of probably 7–10 bar while the hydraulic system is using roughly 10 times higher working pressures.

The higher HPF pressures lead to relative compact but heavier members. The weight of the systems might be quite comparable. The HPF using oil as a medium is probably less prone to leakage compared to the all air

system. Despite the more complex system (using oil and nitrogen ) the general robustness of the HPF is proven and it can withstand the passage of time fairly well. However over time both systems literally go down, mainly due to fossilizing rubber, failing valves and of course gravity.

The good news is that both suspension systems of the M-100 cars are robust , well designed and can be maintained and repaired. Yes maintaining the systems of these beautiful cars is exhausting but the superior ride is well worth the effort.




*11 and 12*
*6.9 Front Axle Nitrogen Gas Spring (Spheres)*

# Meet the Author

***Where did you spend your childhood?***
Friedrichshafen, Germany: I was born in that town on the Bodensee (Lake Constance) in south Germany where the Zeppelin was built. Also located there is ZF and the Maybach factory where I was an apprentice in the 70s.

***What was your first interests with Mercedes?***
As an apprentice at Maybach I saw all the 60s and 70s Mercedes cars.

***What was your first Mercedes vehicle?***
My first Mercedes was a W126 with a 6 Cylinder Diesel. I still own this car. It has 360K miles and never dies.

***What lead to your interest with suspension?***
Great suffering: My first 109 was leaking air like a sieve and I found the car down on the oil pan every morning. The suffering was intense and it drove me to the point that the engineer in me figured out how the system works so I could rebuild it...and I did.

By the way, the same thing happened years after with the 6.9

***Which is your favorite M-100 and why?***
I like them all but I think my favorite one is the understated 6.9.