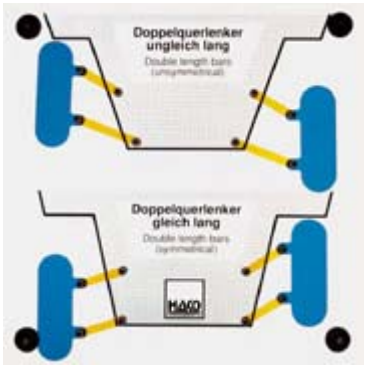
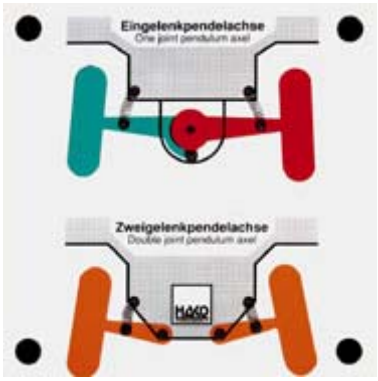
HAKO Overheadmodels - Section 4

Chassis, axle, axle transmission, differentials, suspension, damping, tyres, steering, steering gear



Order no. 111
Wishbones (of identical and different lengths)

- displacement of the axle
- change of track width and camber
- independent displacement of the wheels

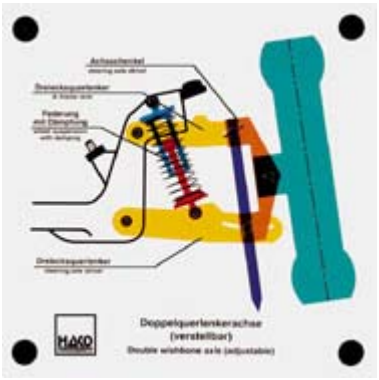


Order no. 109
Single- and two-joint swing axle

- compression of one side or both sides
- compression changes track width and camber

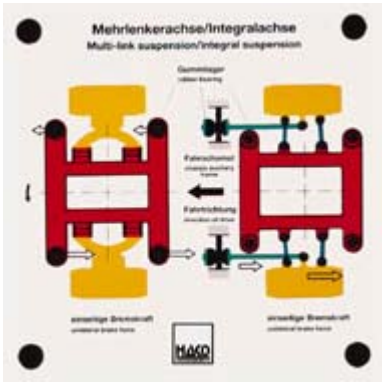
Order no. 113
Mc Pherson strut

- compression changes track width and camber



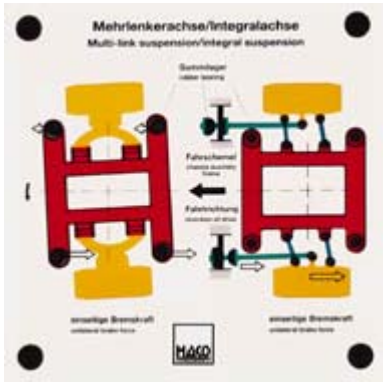
Order no. 163
Adjustable wishbone

- principle of suspension and damping
- compression changes track width and camber
- camber and kingpin inclination adjustable
- different kingpin offset (positiv, zero, negative)



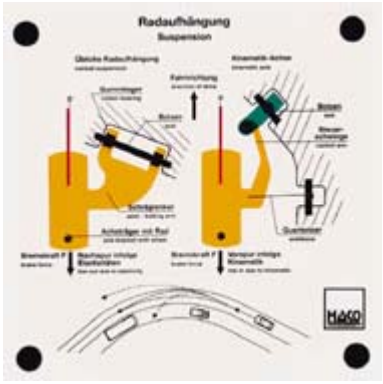
Order no. 254
Multi-link suspension

- with a multi-link suspension, a unilateral brake force causes a torsion of the whole chassis auxiliary frame and thus an undesirable steering motion
- with an integral suspension, a unilateral brake force causes only a longitudinal displacement of the corresponding wheel



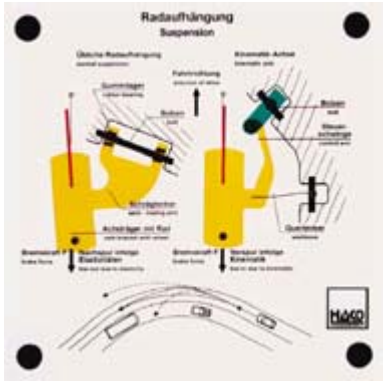
Order no. 114
Rigid axle

- compression of one side
- compression of both sides
without Panhard rod, top moves when vehicle corners
- lateral stability with Panhard rod

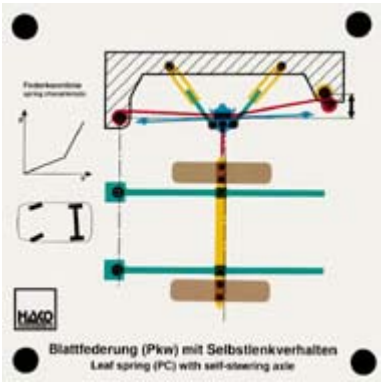


Order no. 251
Wheel suspension

- normal suspension: When the semi-trailing arm is moved by break force, it causes an undesirable toe-out

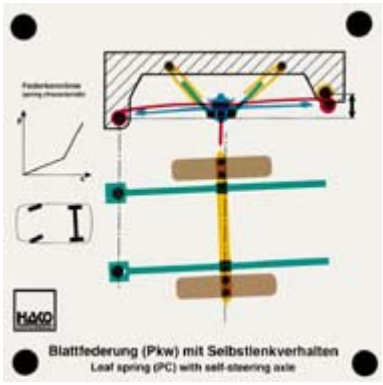


- kinematic axle: Because of the arrangement ot this suspension, the wheel gets a toe-in and introduces an automatic corrention



Order no. 381
Leaf spring (PC)
with self-steering axle

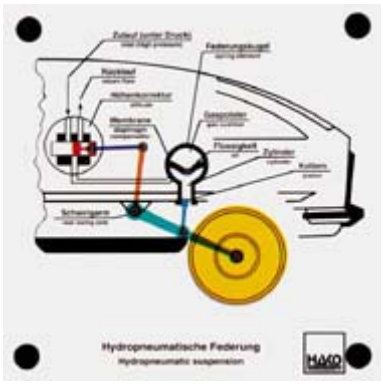
When the wheel to the ouside of the turn is compressed, the nature of the axle suspension means this wheel moves forward, and the axle swings slightly inwards.



Thus the self-steering properties of the axle are achieved

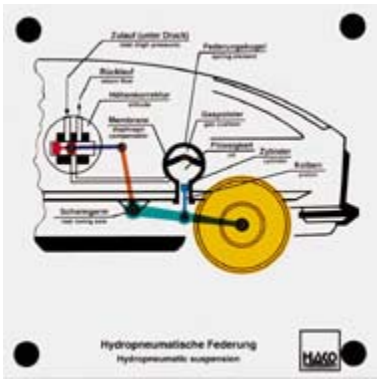
Order no. 437
Spring leg (air suspension)

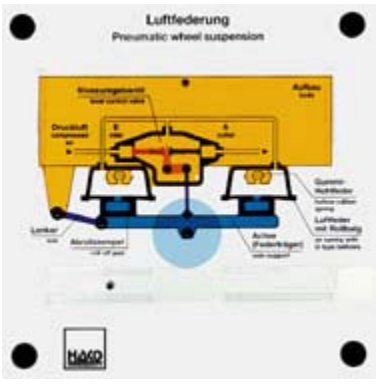
Used in the Daimler Benz S class.
- Function of a modern car air suspension
- Function of the level control
- Function of the damping and the various damping strengths



Order no. 178
Hydropneumatic suspension

- the diaphragm of the suspension element and the piston are moved by wheel compression and rebound
- simulaneously, the right-height control valve (inlet or return) is actuated





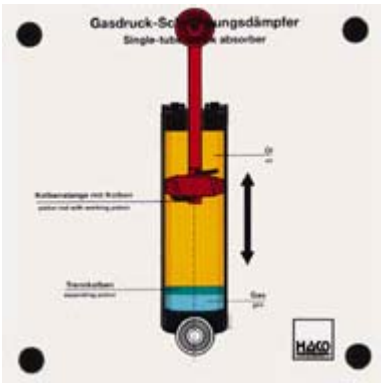
Order no. 285
Pneumatic suspension

- design of pneumatic suspension
- effect of air spring bellows and hollow rubber springs
- principle of level control on loading and unloading

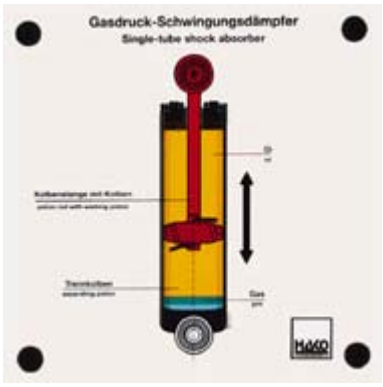
Order no. 456
Pneumatic suspension

Level regulation: if the vehicle is loaded, the level regulator in the control valve opens and air flows into the bellows of the pneumatic spring until the standard level is reached again.

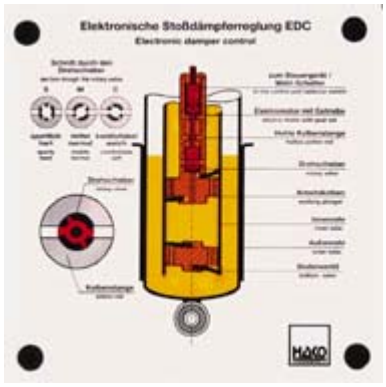
In relief, the level regulator in the control valve opens and allows air to flow out until the standard level is reached again.



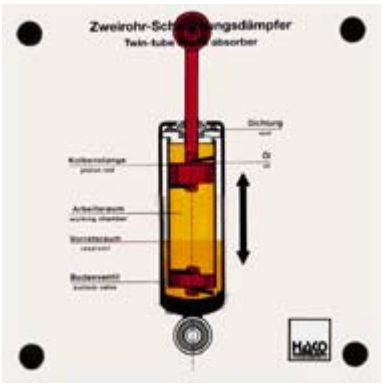
Order no. 247
Single-tube shock absorber
- the shock-absorber piston can be moved
- function of the valves (they open and close automattically)



- moving the separating piston
- changing the volume of the gas reservoir

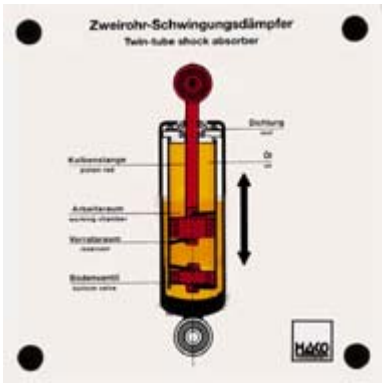


Order no. 248
Electronic damper control
- moving the shock-absorber piston
- function of the valves (they open and close automatically)
- adjusting the desired stiffnes of the shock absorber by means of a rotary valve
- interaction of all elements



Order no. 246
Twin-tube shock absorber
- displacing a shock-absorber piston
- function of the valves (they open and close automatically)

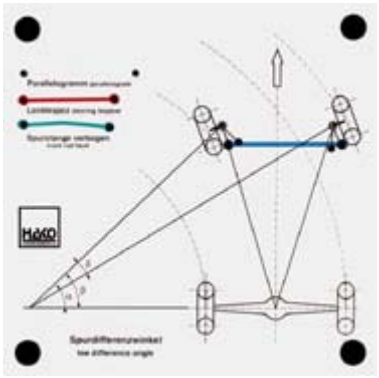
"Compression"



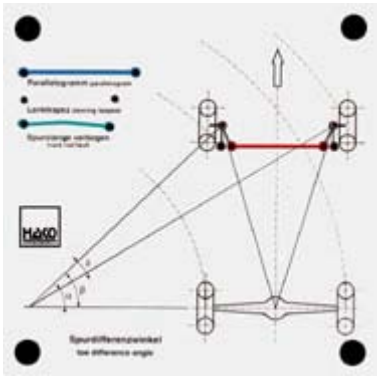
- function of the bottom valve
- moving the piston in and out changes the liquid level in the reservoir

"Rebound"

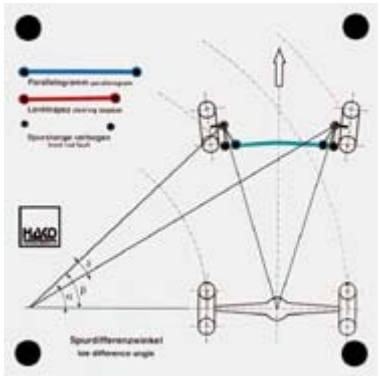
Order no. 379
Twin-tube shock absorber with variable damping
All the functions of a standard twin-tube shock absorber can be demonstrated.
In addition: low damping in the main working area (central) by means of a bypass groove formed in the housing.



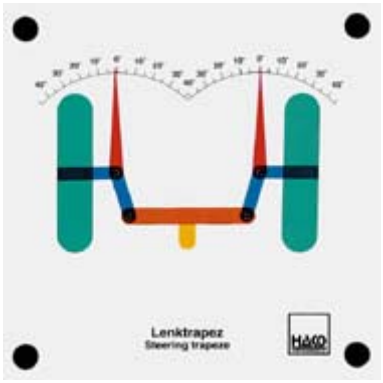
Order no. 212
Steering geomtry - toe difference angle
- with parallel track-rod arms, both wheels have the same steer angle. (steering tie rod #1)



- with a steering trapeze, the wheels have a different steer angle. (steering tie rod #2)



- with a distorted steering tie rod, the wheels have an incorrect steer angle. (steering tie rod #3)
- toe difference angle can be read



Order no. 107
Static steering trapeze

- the wheel at the inside of a curve has a larger steer angle
- a toe difference angle can be read

- the toe difference angle increases with increasing steer angle

Order no. 108
Dynamic steering trapeze

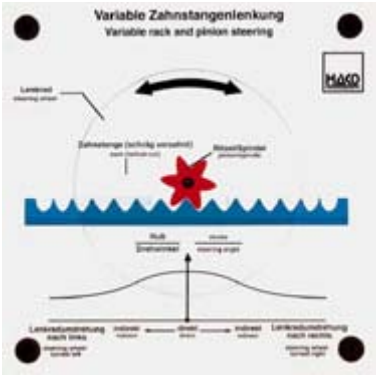
- the wheel at the outside of a curve has a larger steer angle
(e.g. for sportscars)

Order no. 106
Parallel steering trapeze

- both wheels have the same steer angle

Order no. 282
Rack and pinion steering gear

- actuating the pinion
- power transmission to the racks
- variations of track rod division
- reading off the various toe difference angles

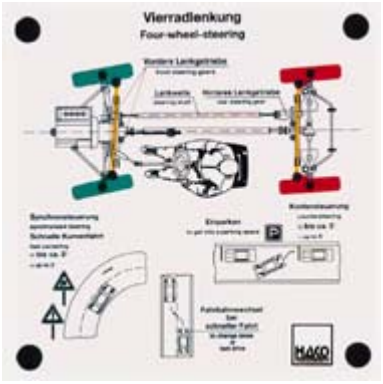


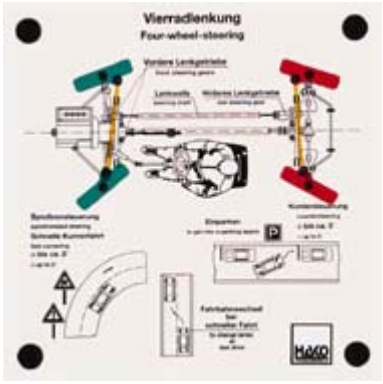
Order no. 232
Variable rack-and-pinion steering

- A rack with variable tooth pitch causes a direct transmission in the middle of the rack. To the sides, the tooth pitch gets finer(indirect) and thus the force needed to steer the wheels decreases.

Order no. 458
Fifth-wheel steering, axle-pivot steering

When both steerings are operated, the differing wheel base and the differing contact area can be clearly demonstrated. A rubber tensed across the middles of the wheels shows the immense lessening of the contact area in a wheel deflection on the fifth-wheel steering. With the axle-pivot steering, there is no alteration of the contact area with a wheel deflection.





Order no. 245
Four-wheel steering

- it is possible to tilt all wheels to show the principle of a four-wheel steering
- synchronized steering for changing lanes and cornering

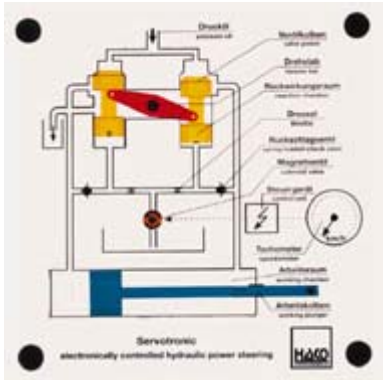
"Synchronized steering"

- countersteering to get into a parking space

"Counter steering"

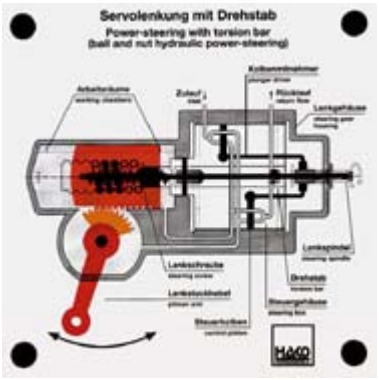
Order no. 297
Rack-and pinion power steering

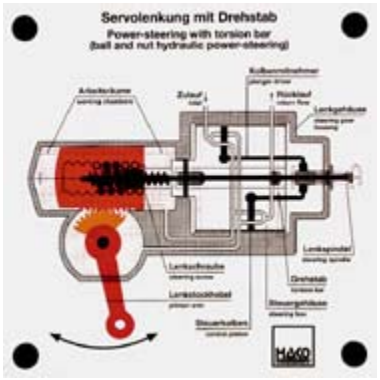
- movement of the gear rack by means of steering spindle and torsion bar
- the control sleeve opens the respective hydraulic lines to the working chambers



Order no. 267
Electronically controlled hydraulic power steering

- turning the torsion bar
- the valve pistons in motion
- the solenoid valve in action
- the working plunger in motion
- reaction torque on the torsion bar
- interaction of all elements





Order no. 302
Power-steering with torsion bar
(ball-and-nut hydraulic power steering)

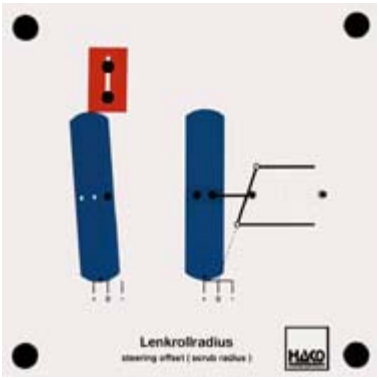
- the steering spindle moves the recirculation ball screw and steering segment
- during steering, the control piston in the steering valve are moved automatically
- the hydraulic lines to the working chambers open automatically

Order no. 298
Worm-and-sector steering

- turning the steering spindle using the steering wheel
- moving the steering worm, worm-gear sector and pitman arm
- calculatting the transmission ratio
- collapse of steering spindle in the event of an accident (passive securety)

Order no. 471
Electric power steering

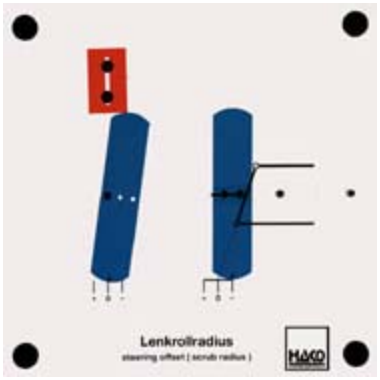
The torsion rod is rotated by the steering wheel being turned.
The signals from the transmitter for the steering torque and the steering position are sent to the control unit, from which the control unit calculates the energy for the electric motor.
The steering column is operated via a wormed gear and the wheel deflection takes place. The toe difference angle can be seen clearly.



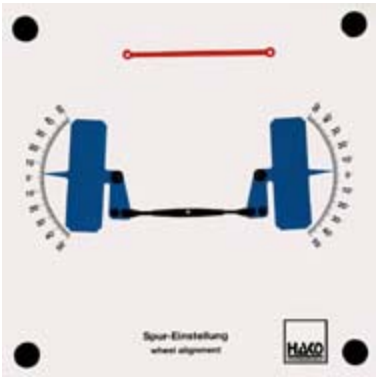
Order no. 320
Kingpin offset

Right:
- positive, zero and negative kingpin offset

Left:
- kingpin offset effect:

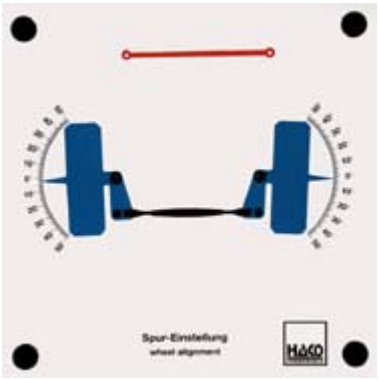


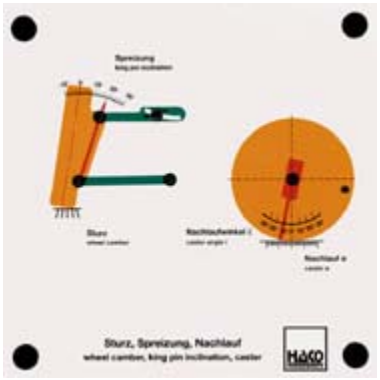
- positive: wheels steer outward
- negative: wheels countersteer
- zero: no wheel torque



Order no. 321
Wheel toe in adjustment

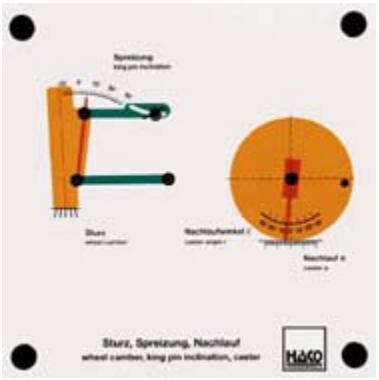
An adjustable steering tie rod allows for demonstration of the following:
- toe-in, toe-out, neutral toe
- steering trapeze and parallel rod
- observation of the toe differnce angle



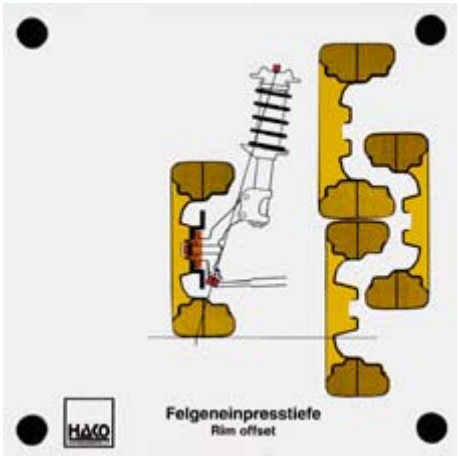


Order no. 322
Kingpin, inclination, castor

Left
- adjustment and observation of various kingpin and inclination angles
- wheel compression

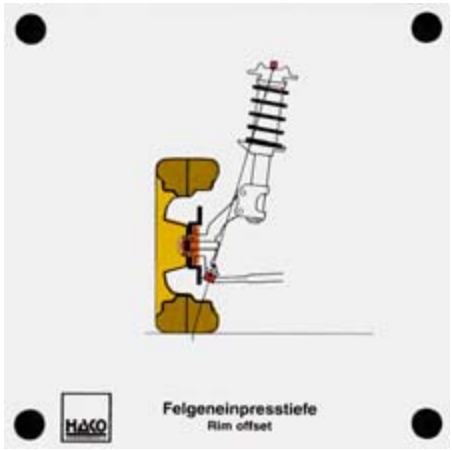


Right:
- adjustment of the negative, zero and positive castors
- observation of castor offstet and castor angles

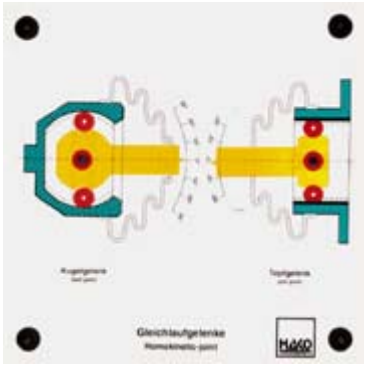


Order no. 445
Rim offset

Meaning of the expression "offset"
Effects of various offsets

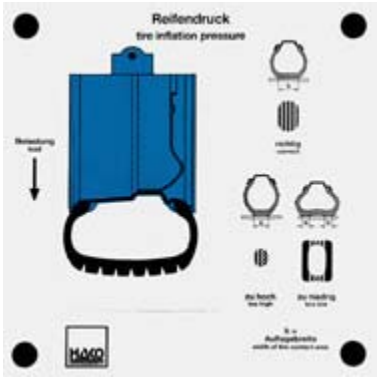


on the kingpin offset (e.g. a negative kingpin offset can turn into a positive one)
Effects of fitting wider tyres



Order no. 194
Homokinetic joint

- ball joint: large inclination angle, without length compensation
- pot joint: smaller inclination angle, with length compensation



Order no. 286
Tire inflation pressure

- deformation of the tire when inflation pressure is too high or too low
- deformation of the tire when the load is exessive
- reduced width of the tire contact area when the inflation pressure is too low or too high
- development of thread wear