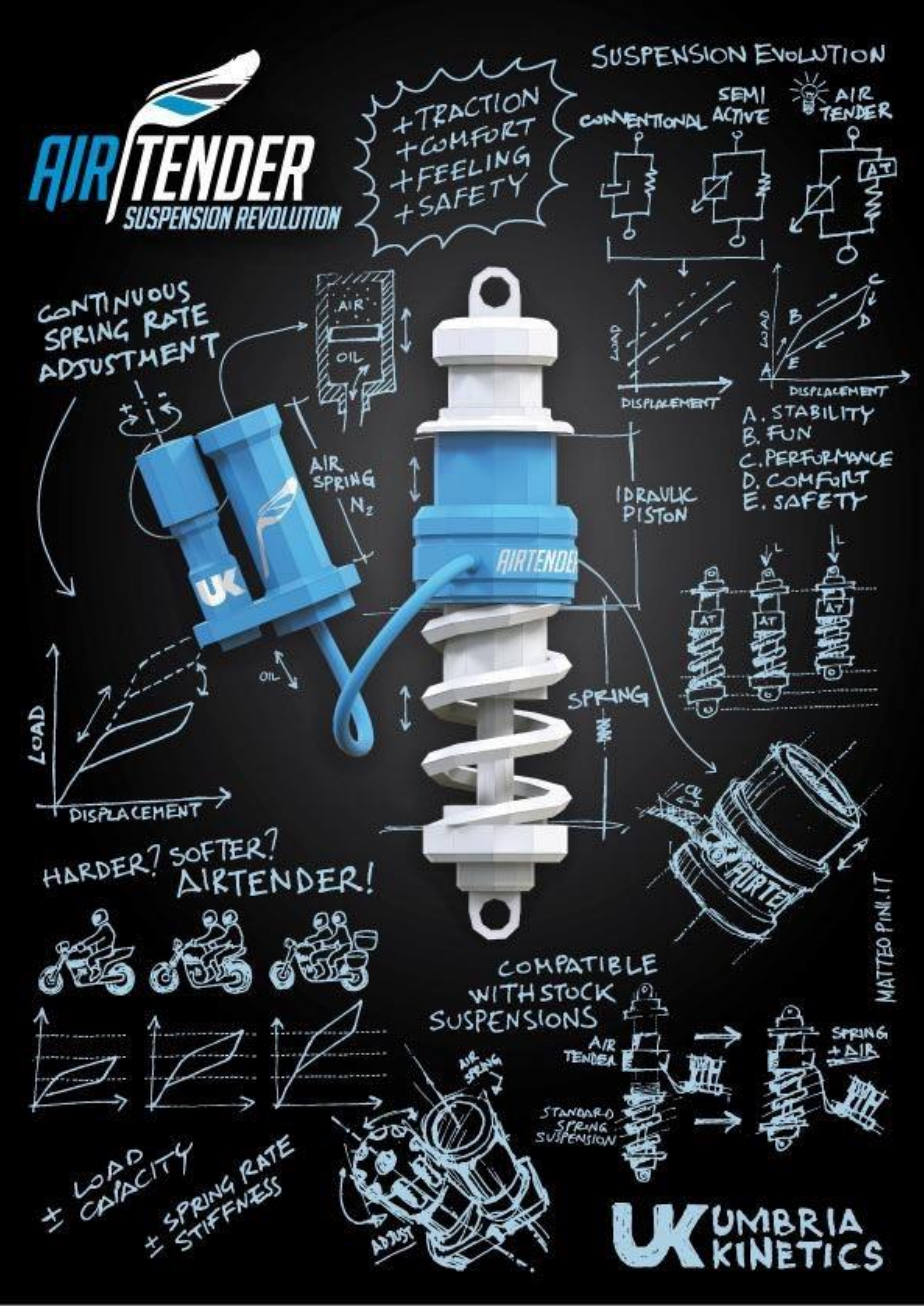
AIR TENDER
SUSPENSION REVOLUTION
+TRACTION
+COMFORT
+FEELING
+SAFETY
SUSPENSION EVOLUTION
CONVENTIONAL
SEMI ACTIVE
AIR TENDER
AT
LOAD
DISPLACEMENT
A. STABILITY
B. FUN
C. PERFORMANCE
D. COMFORT
E. SAFETY
CONTINUOUS SPRING RATE ADJUSTMENT
AIR
OIL
AIR SPRING N_2
IDRAULIC PISTON
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HARDER? SOFTER? AIRTENDER!
COMPATIBLE WITH STOCK SUSPENSIONS
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SPRING + AIR
AIR SPRING
ADJUST
± LOAD CAPACITY
± SPRING RATE STIFFNESS
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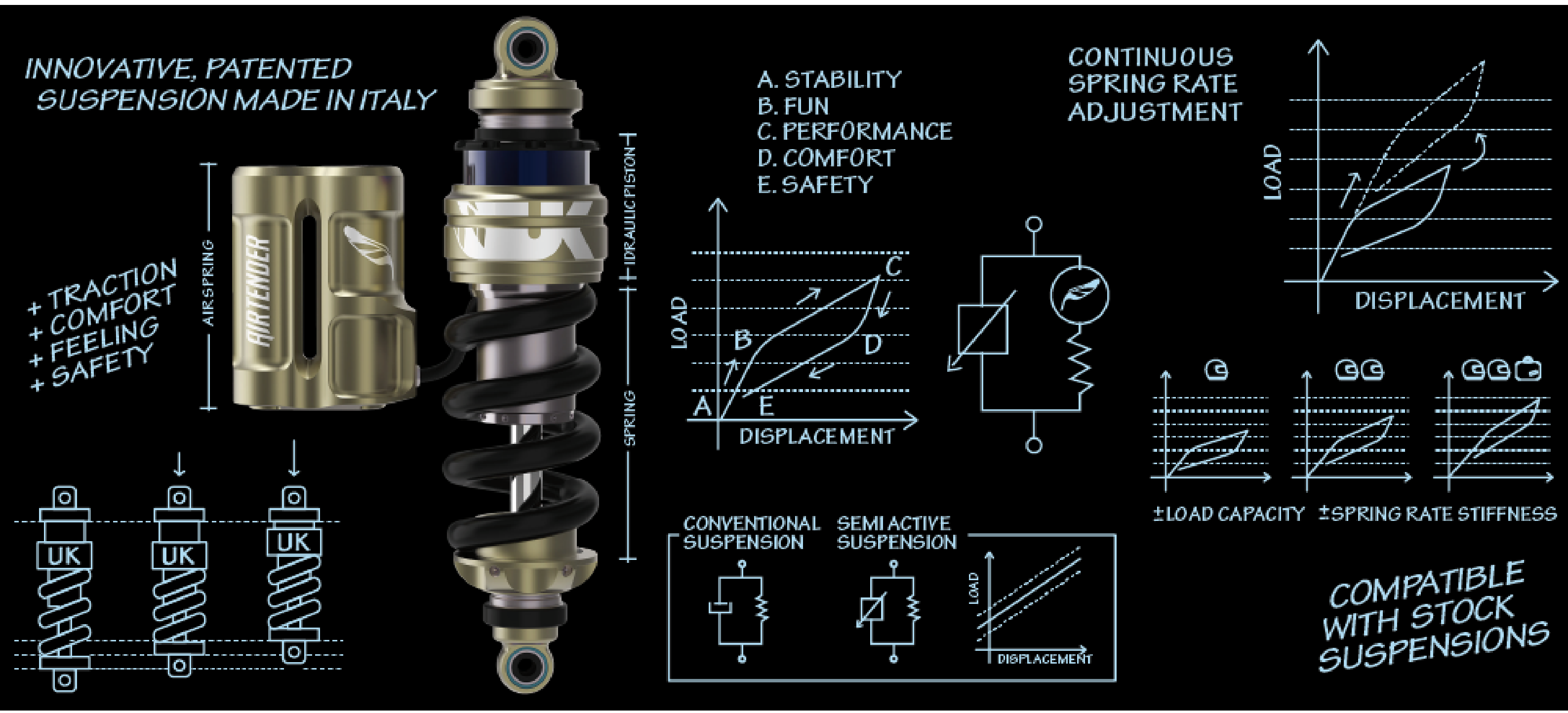
AirTender® working principle

Today most of the vehicles are equipped with a suspension system, adopted to ensure the tyre-ground contact in most of the situations and to guarantee a good comfort level while providing enough handling capability. Commonly a typical suspension system is composed by a shock absorber and a spring, where the spring is used to support the vehicle weight and to absorb the road irregularities while the shock is needed to reduce the amplitude and the time duration of the spring oscillations, dissipating energy. Regardless of the kind of vehicle all the suspension systems where a shock absorber and a spring are employed are subjected to the well-known “ride-handling compromise", indeed comfort and handling require opposite settings of the suspension parameters always leading to a trade-off between the different requirements.

The AirTender is an innovative suspension system that allows to overcome this compromise thanks to the introduction of an hydropneumatic spring into the original suspension structure. Indeed, the AirTender system is composed by a short and stiff coil spring in series to an hydropneumatic one, that replace the original coil spring without any change to the shock absorber. Thanks to the two springs working in series a dynamic change of the equivalent spring rate during the shock absorber travel is obtained. The stroke of the AirTender hydropneumatic spring is 21 mm.
The accumulator consists of two connected chambers, one containing nitrogen and the other containing hydraulic oil.



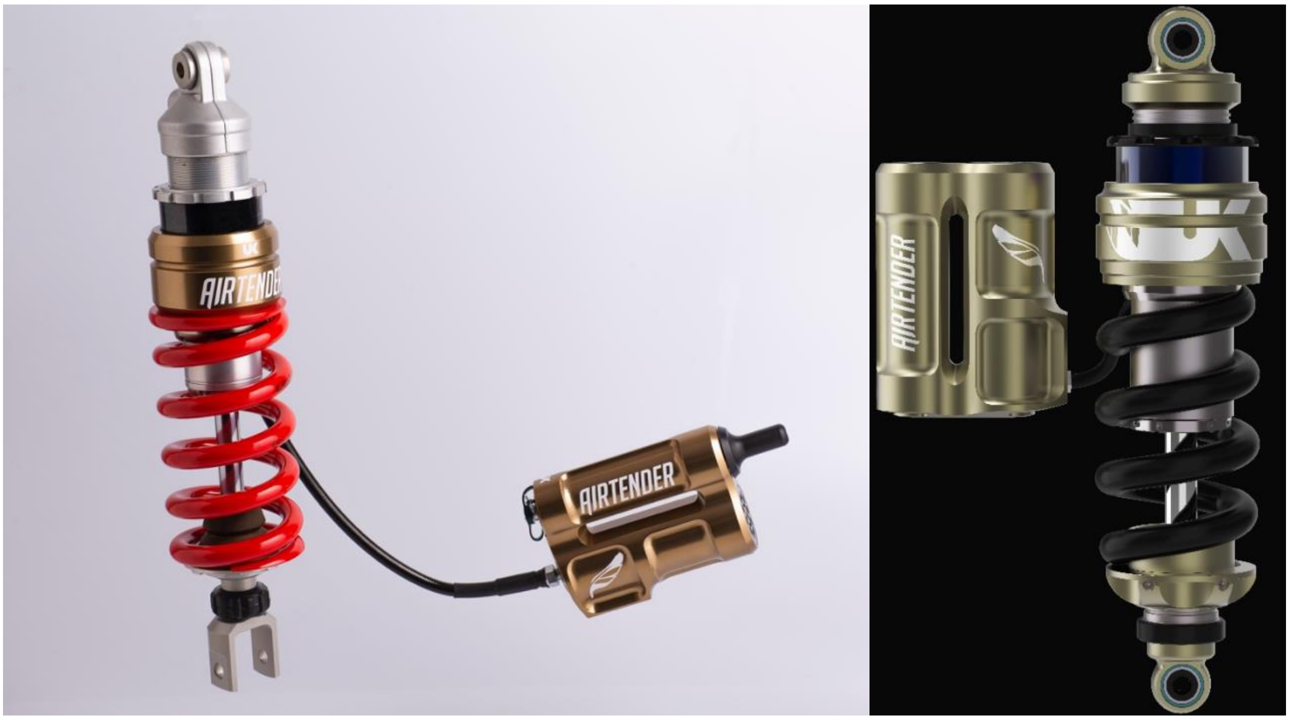


Fig. 1: Shock absorbers equipped with AirTender. The hydropneumatic spring is in series with the coil one.

The AirTender working principle is quite easy. Basically, we have two springs in series, hence the overall spring rate is given by the rate of the two working together. The hydropneumatic spring has a certain threshold value, depending on the gas and oil pressures, below which it is not working. Thus, if a certain force is applied to the suspension but lower than this value only the coil spring works, so that the spring rate seen by the suspension is just the one of the coil, that is much higher than the rate of a standard motorcycle spring. On the other hand, when the force exerted on the shock exceeds this preload also the AirTender spring starts to move together with the coil, and since the hydropneumatic spring rate is much lower than the coil spring rate, the overall value becomes very low. Hence, what we get is a dynamic change of the spring constant depending on the force applied to the suspension, i.e. on the road irregularities.

From the vehicle dynamics point of view this behaviour leads to great advantages since we are not forced anymore to choose the coil spring rate under the “handling-comfort compromise" constraints. Indeed, while the spring rate is usually chosen low enough to guarantee a certain comfort level, now it is possible to use the coil that enhances the most the handling capability of the vehicle without the traditional problems of a stiff spring. If the road profile produces a large force variation on the suspension the AirTender spring comes into play, lowering the spring constant and allowing to absorb efficiently this force.
Hence, we have a stiff spring when it needs to be stiff, like on smooth roads, and a soft one when it needs to be soft, like when hitting bumps. Moreover, no coil preload is necessary when using the AirTender, being this beneficial for the ride performance since you do not have to overcome the preload force to make the shock working each time the suspension extends more than the preload value.

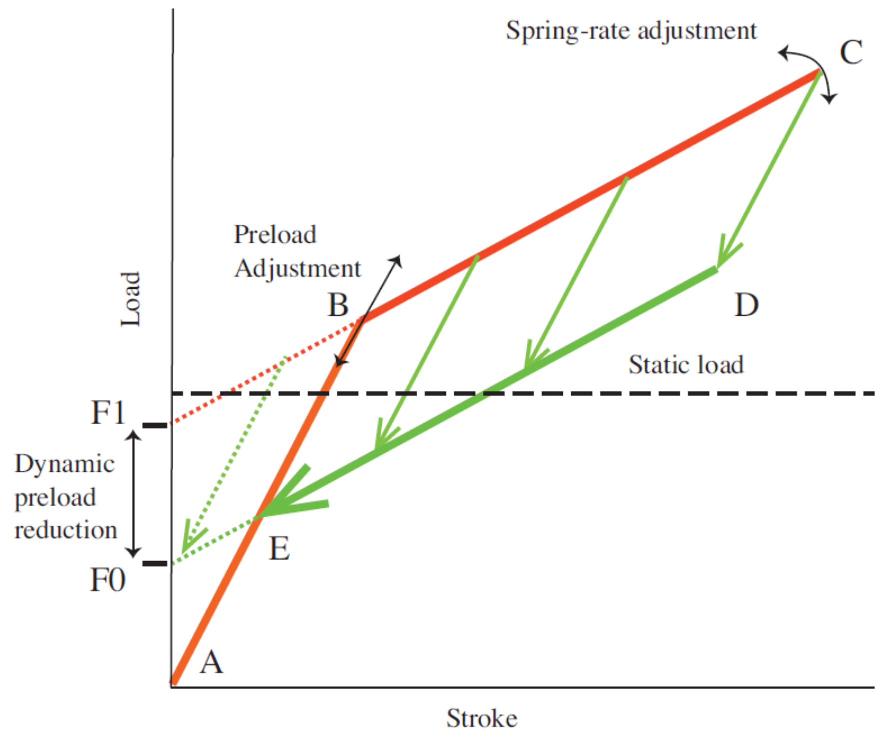


Fig. 2:
AirTender characteristic curve: The A-B segment corresponds to the coil spring while the B-C segment represents the AirTender system. The position of point B and the slope of the B-C segment can be modified thanks to the AirTender adjustment capability. The C-D and the D-E lines represent the rebound phase.

The AirTender behaviour is schematically shown in the force-displacement plot of Figure 2.
The first part of the curve (A-B, orange) corresponds to the coil spring working alone, so the slope of the curve gives its spring rate. On the second section of the curve (B-C, red) also the hydropneumatic spring is working, and the much lower spring rate can be deduced by the much lower slope. The point B, that is the point at which the hydropneumatic spring starts to move, can be adjusted by varying the oil/gas pressure. A pressure increase, achievable by changing the adjuster screw insertion, produces a shift of the point to a higher force level. By changing the gas pressure is also possible to vary the slope of the B-C segment, i.e. the overall spring rate.
The green segment D-E is the spring extension. The area between the upper and the lower part of the curve corresponds to the energy dissipated by the hydropneumatic spring during its operation. If the hydropneumatic spring compresses up to its maximum stroke the coil spring works alone again, so the effect is quite similar to the one of a bump-stop due to the high spring rate.

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AIR SPRING
COIL SPRING
STIFFNESS TUNING:
RED SCREW
SINGLE DRIVER
BLUE SCREW
WITH PASSENGER
REVOLUTION IS IN THE AIR.