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Dear Sir/Madam

The pace of advancement in technical developments nowadays is ever increasing. The scope of the subject matter to be taught is becoming wider and more difficult, furthermore, in most cases, it has to be taught within a considerably shorter teaching period. Greater demands are continually being placed on the pupils' capacity for intellectual thought. Consequently, there is also a growing need for the utilisation of appropriate teaching aids. The great advantage of overhead models is their ability to show key technical processes in sufficient size and action. They are ideal for demonstrating principles and can be amplified through the addition of cutaways of the original parts.

It is important that the actual moving processes should not be demonstrated using a series of static slides, the movement action should instead be allowed to continually unfold. This improves understanding of the procedure whilst on the other hand minimising the amount of time required.

Years of teaching practice in vocational schools, advanced training classes and driving instruction centres led to the development of our overhead models. These models are manufactured from high quality acrylic glass, three millimetres thick and screwed together using galvanised M3 screws and washers to give you years of enjoyment. Should a model nevertheless become damaged we offer a repair service at cost price.

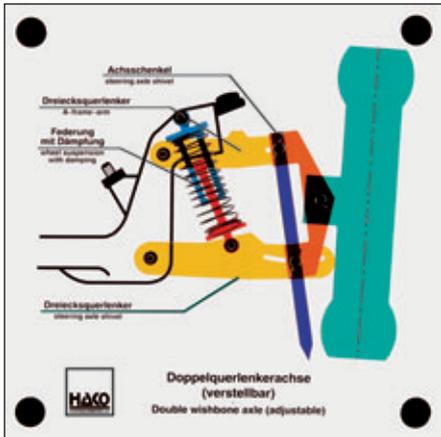
The baseplate on our models is 295x295x3 millimetres in size. If you experience problems with storage of the models, we offer a small stand which holds 10 models and a sealed cabinet for 50 models.

Our cutaway, assembly and functional models are an ideal complement to our range of overhead models. Once the basic functional principles have been worked through using the overhead models, the cutaway original components can then be used to explain the additional functions in more detail. Our range is completed by our engine test stands for workshop use. Adjustment, testing and maintenance works can be performed on working engines, as well as troubleshooting on actuators and sensors.

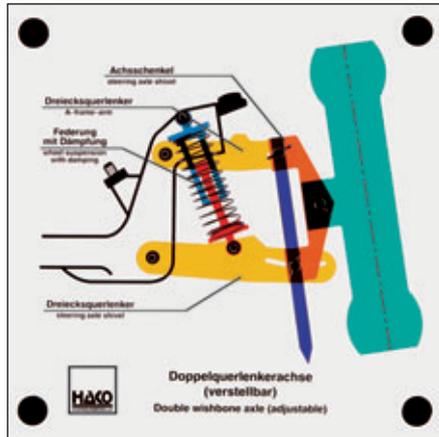
We shall continue to develop further models in the future and will keep you informed of progress. Should you have any suggestions or technical problems concerning demonstration please let us know. We will take them on board and endeavour to seek a solution for them.

Yours sincerely
HAKO Overhead Models

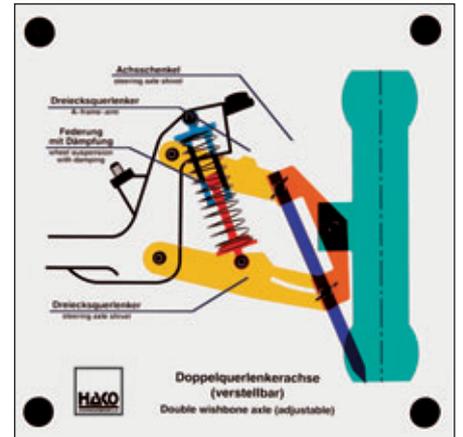
HAKO-OVERHEAD-MODELS – ... and what you can show with them!



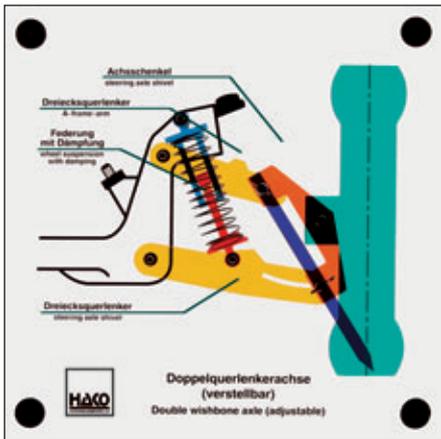
picture 1: positive camber



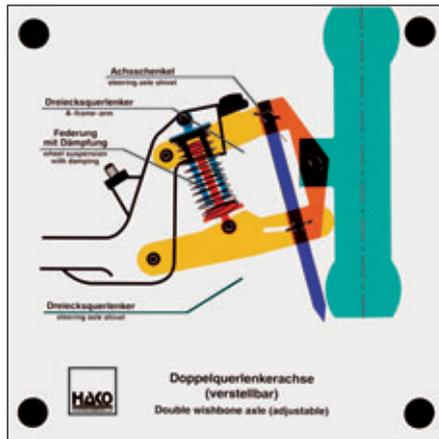
picture 2: negative camber



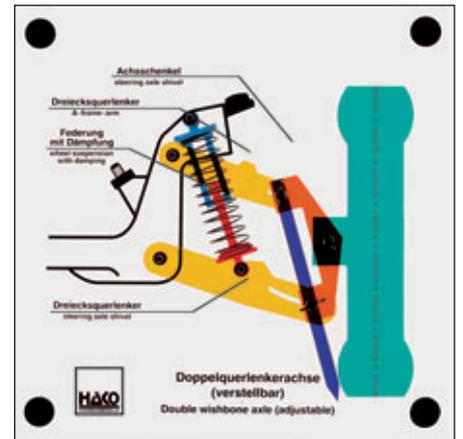
picture 3: positive kingpin offset



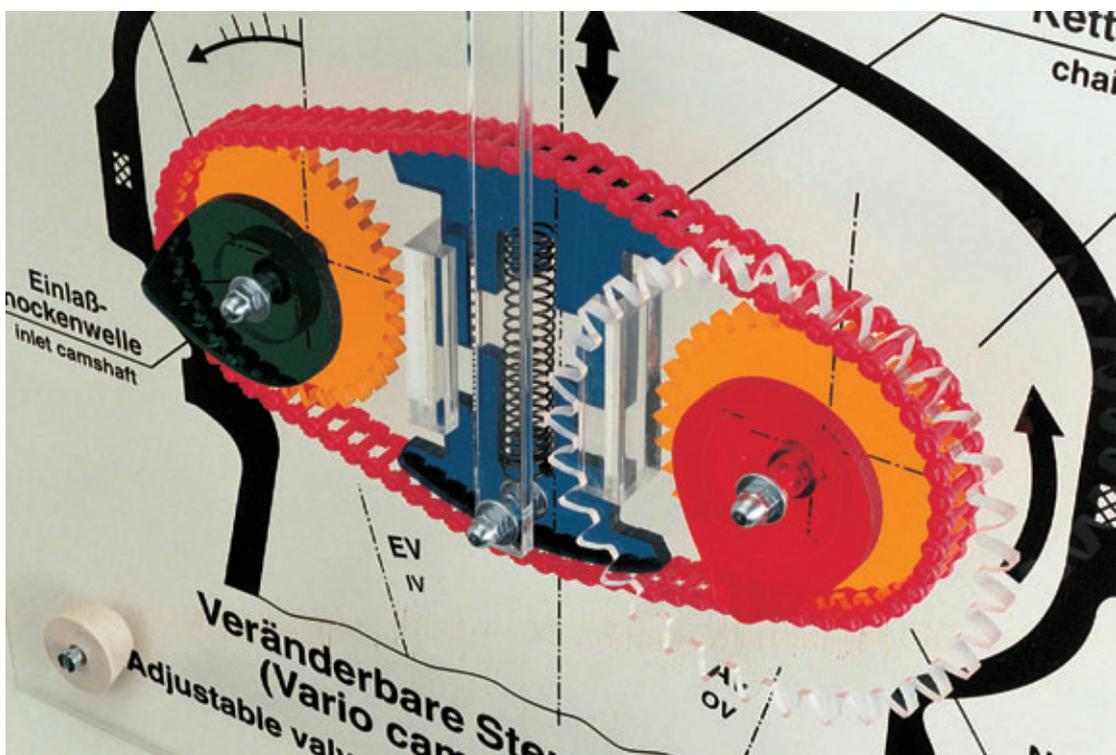
picture 4: negative kingpin offset



picture 5: compression



picture 6: rebound



Overhead models

Combustion engines, steam engines, Stirling engines,
engine management, other models, model stands and
model cabinets for OH models

1

Fuel supply, mixture preparation in petrol and diesel engines,
supercharging, cooling, lubrication

2

Clutches, transmission, synchromesh,
automatic transmission

3

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

4

Hydraulic braking, air-operated braking,
compressed-air valves

5

Motor vehicle electrics, electrics

6

Mechanical engineering, pneumatics, hydraulics

7

Sanitary engineering, two-wheel engineering,
quality assurance, other

8

Cutaway, functional and assembly models

Petrol engines, engine components, petrol engine mixture prepa-
ration, fuel pumps, cooling, diesel engines, engine components,
diesel engine mixture preparation, supercharging, lubrication

9

Clutches, transmission, automatic transmission, rear-
wheel drive, steering, chassis, damping, suspension

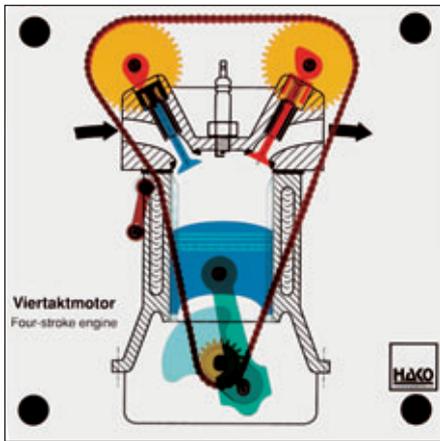
10

Hydraulic braking, air-operated braking

11

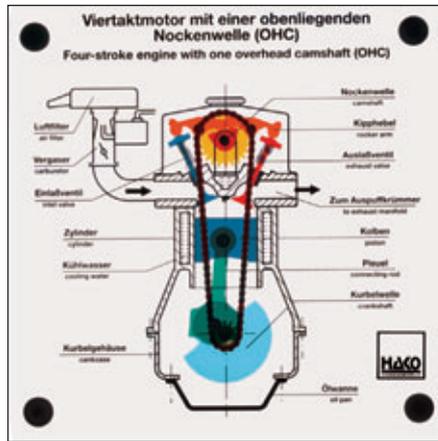
Motor vehicle electrics, pumps

12



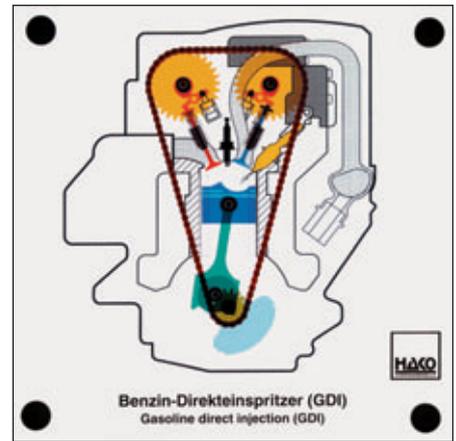
Four stroke engine

- drive of the double overhead camshafts
 - sequence of the four strokes
 - valve opening overlap
 - function of a chain tensioner
- Order no. 101



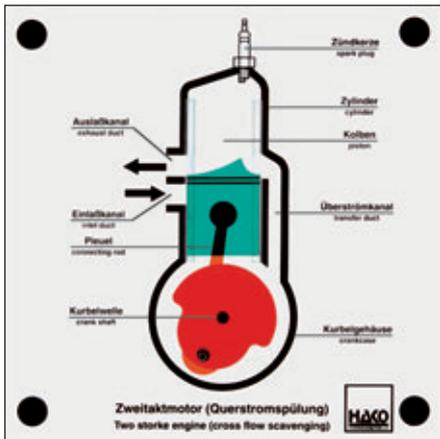
Four-stroke engine with one overhead camshaft (OHC)

- crankshaft drive, stroke of a piston
 - camshaft timing (ratio of 1:2)
 - function of the rocker arms
 - opening and closing the valves
 - valve overlap
- Order no. 255



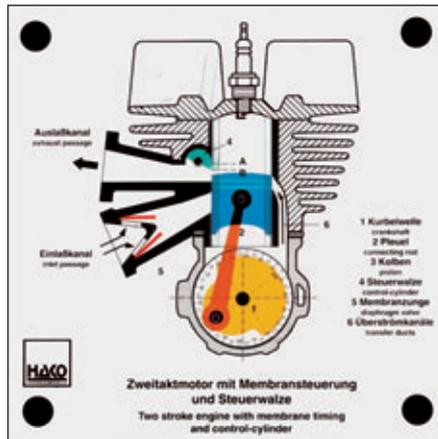
Petrol direct injection engine

- all the functions of a four-stroke engine can be shown with valve overlap
 - direct injection of the petrol into the combustion chamber (bowl-in piston)
- Order no. 417



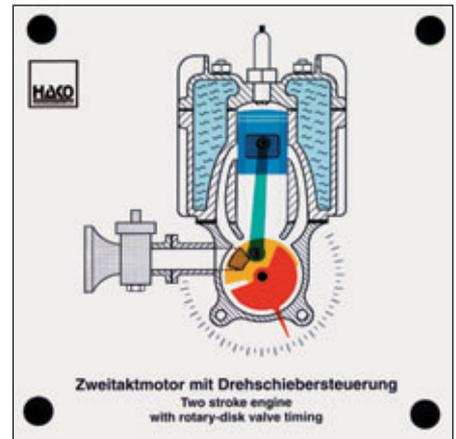
Two stroke engine

- function of combustion chamber and crankcase
 - sequence of the strokes in both chambers
 - function of the transfer duct
- Order no. 102



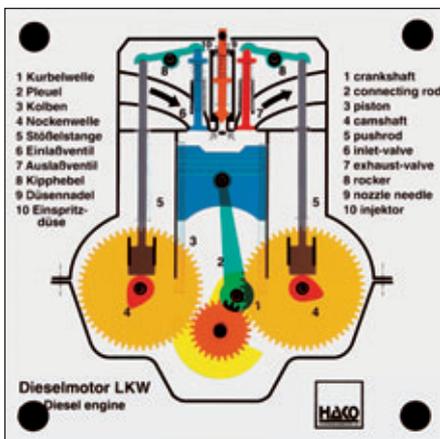
Two stroke engine with diaphragm timing and control cylinder

- principle of a modern two stroke engine
 - function of a diaphragm timing
 - actuating the control cylinder in the exhaust passage
 - the control timing is changed by the control cylinder
 - the control timing can be directly read
- Order no. 193



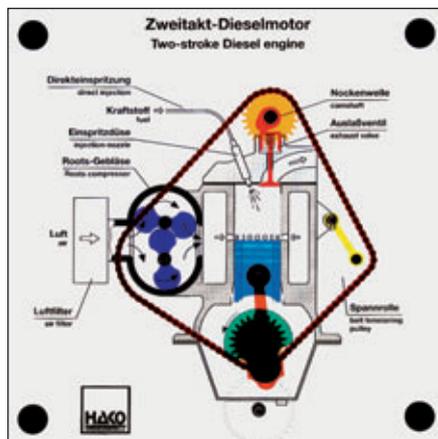
Two-stroke engine with rotary-disk valve control

- gas control in a two-stroke engine with rotary-disk valve
 - reading off the angle for the induction, precompression, overflow, exhaust, compression and working
- Order no. 398



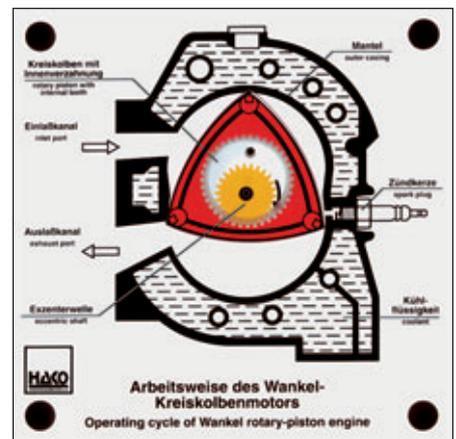
Diesel engine of a truck

- the OHV-engine is driven by means of a camshaft, tappet and rocker arm
 - valve overlapping
 - sequence of the four strokes
 - injection needle in motion
- Order no. 191



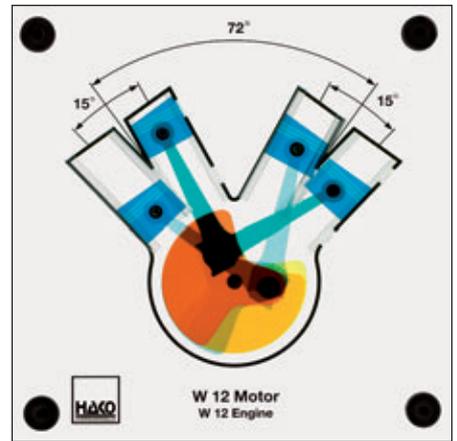
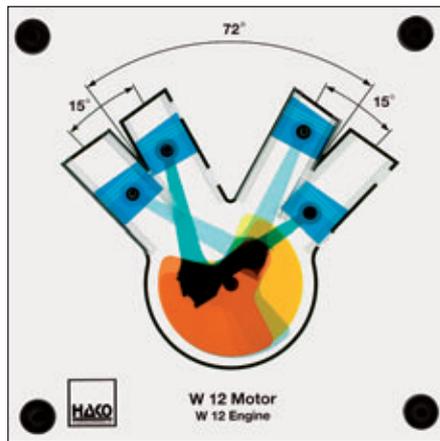
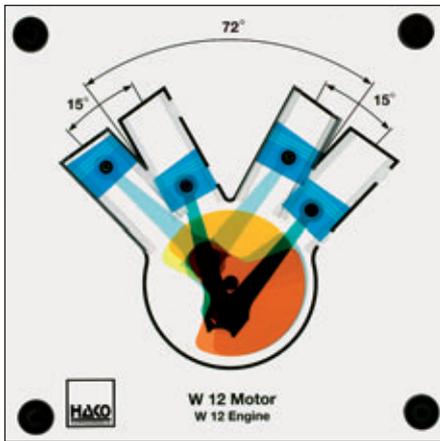
Two-stroke diesel engine

- function of crankshaft drive
 - regulation of camshaft and exhaust valve
 - principle of a roots compressor for in-flow scavenging
 - regulation of charge cycle
- Order no. 287



Wankel engine

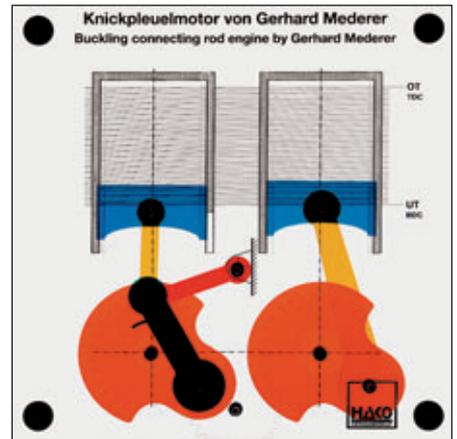
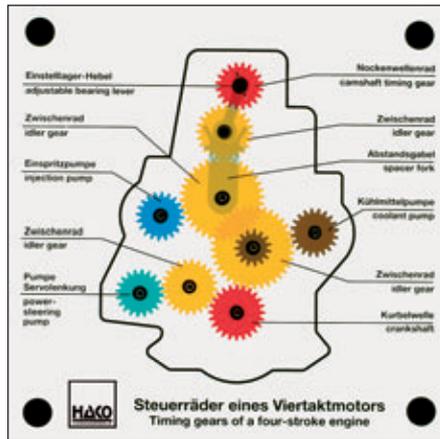
- this big and solid overhead model shows how a Wankel engine works, especially the functions of an eccentric shaft and gearing
- Order no. 238



W 12 Engine

A disk of a W12 6.0 l engine of an Audi A8 was shown. As a result of the bank angle of 72° and an ignition interval of 60°, the 6 crank pins of the cylinders opposite one another are offset by 12°. This is called a "split pin".

When the engine cranks, one sees the displacement of the plungers and the ignition order.
Order no. 478

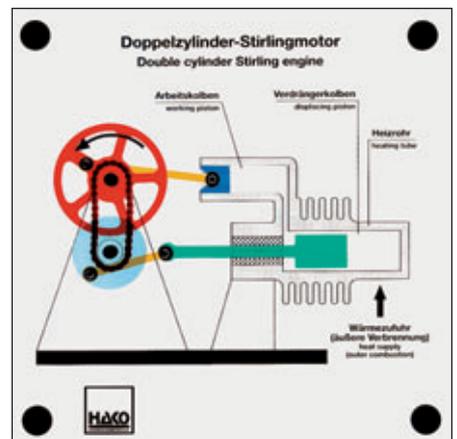
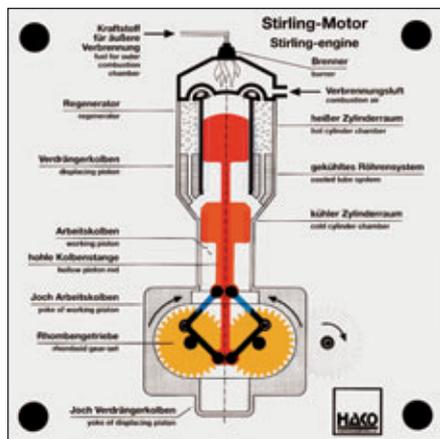


Timing gears of a four-stroke engine

Instead of toothed belts or a chain, 10 spur gears are used to drive the injection pump, the camshaft and the ancillaries. Injection pump and camshaft turn with half the crankshaft speed.
Order no. 479

Buckling connecting rod engine by Gerhard Mederer

The two engines are connected by gear wheels and turn simultaneously.



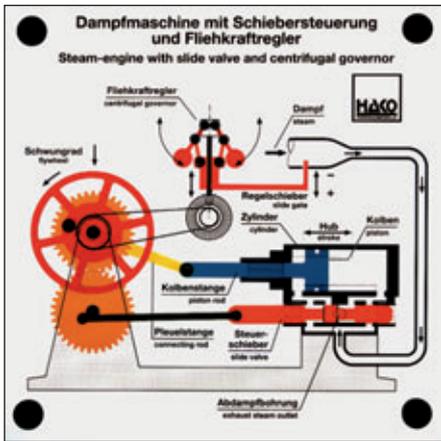
It is clear that the buckling connecting rod engine has a significantly improved linkage towards the crankshaft and a greatly reduced piston side pressure.
Order no. 301

Stirling-engine

- function of a rhomboid gear-set
 - functioning of displacing piston and working piston
 - effect of regenerator in the closed system
- Order no. 289

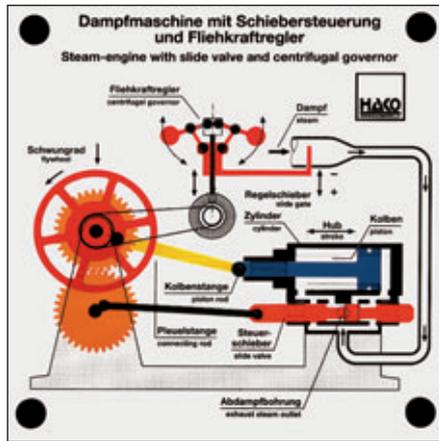
Double-cylinder Stirling engine

- function of a double-cylinder Stirling engine
 - actuating the crankshaft drive
 - interaction of working and displacing piston
- Order no. 304

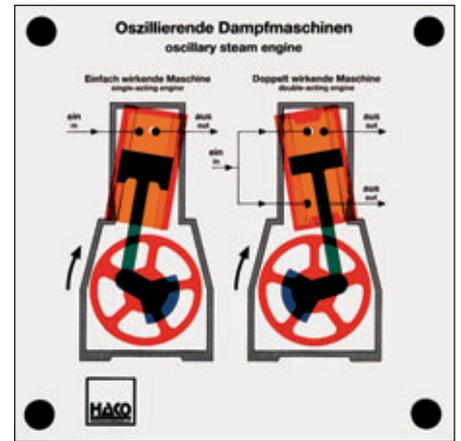


Steam engine with slide valve and centrifugal governor

- function of the piston and flywheel
- function of the slide valve
- function of the centrifugal governor

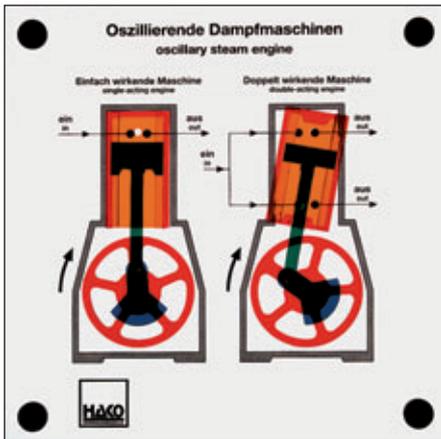


- regulating the steam inlet for constant speed
Order no. 283

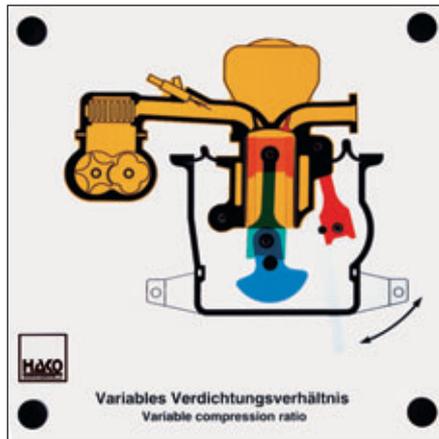


Oscillating Steam Engine

The simplest form of a reciprocating engine is a steam engine with oscillating cylinders. The model shows both the single-acting and the double-acting engine. The mode of operation of the engines and the control of steam inlet and outlet, through a cylinder bore in each case, can be demonstrated particularly well.

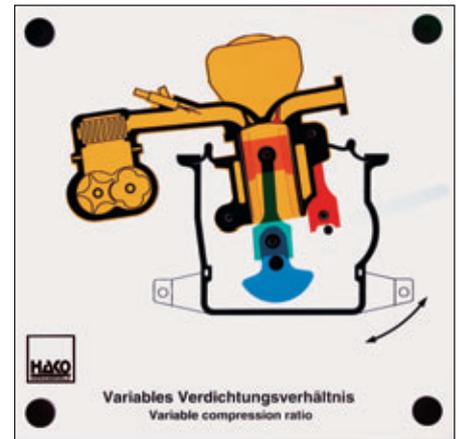


Function: control of steam by moving the cylinder
single-acting: one working chamber (above the cylinder)
double-acting: two working chambers (above and below the cylinder)
Order no. 319

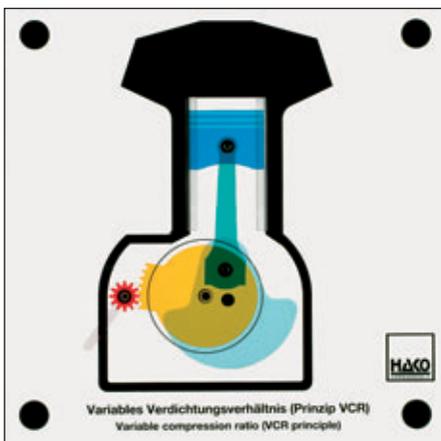


Variable compression ratio (VCR engine)

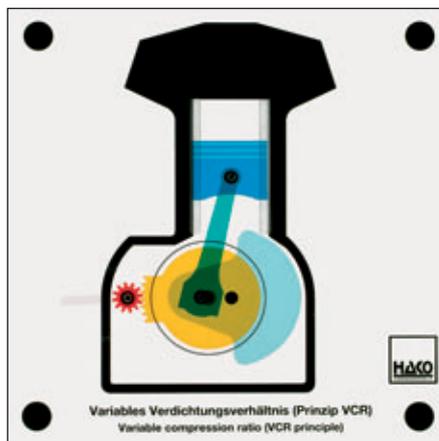
By pivoting the cylinder block plus added parts around a pivoting axis, the compression ratio can be altered infinitely from 8:1 (full load with full loading pressure) to 14:1 (part load with low loading pressure).



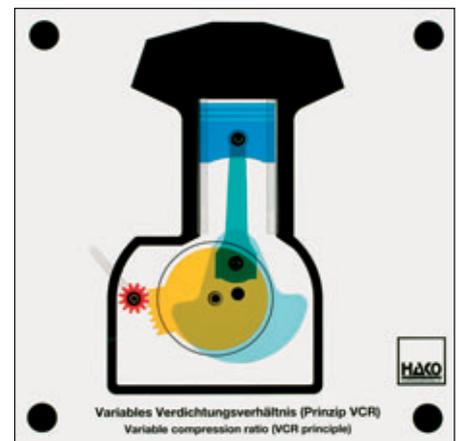
Maximisation of the compression ratio from idling to full load with minimisation of the fuel consumption and pollutant discharge.
Order no. 457



low compression ratio



middle compression ratio

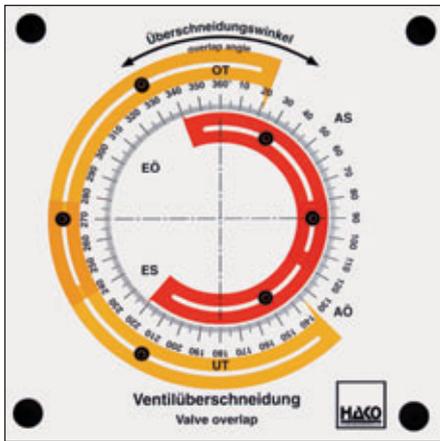


high compression ratio

Variable compression ratio

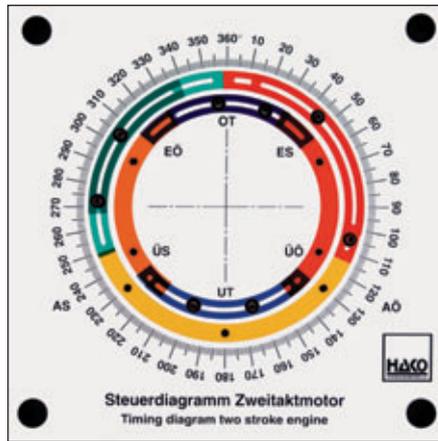
The crankshaft is supported on eccentric disks in the engine block. One toothed gear is moved via a lever and the eccentric disk turned in this way. The compression ratio is increased or reduced in this way.

This can be seen very clearly when the crankshaft is turned.
Order no. 483



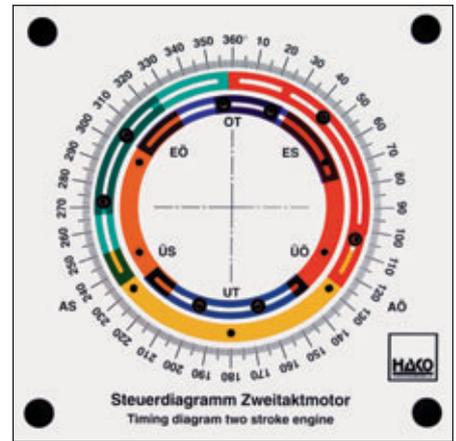
Valve overlap

- the opening and closing angle of the discharge and inlet valves can be adjusted as required
 - the various overlap angles can be read off
- Order no. 395

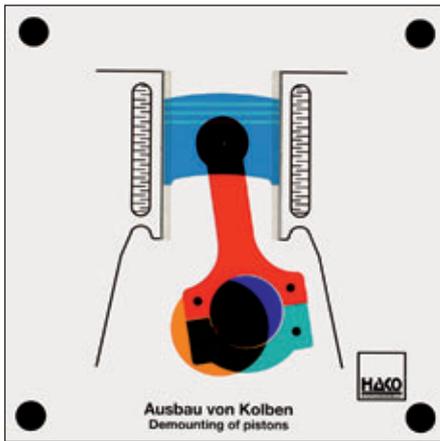


Two-stroke engine timing diagram

- Setting of the various angles for:
- pre-induction, induction, precompression, overflow, exhaust, compression and working
 - setting of symmetrical and asymmetrical timing diagrams

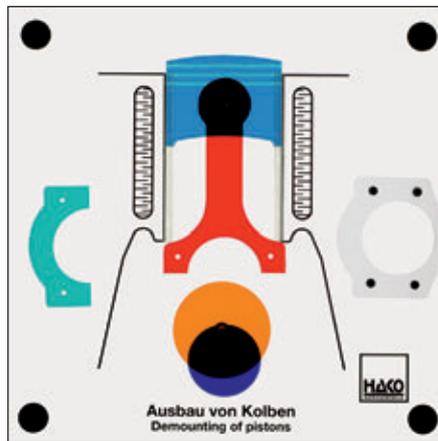


- reading off the various angles
- Order no. 399

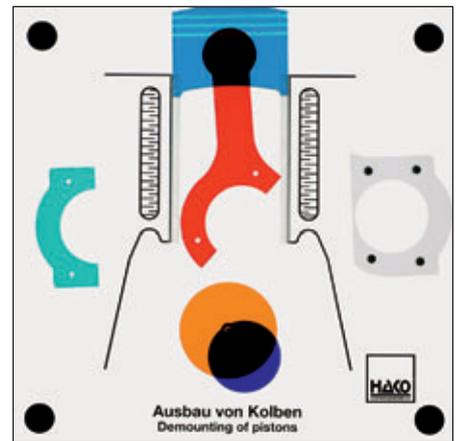


Demounting of pistons

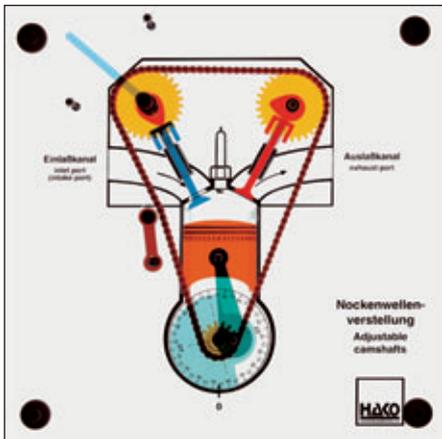
- Demonstration:
- Turn the crankshaft, observe the stroke of the piston
 - Demount the connecting rod bearing cap with straight division (plug-in type connection).
 - The connecting rod big end can not be demounted upwards through the cylinder (too wide), i.e. to dis-



- mount the piston, the crankshaft has to be removed.
- Push piston with connecting rod big end with inclined division into the cylinder
- Demount the connecting rod bearing cap (plug-in type connection).

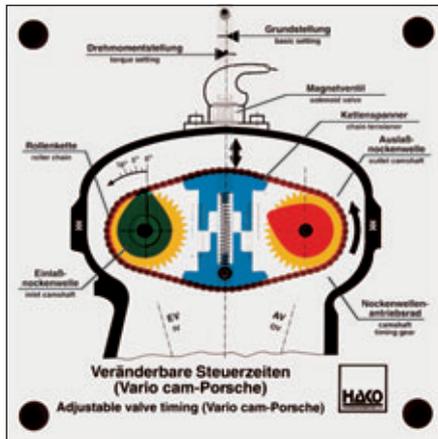


- This connecting rod big end is narrower and can be demounted through the cylinder, i.e. the time-consuming demounting of the crankshaft is no longer necessary.
- Order no. 485



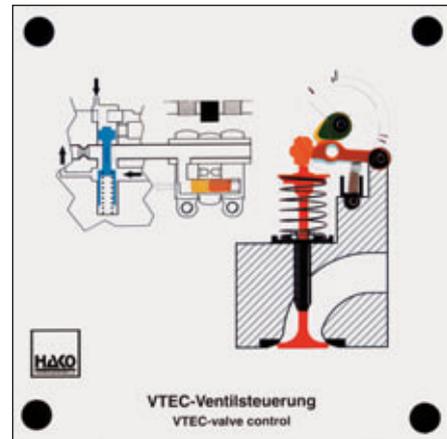
Adjustable camshafts

All functions of a four-stroke engine can be shown, including chain tensioning. Inlet valve and exhaust valve openings can be read in degrees. Valve opening and closing as well as valve overlapping can be shown. The inlet cam can be advanced by means of a lifting cam and a power screw (in the model actuated by a transparent lever). Order no. 187



Variable valve timing system Porsche (VARIO CAM)

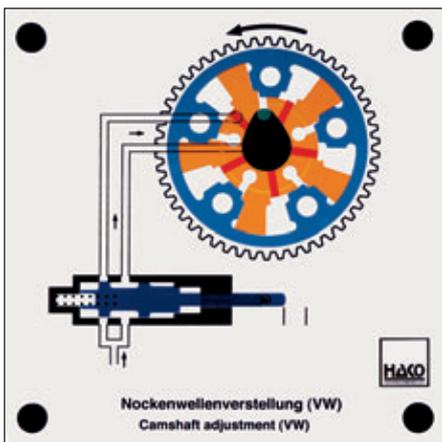
Advancing the inlet camshaft by means of two sliding chain tensioners, which can be moved to and fro via magneto-hydraulic actuation. The exhaust camshaft is driven by the crankshaft. The inlet camshaft is driven by the outlet camshaft via a chain. Order no. 235



VTEC valve control

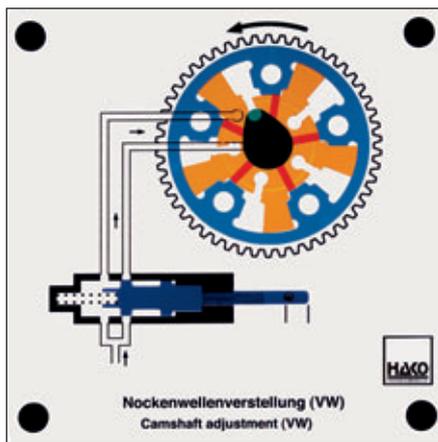
- valve control in the lowest speed range with drag levers released
- locking of the drag lever in the upper speed range, valve control by means of the sharp cam
- entering the control angle

Order no. 419

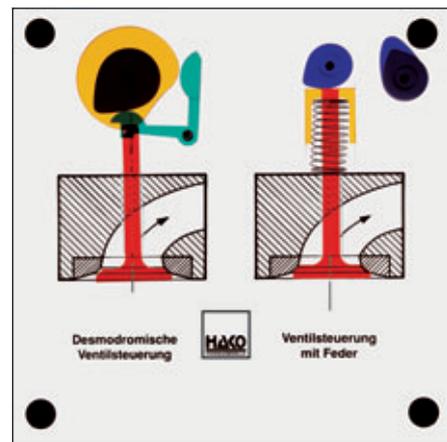


Camshaft adjustment (VW)

In this, the adjustment of the inlet and the outlet camshaft is done with the help of hydraulically operated vane adjuster. In an outer rotor, an inner rotor is rotated hydraulically clockwise or anti-clockwise and adjusts the camshaft in the direction of early or late.



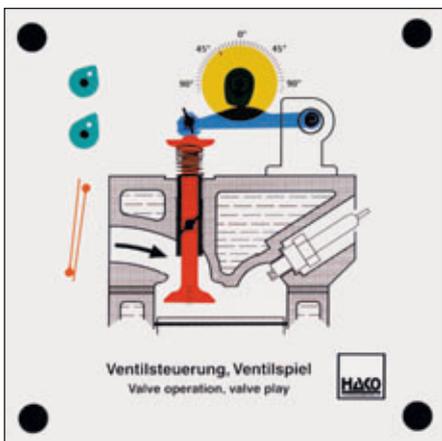
The maximum adjustment angle is 52° crank angle with the inlet camshaft and 22° with the outlet camshaft. Order no. 463



Valve timing

- function of the desmotronic valve actuation (with cams to open and close the valve)
- different cam shapes cause different cylinder fillings

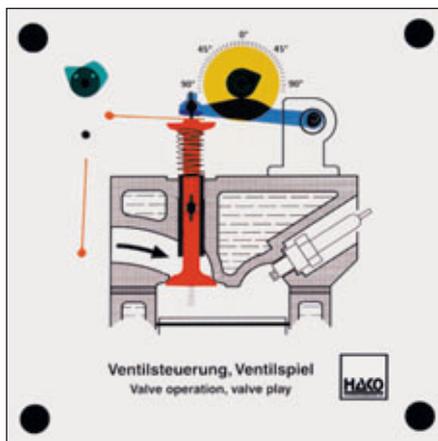
Order no. 130



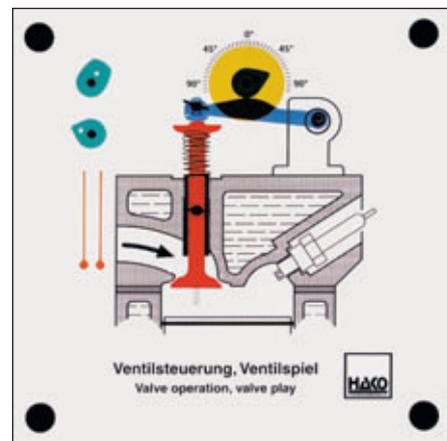
Valve operation, valve play

Functions:

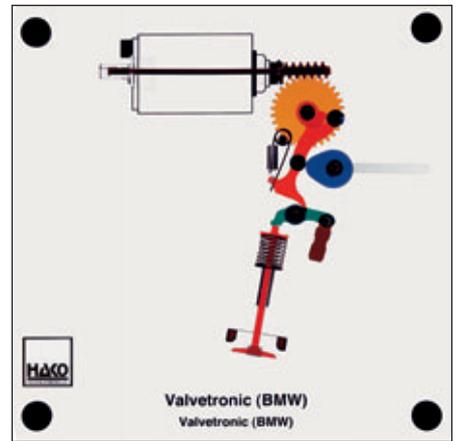
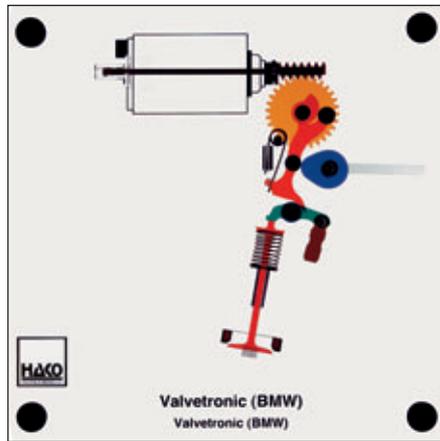
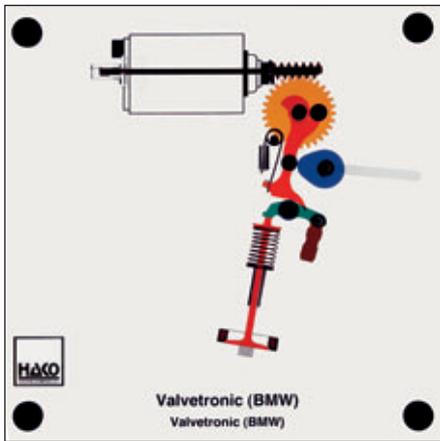
- Differing valve stroke with differing heights of cams.
- Reading off the angle of opening with differing shapes of cams.



- Correct setting of the valve play with the help of a thickness gauge.
- Heat expansion of the valve and the effects if the valve play is too low.
- Effects on the engine if the valve play is too large.



Order no. 435



Valvetronic (BMW)

Instead of a throttle valve, the differing valve stroke is used in the Valvetronic to control the fresh gas. An eccentric shaft is operated by the engine management via an electric motor, a worm and a work wheel.

The eccentric shaft controls an oscillating lever between the cam shaft and the rocker arm, with the result that the cam of the inlet camshaft opens the valve to differing extents (from zero stroke up to maximum stroke).

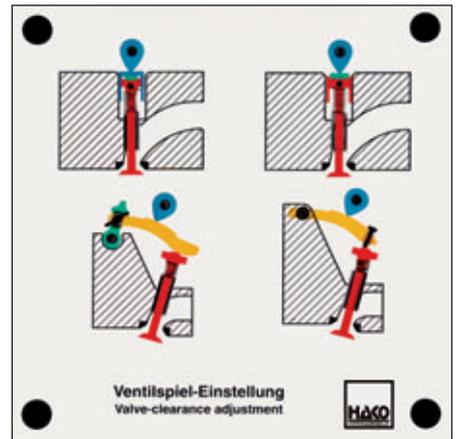
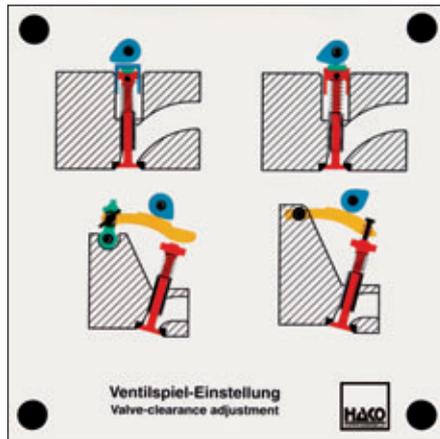
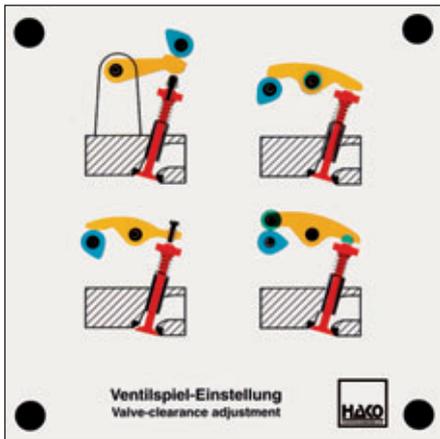
The worm can be operated manually with the help of a small wheel!

Fig. 1: Zero stroke (valve remains closed)

Fig. 2: Half stroke

Fig. 3: Maximum stroke

Order no. 460



Valve-clearance adjustment I

It is possible to demonstrate 4 different ways of setting the valve clearance, by rotating the adjusting screws on the rocker arm or rocker lever, by inserting discs of varying thicknesses or by means of an eccentric on the rocker arm.

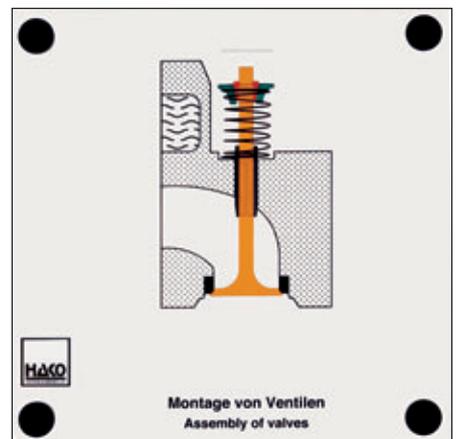
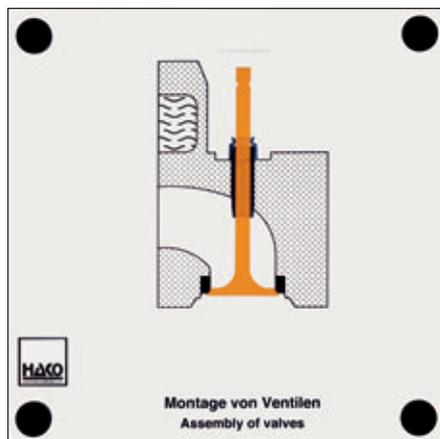
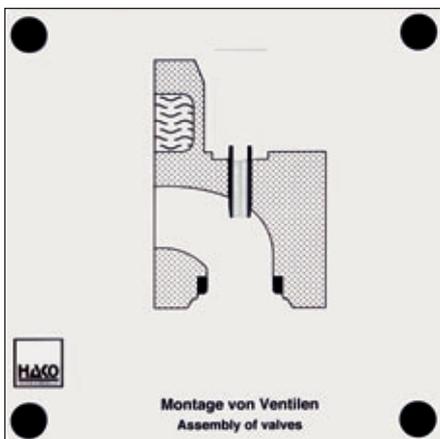
Order no. 390

Valve-clearance adjustment II

It is possible to demonstrate 4 different ways of setting the valve clearance. By inserting discs of varying thicknesses in or under the bucket tappet. By rotating the adjusting screws on the rocker arm and rocker lever.

All cams can be turned, so that the opening stroke at various valve clearances can be demonstrated.

Order no. 391



Assembly of valves

The assembly of a valve into the cylinder head can be demonstrated clearly:

1st figure:

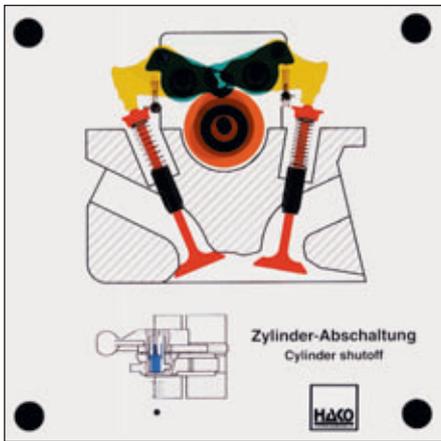
Insertion of the valve shaft into the sleeve on the cylinder head Pushing the valve shaft sealing on

2nd figure:

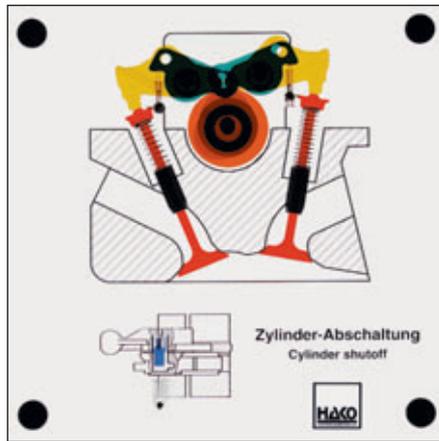
Pushing the spring valve and the spring cap on Pushing the spring valve over the spring cap

3rd figure:

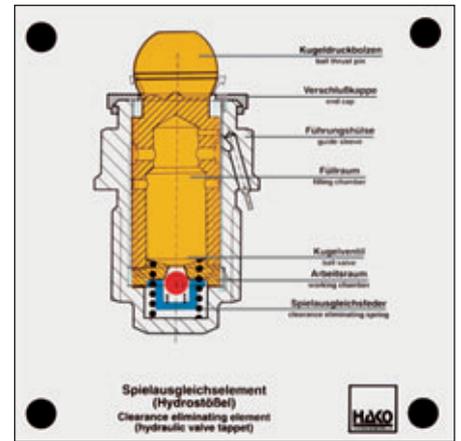
Pushing the valve key into the groove of the spring cap Order no. 464



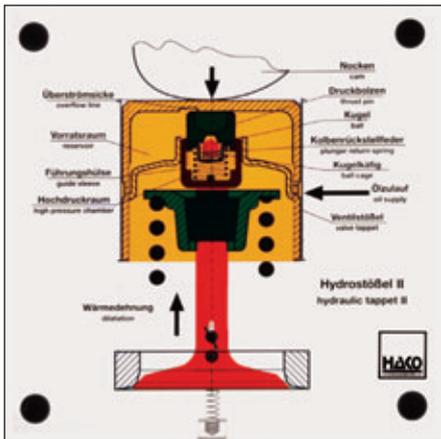
Cylinder shutoff
 The cylinder shutoff, a new development for the new Mercedes-Benz S class, is switched on and off electro-hydraulically by the control unit. In the lower load area, 4 cylinders are switched off, in the upper load area there is a switch-over to 8 cylinders. The valves are operated in a locked state. If the coupling pins



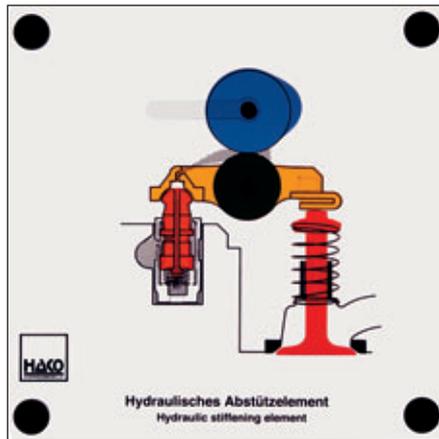
are removed, the valves remain closed. The driving levers are pressed onto the camshaft by springs in an unlocked state.
 Order no. 434



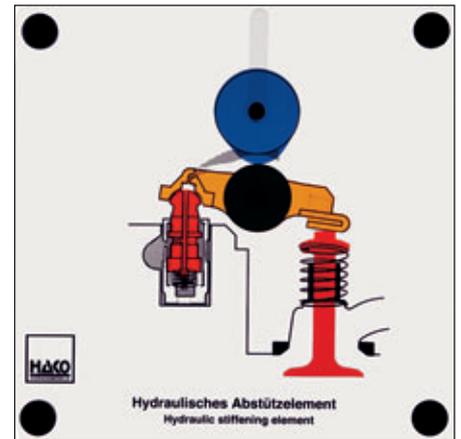
Hydraulic Valve tappet I
 – how the hydraulic valve tappet works under pressure and release
 – function of piston, spring and ball
 Order no. 131



Hydraulic tappet II
 This hydraulic tappet is designed as a bucket tappet and makes a valve adjustment without clearance possible. Function of high pressure chamber, ball valve, clearance-eliminating spring and valve tappet can be shown.
 Order no. 268



Hydraulic stiffening element
 The following can be shown:
 – valve clearance compensation by the hydraulic stiffening element
 – function of the piston in load and relief



– function of the spherical valve
 – opening of the valve by the rocker arm
 – closing the valve by the valve spring
 Order no. 459

Zündfolgen (Viertaktmotor)
 firing orders (four stroke engine)

	0°	90°	180°	270°	360°	450°	540°	630°	720°
1-2-4-8 Zylinder cylinder									
3-6-12 Zylinder cylinder									
5 Zylinder cylinder									

The diagram shows a grid of boxes representing firing orders for different engine configurations. The HAGO logo is present in the top right corner.

Valve-timing diagram
 – firing order of one- to twelve-cylinder engines
 – any firing order can be set
 – especially suited to understand different firing order schemes
 Order no. 145

Zündfolgen (Viertaktmotor)
 firing orders (four stroke engine)

	0°	90°	180°	270°	360°	450°	540°	630°	720°
1-2-4-8 Zylinder cylinder									
3-6-12 Zylinder cylinder									
5 Zylinder cylinder									

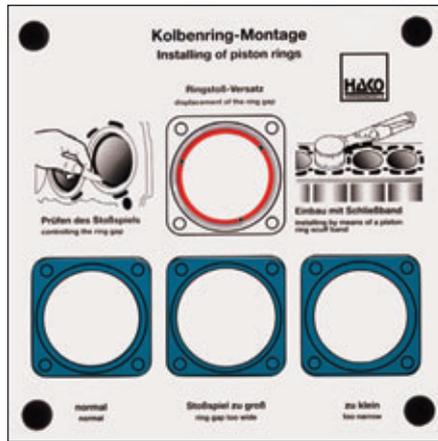
The diagram shows a grid of boxes representing firing orders for different engine configurations. The HAGO logo is present in the top right corner.

Order no. 145 E

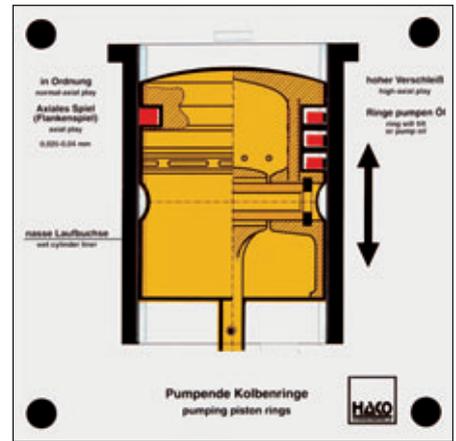


Installation of a piston ring

- inserting three different piston rings shows an incorrect and correct ring gap
- different cylinder diameters cause a piston ring gap that is normal, too wide or too narrow

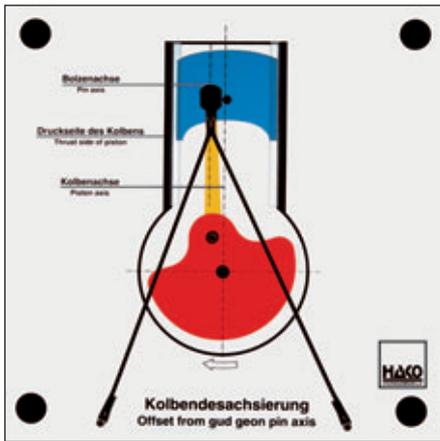


- the piston rings have a spring effect
 - all piston rings can be taken out of the modell
- Order no. 250



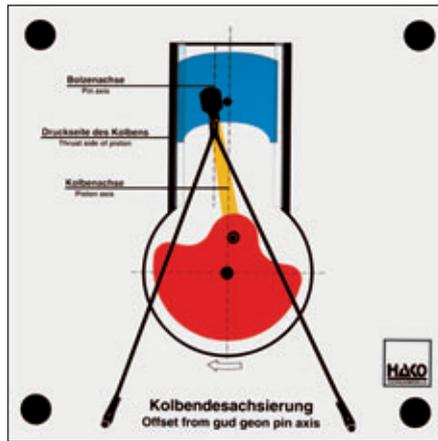
Pumping action of piston rings

- when moving the pistons to and fro, you can see how the piston rings slide up and down in the grooves if there is too much clearance: Oil is pumped into the combustion chamber
 - less clearance and thus a smaller pumping effect is shown on the left side
- Order no. 211



Piston-pin offset

- without offset: piston changes bearing surface after TDC (under full combustion pressure)

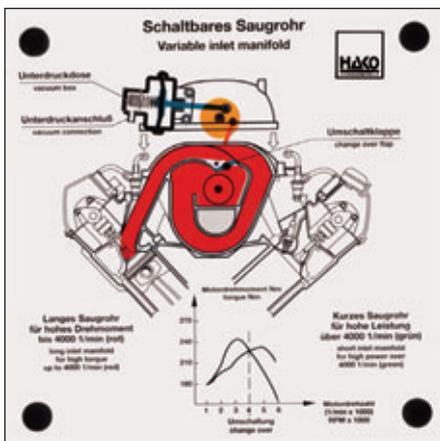


- with offset: piston changes bearing surface already before TDC
- Order no. 146



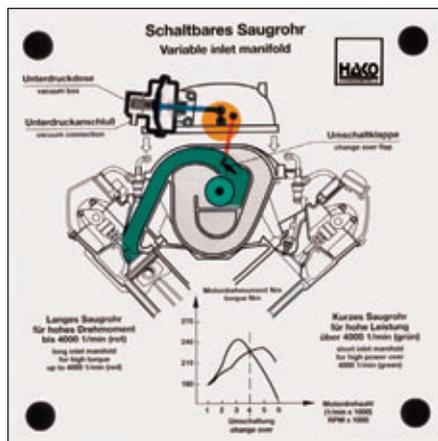
Balance shafts

- The two balance shafts of a four-cylinder inline engine turn towards each other with double crankshaft rpm.
- Order no. 189

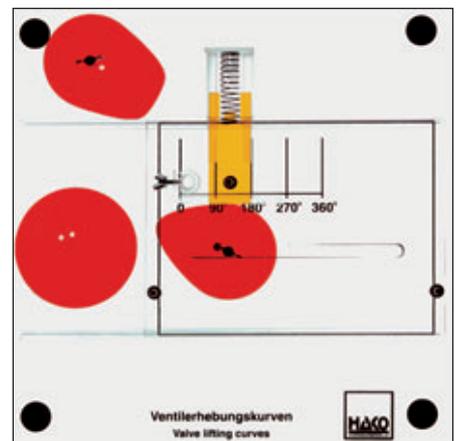


Variable inlet manifold

- Functions:
 - change-over flap is controlled by a vacuum box
 - intake gas flow varies depending on different RPMs

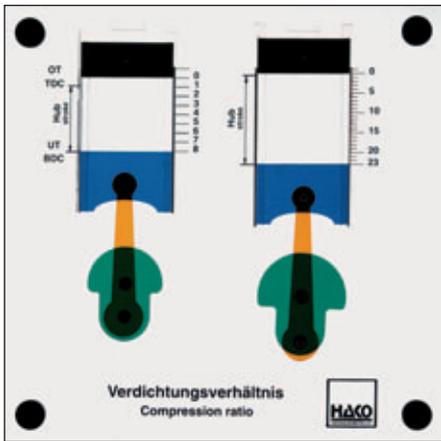


- background knowledge can be explained with the diagram
- Order no. 276



Valve lifting curves

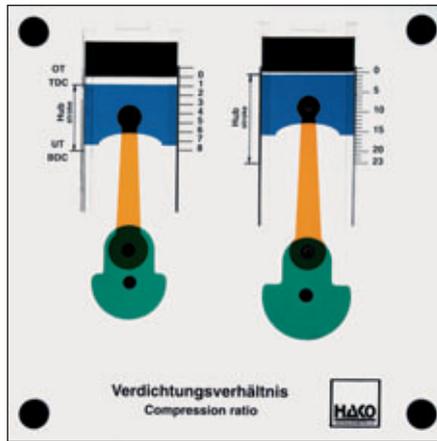
- The filling curves of three different cam shapes can be drawn directly on a mobile slide by means of the three enclosed felt pens (red, blue and green).
- Order no. 196



Compression ratio

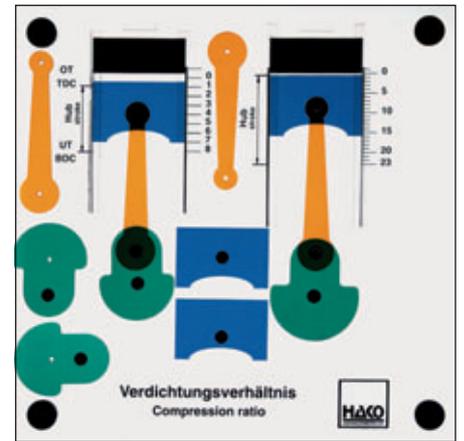
Working out of the different capacities:

- piston capacity, compression space and combustion chamber
- calculation of the compression ratios of Otto and Diesel engines possible ways of modifying



Possible ways of modifying compression:

- introduction of a higher or flatter seal or head resurfacing; this is demonstrated by means of a slide



Introduction of a longer or shorter connecting rod, piston and two different crankshafts.

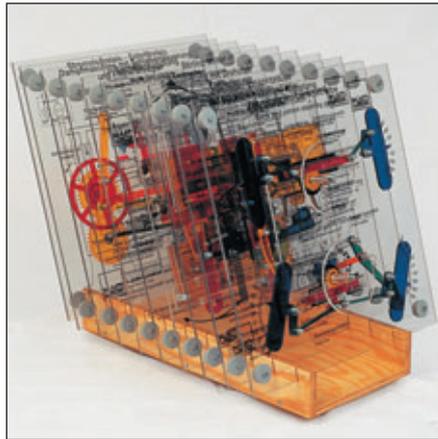
Calculation of the modified compression ratio.
Order no. 337



Model Cabinet

For storing approx 50 to 60 OH models (depending on height).

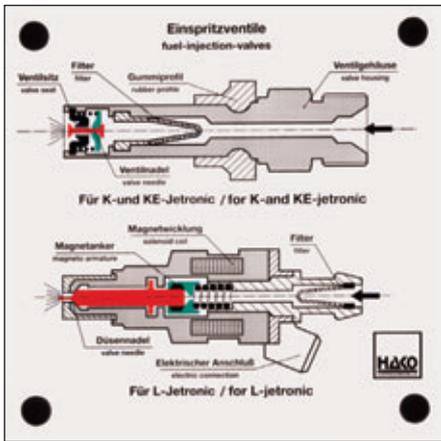
Made of synthetic laminate chipboard, lockable.
Order no. 1015



Model Stands

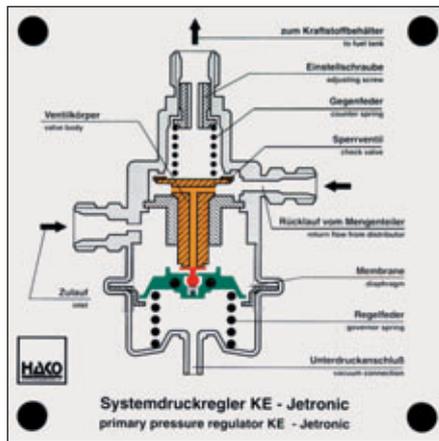
For storing 10 OH models (made of veneered plywood)

Order no. 1014



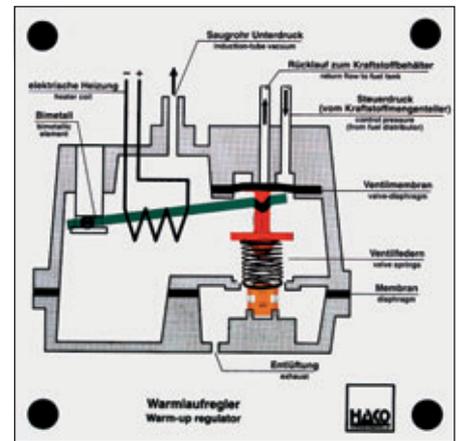
Fuel-injection valves

For K- and KE-jetronic:
 – the valve needle is opened by overpressure (3.3 bar)
 – interaction of valve needle, valve seat and spring
 For L-jetronic:
 – function of the magnetic armature
 – function of the valve needle
 Order no. 261



Primary pressure regulation KE-Jetronic

– function of the diaphragm and of the valve body
 – observation of the exact primary pressure
 – closing of the return line when engine is turned off
 Order no. 325



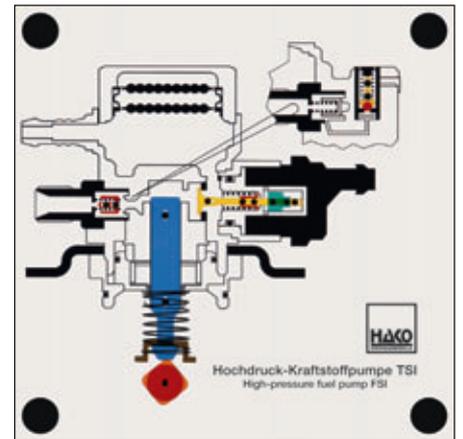
Warm-up regulator K-Jetronic

– function of the bimetal spring
 – function of the valve diaphragm
 – function of the valve springs
 – function of the vacuum diaphragm
 Order no. 149



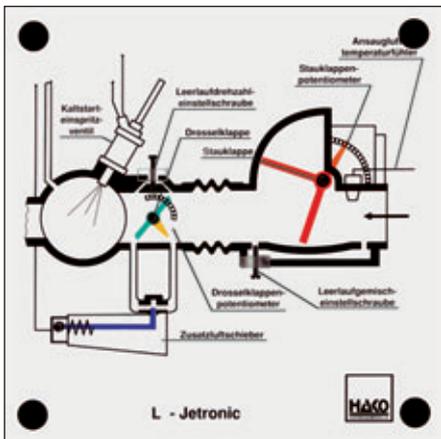
Air flow adjustment by adequate shape of the air funnel

– different angles of the air funnel cause a good adjustment of mixture ratio to load
 – different openings of the air funnel, which depend on height of the opening and angle of the air funnel, can be read
 Order no. 195



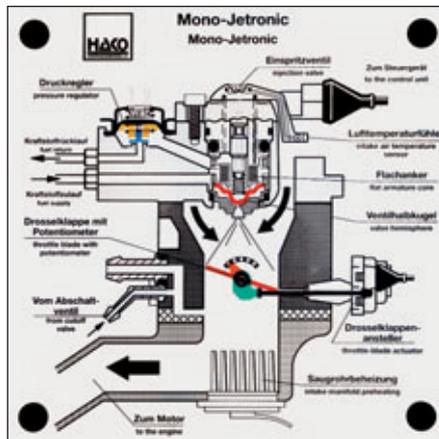
High-pressure fuel pump TSI (FSI)

The following can be shown:
 How the inlet and outlet valves work.
 Up and down movement of the pump piston.
 How the pressure relief valve works.
 Fuel intake stroke, fuel recirculating, fuel pumping stroke.
 Order no. 500



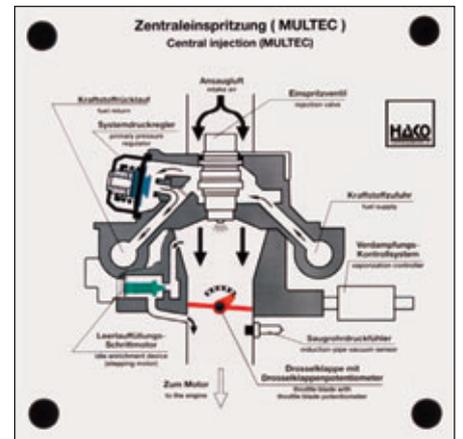
L-Jetronic fuel injection

– throttle, sensor flap and auxiliary-air device can be actuated
 – adjusting idle-speed adjusting screw and idle-mixture adjusting screw
 – function of throttle and sensor-flap potentiometer
 Order no. 182



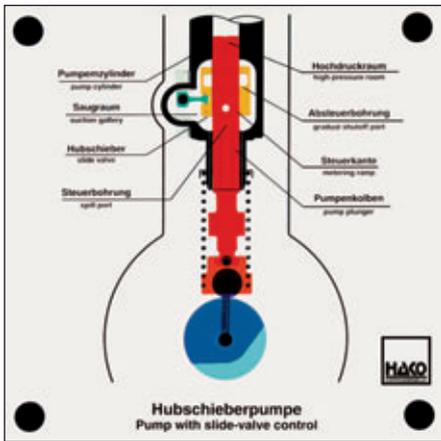
Central injection: Mono-Jetronic

Functions:
 – actuating the throttle blade
 – moving the throttle-blade actuator
 – moving the diaphragm in the pressure regulator
 – moving the pintle-type nozzle valve (opening and closing)
 – interaction of different elements
 Order no. 272



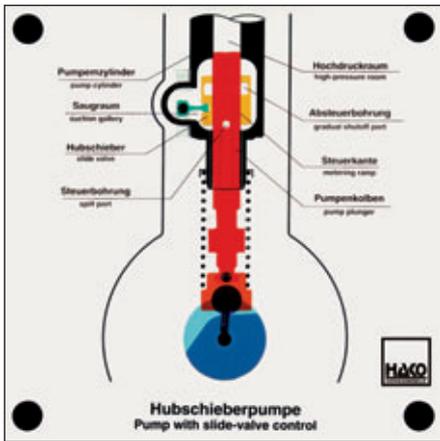
Central injection MULTEC

– moving the throttle blade
 – changing the bypass cross section by means of the stepping motor and thus adjusting the idle speed
 – moving the diaphragm of the primary pressure regulator
 – interaction of different elements
 Order no. 271

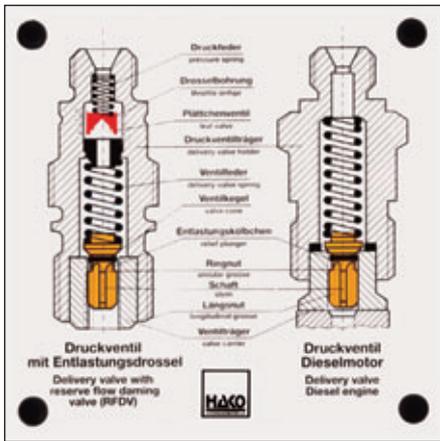


Pump with slide-valve control

The slide valve, which is moved via a rod by a magneto, enables the start and the end of the injection to be determined by the control unit. The point where the pump plunger covers the hole in the control slide valve is the start of injection.



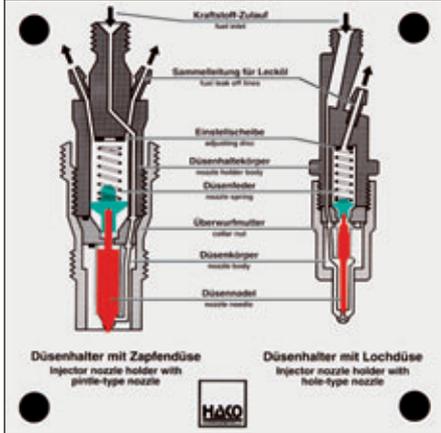
The end of injection is reached when the metering ramp reaches the gradual shut-off port in the slide valve. Order no. 389



Delivery valves

- opening the delivery valve when delivery starts
- closing the delivery valve when delivery ends
- relieving the pressure line with the relief plunger
- With a reverse flow damping valve:
 - the leaf valve can be lifted and closed
 - damping the pressure vibrations with the reverse flow damping valve

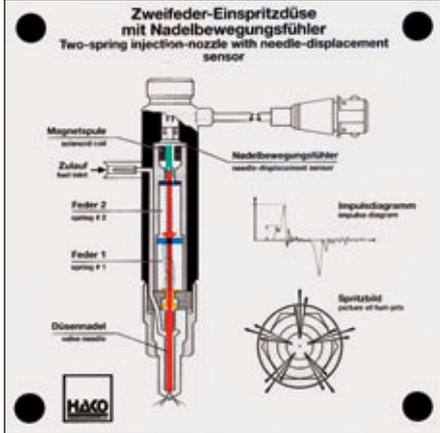
Order no. 259



Injection- nozzle holder with hole-type nozzle and pintle-type nozzle

- two injection nozzles on one overhead model
- similar to a real injection procedure, the nozzle needles can be moved

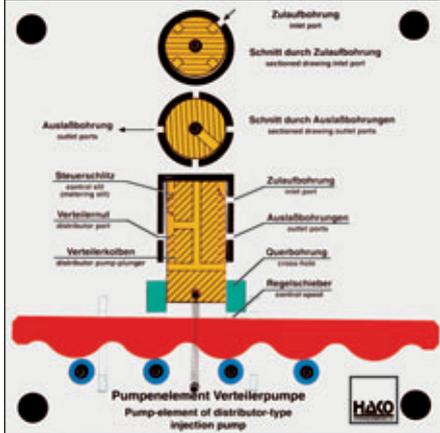
Order no. 208



Two-spring injection-nozzle with needle-displacement sensor

- low fuel injection (the valve needle is lifted against the weak spring # 1)
- high fuel injection (the valve needle is lifted against stiff spring # 2)
- the needle-displacement sensor senses start of injection

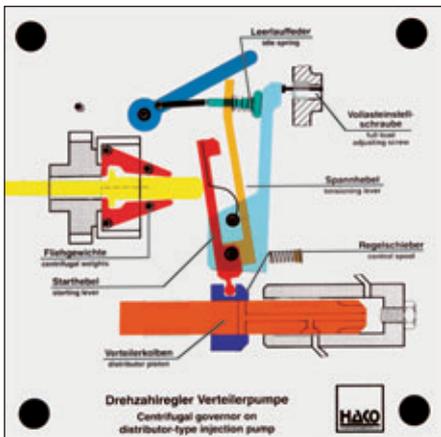
Order no. 291



Pump element of a distributor-type injection pump

- actuating the lifting disk (cams shown in a plane)
- control piston is lifted
- actuating the control sleeve
- cross section of the outlet port can be turned to show the process of distribution

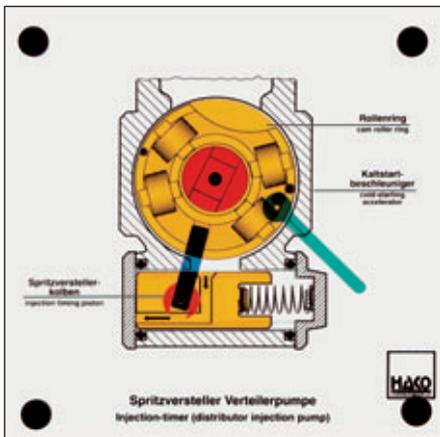
Order no. 180



Speed governor of a distributor-type injection pump

- injection control while accelerating
- the distributor plunger pumping action is cut off
- function of the idle spring
- function of the centrifugal weights
- function of the control sleeve

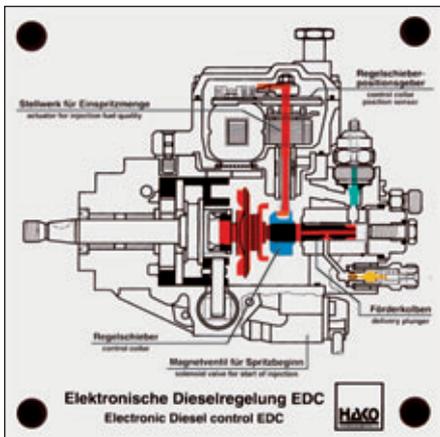
Order no. 135



Injection-timing device of a distributor pump

- injection timing device in motion
- rotating the roller ring
- function of the cold-start accelerator

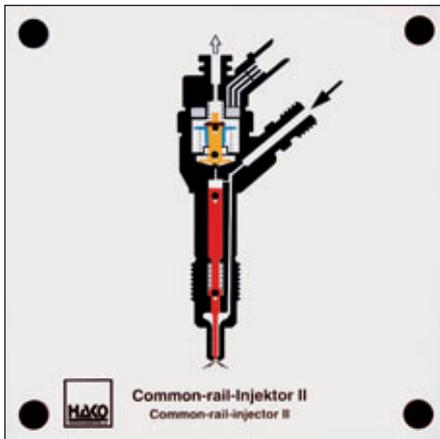
Order no. 136



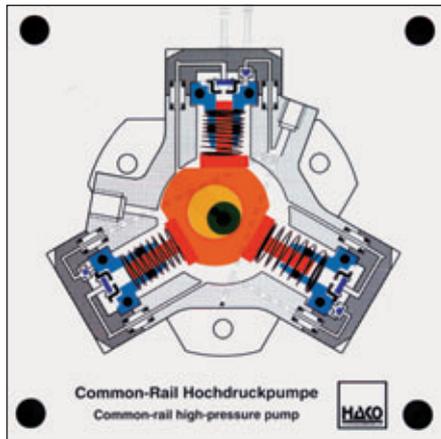
Electronically controlled distributor-type injection pump

- rotating the transducer's eccentric shaft displaces the control sleeve
- actuating the cutoff valve
- function of the pressure valve piston
- moving the distributor piston (a folio with all sensors and a control unit is enclosed)

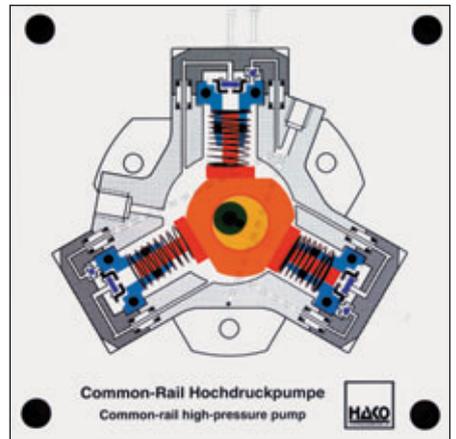
Order no. 210



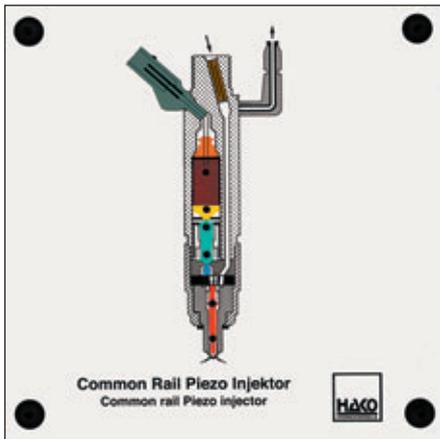
Common rail injektor II
 Opening and closing of the nozzle needle with pilot injection, main injection and subsequent injection. Opening and closing of the spherical valve on the ball support as a function of the solenoid valve and the high pressure on the valve actuation piston.
 Order no. 455



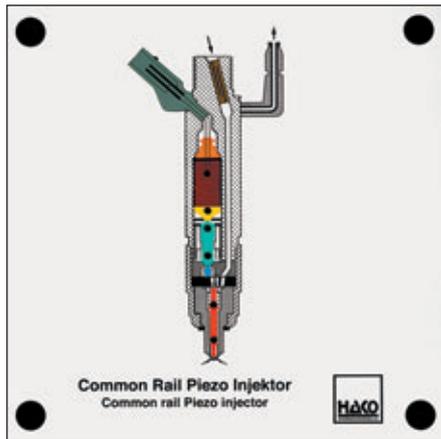
Common rail high-pressure pump
 By turning the operating lever the function of the eccentric cam and the pumping effect of the pump piston can be seen. In addition the aspiration of the fuel via the membrane valve from the interior of the pump and



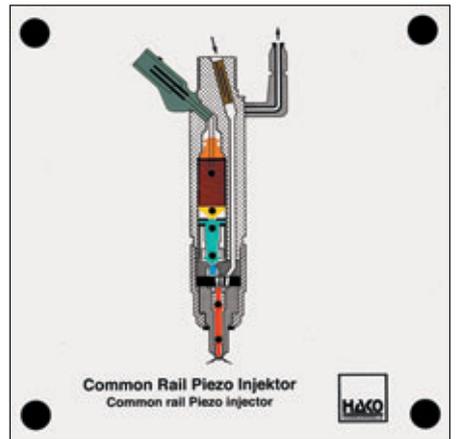
the discharge of the fuel via the ball valve into a collector line to the rail can be demonstrated.
 Order no. 404



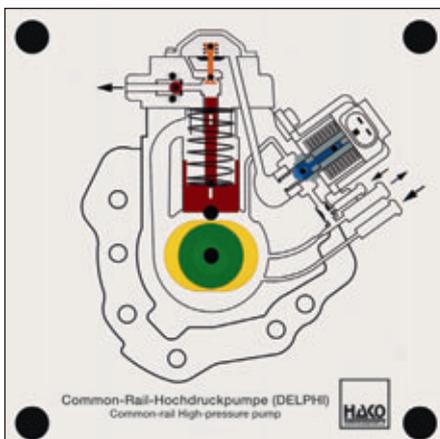
Common rail piezo-injektor
 Functions:
 – extension of the actor module (piezo-layers)
 – movement of the coupler module



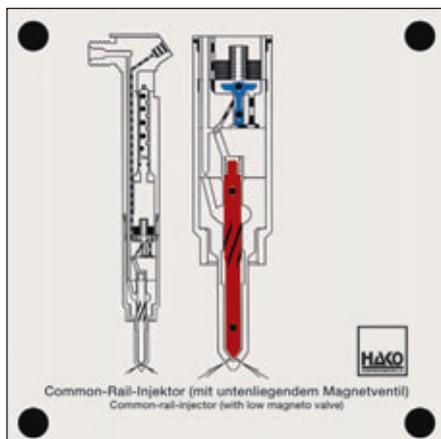
– opening of the valve piston in the switching valve
 – actuation of the nozzle needle and injection



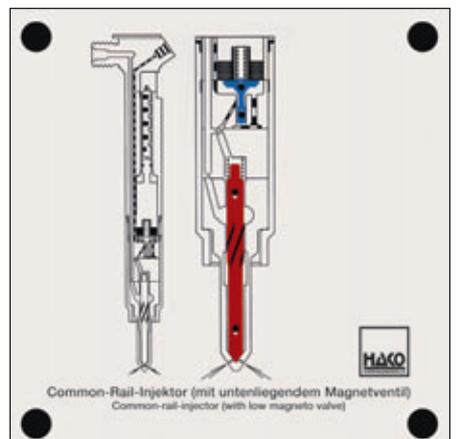
Order no. 476



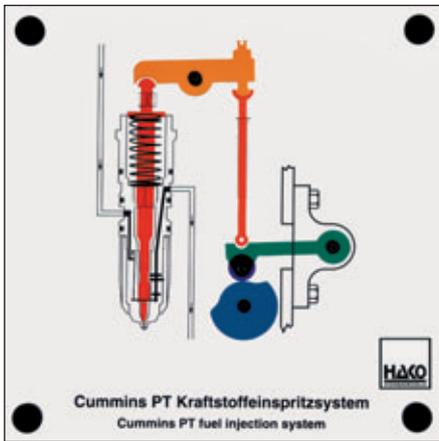
Common rail high-pressure pump (DELPHI)
 The following can be shown: how the drive shaft works with cam and roller tappet. Up and down movement of the pump piston with spring. How the inlet and outlet valves work. Intake and pumping stroke, function of the Venturi nozzle.
 Order no. 504



Common rail injector (with bottom-mounted solenoid valve)
 With this injector, the magnetic coil and the control valve have been installed low down. This does away with the long and slow valve control piston. This in turn results in much shorter shifting times for the solenoid valve.
 Demonstration: Injection valve in initial position,

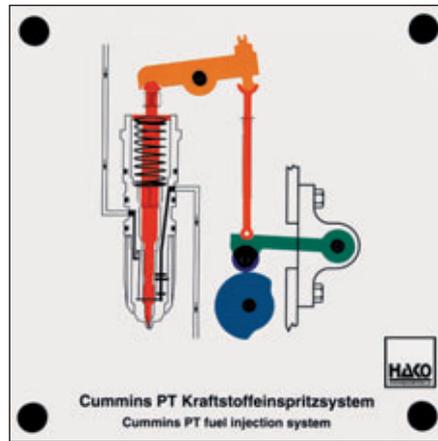


Start of injection phase 1 (control valve is lifted)
 Start of injection phase 2 (nozzle needle is lifted)
 End of injection phase 1 (spring closes control valve)
 End of injection phase 2 (nozzle needle is pushed back into place)
 Order no. 505

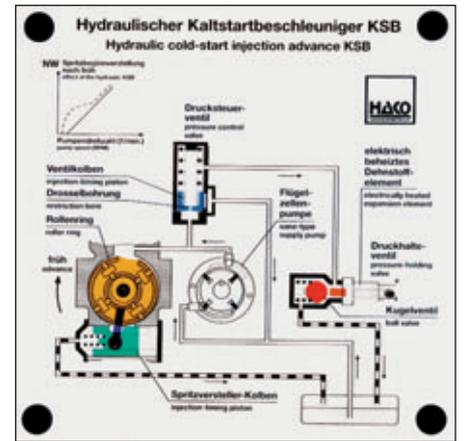


Cummins PT fuel injection system

- injection process via cam, cam follower and rocker arm directly to the injector needle
- fuel delivery control

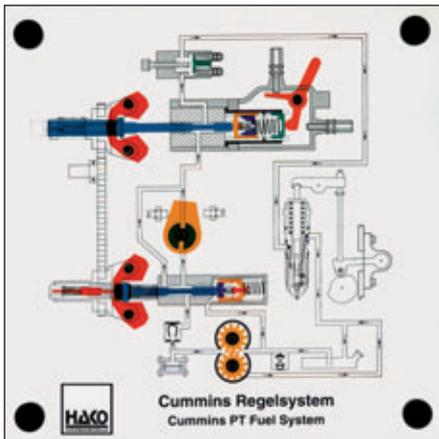


- generation of extremely high injection pressures
- Order no. 355



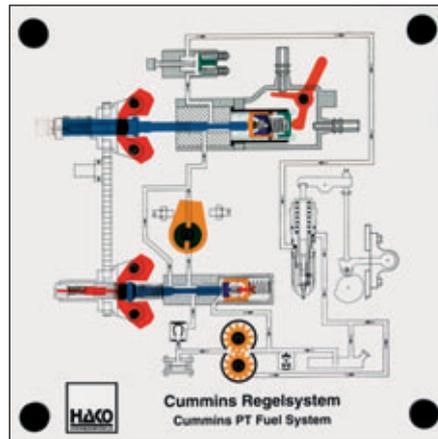
Hydraulic cold-start injection advance KSB

- Model of the whole system
 - actuating pressure control valve and pressure-holding valve
 - when the pressure decreases, the injection-timing piston is moved
 - turning the roller ring into advance direction
- Order no. 314

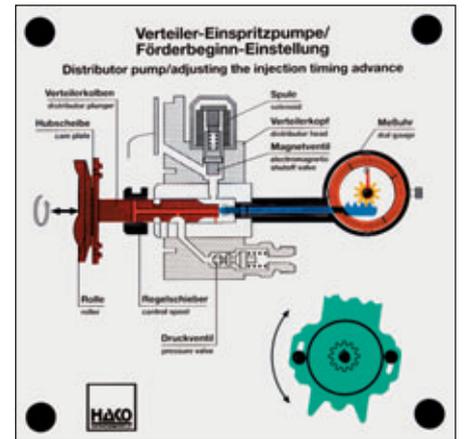


Cummins PT fuel system

- function of the gear wheel pump
- function of the PTG flyweight governor
- function of the VS governor
- function of the throttle shaft

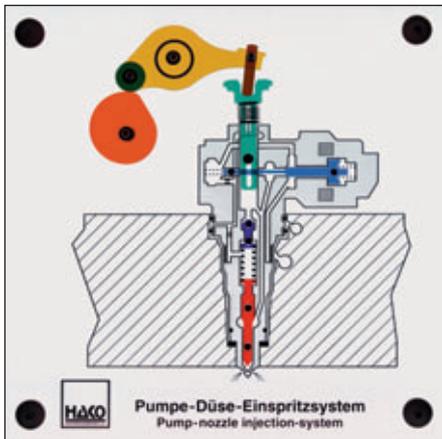


- function of the VS throttle shaft
 - function of the cut off solenoid valve
- Order no. 356

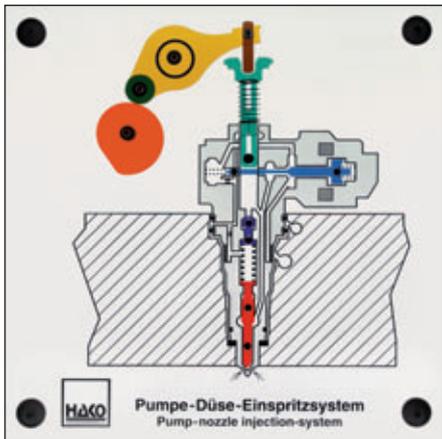


Distributor pump (adjusting the injection timing advance)

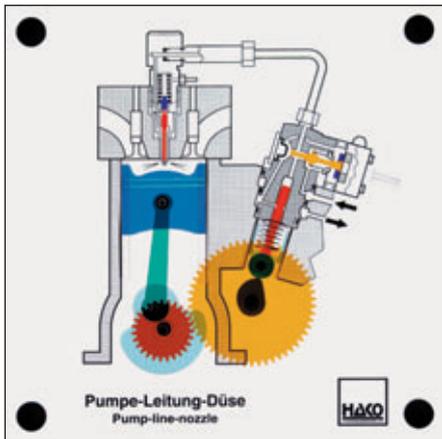
- planning the work process to adjust the injection timing advance
 - TDC-position of the pump plunger
 - setting the dial gauge
 - turning the pump flange to adjust injection timing advance
- Order no. 317



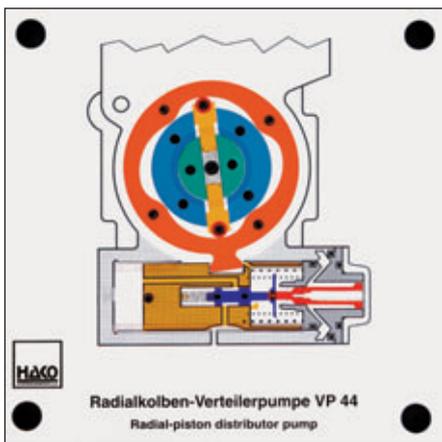
Pump-nozzle injection system II
 Latest generation of the pump-nozzle unit system
 Generation of high pressure (2000 bar)
 Function of injection cam and rocker arm
 Function of the high-pressure injection element



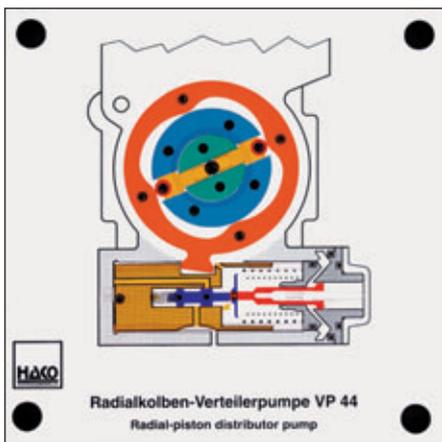
Function of the solenoid valve
 Pre-injection and main injection
 Order no. 440



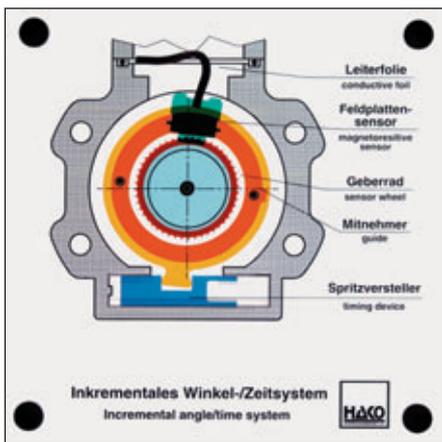
Pump-lines-nozzle
 Combined effect of piston, connecting rod and crankshaft and onward transmission of the power via gear wheels and the cam to the pump piston.
 Function of the injection nozzle and the solenoid valve in controlling the start of injection and the rate of injection.
 Order no. 405



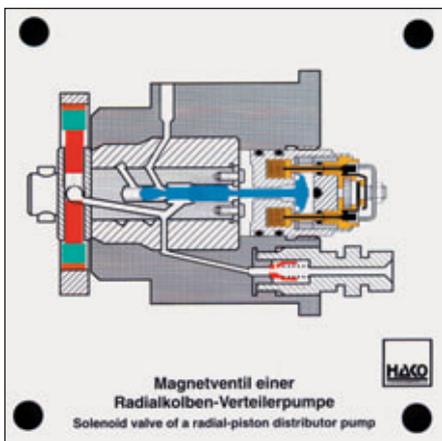
VP 44 radial-piston distributor pump
 – function of the high-pressure pump
 – combined effect of cam ring and roller tappet on piston



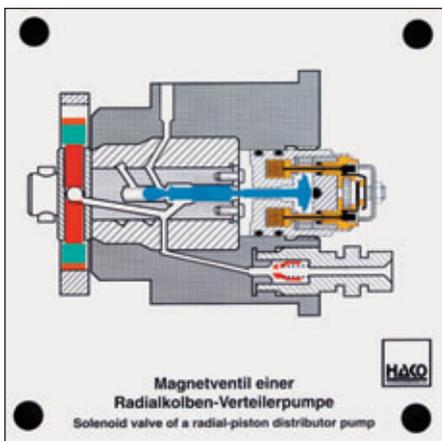
– function of the fast injection timing device with relief piston
 – injection timing
 Order no. 394



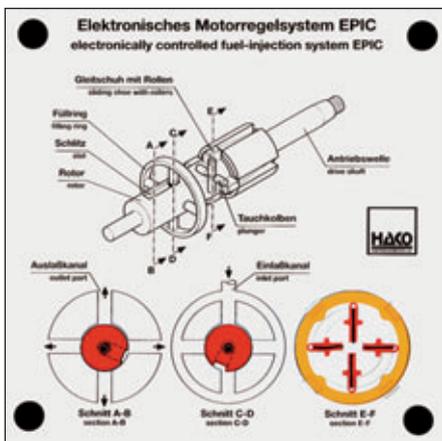
Incremental angle/time system
 – function of the magneto-resistor sensor
 – function of the induction sensor
 – function of the driver
 – function of the injection timing device
 Order no. 396



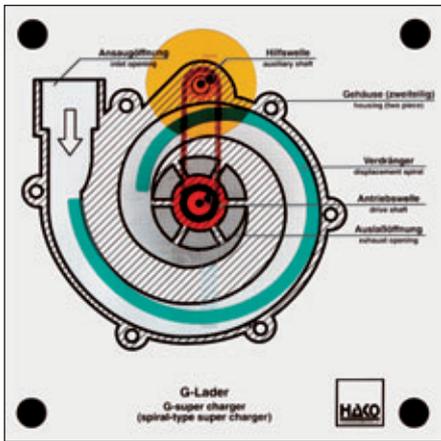
Solenoid valve of a radial-piston distributor pump
 – function of the high-pressure pump
 – opening and closing of the solenoid valve to control the point of injection and the rate of injection



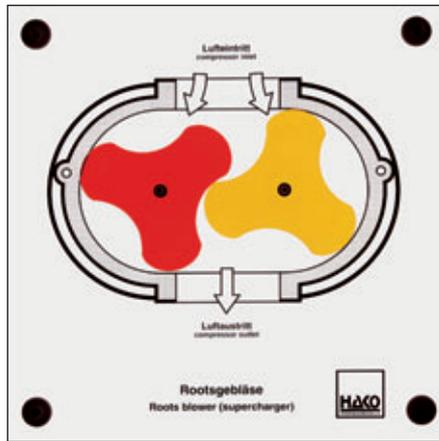
– return flow with solenoid valve open
 – injection with solenoid valve closed
 – function of the return flow throttling valve
 Order no. 412



Electronically controlled fuel-injection system EPIC
 EPIC = Electronically Programmed Injection Control
 – function of the high pressure pump (section E-F)
 – filling procedure (section C-D)
 – fuel distribution to the cylinders (section A-B)
 Order no. 281



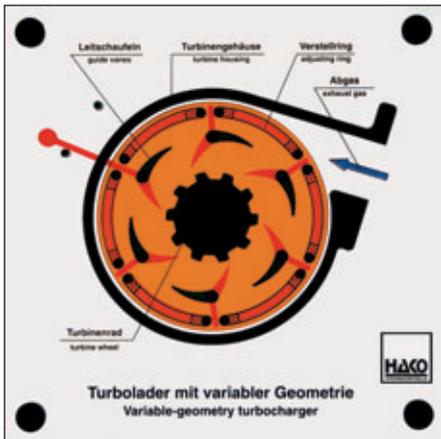
Spiral-type supercharger
 – function of drive shaft and auxiliary shaft
 – motion of the displacement spiral
 – in the housing, air is compressed by the displacement spiral from the outside to the inside
 Order no. 161



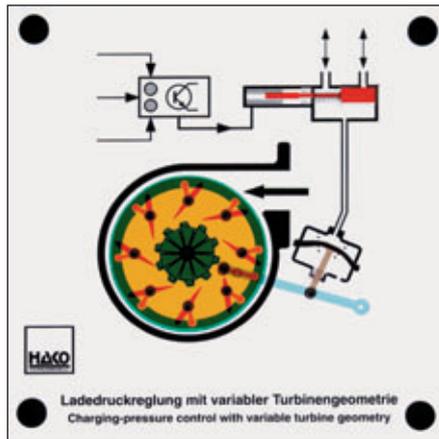
Roots blower
 – function of a roots blower
 – the rotors are driven by spur gears
 – roots blowers are used as chargers for Otto and Diesel engines
 Order no. 205



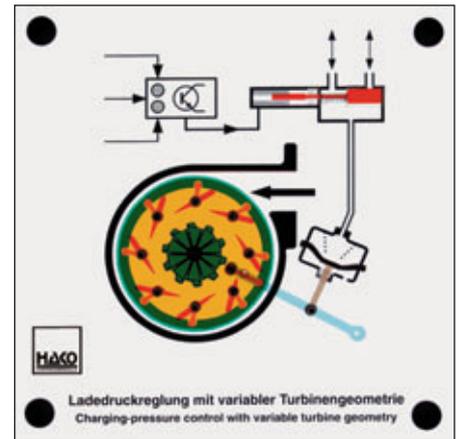
Variable geometry turbocharger
 – guide vane adjustment via setting ring
 – different turbine wheel flow depending on guide vane adjustment



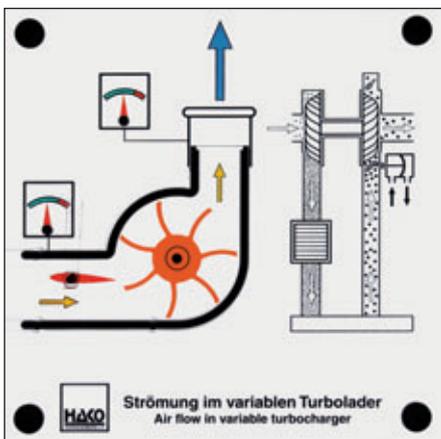
Objective:
 – torque increase in lower speed range
 – in upper speed range bypass is no longer necessary.
 Order no. 358



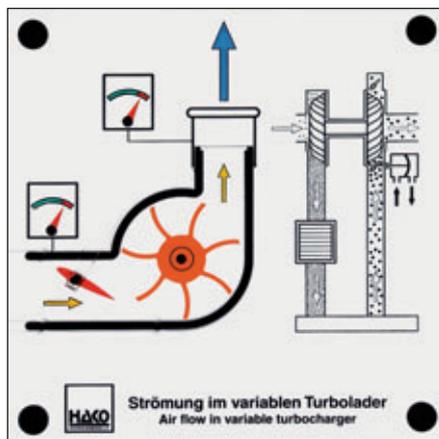
Turbocharger with variable blade geometry
 Function of the turbine and blower wheels.
 Adjustment of the guide vanes by means of the adjusting ring.
 Charging-pressure control via the vacuum cell by turning the adjusting ring.
 Boost-pressure control with variable geometry.



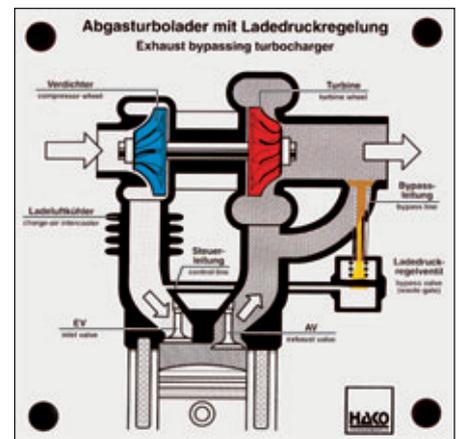
Adjustment of the guide vanes by means of the vacuum cell.
 Control of the vacuum cell.
 Function of the solenoid valve.
 Pressure control by the solenoid valve and control unit.
 Order no. 414



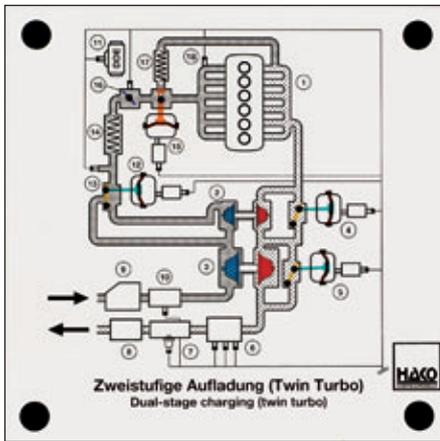
Air flow in a variable turbocharger
 With the help of the fan supplied, air is pressed into the turbo-charger.



Function of the guide vanes:
 if the engine speed is too low, the cross-section is reduced, the output rotor turns more quickly.
 Order no. 442



Exhaust-gas turbocharger
 The model shows an exhaust-gas-turbo-charger in longitudinal section. The function of the charged-pressure control can be demonstrated.
 Order no. 243

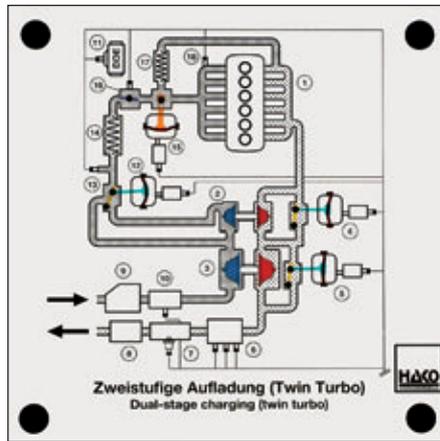


Dual-stage charging (twin turbo)

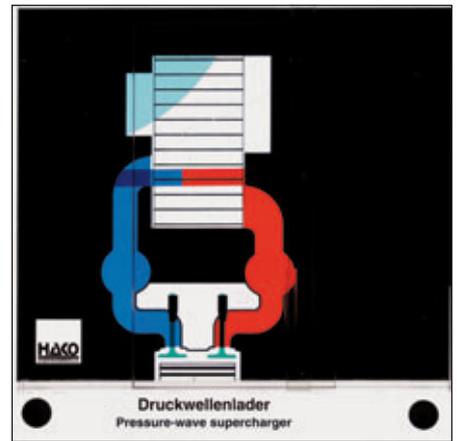
In order to achieve optimum reaction from low speeds and also the band width of maximum torque, two turbochargers connected in series (twin turbo) are frequently used nowadays.

Demonstration:

- paths of the fresh and exhaust gas flow
- opening and closing of the turbine control flap (4)

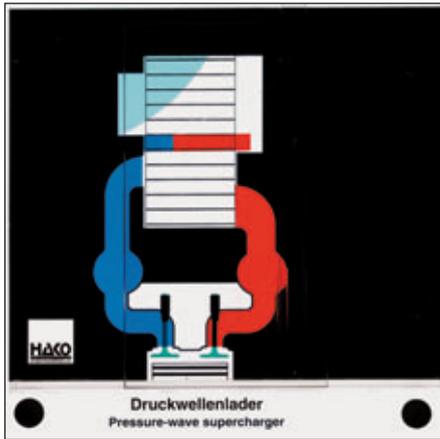


- operation of the waste gate valve (5)
 - opening and closing of the compressor bypass flap (12)
 - operating the throttle valve (16)
 - opening and closing of the exhaust gas recirculation valve (15)
 - interaction of the various parts and components
- Order no. 487



Pressure-wave supercharger

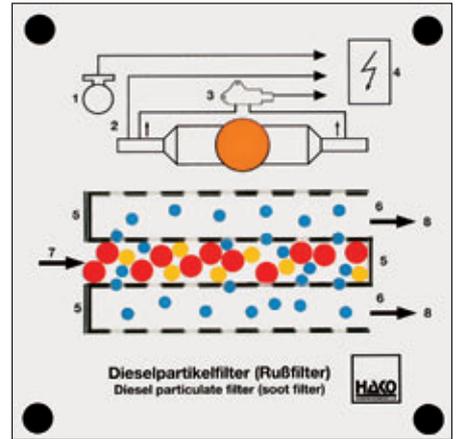
- the opened-up drum can be used to demonstrate the supercharging by sliding the gas column



- the gas-column slide is moved along a curved path, so that the actual flow conditions can be shown

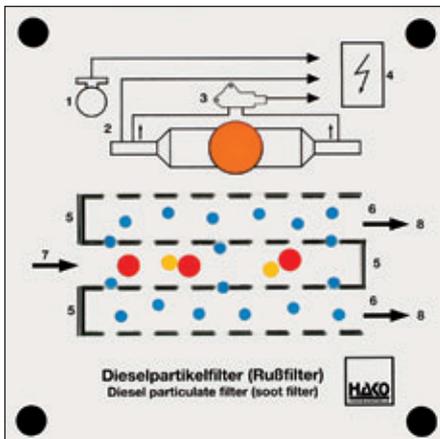


Order no. 416



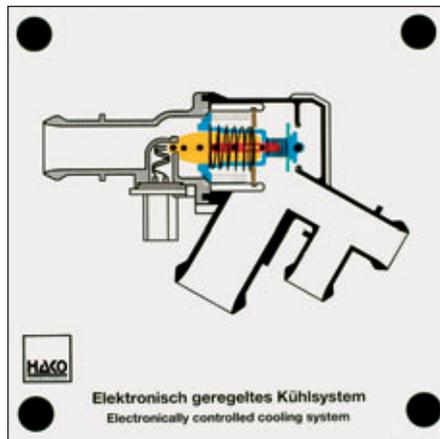
Diesel particulate filter (soot filter)

The particulate filter comprises a beehive-shaped ceramic body. It has been sub-divided into a number of small channels arranged in parallel, which have been arranged alternately. The following gases are contained in the exhaust gas: carbon monoxide, carbon dioxide, nitrogen oxides, hydrocarbons, sulphur dioxide (all shown blue). Further, soot particles (red) and an additive (yellow).



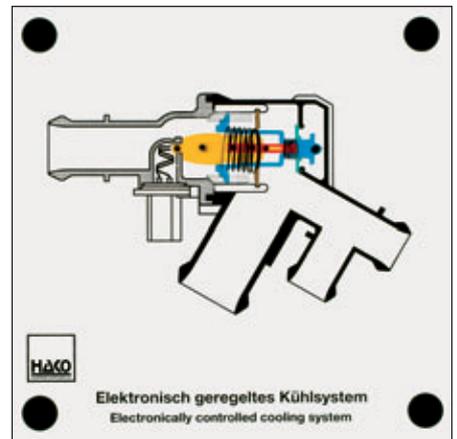
Demonstration:

- insertion of the various gas and soot particles into the middle tube
 - gas particles can escape through the pores of the side wall into the two tubes next to this, whereas the soot and additive remain in the medium tube as a result of their size
 - gas particles can escape to the back into the exhaust pipe
- Order no. 493



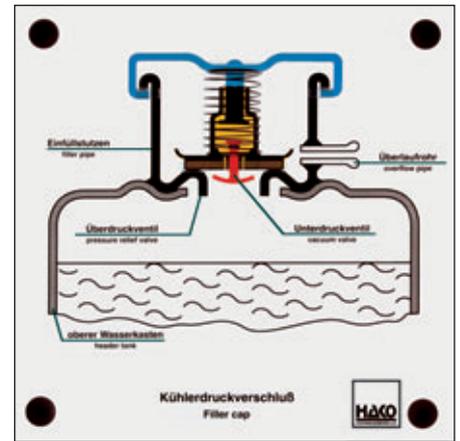
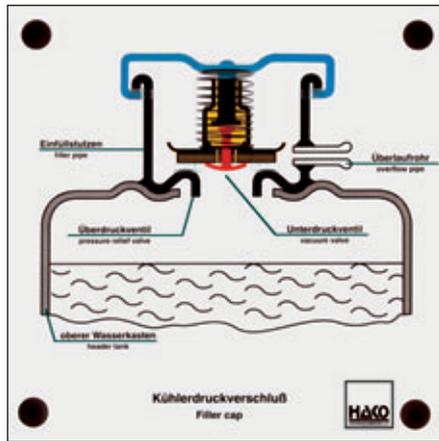
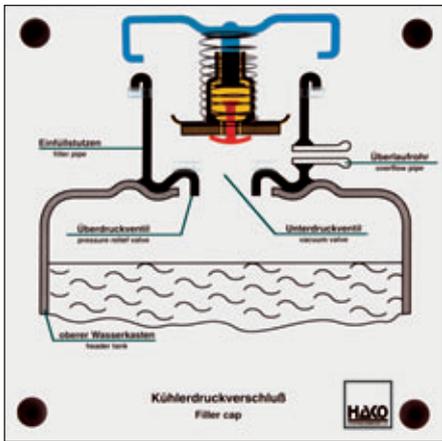
Electronically controlled cooling system

The development of an electronically controlled cooling system has the objective of controlling the operating temperature of the motor to a nominal value as a function of the load state.



According to maps deposited in the engine control unit, an optimum operating temperature is controlled via the thermostat, which can be heated electrically, and the radiator fan phases.

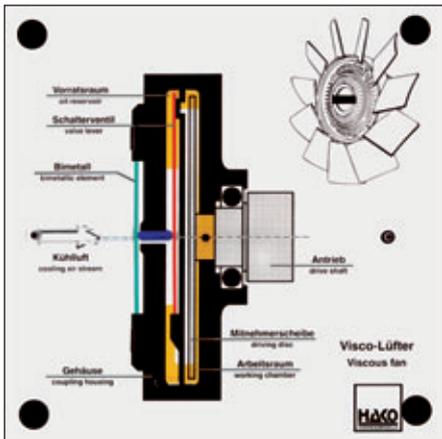
Order no. 481



Radiator cap

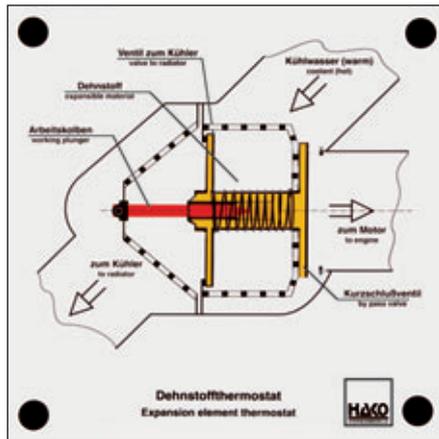
- function of pressure valve and vacuum valve
- putting on the radiator cap pretensions the pressure spring and thus makes a higher pressure build-up in the radiator possible (the boiling point is risen)

- the pressure relief valve opens when the pressure gets too high
 - the vacuum valve opens when the engine cools down
- Order no. 213



Visco blower

- This model can be easily operated from the outside by means of two levers.
- Right lever: The liquid is pumped from the working chamber to the reservoir chamber and vice versa
 - Left lever: The bimetal spring is bent and thus the valve between the two chambers opened
- Order no. 214



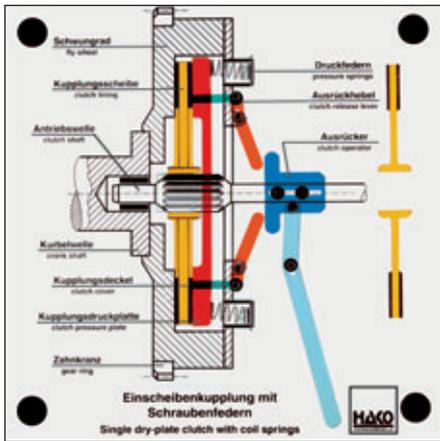
Expansion-element regulator

- Function of the expansion element. The valve can be moved back and forth. When warming up the engine, the dual valve opens the large cooling-water circuit, which circulates through radiator and engine, and closes the small one, which circulates only in the engine block, and vice versa when cooling down the engine.
- Order no. 143



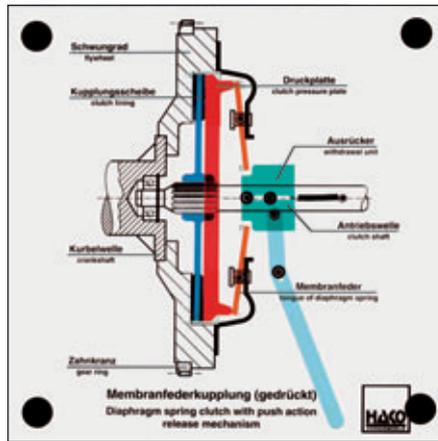
Rotary pump

- The model demonstrates that cooling-water pumps work on the same principle as rotary pumps.
- Order no. 226



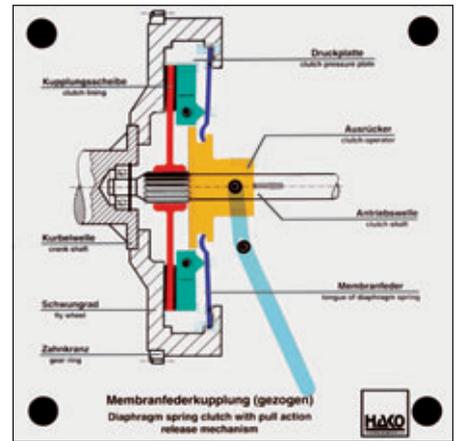
Coil spring clutch

- motion shown when pressure plate is lifted
 - releasing the clutch disk
 - the clutch play decreases with lining wear (shown by means of a thin clutch disk)
- Order no. 115



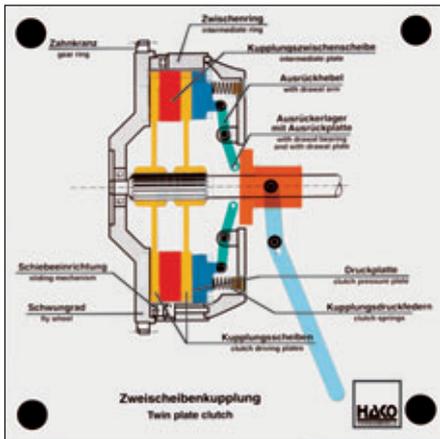
Diaphragm spring clutch

- motion shown when the pressure plate is lifted
 - releasing the clutch disk
- Order no. 116



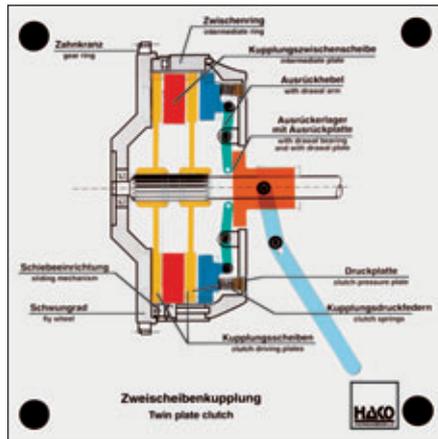
Clutch with pulled diaphragm spring

- characteristics of a pulled clutch in motion
 - releasing the clutch disk
- Order no. 117

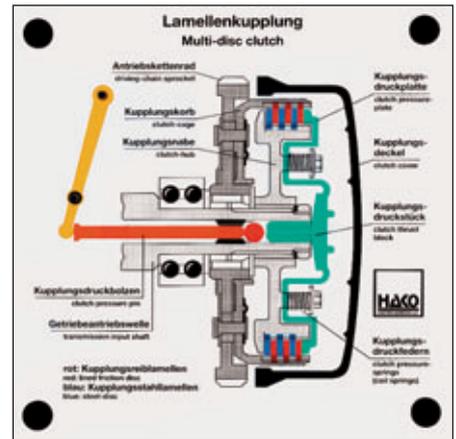


Double-disk clutch

- function of a double-disk clutch
- lifting the pressure plate
- both clutch disks and the intermediate disk can be moved

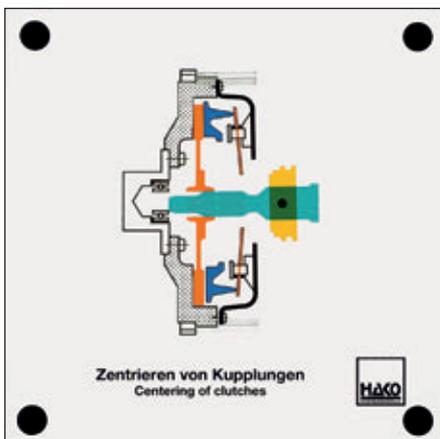


- while the clutch is engaged, steel springs press the pressure plate
- Order no. 207



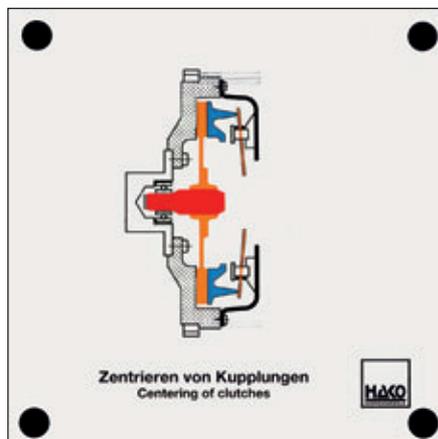
Multi-disk clutch

- pressing the clutch pressure pin by means of the lever
 - lifting the clutch thrust block
 - the clutch pressure-plate presses the springs together and releases the discs
 - the power flow is now interrupted
- Order no. 293

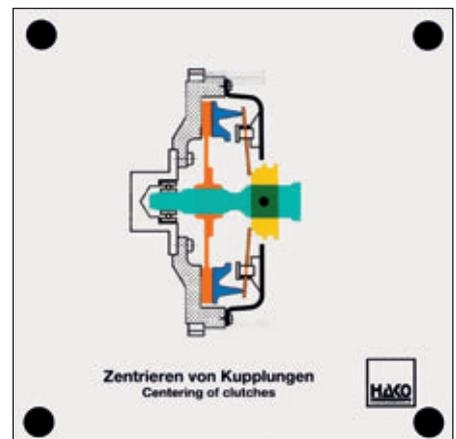


Centring of clutches

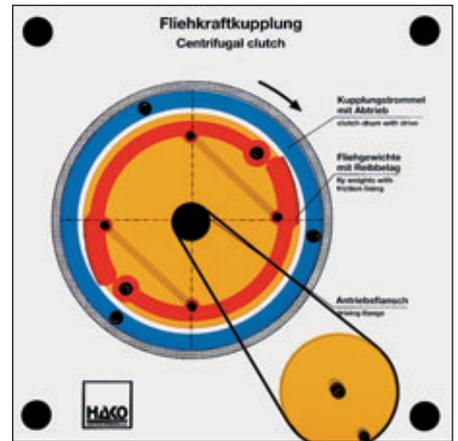
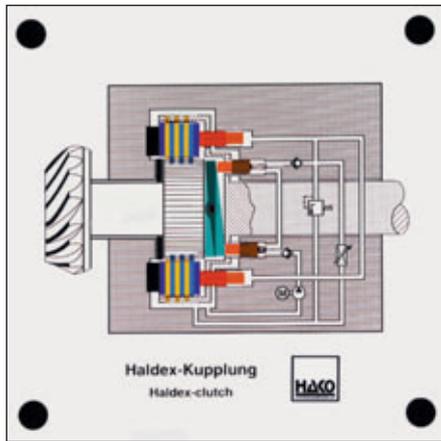
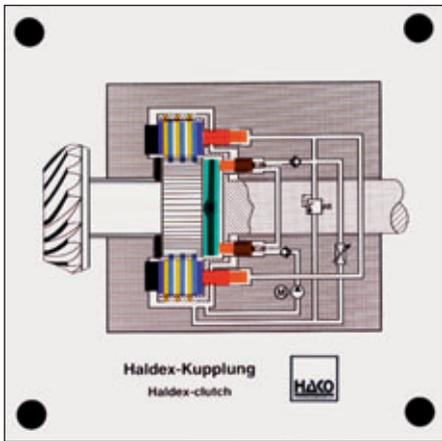
When the driving disk is replaced, it must be centred in the balance wheel at all costs.



- Demonstration:
- unscrew the pressure plate without centring (plug-in type connection). In mounting the transmission, the transmission input shaft can not be pushed into the guide bearing
 - centring of the driving disk with a centring mandrel (red)



- the transmission input shaft can now easily be pushed into the guide bearing
- Order no. 490



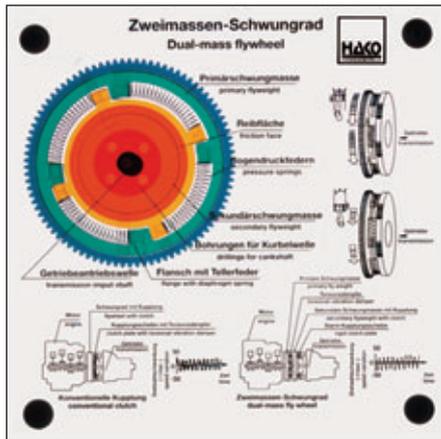
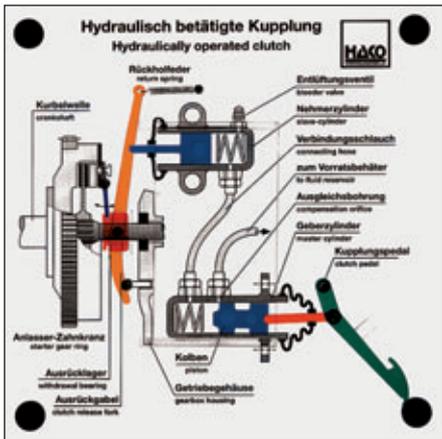
Haldex clutch

It replaces the viscous clutch in four-wheel drive. As soon as a difference in speed comes about between front and rear axle, the swash plate begins to turn. In this, it operates the pump plunger, which presses hydraulic oil into the plunger of the friction disks.

After less than one revolution, adhesion has resulted. With the help of the electronically operated throttle valve, the slip can be adapted to the driving situation in question.
Order no. 429

Centrifugal clutch

– turning the driving crank sets the driving flange into motion
– centrifugal force presses the flyweights with the friction lining against the clutch-drum, thereby driving the clutch-drum
Order no. 295



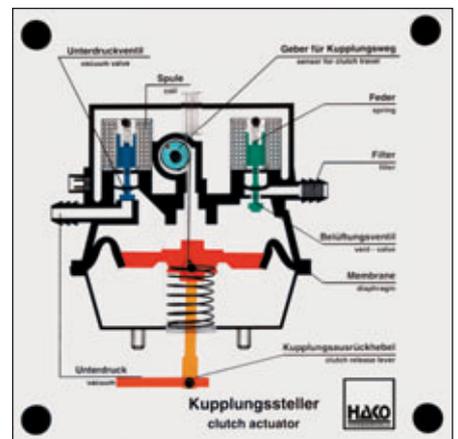
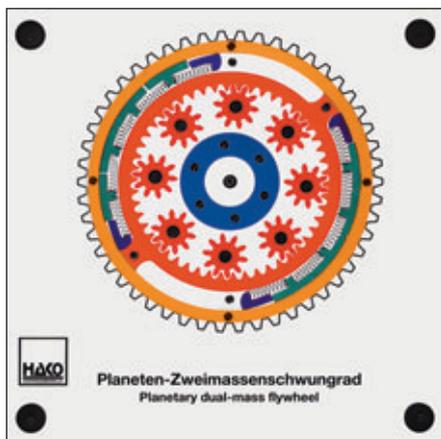
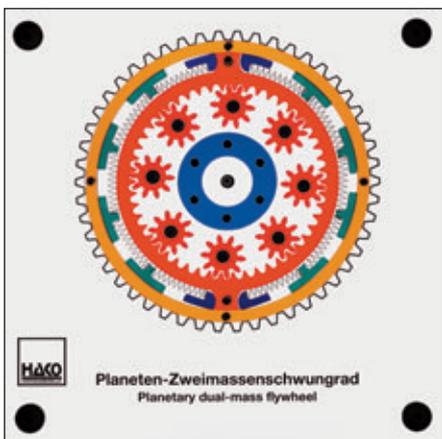
Hydraulically operated clutch

– interaction of master cylinder and slave cylinder
– actuating the clutch release fork
– function of the compensation orifice and bleeding
Order no. 279

Dual-mass flywheel

– design of a dual-mass flywheel
– function of the pressure springs when primary flyweight is subject to torsional vibrations

– function of the torsional-vibration damper between primary and secondary flyweight
Order no. 275



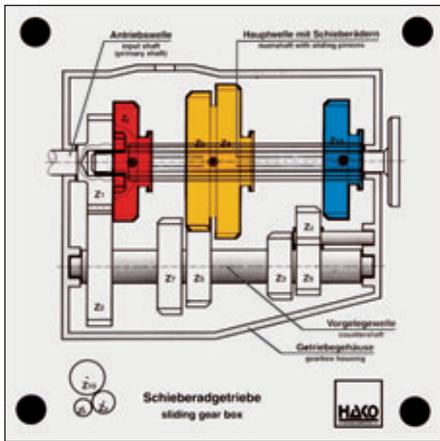
Planetary dual-mass flywheel

– rotation of the secondary flywheel mass against the primary flywheel
– pressing the springs together in their guide shoes without housing friction

– acceleration of the planetary wheels, which attenuate the vibrations of the springs thanks to their friction
Order no. 469

Clutch actuator

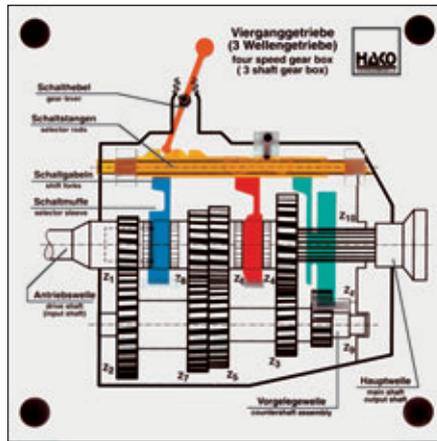
– function of the solenoid valves
– function of the diaphragm and of the retractor spring
– function of the position transducer
– declutching process
– clutch engagement process
Order no. 324



Sliding-gear transmission

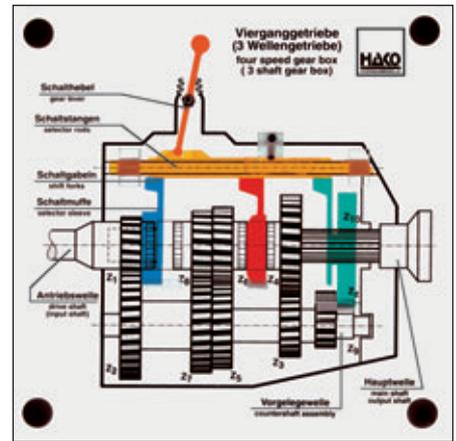
This model facilitates the understanding of a modern car transmission:

- power distribution of four forward gears and one reverse gear can be shown
 - all gear wheels can be moved
 - functions of the transmission's most important parts are shown
- Order no. 199

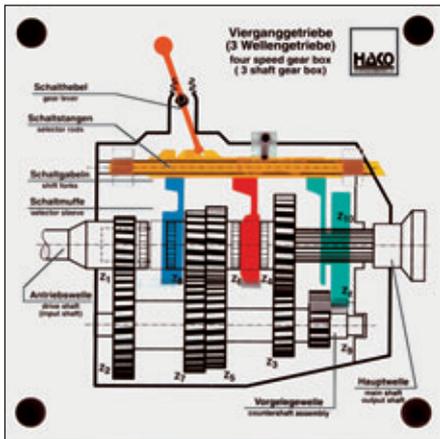


Four-speed transmission "reverse gear"

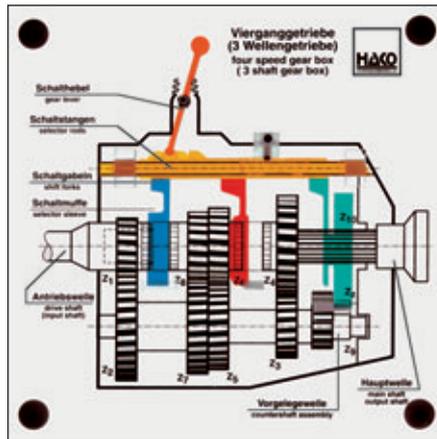
- shifting all gears (four forward gears and one reverse gear) through gearshift lever, sliding sleeve, synchronizing ring and gear wheel
 - power distribution in all gears can be shown
- Order no. 201



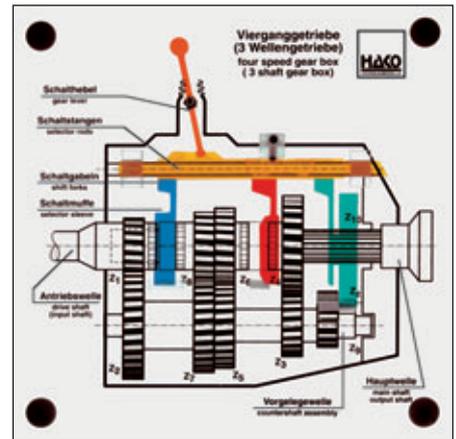
"4th gear"



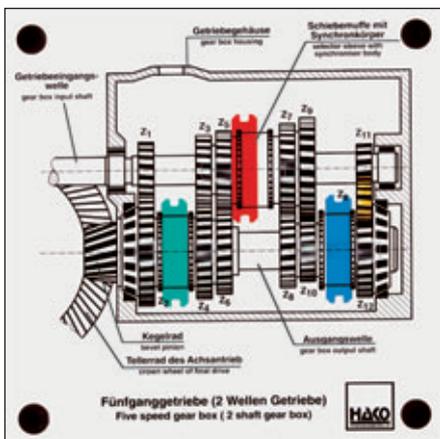
"3th gear"



"2th gear"

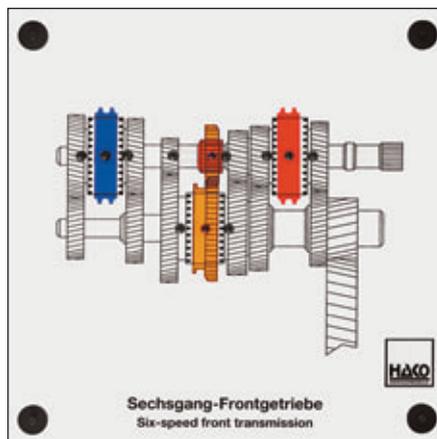


"1th gear"



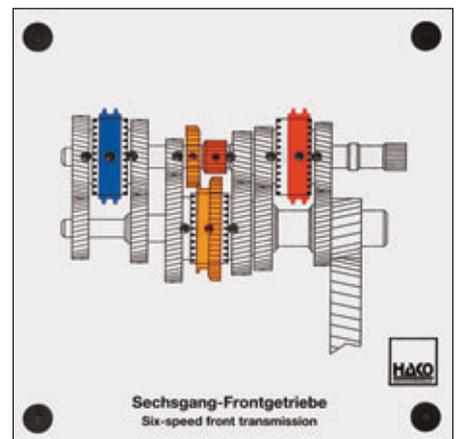
Five-speed transmission

- power distribution in a five-speed transmission
 - all sliding sleeves can be moved
 - the reverse gear is synchronized
- Order no. 202



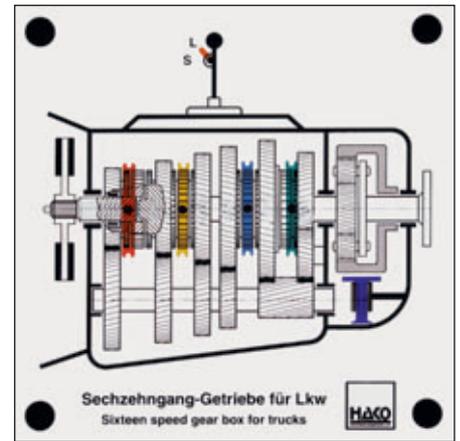
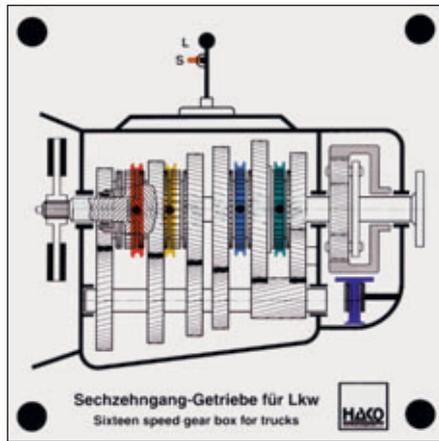
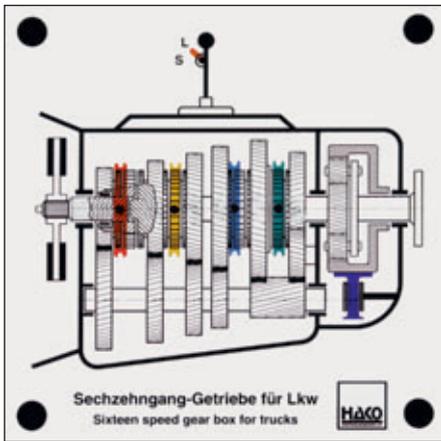
Six speed front transmission

- shifting the 6 forward gears by displacing the gearshift sleeves
- shifting the reverse gear by displacing the reverse wheel



Six-speed front transmission

- power flow in the various gears
 - recognition of the two overdrive gears
- Order no. 466

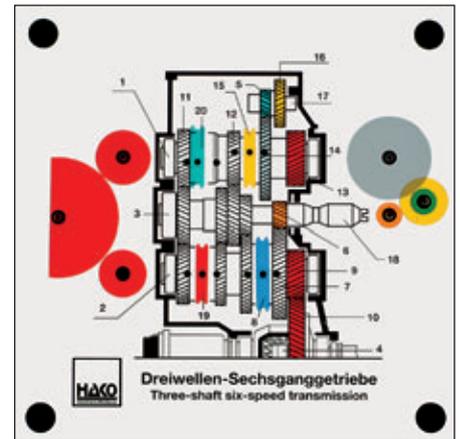
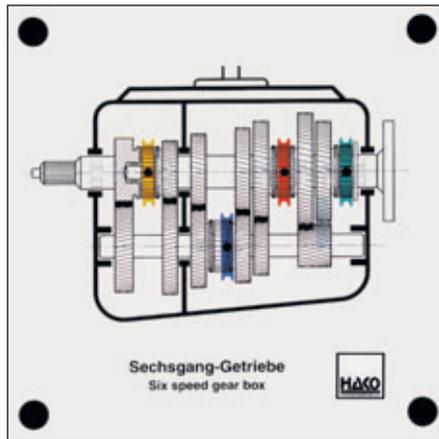
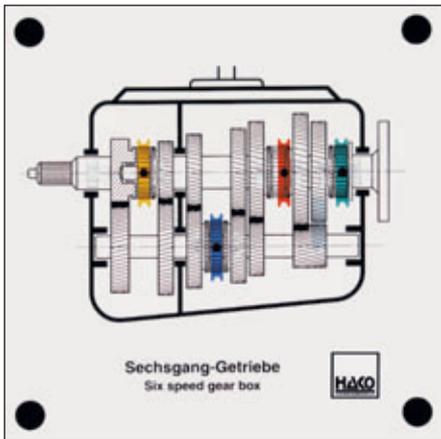


Sixteen-speed gear box for trucks

The basic module comprises a gearbox with four gears. By adding a front-mounted and a rear-mounted module, a sixteen-speed gearbox results. With the help of the left-hand shifting sleeve, the

counter shaft can be driven with two transmission ratios. In this way, eight forward gears result from four gears. In the rear-mounted group, two transmission ratios of the secondary shaft can be shifted with the

help of a simple planetary gear set. Eight gear steps times two results in sixteen speeds. Order no. 438



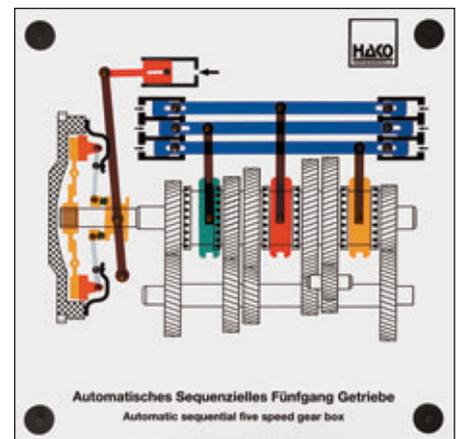
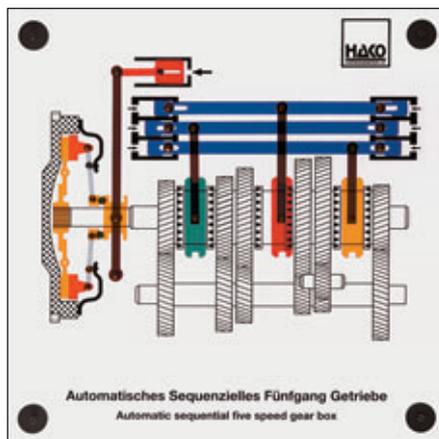
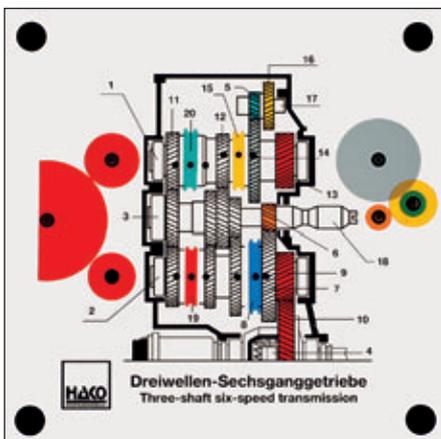
Six-speed gearbox

This gearbox is ideal for practising the power flow in the individual gears. The shifting sleeves are distributed to both main shafts. A fourth shifting sleeve was required for the synchronised reverse gear.

The power flow in the individual gears can be drawn onto a supplied worksheet by the pupils. Order no. 433

Three-shaft six-speed transmission

This frontal transmission is used in the A class of Mercedes-Benz. The double wheel (top right) and the differential with axle shafts (below) have been hinged to the outside. For better understanding, the corresponding toothed wheels on the left and right of the transmission have been shown in their correct positions with the matching colours.



Demonstration:

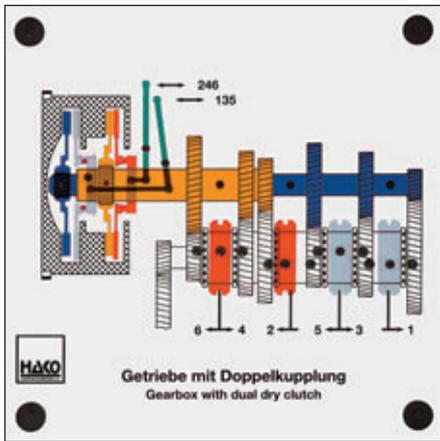
- search for the designations in question on the transmission (nos. 1 to 20)
- displacement of the shifting sleeves and finding the flow of force in all gears
- following the flow of force in the transmission section and the matching side views

Order no. 489

Automatic sequential five speed transmission

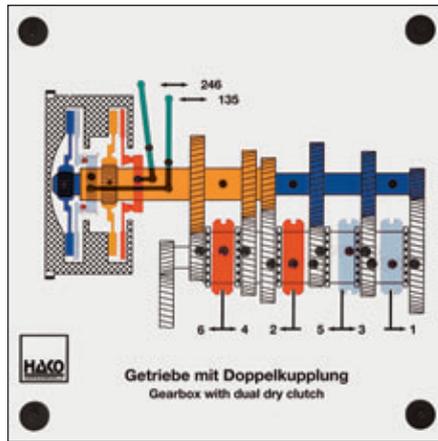
- function of an automatic sequential transmission
- shifting of the gears by hydraulic plungers
- coupling process by hydraulic operation
- power flow in the various gears

Order no. 467

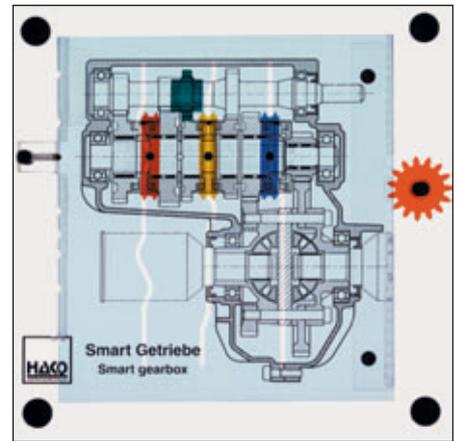


Gearbox with dual dry clutch:

- operation and function of both clutches
- power flow 2nd, 4th and 6th gear, 1st, 3rd and 5th gear via 2 different transmission input shafts

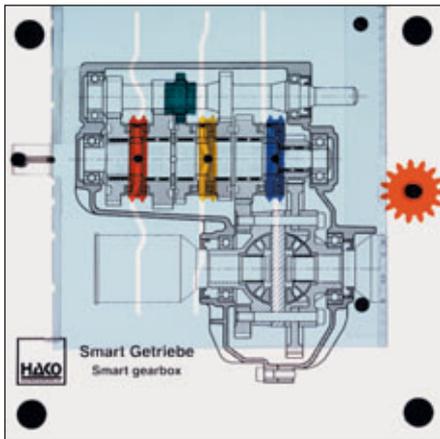


- shifting of all gears by displacing the gearshift sleeves
 - change of clutch with 2 gears shifted
- Order no. 465

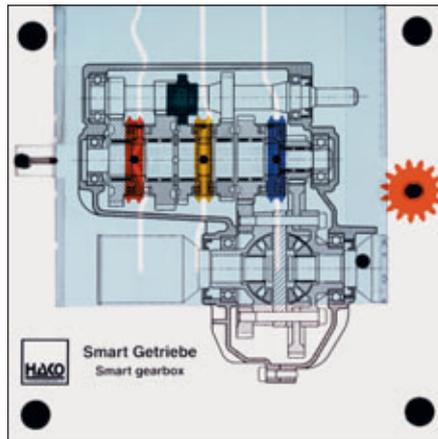


SMART gearbox

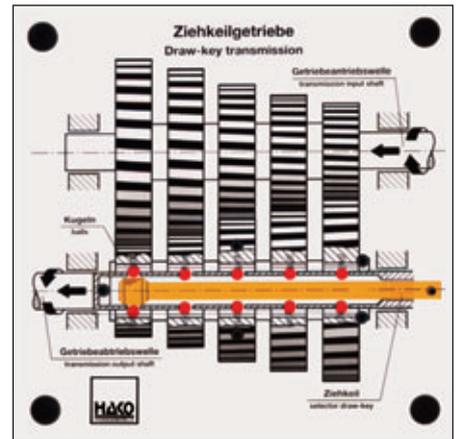
This new construction by the firm of GETRAG shows a mechanical manual transmission with six forward gears and one reverse gear. A gear selector drum driven by an electric motor operates the shifting



sleeves. For the differential, 2 different transmission ratios can be shifted, which means that 6 forward gears result from the 3 forward gears of the main shaft. An automatic clutch actuator takes over the clutch



engagement and de-clutching in each change of gear. The gearbox can be fitted as a semi-automatic or fully automatic gearbox. Order no. 432



Draw-key transmission

- function of a draw-key transmission
 - moving the draw key
 - moving the balls to lock the different gear sets
 - balls are released automatically after shifting
- Order no. 270



Draw-key transmission (section of side view)

Ideal supplement to model no. 270

Functions:

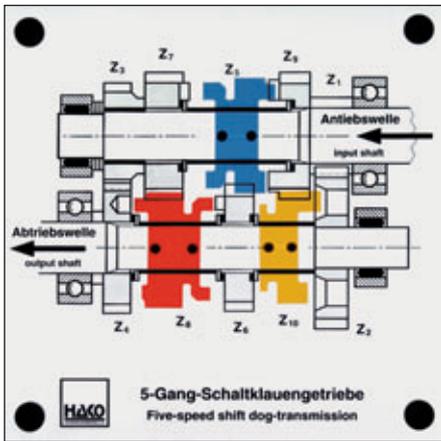
- power transmission: The draw key is pressed down. This causes the balls to role into the tooth space and act as a fitting connection between transmission input/primary shaft and toothed wheel.



- idle gear: When the draw key is pulled up, the balls are pressed inward by the tooth space. The toothed wheel has no more connection to the transmission input shaft.

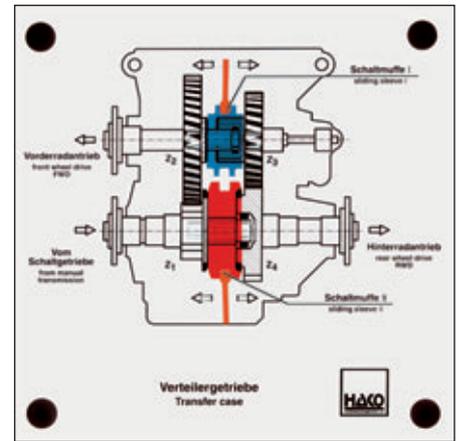
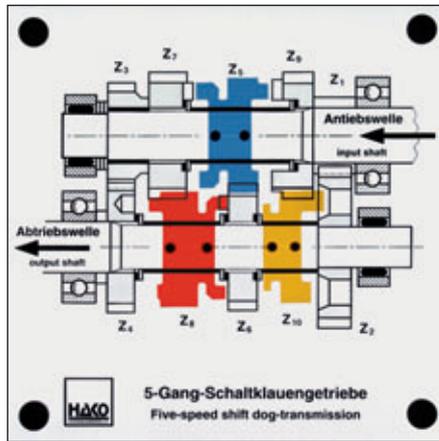
Notation: The draw key can easily be moved from the outside by means of a small cam and lever.

Order no. 278



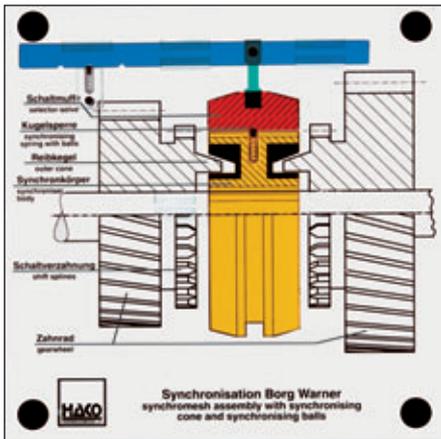
Five-speed shift dog-transmission

Flow of force in the shift dog transmission
Peculiarity of shift dog transmissions
Shifting of the five gears
Order no. 451



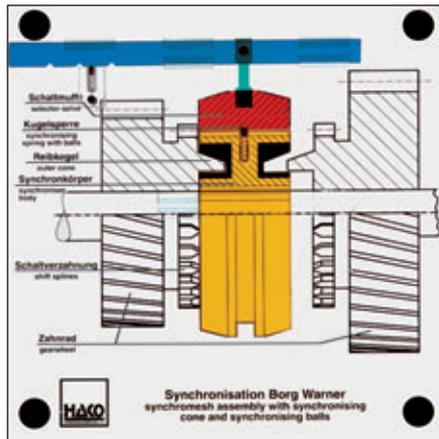
Transfer case

– power distribution in a transfer case
– shift options: front axle only, rear axle only and both axles (four-wheel drive)
Order no. 203

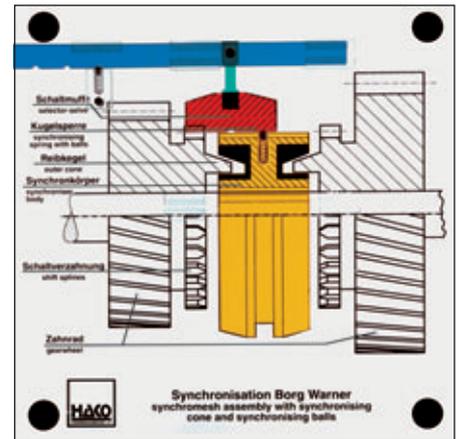


Synchronisation of the transmission

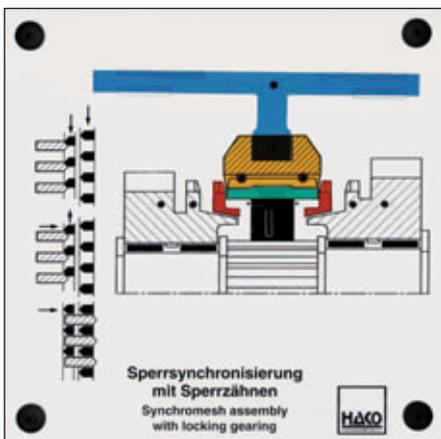
– gearshift rod with gearshift fork in motion
– sliding sleeve moves simultaneously
– synchronization by friction
– meshing of the sliding sleeve
– function of the ball interlock
Order no. 144



"Synchronise"

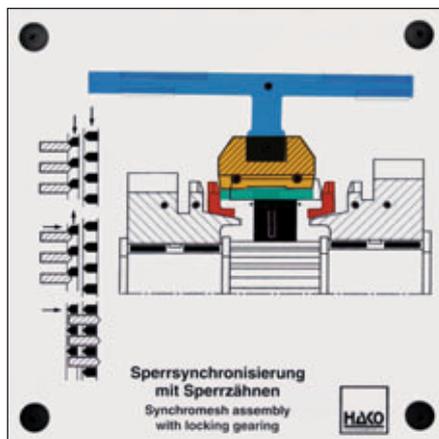


"Put in gear"

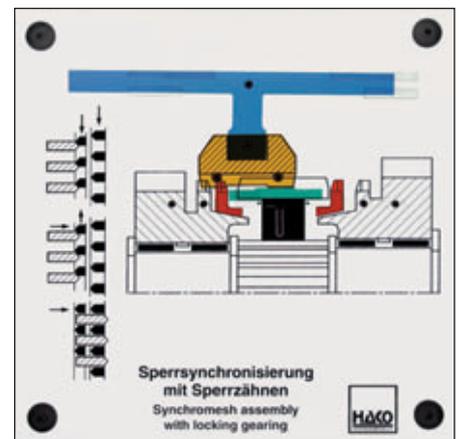


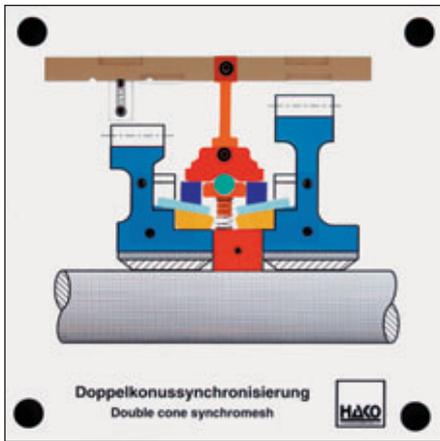
Synchronmesh assembly with locking gearing

Movement of gearshift rod and gearshift fork
Driving of the selector sleeve
Application of the synchroniser rings



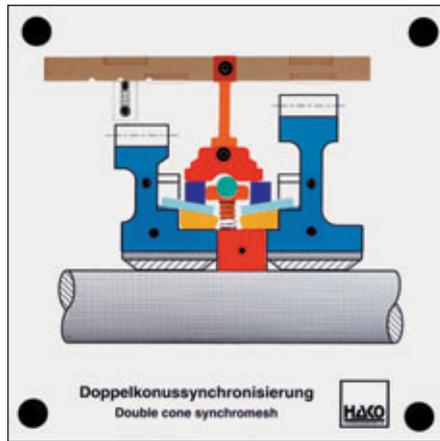
Synchronisation by friction
Shifting of the gears
Order no. 439



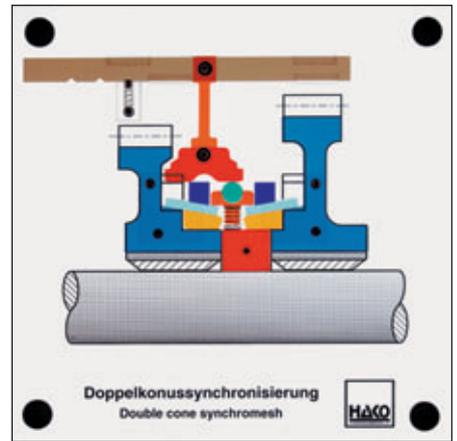


Double-cone synchronization

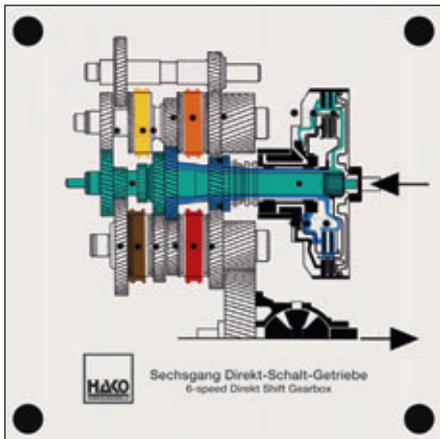
– moving the gearshift rod with gearshift fork and sliding sleeve



– function of the shifting lock
 – function of the two synchronizer rings with four friction surfaces.
 – function of the ball synchronising string

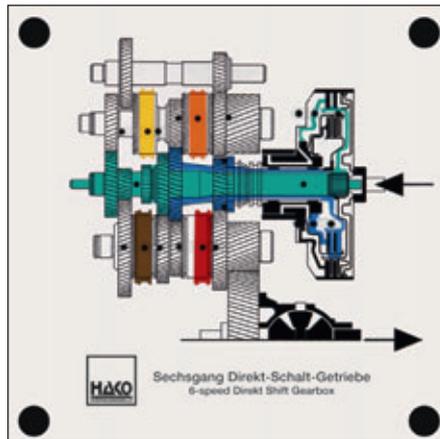


– demonstration of the synchronisation and the shifting of the gears
 Order no. 400

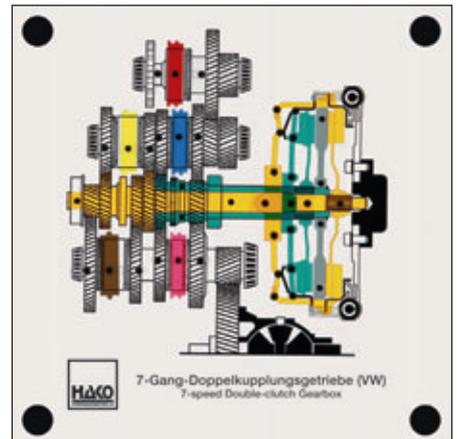


Six-speed direct shift transmission (VW)

Here, the advantages of a manual transmission have been ideally combined with the advantages of an automatic transmission. The following can be shown: engaging the 6 forward gears and the reverse gear. Engaging the inner and outer clutch. Thanks to the respective colour-coding of clutch 1 and drive shaft 1

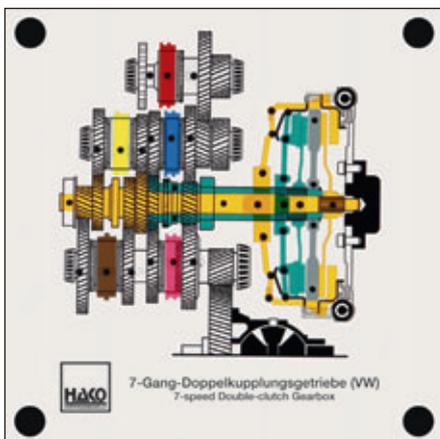


as well as clutch 2 and drive shaft 2 with their respective toothed wheels, the flow of force can easily be seen and understood in all gears. A very detailed operating manual with photos is included.
 Order no. 497

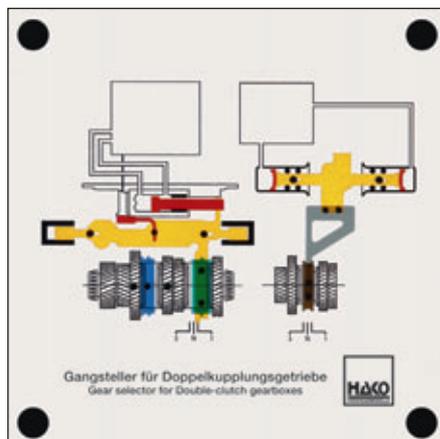


7-speed duplex clutch transmission (VW)

The 7-speed duplex clutch transmission by VW is a further development of the six-speed direct shift transmission. The following can be shown: engaging the 7 forward gears and the reverse gear. Engaging the inner and outer clutch. Thanks to the respective colour-coding for clutch 1 and drive shaft 1 as well

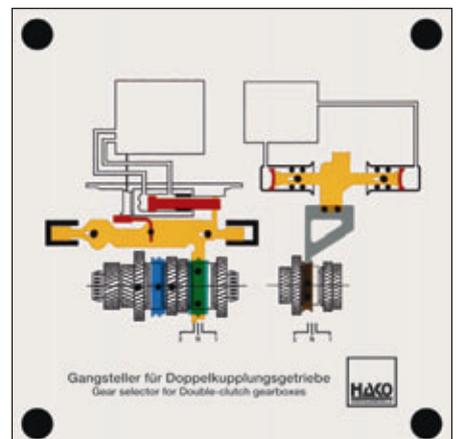


as clutch 2 and drive shaft 2 with their respective toothed wheels, the flow of force can easily be seen and understood in all gears. A very detailed operating manual with photos is included.
 Order no. 498

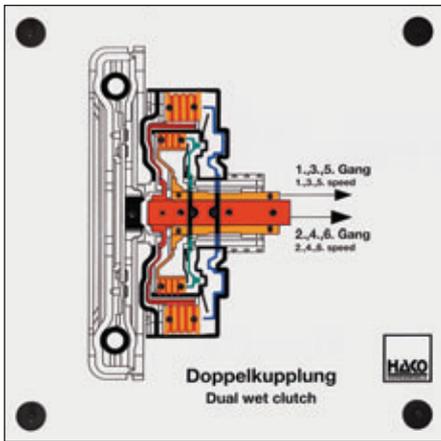


Gear changing device for duplex clutch transmission

With direct shift transmission, the gearshift forks are operated hydraulically and not by gear linkage as with conventional transmissions. The gearshift forks are mounted with ball bearings in a cylinder. For gear shifting, the mechatronic system forces oil into the left or right cylinder. This possibility is shown on the

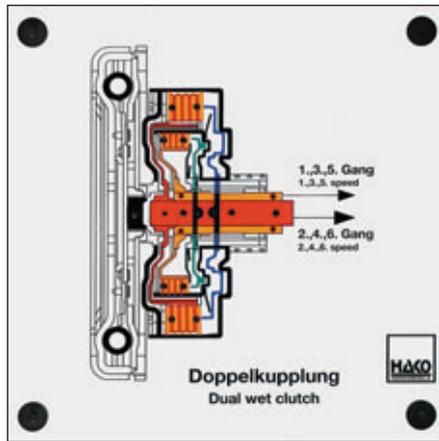


right-hand side of the model. The hydraulic piston is positioned directly on the shifter rail. On the left, an extra shift cylinder with gear changing piston has been installed, which is connected to the gearshift fork and takes this along for gear changing.
 Order no. 499

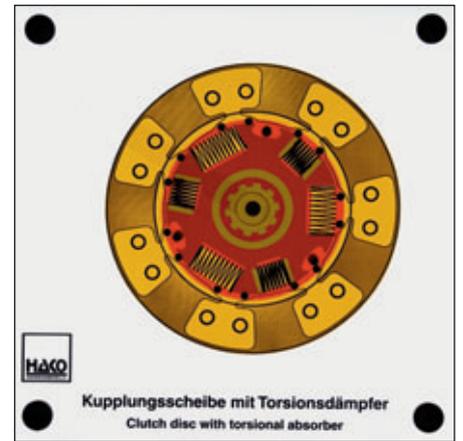


Dual wet clutch

- function of a dual wet clutch with disks
- the external diameter of the dual wet clutch is only 117 mm!
- power flow in 1st, 3rd and 5th gear via the hollow shaft by operating the small hydraulic plunger and clamping the internal disk package

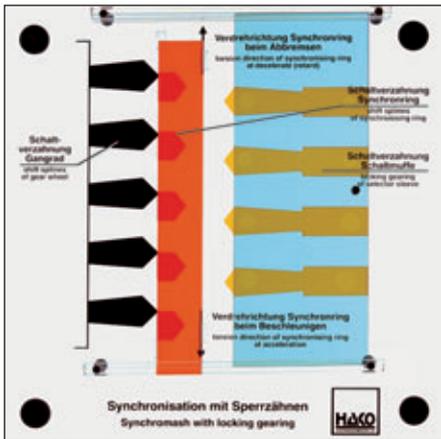


- power flow in 2nd, 4th and 6th gear via the solid shaft by operating the large hydraulic plunger and clamping the external disk package
- Order no. 470

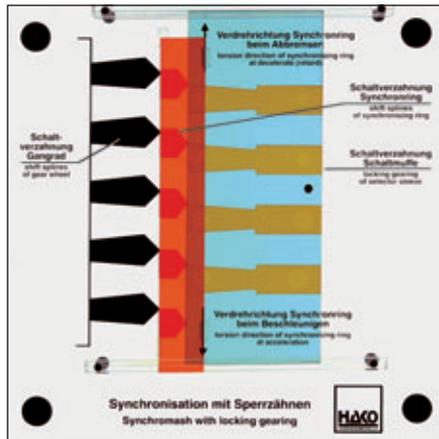


Clutch disk with torsional absorber

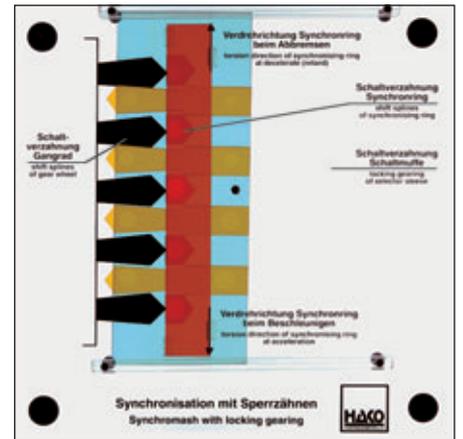
- Purpose of the torsion-bar suspension
 - Task of the torsion springs
 - Mode of effect of the various torsion springs
 - Torsion between hub and disk
 - Function of the stop bolts
- Order no. 447



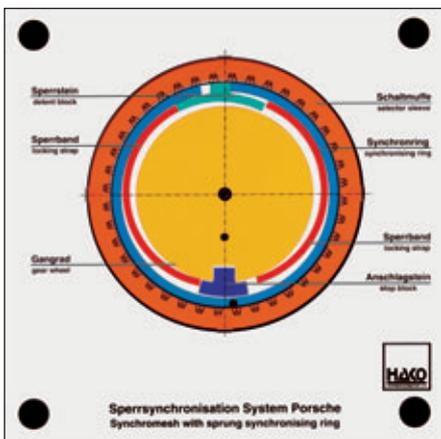
Locking synchromesh with locking gearing
"idle position"



- The synchronizing ring can be shifted half a tooth width up and down (slowing down or accelerating) and thus blocks the shift splines of the sliding sleeve.

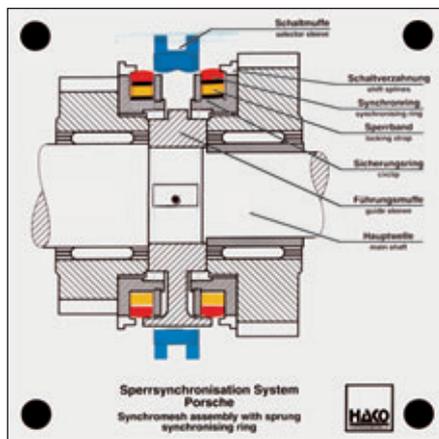


- When the constant velocity (CV) is reached, the shift splines of the sliding sleeve move the synchronizing ring. Then, the gear can be shifted.
- Order no. 186



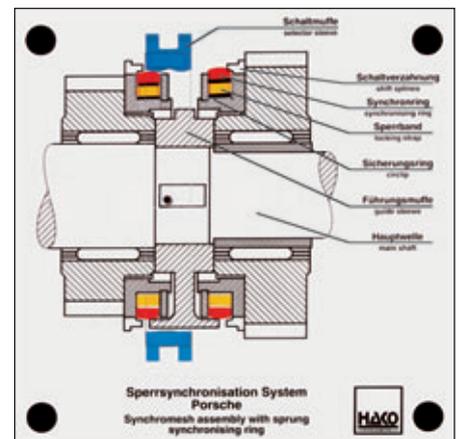
Locking synchronization System Porsche

- dragging of the split synchronizing ring
 - spreading of the locking straps causes synchronizing ring to spread even more
 - function of detent block and stop block
- Order no. 164

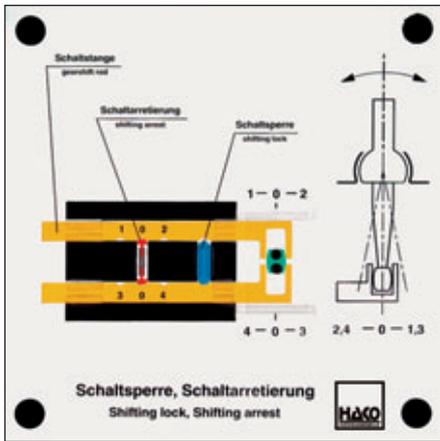


Locking synchronization System Porsche (longitudinal section)

- Neutral position
- this longitudinal section of a locking synchronization facilitates the understanding of model no. 164

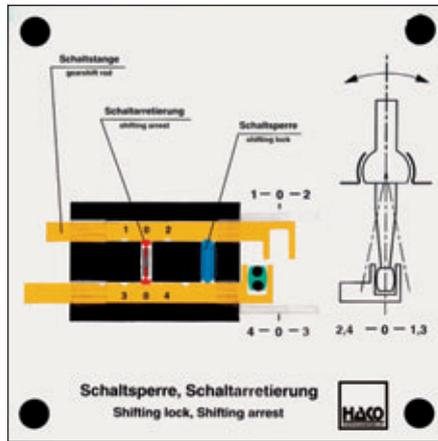


- when moving the sliding sleeve left and right, you can see how the synchronizing ring is squeezed and the locking straps moved
 - shift options: neutral, synchronization and gear shifted
- Order no. 204

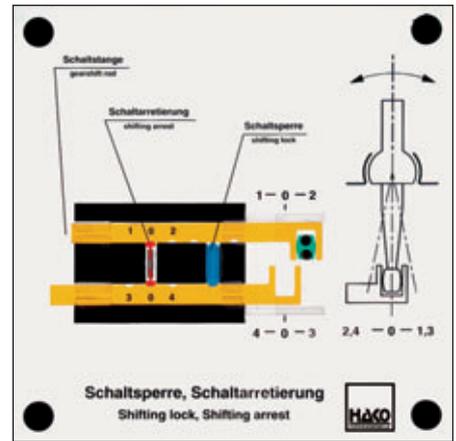


Shifting lock, shifting arrest

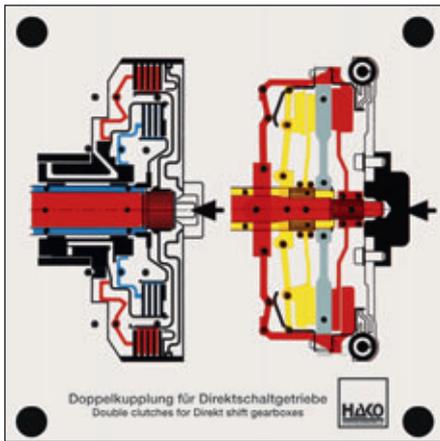
The shifting arrest prevents 2 gears from being selected simultaneously by locking the other gearshift rod. Demonstration: that the simultaneous selection of two gears is not possible.



The wedgelock mechanism prevents a gear from jumping out once selected and keeps the gears which are not selected in the neutral position.

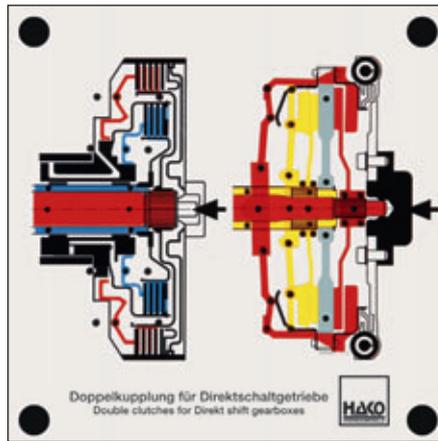


All gears are selectable.
Order no. 371

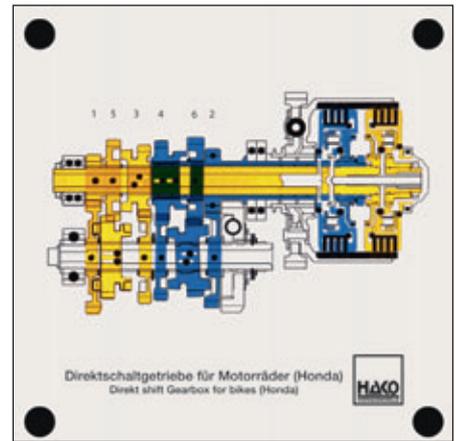


Duplex clutch for direct shift transmission

The direct shift transmission is actually made up of two mutually independent transmissions. There is a multi-disc clutch assigned to each of these transmissions. The left-hand duplex clutch runs in the DST oil. Gears 1, 3, 5 and reverse are shifted via multi-disc clutch K1. Gears 2, 4, 6 are shifted via clutch K2. The

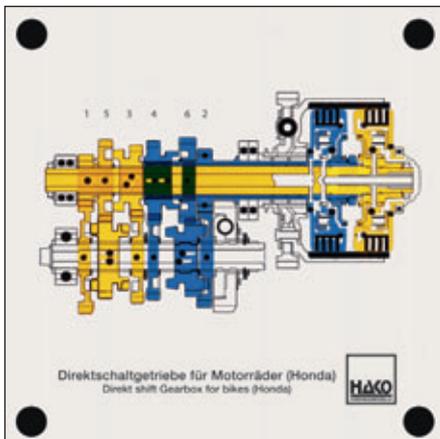


right-hand duplex clutch is made up of two conventional dry clutches combined to form a duplex clutch. Clutches K1 and K2 can be actuated in both duplex clutches. Thanks to the respective colour-coding the force transmission can be followed and understood. Order no. 502

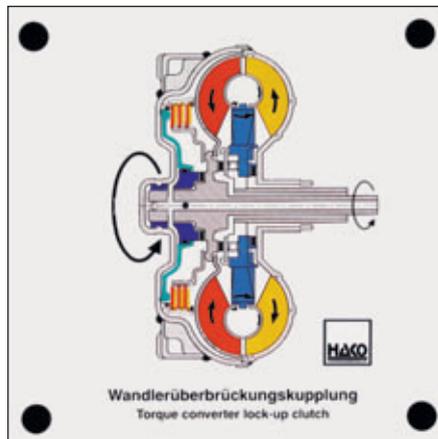


Direct shift transmission for motorbikes (Honda)

The mechanical six-speed transmission is divided into 2 separate transmissions with one clutch each, as it were. It has a divided transmission input shaft. Thanks to the blue/yellow colour-coding, the flow of force from the clutch to the individual gear wheels is easy to follow. Gears 1, 3 and 5 are located on

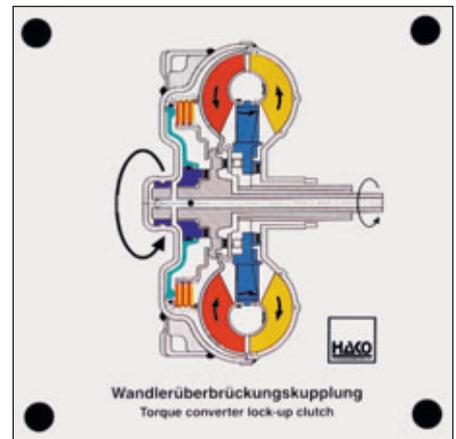


the inner transmission shaft, gears 2, 4 and 6 on the outer transmission shaft. Both clutches of the duplex clutch can be actuated. All gears can be shifted by shifting the toothed wheels. Order no. 503

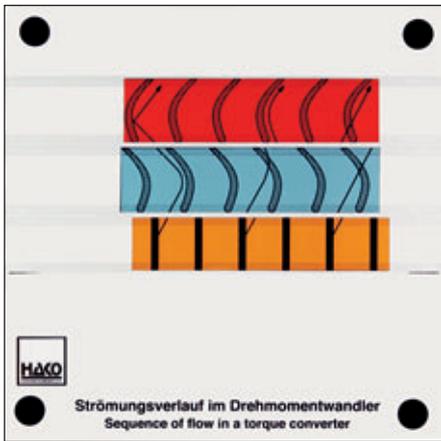


Torque converter lock-up clutch

Functions:
 – power flow from the converter housing via the pump, stator and turbine to the inlet shaft of the gearbox with the lock-up switched off
 – the hydraulic piston is pressed onto the friction disks with the help of the oil pressure



– the power flow now runs from the converter housing directly to the inlet shaft, the slip is switched off
 Order no. 430



Sequence of flow in a torque converter
 The model shows the turbine wheel, the pump wheel and the stator on one level.
1st figure: Starting: In starting, the pump wheel runs, the turbine wheel is still stationary. The flow of oil is guided onto the blades of the pump wheel at a favourable angle by the stator. There is an increase of the engine torque.



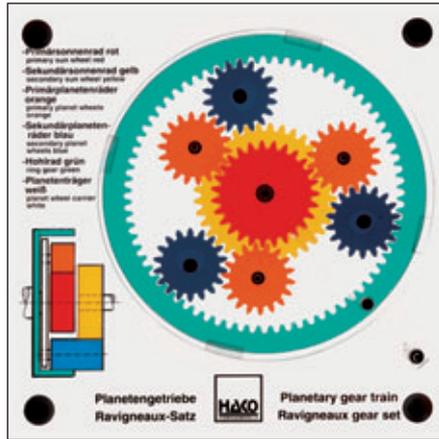
2nd figure: Starting up to the coupling point: With an increasing speed of the turbine wheel, the difference in speed between the pump and turbine wheel becomes smaller and smaller. The flow of oil is not deflected much and impacts on the blades of the stator at a lower angle. The stiffening force and thus also the torque reinforcement becomes less.



3rd figure: Coupling area: When the pump and turbine wheel have approximately the same speed, the stator is flowed onto from the back, the free-wheel releases and the stator also turns. Order no. 462



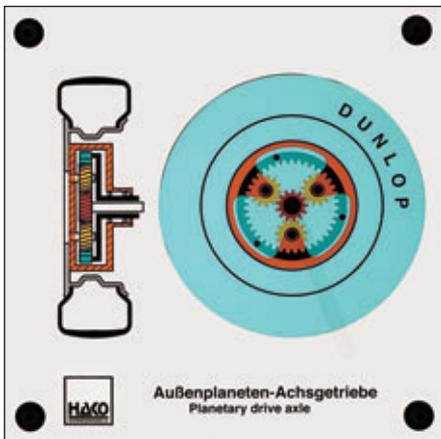
Simple planetary gear train
 All transmission ratios of a simple planetary gear train can be shown by driving and locking different parts of the model from the outside. Order no. 239



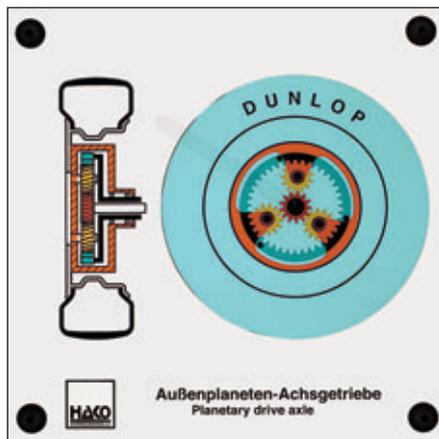
Planetary gear train: Ravigneaux gear set
 Consists of ring gear, planet carriers, two sun wheels and six planetary wheels. The gear train can be set to the desired transmission ratio from the outside. Order no. 240



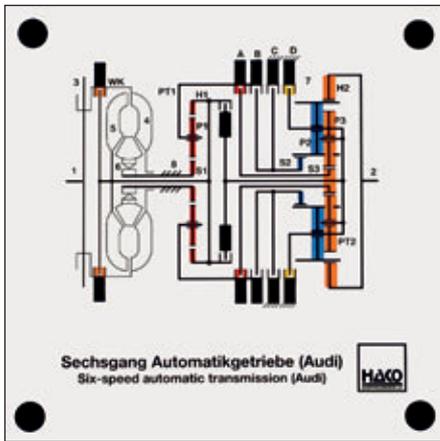
Planetary gear train: Simpson gear set
 Two simple planetary gear sets are combined to formed a single set. The Simpson gear set has 2 ring gears, 2 planet carriers and two connected sun wheels. Various gears (forwards and reverse) can be selected. Order no. 385



Planetary axle wheel drive assembly
 – function of a wheel drive assembly
 – ratio in the planetary gear

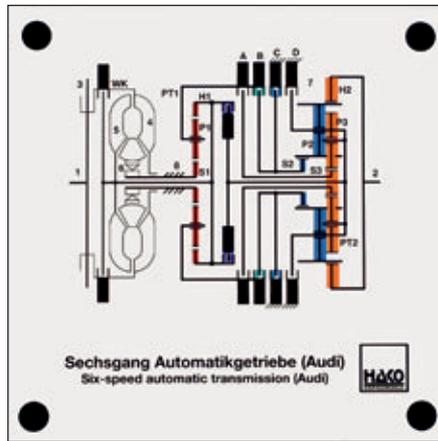


– when you turn the axle shaft, you see how the wheel turns with a ratio of 1:4
 Order no. 473

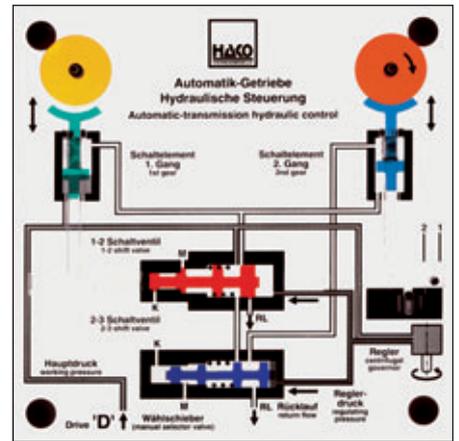


Six-speed automatic transmission (Audi)

Portrayal of flow of force of an automatic transmission with 2 sets of planetary wheels, converter with converter lockup clutch, hydraulic clutch A and B and brakes C and D. All clutches and brakes as well as the converter lockup clutch WK can be operated, with the



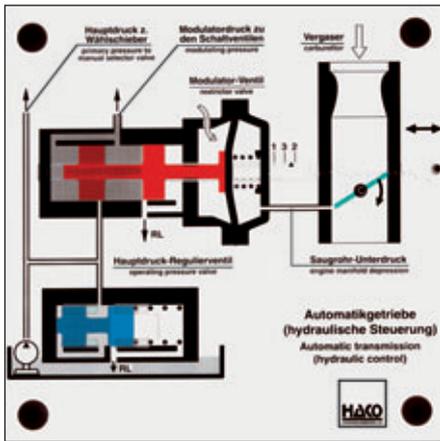
result that the flow of force in all gears can be seen. In the operating instructions, you will find a shift matrix as well as a portrayal of flow of force in all gears (extensive description and drawing).
Order no. 496



Control of an automatic transmission

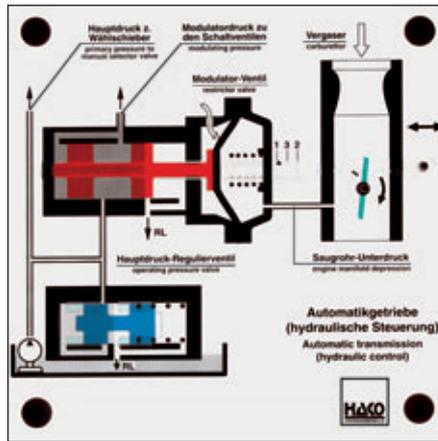
Principles of an automatic transmission:

- by actuating one lever in the model, a piston is moved and simultaneously a brake band tightened and another one released
- Order no. 215

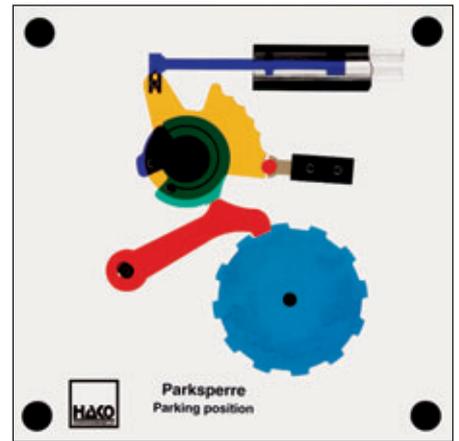


Automatic transmission (pressure-controlled)

The model shows how pressure variations in the intake manifold (i.e. load) act on the control piston via a diaphragm. The control piston influences the shift points of the automatic transmission.



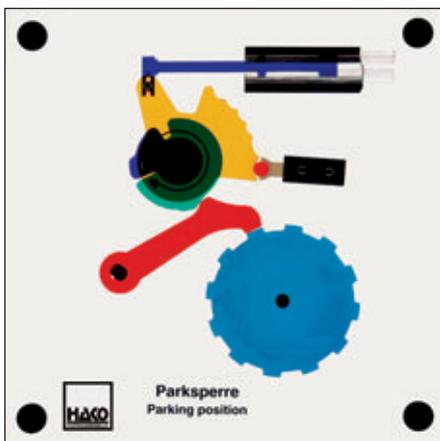
The control piston is moved by the diaphragm when the throttle blade is turned. In the model a small, transparent pinion moves the diaphragm via a gear rack.
Order no. 227



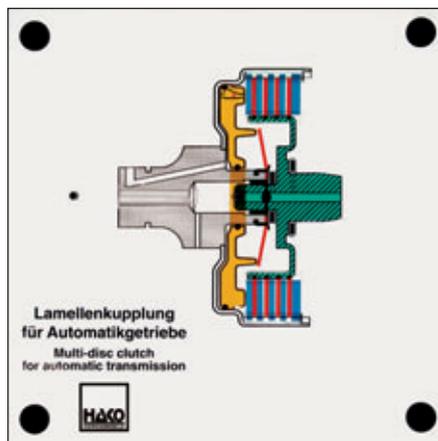
Park position

If the selector lever of an automatic transmission is on "P", the park position is engaged and prevents the vehicle from rolling.

Functions: Selection of the park position by means of the control piston valve.



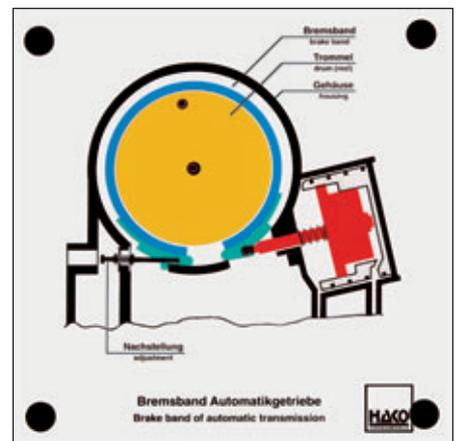
When tooth meets tooth, only the torsion spring is preloaded. When the wheel is turned further, the locking pawl engages in the next indentation.
Order no. 372



Multi-disc clutch for automatic transmissions

Hydraulic clutches are necessary for shifting the planetary gear train. Function of the ventilating system. Power flow: the piston presses the discs. Freewheeling: the piston releases the discs.

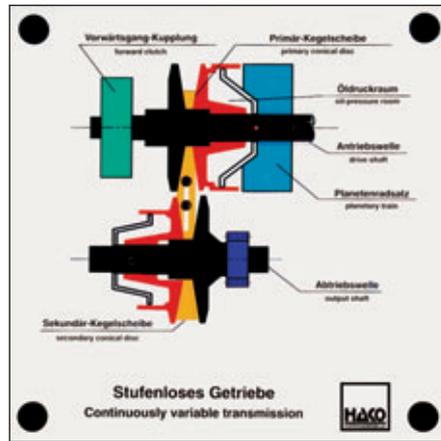
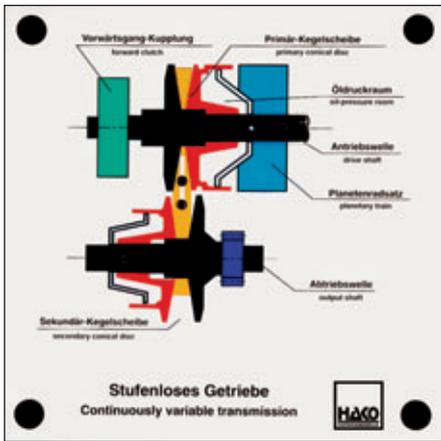
The piston is hydraulically operated.
Order no. 373



Brake band of an automatic transmission

- function of the brake-band plunger
- function of the retracting spring
- tensioning the brake band stops the drum
- resetting the brake band

Order no. 179



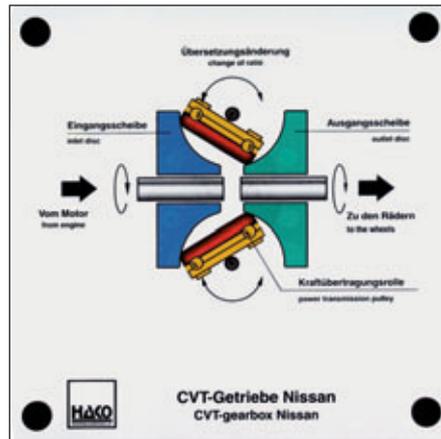
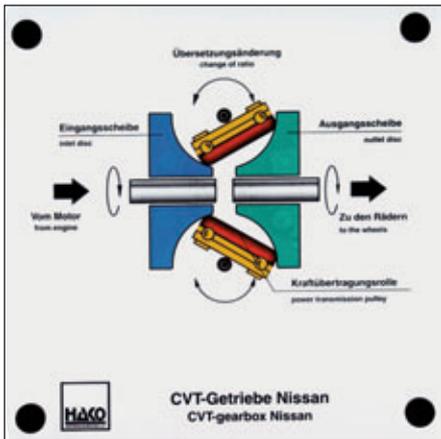
Infinitely variable PC transmission

The transfer of power from the primary conical disc to the secondary conical disc is made by means of the sliding articulated band. The infinitely variable alteration of the transmission ratio is obtained by means of hydraulic pistons.

This either presses the conical discs together or separates them. This causes the sliding articulated band to run on varying friction radii. Order no. 384

Gear drive without backlash

The gear drive without backlash, mainly used for motor bikes, has on one shaft a gear wheel with 49 teeth and another gear wheel with 50 teeth. The two are axially preloaded against each other. With every rotation, the gear wheel with 49 teeth is turned one tooth farther than the gear wheel with 50 teeth. This causes a gear drive without backlash. Order no. 229

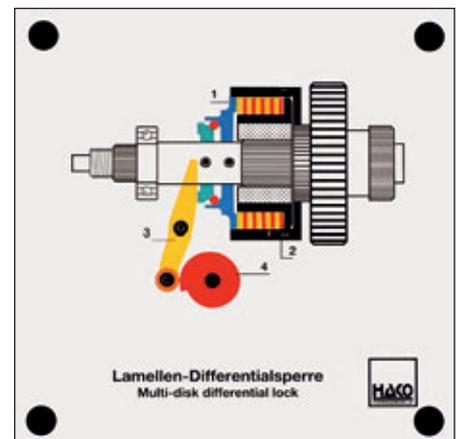
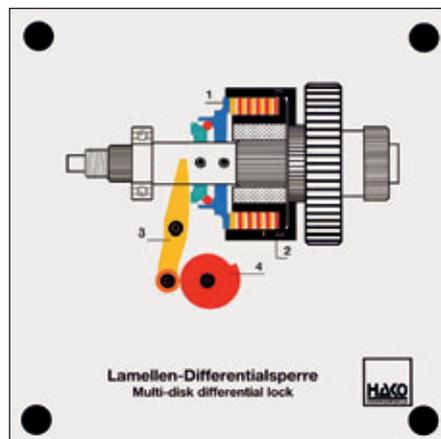


CVT-gearbox Nissan

Infinite transmission for rear-wheel driven cars, suitable up to 500 Nm. A roll is used for the force transmission. Pivoting the roll alters the gear ratio infinitely. Order no. 448

Limited-slip differential with friction plates

Functions:
 – displacing the differential spider gear with shaft
 – putting the shaft of the differential spider gear against the tapers of the thrust rings

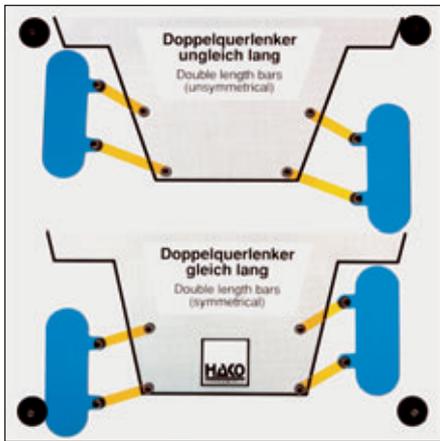


– the thrust rings are spread apart
 – pressing the clutch plates together
 – locking the differential
 – dividing the power flow in the differential
 Order no. 269

Multi-disk differential lock

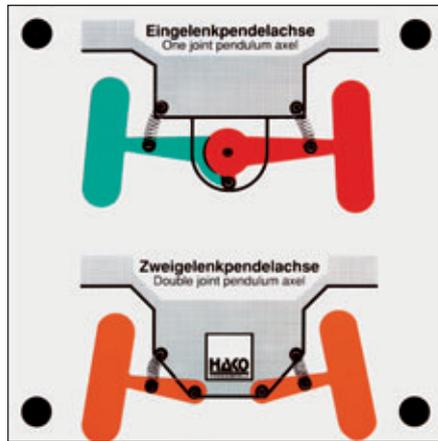
Above all, four-wheel all-terrain vehicles now use electrically operated differential locks in the transfer case. Demonstration:
 – function of the differential lock
 – turning of the radial cam

– movement of the reversing lever and stroke of the starter plate
 – pressing the disk packages together
 – electronically adjustable pressure on the disks, with the result that the lock works just without slip
 Order no. 495



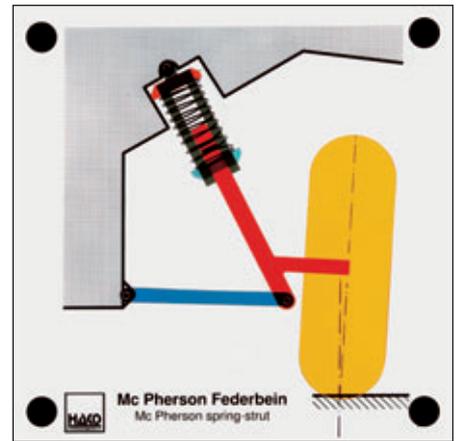
Wishbones (of identical and different lengths)

- displacement of the axle
 - change of track width and camber
 - independent displacement of the wheels
- Order no. 111



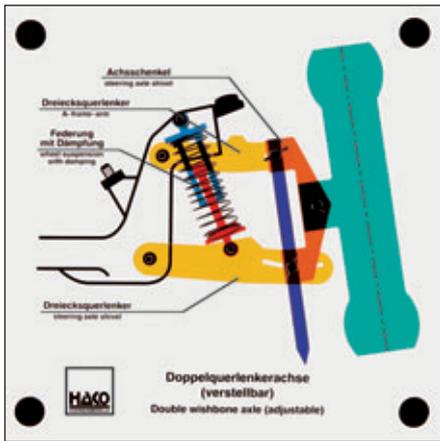
Single- and two-joint swing axle

- compression of one side or both sides
 - compression changes track width and camber
- Order no. 109



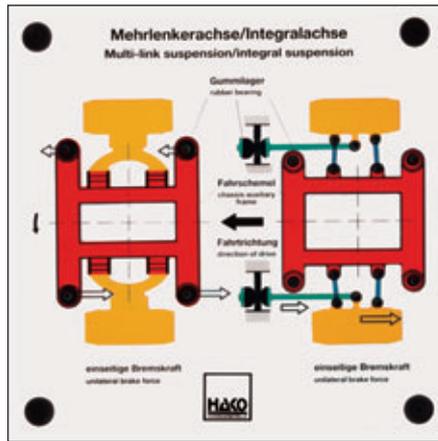
Mc Pherson strut

- compression changes track width and camber
- Order no. 113



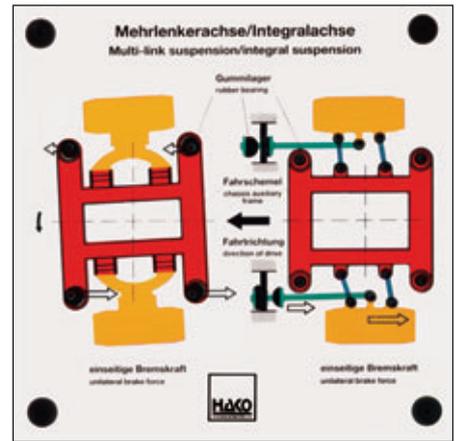
Adjustable wishbone

- principle of suspension and damping
 - compression changes track width and camber
 - camber and kingpin inclination adjustable
 - different kingpin offsets (positive, zero, negative)
- Order no. 163

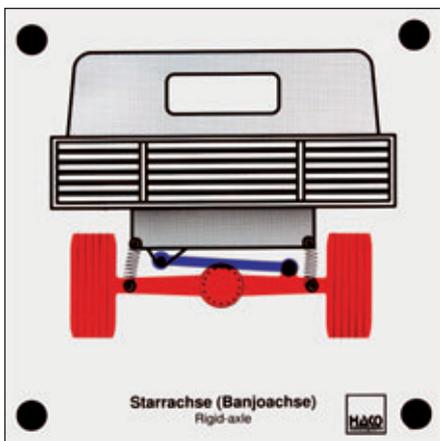


Multi-link suspension

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

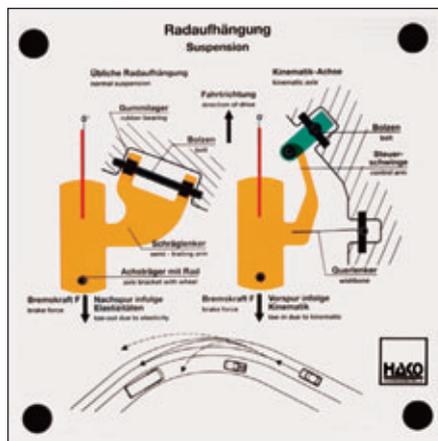


- with an integral suspension, a unilateral brake force causes only a longitudinal displacement of the corresponding wheel
- Order no. 254



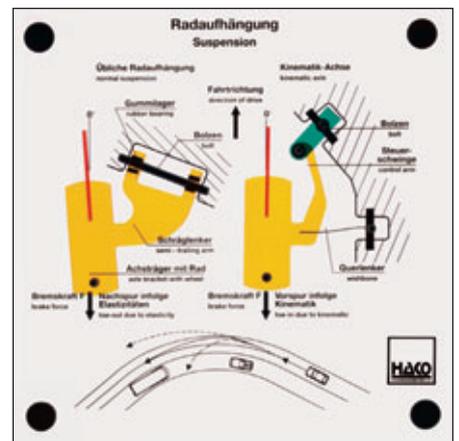
Rigid axle

- compression of one side
 - compression of both sides
 - without Panhard rod, top moves when vehicle corners
 - lateral stability with Panhard rod
- Order no. 114

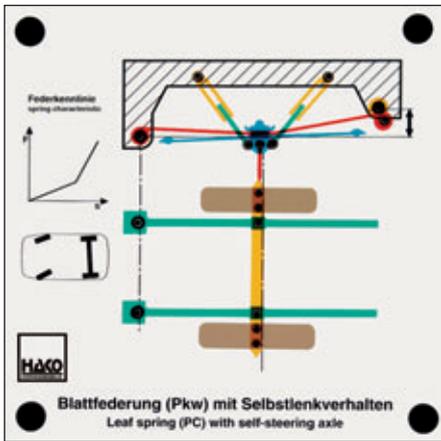


Wheel suspension

- Normal suspension: When the semi-trailing arm is moved by brake force, it causes an undesirable toe-out.

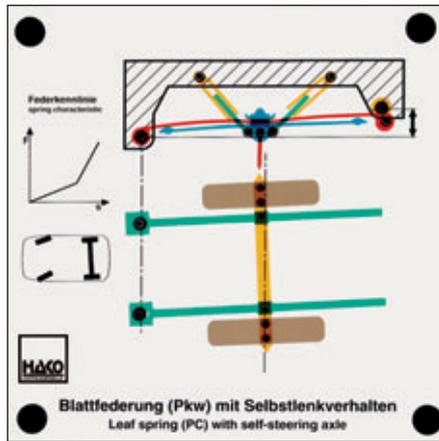


- Kinematic axle: Because of the arrangement of this suspension, the wheel gets a toe-in and introduces an automatic correction.
- Order no. 251

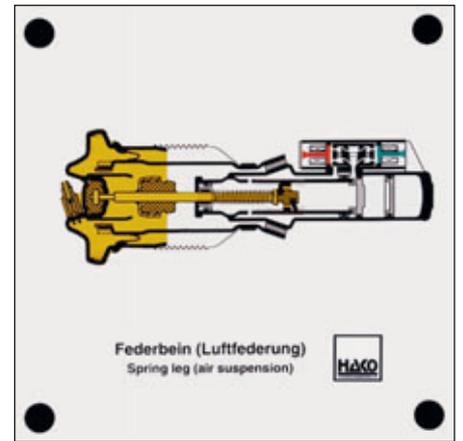


Leaf spring (PC) with self-steering axle

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

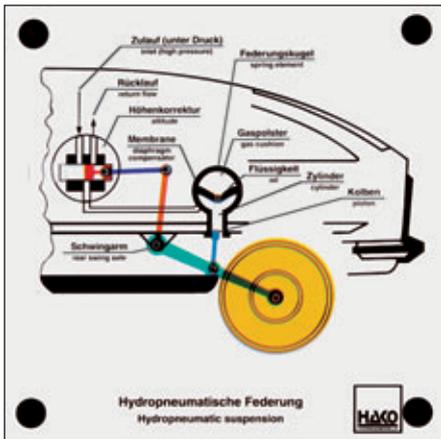


Thus the self-steering properties of the axle are achieved.
Order no. 381



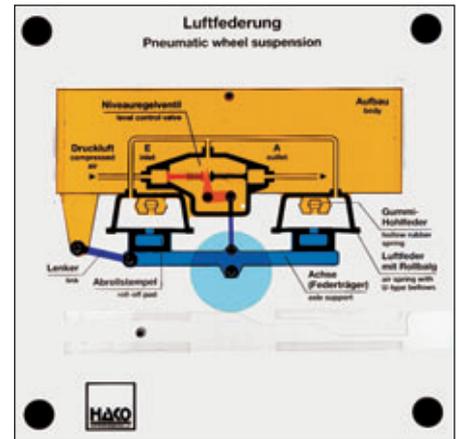
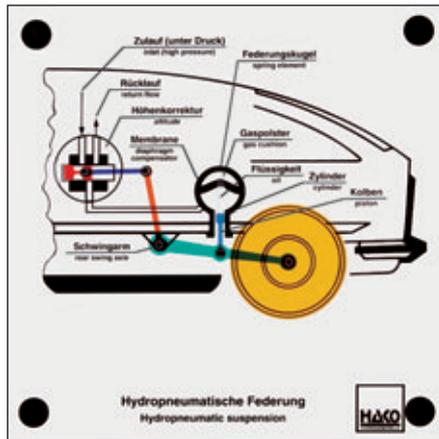
Spring leg (air suspension)

Used in the Mercedes-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. 437



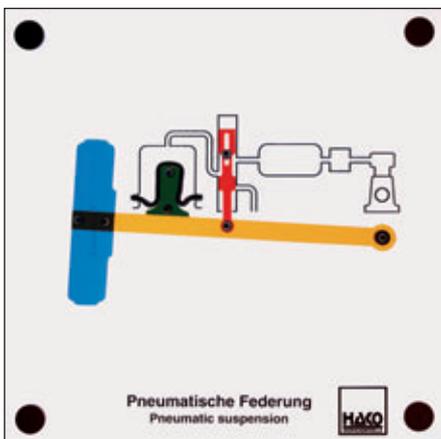
Hydropneumatic suspension

– the diaphragm of the suspension element and the piston are moved by wheel compression and rebound
– simultaneously, the right-height control valve (inlet or return) is actuated
Order no. 178



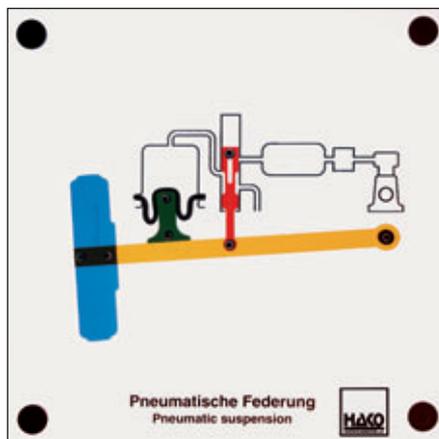
Pneumatic suspension

– design of pneumatic suspension
– effect of air spring bellows and hollow rubber springs
– principle of level control on loading and unloading
Order no. 285

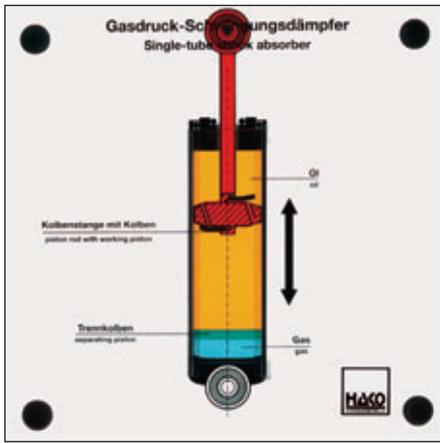


Pneumatic suspension

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.



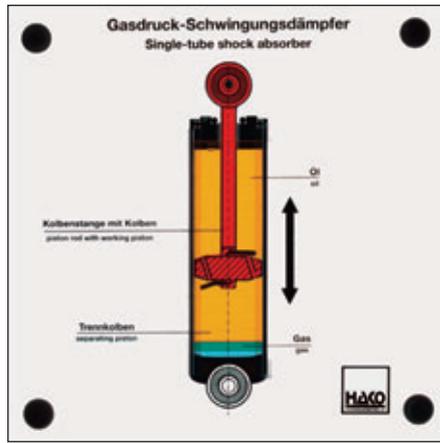
In relief, the level regulator in the control valve opens and allows air to flow out until the standard level is reached again.
Order no. 456



Single-tube shock absorber

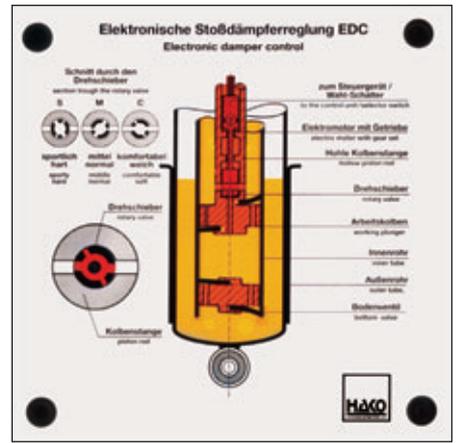
- the shock-absorber piston can be moved
- function of the valves (they open and close automatically)

"Compression"



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

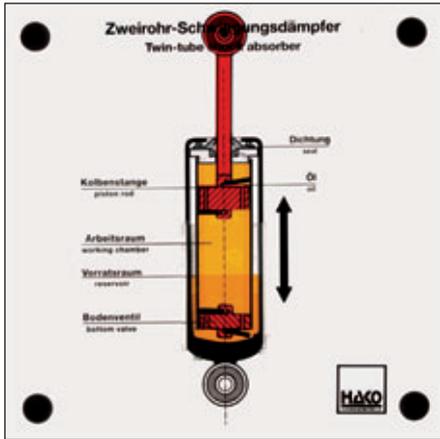
"Rebound"



Electronic damper control

- moving the shock-absorber piston
- function of the valves (they open and close automatically)
- adjusting the desired stiffness of the shock absorber by means of a rotary valve
- interaction of all elements

Order no. 248



Twin-tube shock absorber

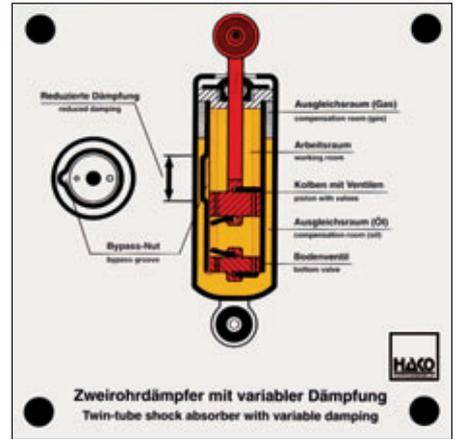
- displacing a shock-absorber piston
- function of the valves (they open and close automatically)

"Compression"



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

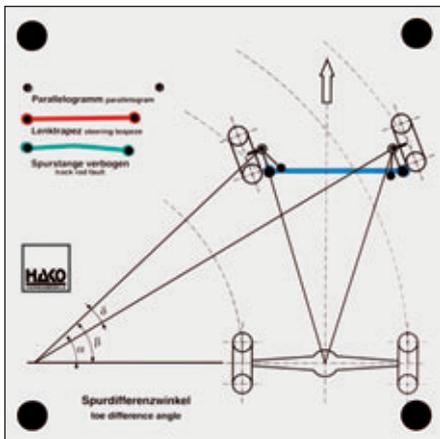
Order no. 246



Twin-tube shock absorber with variable damping

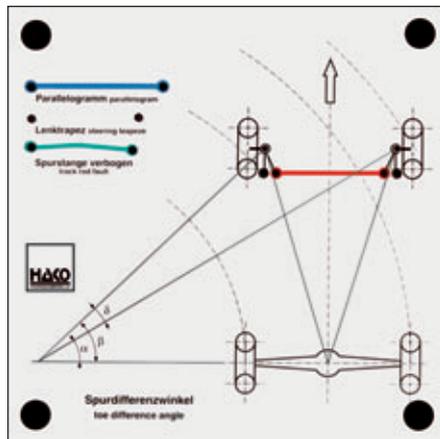
- All the functions of a standard twin-tube shock absorber can be demonstrated.
- In addition: low damping in the main working area (central) by means of a bypass groove formed in the housing.

Order no. 379

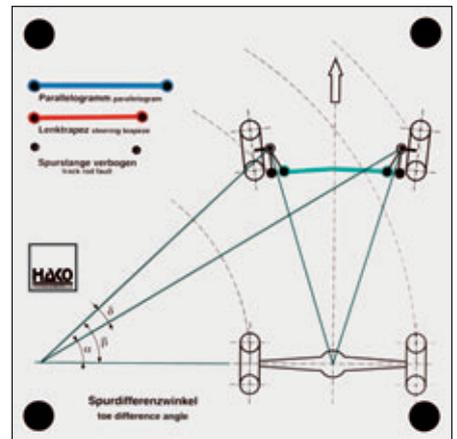


Steering geometry – toe difference angle

- with parallel track-rod arms, both wheels have the same steer angle. (steering tie rod #1)

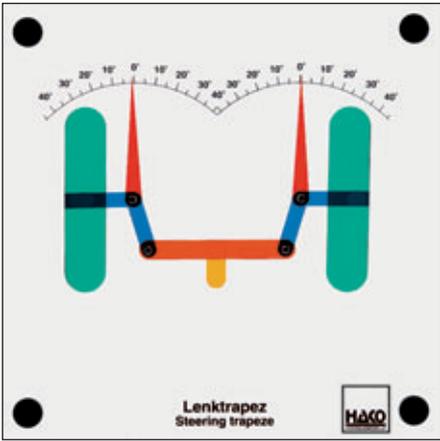


- with a steering trapeze, the wheels have a different steer angle. (steering tie rod #2)



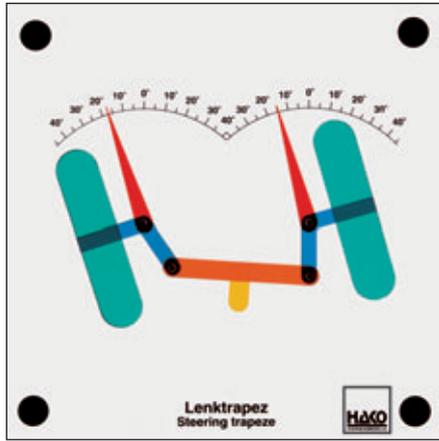
- with a distorted steering tie rod, the wheels have an incorrect steer angle. (steering tie rod #3)
- toe difference angle can be read

Order no. 212

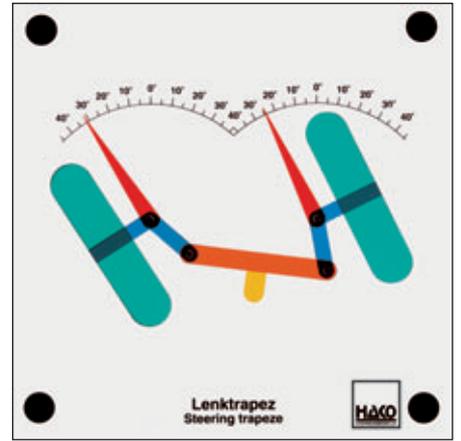


Static steering trapeze

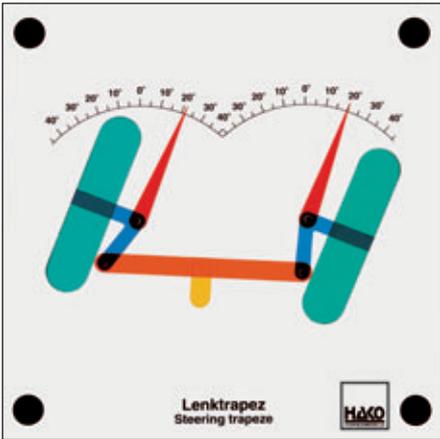
– the wheel at the inside of a curve has a larger steer angle



– a toe difference angle can be read

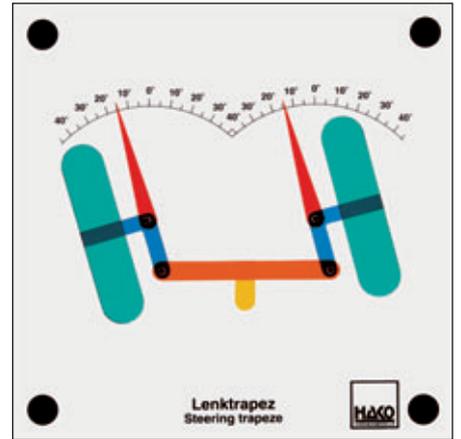
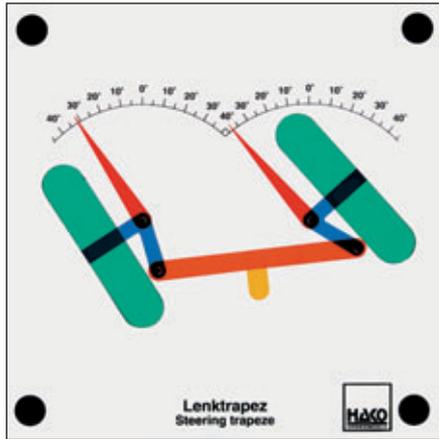


– the toe difference angle increases with increasing steer angle
Order no. 107



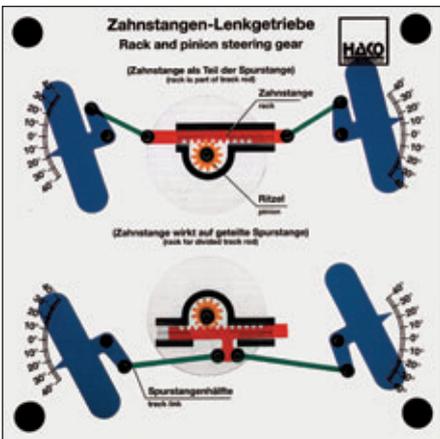
Dynamic steering trapeze

– the wheel at the outside of a curve has a larger steer angle (e.g. for sportscars)
Order no. 108



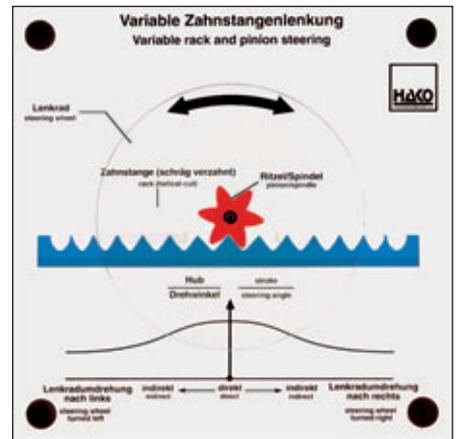
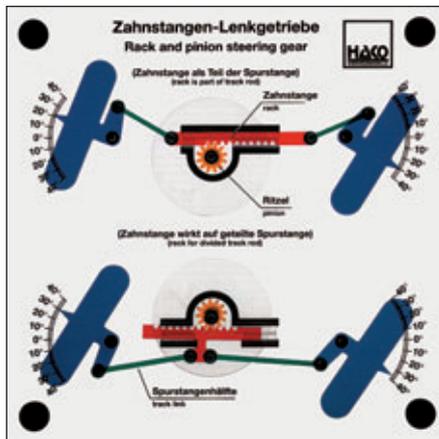
Parallel steering trapeze

– both wheels have the same steer angle
Order no. 106



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. 282



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. 232

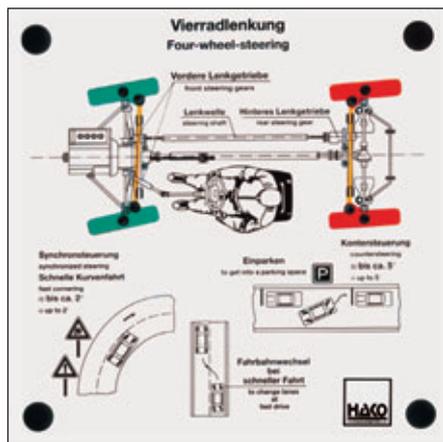


Fifth-wheel steering, axle-pivot steering

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



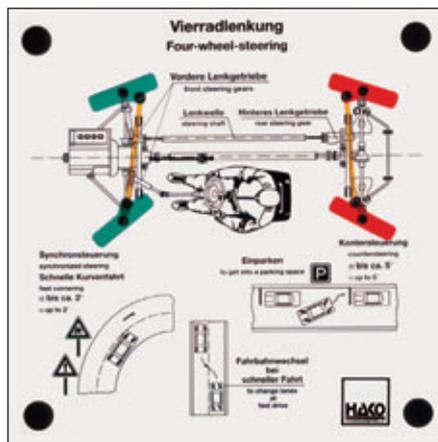
area in a wheel deflection on the fifth-wheel steering. With the axle-pivot steering, there is no alteration of the contact area with a wheel deflection. Order no. 458



Four-wheel steering

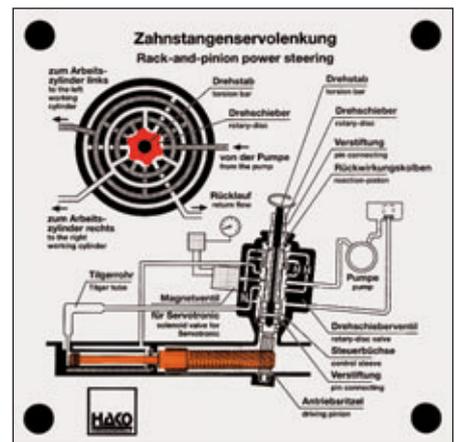
– it is possible to tilt all wheels to show the principle of a four-wheel steering
– synchronized steering for changing lanes and cornering

"Synchronized steering"



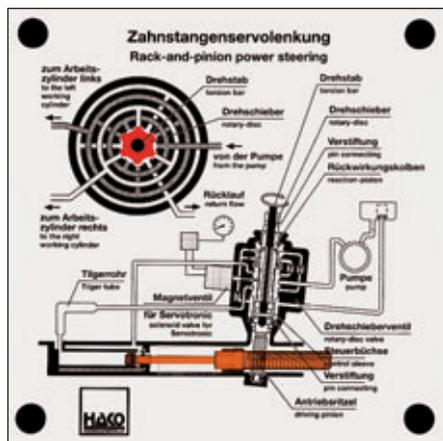
– countersteering to get into a parking space
Order no. 245

"Counter steering"

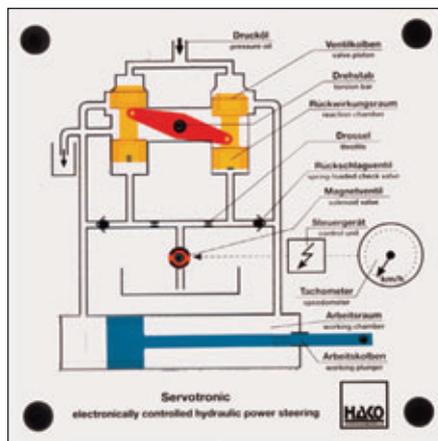


Rack-and-pinion power steering

– movement of the gear rack by means of steering spindle and torsion bar



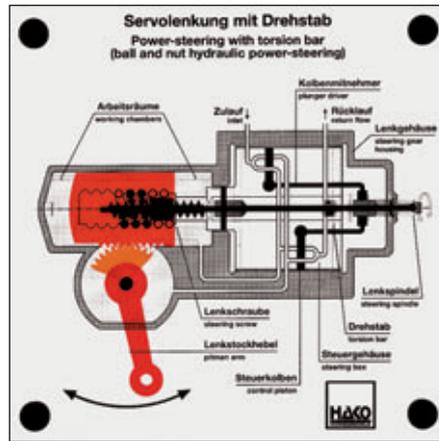
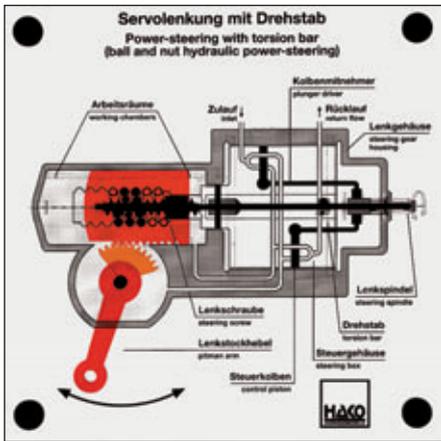
– the control sleeve opens the respective hydraulic lines to the working chambers
Order no. 297



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. 267



Power-steering with torsion bar (ball-and-nut hydraulic power steering)

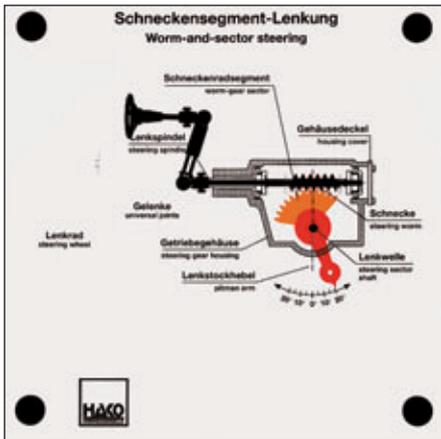
- the steering spindle moves the recirculation ball screw and steering segment
- during steering, the control pistons in the steering valve are moved automatically

- the hydraulic lines to the working chambers open automatically

Order no. 302

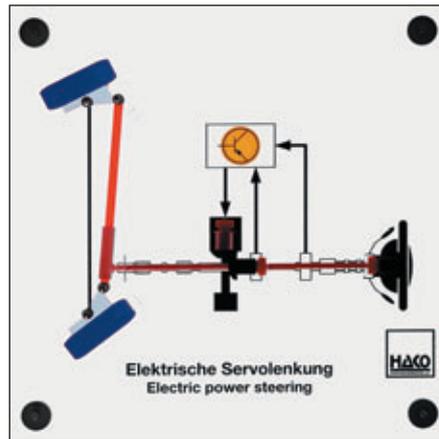
Worm-and-sector steering

- turning the steering spindle using the steering wheel
- moving the steering worm, worm-gear sector and pitman arm



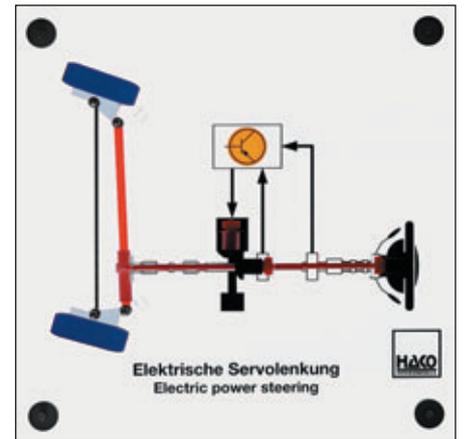
- calculating the transmission ratio
- collapse of steering spindle in the event of an accident (passive security)

Order no. 298



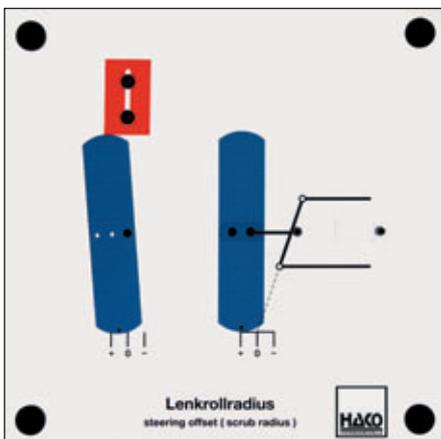
Electric power steering

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



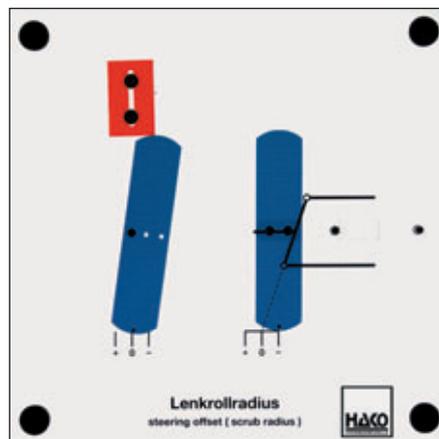
calculates the energy for the electric motor. The steering column is operated via a wormed gear and the wheel deflection takes place. The toe difference angle can clearly be seen.

Order no. 471



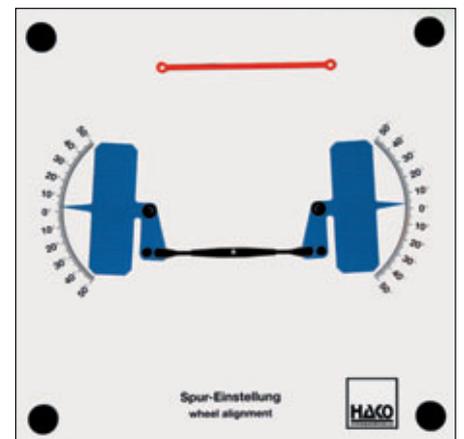
Kingpin offset

- Right:
 - positive, zero and negative kingpin offset
- Left:
 - kingpin offset effect:



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

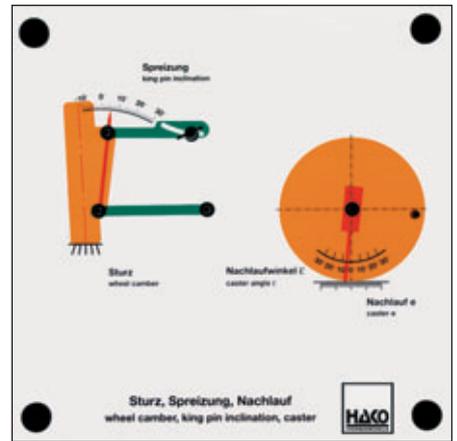
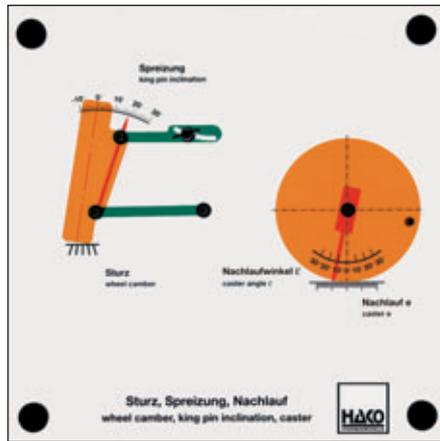
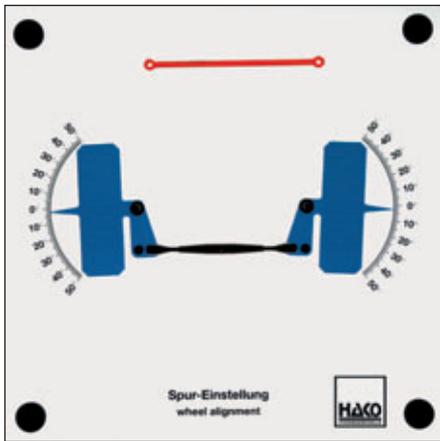
Order no. 320



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 difference angle

Order no. 321



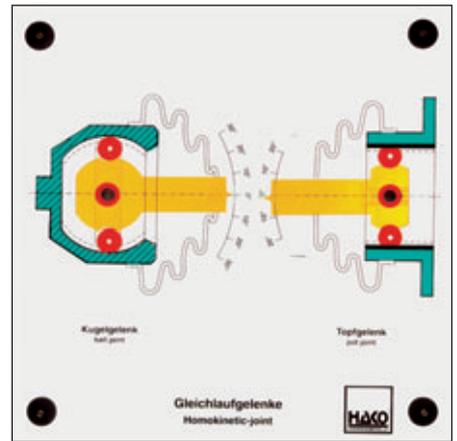
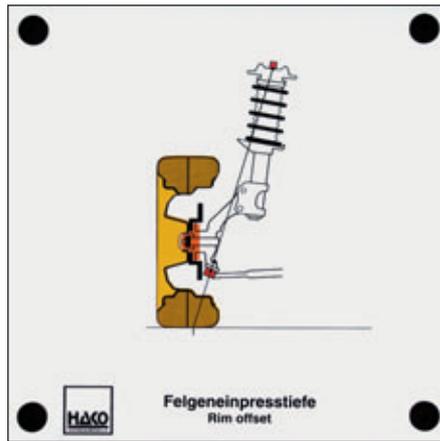
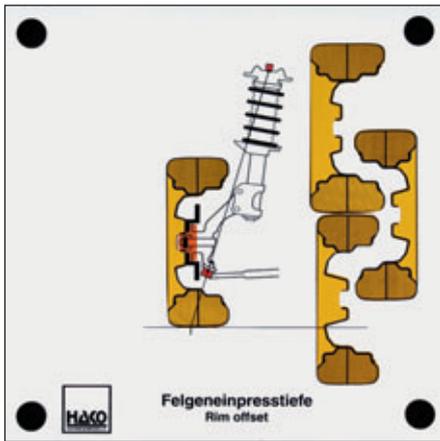
Kingpin, inclination, castor

Left:

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

Right:

- adjustment of the negative, zero and positive castors
 - observation of castor offset and castor angles
- Order no. 322



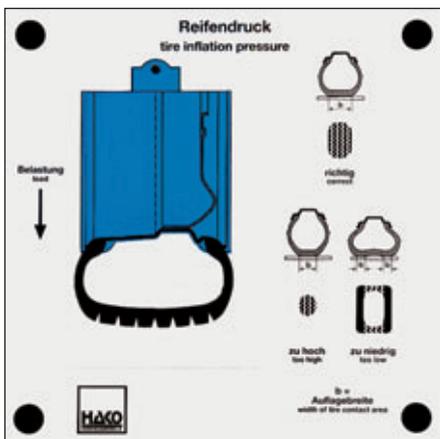
Rim offset

- 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. 445

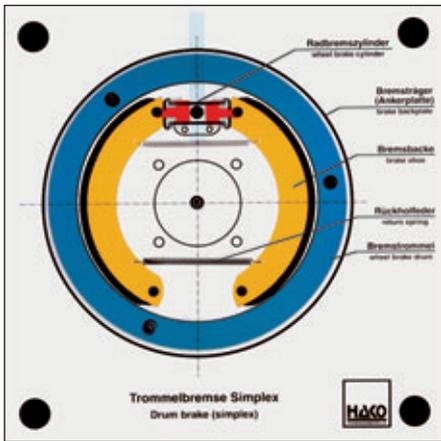
Homokinetic joint

- ball joint: large inclination angle, without length compensation
 - pot joint: smaller inclination angle, with length compensation
- Order no. 194



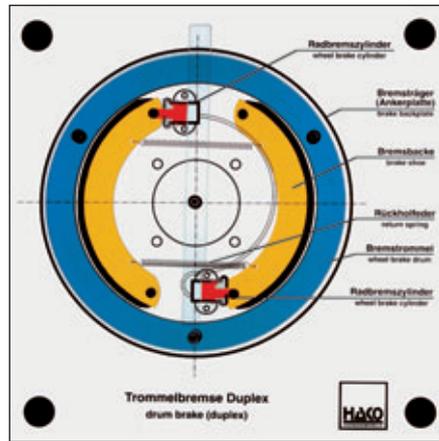
Tire inflation pressure

- deformation of the tire when inflation pressure is too high or too low.
 - deformation of the tire when the load is excessive
 - reduced width of the tire contact area when the inflation pressure is too high or too low
 - development of tread wear
- Order no. 286



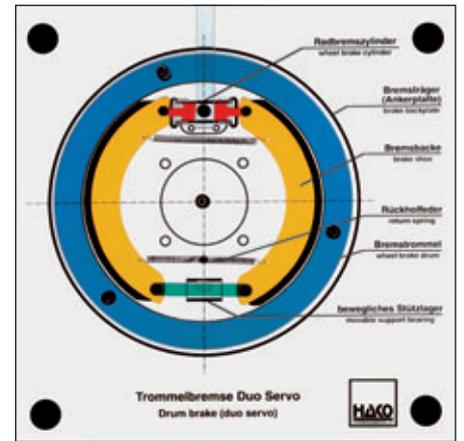
Drum brake simplex

- braking
 - brake shoes fit tightly
 - function of the return spring
 - the leading (primary) shoe is pulled
 - the trailing (secondary) shoe is pushed
- Order no. 118



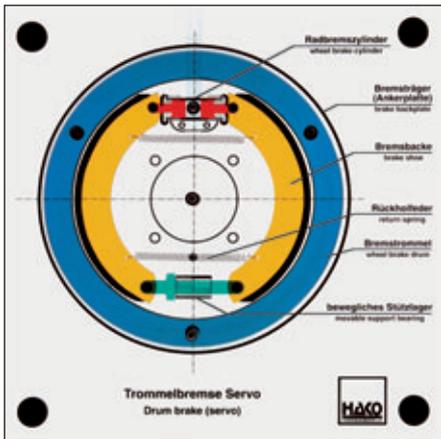
Drum brake duplex (like simplex)

- braking with two leading brake shoes or, when backing-up, with two trailing brake shoes
- Order no. 119



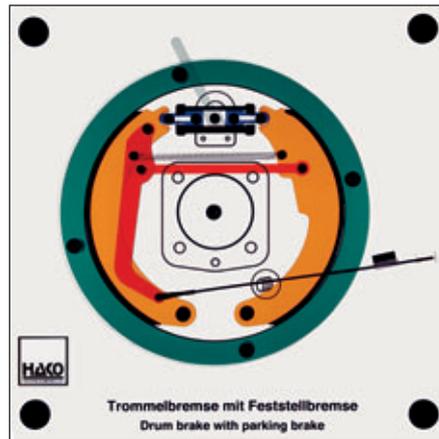
Drum brake duo servo (like simplex)

- transmission of the frictional forces of one brake shoe to the other
 - backing-up the same effect results
- Order no. 120



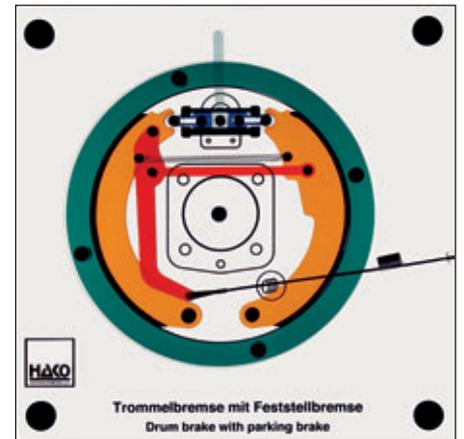
Drum brake servo

- (like duo servo)
Force transmission only possible in one direction.
- Order no. 175

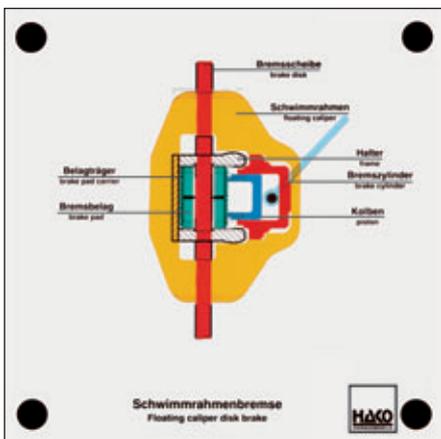


Drum brake with parking brake

- operation of the brake shoes via the wheel brake cylinder
- function of leading and trailing shoe (the leading shoe is pulled onto the drum, the trailing shoe is pushed away)

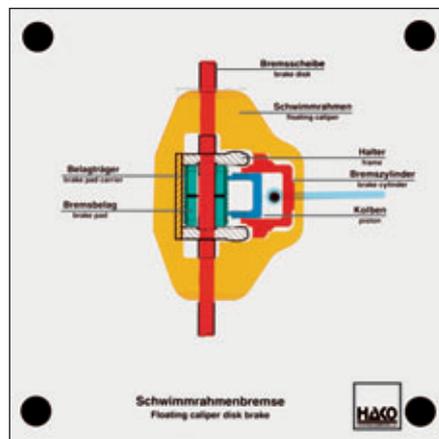


- operation of the service brake via the pistons in the wheel cylinder
 - operation of the parking brake via a linkage
- Order no. 461

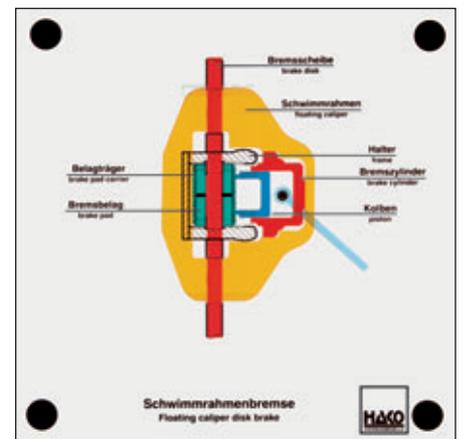


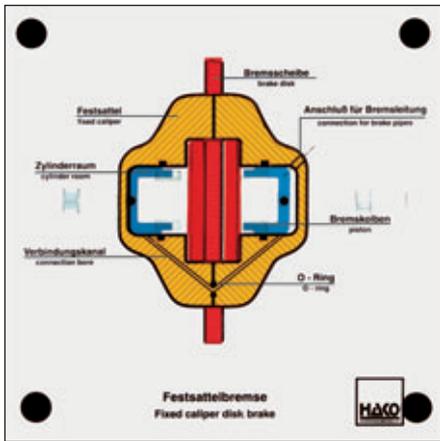
Sliding brake caliper

First, a transparent cam pushes the brake pad against the brake disk.



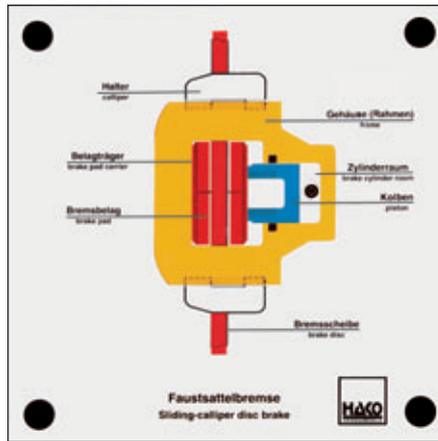
The caliper absorbs the counterforce and is moved by it.
Automatic resetting.
Order no. 171





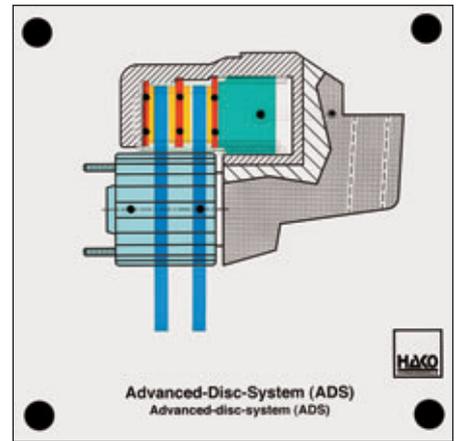
Fixed-caliper disk brake

- actuating the brake pistons
 - the principle of independent readjustment
 - deformation of the sealing ring while braking
 - clearance re-established after braking (sealing ring gets back into original shape)
- Order no. 169



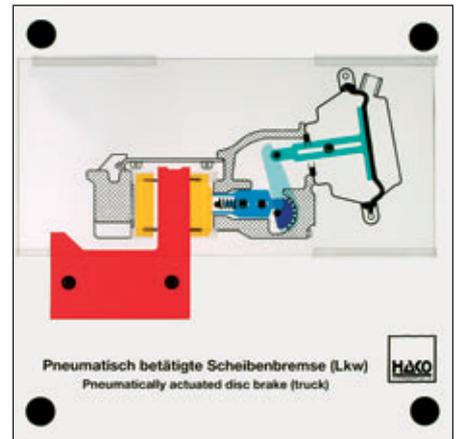
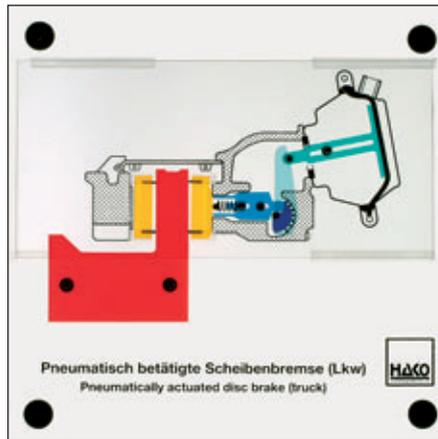
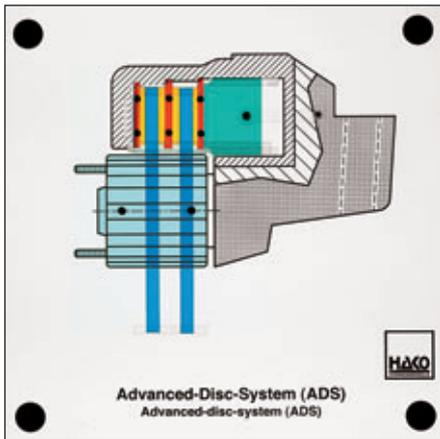
Floating-caliper disk brake

- a small, transparent cam first pushes the piston with brake pad against the brake disc and then the caliper into the opposite direction
 - small, transparent springs move them back after braking
- Order no. 170



Advanced Disc System (ADS)

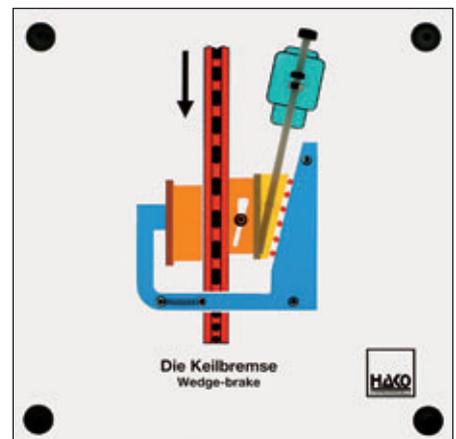
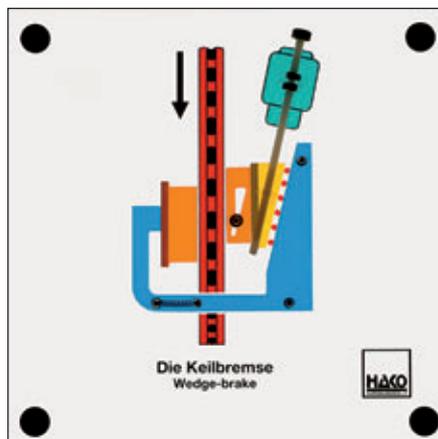
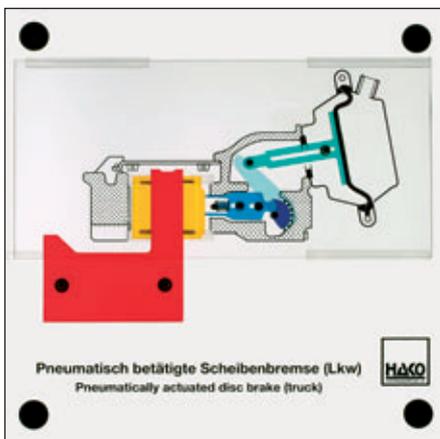
- Latest brake system with 2 floating brake disks
 - extension of the brake plunger
 - application of the 3 brake pads to the brake disks
 - displacement of the two brake disks
- Order no. 475



Pneumatically actuated disc brake (truck)

When the membrane cylinder is actuated, an eccentrically supported lever is pivoted. This lever displaces the bridge. Firstly, the right-hand brake

pad is moved to the disk by the bridge. After this, the complete brake caliper is pulled to the right and the other brake pad moved to the disk. Thanks



to small springs integrated into the brake pads, the brake pads automatically release from the brake disk after each braking process on the model.
Order no. 484

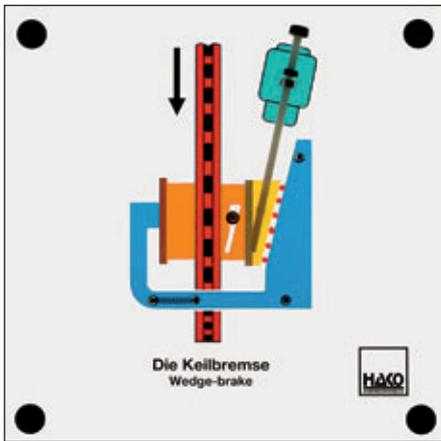
Wedge brake

An electronically operated wedge will replace hydraulic brakes. Then, hydraulic lines and hoses, brake fluid, fluid containers and brake booster will no longer be necessary. The brake pad is pulled downwards when it contacts the disk (servo effect, comparable with leading shoes on drum brakes). In this way, the 12 Volt vehicle electrics are completely sufficient for the operating engine.

Further benefits: no blocking of the wheels, no pedal pulsing, quicker reactions.

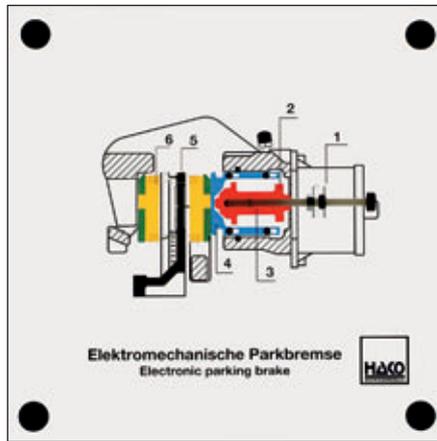
Demonstration:

- movement of the floating brake caliper to the left and right
- turn the threaded spindle, observe movement of the brake wedge until it has contact to the brake disk ▶▶



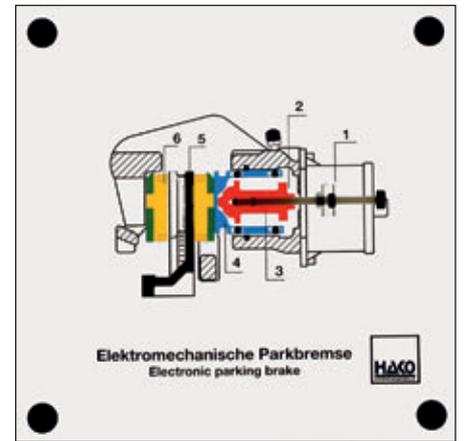
Die Keilbremse
Wedge-brake

– when the threaded spindle is turned further, one sees how the floating brake caliper moves to the right and the other brake pad likewise makes contact with the brake disk
Order no. 488



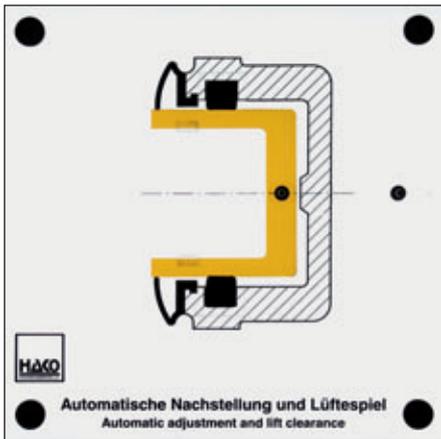
Elektromechanische Parkbremse
Electronic parking brake

Electronic parking brake
The parking brake is activated by pulling a switch. The conversion of the turning movement into a lifting movement on the brake piston is via a geared motor and a spindle. The cylinder pushes the brake piston onto the brake disk by the rotary movement of the spindle, the vehicle is secured against rolling away.



Elektromechanische Parkbremse
Electronic parking brake

Demonstration:
– hydraulic brake function by displacement of the brake piston
– contact of the brake pad to the brake disk, braking function
– automatic release of the brake piston by letting it go
– turning of the threaded spindle, lifting movement of the cylinder until it puts the brake pad into contact with the brake disk. Braking function.
Order no. 494



Automatische Nachstellung und Lüftenspiel
Automatic adjustment and lift clearance

Automatic adjustment and lift clearance

Deformation of the gasket ring
Return to shape of the gasket ring
Production of the clearance



Automatische Nachstellung und Lüftenspiel
Automatic adjustment and lift clearance

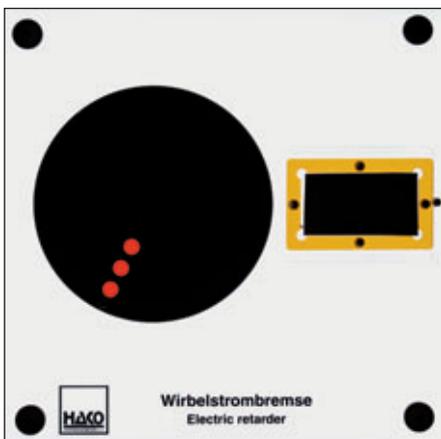
Adjustment with wear of the lining
Order no. 446



Feststellbremse
Parking brake

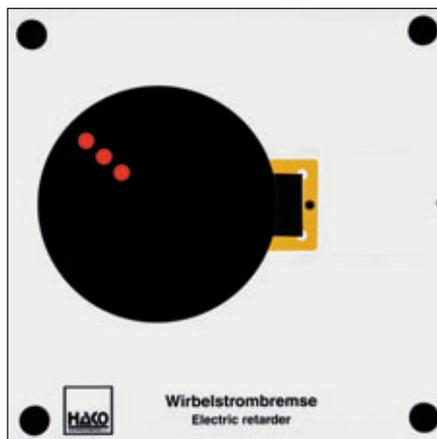
Parking brake

– pulling the parking-brake lever
– function of the ratchet
– braking action of the drum brake
– release of the drum brake
– actuation of the ratchet push-button
Order no. 393



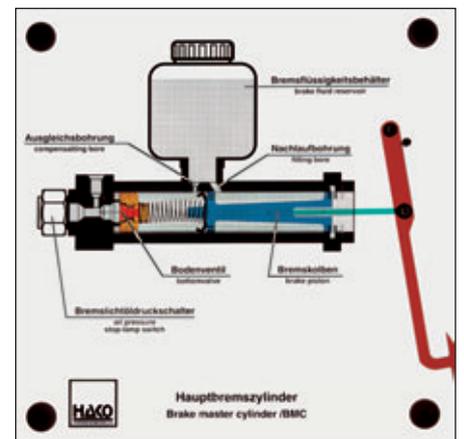
Wirbelstrombremse
Electric retarder

Turning the aluminium plate (ball-bearing)
Movement of the pair of permanent magnets
Slight to strong braking of the disk,



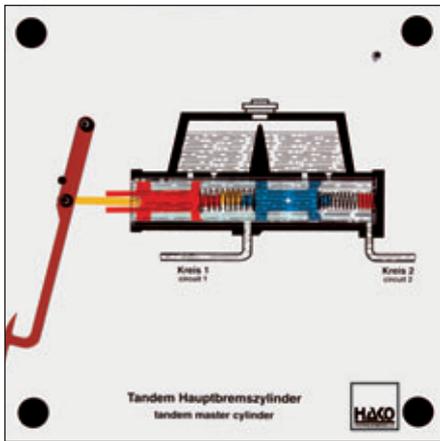
Wirbelstrombremse
Electric retarder

depending upon the position of the magnets
Moving the plate with the help of the magnets
Order no. 449



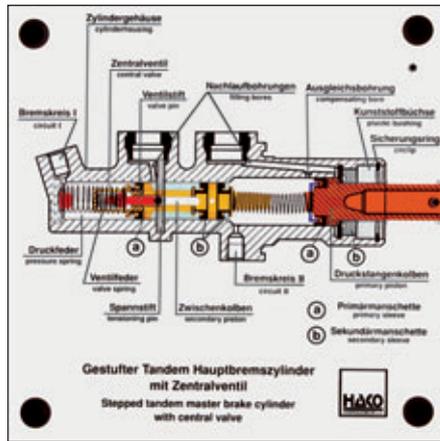
Single-chamber brake master cylinder

– function of piston, piston valve and primary sealing cup
– when the brake is released, the sealing cup is lifted
Order no. 122



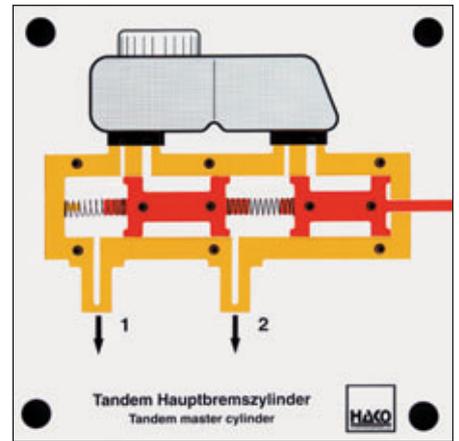
Tandem brake master cylinder

- function of pressure rod piston and intermediate piston
 - simulation of a failure of brake circuit I or II
 - the pedal travel becomes longer when a brake circuit fails
- Order no. 123



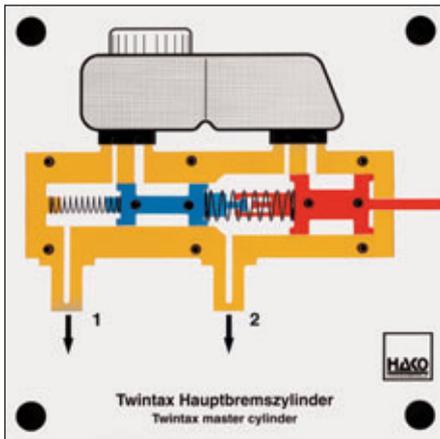
Stepped tandem brake master cylinder with central valve

- Function of a stepped tandem cylinder. Function of the central valve. Function of pistons. Simulation of a failure of brake circuit I or II.
- Order no. 244



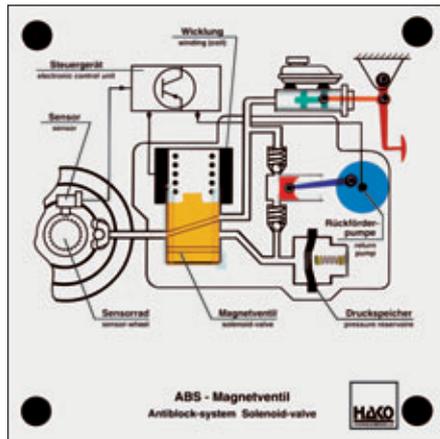
Tandem brake master cylinder

- By pressing the lever the outer valve can be seen to open. The piston rod with diaphragm disk moves forward. The pressure rod moves both the pistons in the brake master cylinder and the braking process is started.
 - function of the pressure rod and the secondary piston
 - function of the brake master cylinder in the case of failure of brake circuit I or II
 - function of the pressure springs
- Order no. 401



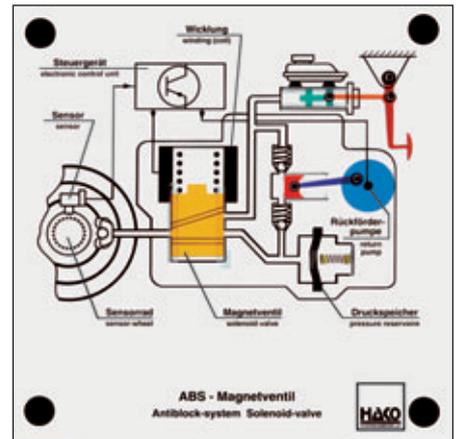
Twintax brake master cylinder

- Function of the pressure rod and the secondary piston. Functions of the brake master cylinder in the case of failure of brake circuit I or II. Increased pressure in the intact brake circuit if one brake circuit fails. Shorter pedal travel in the case of failure of a brake circuit.
- Order no. 418

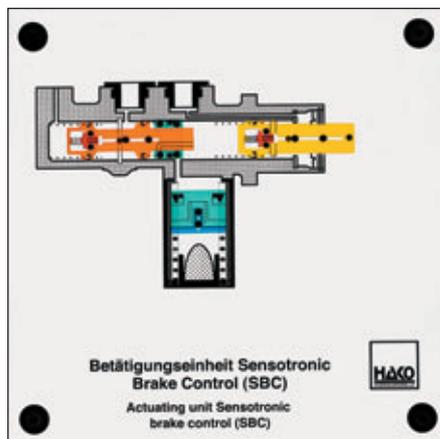
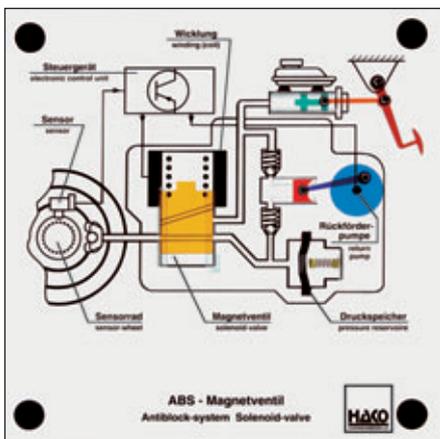


Antiblock system ABS solenoid valve

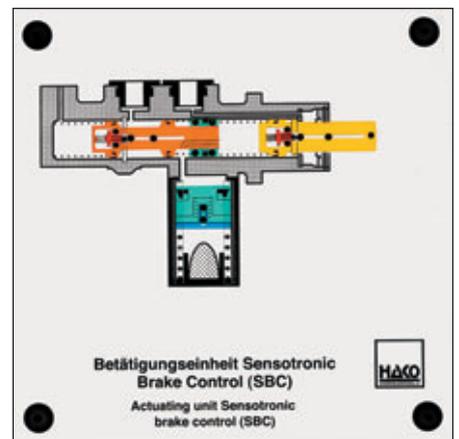
- Brake pedal with piston rod and piston, return pump, solenoid valve and pressure accumulator can be actuated.



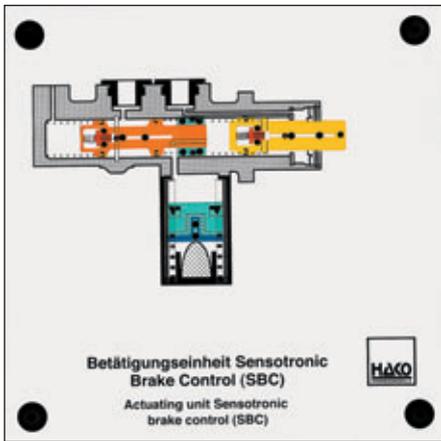
- Function of the solenoid valve: pressure build-up, keeping the pressure the same, pressure decrease through forced return flow.
- Order no. 183



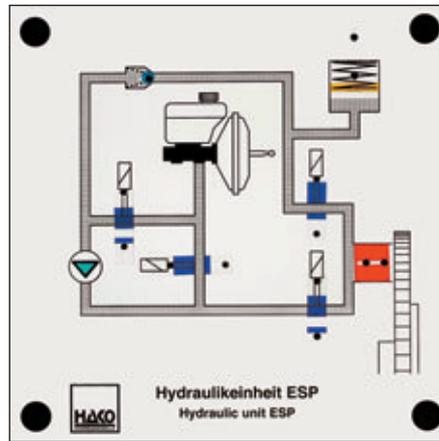
Operating unit Sensotronic Brake Control (S B C)



- Functions:
- operation of the push-rod piston
- operation of the floating piston
- operation of the pistons in the brake pressure simulator

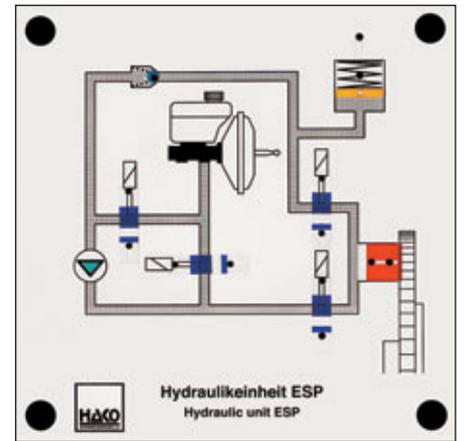


- independent opening and closing of the central valves
 - way of working if the SBC fails
- Order no. 477

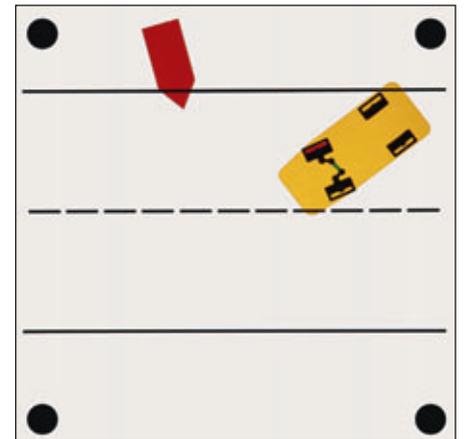
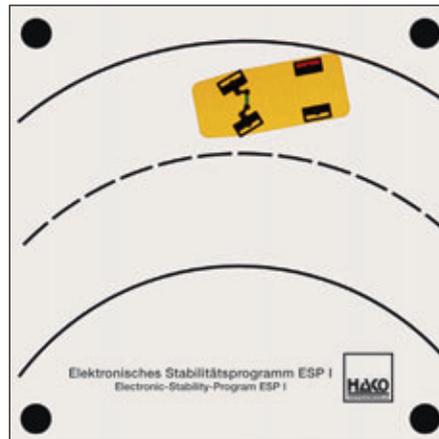
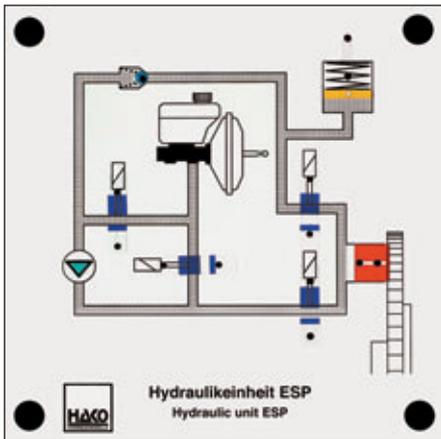


Hydraulic unit ESP

- Functions:
- pressure build-up, hold pressure, relieve pressure
 - switching of the solenoid valves



- movement of the non-return valve, the low-pressure storage plunger and brake plunger
- Order no. 474

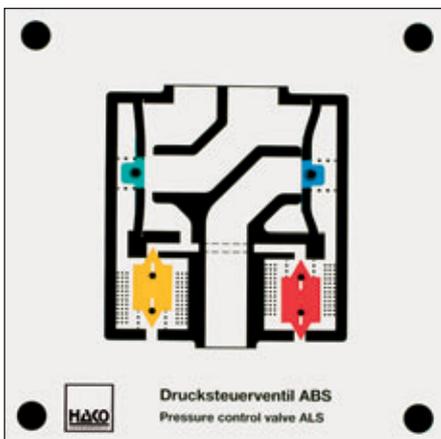


Electronic Stability Program ESP

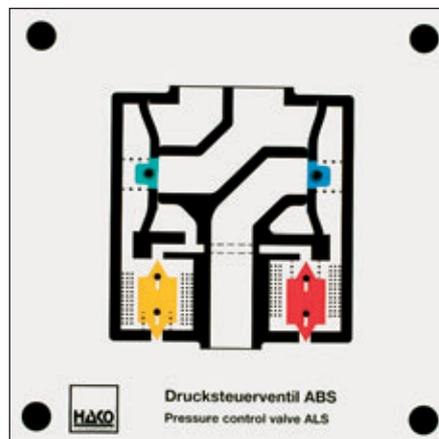
A small vehicle can be pushed on a straight road and a bend. The wheels of the front axle can be turned. Braking of the individual wheels can be simulated through flaps (red). The following situations can be presented: What does ESP do during: oversteering, understeering, driving errors, obstacle avoidance,

skidding movements etc.. The students consider which wheels have to be braked in which situation and why. The model makes it easy to understand how a motor vehicle behaves in critical situations with and without ESP.

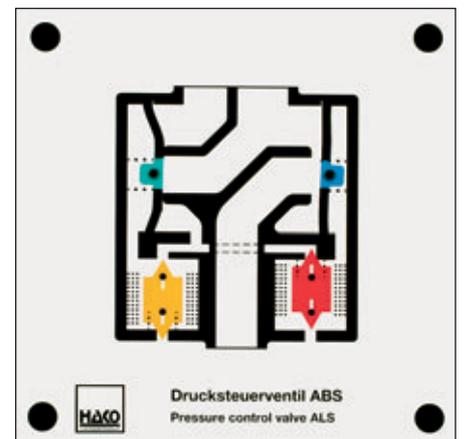
Order no. 501-1, 501-2



Build up braking pressure



Maintain braking pressure



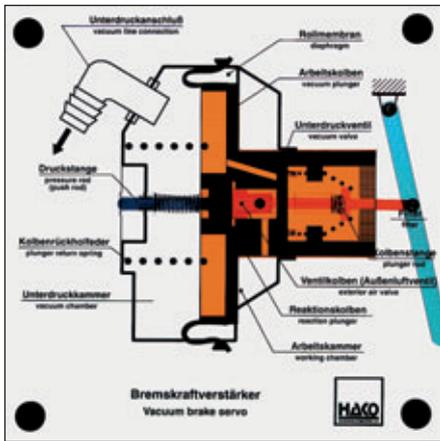
Reduce braking pressure

Pressure control valve ALS

The pressure control valve is part of the anti-locking system for compressed air brake systems. A pressure control valve has been assigned to each controlled wheel. It comprises 2 solenoid valves and

2 diaphragm valves, which enable the following control phases in the brake cylinders.

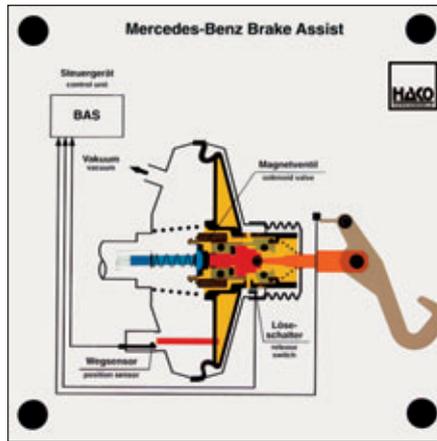
Order no. 480



Pneumatic brake booster

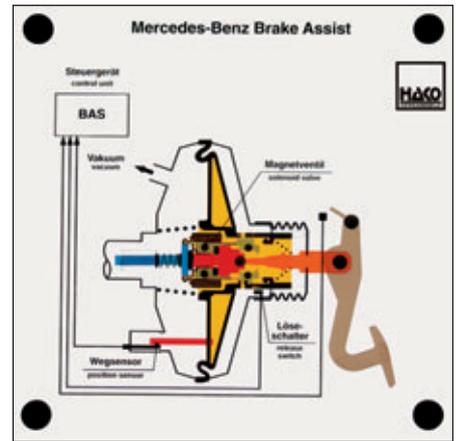
- brakes released (vacuum valve open)
- brakes activated (vacuum valve closed, exterior air valve opened and working piston moved)

Order no. 121



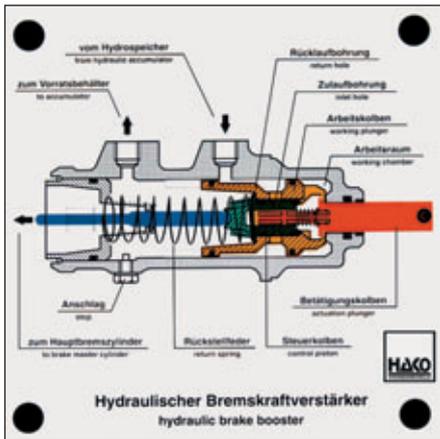
Mercedes-Benz Brake Assist

The Brake Assist system was developed in order to achieve a fast brake response and a maximum braking deceleration in the case of an emergency stop. The control unit measures the speed at which the pedal is depressed and initiates full braking by means of the solenoid valve.



The functions of a standard brake power assist unit can also be demonstrated.

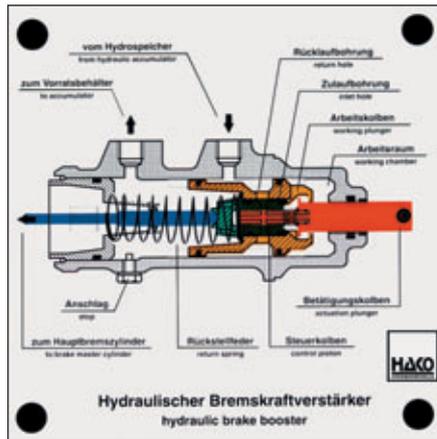
Order no. 388



Hydraulic brake booster

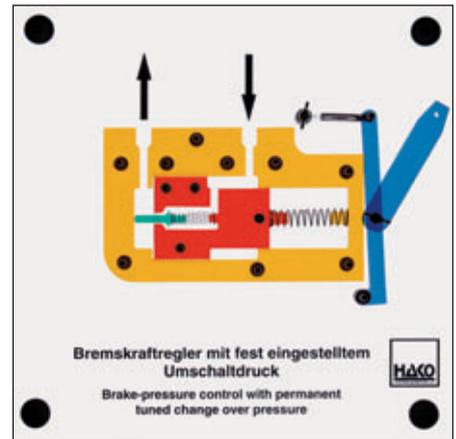
Functions:

- release position
- partial braking
- full braking



- pressure build-up
- pressure reduction

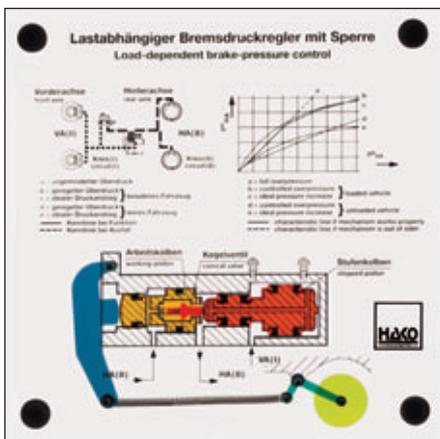
Order no. 327



Brake-power regulator with fixed change-over pressure

- function of a pressure-controlled brake-power regulator
- function of a load-dependent brake-power regulator using the blue additional linkage

Order no. 402

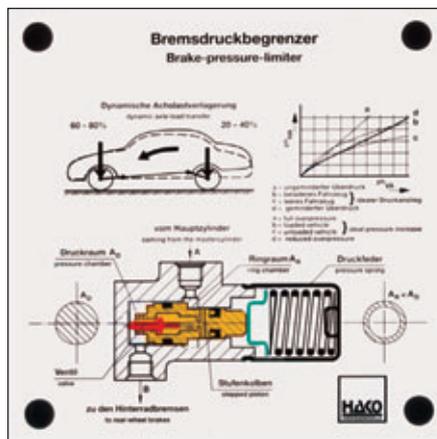


Load-dependent brake-pressure control

Functions:

- brake pressure changes automatically depending on the load
- locking effect when front-axle brake circuit fails
- displacement of both stepped pistons and function of the conical valve

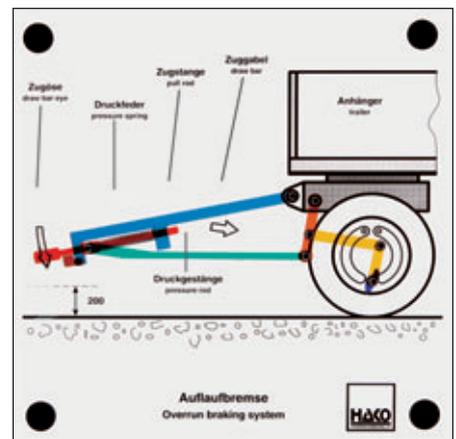
Order no. 256



Brake-power limiter

Displacing the stepped piston shows that starting from a certain brake pressure of the brake master cylinder the pressure to the rear-wheel brakes cannot increase (because it is limited).

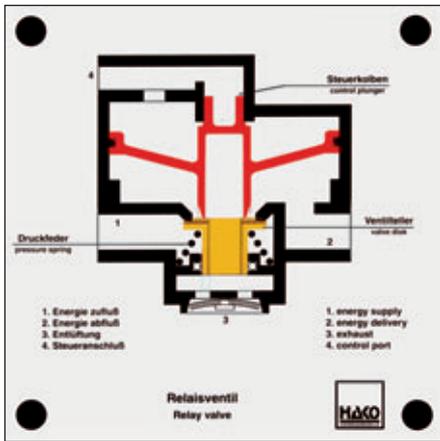
Order no. 258



Overrun brake

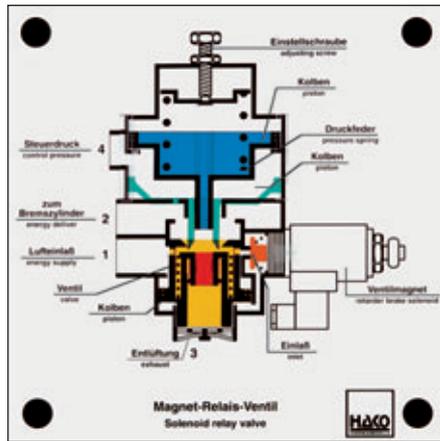
The complete drawbar can be moved, braking while lowering the drawbar, braking while the trailer overruns, actuating the brake cams, function of the reverse blocking (made possible in the model by switching the lever). The reverse blocking is automatically released when driving forward.

Order no. 209



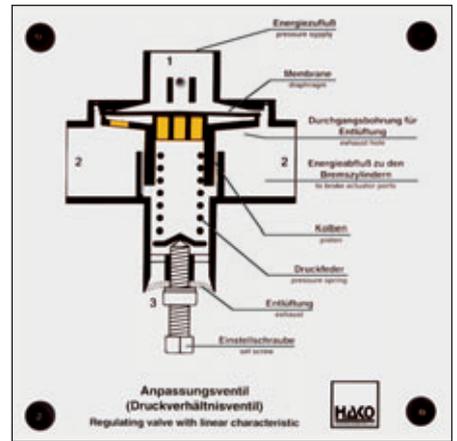
Relay valve

- the relay valve makes a fast filling and bleeding of the brake cylinder possible
 - driving position
 - braking position (control plunger and valve disk can be moved)
- Order no. 154



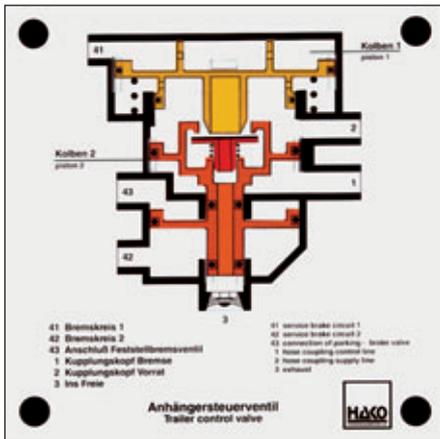
Solenoid relay valve of an air brake system

- Function:
- actuating the permanent brake in the trailer; fast filling and bleeding of brake cylinders decreases reaction delay and response time
 - all the valve's pistons and the solenoid can be moved
- Order no. 225



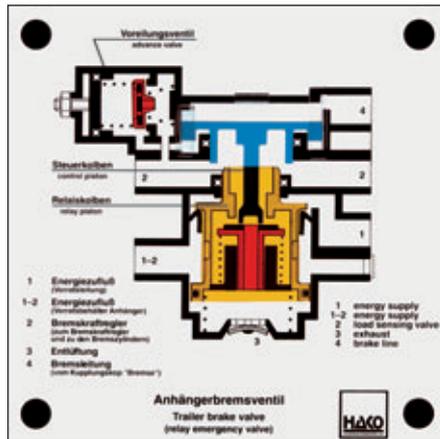
Regulating valve with linear characteristic

- All phases can be shown:
- closing position, passage position and exhaust position
- Order no. 176



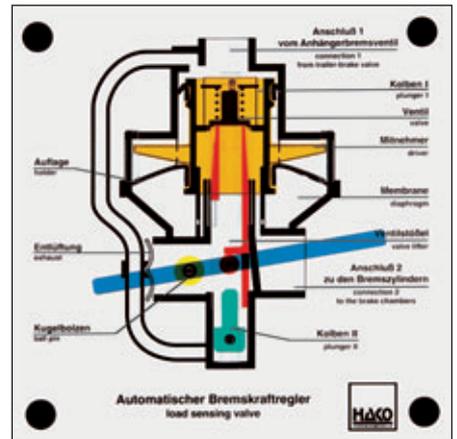
Trailer-control valve

- driving position with an intact unit
 - braking with service-brake valve and defect trailer-brake line
 - braking with service brake system
 - braking with parking brake system
- Order no. 156



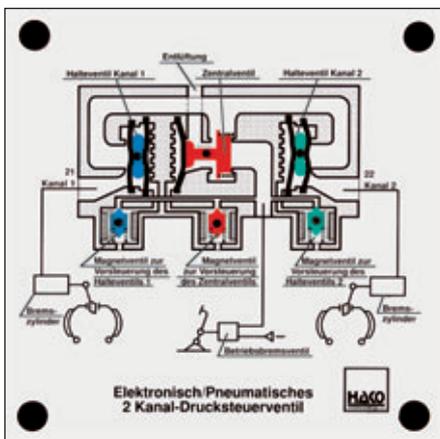
Trailer-brake valve with advance valve

- driving position
 - full-braking position
 - failure of brake line
 - failure of brake and air-reservoir line
- Order no. 157



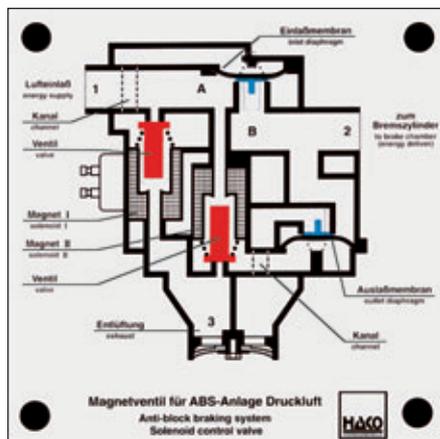
Automatic load-dependent brake-power distributor

- function of the control lever
 - release, partial-load and full-load position
 - actuating the valve
 - the diaphragm touches the driver
- Order no. 172



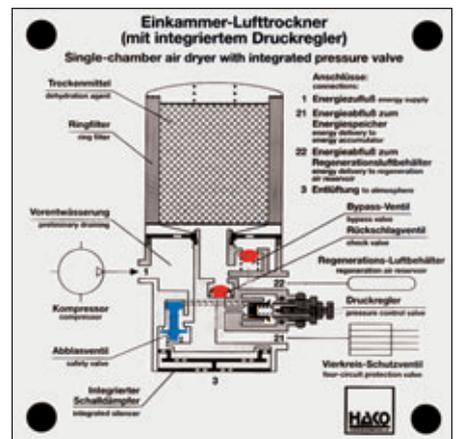
Electronic, pneumatic two-line pressure control valve

- All six valves can be actuated and fixed in any position:
- pressure build-up in line 21 and 22
 - keeping the pressure the same in line 21 and pressure decrease in line 22
 - pressure build-up in line 21 and keeping the pressure the same in line 22
- Order no. 188



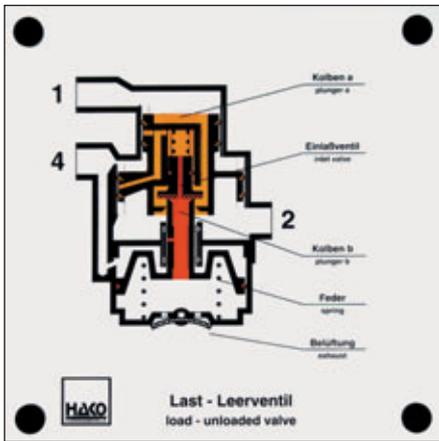
Antiblock system ABS solenoid valve

- solenoid valve of the antiblock system of an air brake
 - diaphragm valve and solenoid valve can be moved
 - all three phases can be shown: pressure build-up, maintaining and pressure decrease
- Order no. 190



Single-chamber air dryer with integrated pressure regulator

- flow of air in a dryer
 - function of the pressure regulator with drain valve
 - function of the bypass valve
 - function of the check valve
- Order no. 280



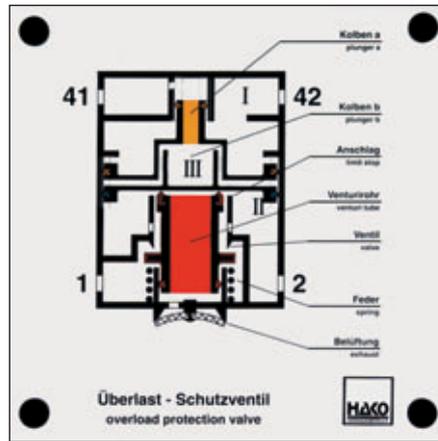
Load-unload valve

Driving position

Actuation:

- of the emergency and parking brake system
- of the service brake system
- corresponding activation and deactivation of the emergency and parking brake system

Order no. 323

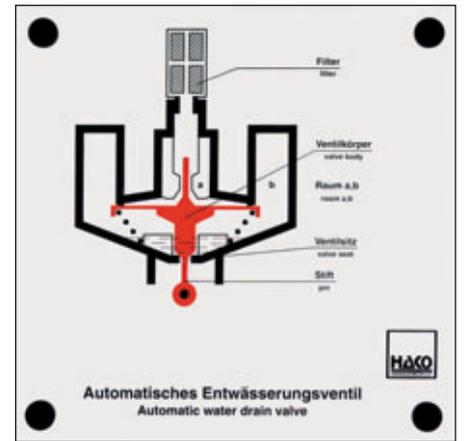


Overload protection valve

Function of the overload protection valve by means of the following switching processes:

- release position and full braking position
- actuation of the service brake
- actuation of the parking brake
- simultaneous actuation of both braking systems

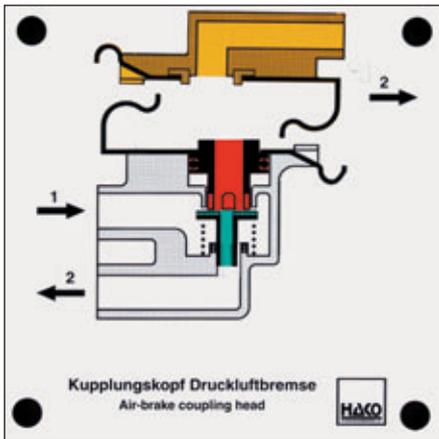
Order no. 326



Automatic water drain valve

- lifting of the valve's body
- condensed water collection
- cambering of the valve body's diaphragm
- condensed water drainage

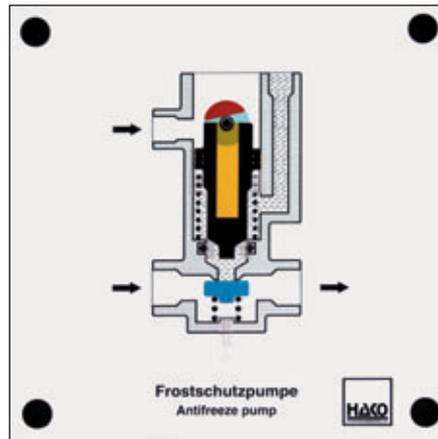
Order no. 334



Air-brake coupling head

- sealing of the coupling head of the air supply line of the tractor unit with the trailer line disconnected
- connection of the trailer line
- release of the compressed air to the trailer

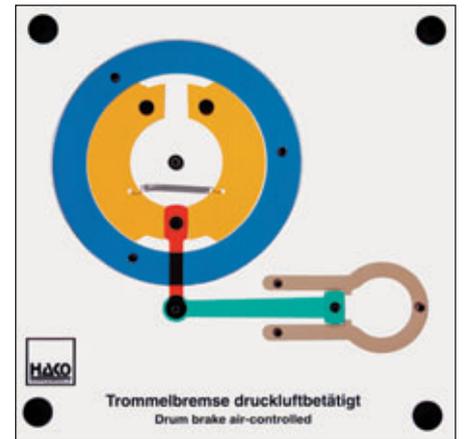
Order no. 408



Antifreeze pump

- function of the delivery of antifreeze
- switching off the antifreeze pump
- function of the pump piston, the valve head and the two springs

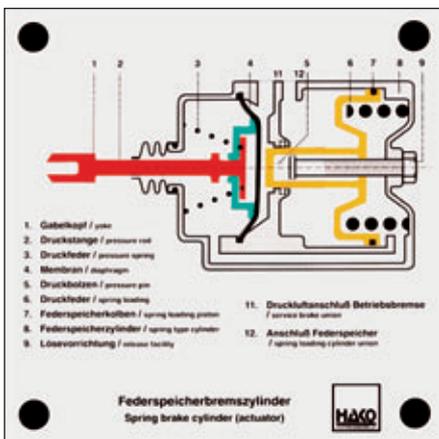
Order no. 409



Air-operated drum brake system

- function of the piston cylinder
- transmission of the power from the piston cylinder to the actuating cam
- spreading of the brake shoes, braking effect on the brake drum

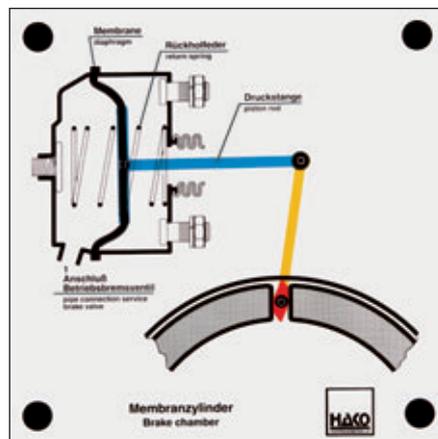
Order no. 403



Tristop spring-brake actuator

- release position
- actuating the service brake system
- actuating the auxiliary and parking brake system
- forces are added when a actuating both brake systems
- function of the mechanical release mechanism

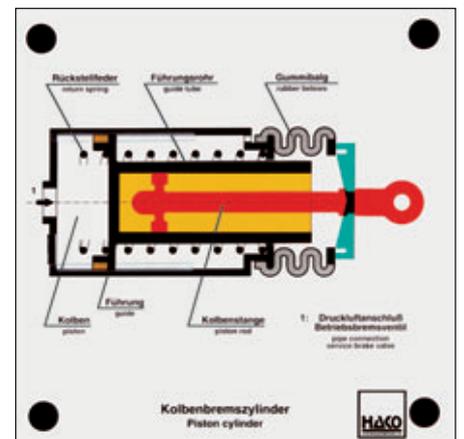
Order no. 155



Diaphragm cylinder

Function of a diaphragm cylinder, the mobile piston of which actuates the brake cam of the wheel brake via a rod.

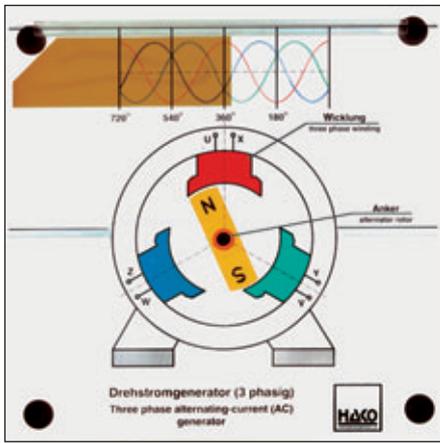
Order no. 197



Piston cylinder

- function of a piston cylinder
- piston cylinders are used in air brake systems if large strokes are needed

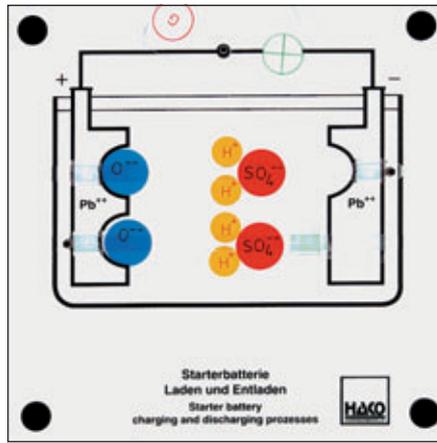
Order no. 198



Three-phase alternating-current (AC) generator

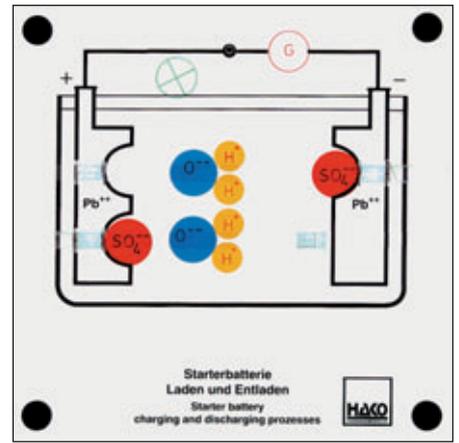
- when the rotor turns, three different and phase-displaced AC voltages are produced. These voltages correspond with the colors of the electromagnets
- the sinusoidal oscillation is at its positive maximum when the rotor's North Pole reaches the electromagnet, and at its negative maximum when the rotor's South Pole reaches the electromagnet

Order no. 174



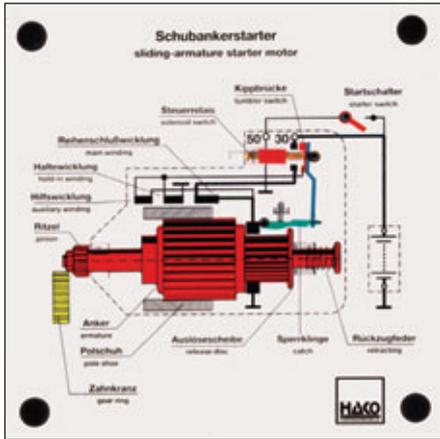
Charging a battery

- discharged battery; charging procedure; charged battery; discharging the battery
- generator or consuming device can be put into the electric circuit



- all chemical procedures can be shown by moving molecules and atoms

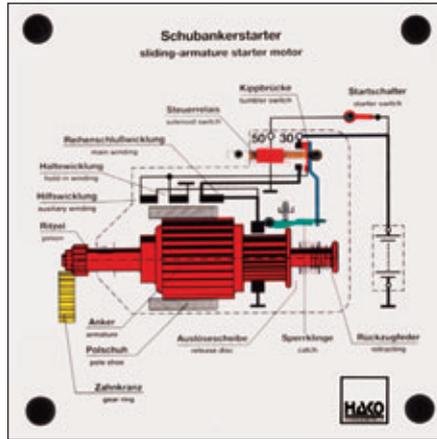
Order no. 167



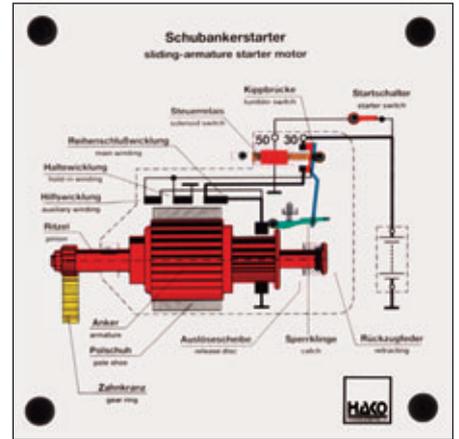
Sliding-armature starter motor

Functions:

- operating the starter switch
- pulling the tumbler switch to one side



- selecting the first shifting stage
- displacement of the entire armature
- the catch is released by the armature

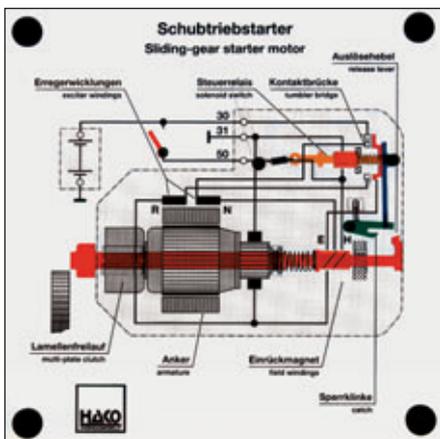


- selecting stage 2 by means of the tumbler switch
- function of the retracting spring

Order no. 262

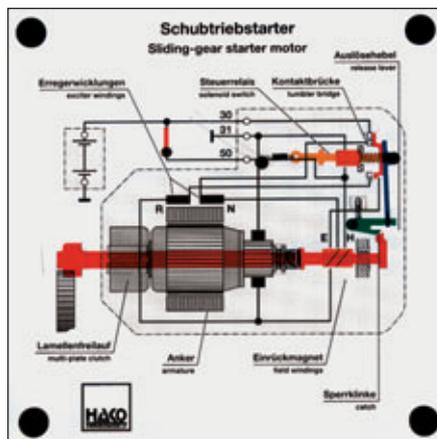
Parked position

Engaging the pinion

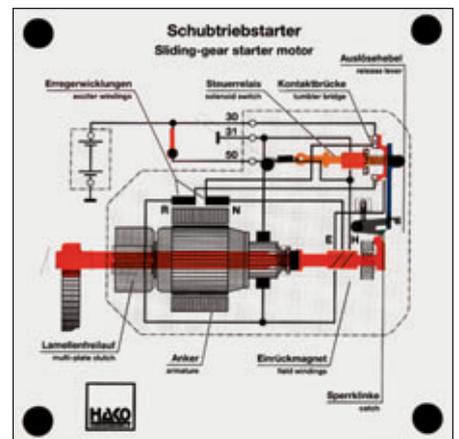


Sliding-gear starter motor

- at-rest position
- actuating the starter switch
- actuating the solenoid switch

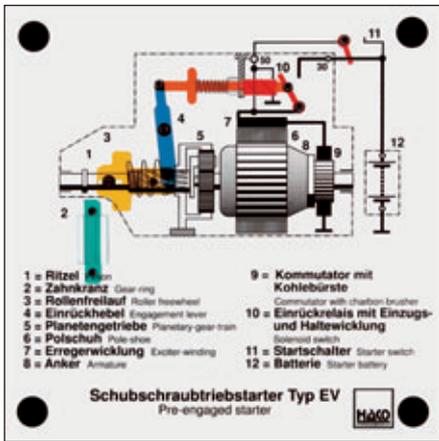


- closing the bypass windings
- function of the tumbler bridge
- engaging the pinion



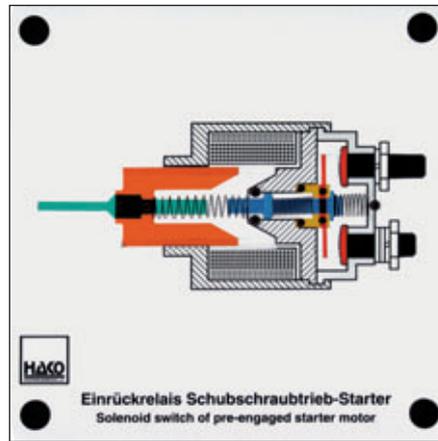
- lifting the catch using the release lever
- connecting the bypass windings

Order no. 312



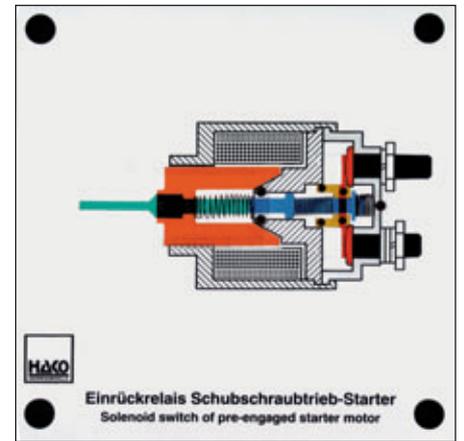
Starter motor

(pre-engaged drive starter with planetary gear by Bosch)
 – starter switch can be moved. The solenoid switch is closed
 – activating the excitation winding. Engaging the pinion
 – function of the spring when tooth touches tooth
 Order no. 142



Solenoid switch of pre-engaged starter motor

Function of pull-in and holding winding
 Pulling of the armature when current flows
 Closing of the contacts by the contact bridge

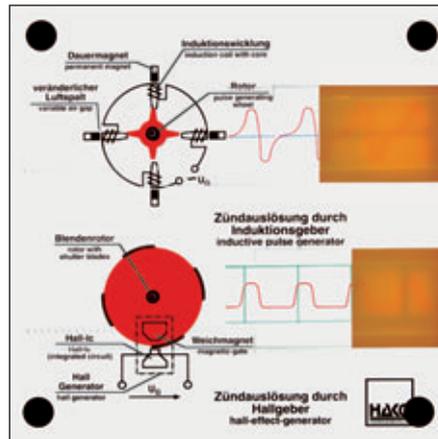


Function and interaction of the springs
 Order no. 450



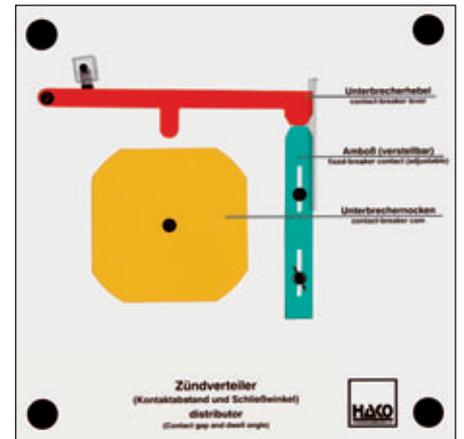
Centrifugal advance device of a distributor

– function of the centrifugal weights
 – function of the retracting spring
 – ignition advance caused by centrifugal weights acting on the contact-breaker cam
 Order no. 140



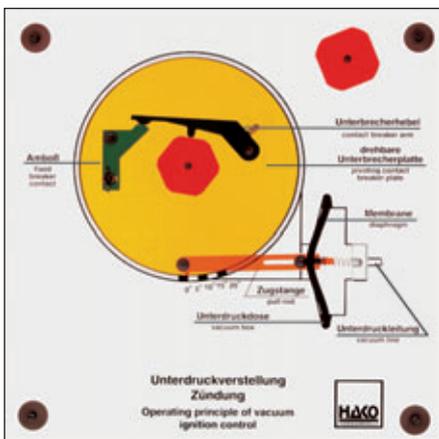
Pulse generation

(made-up of two models)
 a) induction-type pulse generator
 b) hall-effect pulse generator
 The oscilloscope display for the pulse generation is produced by turning the rotor or the rotor with shutter blades
 Order no. 184



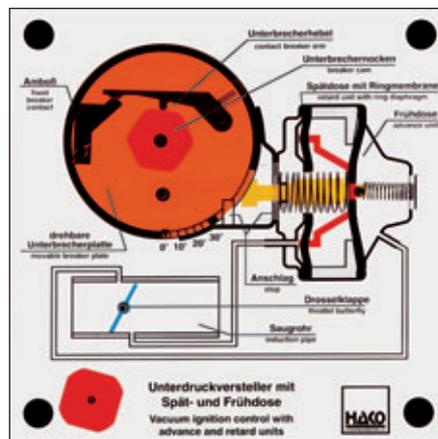
Ignition distributor

– opening and dwell angle can be read
 – change of the breaker-point gap
 – opening and dwell angle change depending on the breaker-point gap
 Order no. 138



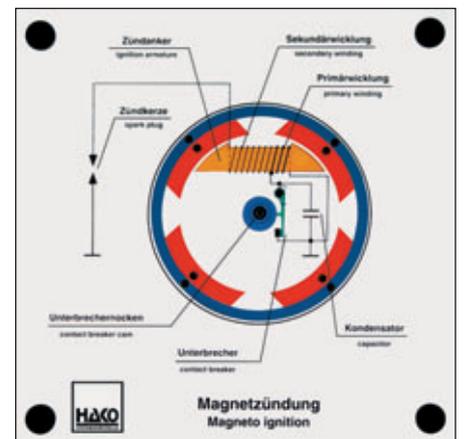
Vacuum advance at an ignition distributor

– rotating of the contact-breaker plate by the vacuum box
 – ignition advance
 – the ignition interval can be changed – there are cams for four and six cylinders
 Order no. 139



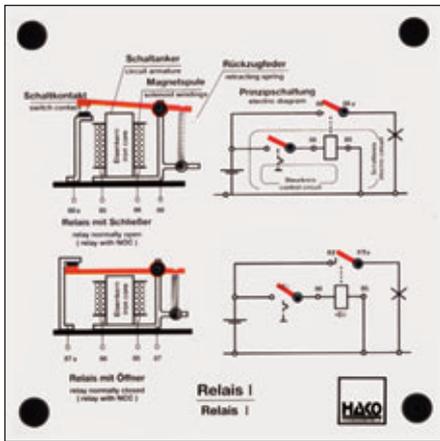
Ignition distributor with advanced and retarded ignition

– in addition, the functions of advanced and retarded ignition can be shown and the interaction of both ignition-timing systems can be seen.
 (All parts can be moved and are equipped with real steel springs and diaphragms.)
 Order no. 230



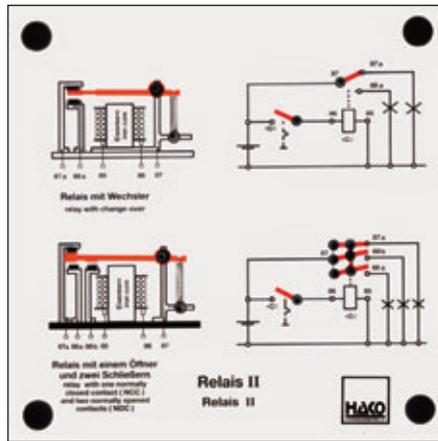
Magneto ignition

– function of the contact breaker
 – function of the pole wheel with permanent magnets
 – magnetic field layout
 – high-voltage generation
 – function of the condenser
 Order no. 330



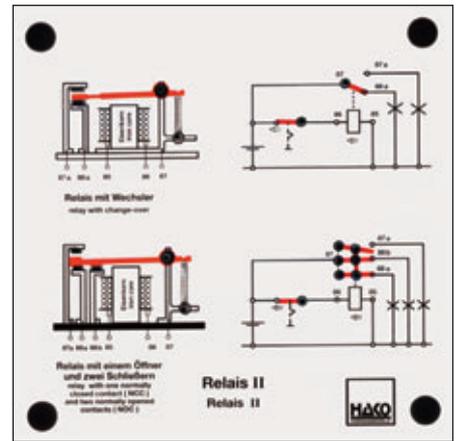
Relay I

The following can be shown:
 – difference between normally closed contacts (NCC) and normally opened contacts (NOC)
 – function of the NCC and NOC relay
 – motion of the circuit armature is shown on relay model
 – motion of the circuit armature in the electric diagram
 Order no. 273

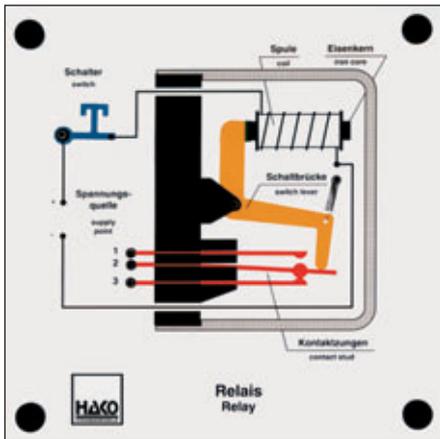


Relay II

Functions:
 – motion of the circuit armature is shown on relay model
 – motion of the control switch in the electric diagram

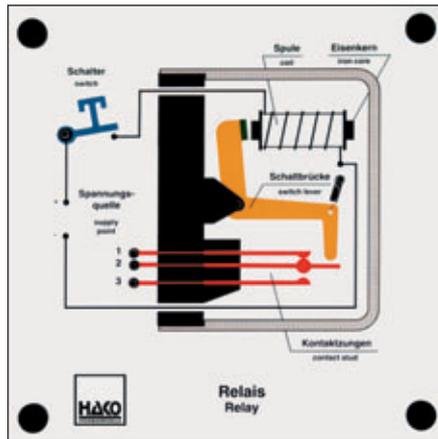


– motion of the circuit armature in the electric diagram
 – selecting different electric circuits
 Order no. 274

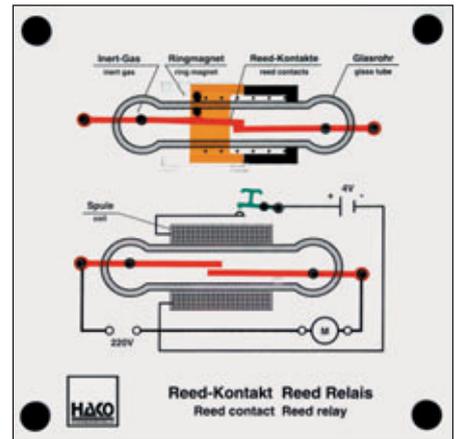


Relay III

When the switch is actuated the jumper is drawn to the solenoid coil by means of a transparent cam plate. Simultaneously, the jumper switches

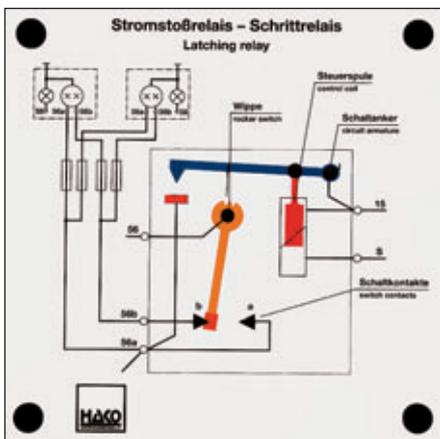


the contacts of electric circuit 2-1 over to circuit 2-3.
 Order no. 341



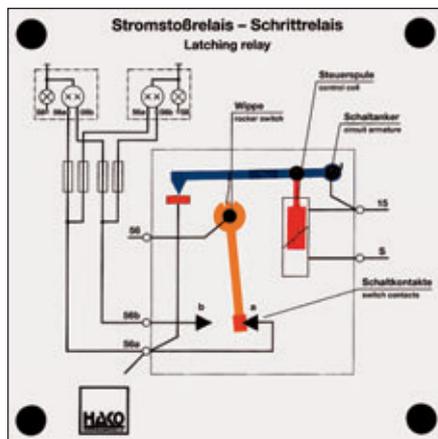
Reed contact relay

– function of the foric magnets
 – function of the magnet coils
 – opening and closing of the reed contacts
 – application of the reed contacts and of the reed relay in automotive engineering
 Order no. 357

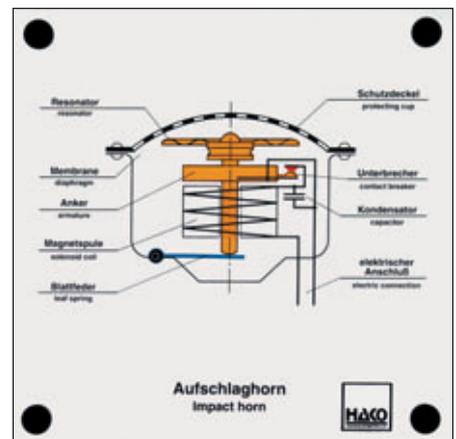


Latching relay

– pulling the circuit armature
 – actuating the rocker switch
 – rocker switch in contact positions

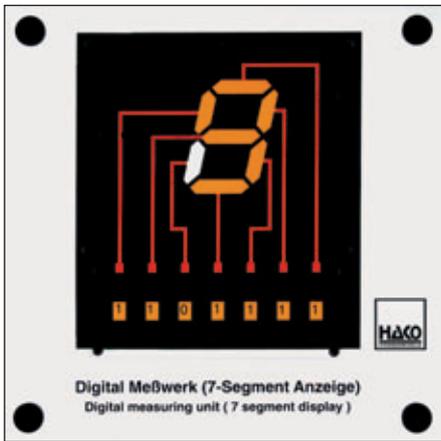


– switching to full beam or dipped headlights
 Order no. 300



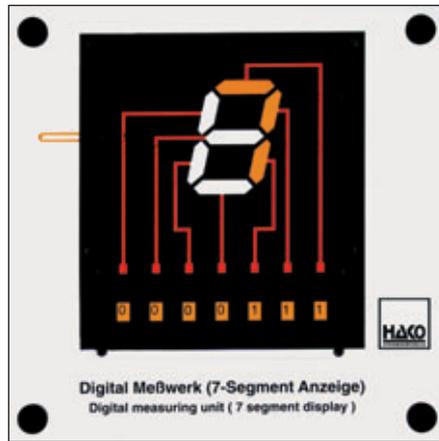
Impact horn

– magnetic field layout
 – armature stroke against iron coil core
 – resonator movement
 – CI interruption and connection of the electric circuit
 – function of the leaf spring
 Order no. 333

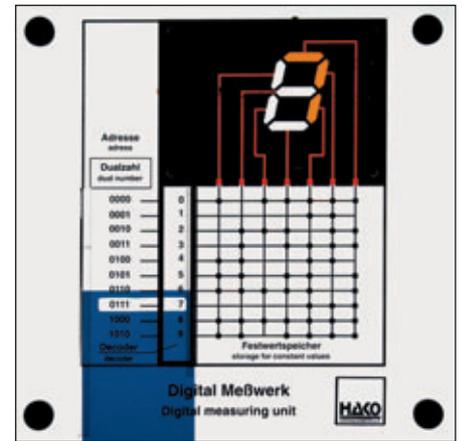


Digital Measuring Unit I

- method of functioning of a digital measuring unit
- control via a 7-character binary word
- formation of the numbers 0-9 and some letters

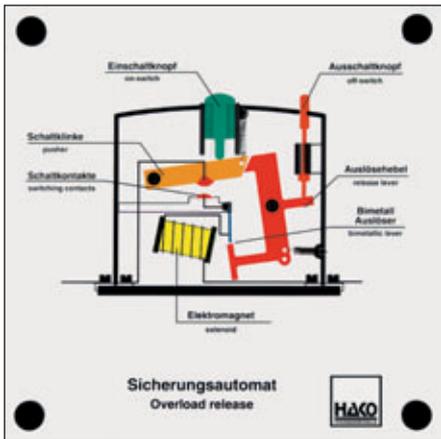


- (by the simple sliding of the windows of controlled segment and of the binary numbers in the field of vision)
- Order no. 344



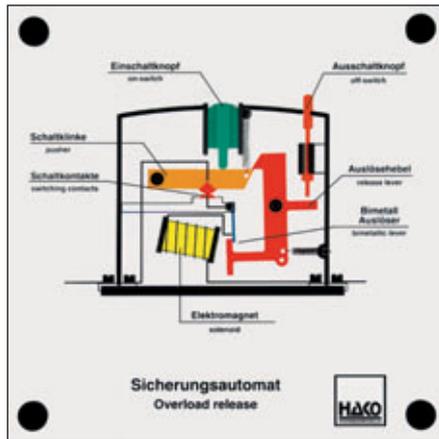
Digital Measuring Unit II

- Conversion of the binary number at the input of the decoder into a decimal number on the display.
- Control of the one-character seven-segment display via the constant memory (by moving the field of vision and sliding the illuminated window of the controlled segments).
- Order no. 345

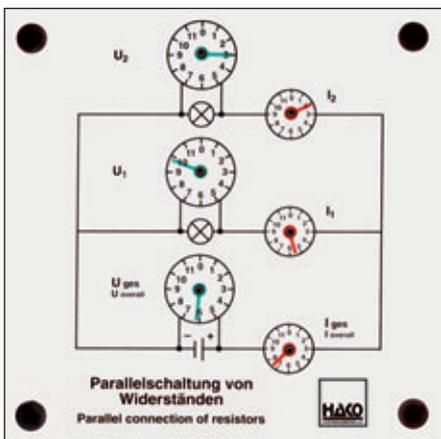


Overload release

- power flow in overload release
- release caused by overload
- thermal release

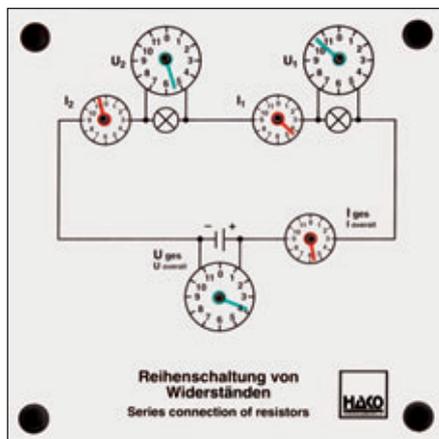


- manual release
- power flow recovery after release
- Order no. 340



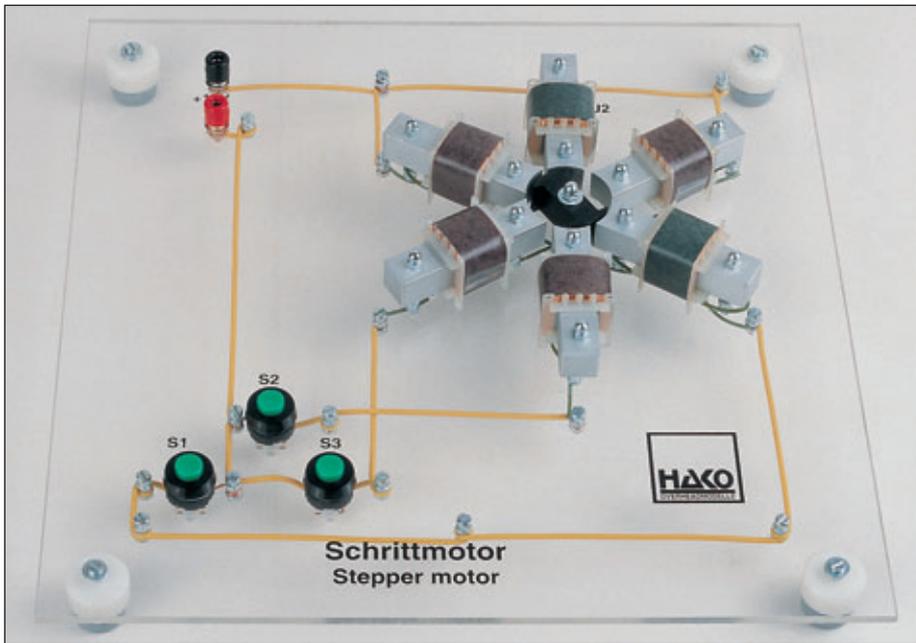
Parallel connection of resistors

- Flow of current and voltage when using a parallel connection of resistors can be shown by means of three voltmeters and three ammeters.
- Order no. 241



Series connection of resistors

- Flow of current and voltage when using a series connection of resistors can be shown by means of three voltmeters and three ammeters.
- Order no. 242



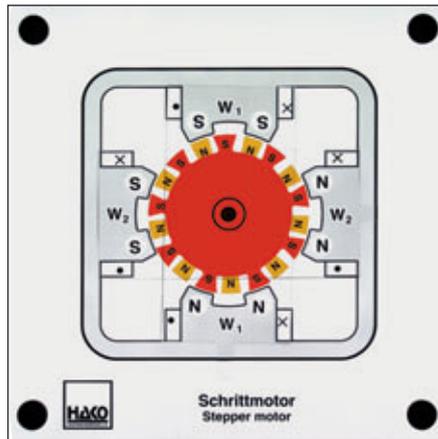
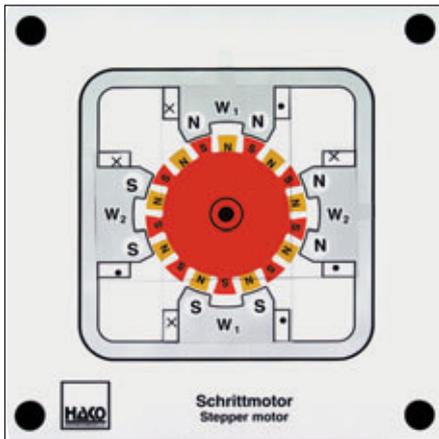
Stepper motor

The principle of the electric stepper motor can be demonstrated by means of the switch and the swivel rotor.

– single excitation: 6 steps

– double excitation: 12 steps

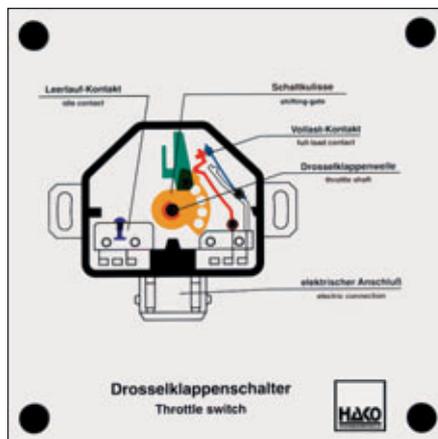
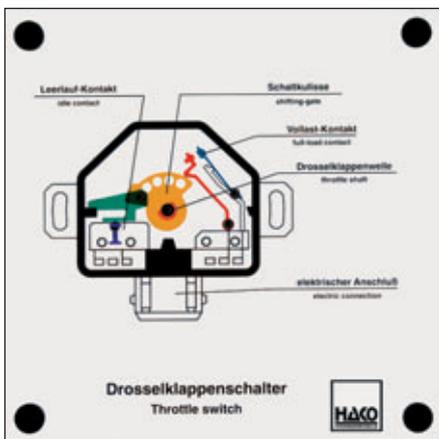
The model requires a 6 to 10 Volt DC voltage supply.
Order no. 332



Stepper motor

Mode of effect of a stepper motor
Polarity reversal of windings 1 and 2
Change of the poles of the magnetic fields

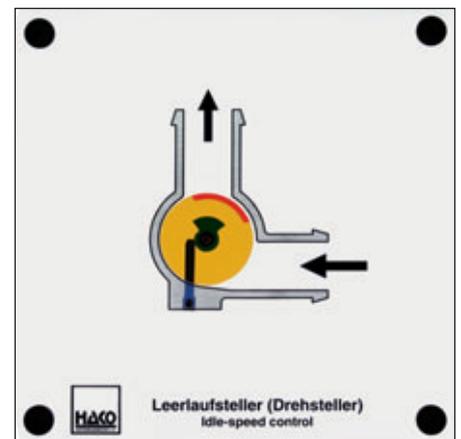
Movement of the impeller
(steps turning left or right)
Order no. 452



Throttle switch

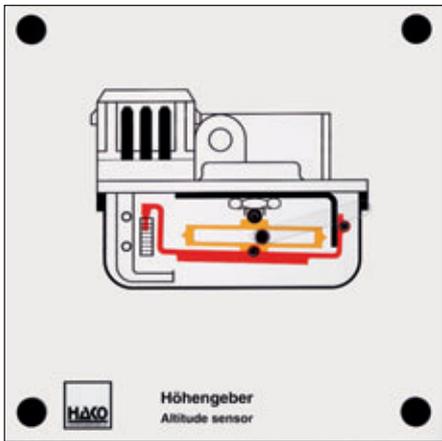
– closing of the idle contact with idling position and trailing throttle
– closing of the full-load contact with full-load operation

– opening of the idle contact and of the full-load contact with part load operation
Order no. 336



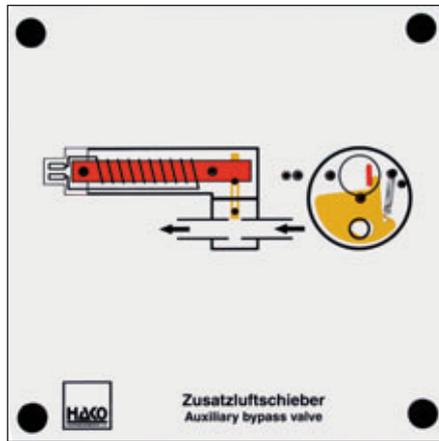
Idle-speed control

Task of the rotary actuator
Function of the rotary valve
Normal function, emergency operation function
Order no. 444



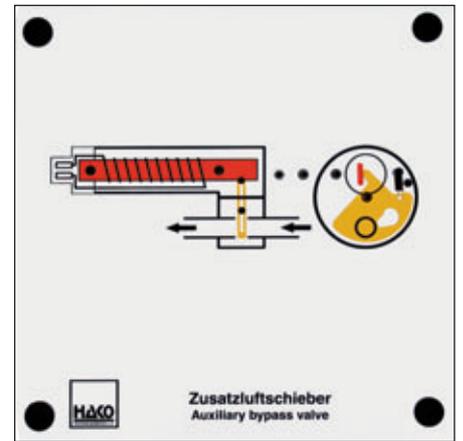
Altitude sensor

With the help of a lever on which there is a cam, the altitude capsule can be spread and one sees how the red lever is moved and the sensing on the resistance path of the potentiometer is displaced. The altitude sensor reports the alteration in air pressure compared with the loading pressure regulation to the control device and leads to a correction of the amount injected. Order no. 453

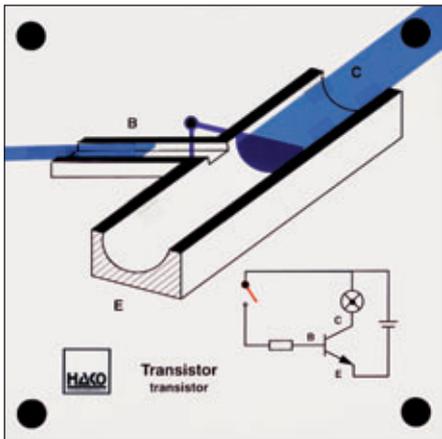


Auxiliary bypass valve

The additional air slide as a bypass
Function of the bimetal

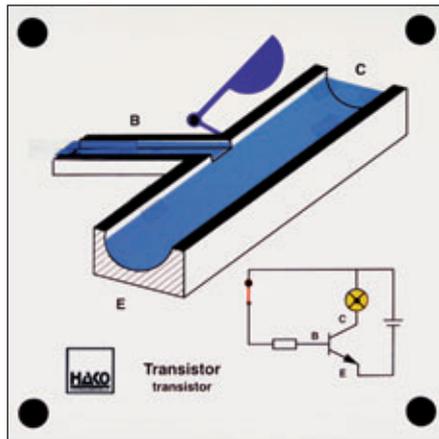


Operation of the rotary valve
Regulation of the additional air feed
Order no. 443

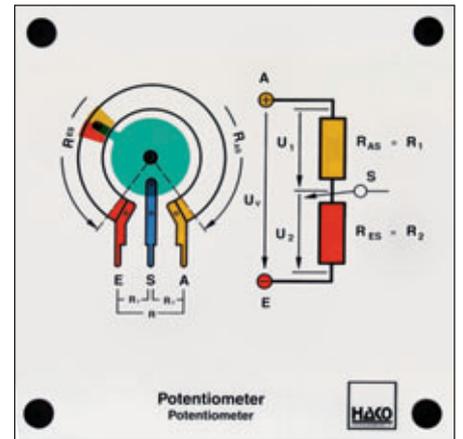


Transistor

The base is actuated by closing the switch. The collector emitter line becomes conductive, the lamp lights up. This can be shown clearly with the help of the water analogy. When the small flow of water

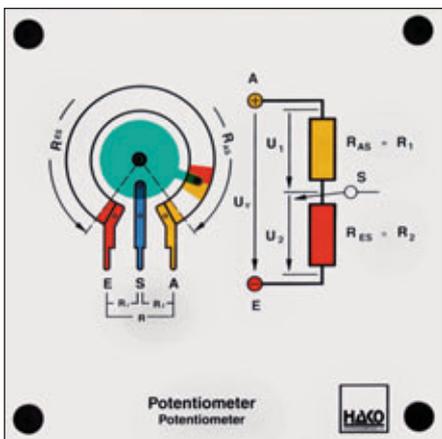


reaches the base, this flow of water opens the slide and makes the way free for the large water flow (collector emitter line), the water can flow. Order no. 427

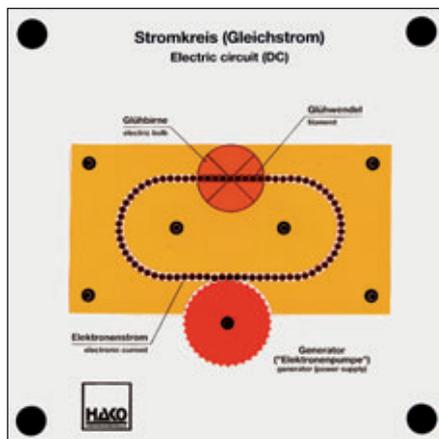


Potentiometer

Mode of effect of a potentiometer
Wiring diagram of a potentiometer
Function of the sliding contact

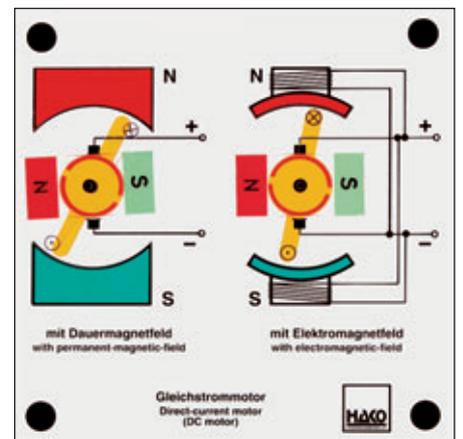


Function as a power divider
Order no. 441



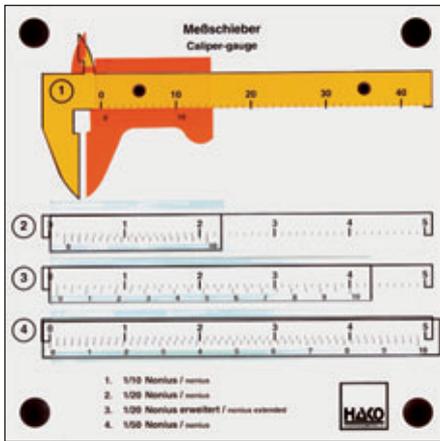
Electric Circuit (DC)

The model shows how the generator (electron pump) actuates the electrons in the wire. In the electric bulb the electrons are slowed down (line restriction). Thus friction heat and light are produced. Simulation:
– DC: The electrons move in one direction only
– AC: The electrons are moved back and forth
Order no. 313



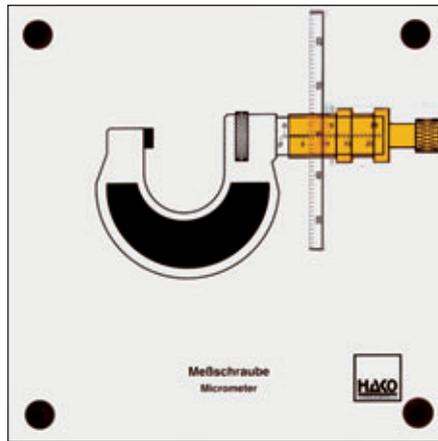
Commutator

Principle of a direct-current (DC) motor and a commutator
The magnetic field turns with the electromagnet; after 180 degrees, the current direction changes
Order no. 162



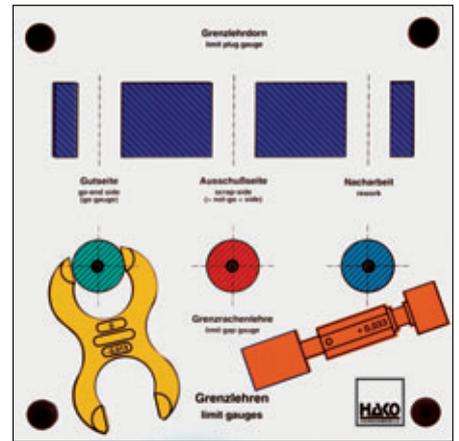
Caliper gauge

- design of a caliper gauge
 - four different vernier scales can be read (1/10 mm, 1/20 mm, 1/20 mm extended and 1/50 mm)
 - all values can be clearly read
- Order no. 216



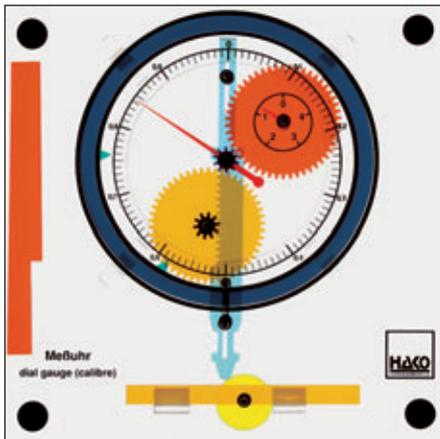
Micrometer

- full and half millimeters can be read off the scale
 - hundredth millimeters can be read off the graduated drum (developed view of drum)
- Order no. 218



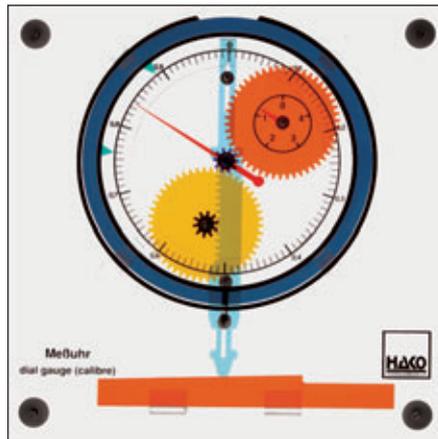
Limit gauges

- both gauges have a go end and a no-go end and are marked accordingly
 - since both gauges fit into several work pieces, it is possible to demonstrate the following: workpieces within tolerance range, scrap and rework
- Order no. 231

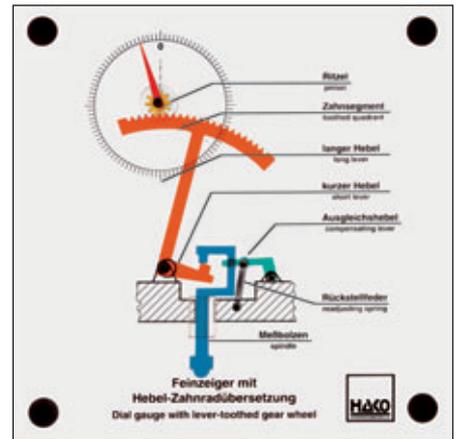


Dial gauge

- all interactions in a dial gauge can be shown
- indication of full and hundredth millimeters can be seen
- demonstration of the gauge's uses: parallelism of work pieces and concentric running of round pieces

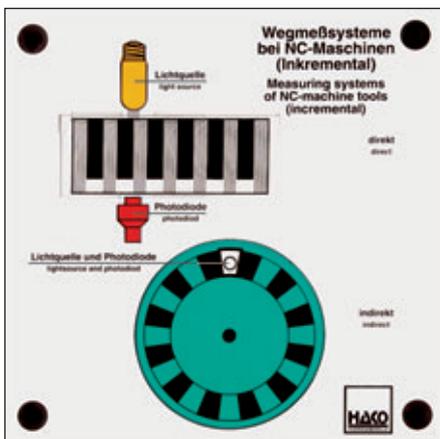


- there is no backlash because a compensating pull spring and a spiral spring are used
- Order no. 228



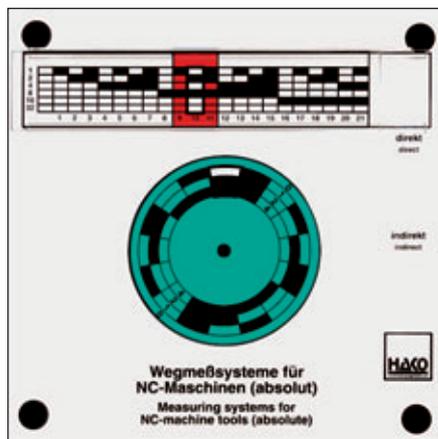
Dial gauge

- function and interaction of the parts in a dial gauge can be shown
- Order no. 233

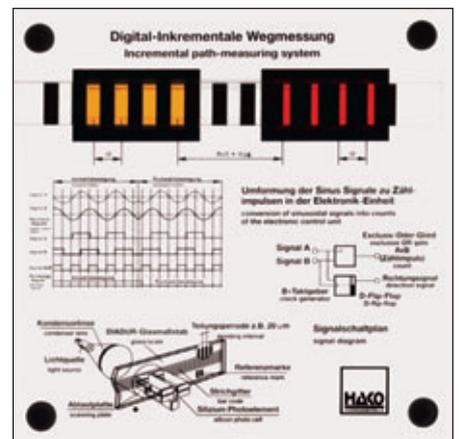


Path-measuring system (made-up of two models)

- the four most common path-measuring systems are shown:
 - incremental: direct and indirect
- Order no. 237



- absolute: direct and indirect
 - complex actions made easy
 - the principle of digital counting can be deduced
- Order no. 110



Incremental path-measuring system

- Functions:
- displacement of the scanning plates by one quart of alpha
 - bar code can be moved in both directions
 - transformation of the determined signals
 - forward and backward motion can be recognized
- Order no. 263



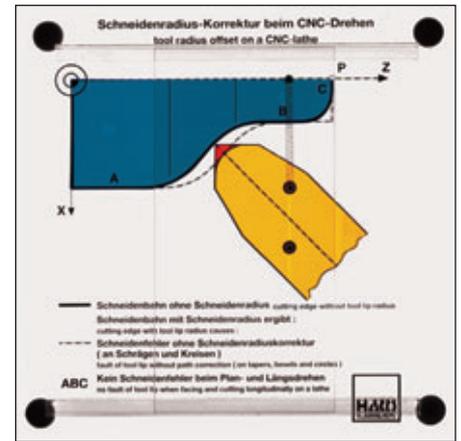
General angle measuring instrument

- fine scaling makes easy reading and precise measuring possible
 - correct reading can be practised on plexiglass workpieces
- Order no. 236

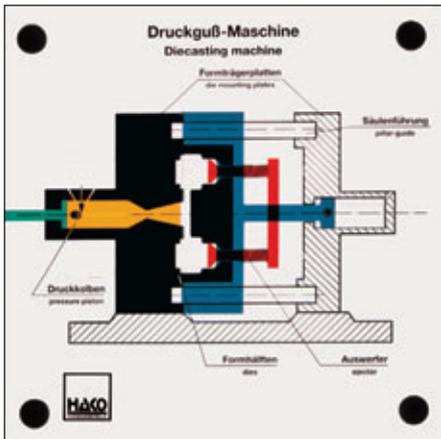


Tool radius offset on a CNC-lathe

- Moving along the cutting edge with the tool shows the following:
- no fault of tool lip without tool lip radius

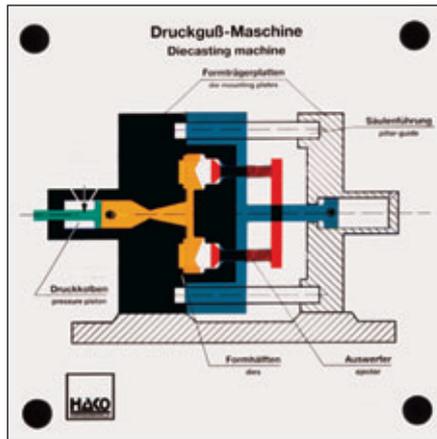


- fault of tool lip if tool lip radius has no path correction
 - no fault of tool lip with path correction
- Order no. 266

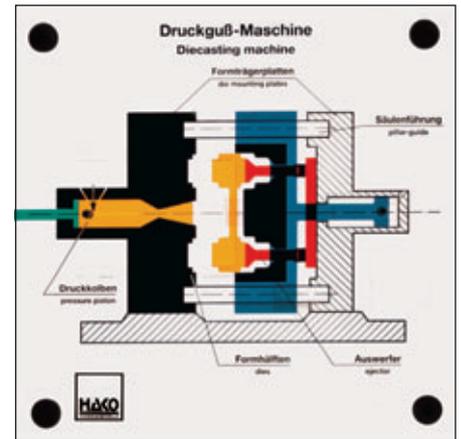


Diecasting machine

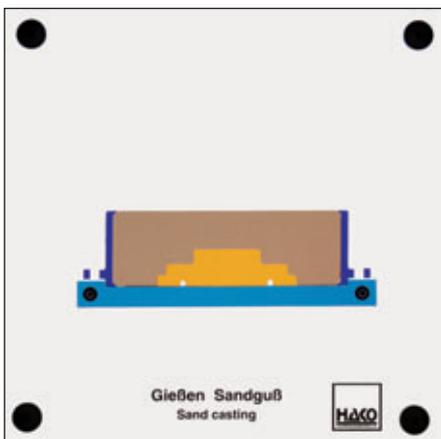
- The following functions can be shown:
- filling the dies by displacing the pressure piston
- (Demonstrated a plexiglass / an acrylic glass yellow plate.)



- dies can be opened by means of a second working piston
- the work piece is ejected by means of an ejector

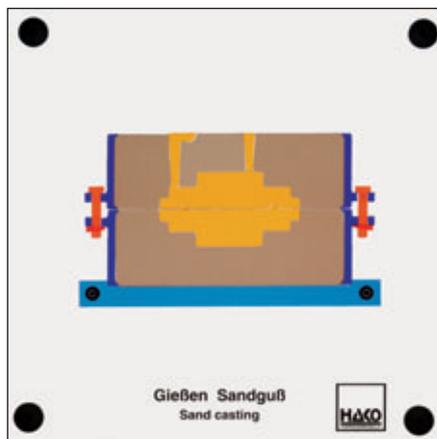


- the dies are closed for the next cast
- Order no. 277

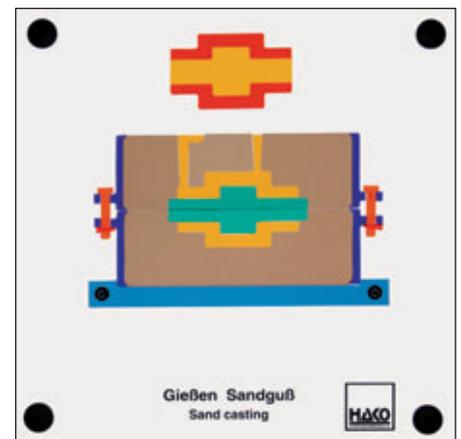


Sand casting

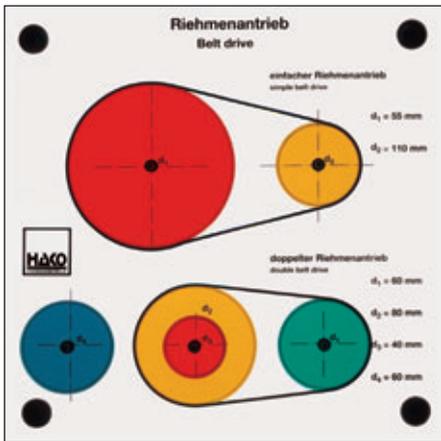
- placing a pattern half on the base plate
- positioning the bottom box
- filling with sand
- turning the bottom box
- positioning and wedging the top box
- inserting the second half of the pattern, the rising gate and the runner gate



- filling with sand
- removal of the model halves, the rising gate and the runner gate.
- insertion of the core and positioning of the top box
- casting



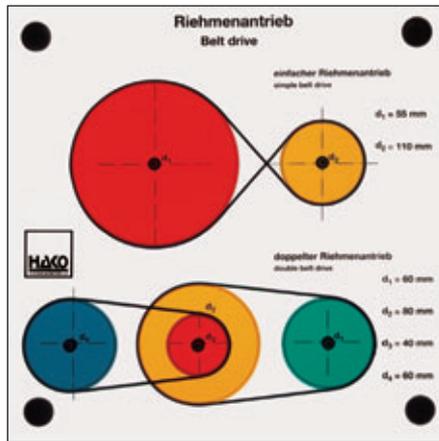
- appearance of the finished workpiece with runner and riser
 - removal of the core
 - appearance of the finished workpiece
- Order no. 413



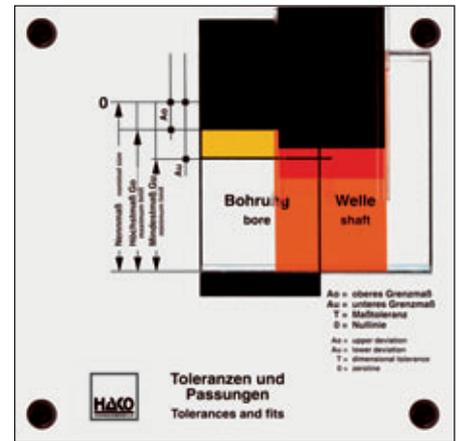
Belt drive

Functions:

- simple and double belt drive
- reversing the direction of rotation when belts are crossed

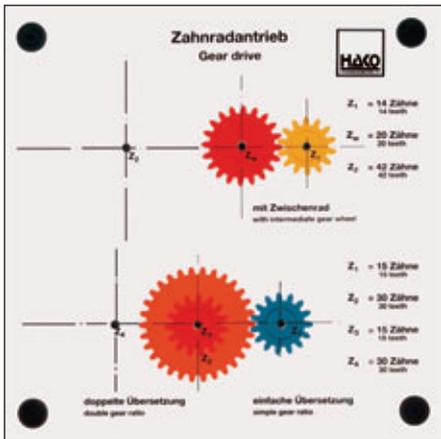


- transmission changes with pulleys of different diameters
 - angle of arc of belt contact
 - well suited for mathematics
- Order no. 253



Tolerances

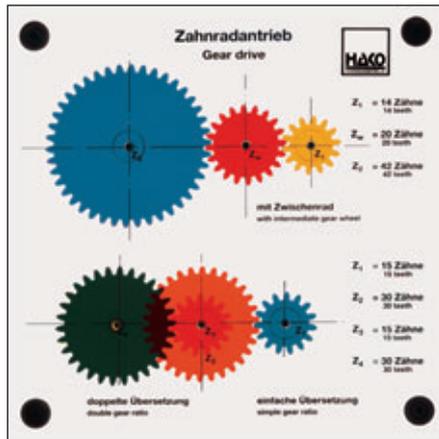
- variable location and size of the allowances
 - all fits can be shown
 - limit size and minimum or maximum are shown directly
 - shaft can slide into the hole
- Order no. 168



Gear drive

Functions:

- transmission to faster motion
- transmission to slower motion
- simple and double transmission



- function of an intermediate gear wheel
 - all wheels can be taken out of the model
 - well suited for mathematics
- Order no. 252



Gear drive without backlash

The gear drive without backlash, mainly used for motor bikes, has on one shaft a gear wheel with 49 teeth and another gear wheel with 50 teeth. The two are axially preloaded against each other. With every rotation, the gear wheel with 49 teeth is turned one tooth farther than the gear wheel with 50 teeth. This causes a gear drive without backlash. Order no. 229



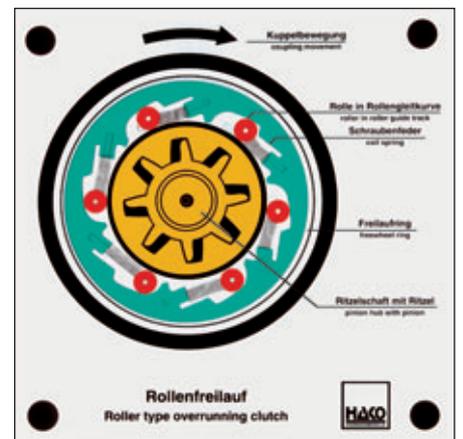
Transmission ratio (speed, number of teeth)

With this model, the interconnection between speed and number of teeth can be derived. The numbers of teeth are: pinion: $z = 12$, toothed wheels: $z = 24, 36$ and 48 teeth.

The bracket can be moved upwards by loosening a butterfly nut, with the result that the ratio of pinion

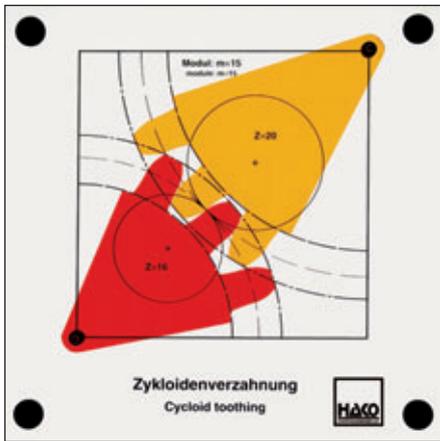


and toothed wheel 1 can be demonstrated first. When the bracket has been moved down, the other speed ratios can be demonstrated. Order no. 491



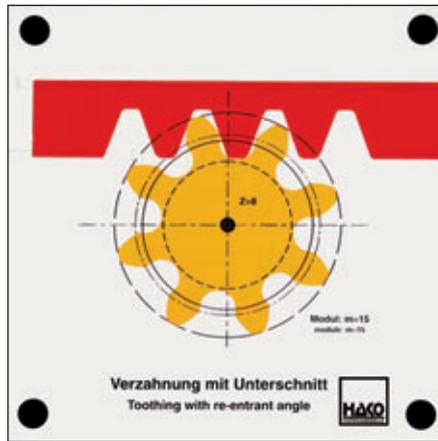
Roller-type free wheel

Function of the rollers rotating counter-clockwise and clockwise. Jamming and free-wheeling. Order no. 141



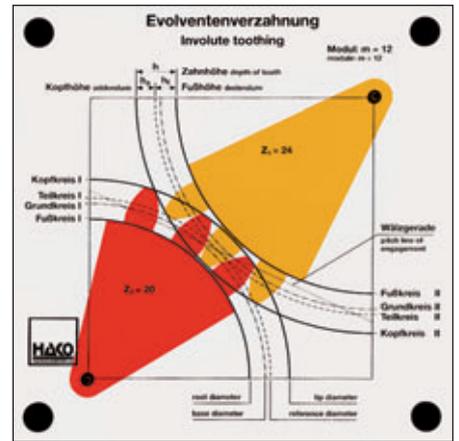
Cycloid tothing

The epicycloid is obtained by rolling a pitch circle on a pitched line of engagement. It can be clearly seen how the addendum flank of the tooth of gear wheel 1 rolls off the dedendum flank of the tooth of gear wheel 2. Order no. 369



Tothing with re-entrant angle

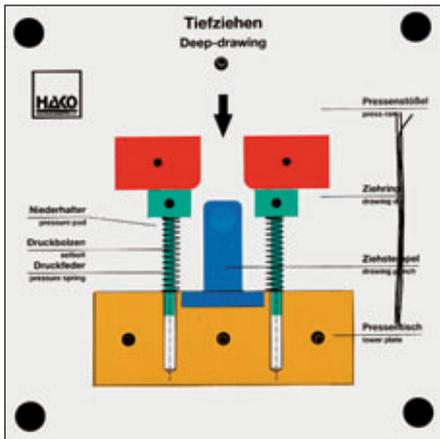
When a gear wheel is being manufactured, if the number of teeth is below the lower limit (e.g. 12 teeth), then the tooth faces must be made with a re-entrant angle. This process weakens the tooth faces. Order no. 370



Involute tothing

- meshing
- turning the tooth segments
- moving the involute on the pitch line of engagement
- displacing the pitch point of engagement
- marks on tothing

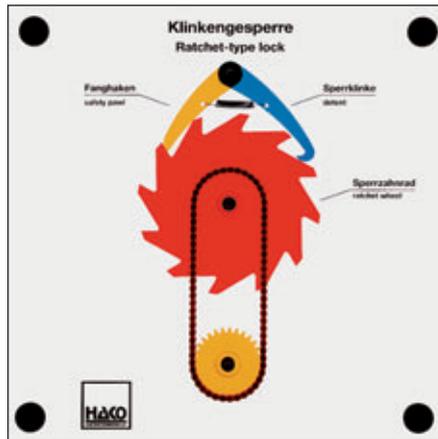
Order no. 296



Deep-drawing

- design of a deep-drawing tool
- production of a deep-drawn tin wire part
- influence of pressure pad force and pad pressure

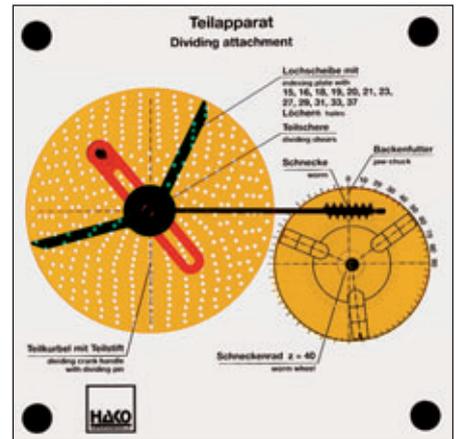
Order no. 290



Ratchet-type lock

- cycle of movement in lock and release directions
- how detents work

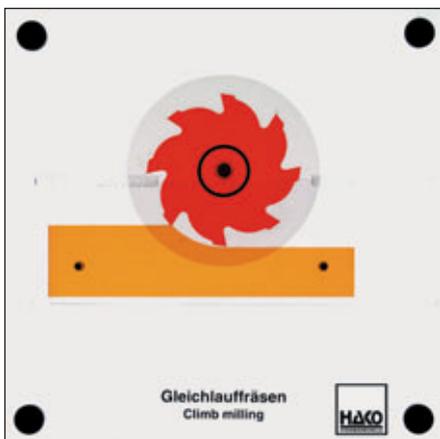
Order no. 309



Dividing attachment

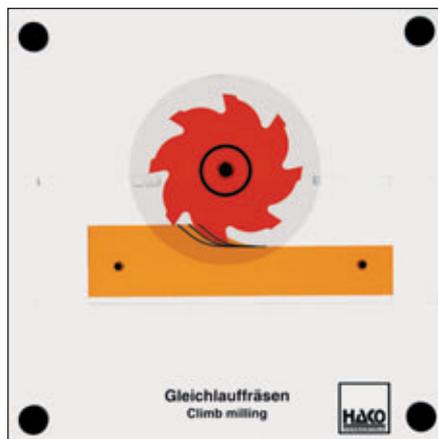
- function of a dividing attachment
- adjusting the dividing crank according to diameter of pitch circle
- adjusting the dividing shears
- turning the dividing shears
- automatic turning of the jaw-chuck (1:40)
- calculations on a dividing attachment

Order no. 292



Climb Milling

Turning of the miller with simultaneous table feed in the same direction. Under the miller there is a transparent 2 mm Plexiglas plate. The plate has boreholes at the ends of the

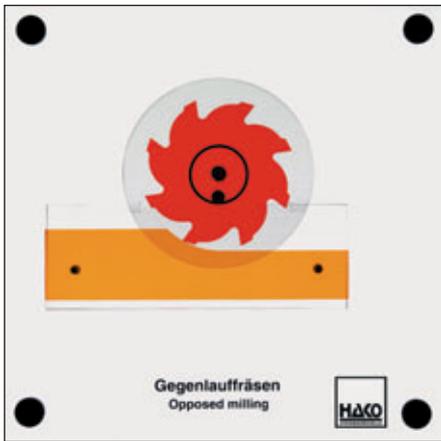


miller teeth. With the aid of a fibre-tip pen, one can see the development of a turning comma during the rotation of the miller. Order no. 346



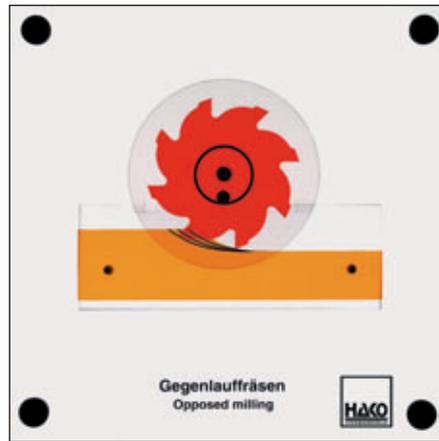
Front Milling

Turning of the miller with simultaneous table feed. With the aid of a fibre-tip pen, one can see the development of a turning comma during the rotation of the miller. Order no. 348

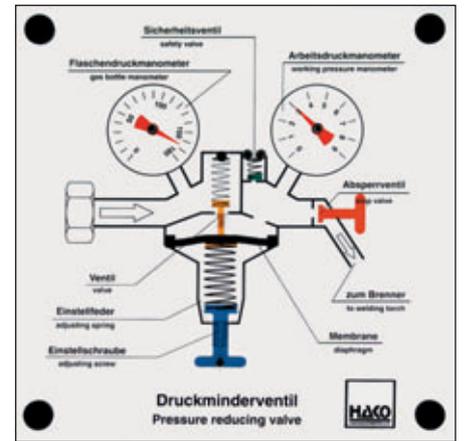


Opposed Milling

Turning of the miller with simultaneous table feed in the opposite direction. Under the miller there is a transparent 2 mm Plexi-glas plate.



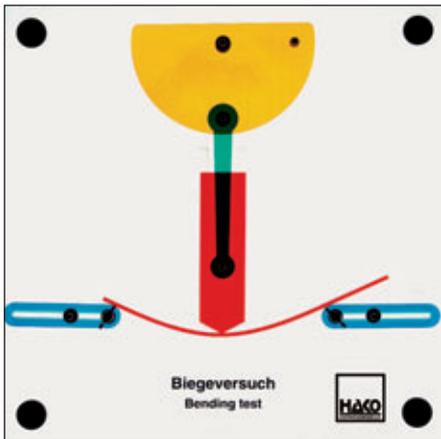
The plate has boreholes at the ends of the miller teeth. With the aid of a fibre-tip pen, one can see the development of a turning comma during the rotation of the miller. Order no. 347



Pressure reducing valve

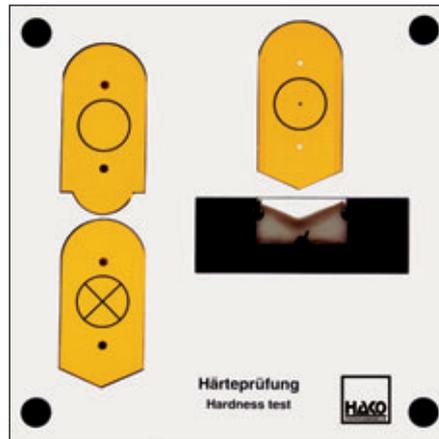
- function of the safety valve
- function of the shut-off valve
- function of the adjusting screw and governing spring for pressure regulation
- function of the diaphragm and the valve
- movement of the needle according to the level of pressure

Order no. 331



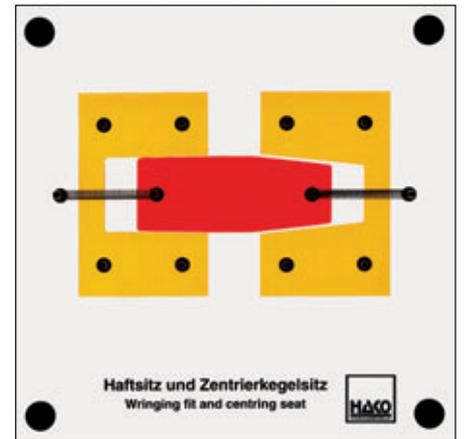
Bending test

The properties of various materials and cross-sections when subjected to bending. The properties of the materials at different sweeps. Order no. 366



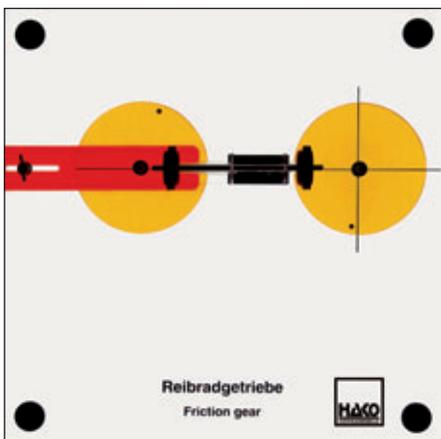
Hardness test

3 different penetrators enable the demonstration of the Brinell-Rockwell and Vickers processes. Before the penetration of a second test piece the surface is automatically smoothed. Order no. 367



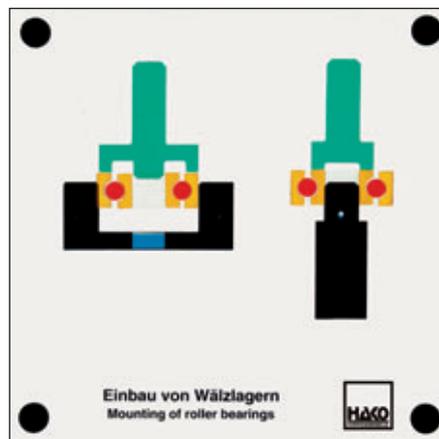
Wringing fit and centring seat

Demonstration: The difference between the wringing fit and centring seat. The wringing fit with a taper of 1 : 50 centres and has good adhesion qualities. The centring seat with a taper of 1 : 10 centres well, but is self-releasing. Order no. 362



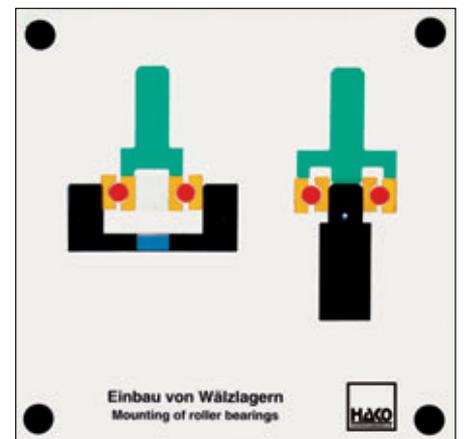
Friction gear

Application for e.g. screw presses. By sliding the drive shaft an infinitely-variable alteration of the gear ratio is possible. The power flow is obtained by friction. Order no. 368



Mounting of roller bearings

Left diagram: Correct mounting of roller bearings. The force for pressing together the outer ring (left) and the inner ring (right) is applied directly to the ring which is firmly fixed.

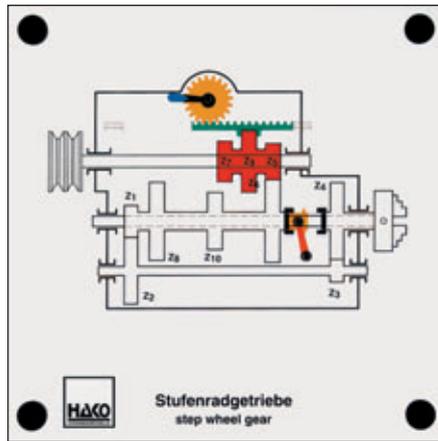


Right diagram: incorrect mounting of roller bearings. The joining force is transferred to the roller. This can be well demonstrated by the backlash of the balls. This damages the rings. Order no. 383



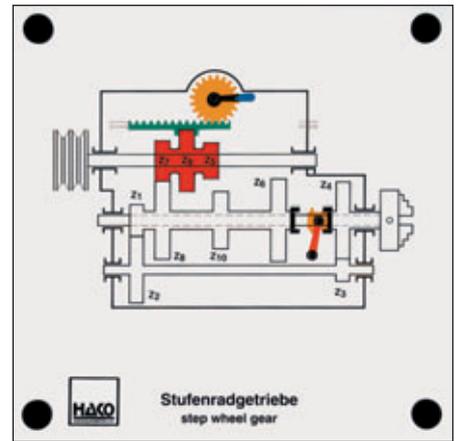
Relieve

Used for the manufacture of profile cutters.
A water-soluble marker is used to show the path of the cutting tool on the blank.
Order no. 363

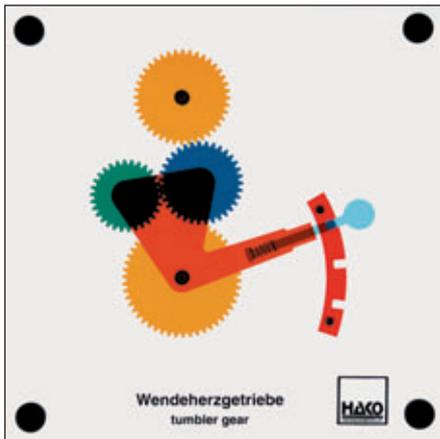


Step wheel gear

– layout of a step wheel gear
– shifting of the countershaft to positions 1 and 2
– shifting of the main shaft to positions 1 and 2
– demonstration of power flow with the 6 different rotational speeds

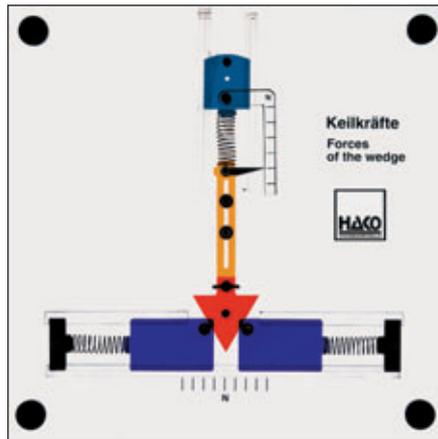


– calculation of rotational speeds and torques with help of the operating instructions
Order no. 329



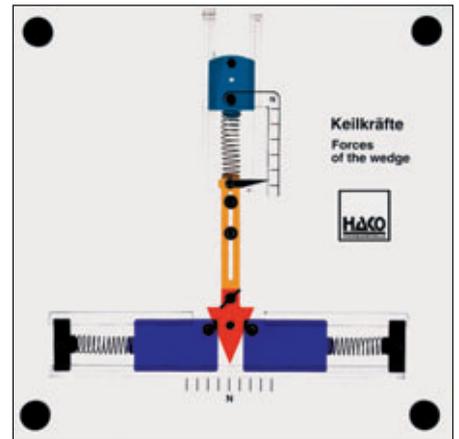
Tumbler gear

– modifying the sense of rotation by means of the tumbler gear
– power flow with clockwise and counter clockwise rotation
– no power flow in idling position
Order no. 328



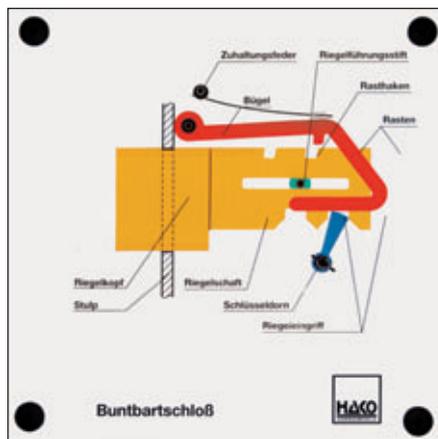
Forces on the wedge

With the help of 3 wedges (30, 45 and 60 degrees) it is possible to observe the wedge force dependent on the different pressure forces
Order no. 335



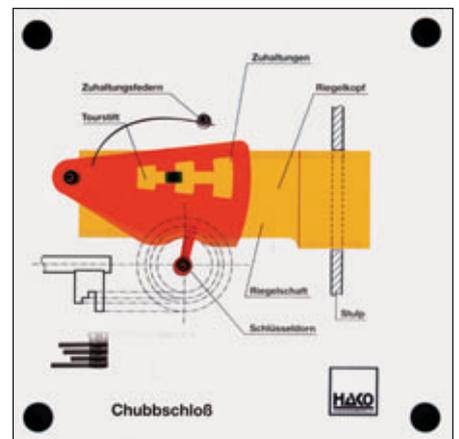
Spindle drive free from backlash

Without initial tension of the threaded nut the threaded spindle is seen to have a lot of backlash.
With initial tension of the threaded nut the threaded spindle is free from backlash.
Order no. 365



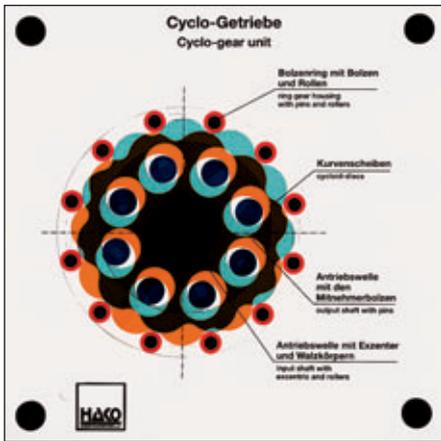
Buntbart lock

– function of the locking and unlocking action of a Buntbart lock
– stoppage of the lock when using various incorrect keys
– security of the lock
Order no. 407



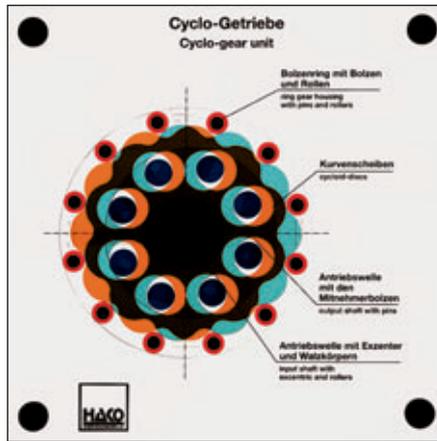
Chubb lock

– function of the locking and unlocking action of a Chubb lock
– stoppage of the lock when using an incorrect key
– security of the lock
Order no. 406



Cyclo-gear unit

- function of a cyclo-gear unit
- power transmission by rolling motion

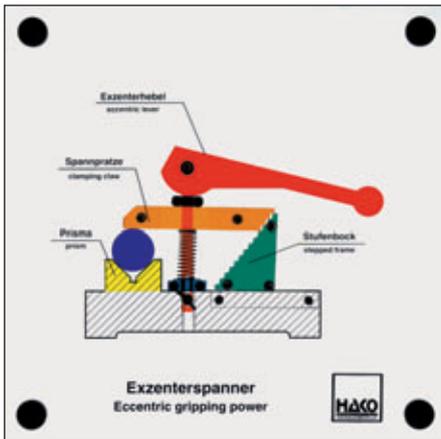


The advantages of a cyclo-gear unit: compact design, high transmission ratio, no sliding friction, high dynamics, low moment of inertia, silent run, high efficiency, three-stage transmission up to 428285:1
Order no. 294



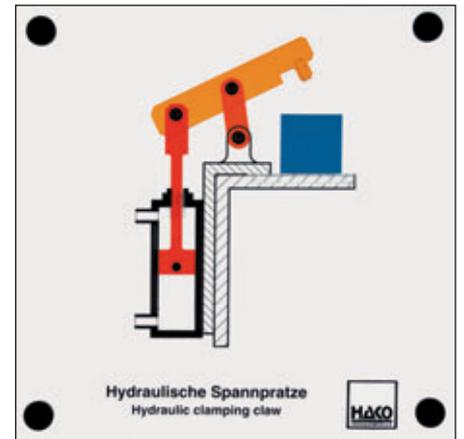
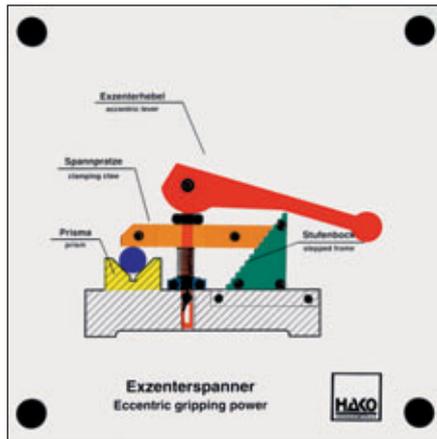
Maltese Cross

Maltese cross-type transmission is used for the control of rotary indexing tables. Each turn of the curved wheel rotates the Maltese wheel through 90°, and it remains in this position until the next time the curved wheel is turned.
Order no. 359



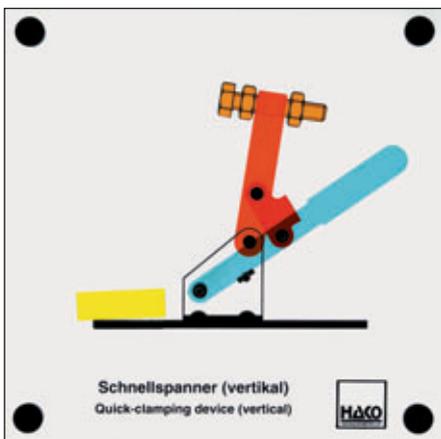
Eccentric gripping power

- eccentric function during clamping
 - clamping of different diameter workpieces
 - displacement of stand and clamping claw to ensure adaptation to the respective workpiece diameter
- Order no. 339



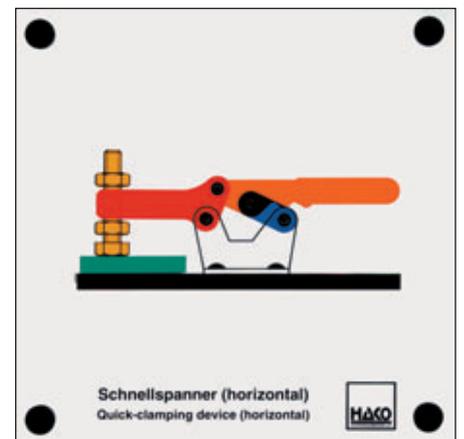
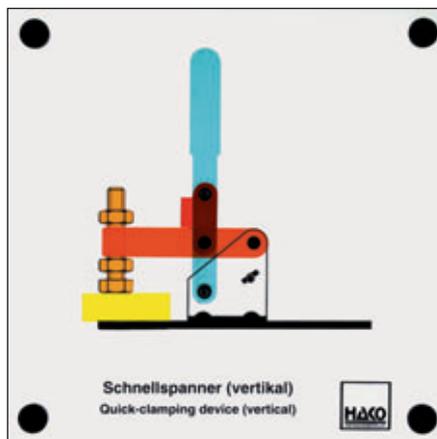
Quick clamping device, hydraulic

- opening and closing of the clamping device by means of the plunger stroke and the hydraulic cylinder
- Order no. 351



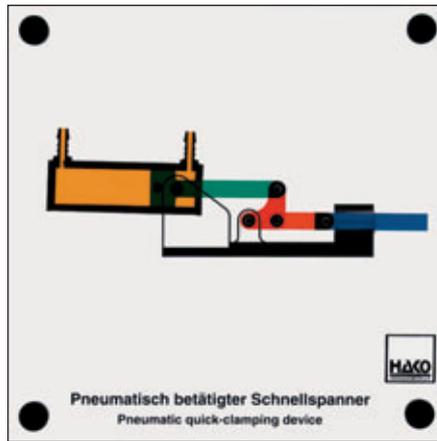
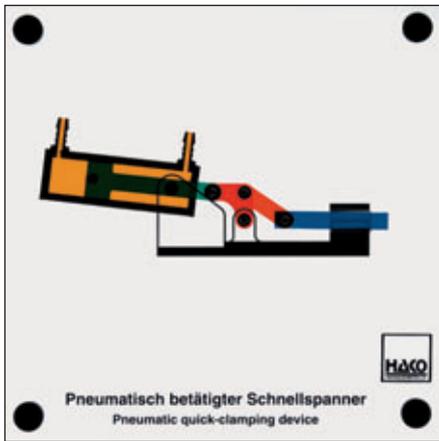
Quick clamping device, vertical

- opening and closing of the clamping device
 - large lever arm on handle and smaller lever arm on clamping claw provide intensive clamping forces
 - function of the knee lever
- Order no. 349



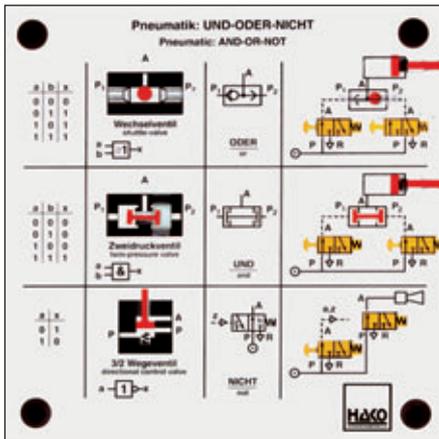
Quick clamping device, horizontal

- opening and closing of the clamping device
 - large lever arm on handle and smaller lever arm on clamping claw provide intensive clamping forces
 - function of the knee lever
- Order no. 352



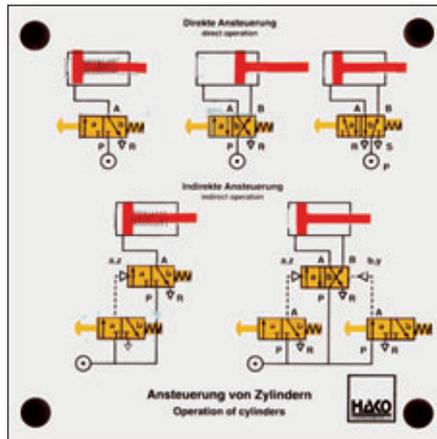
Quick clamping device, pneumatic

- opening and closing of the clamping device
 - large plunger stroke and smaller closing stroke
 - via force deflection in knee lever
 - cylinder movement during stroke
- Order no. 350



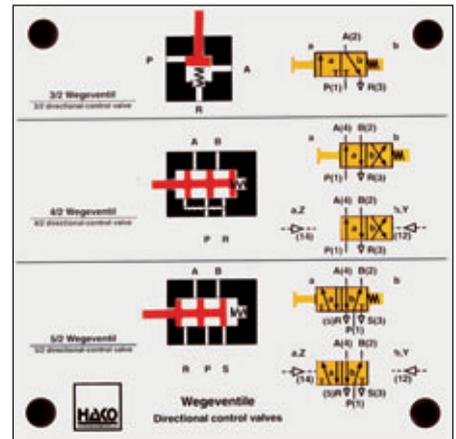
Pneumatics: decision elements AND – OR – NOT

- a cylinder is triggered from two sides
 - only one cylinder should be actuated when two signals are given
 - one protecting guard is not closed, an acoustic warning sounds
- Order no. 219



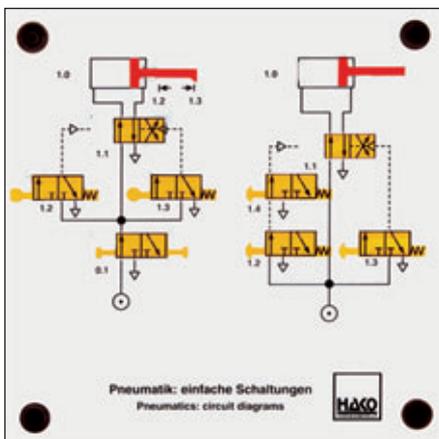
Pneumatics: triggering a cylinder directly and indirectly

- all pistons and valves can be actuated
 - differences between direct and indirect triggering of cylinders
 - different methods of actuating; spring reset
 - ideal model to simulate movement patterns
- Order no. 220



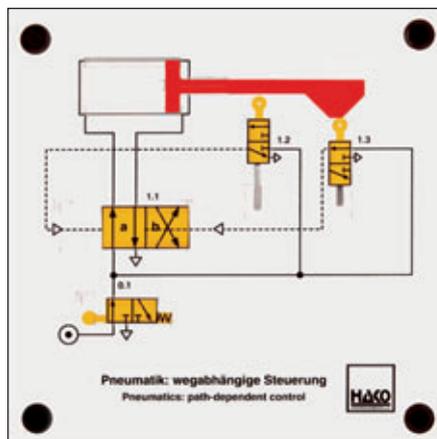
Pneumatics: 3/2-, 4/2- and 5/2-port directional control valves

- all directional control valves and graphical symbols can be moved
 - function and description of the different valves
 - the model facilitates the understanding of symbols by comparison with real valves
- Order no. 217



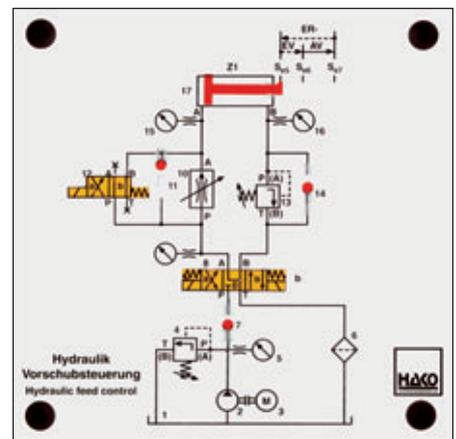
Pneumatics: decision elements

- all pistons and valves can be actuated
 - cooperation of valves and pistons
 - ideal model to simulate movement patterns (back and forth)
- Order no. 221



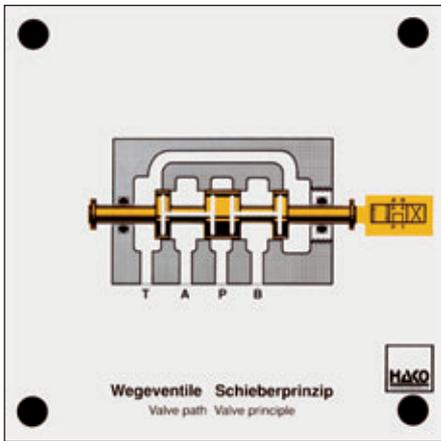
Pneumatics: Path-dependent control

- in this model, the extending piston directly moves the directional control valves, which are reset by real steel springs
 - the model is especially suited to introduce the functions of model # 221
- Order no. 234



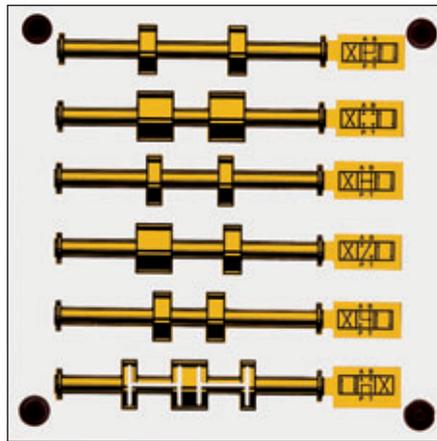
Hydraulics: connection diagram of a feed control

- directional control valves, pistons and check valve can be moved
 - simulation of all movement patterns
- Order no. 222

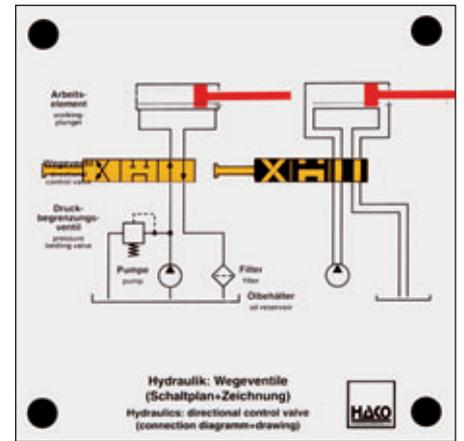


Hydraulics: directional control valves with six different pistons

- different directional control valves
- possible flow paths through the different original pistons; six different pistons can be applied

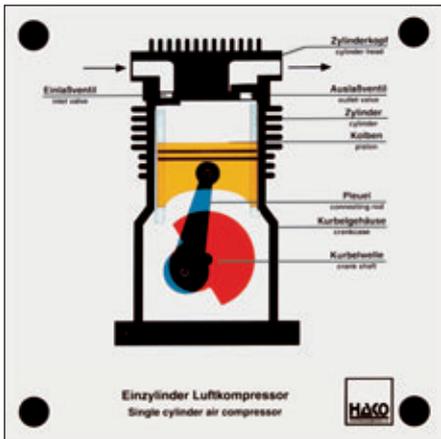


- assigning piston shapes to graphical symbols
- Order no. 223



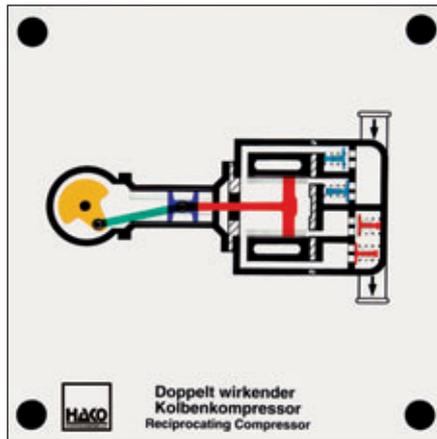
Hydraulics: directional control valve (connection diagram and drawing)

- the two valves are connected in a way they can move together
 - combining the two pistons
 - how graphical symbols of directional control valves come about
 - three different shift positions can be set
- Order no. 224



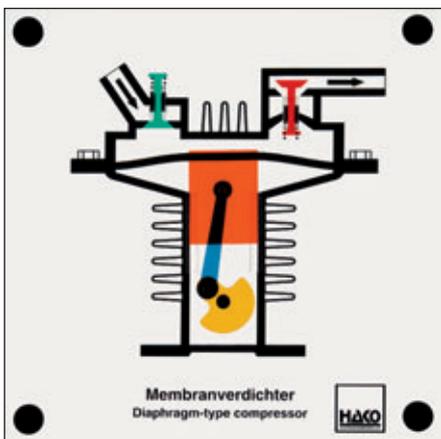
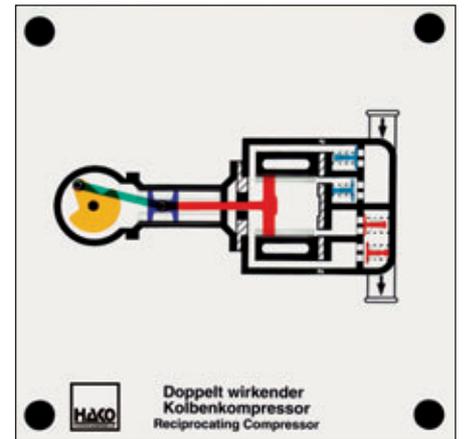
Single-cylinder air compressor

- function of suction and delivery valve
 - function of the piston when turning the crankshaft
- Order no. 181



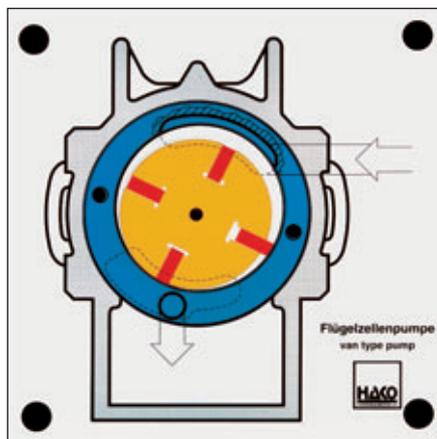
Reciprocating compressor

- Used for the supply of larger quantities of compressed air.
 - By opening the relevant inlet and outlet valves it delivers on both the forward and return stroke.
- Order no. 374



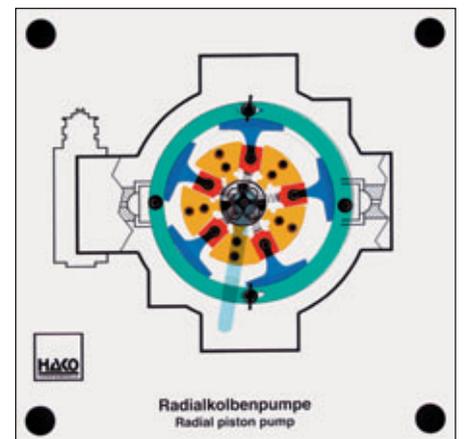
Diaphragm-type compressor

- Used when the compressed air has to be free from lubricant residues.
 - The membrane is fixed at the top of the piston and follows it in the course of the strokes.
- Order no. 375



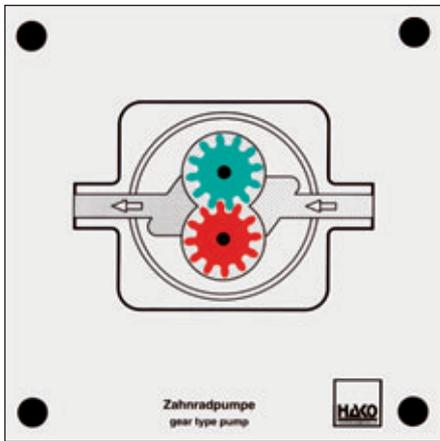
Vane-pump

- function of the pump
 - centrifugal force causes apex seal to fit
 - apex seals do not fit at slow rotation
- Order no. 124



Radial-piston pump

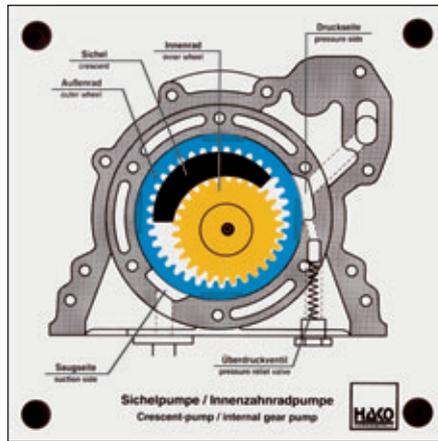
- the regulation of the delivery rate is performed hydraulically by moving the piston ring.
 - the piston ring on the model can be moved from zero to maximum delivery
- Order no. 421



External gear pump

- oil flow through the pump
- function of the pump

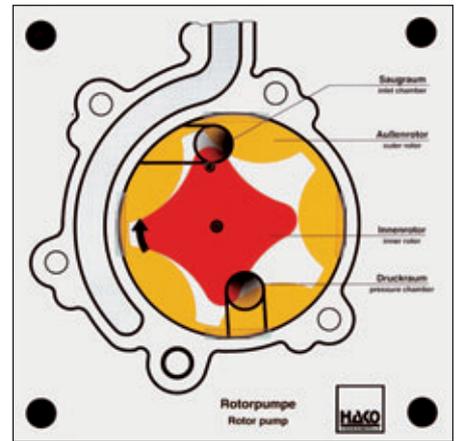
Order no. 128



Internal gear pump

- function of an internal gear pump: increasing and decreasing the volume of suction and pressure chamber
- internal gear pumps are used as engine-oil pumps and oil pumps in automatic transmissions

Order no. 206



Rotor pump

- an increase or decrease in volume of the chambers between inner and outer rotor causes suction or pressure

Order no. 129



Controlled oil pump (duocentric)

The controlled duocentric oil pump regulates the oil pressure to around 3.5 bar over the entire speed range. A control ring and control spring are responsible for regulating the pressure. Oil pressure less than 3.5 bar: The control spring presses the control ring against the oil pressure, the external rotor is turned and the space between internal and external



rotor is enlarged. Oil pumping increases, as does the oil pressure. Oil pressure greater than 3.5 bar: The oil pressure presses the control ring against the control spring. The rotor is turned back and the space between the internal and external rotor is reduced. As the oil quantity drops, so does the oil pressure.

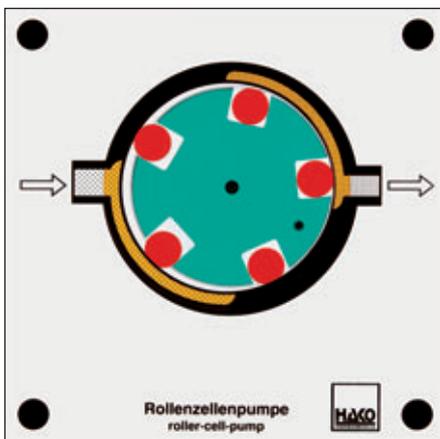
Order no. 506



Rotary pump

The model demonstrates that cooling-water pumps work on the same principle as rotary pumps.

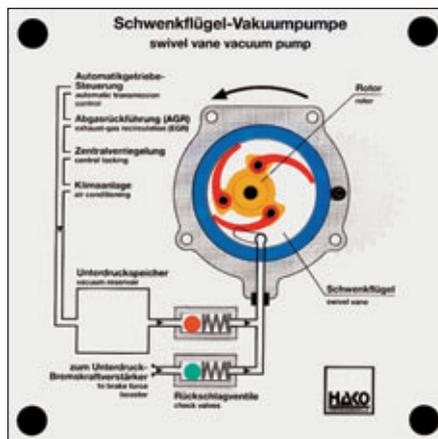
Order no. 226



Roller-cell pump

- function of the pump
- centrifugal force causes rollers to seal

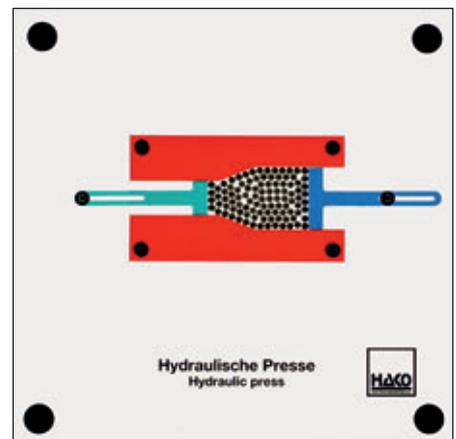
Order no. 125



Swivel vane vacuum pump

- vacuum created by continuous volume reduction of inlet side
- function of ball valves

Order no. 288

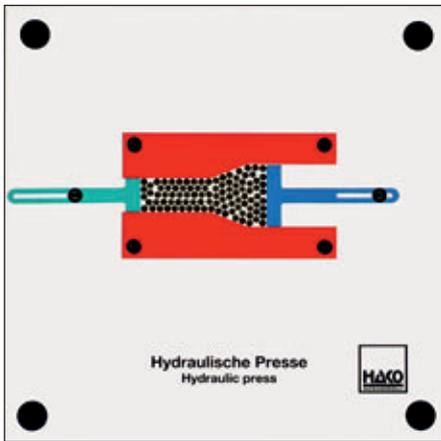


Hydraulic press

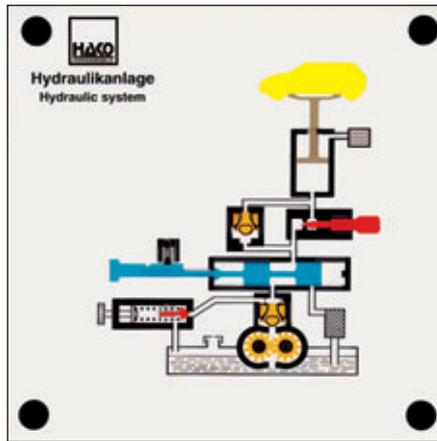
The basic principle of hydraulic presses has been shown.

Demonstration:

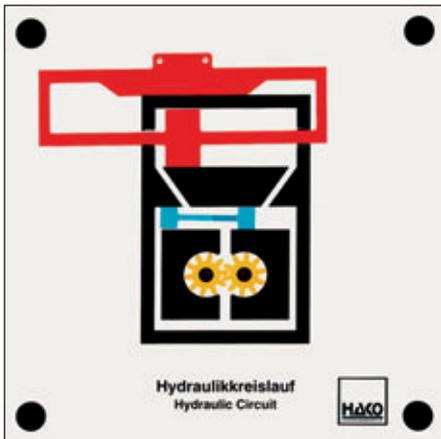
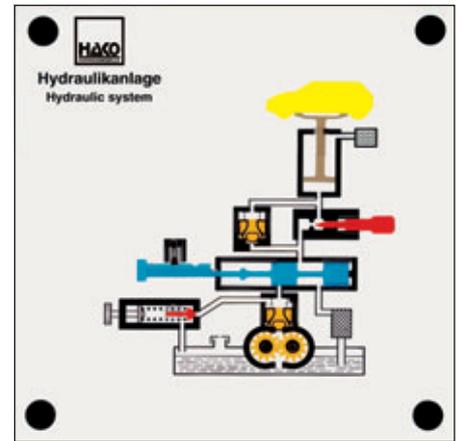
- move the small piston to the inside. Large distance, small force



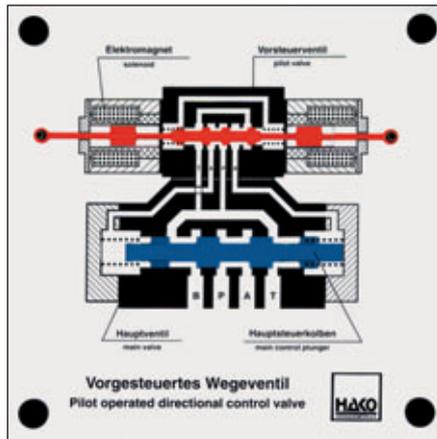
– move the large piston to the inside. Small distance, large force
 – displacement of the small piston and simultaneous pressing against the large piston. One clearly notices the difference in force
 Order no. 492



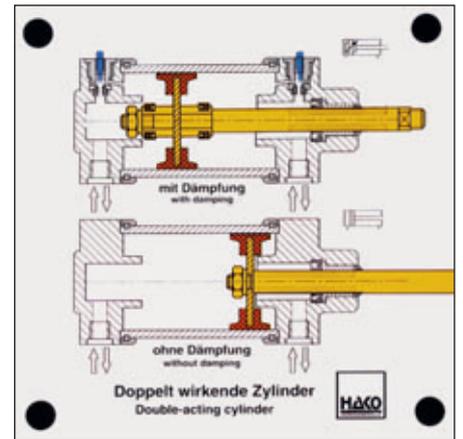
Hydraulic system
 All the important components of a hydraulic system can be demonstrated:
 Function of the control piston, pressure relief valve, throttling valve, working piston and shift valve.
 Shows movements of the lifting platform.
 Order no. 378



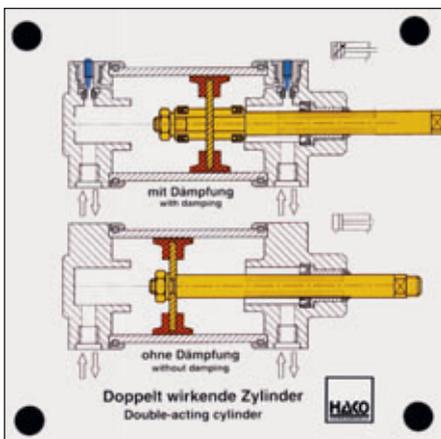
Hydraulic circuit
 The most important components of a hydraulic system are presented clearly and simply: Function of the gear pump, a directional-control valve and the control piston.
 Order no. 361



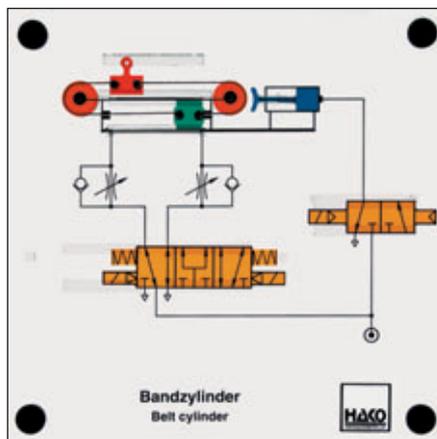
Pilot operated directional control valve
 – actuation of the pilot valve
 – primary valve switching
 – release of the directional ports via primary valve
 Order no. 338



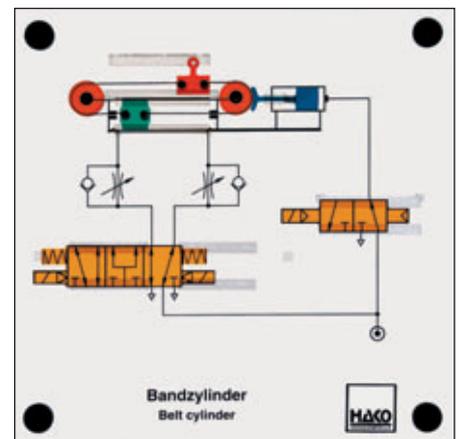
Double acting cylinder
 Function of a double acting cylinder without damping. Function of a double acting cylinder with damping. Both throttle valves are mobile, which

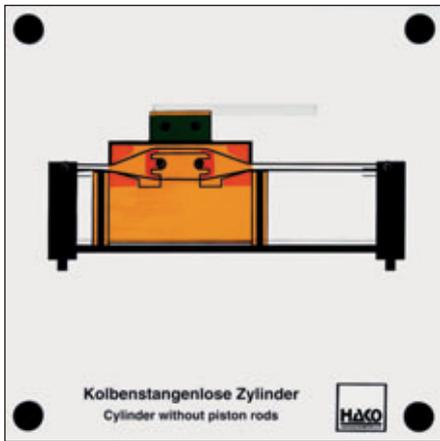


means that differing damping figures can be set.
 Order no. 431



Belt cylinder
 – function of the 5/3 port directional control valve
 – function of the 3/2 port directional control valve
 – throttling function
 – function of the belt cylinder
 – function of the band brake
 Order no. 353

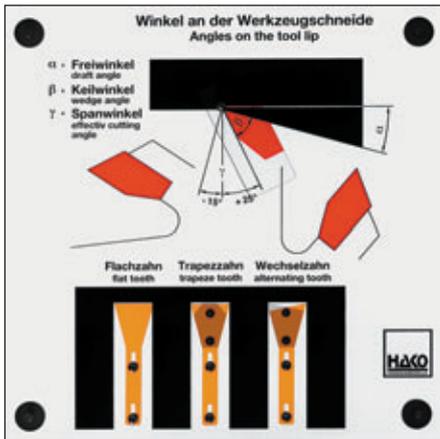




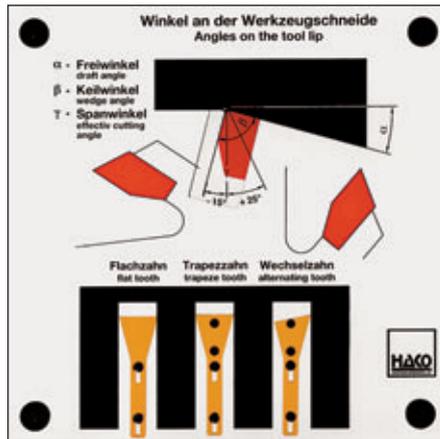
Cylinder without piston rods
 – function of the piston and of the cylinder
 – function of the sealing band for sealing of cylinder slot
 Order no. 354



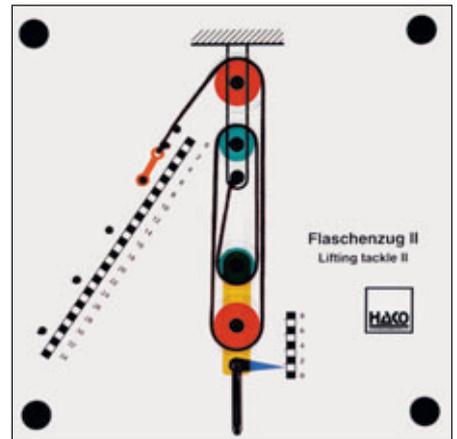
Angles on the tool lip
 – the size and position of the clearance, leading edge and effective cutting angle can be changed
 – mutual influence of clearance, leading edge and effective cutting angle can clearly be seen
 – results in the negative effective cutting angle
 Order no. 468



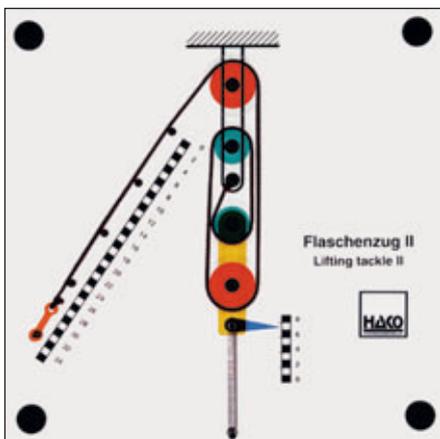
Angles on the tool lip
 – the size and position of the clearance, leading edge and effective cutting angle can be changed
 – mutual influence of clearance, leading edge and effective cutting angle can clearly be seen



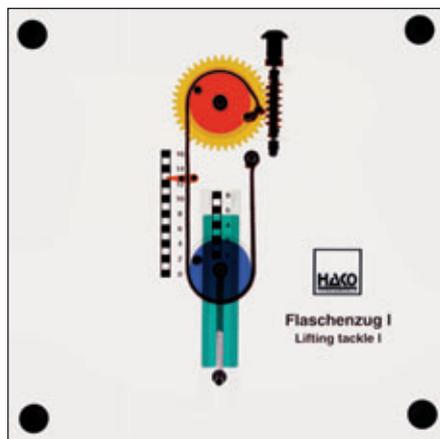
– results in the negative effective cutting angle
 – various shapes of tooth can be shown by adding variously shaped teeth
 Order no. 472



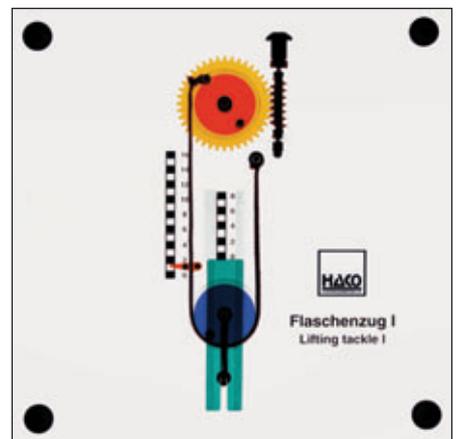
Lifting tackle II
 Functions:
 – principle of a lifting tackle with two loose and two fixed rolls

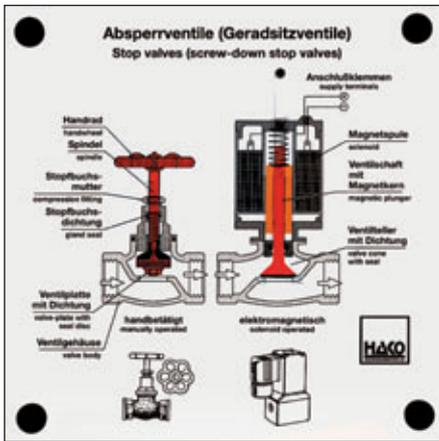


– reading off the various distances; differing forces result from this
 Order no. 436



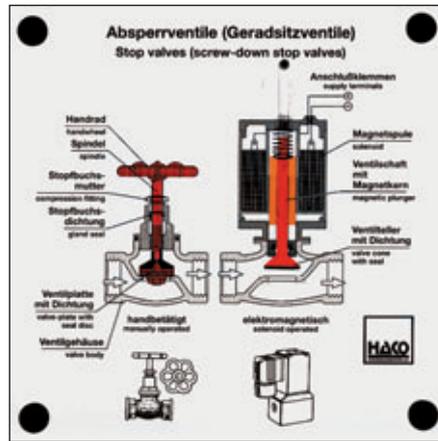
Lifting tackle I
 – function of a lifting tackle with a loose roll-read-off of the various distances-Function of the worm drive with a transmission ratio of 40 : 1
 Order no. 426



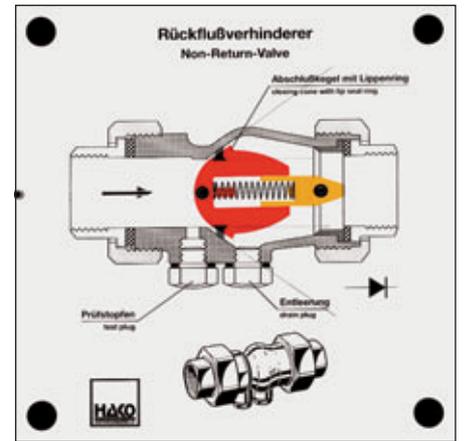


Stop valves

– flow control by means of a manually actuated valve plate and a solenoid operated valve cone

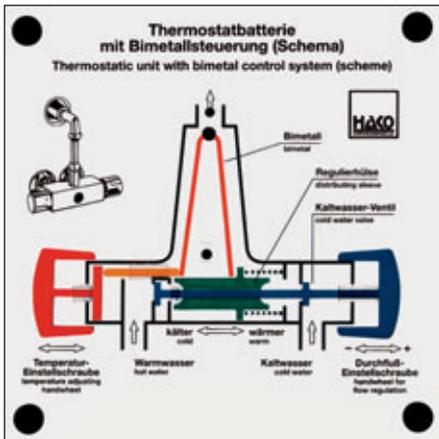


– opening and closing of both valves
Order no. 306



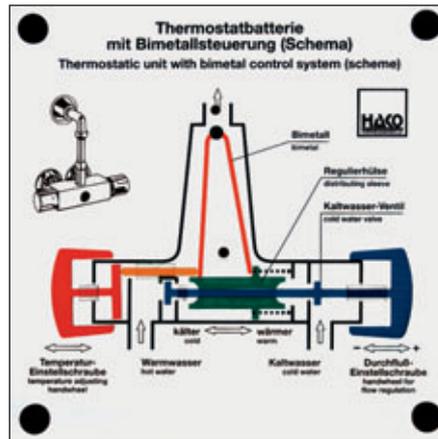
Non-return valve

– function when water flows through
– shut-off effect when water flows back
Order no. 303

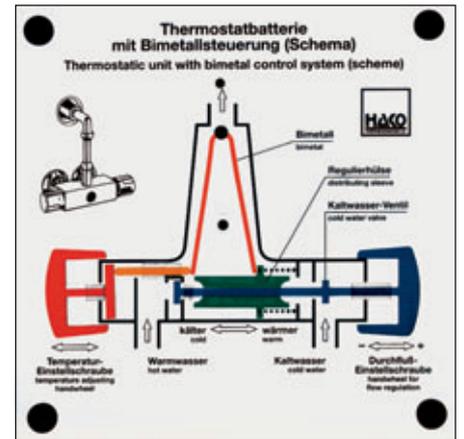


Thermostatic unit with bimetal control system

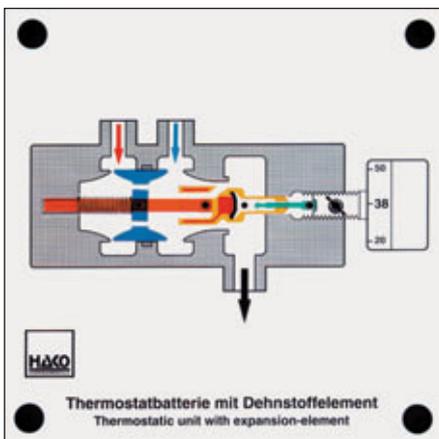
The diagram shows the operation of a thermostatic unit when the outflow of water is adjusted, and the function of the bimetallic spring.



Moving the distributing sleeve from cold to warm (and vice versa) changes the cross sections of the outlets

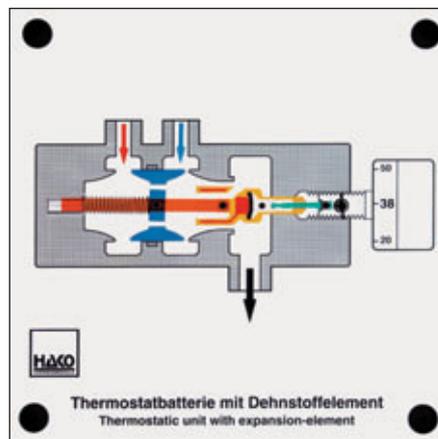


and consequently the water temperature.
Order no. 311

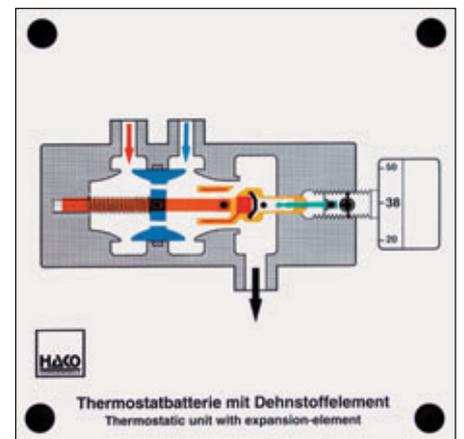


Thermostat battery with expansion element

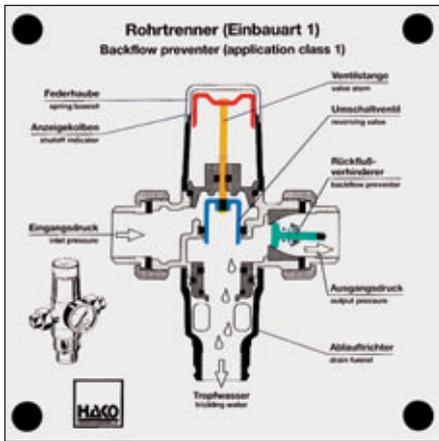
– movement of the double conical valve for the setting of the desired temperature



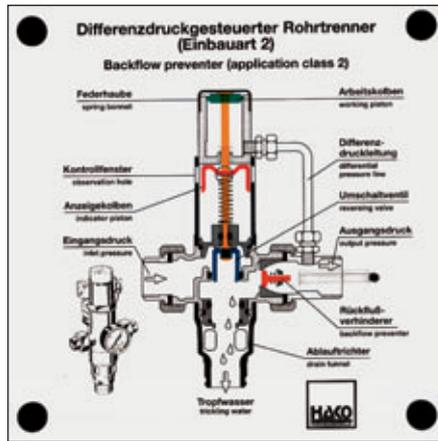
– expansion of the expansion medium at increased temperatures, thus moving the double conical



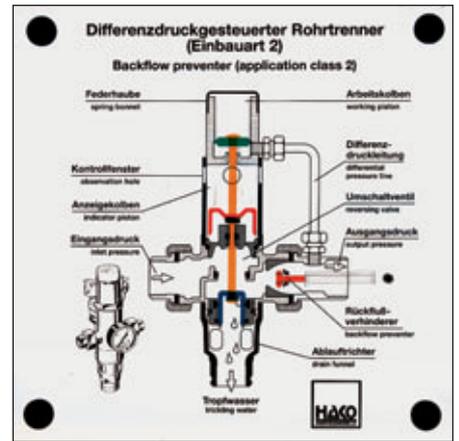
valve to achieve regulation of the temperature set
Order no. 422



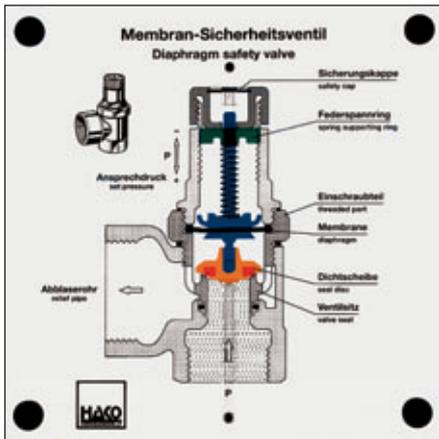
Backflow preventer (EA 1)
 Function of the safety valve at normal rate of flow and shutoff when inlet pressure is too low.
 Order no. 305



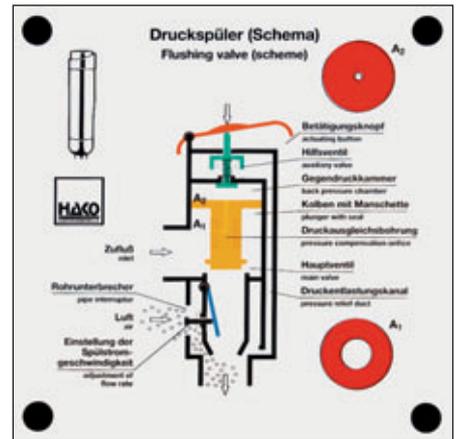
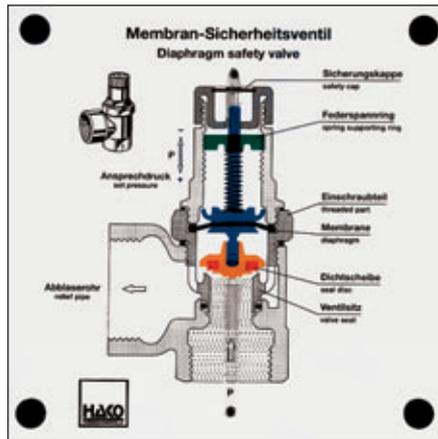
Backflow preventer (EA 2)
 – function of the safety valve at the usual shutoff point



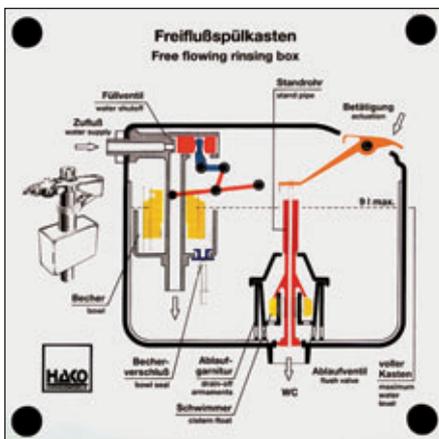
– flow-through when water is taken off, controlled by differential pressure
 Order no. 308



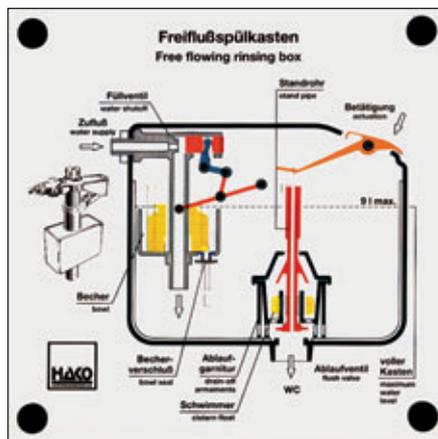
Diaphragm safety valve
 Demonstration of relief when overpressure is too high
 Order no. 307



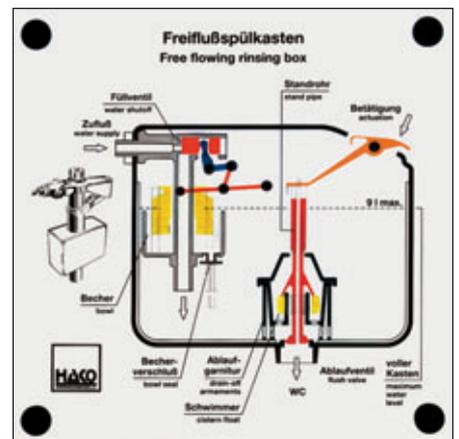
Flushing valve
 – actuating the minimum flow
 – function of the backflow preventer
 – automatic shutoff
 – adjustment of flow rate
 Order no. 315



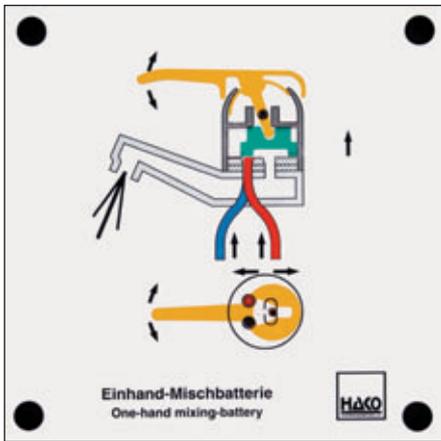
Free-flowing rinsing box
 – cycle of movement while filling or flushing
 – function of the two floats



– function of water shutoff and flush valve

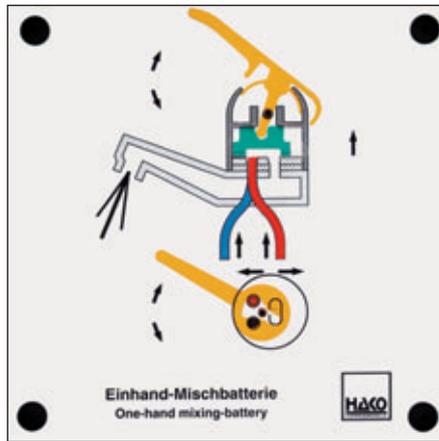


– function of the safety valve
 Order no. 310



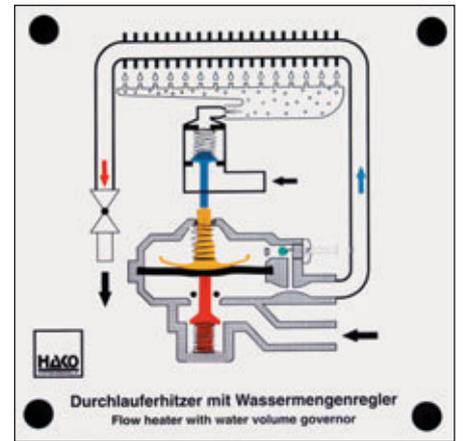
Single-handed mixer tap

– setting the desired water volume by moving the lever up and down and turning the movable ring (upper part)



– setting the desired temperature by turning the lever and the movable ring (lower part)

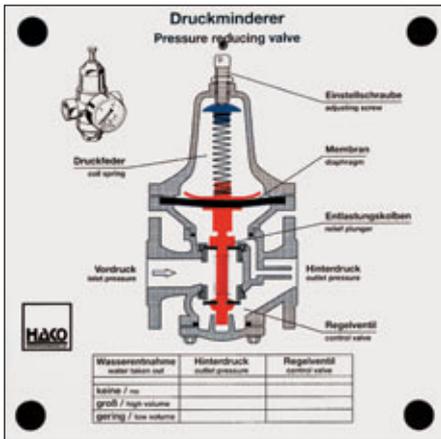
Order no. 423



Instant water heater with water volume control

– water volume control in the water volume control unit by means of pistons and springs
– function of the Venturi nozzle
– regulation of the gas volume by means of a connecting rod to the water volume control unit

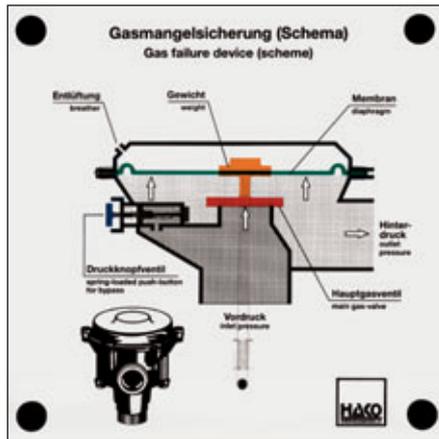
Order no. 425



Pressure-reducing valve

– if the pressure is too high, the valve closes
– if the pressure decreases, the valve opens
– reduction of inlet pressure

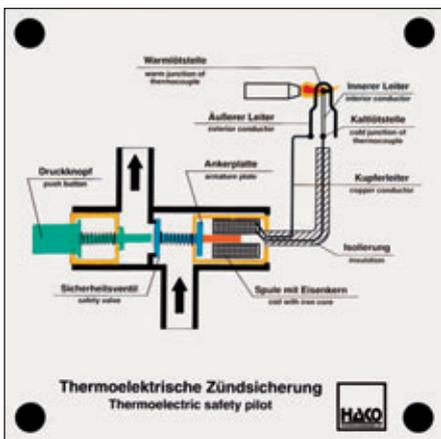
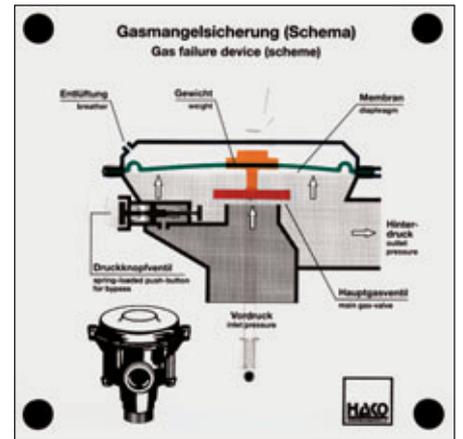
Order no. 318



Gas failure device

– safety function when line divisions are not closed
– after actuation of the spring loaded push-button for bypass, the main gas-valve is lifted and rest pressure increases

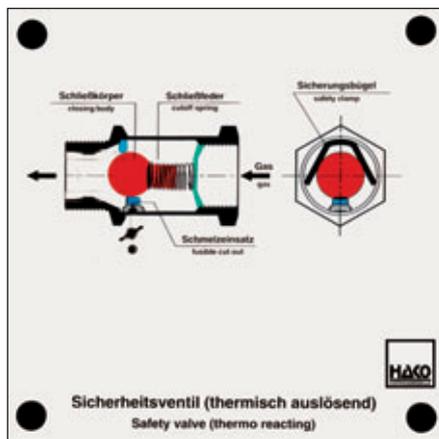
Order no. 316



Thermoelectric safety pilot

When the flame is alight, the safety valve is pulled back by the coil, and the gas can flow.
If the flame is extinguished, the safety valve is immediately closed by the spring, as there is no longer any magnetism.

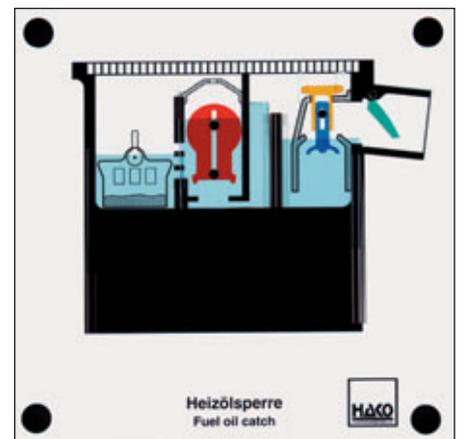
Order no. 377



Safety valve

The closing body is held in the back position by a fuse, and the gas is able to flow.
If the fusible cut out melts, e.g. because of fire, the fuse body is pushed forwards by the spring, and the gas flow is interrupted.

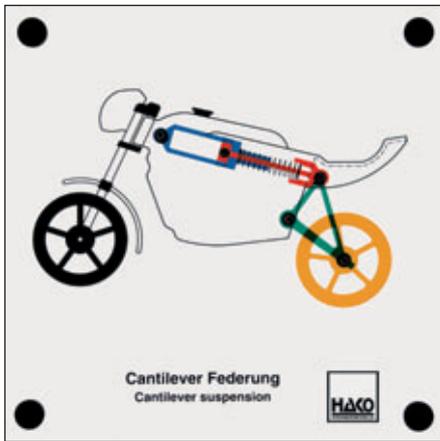
Order no. 380



Fuel oil hold-back system

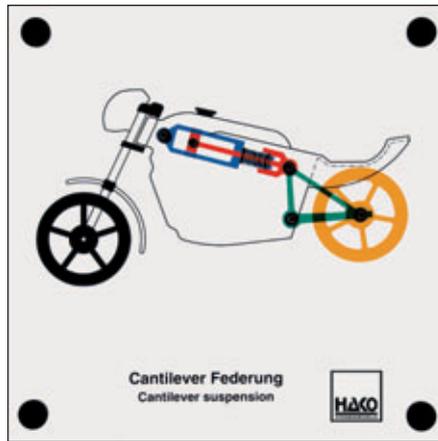
– function of the float on ingress of waste water or the ingress of heating oil
– function of the backpressure flap and the backpressure seal
– the inflow of the waste water can be demonstrated by three movable slide bars

Order no. 424



Cantilever suspension

- function of the central suspension strut
 - function of suspension and damping during compression and rebounding
 - spring progression via power deflection
- Order no. 342



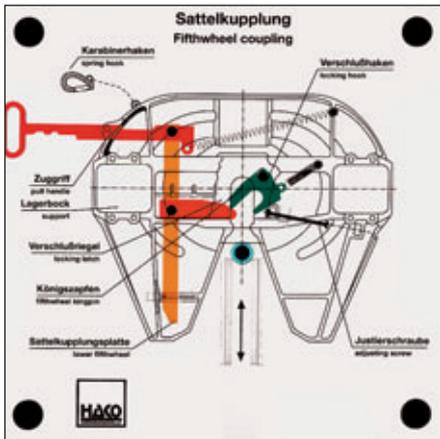
Cantilever Federung
Cantilever suspension



Hinterradschwinge
Rear swinging fork

Rear swinging fork

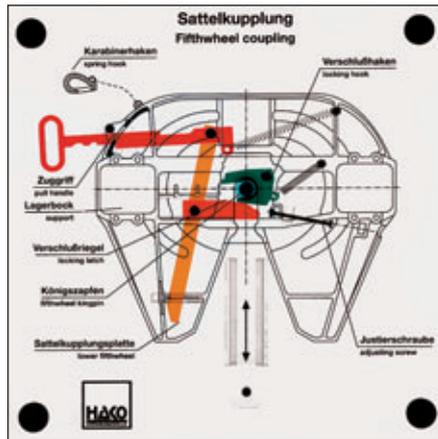
- function of a conventional rear swinging fork
 - function of suspension and damping during compression and rebounding
- Order no. 343



Fifthwheel (semitrailer) coupling

- coupling ready for drive in
- driving in the tractor
- latch locks automatically

"Ready for running in"



- the spring hook serves as a safety device
 - opening the spring hook, pulling out the pull handle, releasing the locking latch, driving out tractor
- Order no. 299

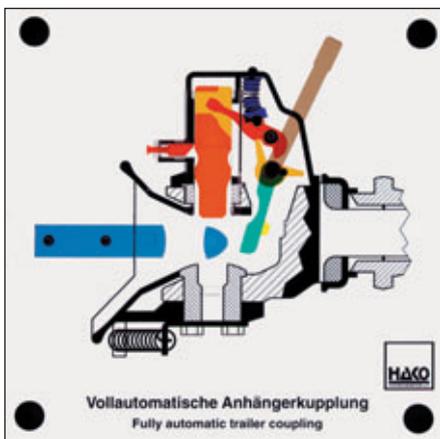
"Coupling inserted"



Vollautomatische Anhängerkupplung
Fully automatic trailer coupling

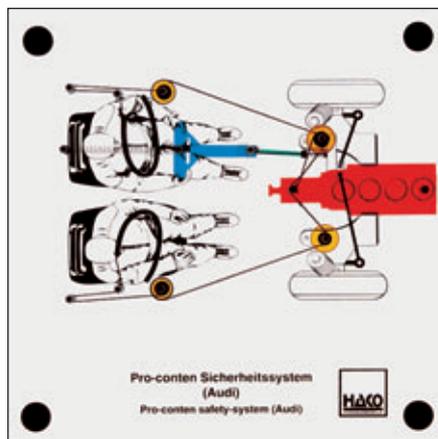
Fully-automatic trailer coupling

- opening the trailer coupling by means of the hand lever
- inserting the trailer drawbar eye
- releasing the automatic locking of the trailer coupling



Vollautomatische Anhängerkupplung
Fully automatic trailer coupling

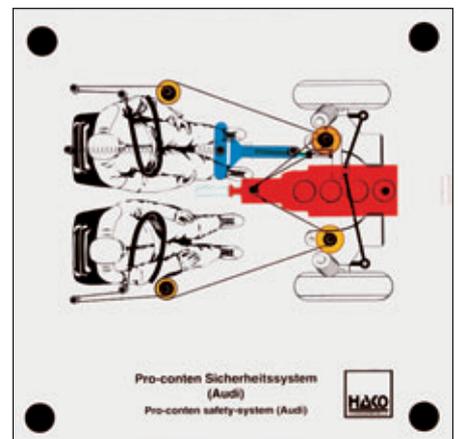
- securing the locked trailer coupling
 - function of the control pin
- Order no. 410



Pro-Conten Sicherheitssystem (Audi)
Pro-Conten safety-system (Audi)

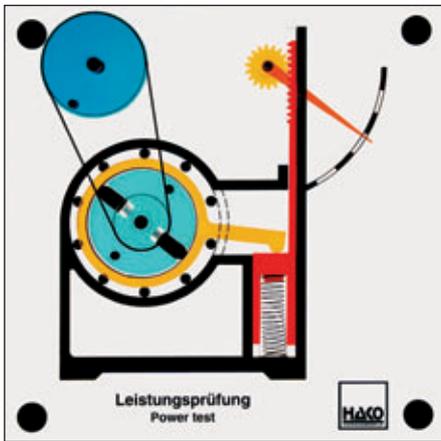
Pro-Conten safety system (Audi)

- engine can be moved backwards (simulating a frontal collision)
- the steering wheel is pulled out of the passenger compartment, and the pretensioning device



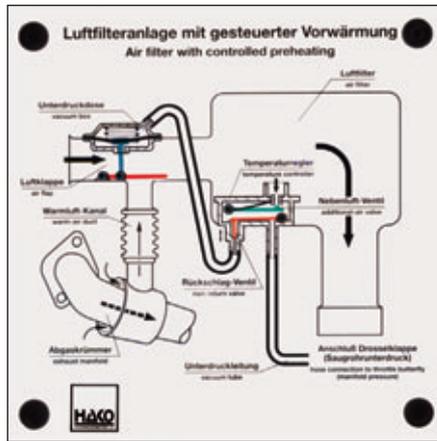
Pro-Conten Sicherheitssystem (Audi)
Pro-Conten safety-system (Audi)

- tensions shoulder and lap belt of driver and passenger simultaneously
 - automatic resetting
- Order no. 185



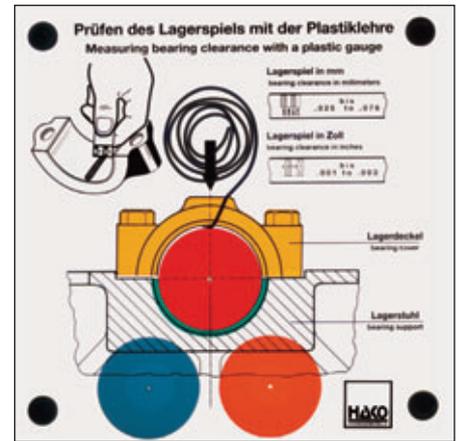
Power test

Design and function of a power analyser. The rotor is turned by the drive wheel. The flyweights make contact with the stator. The stator lever presses on the balance. This actuates the force indicator by means of a lever and gear rack. A DC supply from 0 to 12V is required. Order no. 360



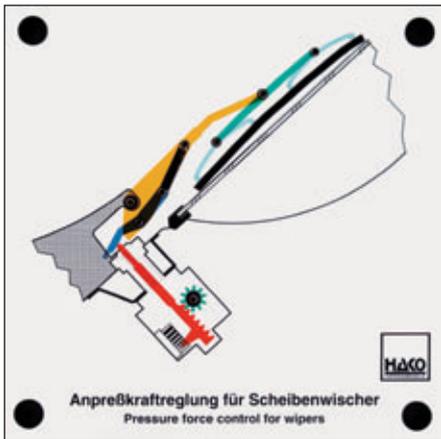
Air filter with controlled preheating

– controlling the air flap by means of the vacuum box
 – function of the temperature controller depending on the temperature of the inlet air
 – function of the non-return valve
 – interaction of all elements in different operating conditions
 Order no. 257



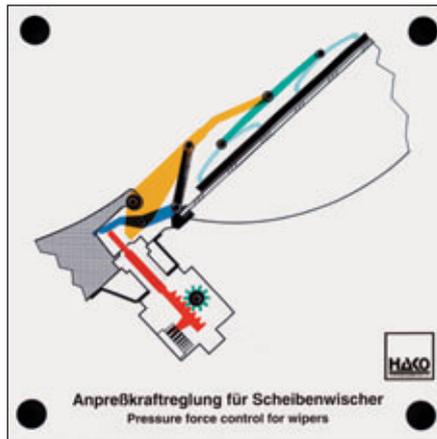
Measuring bearing clearance

– the plastic gauge can be applied
 – you can insert different journals with different diameters
 – the bearing cover is pressed down
 – different bearing clearances can be evaluated by comparing the width of gauge with imprinted scales
 Order no. 249

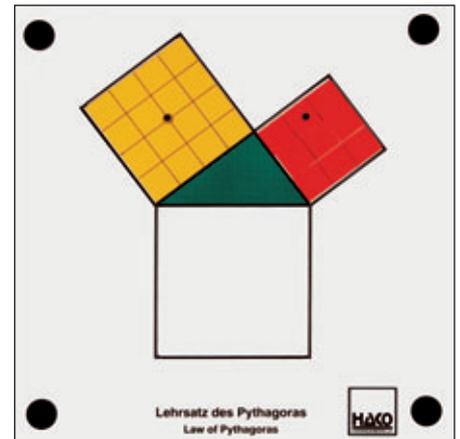


Vertical force control of windscreen wipers

– function of a windscreen wiper linkage
 – function of the vertical force control by means of an electric motor, rack and pinion

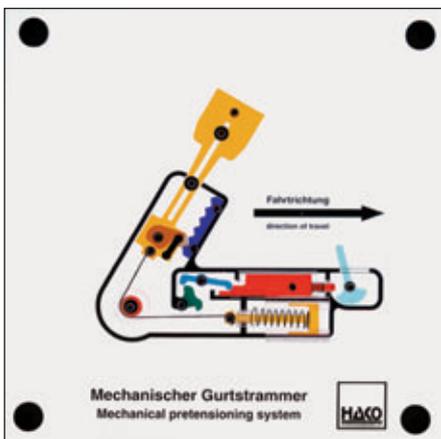


– demonstration of the wiper blade pressed down and raised
 Order no. 397



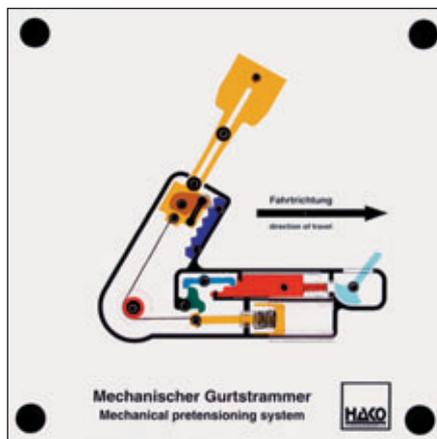
Pythagoras' Theorem of

– the theorem of Pythagoras can be shown by converting the squares above the catheters into the square above the hypotenuse
 Order no. 160

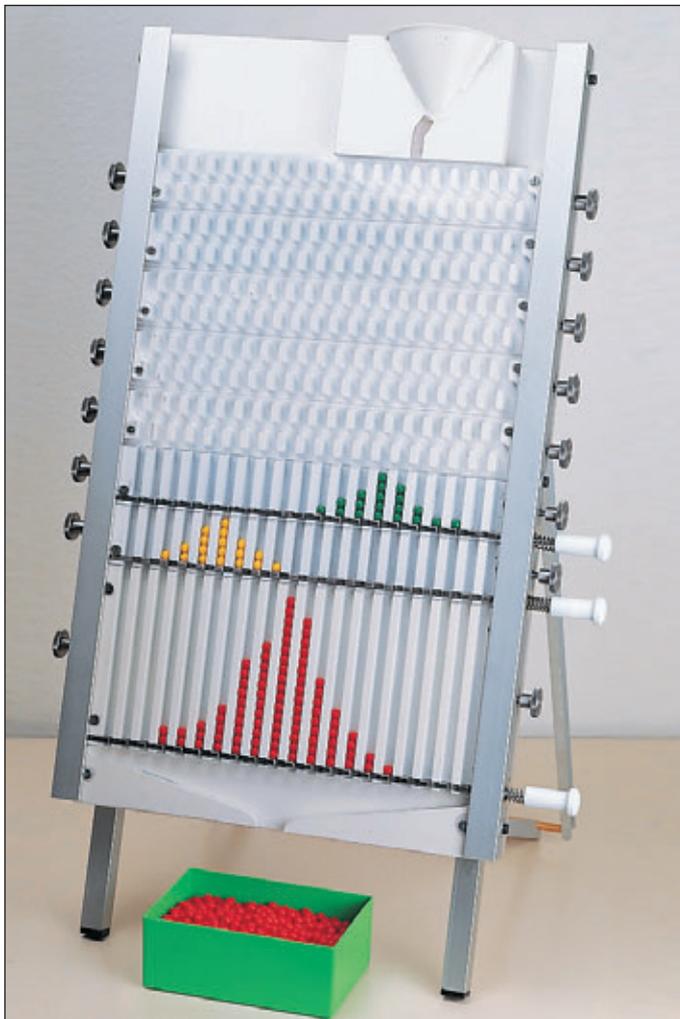


Mechanical pretensioning device

– release of the pretensioning device by the sensor mass
 – release of the spring and pretensioning of the belt, holding it in this position by the locking plate



– switching off the pretensioning device
 Order no. 415



Distribution and SPC simulator

Increasing use of statistical process control (SPC) in many areas of production requires an increasing level of expertise in the field of statistical random distribution.

The assessment capability of the quality management specialist is increasingly called for in various random distribution processes and their mathematical description.

Using the distribution and SPC simulator, numerous random processes can be simulated realistically and represented graphically. Real random results can be compared immediately with the ideal mathematical distribution curves.

Due to the modular construction of the simulator, the processes of formation of various distribution forms can be reconstructed.

The simulator can be used by teachers for clarification or by trainees for random experiments in a statistics laboratory.

Structure:

A baseplate with side guides, a stand and a ball outlet form the basic system which is used to locate individual modules in desired combinations:

1. "Centralised module"

This is used to receive and display large sample sizes (up to approx. $n = 120$). Many small individual samples can be combined with it to obtain overall distribution. Machine-capability and preliminary studies can thus be simulated.

2. "Random sampling module"

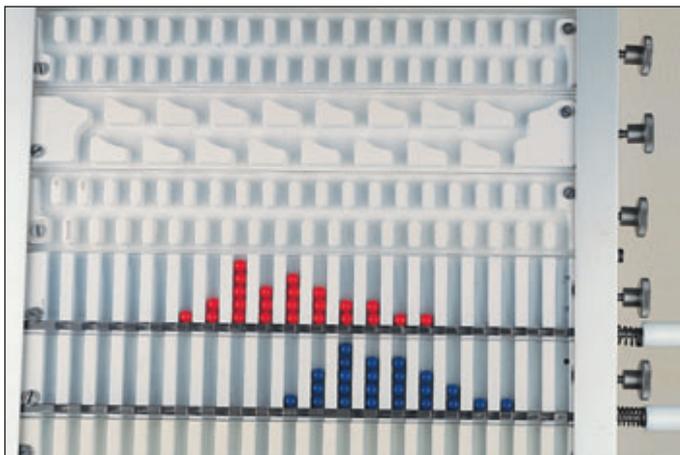
This is used to receive and display random samples up to approx. $n = 20$. Two such modules are supplied, thus always allowing the comparison of two random samples, before they are added to the overall distribution by opening the blocking slides. It also enables the centralised module to be extended, if the blocking slides of the random sampling module are opened.

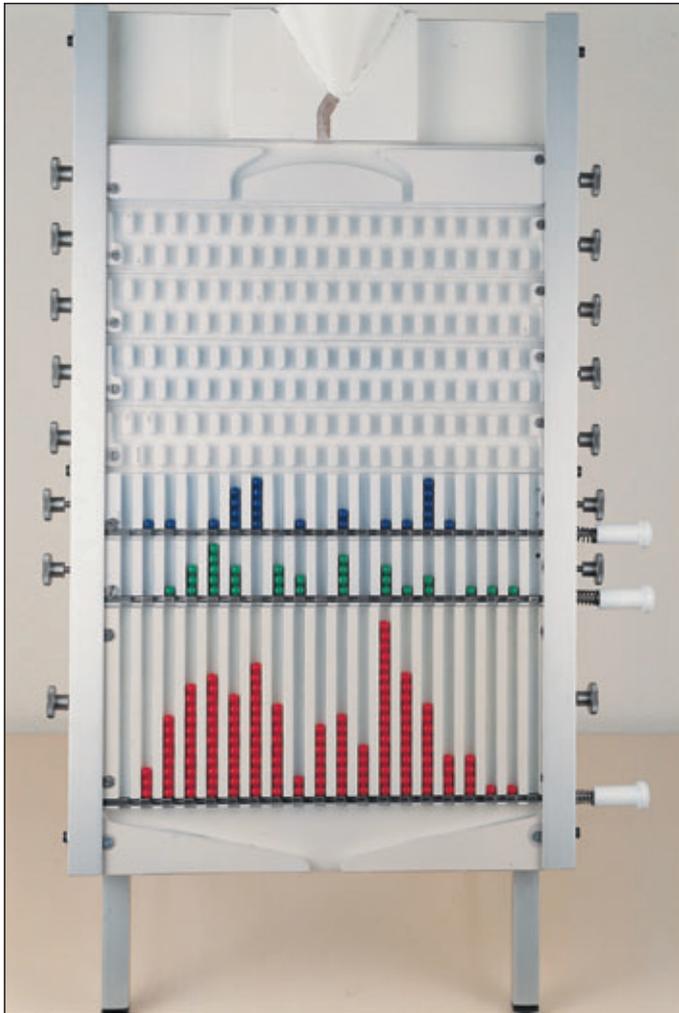
3. "Normal distribution module"

Two rows of oval lugs are located on this component which distribute the arriving balls using the random sampling principle. So that the balls always impinge on the next series of lugs perpendicularly, they are made to continue rolling perpendicularly after each distribution in an oblong hole. 5 standard distribution modules are supplied. Depending on the quantity of these modules, each of which simulates two random events, the scatter can be varied.

4. "Asymmetrical distribution module"

The arriving balls are distributed at different distances to the left or right on two series of lugs. Different asymmetrical distributions can be simulated by combination with several standard distribution modules. ▶▶





5. "Coarse distribution module"

The arriving balls are distributed to the far left and right on a greatly enlarged distribution lug. In combination with some standard distribution modules, typical arbitrary distribution occurs for processes with parameters having a wide scatter. The deviation probabilities can be varied to the left or right by fine horizontal adjustment.

The horizontal positions of all modules can be finely adjusted and set by means of adjusting screws on the side guides.

Scope of supply:

1. Baseplate with side guides, ball outlet and folding stands
2. One central module with blocking slide
3. Two random sampling modules with blocking slides
4. Five standard distribution modules
6. One asymmetric distribution module
7. One coarse distribution module
8. 300 red balls
9. 50 balls each colour: green, blue, yellow and black
10. Collection and storage box for the balls

Order no. 1074



Random sample simulator

The AQL system according to DIN 40 080 can be simulated using the random sample simulator.

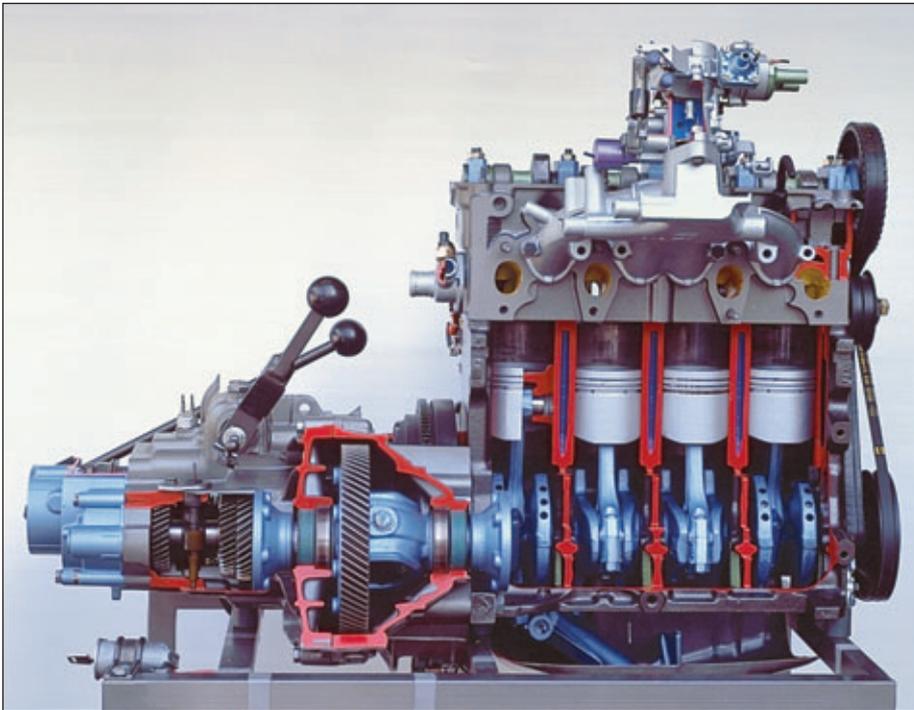
In a total population of $n = 1000$ balls, 0.5%, 1%, 2%, 5%, 10% and 20% of the balls are of different colours.

This symbolizes the quantity of "bad" parts. Only the appropriate colour is considered and evaluated, depending on the AQL value assumed.

A random sample of $n = 100$ can be taken and evaluated by simply tilting the simulator.

The balls roll in ten channels. The random sample is thus shown clearly and the evaluation is simplified. Smaller random samples can also be simulated by evaluating only one part of the channel.

Order no. 1075

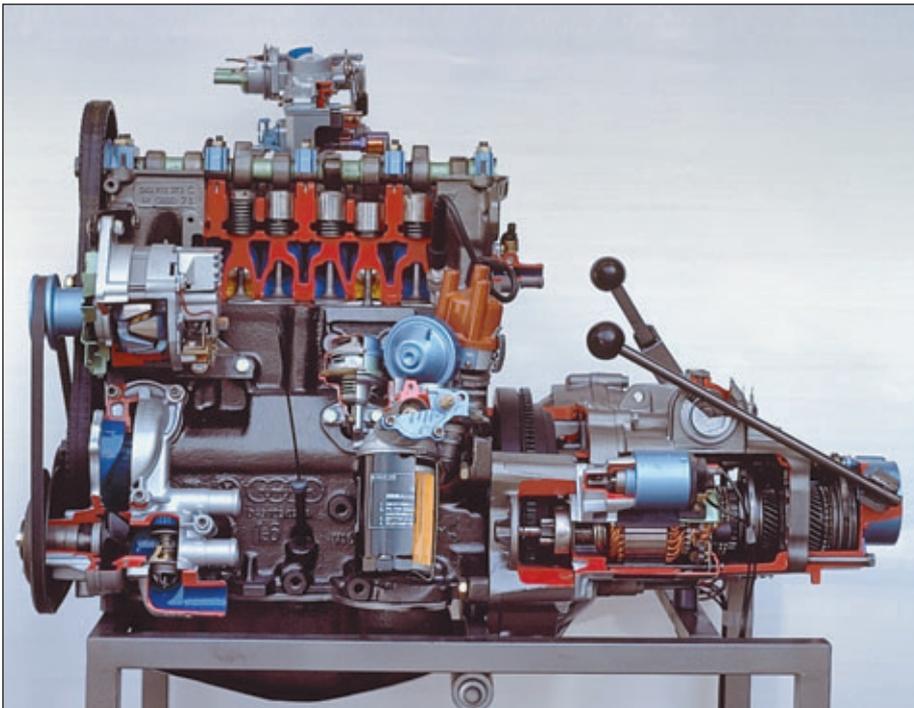


Engine of a VW Golf with transmission

The cutaway, an original engine of a VW Golf with clutch and transmission, is fixed on a mobile rack. The engine with all units is driven slowly by means of an electric motor and a battery.

Parts cut in this model:

- the four cylinders
- one piston
- four valves with bucket tappets and valve gear
- ignition distributor
- generator
- fuel pump
- carburetor
- oil pump
- clutch
- transmission and differential gear
- water pump with thermostat
- starter

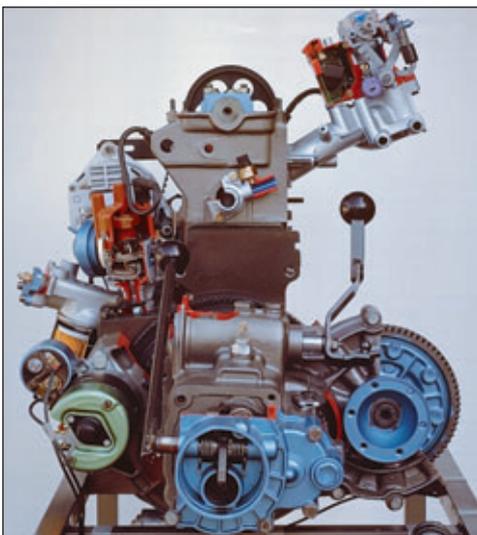


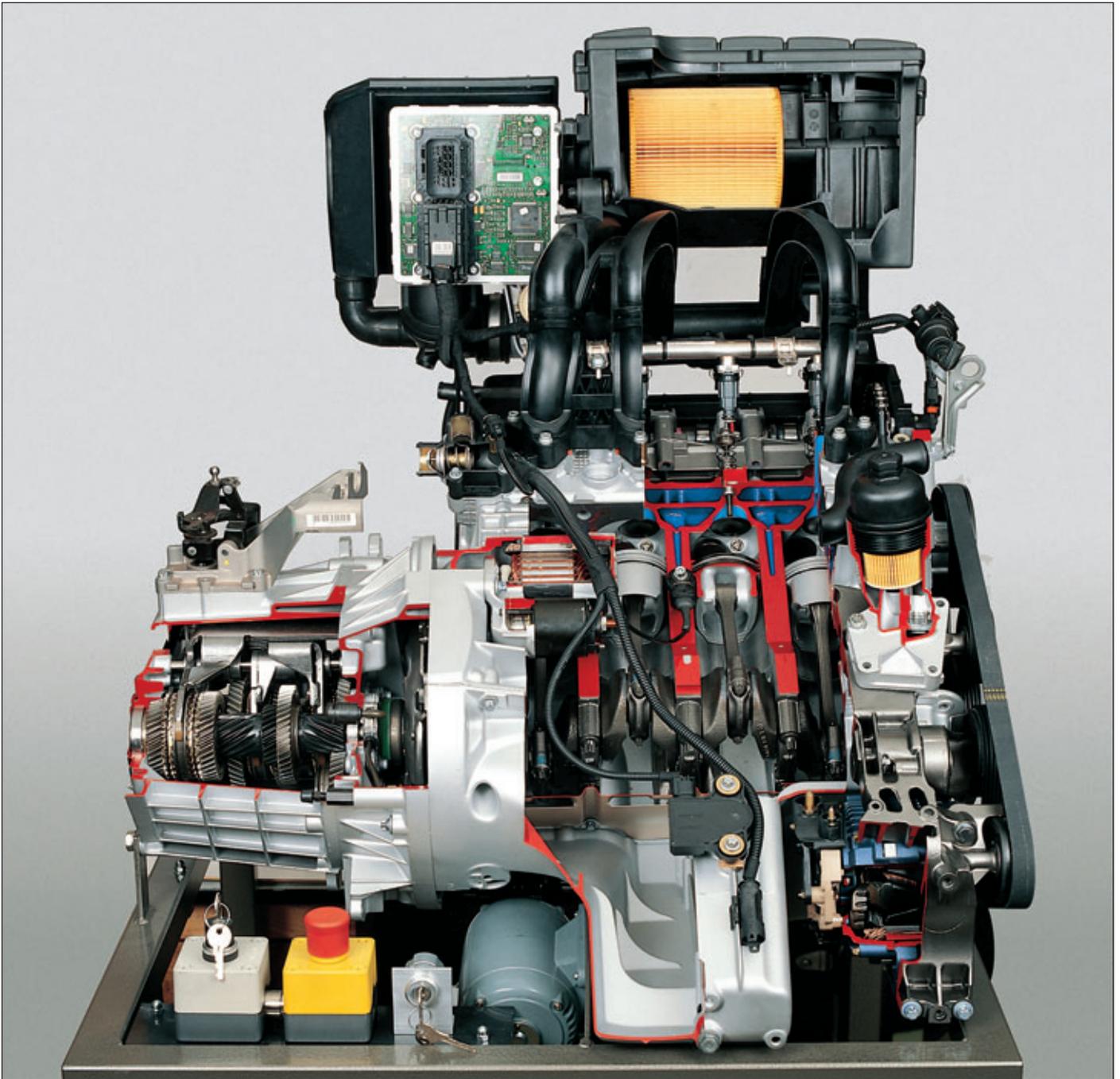
Functions:

- the transmission can be shifted into any gear
- the starter can be engaged and disengaged by means of an ignition lock
- the clutch can be actuated
- by stopping one drive shaft, it can be shown how the differential works

This model can easily be moved into the classroom. It can be used for many teaching units and thus can replace many single models.

Order no. 1001





Mercedes-Benz A Class petrol engine with injection

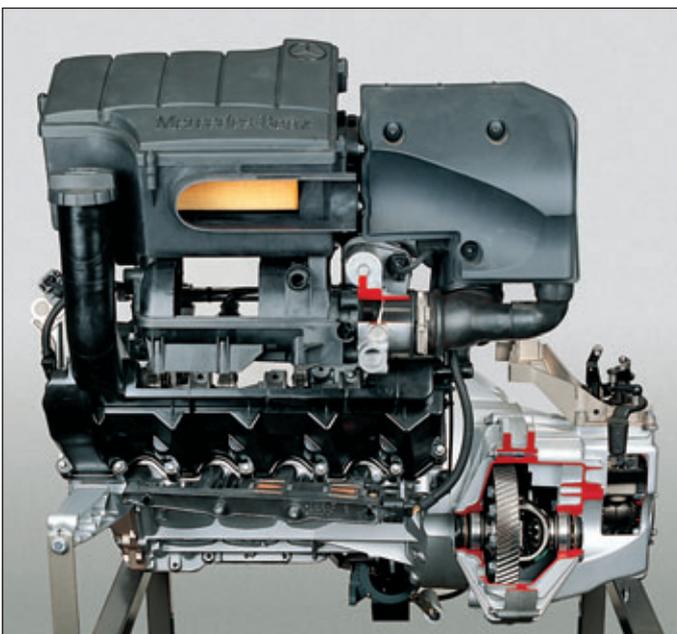
New construction with the latest technique.

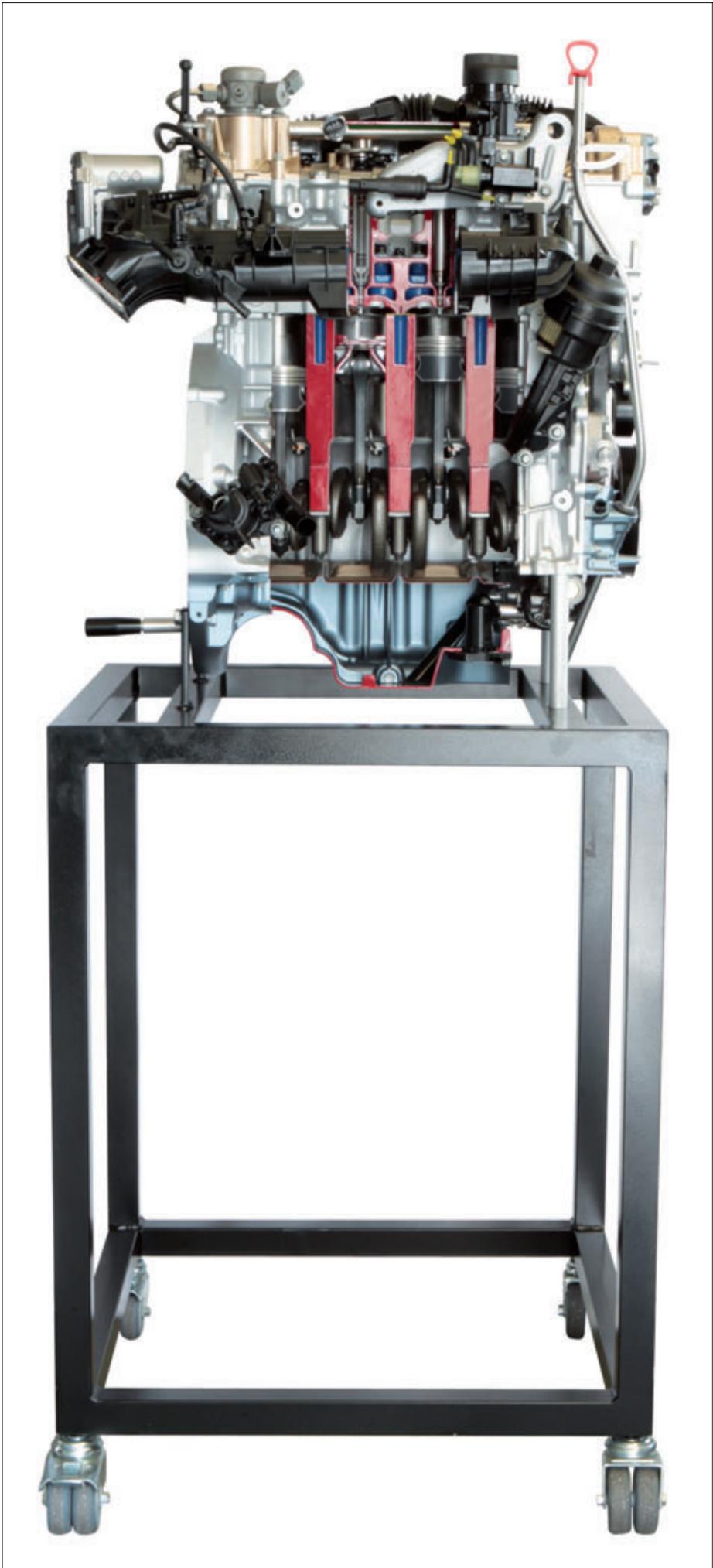
The engine is driven by a 220V geared motor, all the assemblies also run.

The start can be engaged, the transmission shifted.

The following are cutaway: cylinder head, cylinder block, crankcase, oil pan, one piston, roller valve lever with clearance compensation element, oil pump, chain case, generator (internally ventilated), starter, intake manifold, air filter box, double ignition coil, electronic control unit, actuator, throttle valve, valve cover, oil filter, thermostat, air-mass sensor, 5-gear transmission and differential. All actors and sensors are available and connected to the cable tree.

Order no. 1249





**Petrol direct injection engine
M 270 Mercedes-Benz**

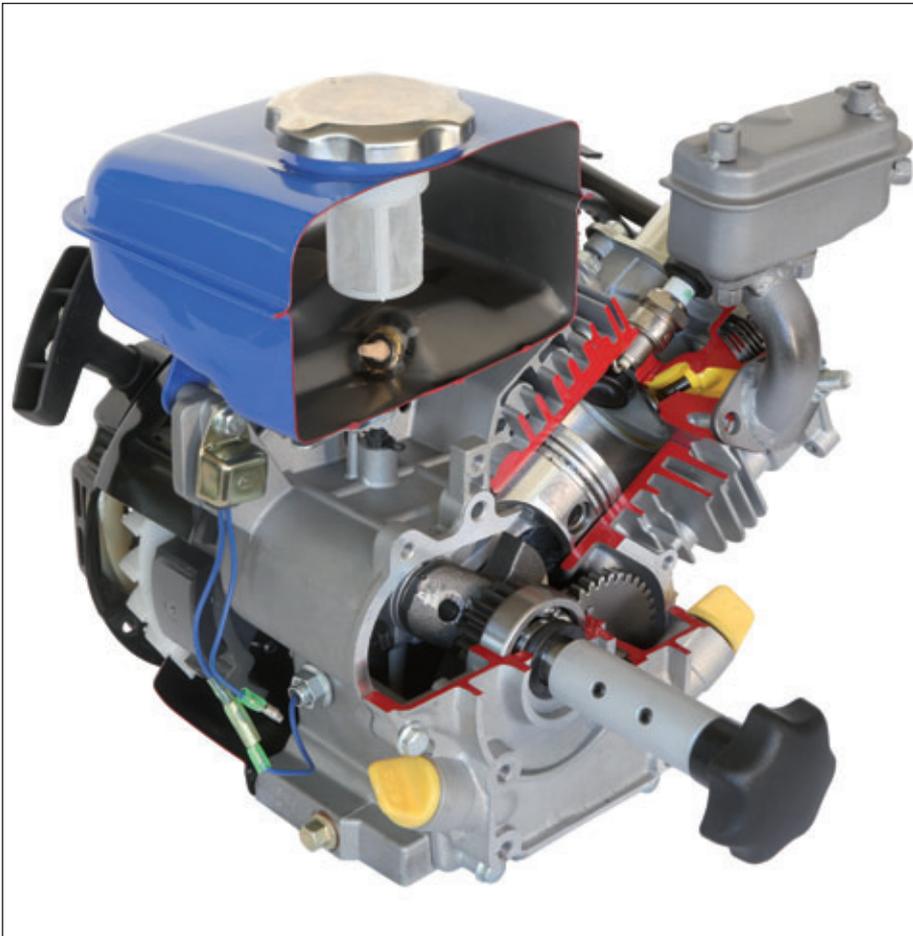
The engine can be turned easily by a crank handle.
All parts move along.

Cutaway are:

- cylinder and cylinder head
- turbo charger
- water pump
- valve cup
- camshaft timing chain housing
- vacuum pump
- fuel injection pump
- ignition coil
- rail tube
- injection nozzle
- air intake manifold
- hydraulic valve lifter
- oil pump

Order no. 1343





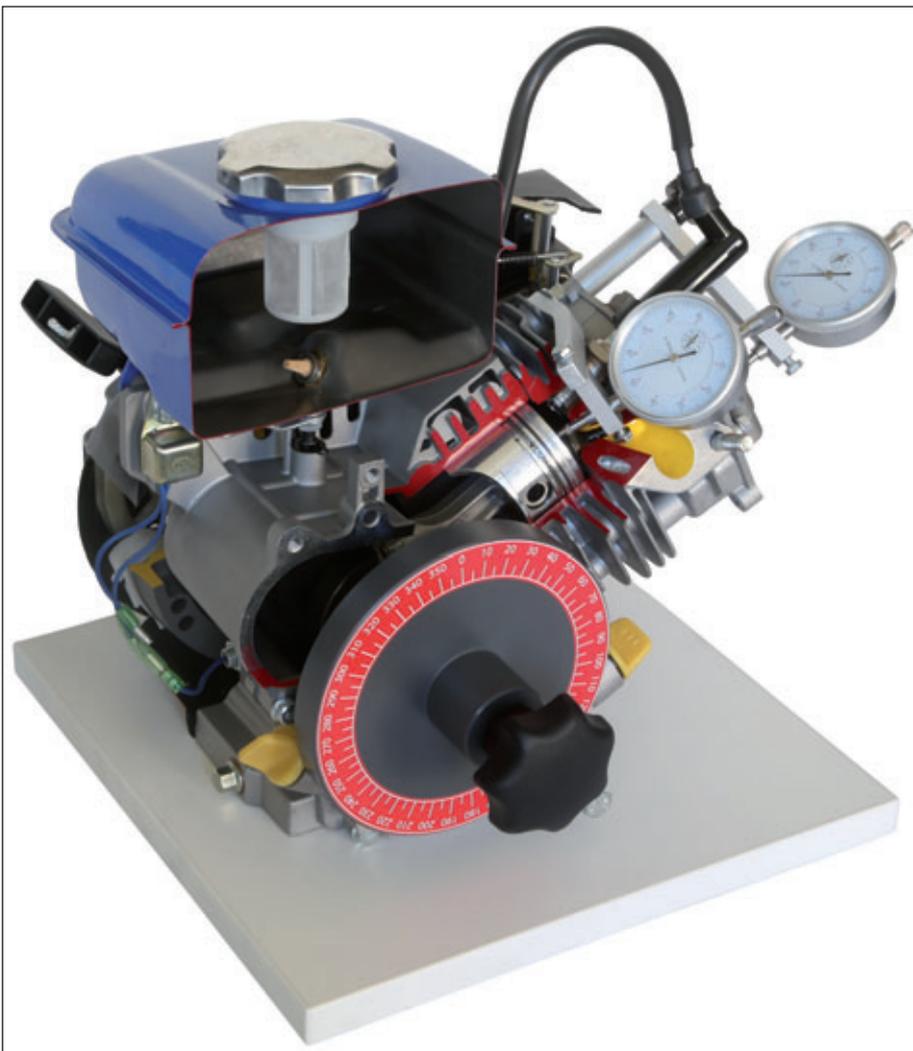
Side-valve four-stroke engine

This is a unit engine with the camshaft positioned at the bottom.

Functions:

- turn the star handle (crankshaft), the piston moves up and down
- the camshaft at the bottom is driven and opens the valves
- intake, compression, working and ejection
- function of the magnetic ignition
- starting of the engine via manual starter
- function of air filter, carburettor (with floater and throttle valve), exhaust silencer, fuel tank, fuel tap, oil tank, crankcase ventilation
- on the camshaft, there is a centrifugal advance device, which turns the throttle valve in the carburettor via a linkage, in order to regulate the speed

Order no. 1318



Side-valve 4-stroke engine with timing wheel

Cutaway are: crankcase, cylinder, cylinder head, tank, air filter, valve timing, carburettor and ignition.

The dial gauges can be used to set the upper dead centre exactly on the timing wheel, and thus determine all other piston positions and measuring valve lift as well. The engine can be turned easily.

Order no. 1329



Cylinder head four-valve engine

Roof-shaped combustion chamber with four-valve system.
 Function of the valve actuation with bucket tappets.
 Fine springs ensure easy actuation of the valves.
 Distribution of the intake and exhaust ports.
 Function of the cut-away bucket tappets.
 Order no. 1186



Cylinder head four-valve mechanism

Roof-shaped combustion chamber with four-valve mechanism. Distribution of the ducts for discharge and intake valves. By turning the camshaft the opening and closing of the valves can be demonstrated.
 Order no. 1230



Cylinder head with 3 valves

2 inlet valves with separate intake ports, one exhaust valve.
 Actuation of the valves (fine springs ensure easy actuation of the valves).
 Roof-shaped combustion chamber with lateral spark plugs.
 Order no. 1200



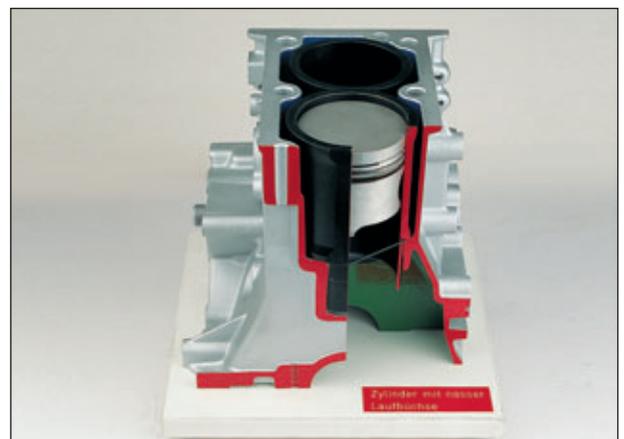
Mercedes-Benz A-Class cylinder head

A modern cylinder head with overhead camshaft. By turning the camshaft the opening and closing of the valves can be demonstrated.
 Function of the cam lever with cam followers and integrated hydraulic clearance-compensation elements.
 Order no. 1231



Cylinder and cylinder head with tappet control

Valve drive via push rods and rocker arm (VW Beetle) in comparison with modern engines with top-positioned camshafts.
 The following can be seen: cylinder, cylinder head, piston, rocker arm, valves, push rods and tappet tubes.
 Order no. 1269



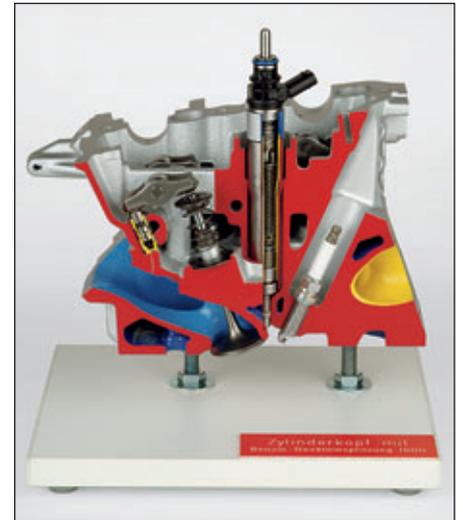
Cylinder block with wet liners

The cylinder block is cut open so that the wet cylinder liners are clearly visible.
 Cooling ducts (painted dark blue) and cylinder liner seals are easily recognised.
 Order no. 1178



Audi cylinder head with 5 valves

- recognition of the arrangement of the five-valve technique
 - operation of the valves by use of weaker springs
 - recognition of the channels by varying colours
- Order no. 1287



Cylinder head with direct petrol injection (GDI)

This is a Mercedes cylinder head with 4 valves. One valve had to be cutaway in order to show the injection valve and the spark plug.

The following can be shown:

- function of the 3 remaining valves
- function of the hydraulic valve tappet
- function of inlet and outlet channels
- function of the cutaway GDI injector with
 - Teflon ring (bottom, on the nozzle body), nozzle module, piezo-actor module, coupler module, fuel intake (high pressure), O-ring (leakage line) and electrical connection

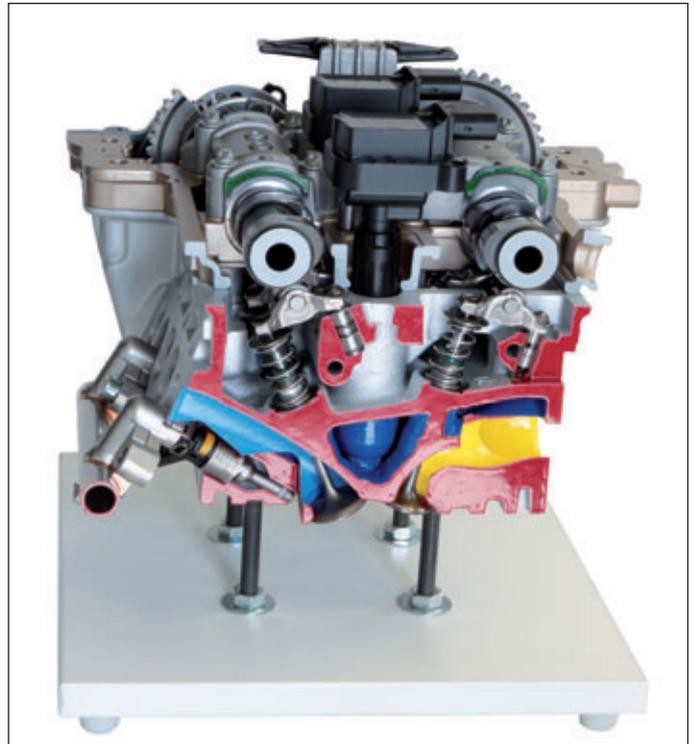
Order no. 1319



Audi cylinder head with 5 valves and camshaft adjustment

- recognition of the arrangement of the five-valve technique
- operation of the valves by use of weaker springs
- recognition of the channels by varying colours
- Porsche camshaft adjustment can be operated

Order no. 1288



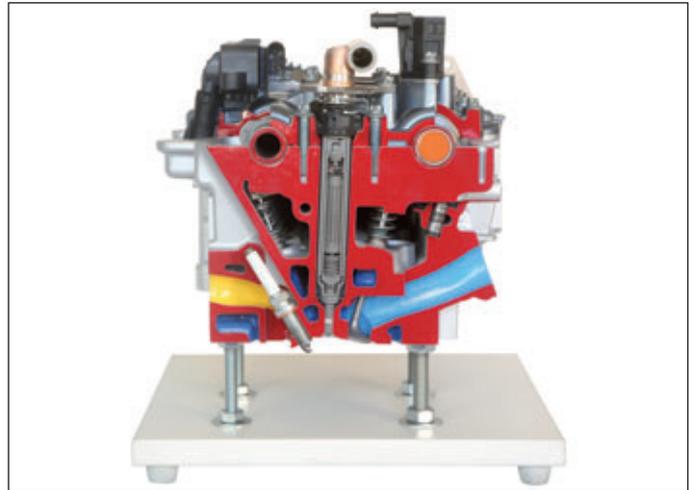
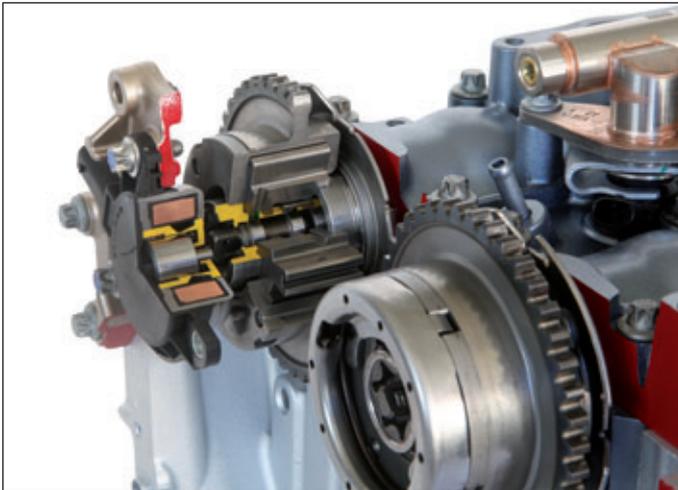
Cylinder head of a petrol direct injection engine M 271 Evo Mercedes-Benz

Both camshafts can be turned easily. The vane-type camshaft adjuster can be actuated.

The following are easy to recognize:

- inlet and outlet valves
- fuel injection pump
- rail tube
- ignition coil
- ignition plug
- vane-type camshaft adjuster
- camshafts
- solenoid coil
- hydraulic piston
- hydraulic valve lifter
- oil channels

Order no. 1344



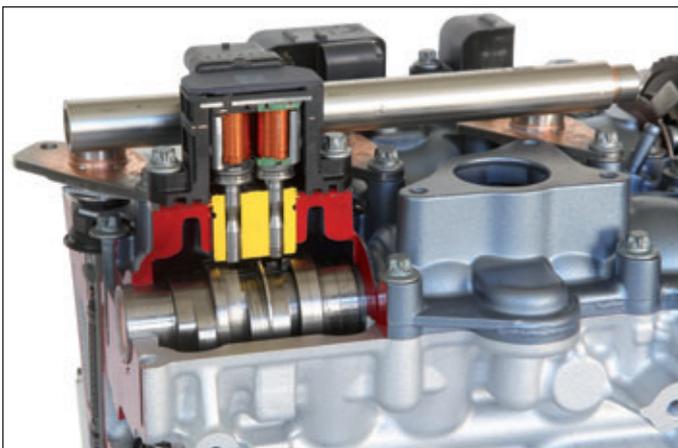
Mercedes-Benz cylinder head M 270 with camtronic

The camshaft can be deferred by an electrically operated actuator for changing to a smaller or larger cam lift. That serves the fuel saving.

The following is visible:

- actuator and lift solenoids
- large and small cam
- intake and exhaust ports
- injection nozzle
- spark plug
- input and output valve
- camshaft and carrier shaft
- hydraulic valve lifter
- camshaft adjuster
- solenoid coil
- rail pipe
- ignition coil
- cooling channels

Order no. 1354

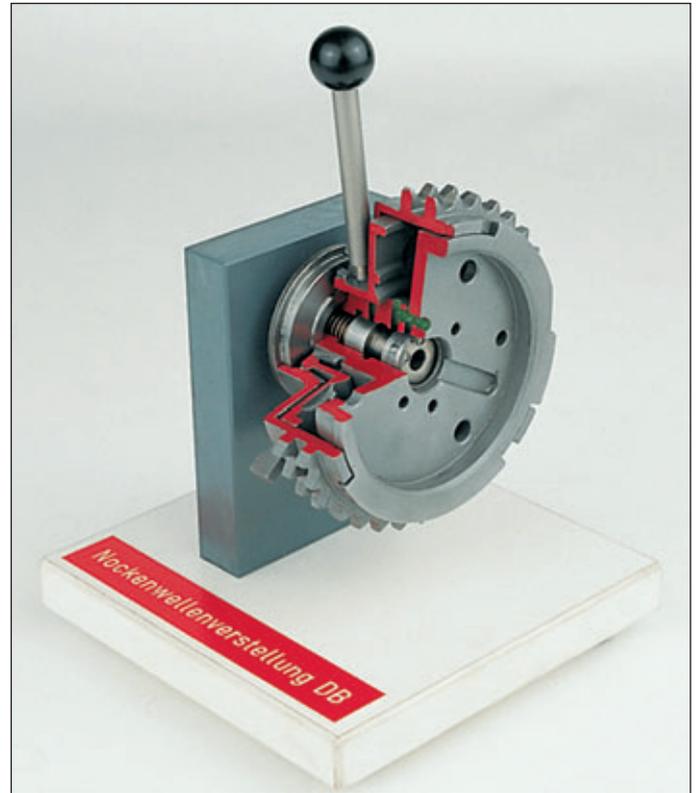




Vane-type camshaft adjuster

In an external rotor, an internal rotor is turned in a clockwise or anti-clockwise direction by oil pressure (early or late opening of the valves). The internal rotor is kept in its rest position by springs. The control channels in the shaft and in the rotor are easily recognisable. The solenoid coil for the control – early or late – has also been cutaway.

Order no. 1289



Mercedes-Benz camshaft adjustment

The adjustment piston is moved by means of a lever. The inbuilt coarse thread causes the camshaft to turn against the camshaft timing gear and the intake valve opens 20 to 30 degrees earlier. The change-over is effected by a control piston, which is actuated electromagnetically.

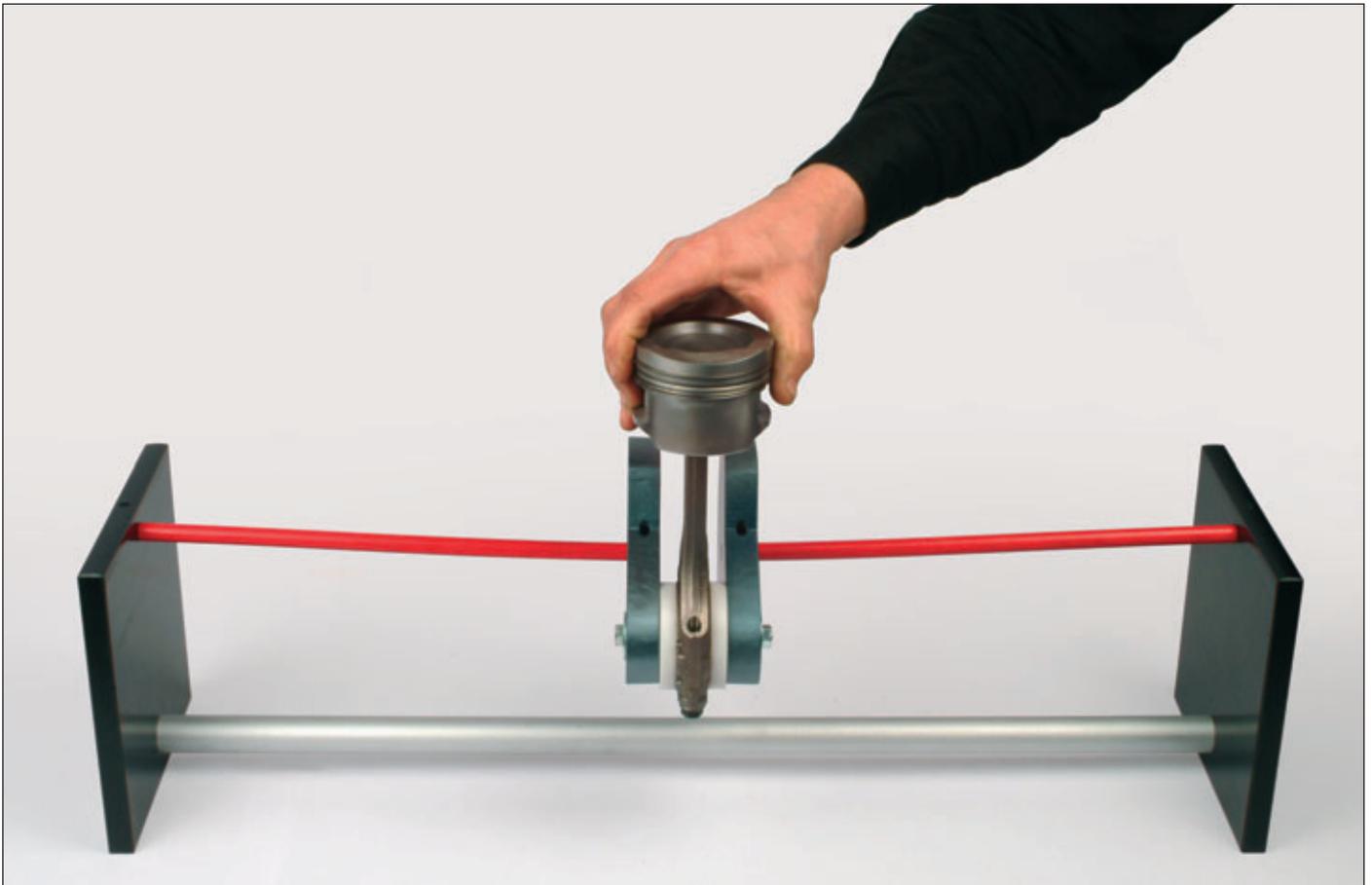
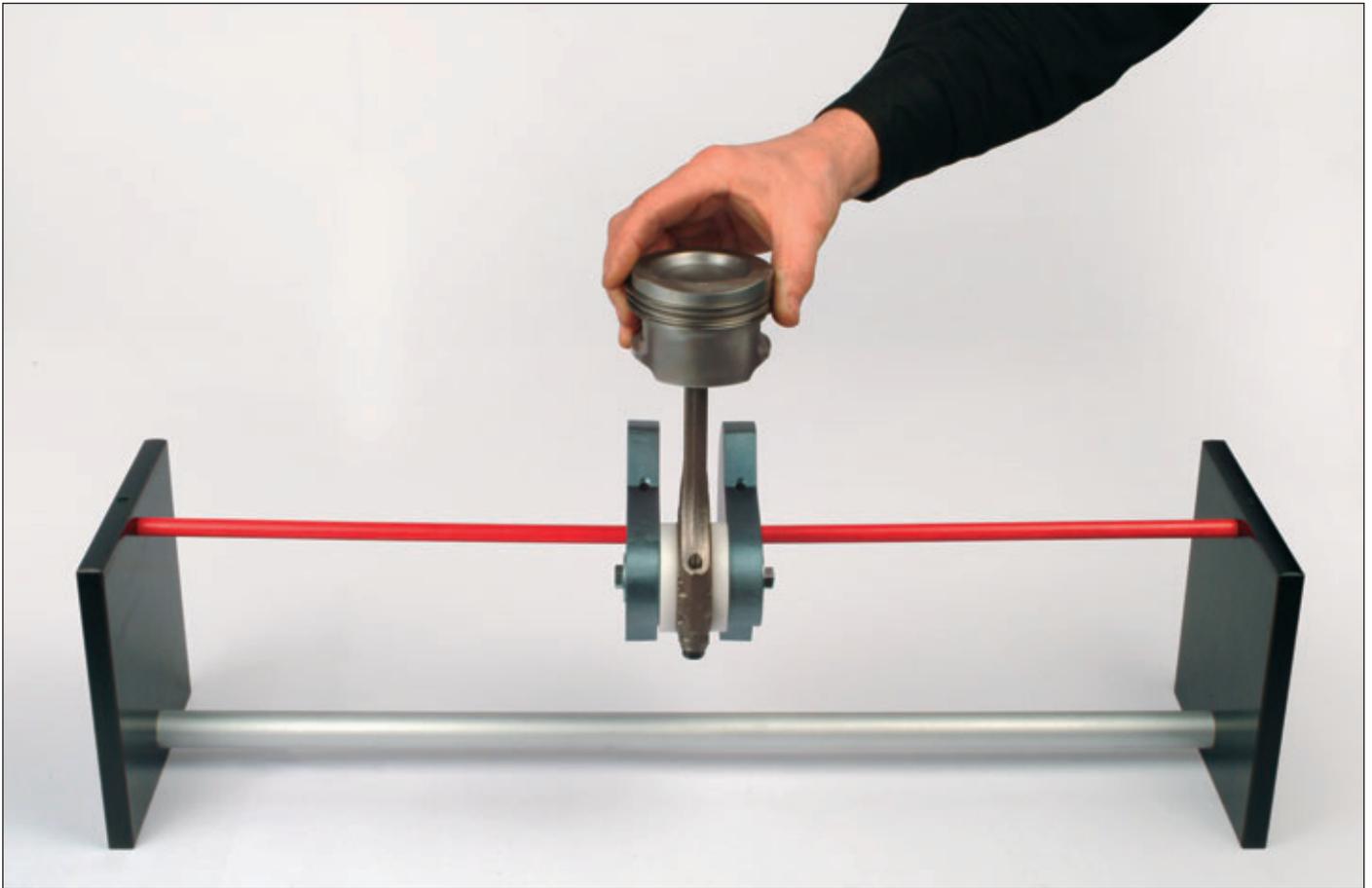
Order no. 1233



Camshaft adjustment Porsche

- drive of the outlet camshaft via a rotary button
- drive of the inlet camshaft via a control chain
- holding the outlet camshaft with the help of a set screw
- with the help of a push bar, the hydraulic piston can be displaced and the adjustment of the inlet camshaft read off directly on a scale.
- the function of the chain tensor is easily recognised.
- the hydraulic piston and the piston of the solenoid valve are cut away

Order no. 1281



Function model crankshaft

It is often difficult to make the special kinds of strain on a crankshaft understandable for the pupils.

The main kinds of strain, torsion and flexion can be demonstrated graphically on the model.

If you push the plunger down by hand (e.g. work cycle), you see the flexing and the distortion of the crankshaft quite clearly as a function of the force applied.

Order no. 1314



Model case Two-wheel technique

This model board enables a comparison of car engine components and two-wheel technique. The following components have been cutaway: Moped cylinder with piston, generator, starter, four-stroke single-track piston 1 segment of a complete cylinder head with 16 valves.

The following are also on the model board: ignition coil, camshaft, one-cylinder engine, camshaft four-cylinder with 16 valves, crankshaft with connection bar and rolling bearing, camshaft with clearance compensation, connecting bar and rocker arm.

Order no. 1254



Model case Clutches

Hydraulic clutch control mechanism. A pressure plate with coil springs and release levers. A complete diaphragm spring clutch with flywheel. Two flexible clutch disks with torsional-vibration damping. Linings: synthetic fibres and sintered metal. A clutch disk prepared for the demonstration of the torsional-vibration damping. Clutch release bearing and release lever.

Order no. 1226



Model case Pistons

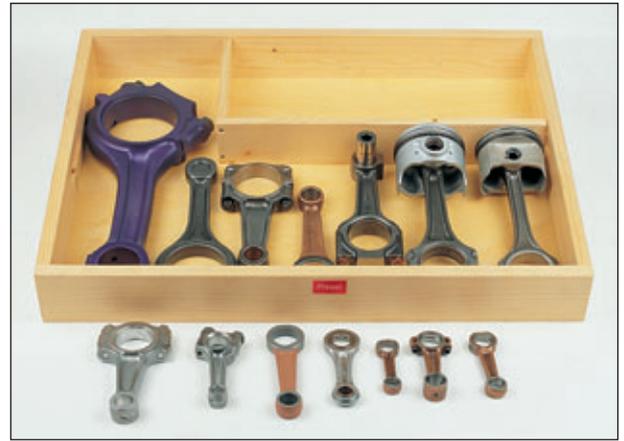
Modern pistons, cut open in parts.

Various pistons, including:

AT piston, autothermic piston, full-skirt piston, duo-therm piston, ring-carrier piston, piston for two-stroke engines, ring locks, piston pins, piston rings.

Assembled piston with connecting rod and piston rings.

Order no. 1187



Model case Connecting rods

2 connecting rods with pistons and piston pins.

Divided and undivided connecting rods.

Steel and aluminium connecting rods

Connecting rods with straight and offset divided big end

Connecting rods with smooth, toothed, pinned and broken big end

Order no. 1232



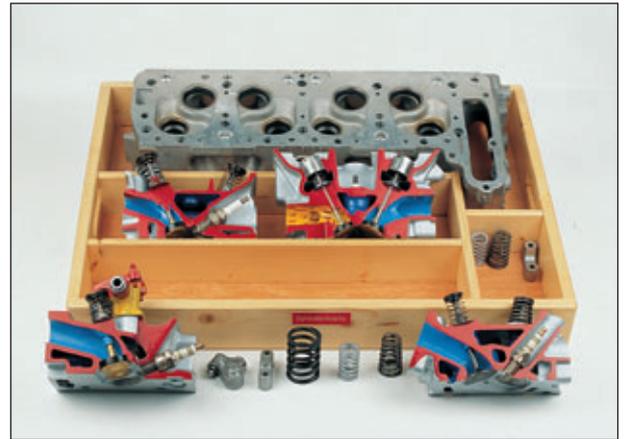
Model case Crankshafts

– crankshaft of a four, five and six-cylinder engine

– crankshaft of an opposed-cylinder engine and a half-crankshaft of a Class A engine (Mercedes-Benz) with cut-away oil duct

The crankshafts can all be mounted on the steel stands and turned for demonstration purposes.

Order no. 1205



Model case Cylinder heads

– cutaway model of a cylinder head with 2 valves in sequence with 2 rocker arms.

– cutaway model of a cylinder head with 2 valves (transverse arrangement)

– cutaway model of a cylinder head with 3 and 4 valves

– whole cylinder head without valves

– camshaft bearing and various valve springs

Order no. 1214



Model case Camshafts

Built-up, forged and cast camshafts.

Camshafts for 4-, 5-, 6-cylinder engines.

Camshafts for four-valve engines.

Camshafts for flat engines.

Cut-away cams.

Various camshaft bearings.

Order no. 1188



Model case Cooling system

All the components of a modern water cooling system:

– 2 viscous-drive fans, functional and cut away

– electric fan with electric motor and ventilator

– water pump, cut away, with thermostat

– expansion-element thermostat and thermostatic switch, cut away

– oil cooler, one each of tubular radiator and finned radiator

– radiator cap with pressure relief valve and vacuum valve

Order no. 1204



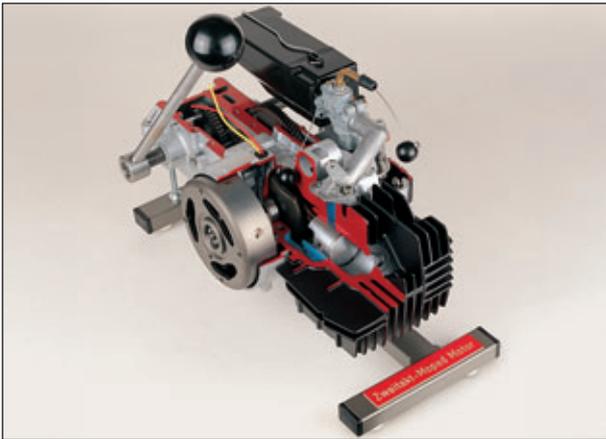
Model Case Valves

- valve manufacture, from blank stage to finished part
 - different types of valves
 - special valves (sodium-filled and hard-faced valves)
 - valve accessories
- Order no. 1124



Model case Valve timing

- Camshaft timing by means of:
 - Spur gears, simple and double chains, toothed belt
 - Hydraulic chain tensioner with tensioner blade
 - Camshaft, shaft with 4 rocker arms,
 - Follower and valve lever, (one with clearance compensation)
 - Hydraulic tappet, cut away
 - Tappet, guide tubes and camshaft mounting
- Order no. 1206



Two-stroke moped engine

- The following have been cutaway: cylinder head, cylinder, crankcase, carburettor, transmission and air filter
- Carburettor and clutch can be operated



- With the help of the starting lever, the crankshaft with the connecting rod and the piston can be put into motion with the clutch pulled.
- Order no. 1253



Visco blower

- function of the working chamber and oil reservoir
 - function of the driving disc
 - function of the bimetallic spring
- Order no. 1128



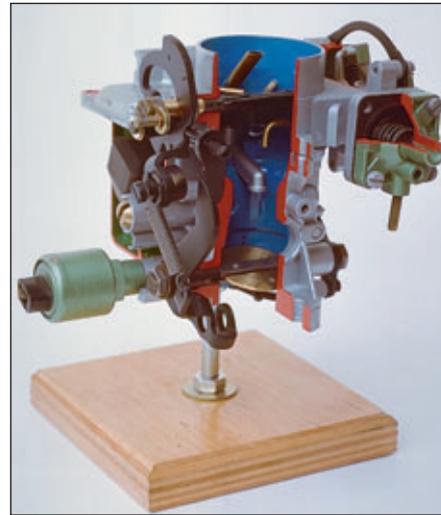
Balancing model for crankshafts

- by putting on, taking off or changing the position of different counterweights, a static or dynamic unbalance of crankshafts can be shown
 - proper selection and positioning of the weights cause a true running
- Order no. 1010

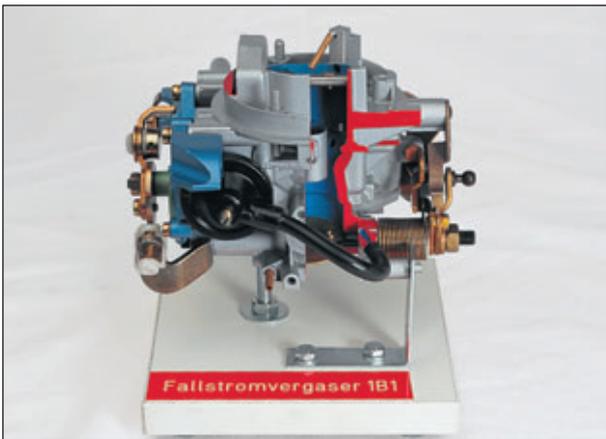


Downdraft carburetor

Parts cut in this model: mixing chamber, float chamber, float-needle valve, idle-speed channel, accelerator pump, pull-down and automatic choke.

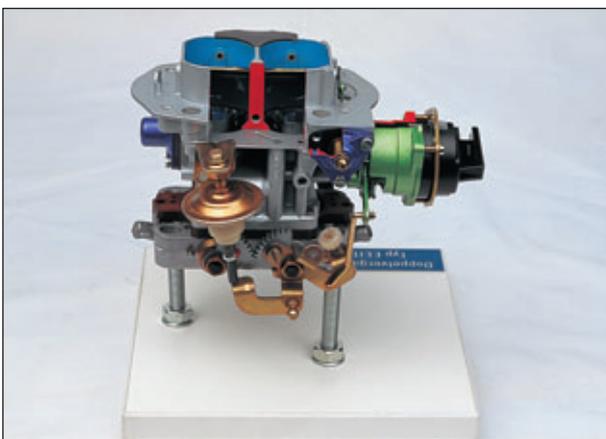
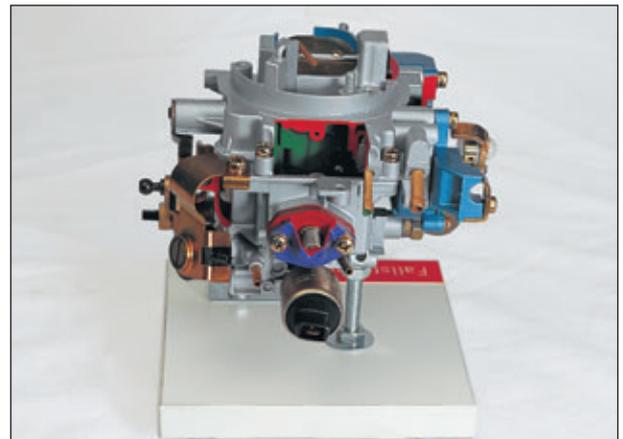


All parts can be easily moved.
Order no. 1006



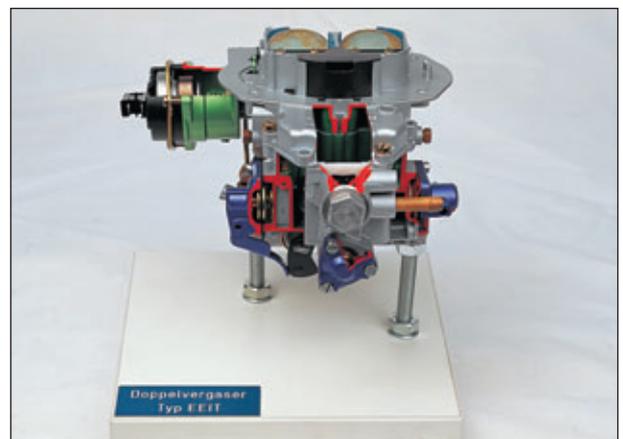
Downdraught carburetor 1B1

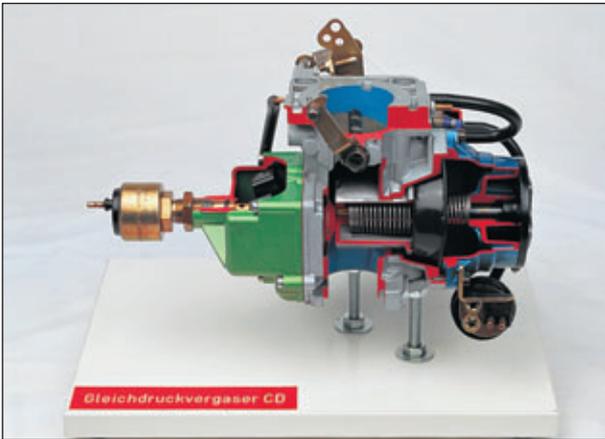
Possible demonstrations:
Function of throttle butterfly, choke butterfly, float with valve needle, automatic choke, pulldown device, accelerator pump, idle mixture cutoff valve, idle-speed and idle-mixture adjusting screw.
Order no. 1027



Twin-choke downdraught carburetor

Possible demonstrations:
– throttle butterflies open simultaneously
– function of choke butterflies, throttle butterflies, float with valve needle, pulldown device, accelerator pump and idle-speed stop
Order no. 1029



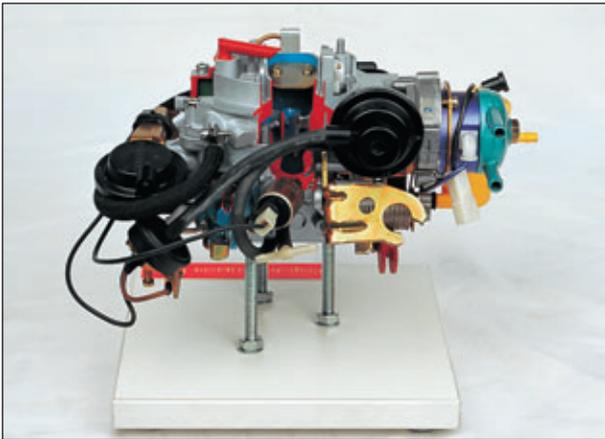
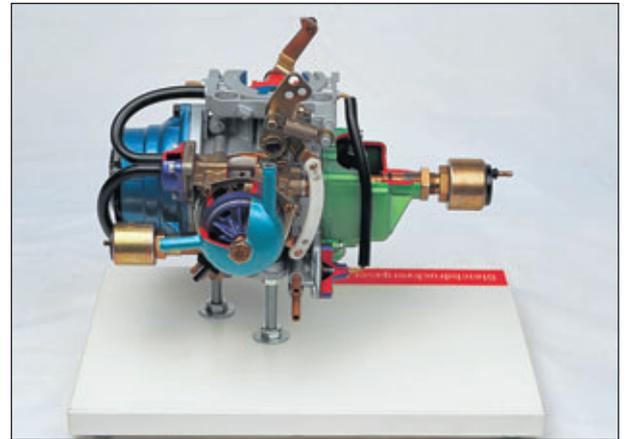


Constant vacuum carburetor

Possible demonstrations:

- function of vacuum piston with jet needle
- functions of damper piston, throttle butterfly, float with valve needle, fuel adjusting screw and idle-mixture cutoff valve
- particular characteristics of the variable airflow cross-section

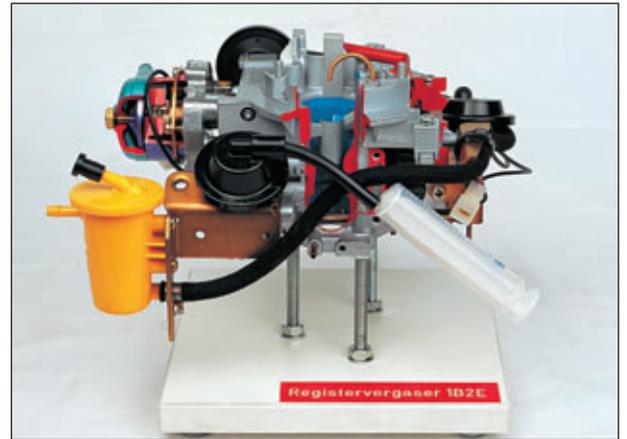
Order no. 1032



Two-stage carburetor

Possible demonstrations:

- stage 1 throttle butterfly is actuated mechanically
- stage 2 throttle butterfly is closed as long as stage 1 is not completely opened
- stage 2 is opened pneumatically by a vacuum control system (simulated by a syringe model)



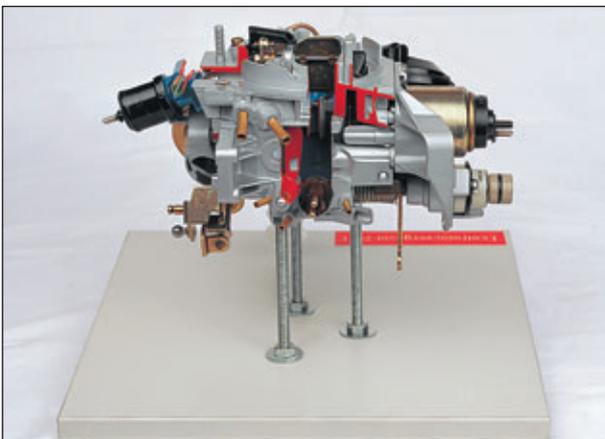
- function of float, float needle valve, automatic choke, accelerator pump and choke-butterfly

Order no. 1028

Two-stage twin-choke downdraught carburetor

(without picture)

Order no. 1025



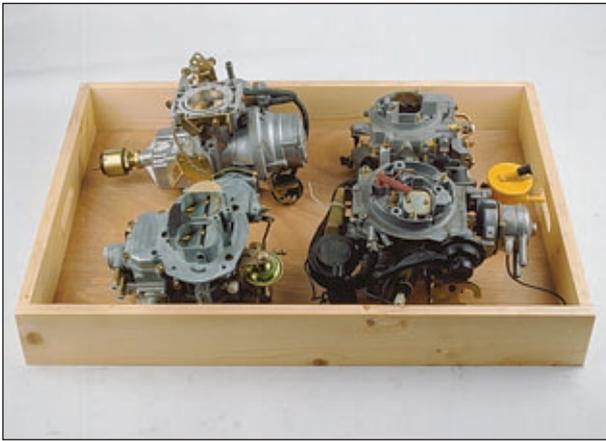
Ecotronic system (Carburetor)

Function of:

- choke valve regulator, solenoid valves, potentiometer, corrector needle, throttle valve regulator, float, float needle valve, throttle valve and idle-mixture adjusting screw

Order no. 1033





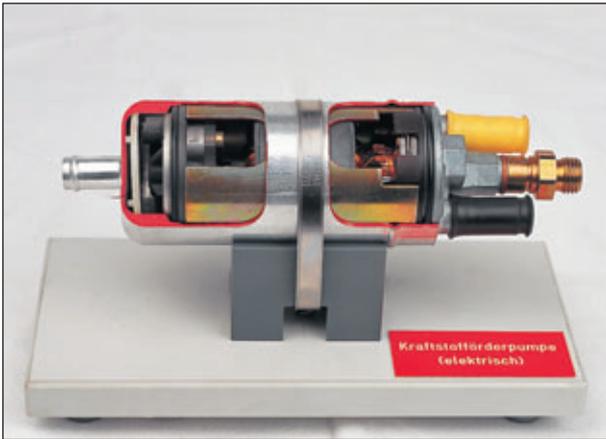
Carburettor test

4 similar or different carburetors prepared for dismantling and assembly (single downdraft carburettor, dual-barrel carburettor, register carburettor, Stromberg carburettor).
Board-mounted tuition unit.
Order no. 1099



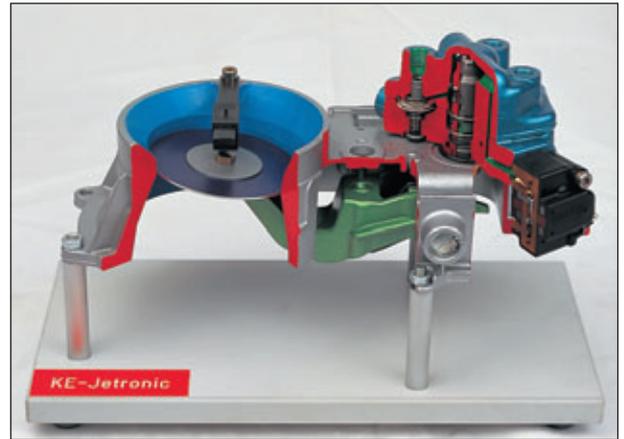
Mechanical fuel pump

Function of diaphragm, pushrod and valves
Suction and pressure stroke
Variable delivery
Order no. 1084



Electric fuel pump

Possible demonstrations:
– the pump runs when connected to a 12V-battery
– the pump can be taken apart
– the roller-cell pump has a Plexiglass cover so that all parts are visible
Order no. 1017



Mixture control unit of KE-Jetronic

Possible demonstrations:
– shifting of air-flow sensor plate
– displacement of control plunger
– function of differential pressure valves, idle-speed control device and idle-mixture adjusting screw
Order no. 1021



Monojetronic

Function of speed regulator, central injection valve, throttle blade, throttle-blade actuator with control motor and potentiometer.
Order no. 1022





High-pressure pump for engines with direct petrol injection (GDI)

The necessary high pressure is generated by a 3-plunger radial-piston pump with the following features:

compact construction, stainless steel housing with integrated quantity control valve, shut-off attenuator, fuel-lubricated, max. fuel pressure of 200 bar.

The knurled screw can be used to drive the high-pressure pump and one sees how the pump pistons work.

The eccentric shaft is guided on the drive side by a roller bearing and opposite by a plastic friction bearing (fuel-lubricated).

Also cutaway: fuel return with shut-off attenuator, quantity control valve with magnetic coil and filter.

Order no. 1321



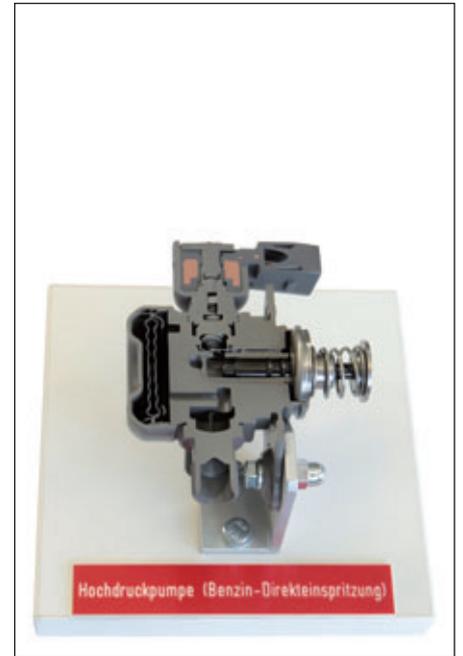
Injector for engines with direct petrol injection (GDI)

The benefit of these injectors is that they switch extremely quickly and thus inject minimum quantities of fuel, which makes multiple injection (3) possible. As all the parts of the injector are multiple laser-welded, it is not possible to cutaway these parts any further.

The following can be seen:

- cutaway injector housing and interior housing
- teflon ring for sealing in the cylinder head
- nozzle module
- coupler module
- fuel flow (high pressure)
- o-ring to seal the leakage line
- electrical connections for voltage supply to the piezo-actor module.

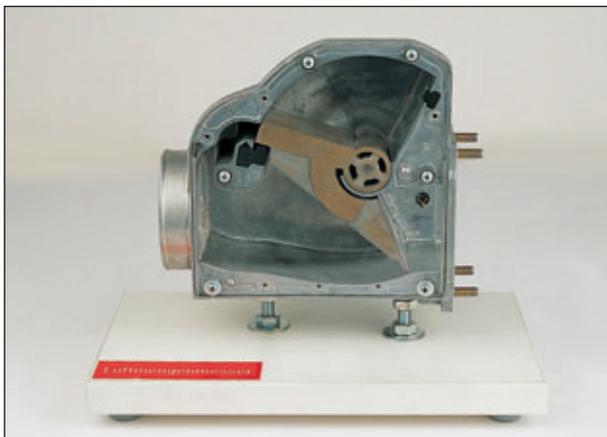
Order no. 1320



High-pressure pump (petrol direct injection)

This is the high-pressure petrol pump from Bosch, which can be used for fuel pressures of more than 200 bar. Tappet and solenoid can clearly be seen. The tappet can be moved.

Order no. 1337

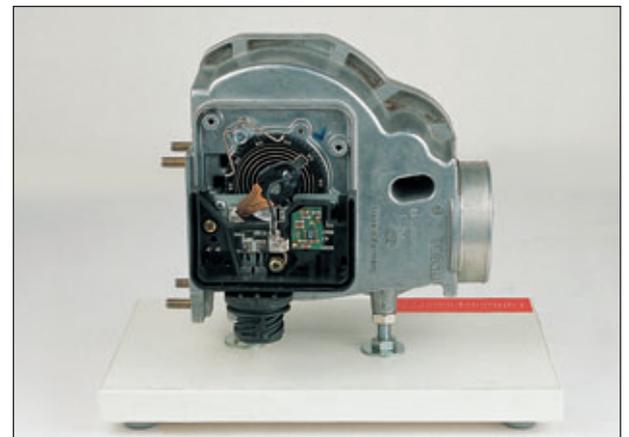


Air-flow sensor

The air-flow sensor flap and compensation flap are clearly visible behind the Plexiglas housing and can be moved back and forth.

Can be seen from behind the potentiometer and the IC.

Order no. 1183





Hot film air-mass sensor

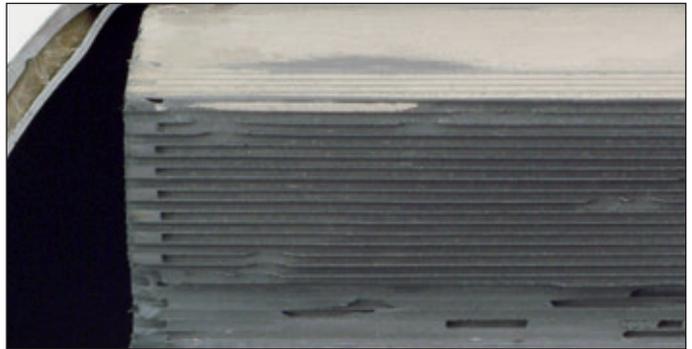
The ceramic layer with sensor element (film resistance) can be seen in the cut-away plastic housing.
Order no. 1184



Diesel particulate filter (soot filter)

The particulate filter comprises a beehive-shaped ceramic body (silicon carbide). It is sub-divided into a number of small channels arranged in parallel, which have been positioned alternately.

The exhaust gas contains the following gases: carbon monoxide, carbon dioxide, nitrogen oxides, hydrocarbons, sulphur dioxide, as well as soot particles and an additive. The additive, which is mixed into the fuel in fine traces, lowers the ignition temperature of the carbon from 650 to 500 degrees.



Demonstration:

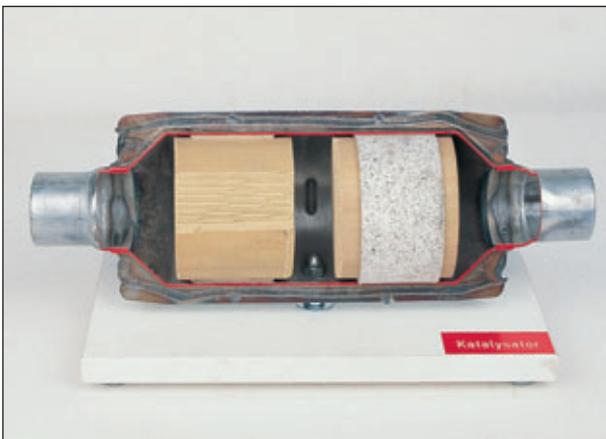
- The ceramic body, surrounded by fibre materials and steel wool, is in the metal housing
- On the cutaway part and also on the front and face surfaces, one recognises the alternately closed and opened channels
- Gas particles can escape through the pores of the side walls into the adjacent tubes, whereas soot and additive, as a result of their size, remain in the middle tube
- Gas particles can escape to the back into the exhaust pipe
- After about 500 to 700 kilometres of driving, there is regeneration (the soot is burnt off). With the help of pressure sensors in front of and behind the filter and of the exhaust gas temperature, the time when regeneration is necessary is calculated. Now, the filter is empty again.

Order no. 1315



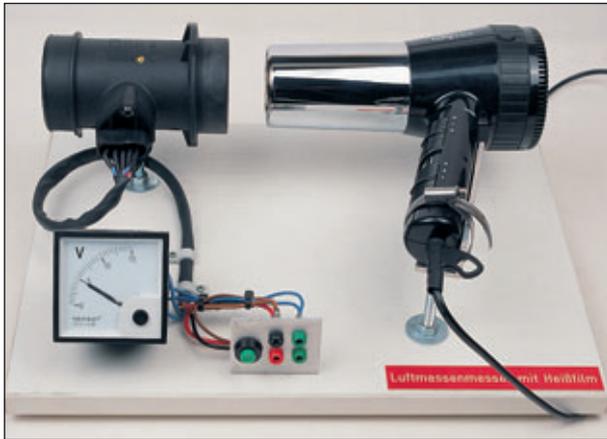
Air-flow sensor with platinum heating filament

Inside the cut-away plastic housing, the platinum heating filament, the precision resistor and the temperature compensation resistor can be seen in the inner tube.
The printed circuit board with its hybrid circuit can be seen at the back on the cut-away housing.
Order no. 1210



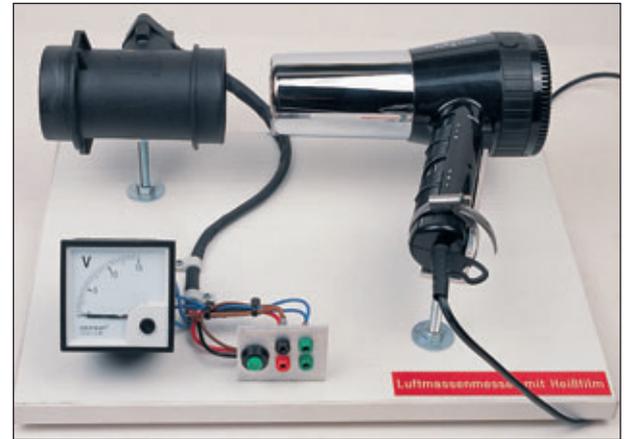
Catalytic converter

Metal housing of a new catalytic converter cut-open to show both ceramic casings. In addition, cut-open honeycomb showing the tubing inside the ceramic casing.
Order no. 1111



Air-mass sensor with hot film (with compensation of the suction tube vibrations)

With the help of a hair-dryer with 2 cold and 2 hot levels, the function of an air-mass sensor with hot film can be demonstrated. The output signals can be read off directly on the voltmeter. In addition, 2 jacks for the connection of an additional measuring device are provided. This hot film air-



mass sensor is part of the latest generation. It compensates the vibrations in the suction tube and only measures the air flowing in one direction. This can be demonstrated by turning the air-mass sensor 180 degrees, the device does not show any reaction. Order no. 1244

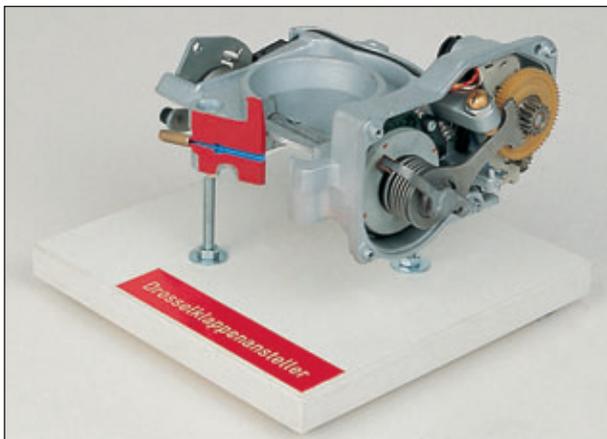


Functional model lambda probe (EGO sensor) with electric probe heating

Probe light-off time with and without electric heating. The enclosed gas burner allows for demonstration of the millivoltmeters and lambda control:

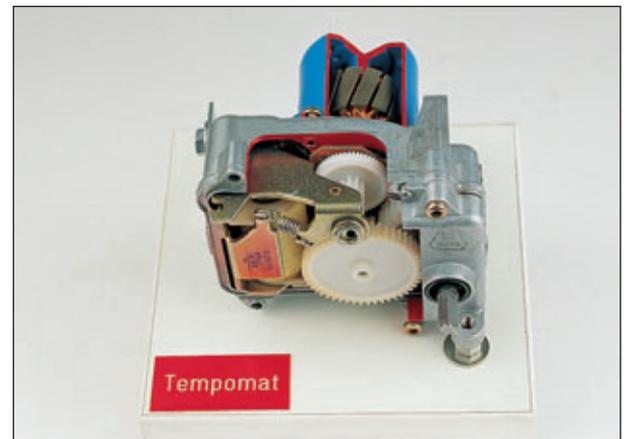


– rich mixture: little air, yellow flame, high lambda voltage
 – lean mixture: a lot of air, blue flame, low lambda voltage
 Order no. 1123



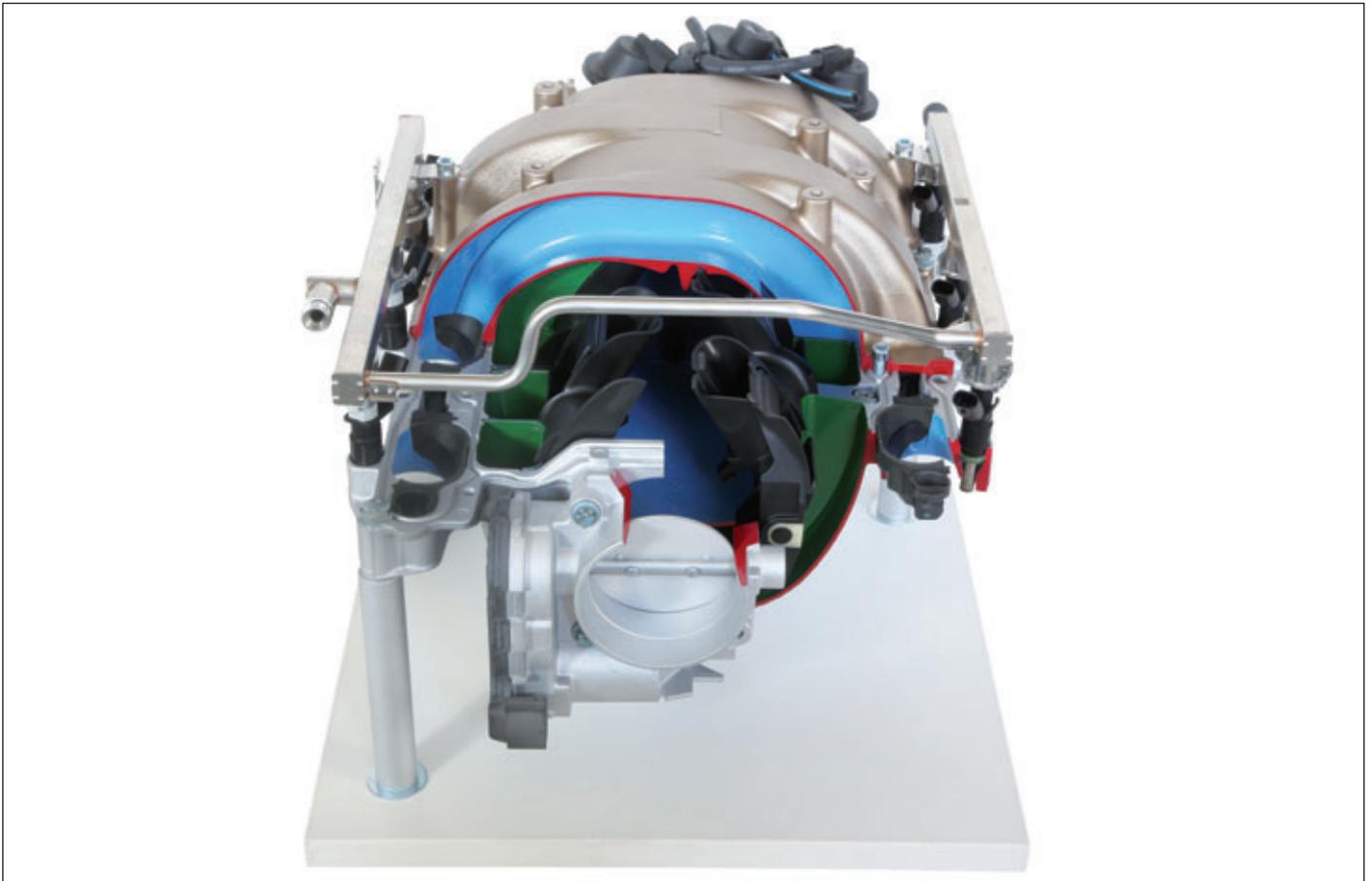
Throttle jacking device

– throttle jacking via a controlled electric motor and gear wheels with gear rack
 – function of the idle switch
 – function of the throttle potentiometer
 Order no. 1126



Actuator for cruise control

Function of the control motor.
 Attraction of the operating magnet.
 Transmission via toothed gears.
 Rotation of the spindle to control the accelerator pedal setting.
 Order no. 1165

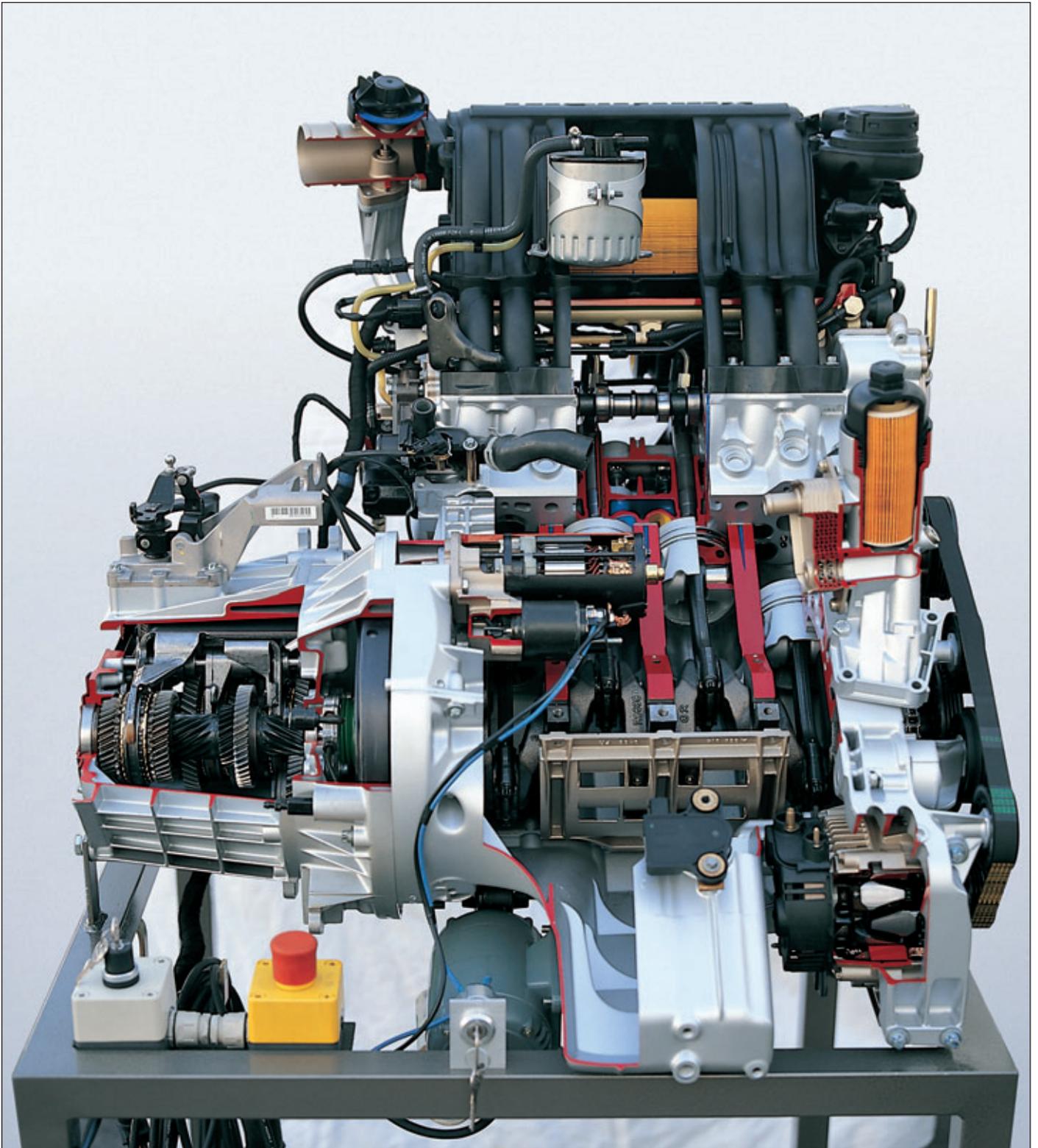


Switch-over induction system

The following can be demonstrated:

- function of the vacuum cells (they can be moved with the connected injector)
- actuation of the switch-over flaps via the vacuum cells
- opening and closing of the various switch-over flaps

- the various fresh gas paths can be recognised easily by corresponding colouring
 - function of the throttle flap with electronically actuated control motor
 - injection stripes and nozzles
- Order no. 1280



Mercedes-Benz A Class diesel engine with common rail technique

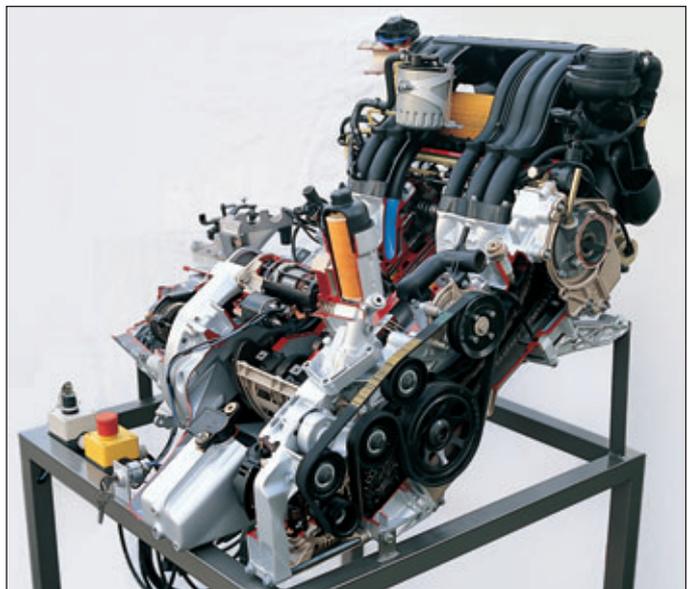
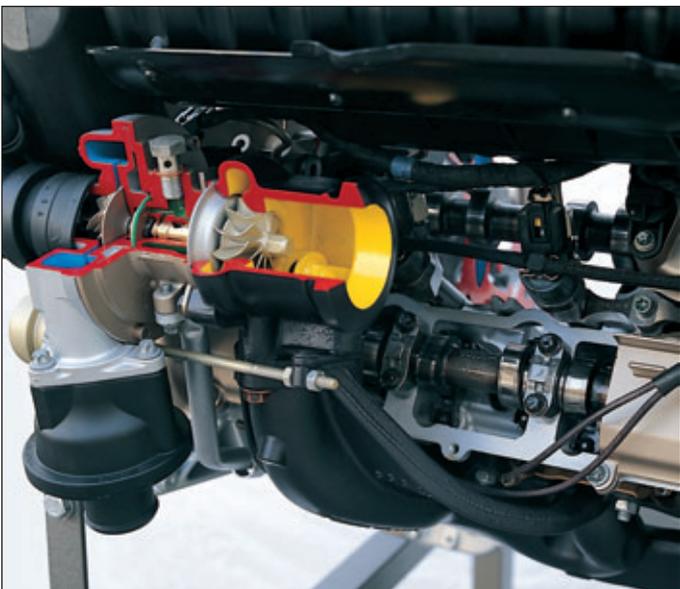
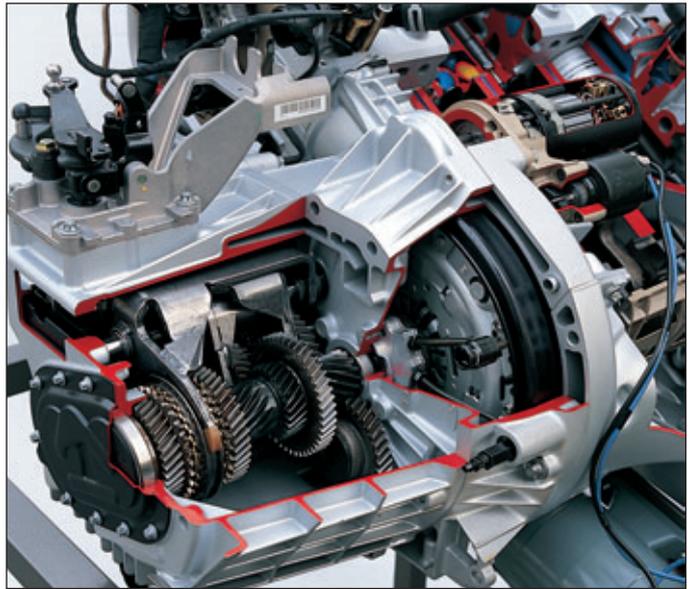
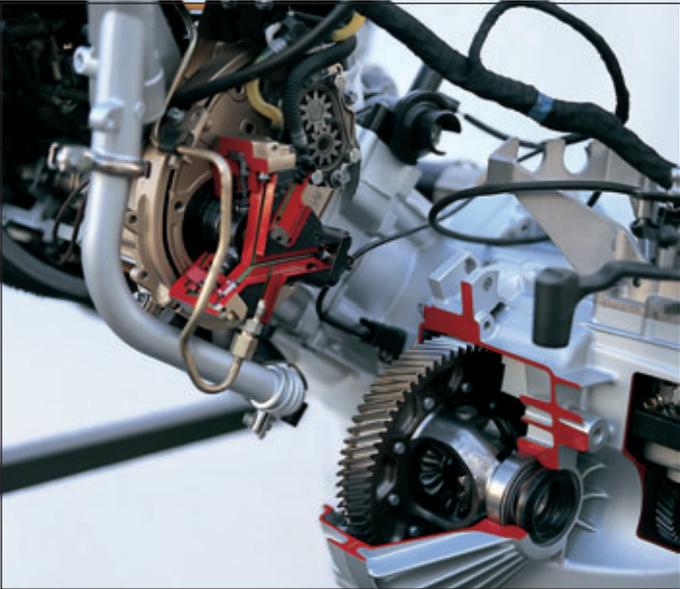
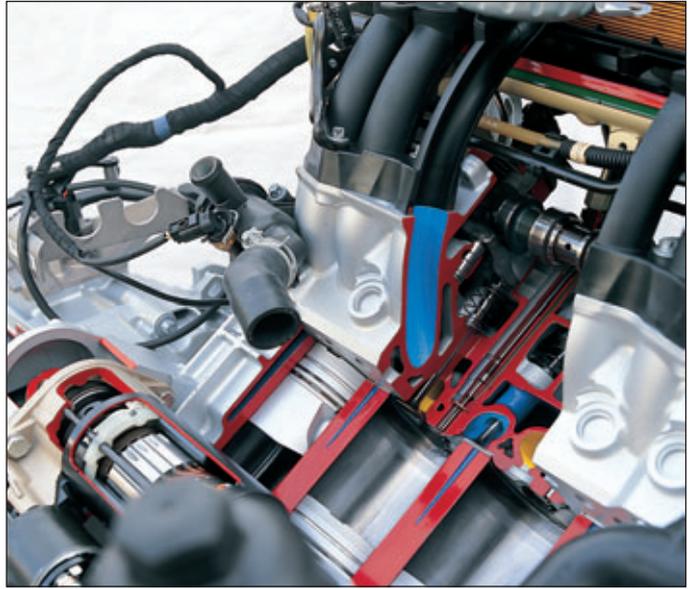
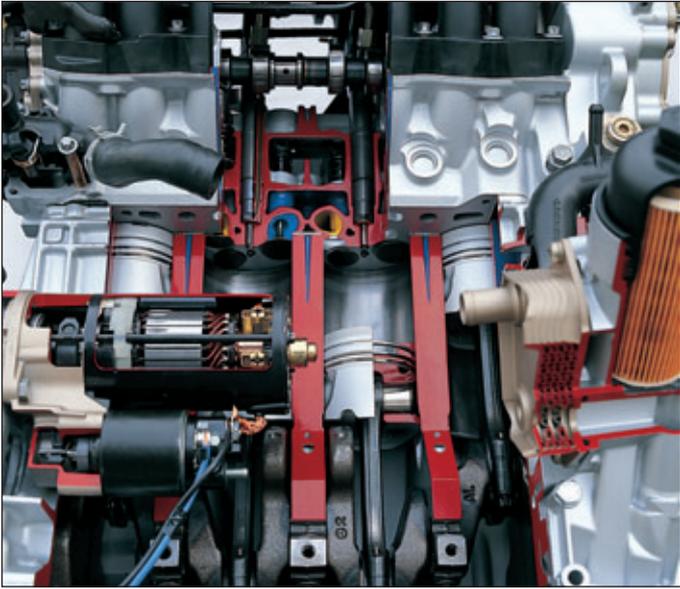
A superlative engine with the latest technique.

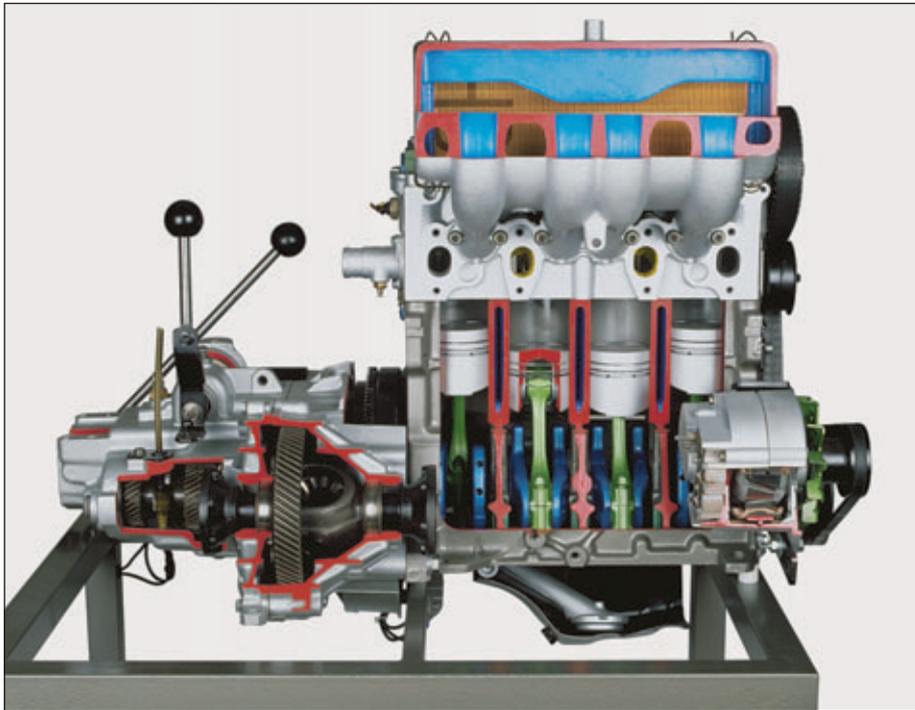
The engine is driven by a 220V geared motor, all the assemblies also run. The start can be engaged, the transmission shifted.

The following are cutaway: cylinder head (with 16 valves), cylinder block, crankcase, oil pan, one piston with cooling duct, oil injection cooling for pistons, hydraulic valve tappet, oil pump, chain case, generator (internally ventilated), starter, exhaust gas re-circulation valve, turbocharger, intake manifold, air filter box, high-pressure pump, one injector, feed pump, rail manifold, valve cover, air-mass sensor, oil filter with heat exchanger, thermostat, modern single-vane vacuum pump, 5-gear transmission and differential.

All actors and sensors are available and connected to the cable tree.

Order no. 1250



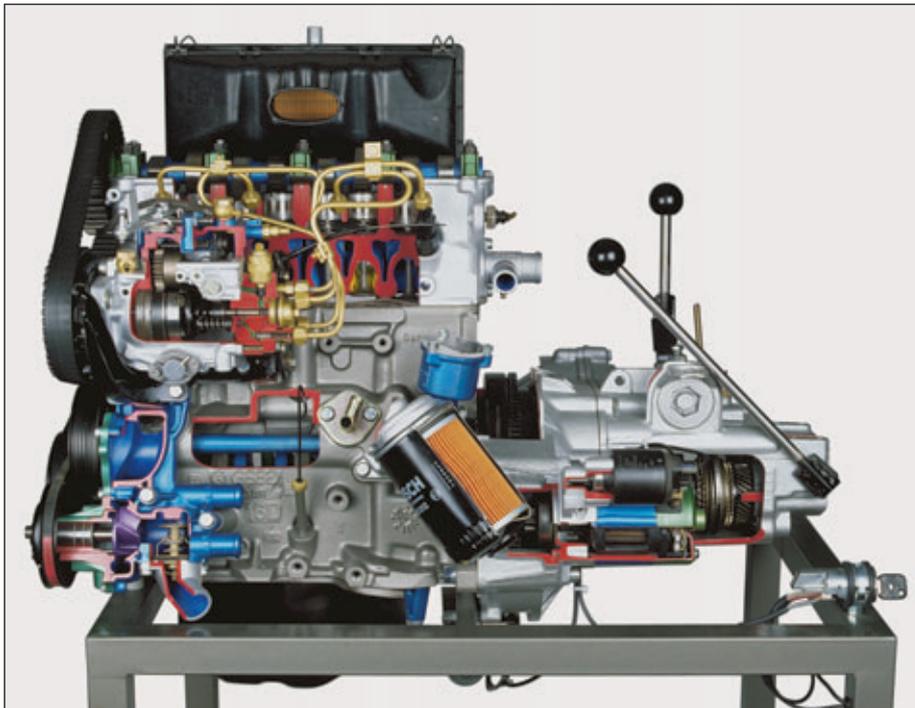


Diesel engine of a VW Golf with transmission

The cutaway, an original engine of a VW Golf with clutch and transmission, is fixed on a mobile rack. The engine with all units is driven slowly by means of an electric motor and a battery.

Parts cut in this model:

- the four cylinders
- one piston
- four valves with bucket tappets and valve gear
- generator
- oil pump
- clutch
- transmission and differential gear
- water pump with thermostat
- starter
- distributor injection pump
- injection nozzle

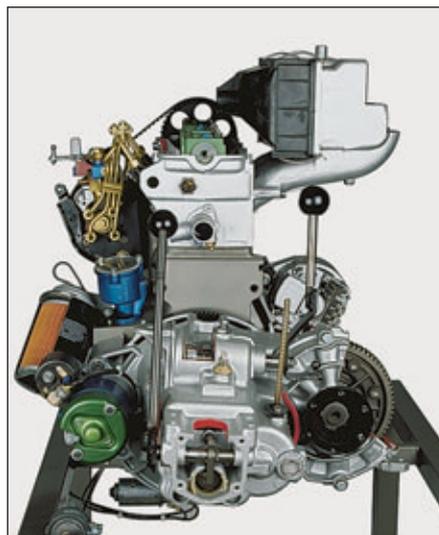
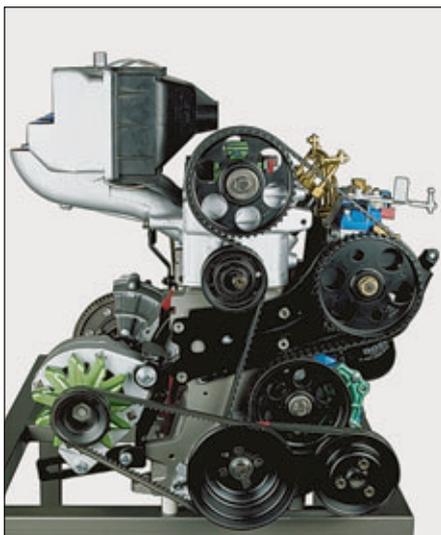


Functions:

- the transmission can be shifted into any gear
- the starter can be engaged and disengaged by means of an ignition lock
- the clutch can be actuated
- by stopping one drive shaft, it can be shown how the differential works

This model can easily be moved into the classroom. It can be used for many teaching units and thus can replace many single models

Order no. 1065



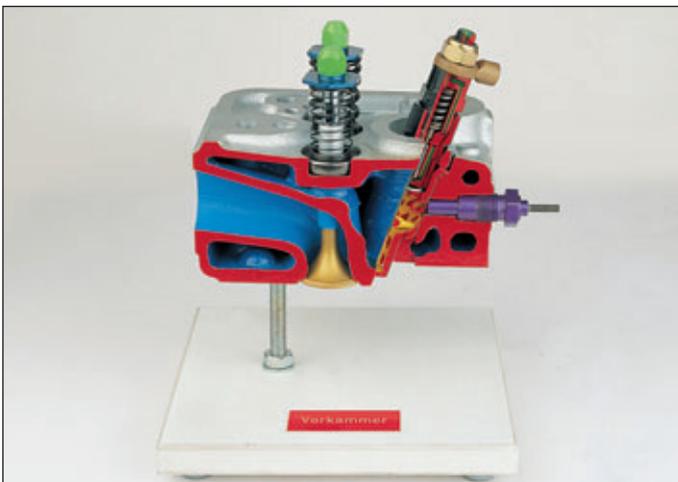


Diesel-powered industrial motor

Cutaway are: engine case, cylinder, cylinder head, injection nozzle, injection pump, starter, muffler, air filter and rotor. This engine is a 1-cylinder naturally aspirated

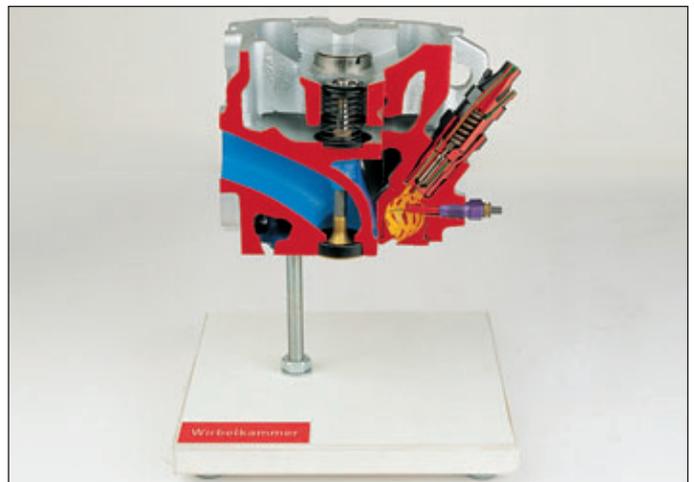


diesel engine with balancer shaft and bottom-mounted camshaft. The engine can be turned easily. Order no. 1330



Cylinder head with prechamber

- function of the valves
(fine springs enable smooth operation)
 - function of the cut up injection nozzle
 - function of the glow plug
 - function of the prechamber
- Order no. 1170



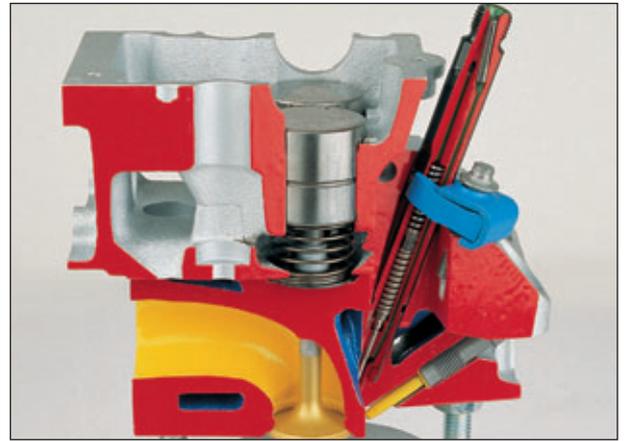
Cylinder head with swirl chamber

- function of the valves and bucket tappet
(fine springs enable smooth operation)
 - function of the cut up injection nozzle
 - function of the glow plug
 - function of the swirl chamber
- Order no. 1171



Cylinder head – direct injection engine

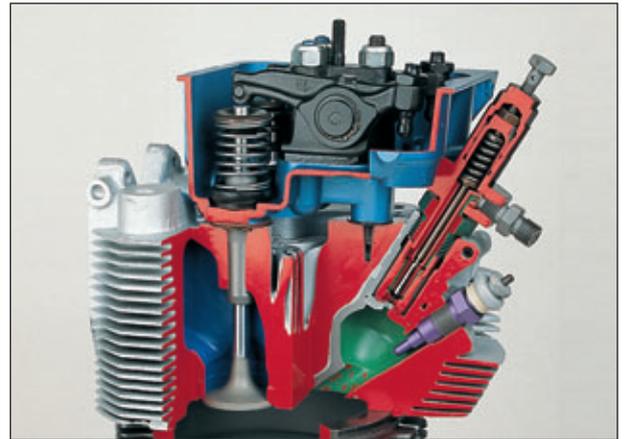
Modern PC cylinder head (Mercedes-Benz C Class)
 with two-spring injection nozzle and bowl-in piston.
 Function of the valves and bucket tappet
 (fine springs enable smooth operation).
 Function of the cut up injection nozzle.
 Function of the hydraulic valve tappet and the glow plug
 Order no. 1172



Diesel cylinder

- function of the valves
- function of the cut up injection nozzle
and of the glow plug
- function of the swirl chamber and of the connecting port

Order no. 1108



MAN Direct injection with bowl-in piston

- function of the rocker and valves
(fine springs enable smooth operation)
- function of the cut up injection nozzle
- function of the bowl-in piston
- function of the air-cooled cylinder

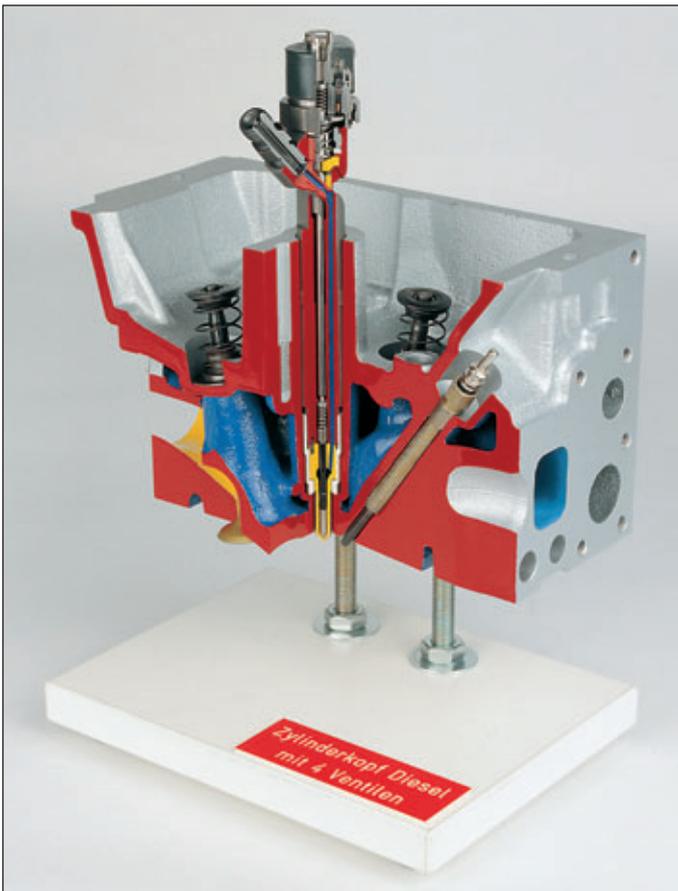
Order no. 1167





Four-valve cylinder head, diesel direct injection, lorry
 This heavy Mercedes-Benz four-valve cylinder head with direct injection is made of grey cast iron. The valves can be operated easily by installing thinner springs. In the middle of the head is the cutaway injection nozzle. Further, there is a decompression valve between the valves.

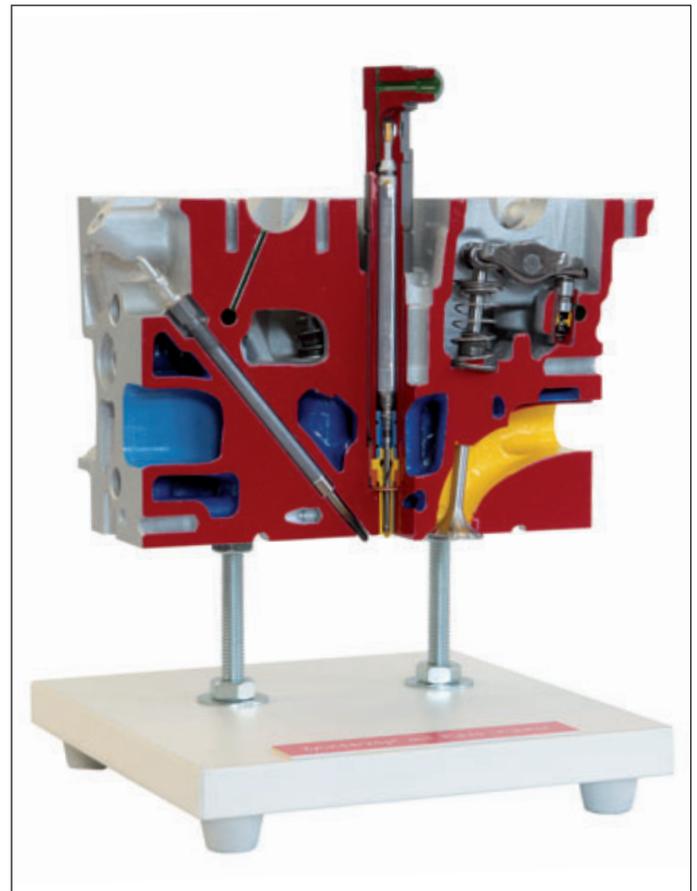
Order no. 1259



Cylinder head, diesel direct injection, with four-valve technology

Modern cylinder head, diesel engine, direct injection with four-valve technology. Function of the cutaway common-rail injector and the sheathed-element heater plug.

Order no. 1268



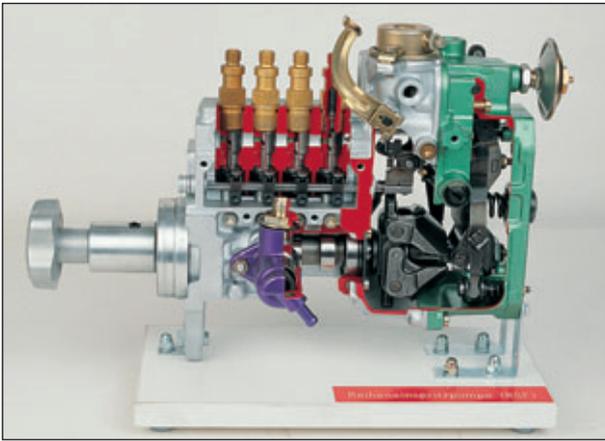
Cylinder head with piezo injector

This cylinder head originates from the OM 651 engine from Mercedes Benz and is fitted in almost all common Mercedes Benz models. The valves can be moved easily.

The following are easy to recognise:

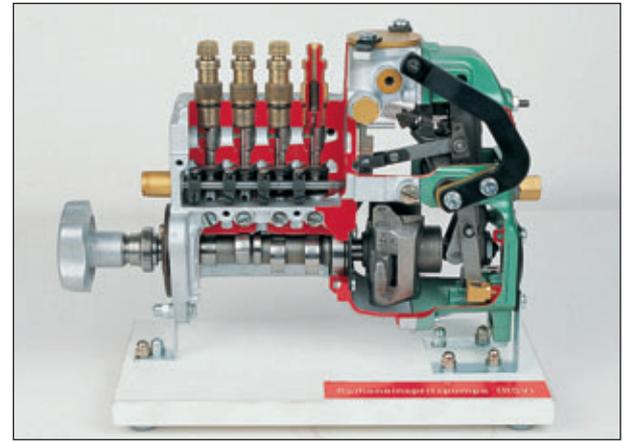
- Valves
- Glow plug
- Injector
- Hydraulic tappet
- Water channels
- Inlet and outlet channels

Order no. 1339



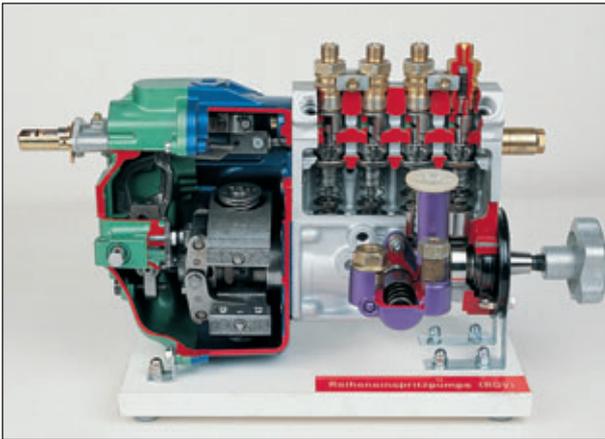
In-line pump with RSF flyweight governor

- function of the RSF governor (idle final speed)
 - displacement of the piston rod
 - torsion of all pump plungers
 - by turning the camshaft one can see the stroke of all pump plungers
 - function of the pressure valves
- Order no. 1138



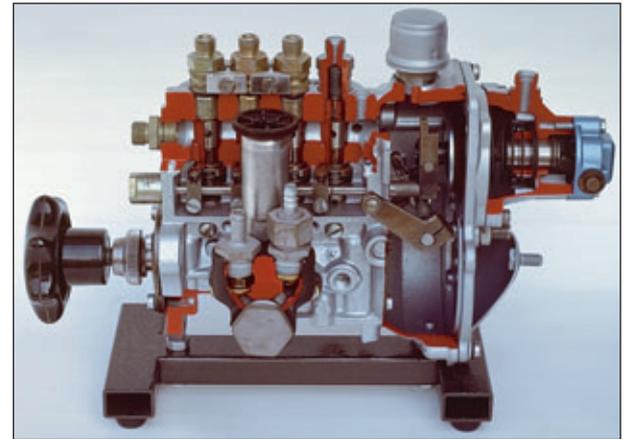
In-line injection pump with RSV flyweight governor

- function of the RSV governor (variable-speed governor)
 - displacement of the piston rod
 - torsion of all pump plungers
 - by turning the camshaft one can see the stroke of all pump plungers
 - function of the pressure valves
- Order no. 1141



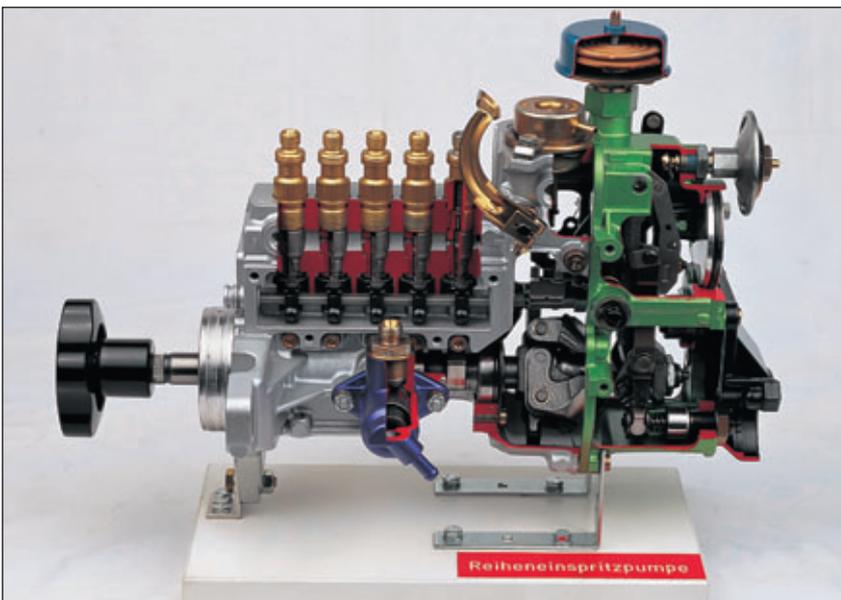
In-line injection pump with RQV flyweight governor

- function of the RQV governor (variable-speed governor)
 - displacement of the piston rod
 - torsion of all pump plungers
 - by turning the camshaft one can see the stroke of all pump plungers
 - function of the pressure valves
- Order no. 1145



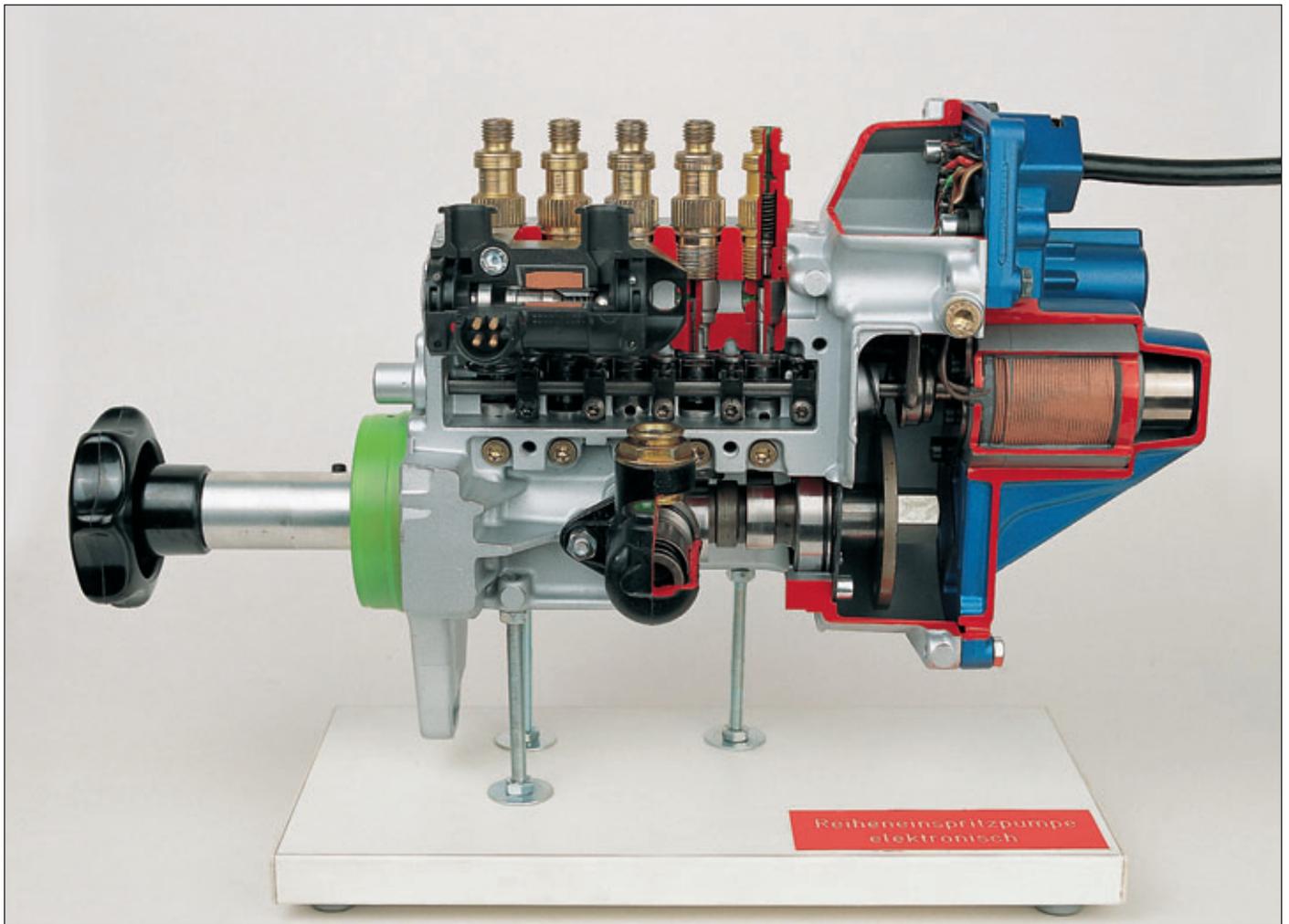
In-line fuel-injection pump with vacuum governor

- Possible demonstrations:
- function of vacuum governor
 - displacement of control rod
 - rotation of the pump plungers
 - stroke of pump plungers
 - function of pressure valves
 - function of supply pump
- Order no. 1008



In-line fuel-injection pump with centrifugal governor

- Possible demonstrations:
- function of centrifugal governor
 - displacement of control rod
 - rotation of the pump plungers
 - stroke of pump plungers
 - function of pressure valves
 - function of supply valves
 - function of supply pump
- Order no. 1009



In-line type injection pump with electronic control

Connection to a 12 V transformer enables the volume control by the operating magnet to be visually demonstrated.
Further functions: Emergency-stop valve, control travel sensor, pressure valves, feed pump, position sensor and pump pistons.

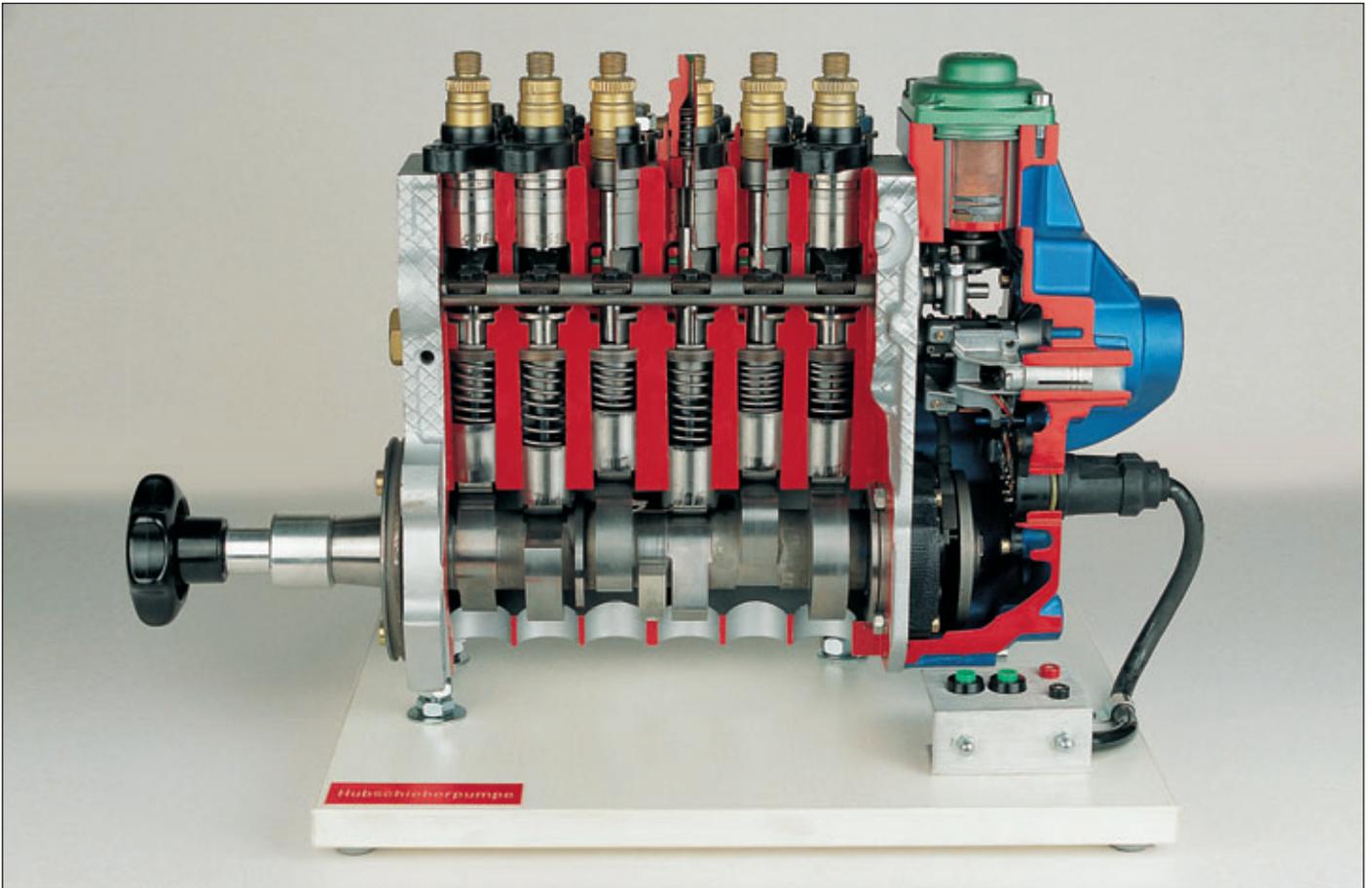
Order no. 1179



Injection timing device, in-line pump

Pulling the buttons draws the flyweights outwards against the spring force and causes the eccentric to readjust the output in the direction "advance injection" eccentric.

Order no. 1119



Pump with slide-valve control (electronically controlled)

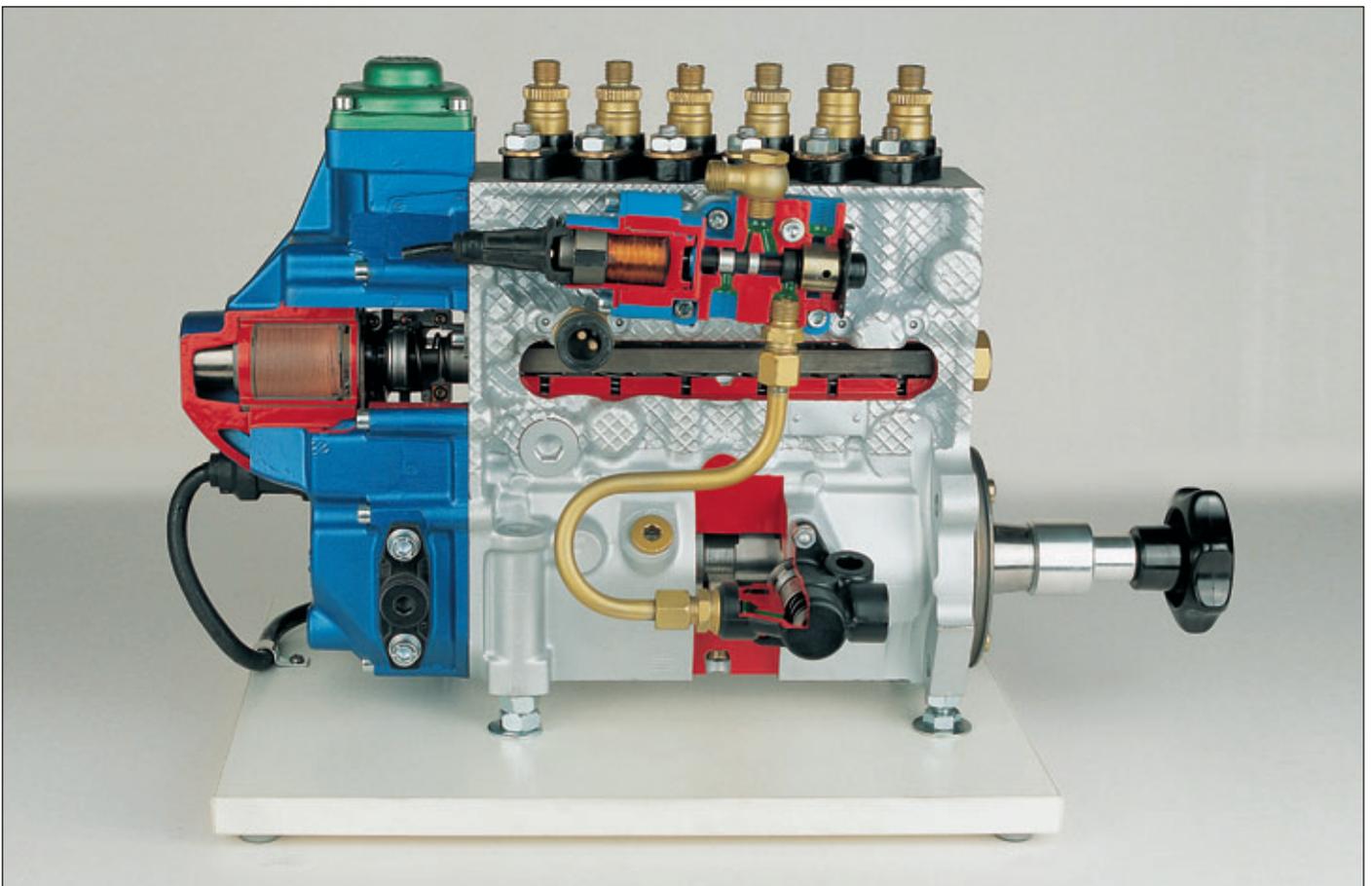
The pump can be connected to a 24 Volt transformer.

Key 1: Volume control by operating magnet 1. This moves the control bar.

Key 2: Injection control by operating magnet 2. This rotates a shaft which moves the slide valve.

Further functions: Emergency-stop valve, control travel sensor, pressure valves, feed pump, position sensor and pump pistons.

Order no. 1180



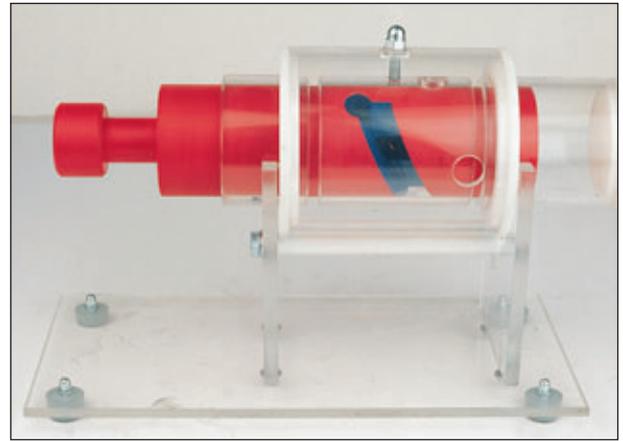


Pump tappet of an in-line pump

The functions of a modern pump tappet:

- filling the pressure chamber
- start of injection, feed, injection
- volume control by rotating the piston

Order no. 1181



Pump tappet of a lifting-disk pump

The functions of a lifting-disk pump tappet:

- filling the pressure chamber
- start of injection, feed, injection
- volume control by rotating the plunger
- injection start control by means of the movable lifting disk

Order no. 1182

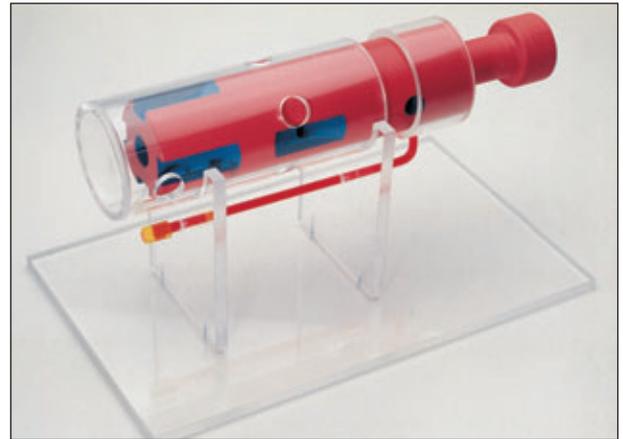


Distributor plunger

- this model is made out of acrylic glass and PVC

- fuel delivery and distribution as well as the function of a control sleeve can be shown

Order no. 1012



Distributor plunger (on a rack)

- model # 1012 is fixed on a rack

- the control sleeve can be moved from the outside by means of a rod

Order no. 1013



Feed pump, diesel (single-acting)

- function of the delivery plunger
- function of the 2 valves
- elastic delivery by means of the plunger spring

Order no. 1134



Feed pump, diesel (double-acting)

- function of the delivery plunger
- function of the 4 valves
- elastic delivery by means of the plunger spring

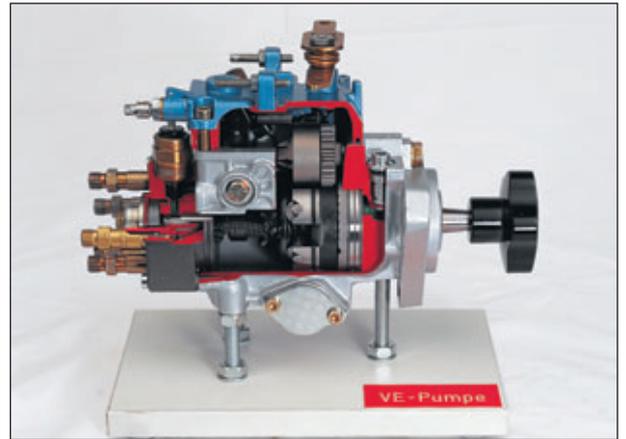
Order no. 1135



Pump element

- function of the tappet and the pump piston. Volume control by displacement of the tappet and rotation of the pump piston
- function of the pressure valve, the ducts and the spill port

Order no. 1190



Distributor-type fuel-injection pump with centrifugal governor

- working manner of central plunger (supply and distribution of fuel)
- functions of roller ring and cam plate
- functions of the mechanical governor
- function of injection timing device
- function of shutoff device
- functions of pressure valves

Order no. 1007

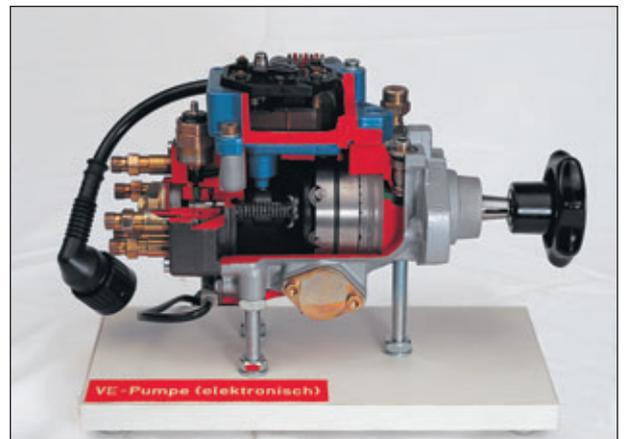


Distributor-type fuel-injection pump with charging-pressure control

Demonstrations as for # 1007

In addition the function of the charging-pressure control can be shown.

Order no. 1019

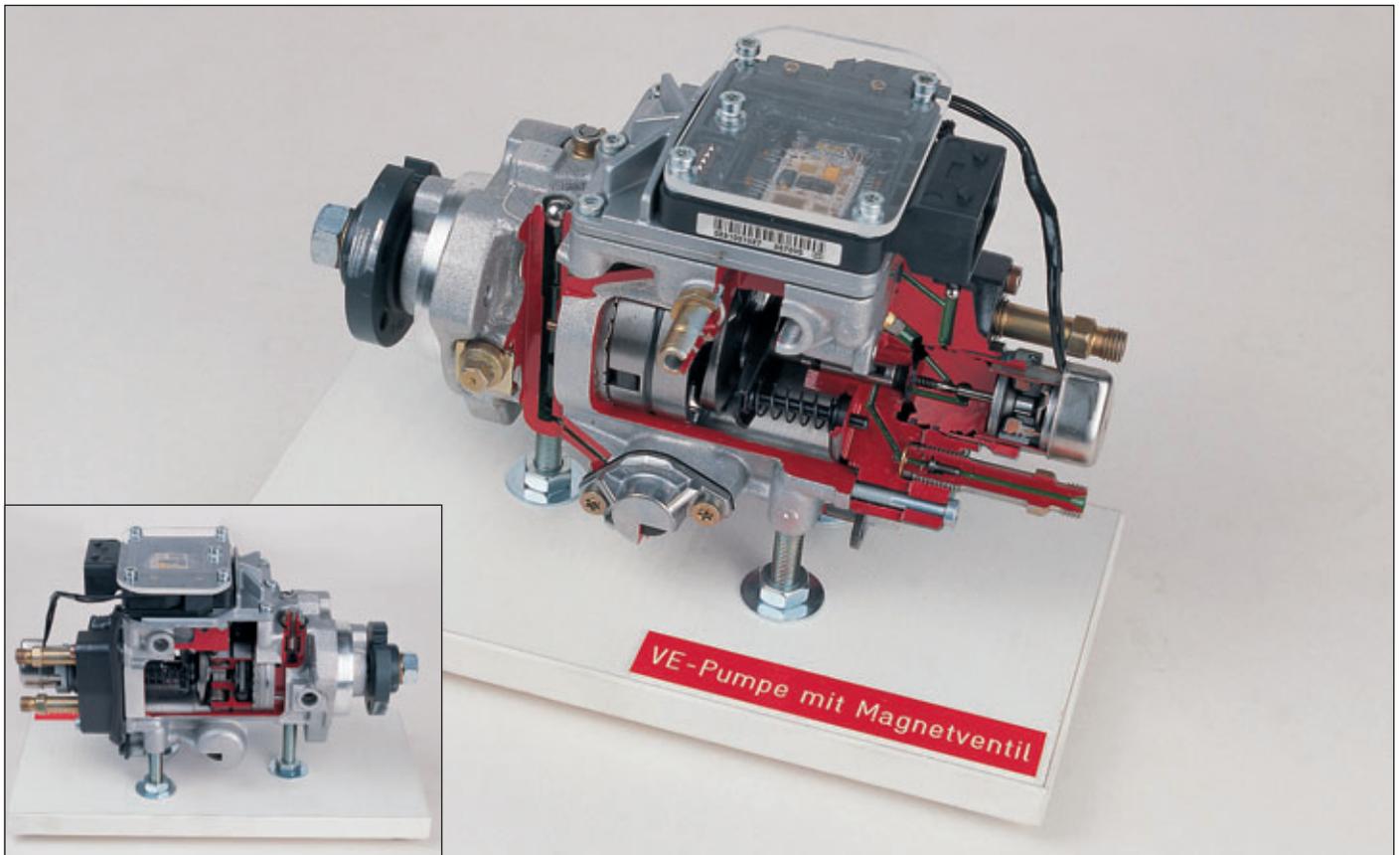


Distributor-type fuel-injection pump with electronic governor

- demonstrations as for #1007

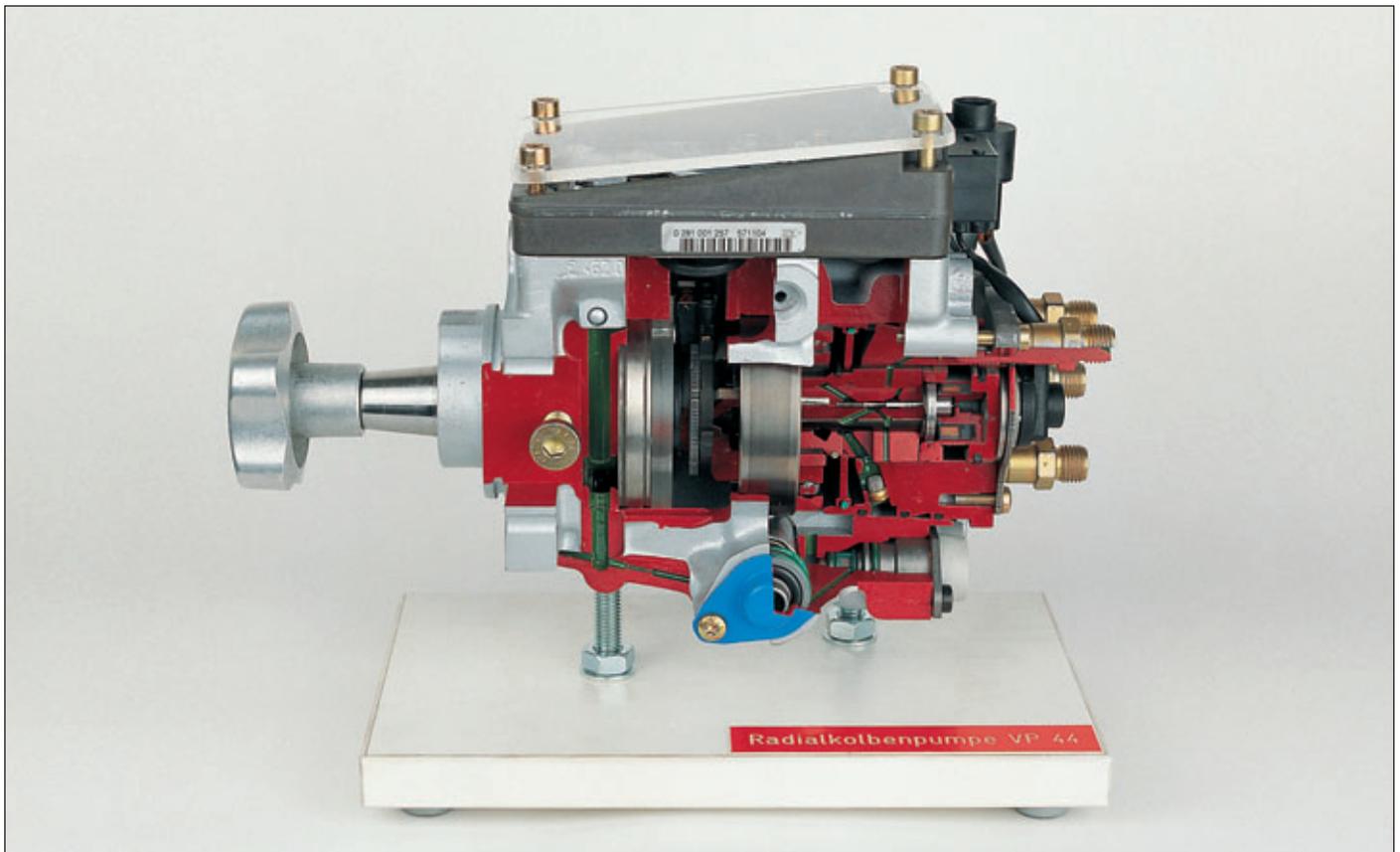
- the mechanical flyweight governor is replaced by a solenoid
- the metering sleeve can be moved at the shaft of this actuator
- in addition the solenoid actuator can be actuated electrically to demonstrate fuel metering

Order no. 1020



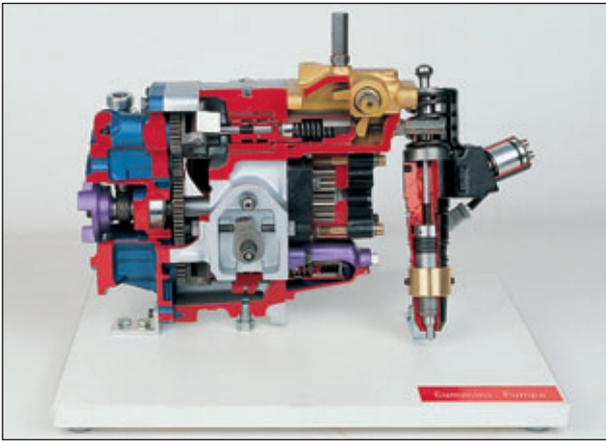
VE pump, electronically controlled with solenoid valve VP 30 (Bosch)

The basic set-up is similar to that of conventional VE pumps. In addition, the pump has a solenoid valve for quantity control, a digital-incremental distance measurement and its own pump control unit. The following functions can be shown: delivery and distribution through the pump plunger, injection control with coupled digital-incremental distance measurement, opening and closing of the solenoid valve and further valves. In addition, the throttle valve and the control unit can be seen. Order no. 1242



VP 44 (Bosch) radial-piston distributor-type injection pump

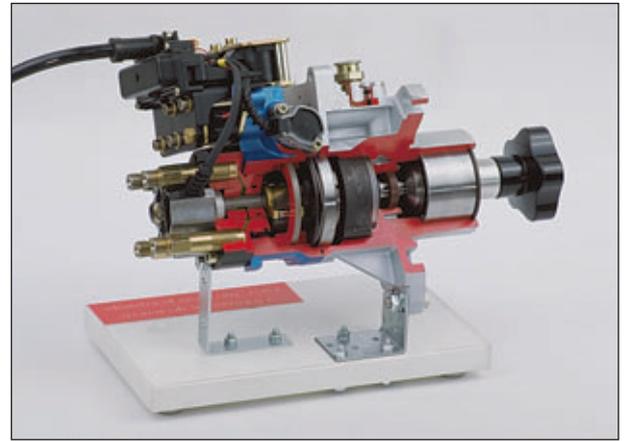
All components are cut away: Pump timing case, cam ring, injection timing device, distributor plunger, vane-type pump, solenoid valve. The following functions can be demonstrated: Incremental angle/time recording, Fuel feed, distribution, injection timing, operation of the high-pressure piston, the solenoid valve, the shut-off valve and the return flow throttling valve. Order no. 1194



Cummins Pump

- function of the VS flyweight governor
- function of the PTG flyweight governor
- function of the gear wheel pump
- function of the throttle shaft
- function of the VS throttle shaft
- function of the injector
- function of the AFC plunger

Order no. 1140



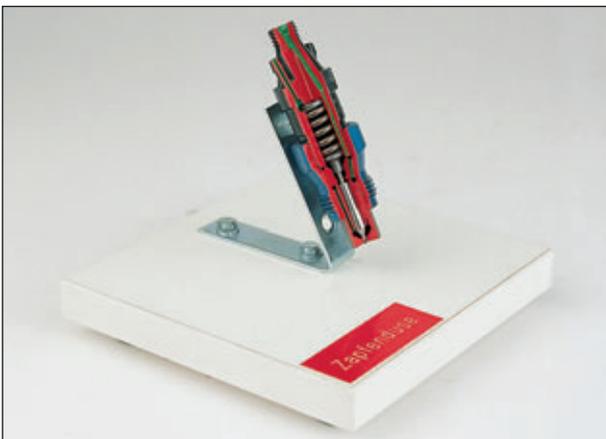
Electronically controlled LUCAS pump

Function of the high-pressure pump, distribution, injection control and quantity control
Order no. 1087



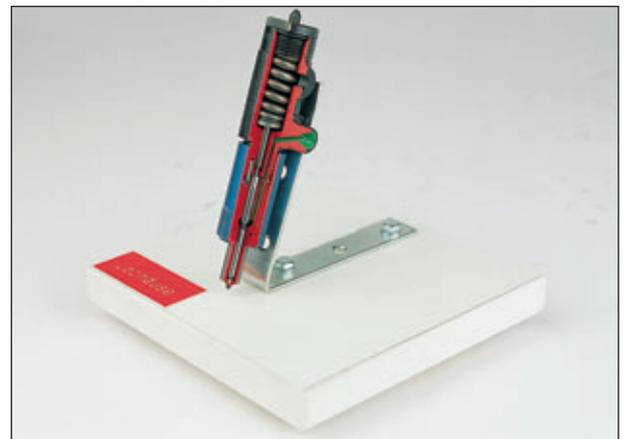
Pump-lines-nozzle

Actuation of the pump piston by means of roller tappet to achieve the high pressure.
Solenoid valve to control the rate of injection and the start of delivery.
High-pressure lines to the injection nozzle.
Injection nozzle with needle and pressure spring.
Order no. 1196



Nozzle holder with pintle-type nozzle

- function of the nozzle holder, nozzle, nozzle needle, pressure pin and pressure spring
 - function of the inlet and outlet ducts
- Order no. 1173



Nozzle holder with hole-type nozzle

- function of the nozzle holder, nozzle, nozzle needle, pressure pin and pressure spring
 - function of the inlet and outlet ducts
- Order no. 1174



Nozzle holder with two-spring injection nozzle and needle-displacement sensor

- function of the nozzle holder, nozzle, nozzle needle, pressure pin and pressure spring
- function of the inlet and outlet ducts. Detection of start of injection by a coil

Order no. 1176



Injection nozzle, truck

The cutaway models shows a particularly large truck injection nozzle with nozzle holder.

- Function of the nozzle holder, nozzle, nozzle needle, pressure pin and pressure spring.

Function of the inlet and return ducts.

Order no. 1227



Nozzle holder with two-spring injection nozzle

- function of the nozzle holder, nozzle, nozzle needle, pressure pin and pressure spring
- function of the inlet and outlet ducts

Order no. 1175

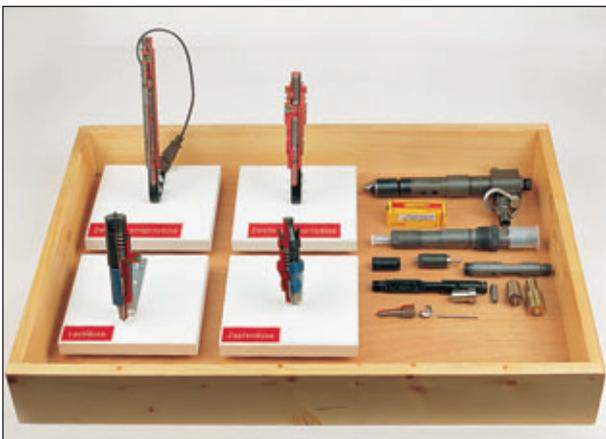


Common rail injector with magnetic coil at the bottom

In this new construction, the magnetic coil and the valve body have been moved to the bottom compared with injectors used up to now and are positioned directly above the nozzle needle. The long and sluggish pressure rod is no longer needed. In this way, quick gearshift times, also with solenoids, are possible. In addition, a spiral-shaped groove has been milled into the nozzle needle, resulting in an optimum injection jet of fuel when it leaves the injection nozzle.

The following is seen in the cutaway of the injector: Injector housing with cap nut, nozzle body with nozzle needle, high-pressure canal, pressure spring, valve body, solenoid, fuel feed, edge-type filter and electrical connection.

Order no. 1322

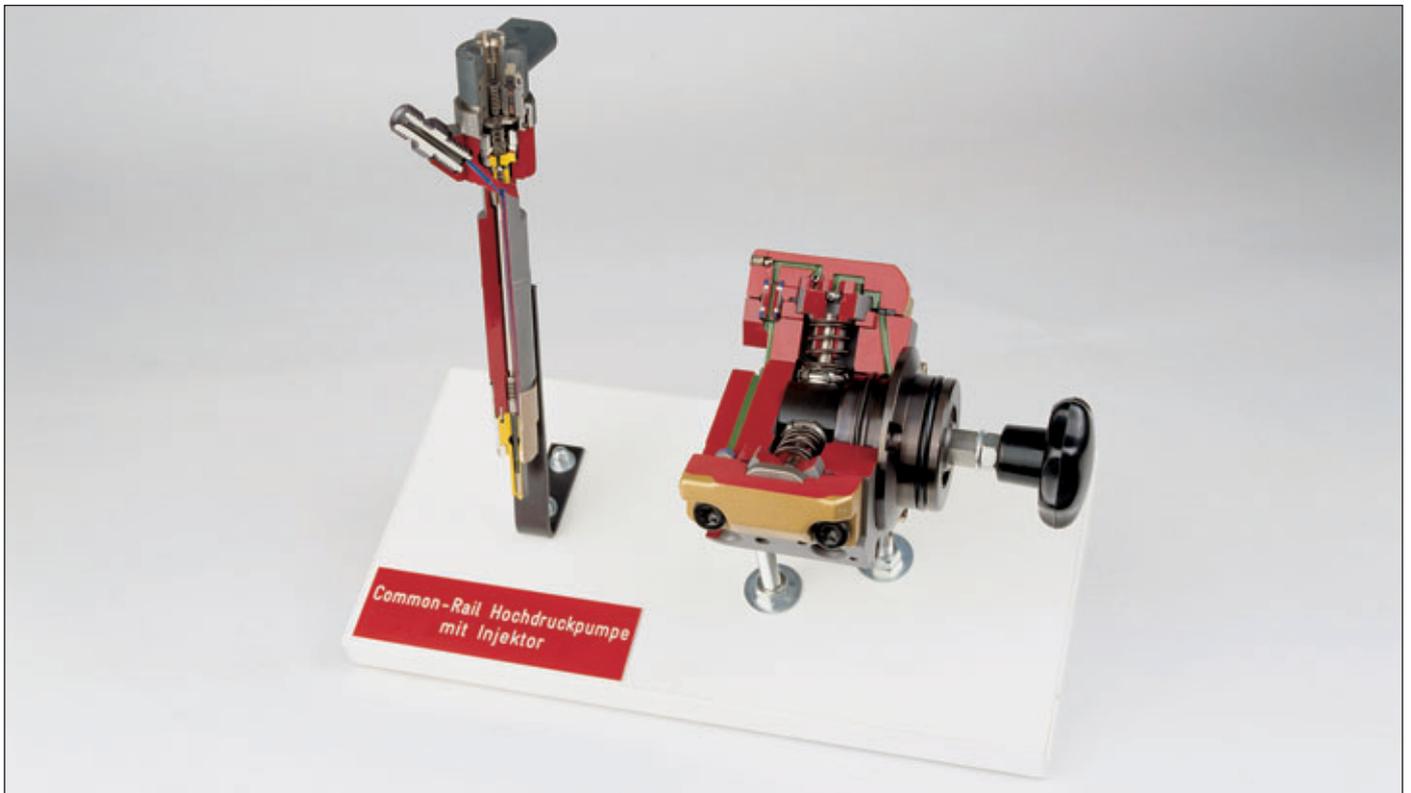


Nozzle holder set with 4 injection nozzles

Four injection nozzles (Nos. 1173 to 1176) mounted on one model board.

Also a dismantled nozzle holder along with various nozzles, and an uncut nozzle holder.

Order no. 1177



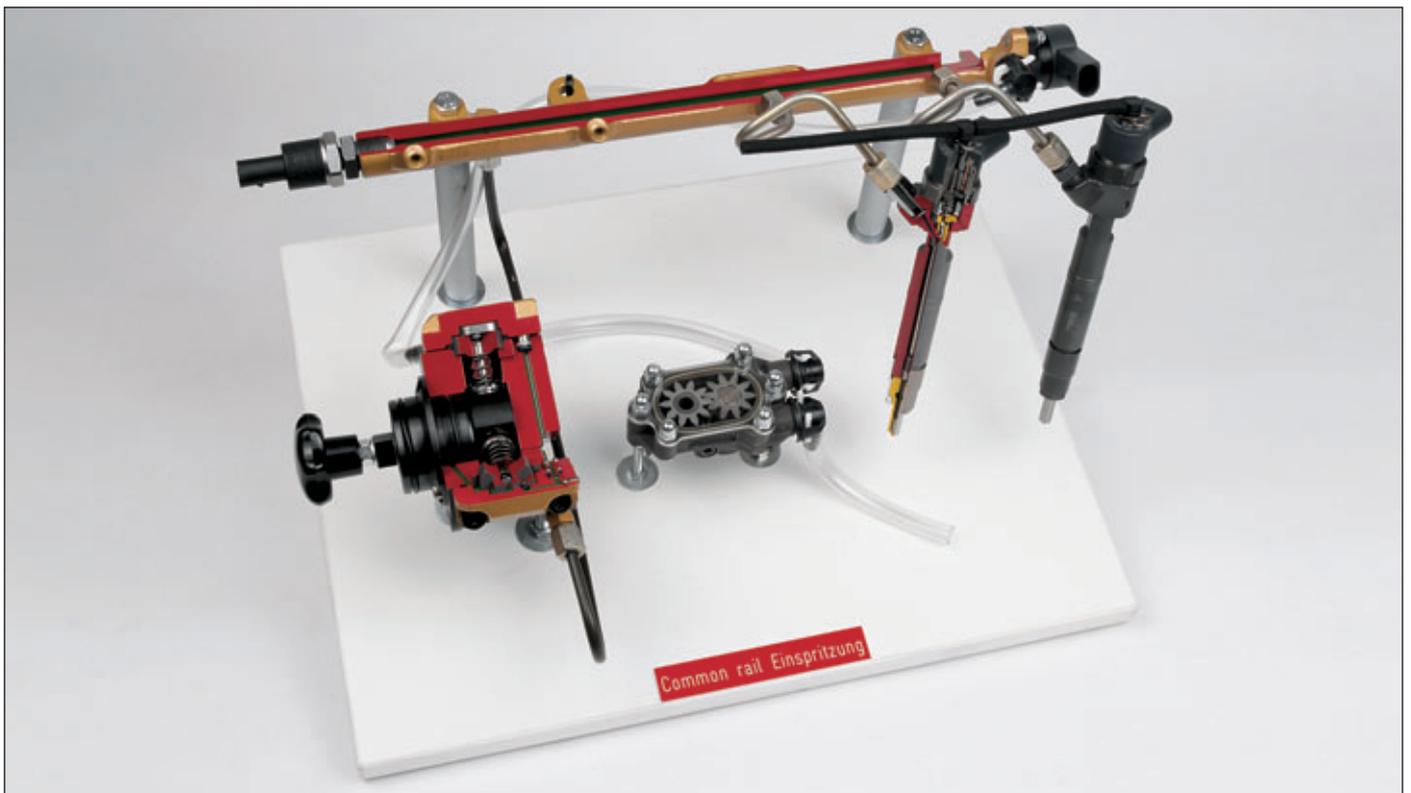
Common rail high-pressure pump with injector

High-pressure pump:

By turning the eccentric cam the operation of the pump piston can be seen. Aspiration of the fuel from the interior of the pump via a flat valve. Discharge of the pressurized fuel via a ball valve into the collector line to the rail.

Injector: Injection nozzle, solenoid valve for volume control and for control of start of delivery.

Order no. 1195



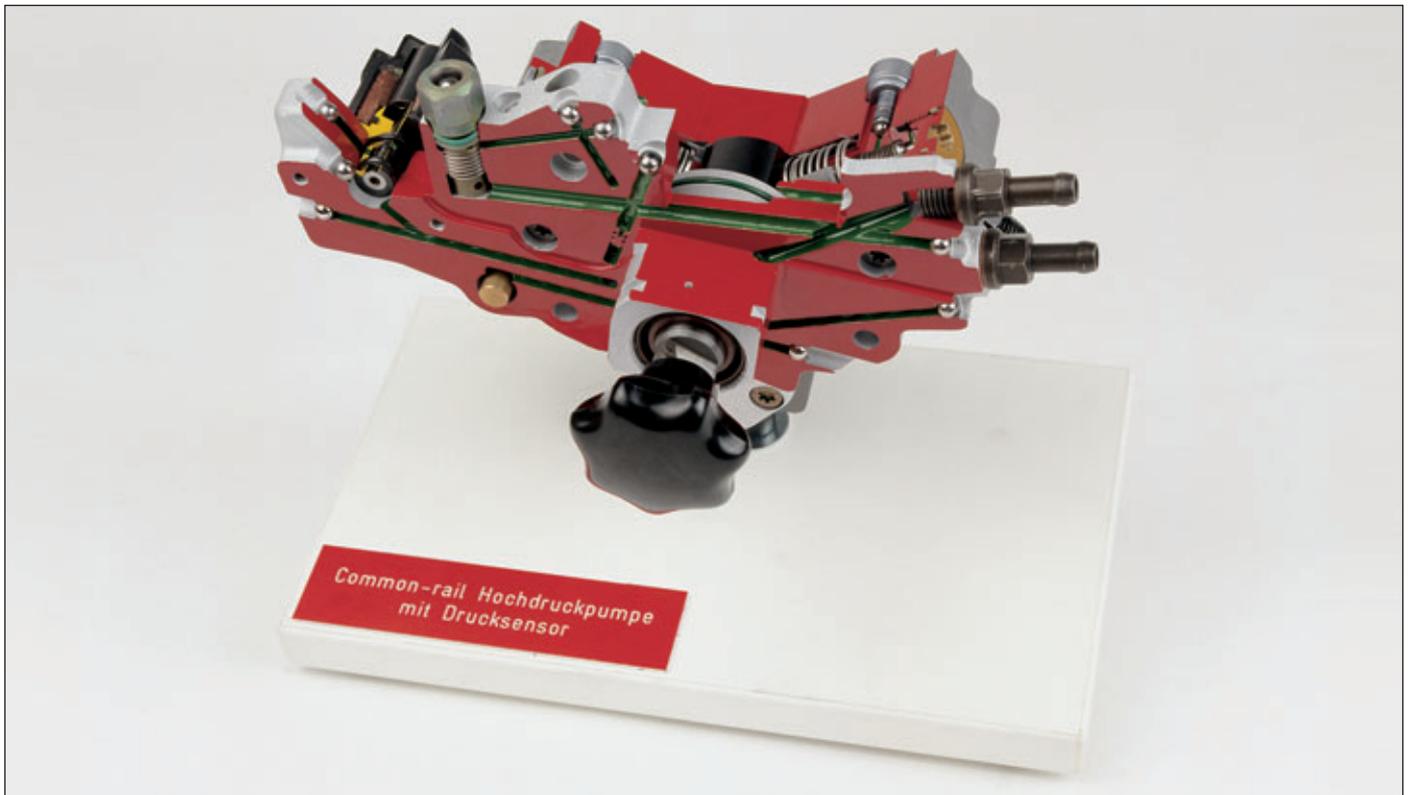
Common rail injection

On this model board, the most important elements of the common rail injection unit can be set up and connected to fuel lines.

The fuel is fed by the feed pipe (gear wheel pump, cutaway) to the high-pressure pump. By turning the clamp screw grip, you see the generation of the high pressure. From here, the fuel is pushed into the cutaway manifold and then enters the injectors (one injector cutaway). Further, the return passage of the fuel can be seen.

On the left and right of the cutaway manifold, you can see the rail pressure sensor and the rail pressure transmitter.

Order no. 1258



Common rail high-pressure pump with fuel-delivery regulation valve

- this high-pressure pump is the latest generation
 - pump cylinder and housing form a block
 - injection pressure: 1500 bar
 - by turning the star grip, one sees the function of the pump plungers
 - the fuel-delivery regulation valve and the fuel channels are also cutaway
 - these pumps are installed in the latest Daimler-CDI vehicles
- Order no. 1291



Common rail high-pressure pump with fuel-delivery regulation valve and injector

- this high-pressure pump is the latest generation
 - pump cylinder and housing form a block of hardened steel
 - by turning the star grip, one sees the function of the pump plungers
 - the pressure sensor and the fuel channels are also cutaway
 - these pumps are installed in the latest Daimler-CDI vehicles
 - the following can easily be seen in the injector: injection nozzle, solenoid valve, high and low-pressure channels, feed and drain bores
- Order no. 1292



Cutaway model Piezo injector

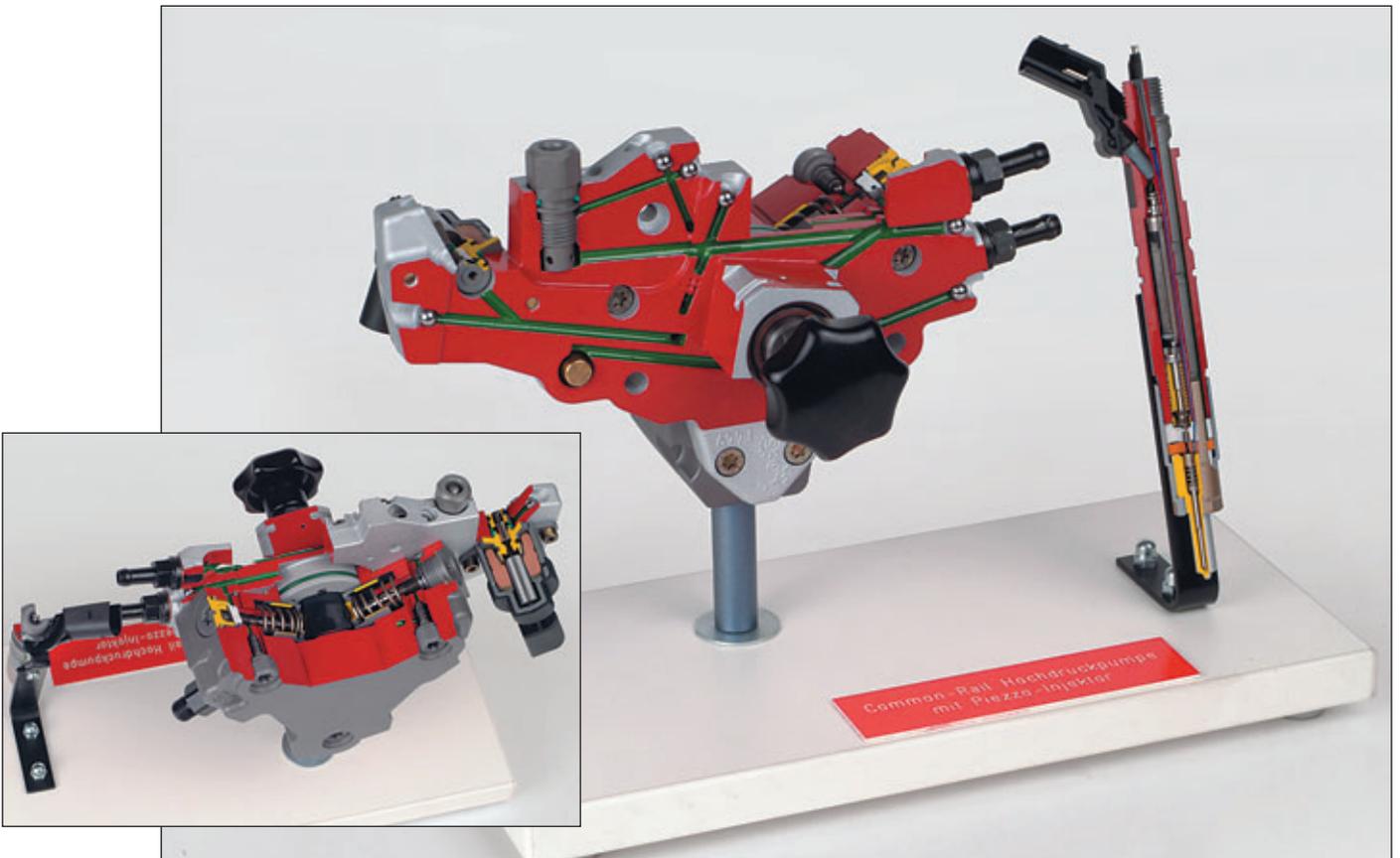
The following parts have been cut away:

- fuel rod filter and high-pressure channel
- low-pressure channel (10 bar)
- actor module with Piezo layers



- coupler module and switching valve
- high-pressure channel and throttle plate
- injection nozzle with nozzle needle

Order no. 1295



Piezo injector with high-pressure pump

The following parts have been cut away on the injector:

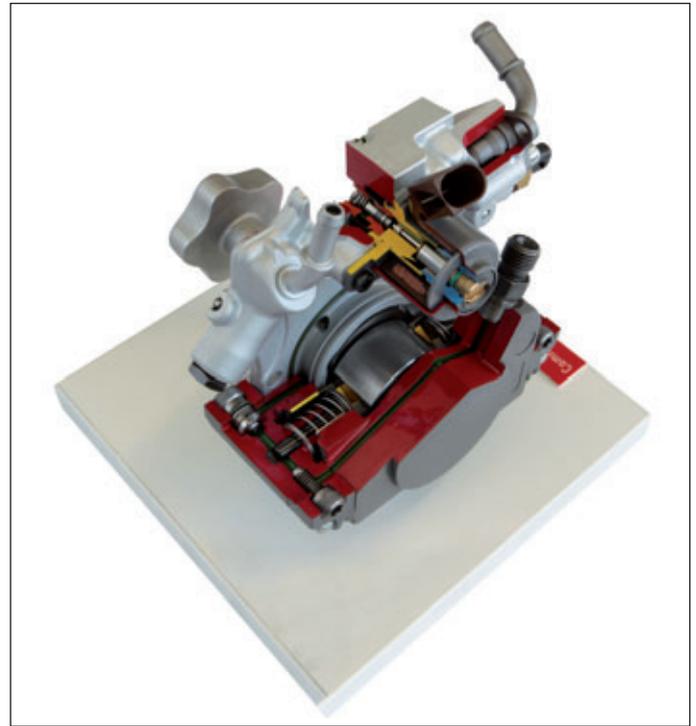
- fuel rod filter and high-pressure channel
- low-pressure channel (10 bar)
- actor module with Piezo layers
- coupler module and switching valve
- high-pressure channel and throttle plate
- injection nozzle with nozzle needle

The following parts have been cut away on the high-pressure pump:

- pump cylinder
- fuel quantity regulation valve
- fuel channels

By turning the star grip, you see the function of eccentric cam and pump plungers

Order no. 1296



Common rail injection pump from Delphi

Cutaway are:
 Pump cylinder
 Fuel quantity control valve
 Fuel channels and valves

This pump originates from the OM 651 diesel engine from Mercedes-Benz and is fitted in almost all common Mercedes-Benz models. The pump is easy to turn. The functions of the pumping elements can be demonstrated.
 Order no. 1338



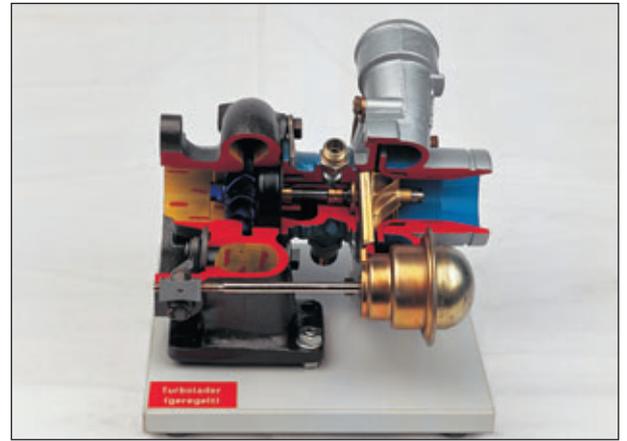
Pump nozzle III

Pump tappets can be operated through the installation of a weaker spring.
 Cut away a long way at the front and back with the result that all the channels and the solenoid valve are easily visible.
 Good matching of colours makes the many individual parts easy to recognise.
 Attention: new, more favourable price compared with the predecessors.
 Order no. 1274



Exhaust-gas turbocharger

- the housing of the charger is cut in a way you can see compression wheel, turbine wheel and bearings
 - the two sides are marked by colours: compression side - blue, turbine side – red
 - all parts can be easily moved
- Order no. 1004



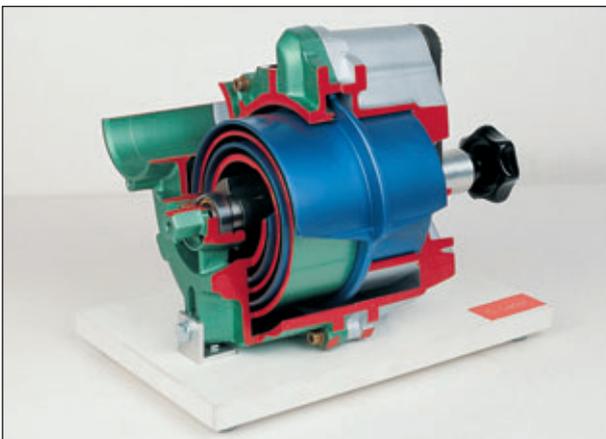
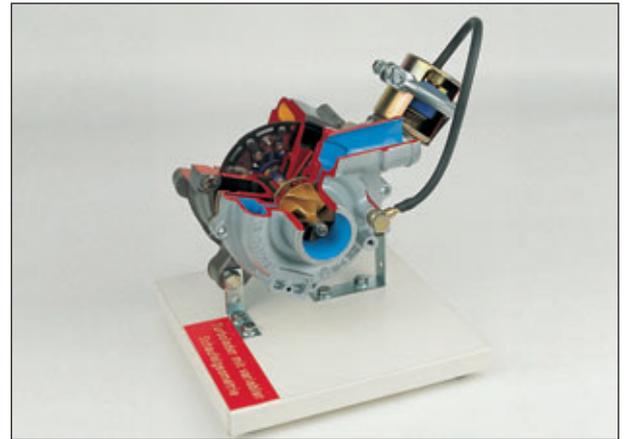
Exhaust turbocharger with charging-pressure control

- all functions of model # 1004 and the function of a charging-pressure control
- Order no. 1005



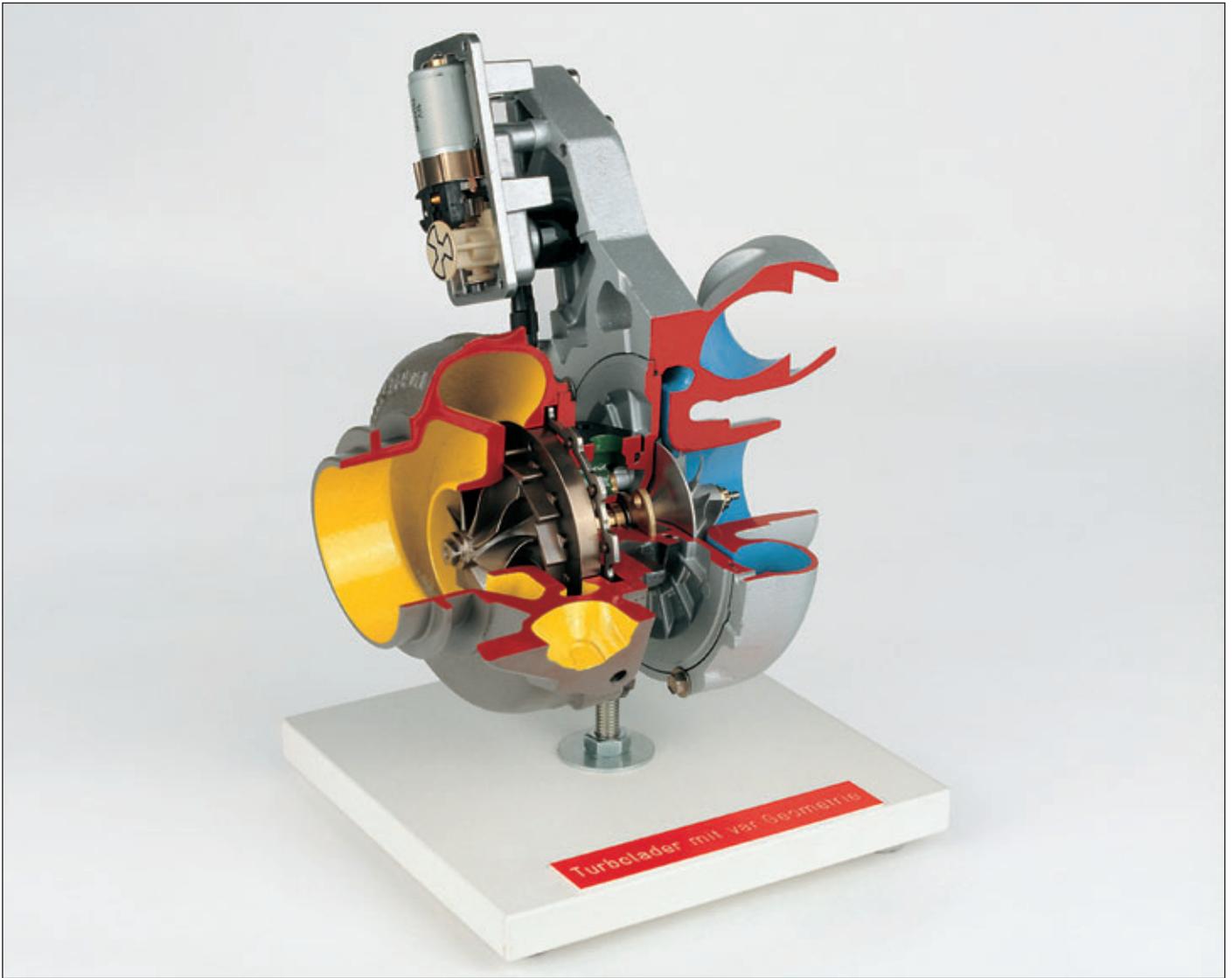
Turbocharger with variable blade geometry

- Function of the turbine and blower wheels.
 - Adjustment of the guide vanes by means of the adjusting ring.
 - Charging-pressure control via the vacuum cell by turning the adjusting ring.
- Order no. 1197



Spiral-type supercharger

- movement of the displacement spiral
 - function of the drive shaft and auxiliary shaft and of the balance weights
 - air compression outwards-inwards
 - toothed-belt driven auxiliary shaft
- Order no. 1122

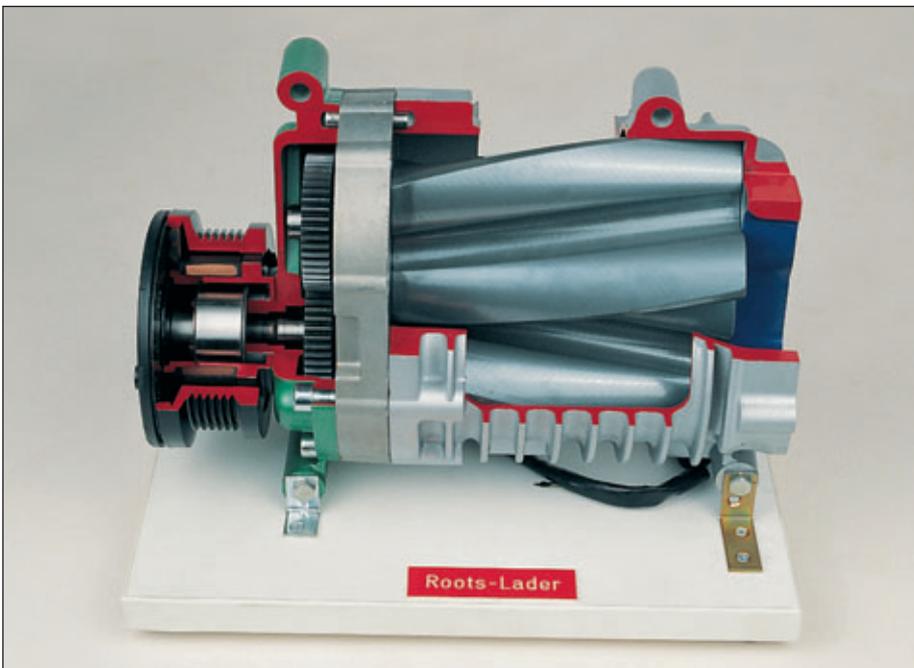


Turbo-charger with variable geometry and electrical control motor

Function of turbine and fan wheel as well as the bearings of the shaft.

Adjustment of the guide blades by an electronically actuated control motor instead of the vacuum-controlled advance used up to now.

Order no. 1267

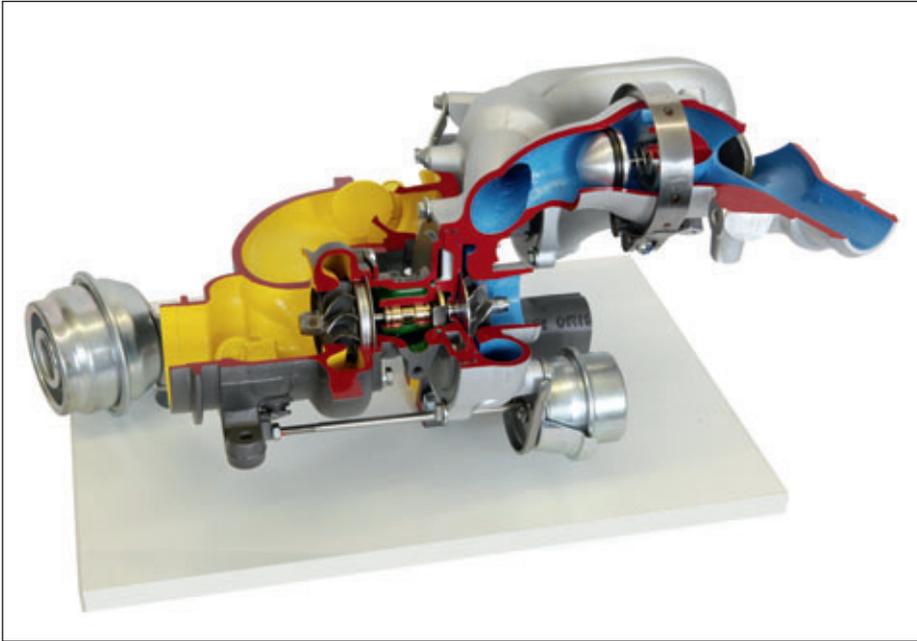


Roots supercharger

This mechanical supercharger is installed in Mercedes-Benz compressor sports cars.

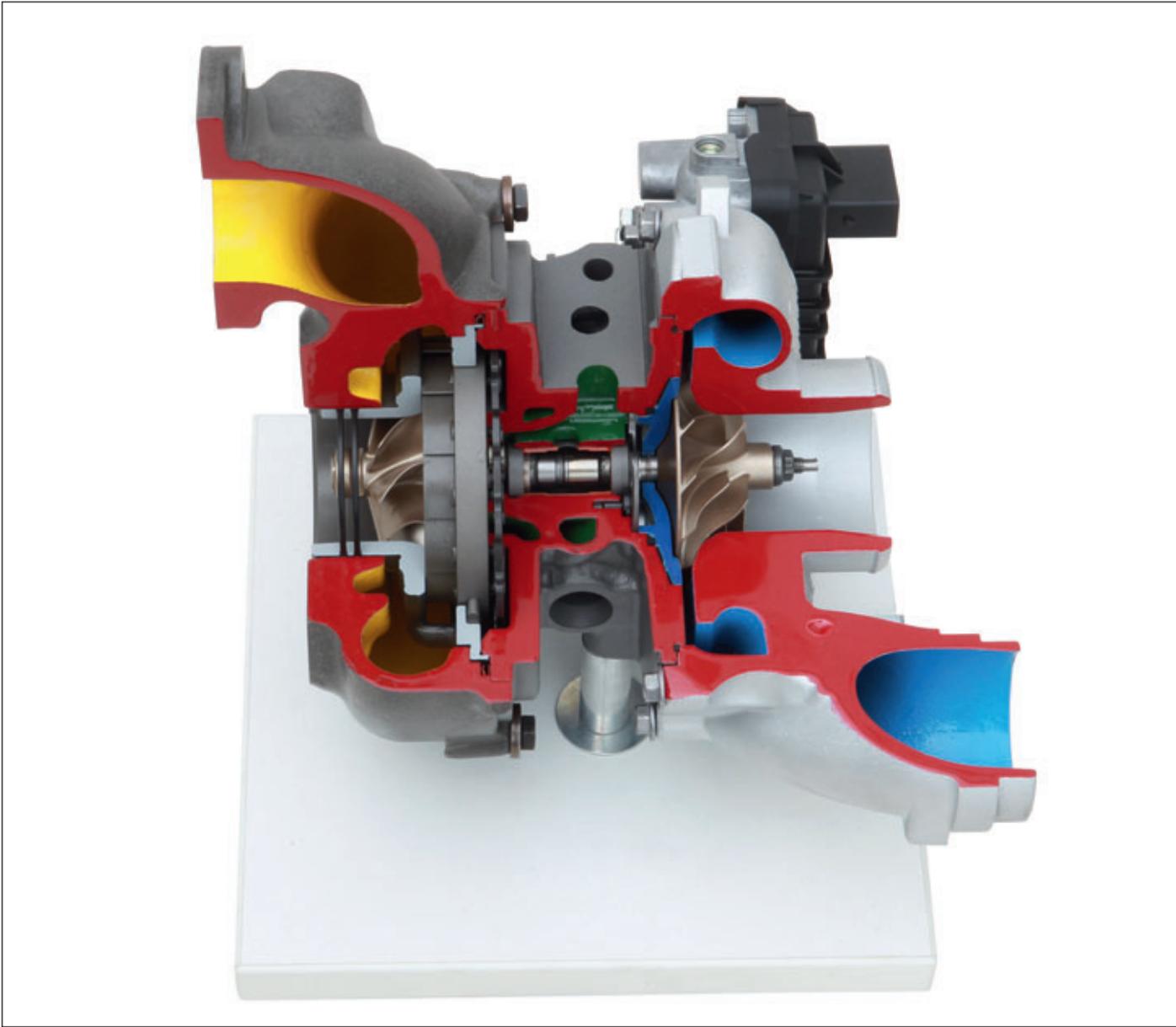
The two rotors have three vanes each and are driven via gear wheels. The suction and compression can be shown particularly clearly.

Order no. 1239



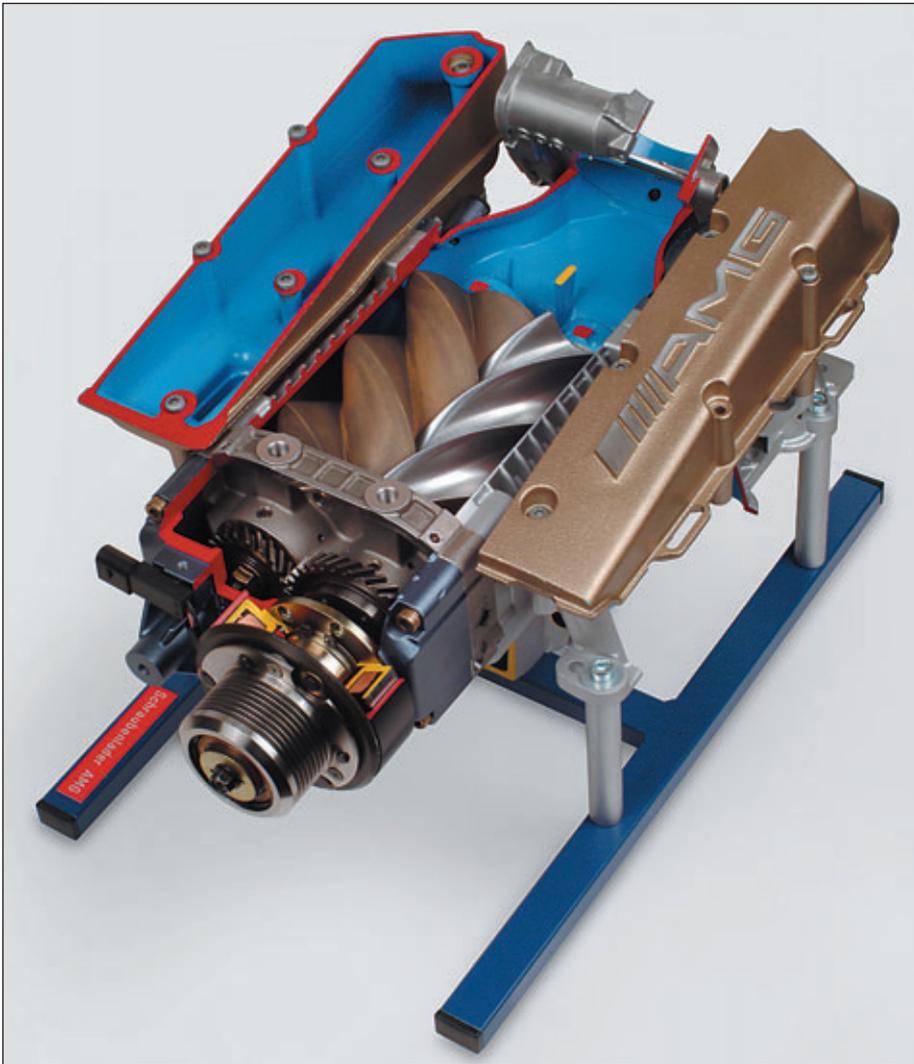
Two-stage turbocharger (bi-turbo)

Cutaway are: both turbochargers, control flaps and the fresh-air valve. The turbines and throttle valves can be moved. Exhaust air, fresh air and oil channels are accentuated in colour. Order no. 1327



Turbocharger with ball bearing and variable vane geometry

This is a model of the latest generation of turbochargers in which the friction bearing has been replaced by two ball bearings with ceramic balls. This makes up to 300,000 rpm possible. These turbochargers have less abrasion, can transmit greater powers, suffer less from the afterworker effect and have a high charging effect even at low speeds. Order no. 1331



Screw compressor with charge-air cooling

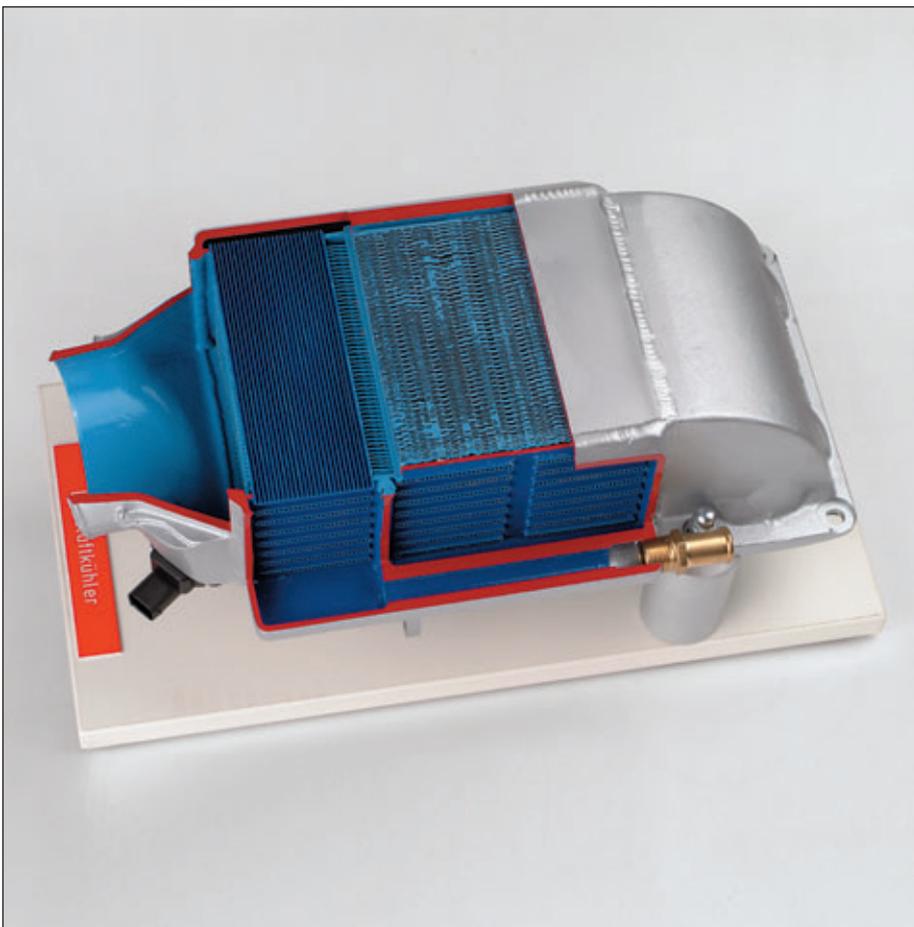
High-performance compressor of the firm of AMG

Easily visible: the two screw spindles, driven via a magnetic clutch and gear wheels. The charger runs at 12,000 RPM. At the bottom of the charger, is the cutaway charge-air cooler with water channels. Order no. 1298

Screw compressor without charge-air cooling

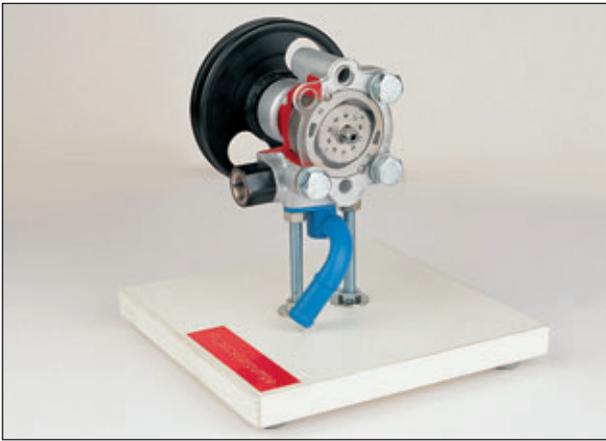
High-performance compressor of the firm of AMG

Easily visible: the two screw spindles, driven via a magnetic clutch and gear wheels. The charger runs at 12,000 RPM. Order no. 1299



Charge-air cooler

This charge-air cooler is an air/water heat exchanger with a separate coolant circulation. The water and air channels have been cut away and painted accordingly. Order no. 1300



Vane-type pump, PC

Suction and pressure effect via reduction or enlargement of the chambers.

Centrifugal force causes apex seal to fit against housing.

- function of the pressure relief valve
- function of the V-ribbed belt drive

Order no. 1151



Rotor pump, PC

Suction and pressure effect via reduction or enlargement of the chambers.

- function of the pressure relief valve
- function of the timing chain drive

Order no. 1150



Internal gear pump, PC

Suction and pressure effect via reduction or enlargement of the chambers.

- function of the pressure relief valve. Intake port and delivery port cut away. Use as oil pump for pressure circulation lubrication and for automatic transmissions.

Order no. 1152

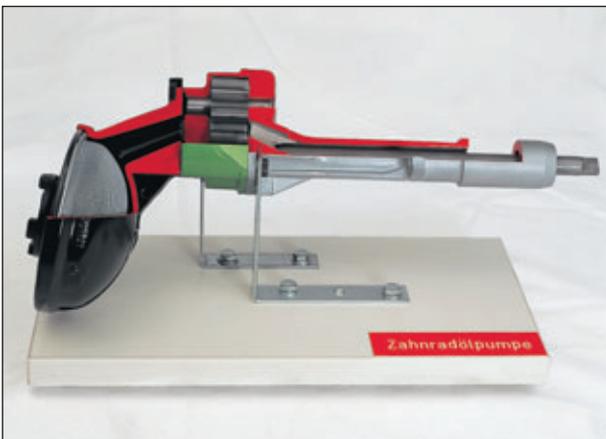


Tandem hydraulic pump, PC

Hydraulic pump for 2 separate hydraulic circuits.

- function of the vane-type pump
- function of the piston pump
- function of the pressure relief valve

Order no. 1153



Geared Pump

Demonstration:

- spur wheel function
- excess pressure valve function
- pressure and vacuum chamber function

Order no. 1047



Rotor pump, trucks

- function of the pressure relief valve
- interplay between inner and outer rotors
- suction and pressure effect via reduction or enlargement of the chambers between the inner and outer rotor

The model can be put together with effortless ease.

Order no. 1143



Swivel-vane vacuum pump for diesel engine

Swivel-vane vacuum pumps are currently the state of the art for creating the vacuum required for brake power assist units for diesel engines. Negative pressures of up to 0,98 bar are possible. By turning the eccentrically-positioned rotor it can be seen how the swivel vanes lie against the casing. The negative pressure is created by increasing and reducing the space. Order no. 1208



Model case Pumps

A collection of 8 different pumps for various applications and showing various pumping principles:

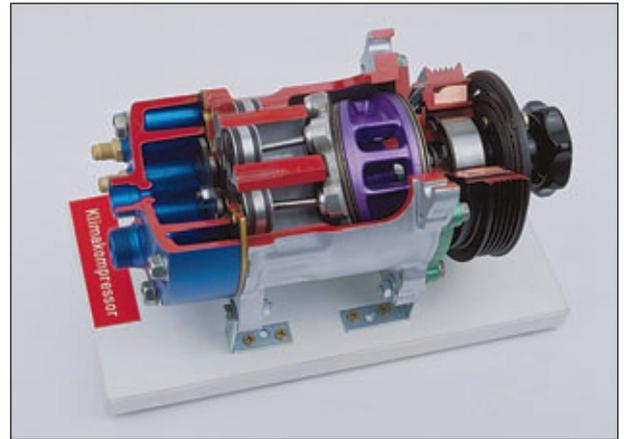
- fuel pumps: diaphragm and roller-cell pumps
- oil pumps: external and internal gear pumps, rotor pump
- vacuum pumps: vane-type pump, piston pump
- water pump: rotary pump

Order no. 1207



Single-vane vacuum pump

In order to supply a vacuum for brake boosters, vacuum pumps are used in both diesel and, increasingly, in Otto engines. The pump has a very simple and robust set-up and nevertheless has a very high capacity. If the rotor is turned, the enlargement and reduction of the working area can be seen particularly well, as can the contact of the slide shoes in each position of the vane. The pressure and suction valve and the oil duct are cut open. Order no. 1245



Climatic compressor

- function of magnetic clutch
- function of compressor and valves

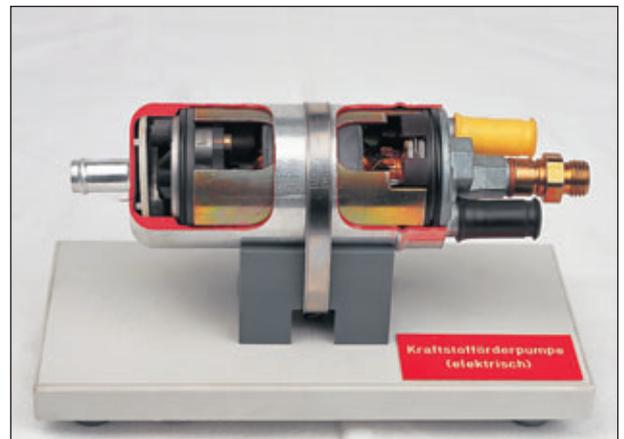
Order no. 1097



Mechanical fuel pump

- function of diaphragm, pushrod and valves
- suction and pressure stroke
- variable delivery

Order no. 1084

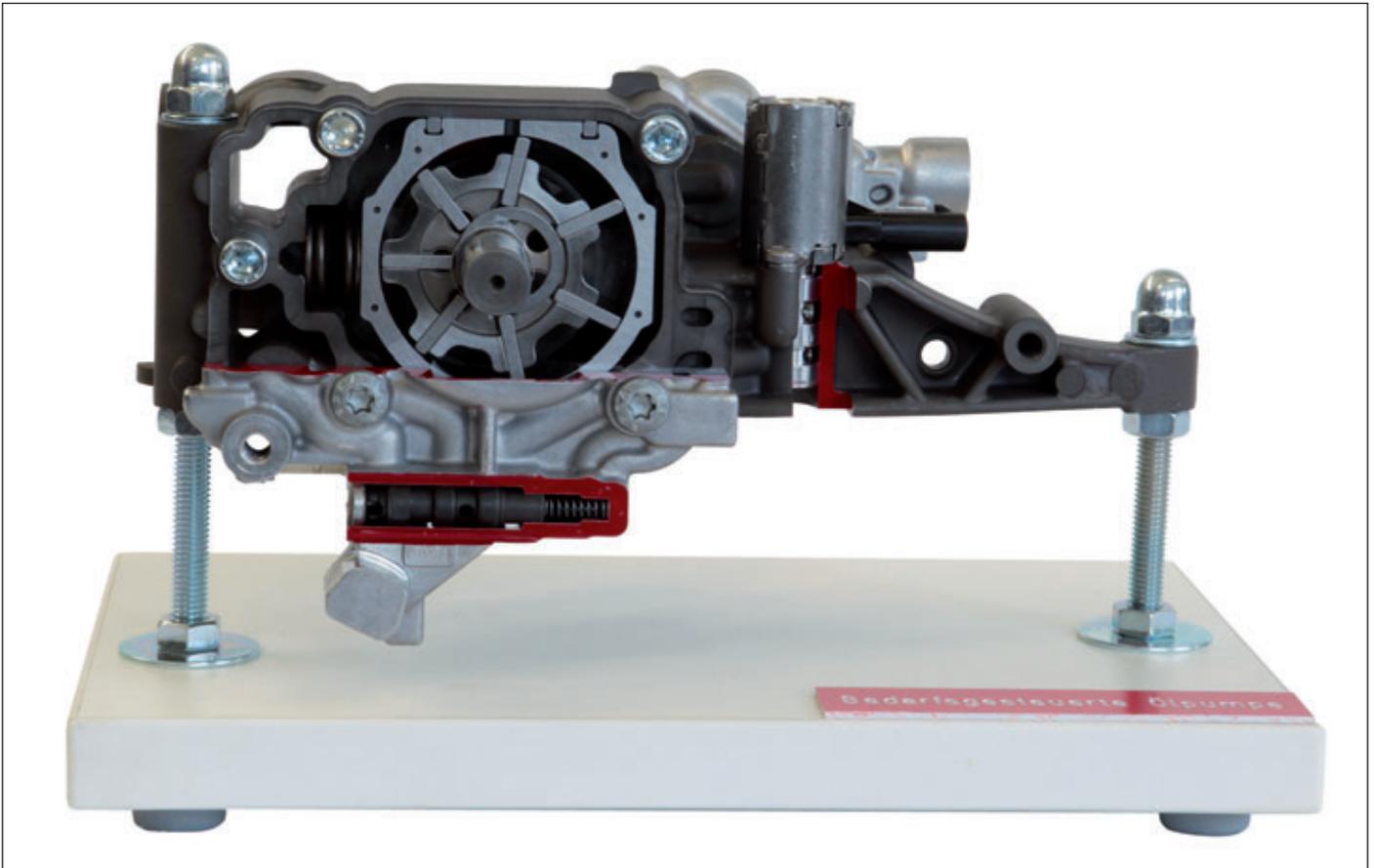


Electric fuel pump

Possible demonstrations:

- the pump runs when connected to a 12V-battery
- the pump can be taken apart
- the roller-cell pump has a Plexiglass cover so that all parts are visible

Order no. 1017



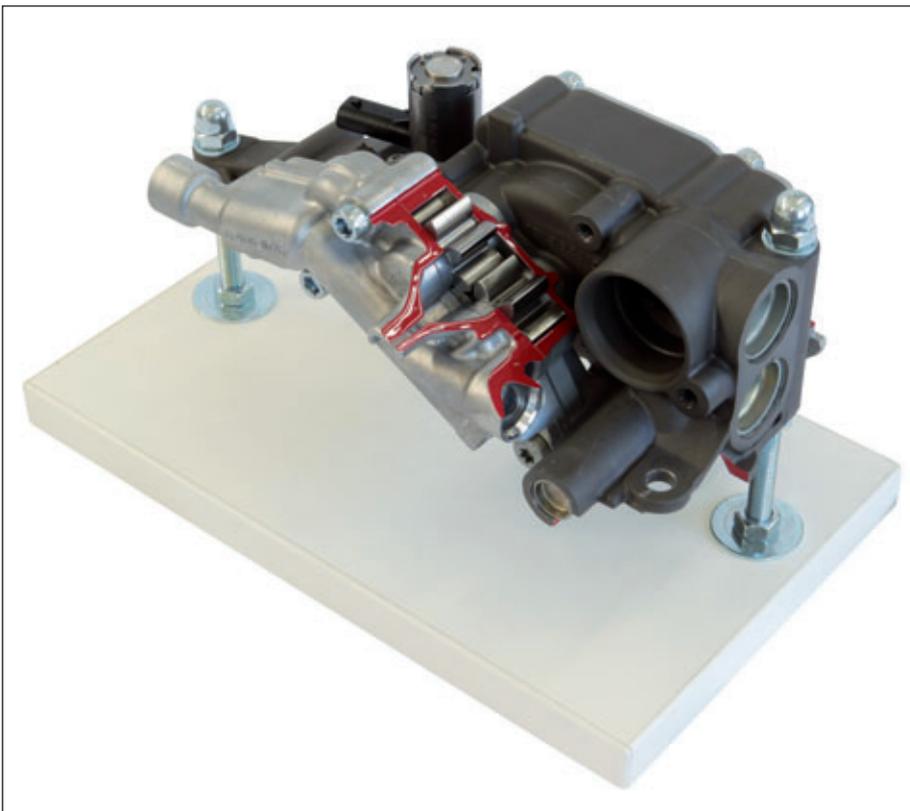
Demand-driven oil pump without suction stage (V6)

A newly developed vane-type oil pump with demand-driven quantity regulation and two map-controlled pressure stages is used in the new 6- and 8-cylinder V engines from Mercedes-Benz.

This control concept allows the engine lubricating and cooling points to be supplied independently of engine load and engine speed absolutely and with a significantly lower drive power particularly in the part-load range than would be possible with a non-controlled pump. The pump is easy to turn.

The following are easy to recognise:

- control piston
 - cold-start protection valve
 - valve for motor oil pump
 - rotor with vane
 - adjusting ring
- Order no. 1341



Demand-driven oil pump with suction stage (V8)

A newly developed vane-type oil pump with demand-driven quantity regulation and two map-controlled pressure stages is used in the new 6- and 8-cylinder V engines from Mercedes-Benz.

This control concept allows the engine lubricating and cooling points to be supplied independently of engine load and engine speed absolutely and with a significantly lower drive power particularly in the part-load range than would be possible with a non-controlled pump. The pump is easy to turn.

The following are easy to recognise:

- control piston
 - cold-start protection valve
 - valve for motor oil pump
 - rotor with vane
 - adjusting ring
 - toothed wheel for oil pump
- Order no. 1342



Exhaust gas re-circulation valve I

- function of the cut-away diaphragm box
- function of the valve in metering the recirculated exhaust gas

Order no. 1189



Exhaust gas re-circulation valve II

Modern exhaust gas re-circulation valve in which the valve, the vacuum unit and the throttle valve are directly integrated in the induction pipe. The throttle valve can be operated via the vacuum unit with the help of a syringe.

Order no. 1256



Exhaust gas re-circulation valve III

Modern exhaust gas re-circulation valve in which the valve and the vacuum unit are directly integrated in the induction pipe. Exhaust gas re-circulation is increasingly being used nowadays in petrol engines.

Order no. 1257



Clutch functional model

A diaphragm spring clutch is mounted so that it can be turned on a stable tubular steel frame. When engaged, power is able to flow between the disk flywheel and the clutch lining. By pressing the lever it can be seen how the release bearing tilts the outer edge of the diaphragm spring around the tilted rings, thus releasing the clutch disk. The power flow is interrupted.

Order no. 1211

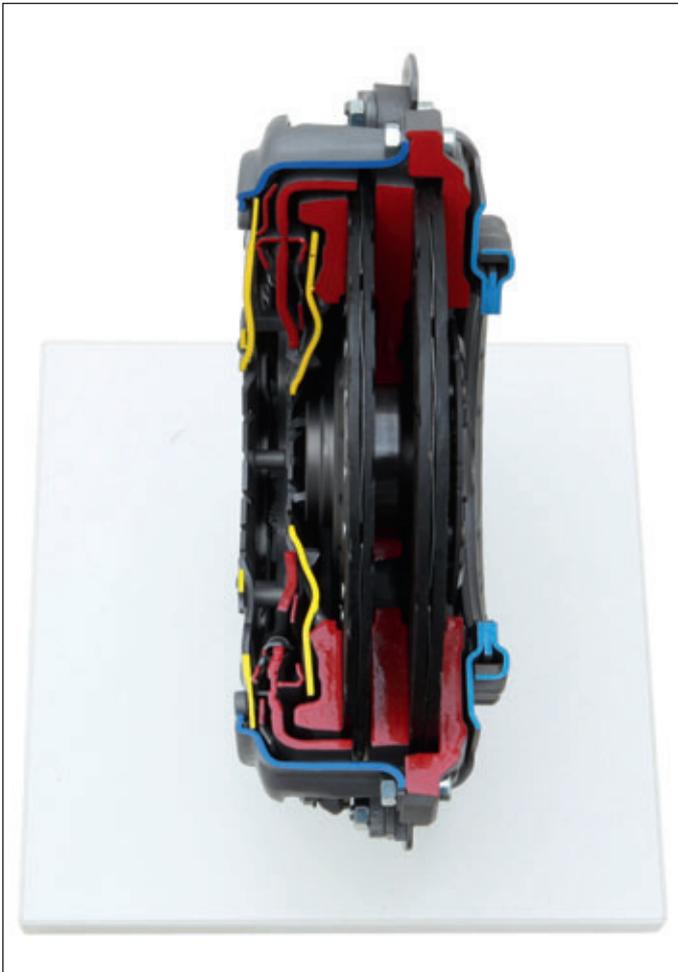


Clutch with adjustment for wear

As a result of the wear and tear on the driving disk, the position of the diaphragm spring alters, which means that the pressure from the diaphragm spring on the ramp-shaped setting rings drops.

The locking bolt has the effect that the setting rings turn as a result of the tension of the springs. In this way, the clearance between the diaphragm spring and the pressure plate is compensated.

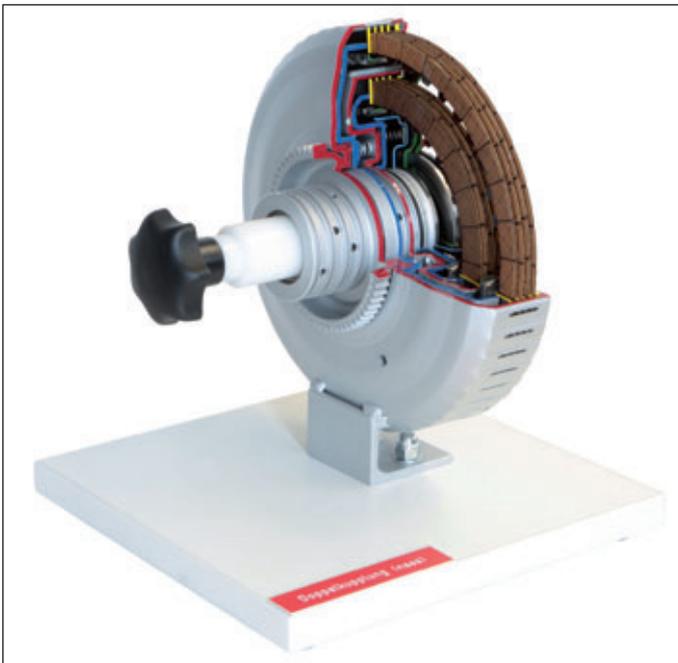
Order no. 1265



Dry duplex clutch

The clutch discs, cup springs and pressure plates are easy to see. Both clutch discs can be moved. The following can be shown: function of the intermediate drive plate, flow of force from clutch 1 and 2, how the cup springs work, different sizes of clutch discs.

Order no. 1334



Wet duplex clutch

Both clutches can be turned by a star handle. The actuation of the clutches can be demonstrated by compression of the discs.

The following are easy to recognize:

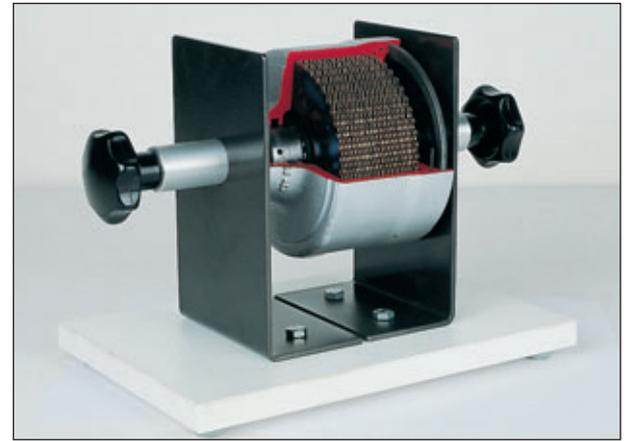
- secondary plate and friction disc
- disc carrier
- hydraulic piston
- coil spring packages
- axial needle bearing

Order no. 1345



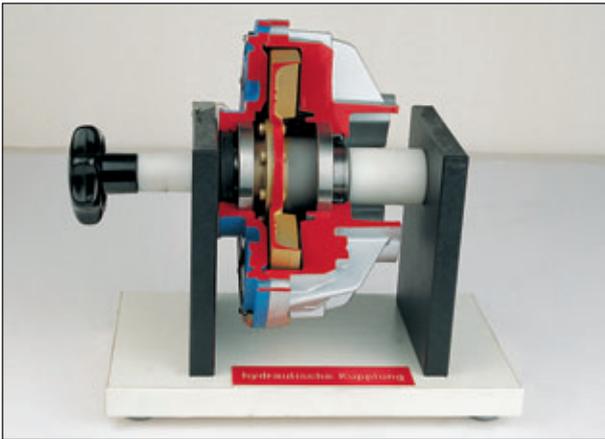
Multi-disk clutch

Design of a multi-disk clutch (without disengaging gear). This clutch has a number of internal and external disks in its basket, which means that a large torque can be transmitted despite a small diameter. The pressing force of the disks results from a number of helical springs. Order no. 1266



Viscous clutch

– all externally toothed discs are fixed to the housing
 – all internally toothed discs are fixed to the driving shaft
 – power transmission is attained via the shearing effect of the silicone fluid between the slots and the holes in the discs (in the cutaway model there is no silicone fluid)
 Order no. 1139



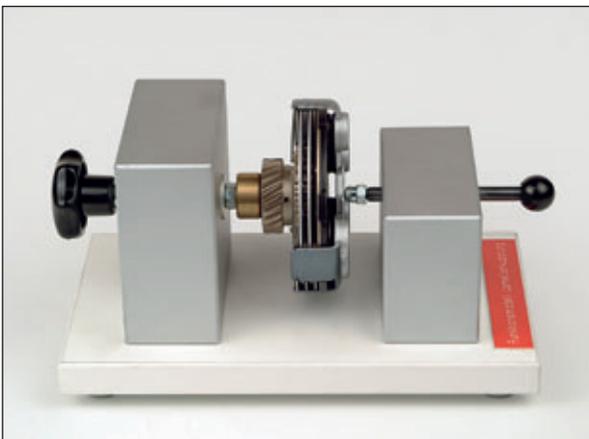
Hydraulic coupling

Also called fluid clutch.
 – function of the pump wheel
 – function of the turbine wheel
 – mounting of the turbine wheel
 Order no. 1160



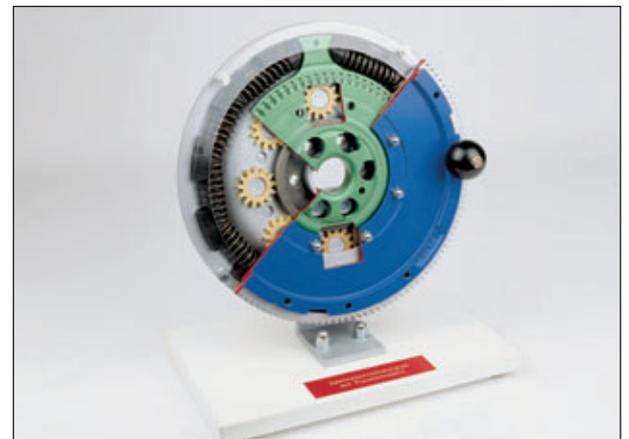
Multi-disk clutch for mopeds

Interaction of piston, connecting rod, crankshaft and clutch.
 No power flow at low revs.
 Power flow at high revs by means of flyweights.
 Power flow on pressing the starting lever.
 Order no. 1155



Multi-disk clutch

This kind of clutch is mainly used in two-wheel vehicles. It comprises a number of friction disks with external tothing and steel disks with internal tothing alternately arranged behind one another. The necessary application pressure is generated by coil or diaphragm springs. Our model has been installed in a Vespa.
 Functions: – turning of the clutch in the engaged state: flow of force
 – pressing the clutch: clutch has now been released
 – turning the clutch in the released state: flow of force interrupted
 Order no. 1324



Planetary dual-mass flywheel

– rotation of the secondary flywheel mass against the primary flywheel
 – pressing the springs together in their guide shoes to absorb vibrations by ignition-induced rotary unevenness of the motor
 – acceleration of the planetary wheels, which attenuate the vibrations of the springs thanks to their friction
 Order no. 1293



Dual-mass flywheel with centrifugal pendulum-type absorber

The structure of a dual-mass flywheel can clearly be seen.

Functions:

Pendulum function

Function of the bow spring during rotary oscillations

Function of the damping for primary and secondary mass

The primary flywheel mass can be turned against spring force on the model

Order no. 1336



LUK dual-mass flywheel

– structure of a dual-mass flywheel

– function of the pressure springs when subject to torsional vibrations

– function of the torsional-vibration damper between primary and secondary flyweights. The primary flyweight on the model can be turned against the force of the springs

Order no. 1157



Model case Clutches

– hydraulic clutch control mechanism

– a pressure plate with coil springs and release levers

– a complete diaphragm spring clutch with flywheel

– two flexible clutch disks with torsional-vibration damping Linings:

synthetic fibres and sintered metal

– a clutch disk prepared for the demonstration of the torsional-vibration

damping. Clutch release bearing and release lever.

Order no. 1226

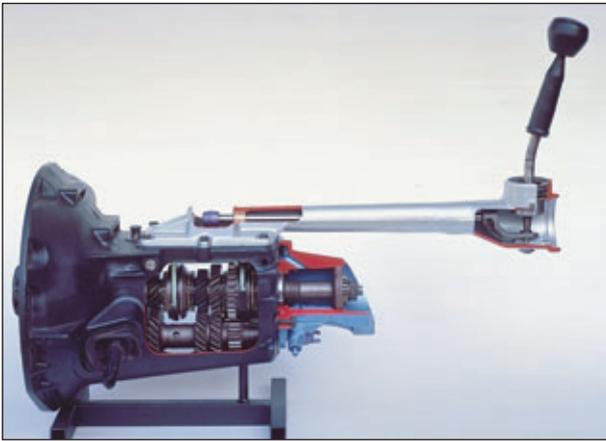


Clutch master cylinder and slave cylinder

Function and interaction of the master cylinder and slave cylinder of

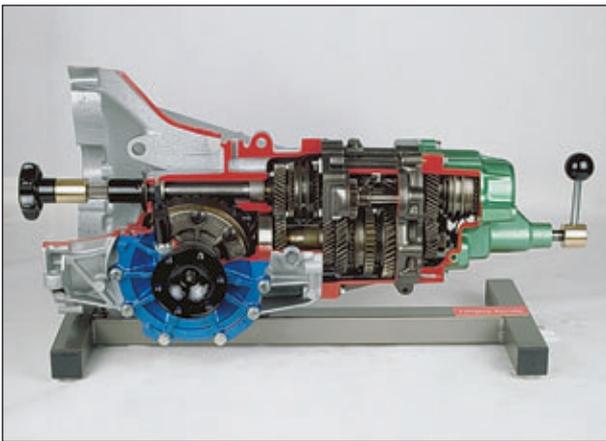
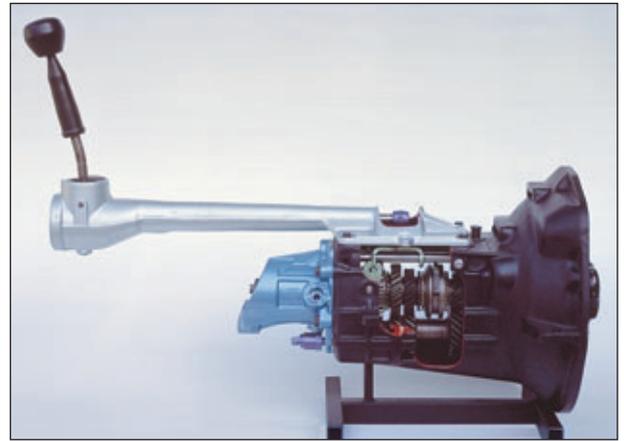
a hydraulically-operated clutch. Function of the bleeding of the unit.

Order no. 1166



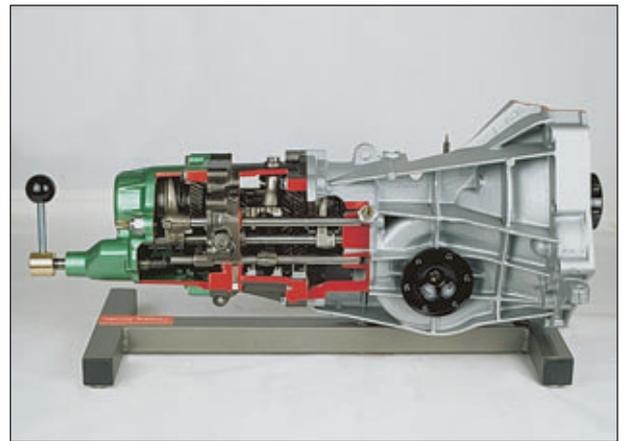
Four-speed transmission with locking synchronization

- the transmission is cut wide open at the front and back
 - all gears can be shifted
- Order no. 1002



Five-speed transmission with differential

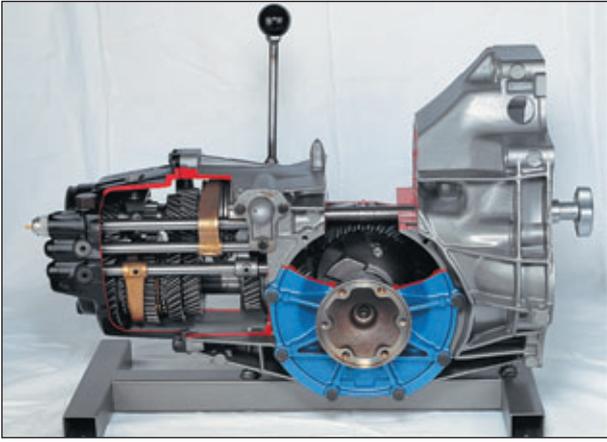
- Demonstration:
- shifting all gears
 - synchromesh
 - function of differential
- Order no. 1089



Four-speed front transmission (VW Golf)

- Layout of the entire transmission front, upper part and rear widely cut open
- smooth shifting of all gears
 - function of the spur-gear differential
 - function of the synchromesh
- Order no. 1132





Four-speed transmission with differential

Possible demonstrations:

- shifting all gears
- function of a differential gear
- synchronization

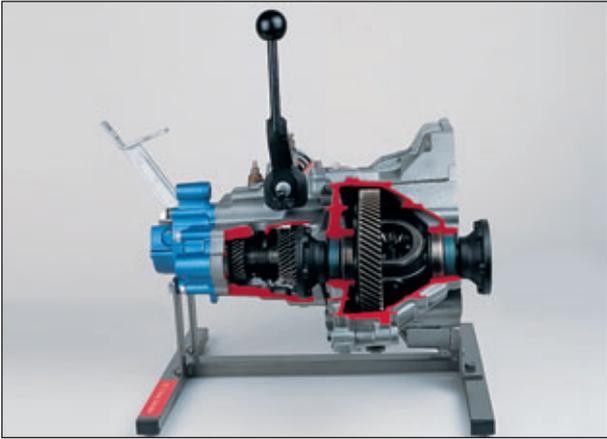
Order no. 1054



Transfer case

- power flow and power distribution in the transfer case
- shifting of the off-road gear and road gear
- function of the differential in the transfer case
- differential lockup

Order no. 1121

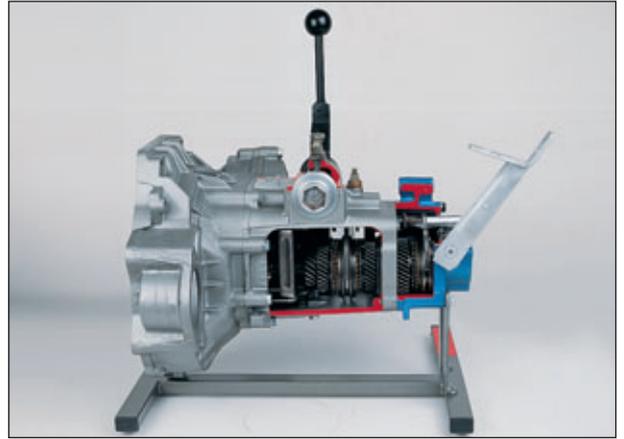


Five-speed front transmission (VW Golf)

Layout of the entire transmission front, upper part and rear widely cut open

- smooth shifting of all gears
- function of the spur-gear differential
- function of the synchromesh

Order no. 1133



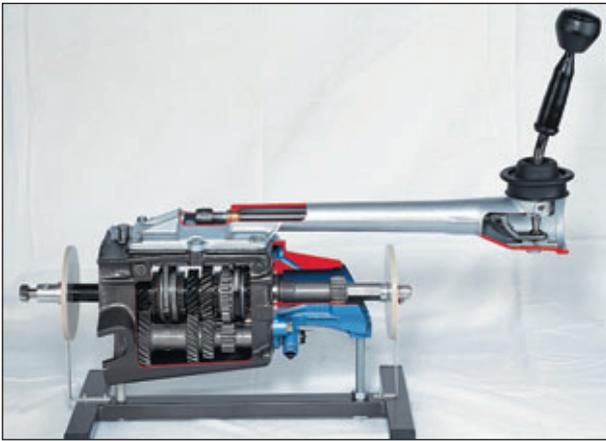
Modern five-speed front transmission with differential

(Mercedes-Benz A Class)

- Flow of power from the drive shaft to the output shaft and differential.
- Very smooth shifting of all gears.
- Locking device to prevent the selection of reverse gear from fifth gear.
- Control of the hydraulic clutch mechanism.

Order no. 1199





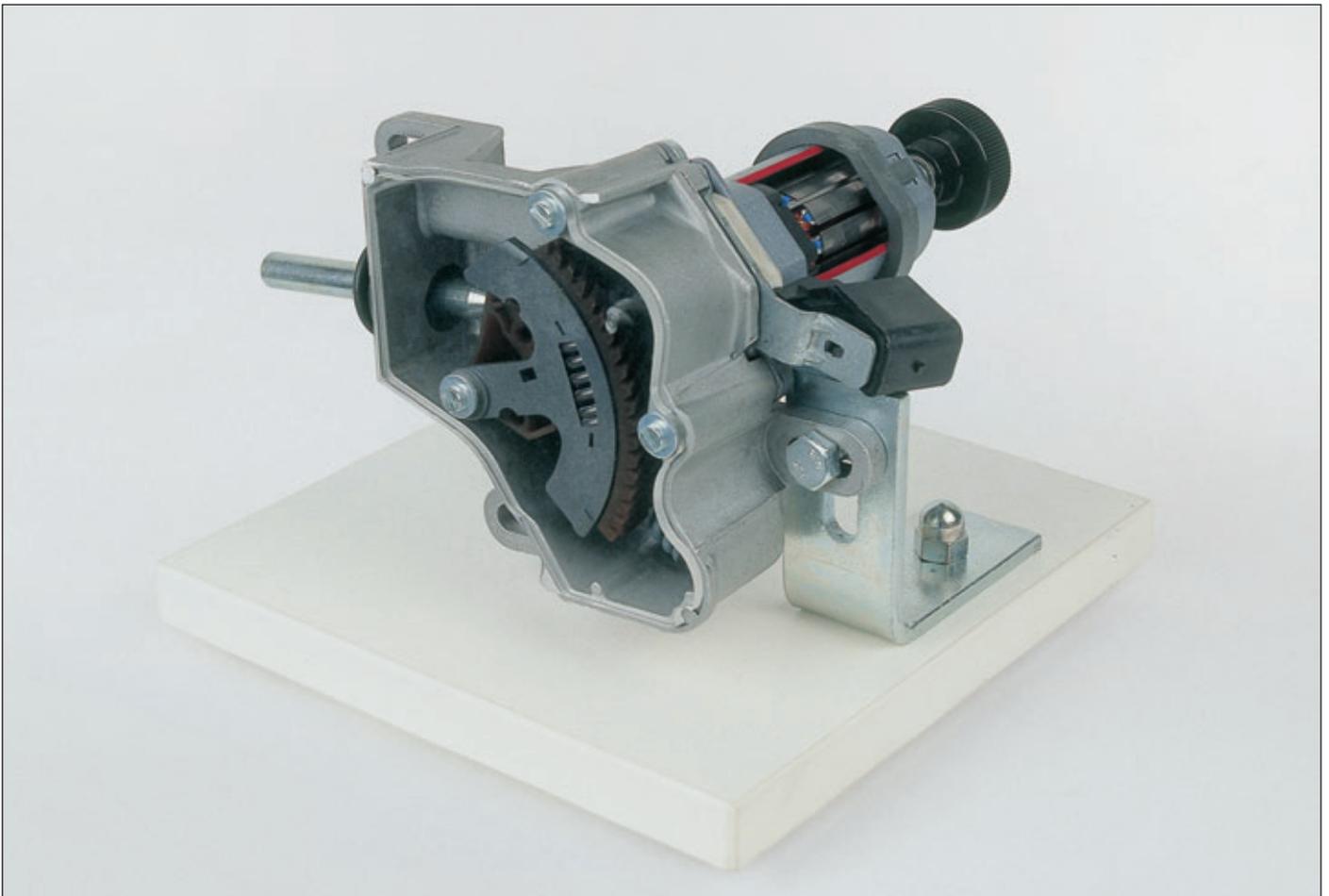
**Four-speed transmission,
suited for the technology lab**

Functions:

- shifting all gears
- synchronization



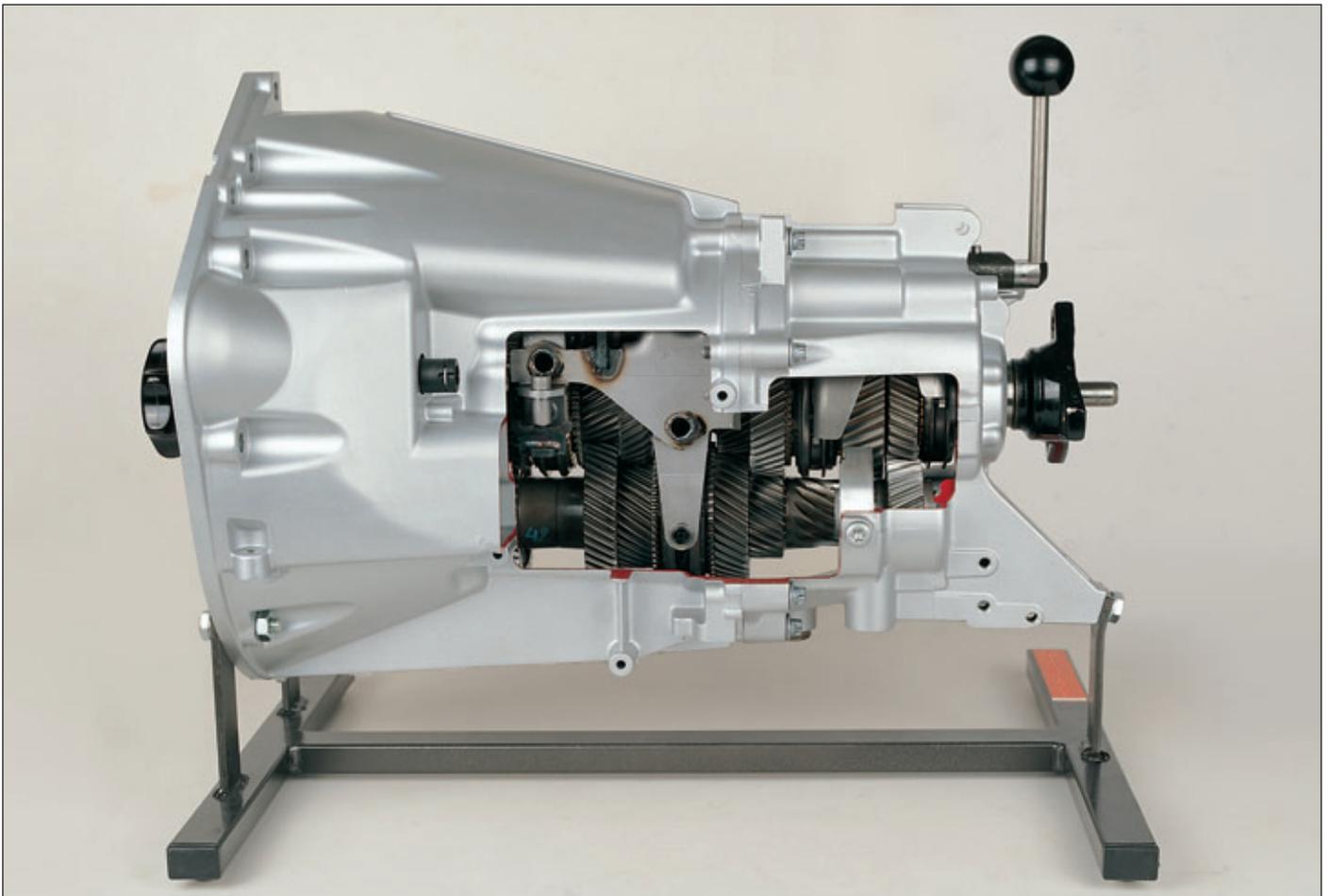
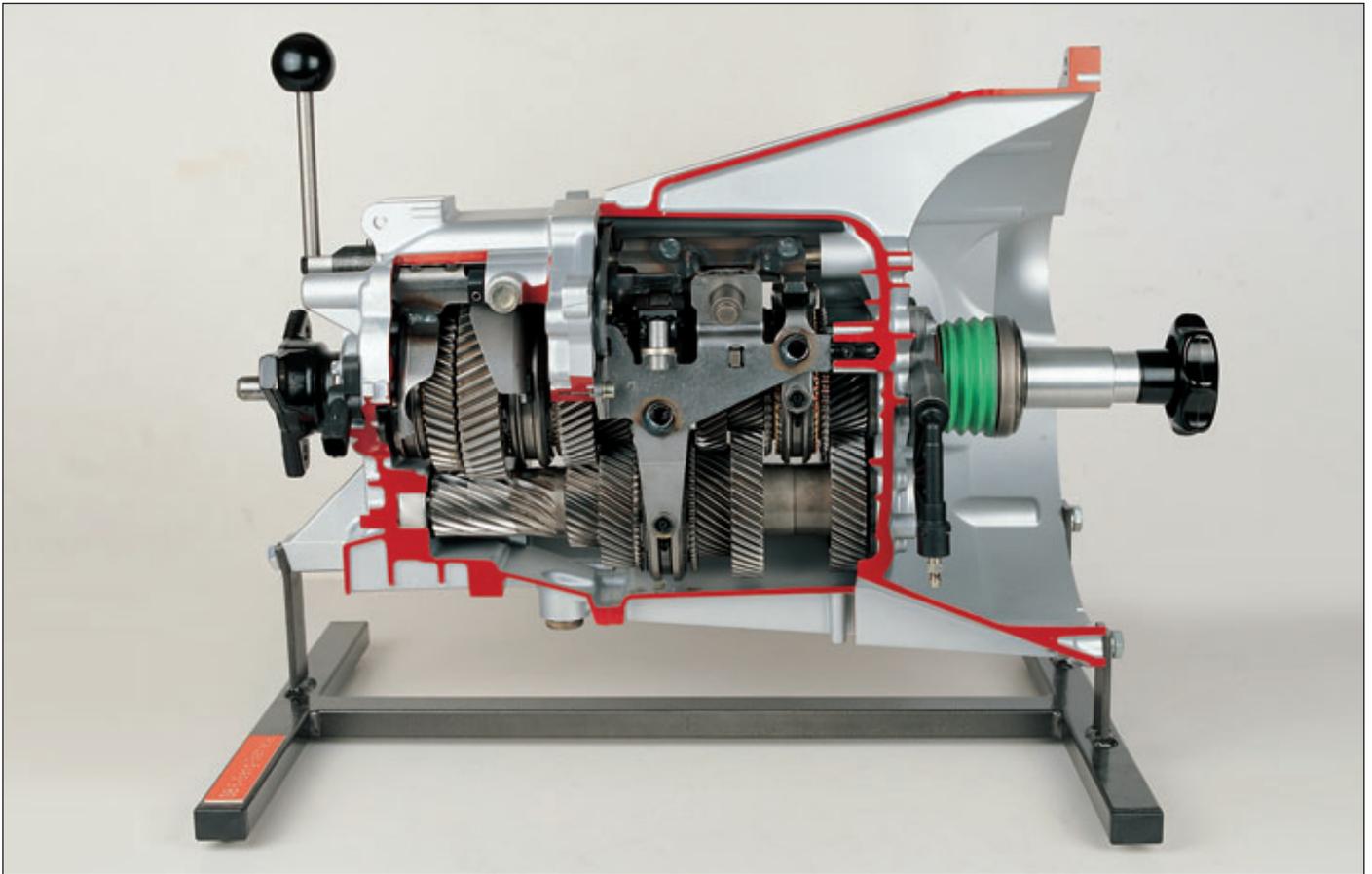
- measuring the torques in all the gears
 - measuring and calculation of the gear-ratios in all gears using a graduated scale
- Order no. 1055



Clutch actuator

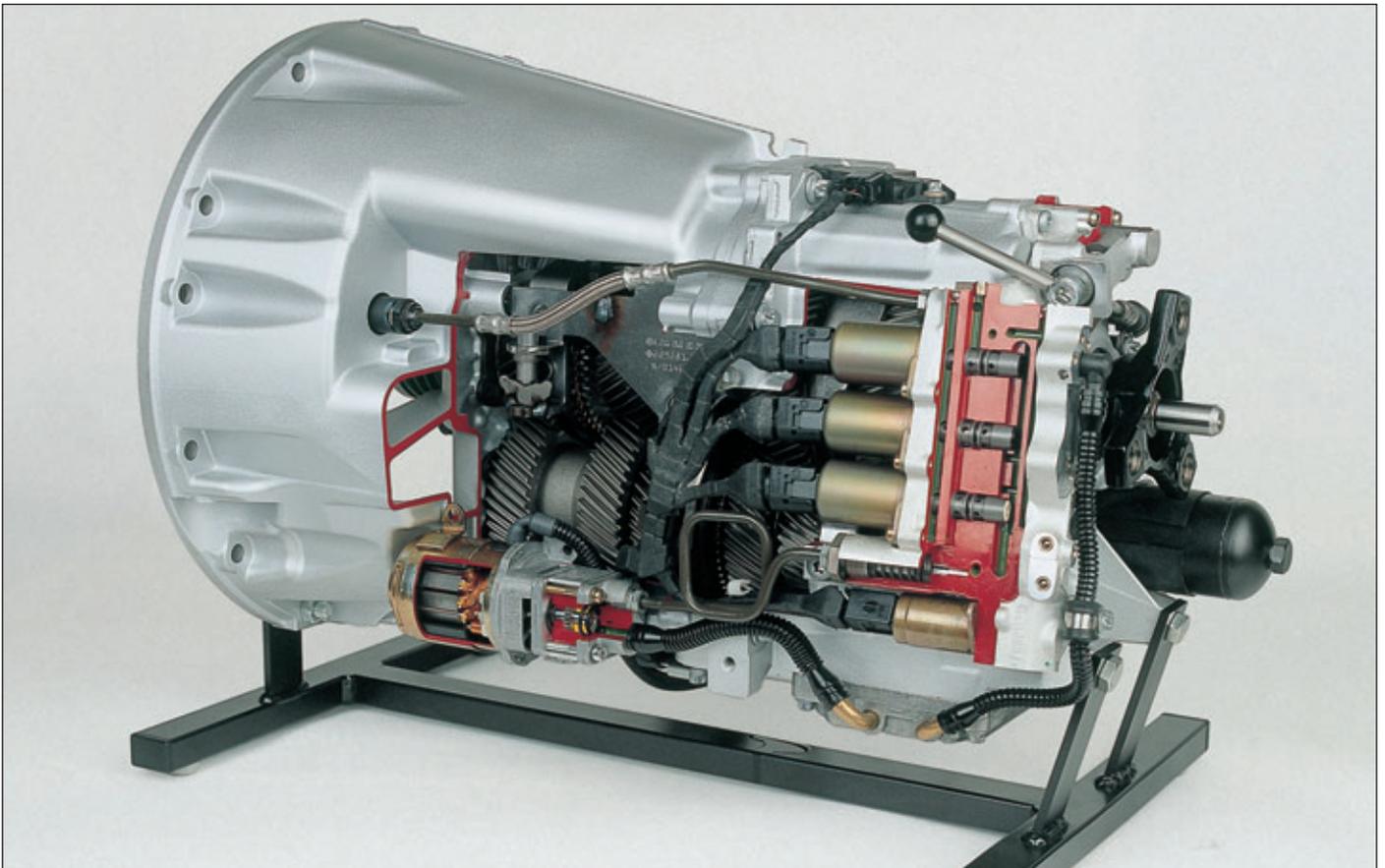
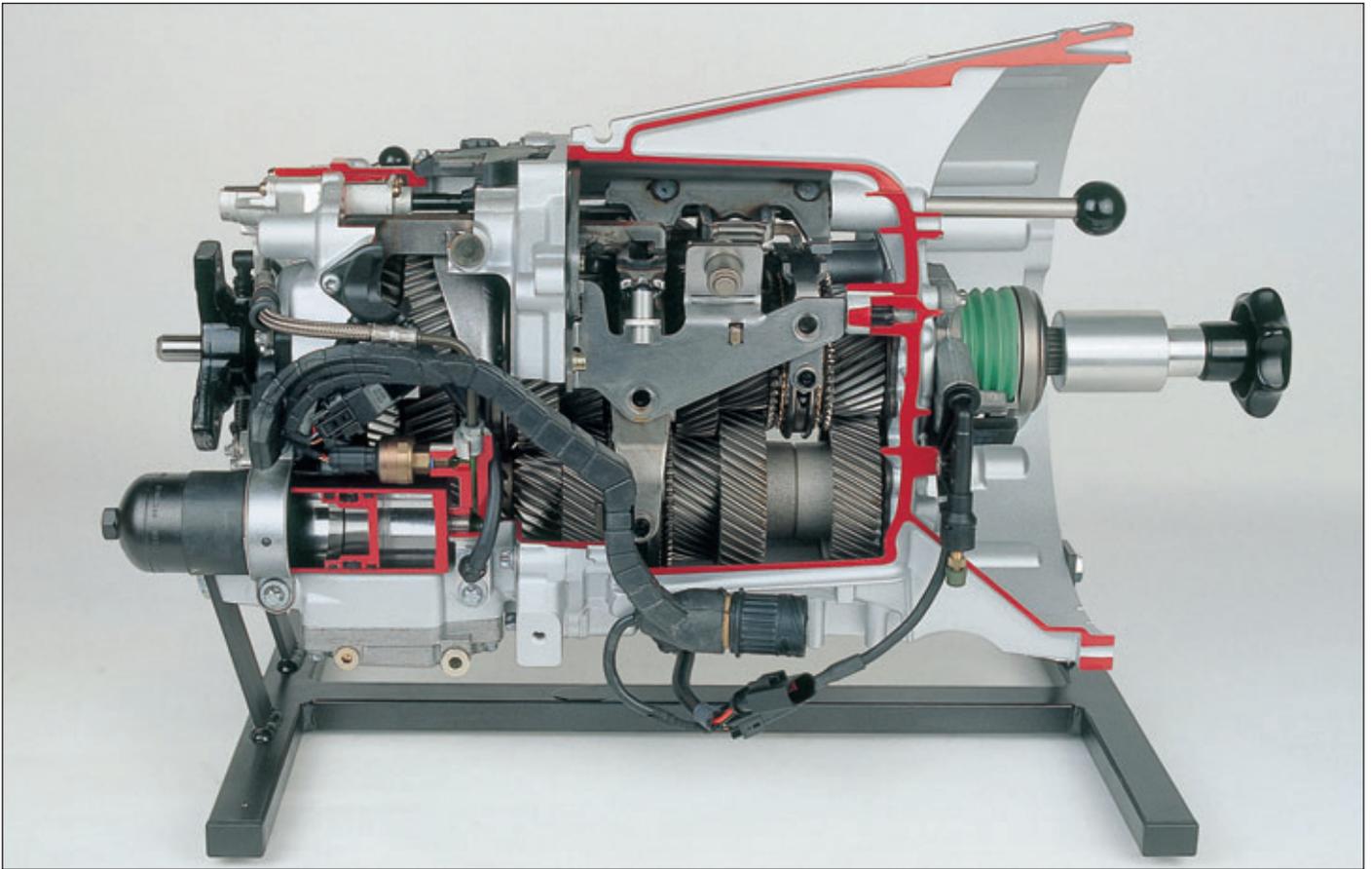
An electric motor drives a segment of a worm wheel via a worm. The worm wheel presses the release pin forwards, thus separating the flow of power in the clutch. The large tensioning forces to separate the clutch are taken over by a strong spring, which means that the electric motor only supplies the torque to overcome the friction. A button can be used to turn the electric motor and to demonstrate the release process. The installed pane of Plexiglas means that everything can be seen easily.

Order no. 1285



Mercedes-Benz 6-gear transmission

This new construction is an equal-axle three-shaft transmission with 6 forward and one synchronised reverse gear. The shift elements are distributed on 2 shafts. Operation of the clutch is done automatically via a hydraulic central disengaging gear. The transmission can easily be turned in neutral. All the gears can be shifted and the flow of force shown.
Order no. 1255



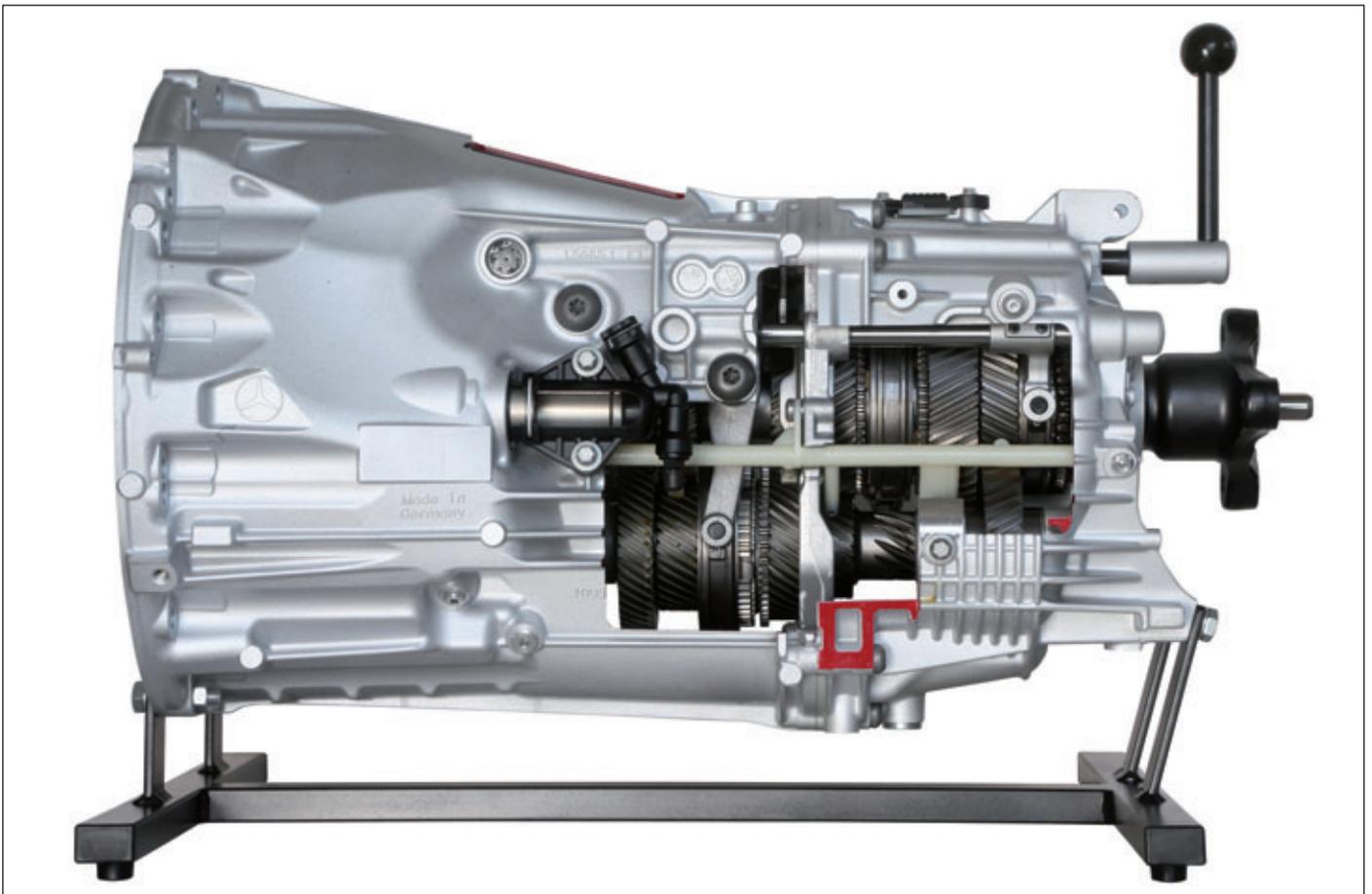
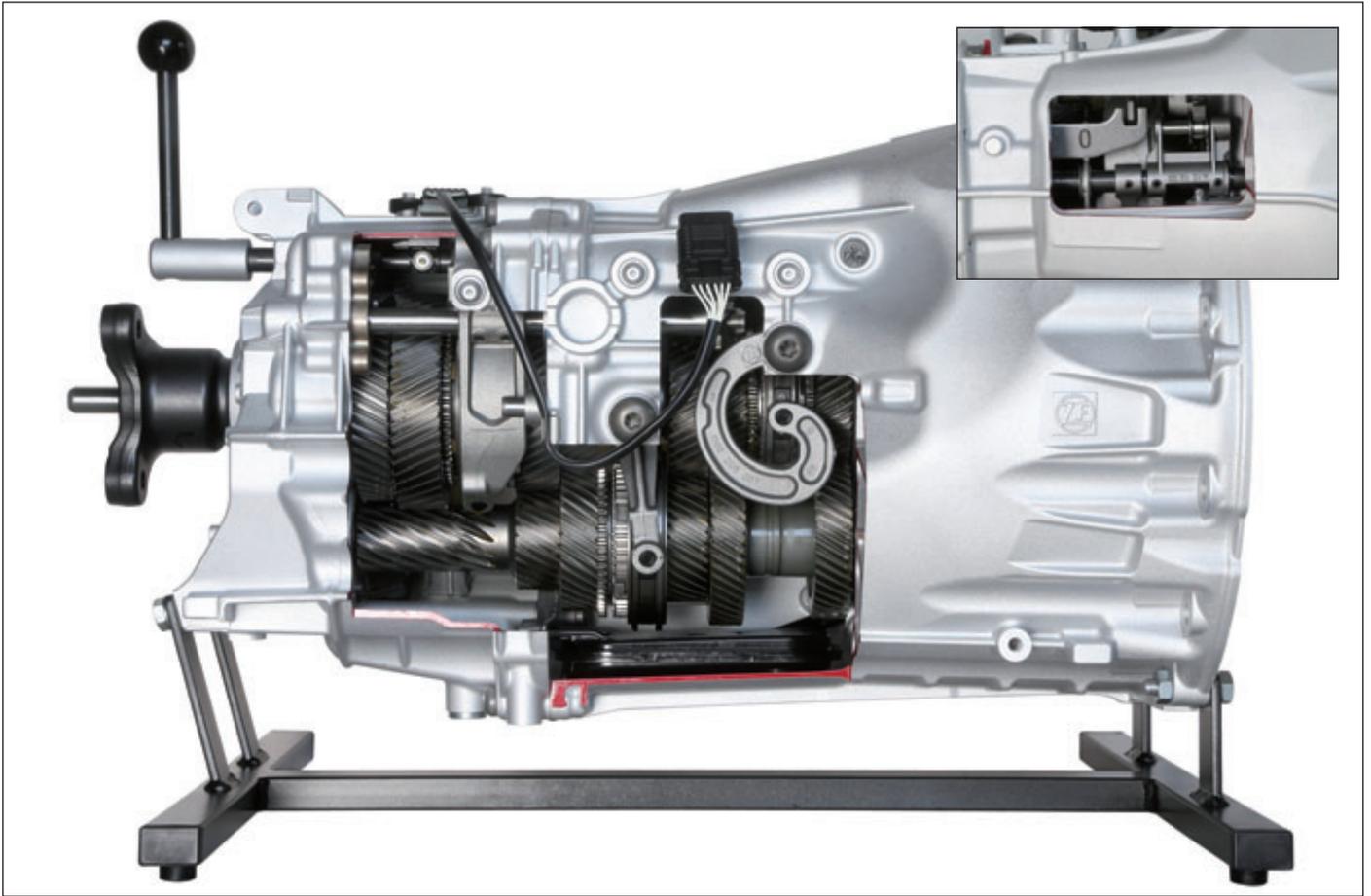
Automatic sequential six-gear transmission (Mercedes-Benz)

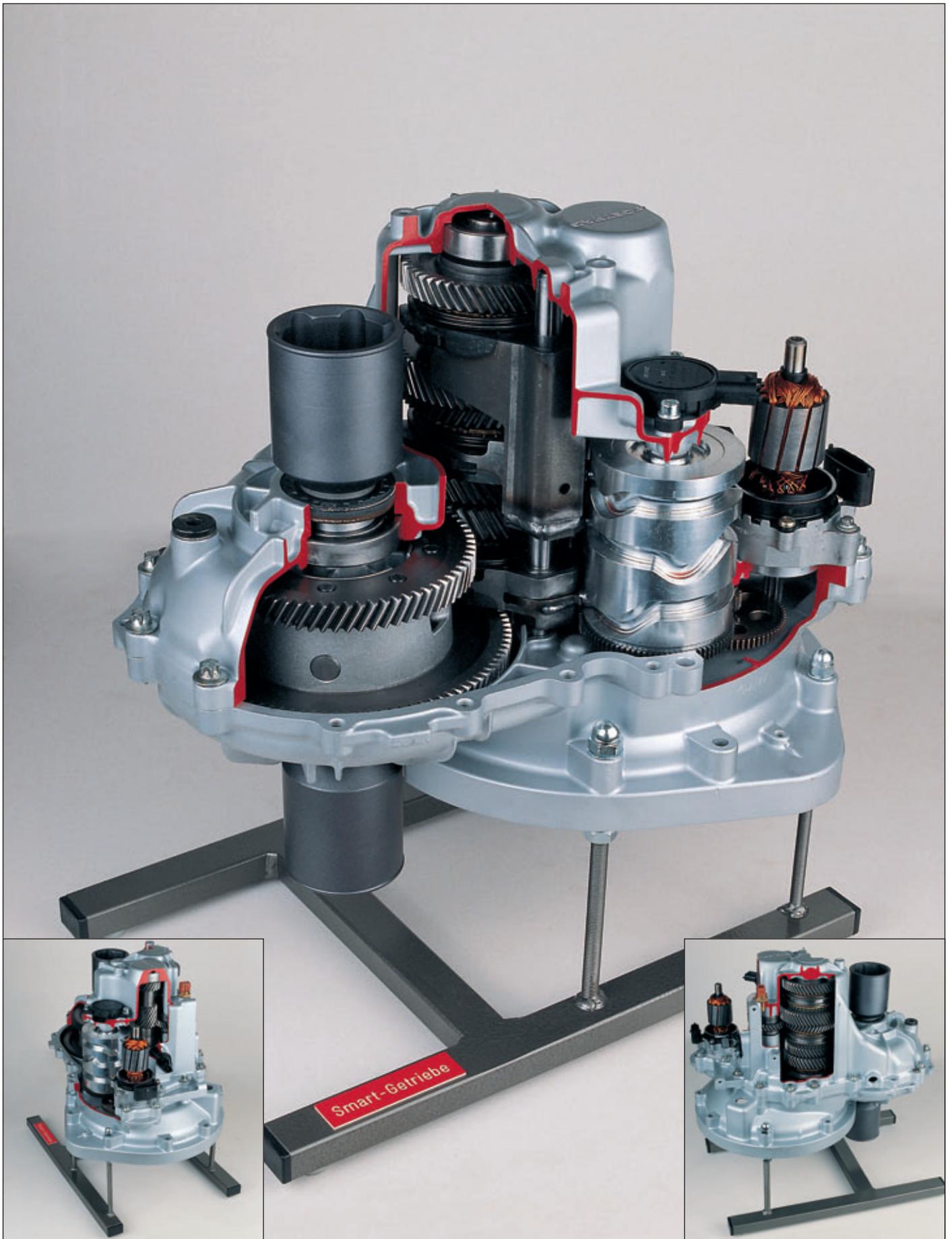
The automated, sequential six-gear transmission developed from the classical six-gear manual transmission is controlled by the engine management. With the help of a hydraulic piston, 2 gears can be shifted on each shift level. To change to another shift level, a gate sleeve, which had been able to rotate loosely up to then, is arrested by a second hydraulic piston. In this way, the old gear is firstly removed and then the selector shaft turned onto a different shift level by a pin in the arrested gate sleeve when the inlet selector shaft is displaced by the first hydraulic piston. Now, shifting into the next gear is possible. The installation of a gearshift rod with a button and a mechanical clamping lever means that all the gears can be shifted and the function of the hydraulic controls demonstrated. The following are cut away: transmission housing front and back, hydraulic pump with electric engine, hydraulic unit and the hydraulic pressure accumulator. Order no. 1282

Six-speed ZF manual transmission

A six-speed manual transmission of the latest generation by ZF. It can be turned and completely interconnected. The gear wheels and the synchronisations are easy to recognise: The transmission is installed in the new Mercedes-Benz C-Class.

Order no. 1360

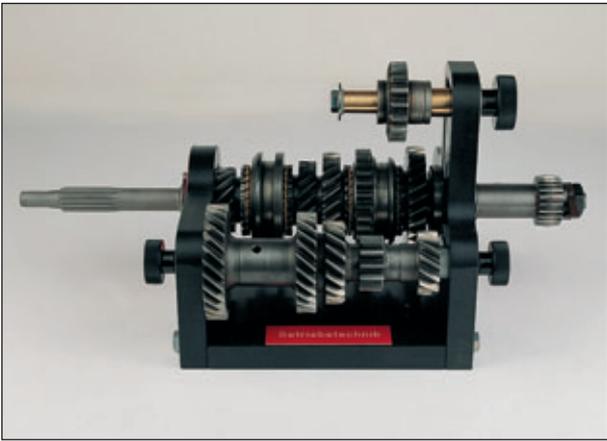




SMART gearbox

The new construction from the firm of GETRAG is a mechanical shift gear with 6 forward gears and one reverse gear. The shifting of the gearbox is done by an electric motor via a gear wheel transmission onto a gear selector drum. The slide shoes of the gearshift rods engage into the groove tracks of the gear selector drum. For the differential, 2 differing transmission ratios can be shifted, which means that 6 forward gears result from the 3 forward gears of the main shaft. In shifting, an automatic clutch actuator takes over the clutch engagement and de-clutching. The gearbox is supplied as a semi-automatic or fully automatic gearbox. All the gears can be shifted by turning the electric motor. The function of the differential is also easily visible.

Order no. 1238

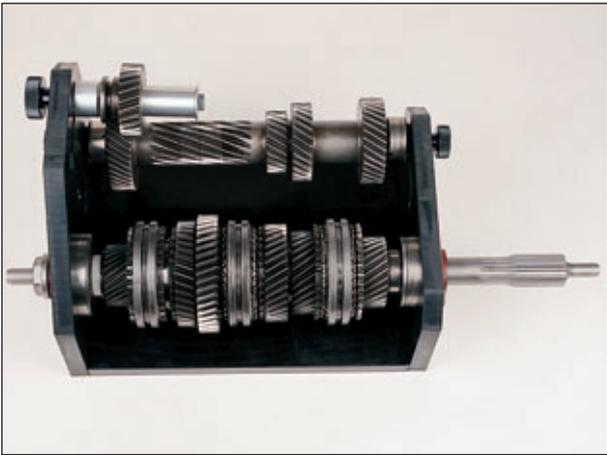


Transmission technology

Function of the drive shaft, main shaft, countershaft and the reverse gear. Interaction of the individual shafts.

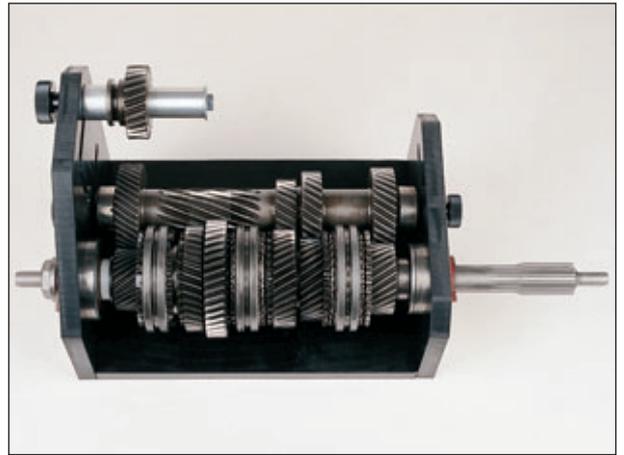


Shifting of all gears, power distribution. Calculation of the different transmission ratios. Order no. 1169

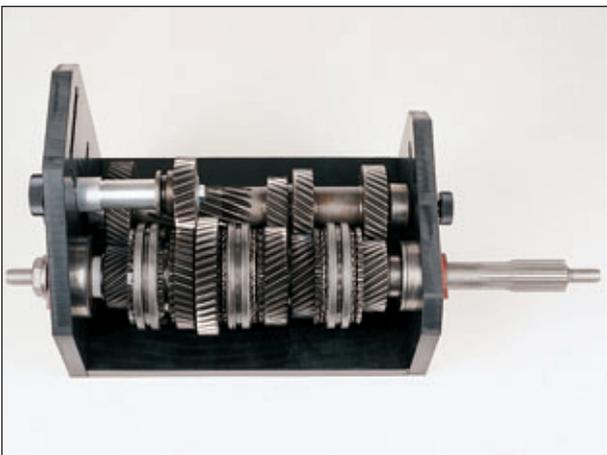


Transmission technique: 5-gear transmission

Function of the drive shaft, main shaft, countershaft and the reverse gear wheel
Set-up of a 5-gear transmission
Pushing together of the individual shafts
Switching of all the gears, flow of force in the various gears.



Calculation of the gear ratios in all the gears
Extensive operating instructions with worksheets for pupils and teachers
Order no. 1248

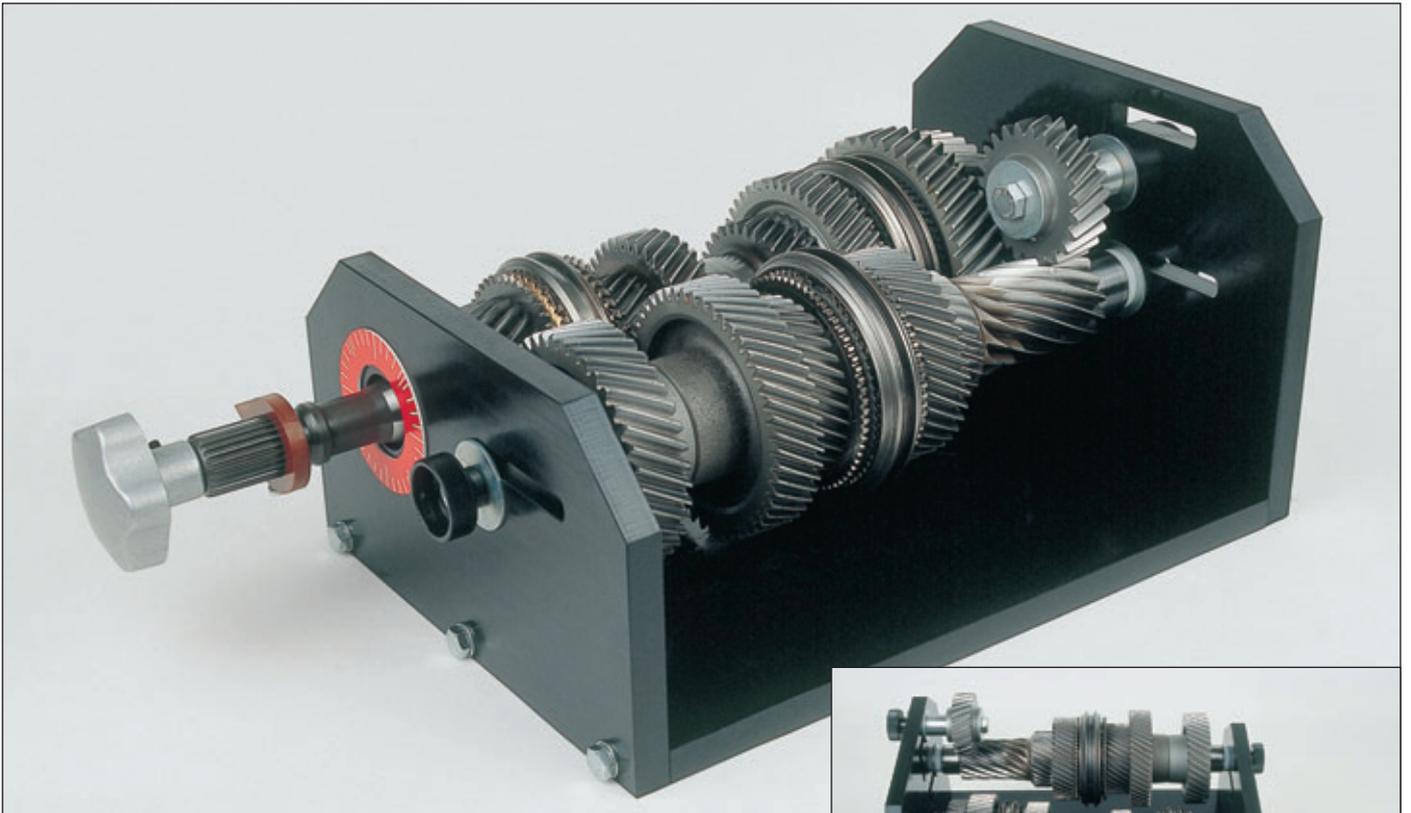
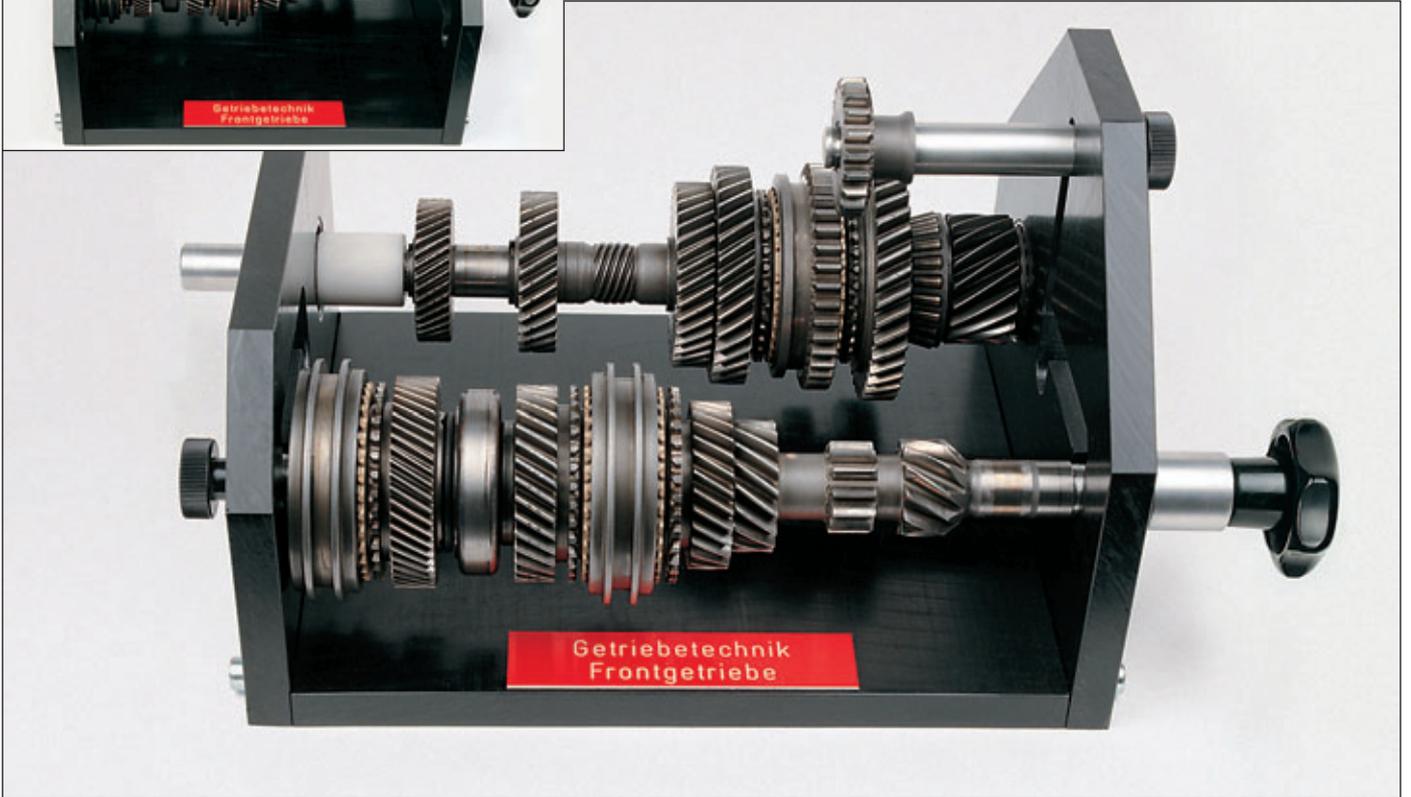




Functional model: Transmission technology, five-gear front transmission

Design of a two-shaft transmission for vehicles with front-wheel drive. Pushing together of the transmission shafts. Shifting of all gears, observation of flow of force in the individual gears. Reading and calculation of the various transmissions.

Order no. 1273

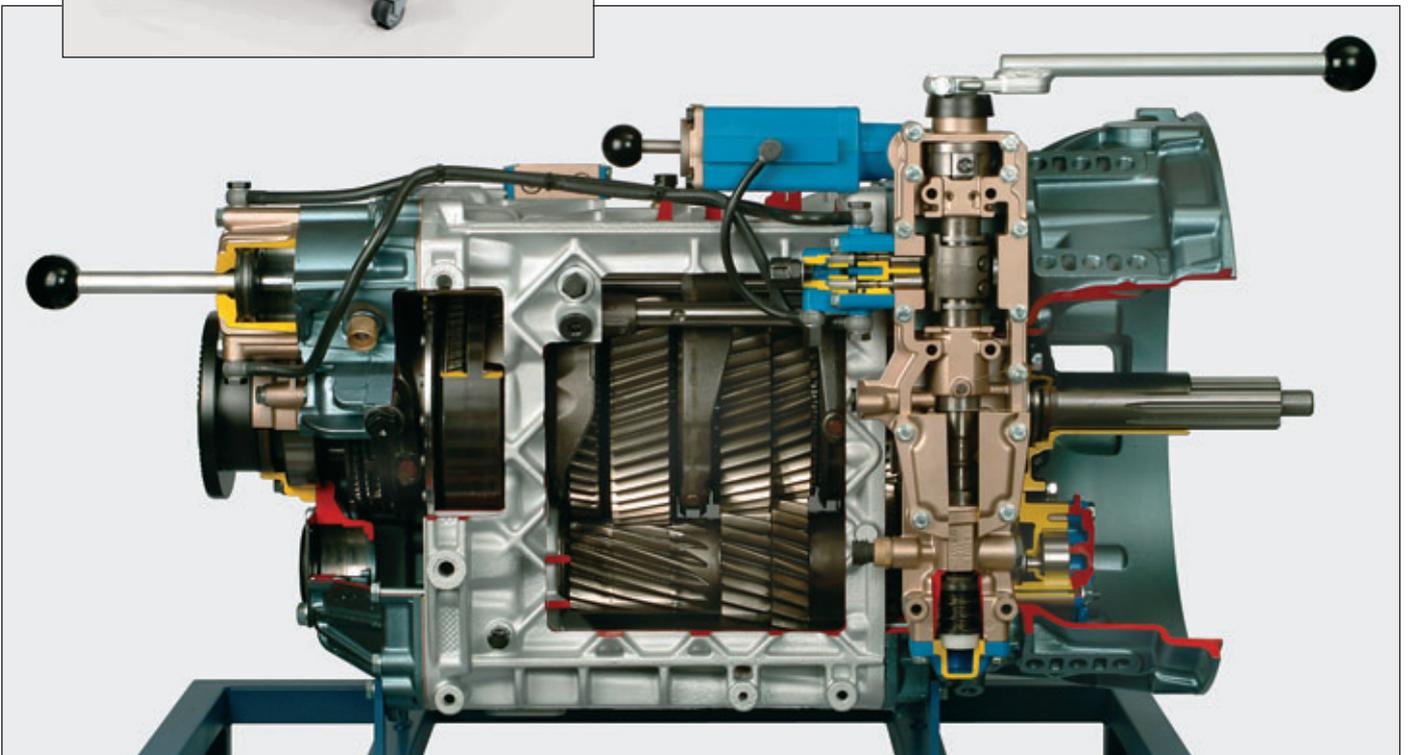
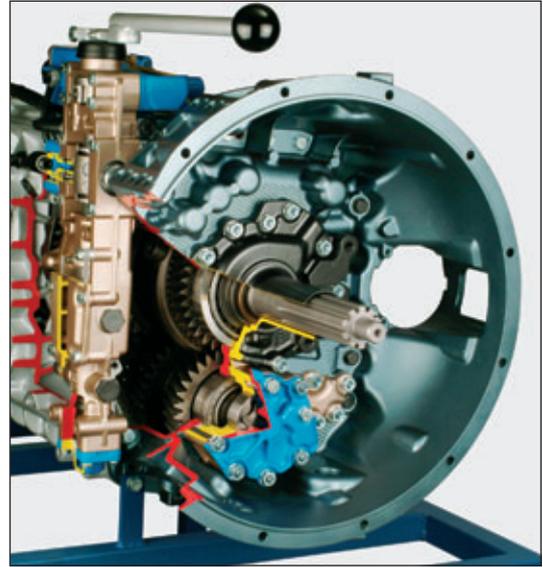
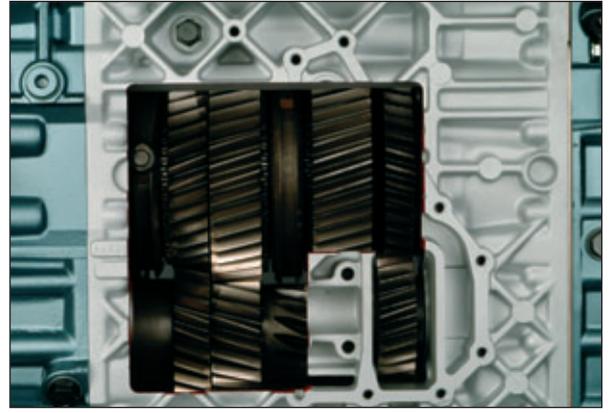
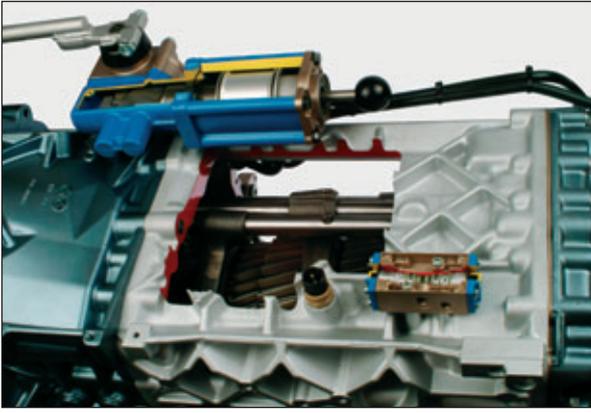


Transmission technique: six-gear transmission

- set-up of a equal-axled three-shaft transmission
- pushing together and separation of the shafts
- insertion of the reverse pinion
- shifting the 6 forward gears and the reverse gear
- reading and calculation of the various ratios

Order no. 1278





Truck transmission ZF-ECOSPLIT

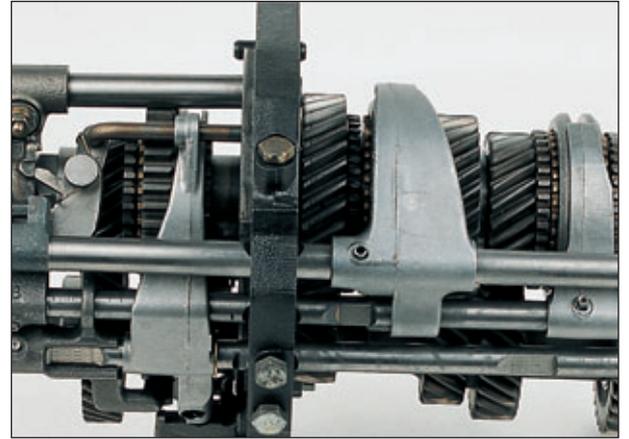
The transmission has 4 forward gears and one reverse gear. By a different transmission onto the countershaft, the split group makes it possible for 4 further gears each to be found between the 4 other gears to be shifted. A planetary gear train acts as a rear-mounted group, with the result that the 8 gears can be used in fast mode or in slow mode. In this way, a total of 16 gears is available. The rear-mounted group and the 4 basic gears are shifted mechanically on the mo-

del, the split group pneumatically. Transmission input shaft, main shaft, countershaft and reverse gear, the control forks with gearshift linkage, pneumatic cylinder and the rotor oil pump are very easy to see. As the transmission has a weight of about 320 kg, it has been fitted on a trolley. Order no. 1308



Five-speed transmission assembly model

This assembly model is well-suited to pupils' own use. Without a puller and press the transmission can be taken apart and reassembled. The following can be learnt from it:



Various synchromesh mechanisms, shifting locks and shifting catches, the shifting of all gears including reverse gear, the function of the gearshift rods and the gearshift forks. Order no. 1212



Assembly of a Borg-Warner synchromesh

Main shaft stub, mounted on stands, for dismantling and assembly of two gears, including tool. A synchronising unit was prepared so that it can be



assembled without a puller and press. Particularly suitable for producing a work schedule. The gears can be shifted easily. Order no. 1101



Assembly of a Porsche synchromesh

Main shaft stub, mounted on stands, for dismantling and assembly of two gears, including tool. A synchronising unit was prepared so that it can be



assembled without a puller and press. Particularly suitable for producing a work schedule. The gears can be shifted easily. Order no. 1102



Assembly of complete main shaft

A complete main shaft with drive shaft has been prepared so that it can be dismantled and assembled without press and puller. The tool is supplied.



The correct assembly can be checked with the aid of the countershaft. The gears can be shifted easily. Order no. 1100



Students assembly set, main shafts

includes the following: 5 main shafts – different makes (Mercedes-Benz, Opel, Ford, VW). Functions as described above.

Order no. 1147



Students assembly set - Borg Warner synchromesh

includes the following: 5 different main shaft stubs, i.e. main transmission shafts of vehicles with front wheel drive. Makes: Opel, VW, Ford. Functions as described above.

Order no. 1148



Model case Variable-speed transmission I

Four-speed transmission with drive shaft, main shaft and countershaft for rear-wheel drive (equal-axle transmission). All components are clearly visible and arranged in the correct order: shafts, gear wheels, synchronizer body, sliding sleeves, synchronizer rings, sliding blocks, springs and bearings. Everything has been prepared so that the shafts can easily be put together. Order no. 1218



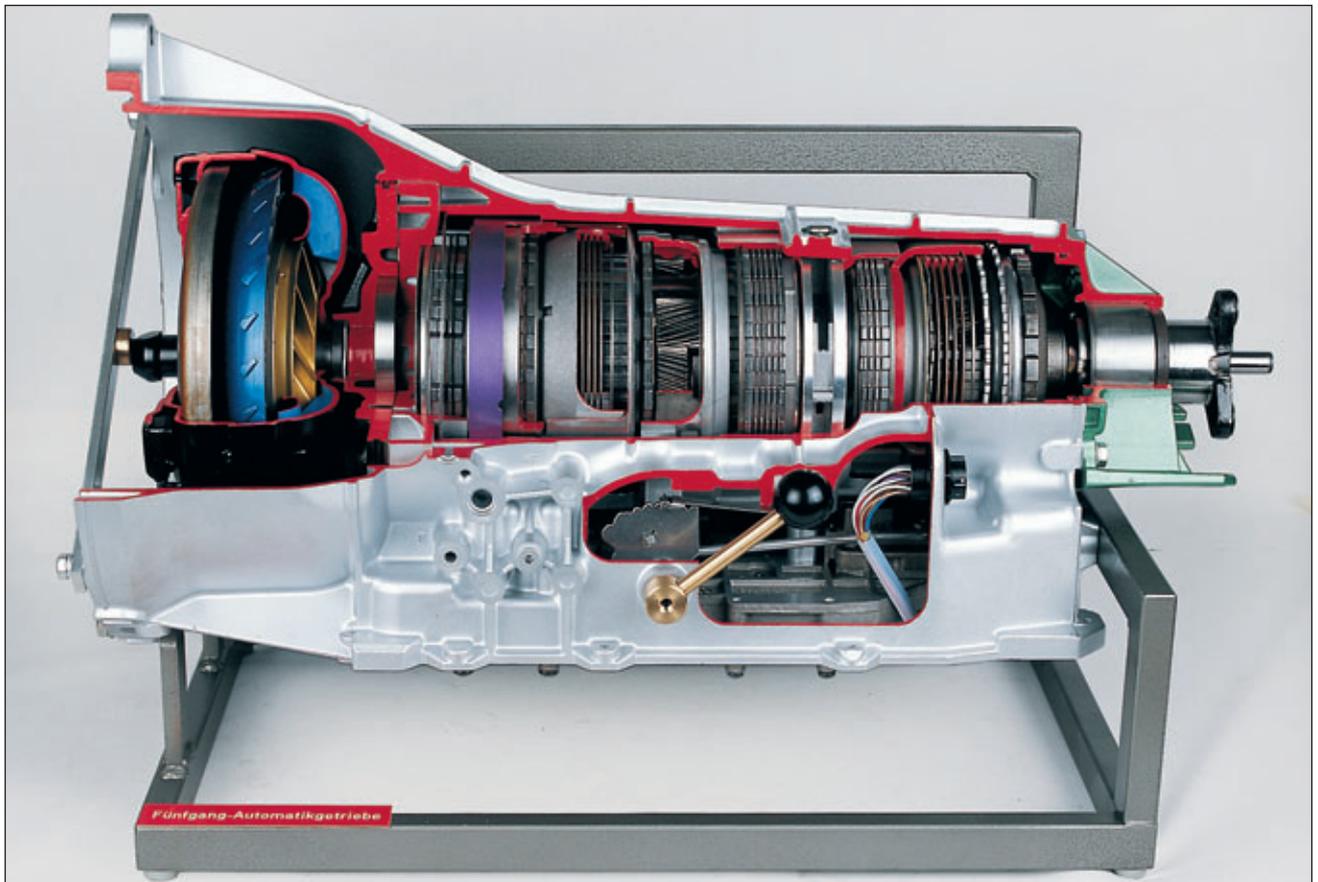
Model case Variable-speed transmission II

Four-speed transmission with drive shaft and output shaft for front-wheel drive (unequal-axle transmission). All components are clearly visible and arranged in the correct order: shafts, gear wheels, synchronizer body, sliding sleeves, synchronizer rings, sliding blocks, springs and bearings. Everything has been prepared so that the shafts can easily be put together. Order no. 1219



Model case Variable-speed transmission III

Four-speed transmission with drive shaft and countershaft for front-wheel drive (unequal-axle transmission). All components are clearly visible and arranged in the correct order: shafts, gear wheels, synchronizer body, sliding sleeves, synchronizer rings, sliding blocks, springs and bearings. Everything has been prepared so that the shafts can easily be put together. Order no. 1220

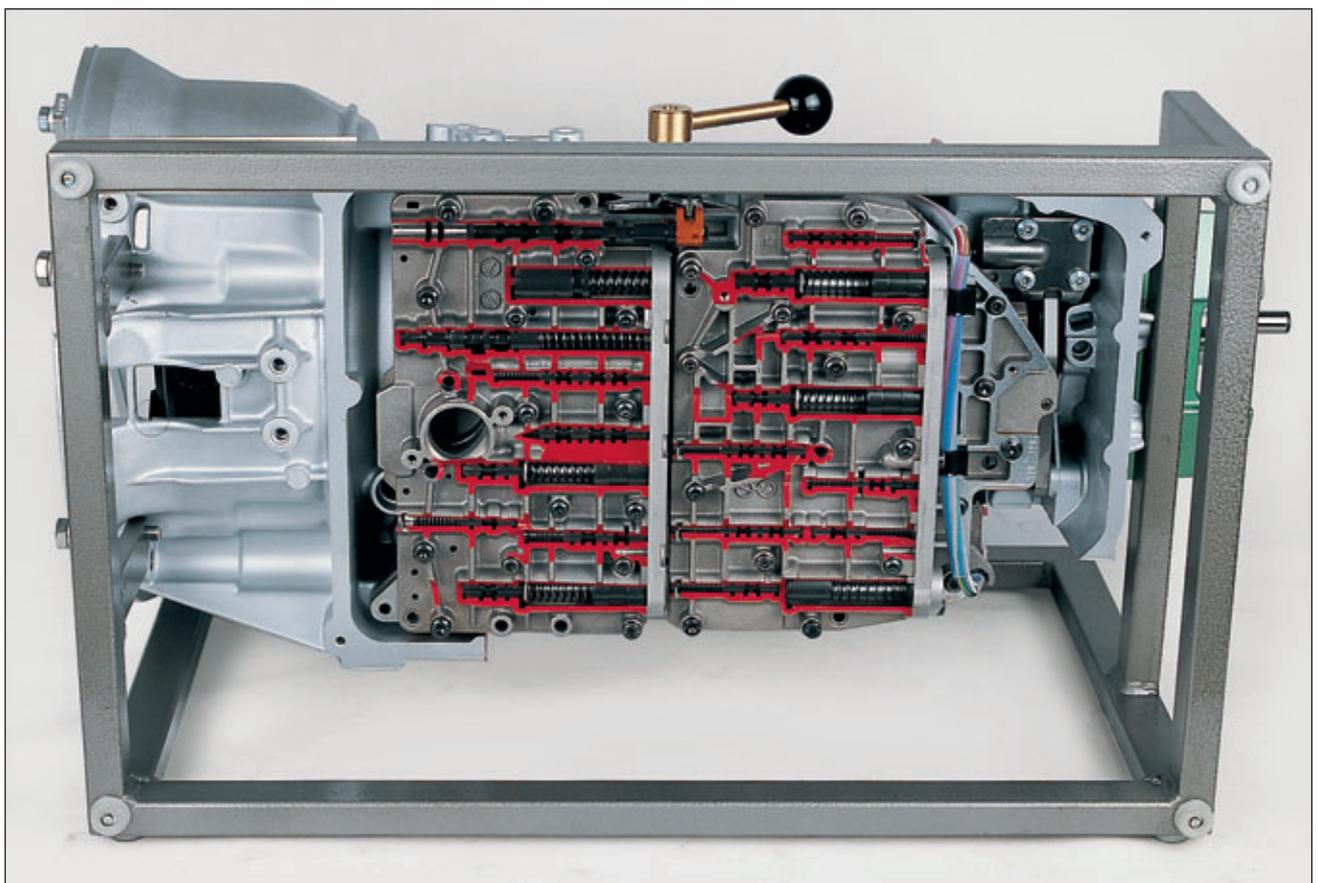


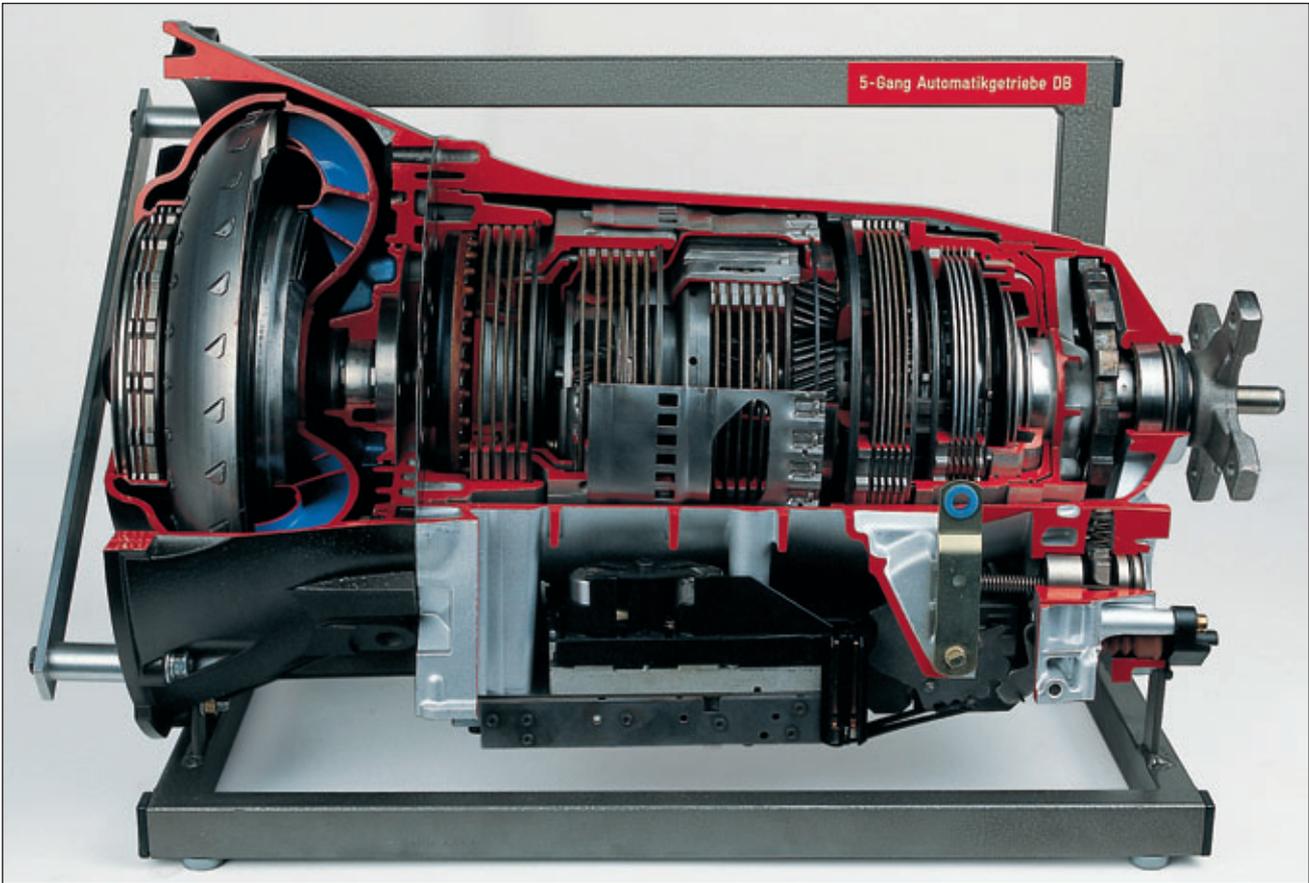
Five-speed automatic transmission, electronically controlled, with torque converter and torque converter lock-up clutch (ZF)

Cut-outs are:

- front and rear housing
- torque converter with lock up clutch
- all couplings
- internally-geared wheels for planetary gear sets
- crescent-type pump and brake band
- shift valve housing with all valves and pistons
- actuating piston for brake band

Order no. 1090





Electronically controlled five-speed transmission (Mercedes-Benz)

A newly developed automatic transmission from Mercedes-Benz!

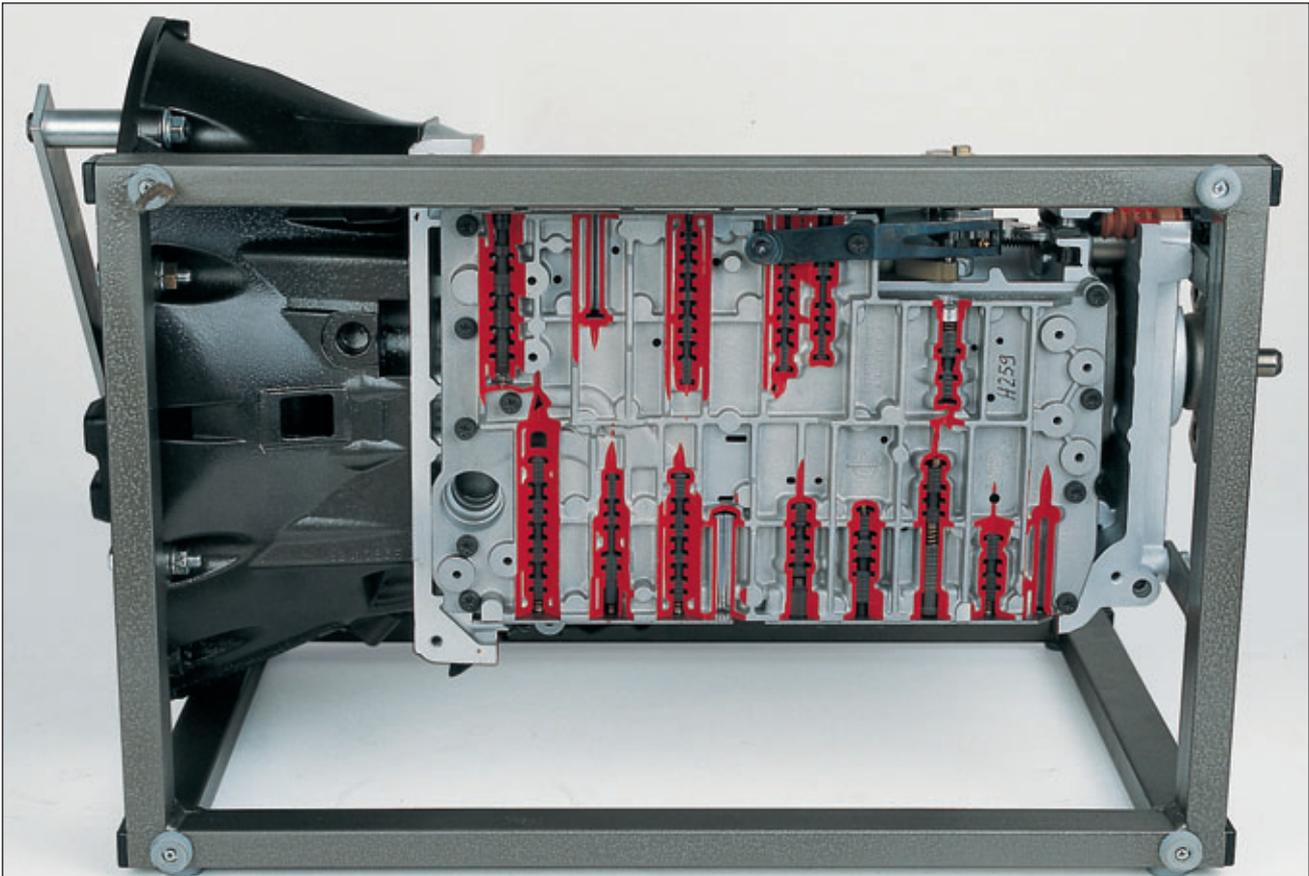
Cut open parts:

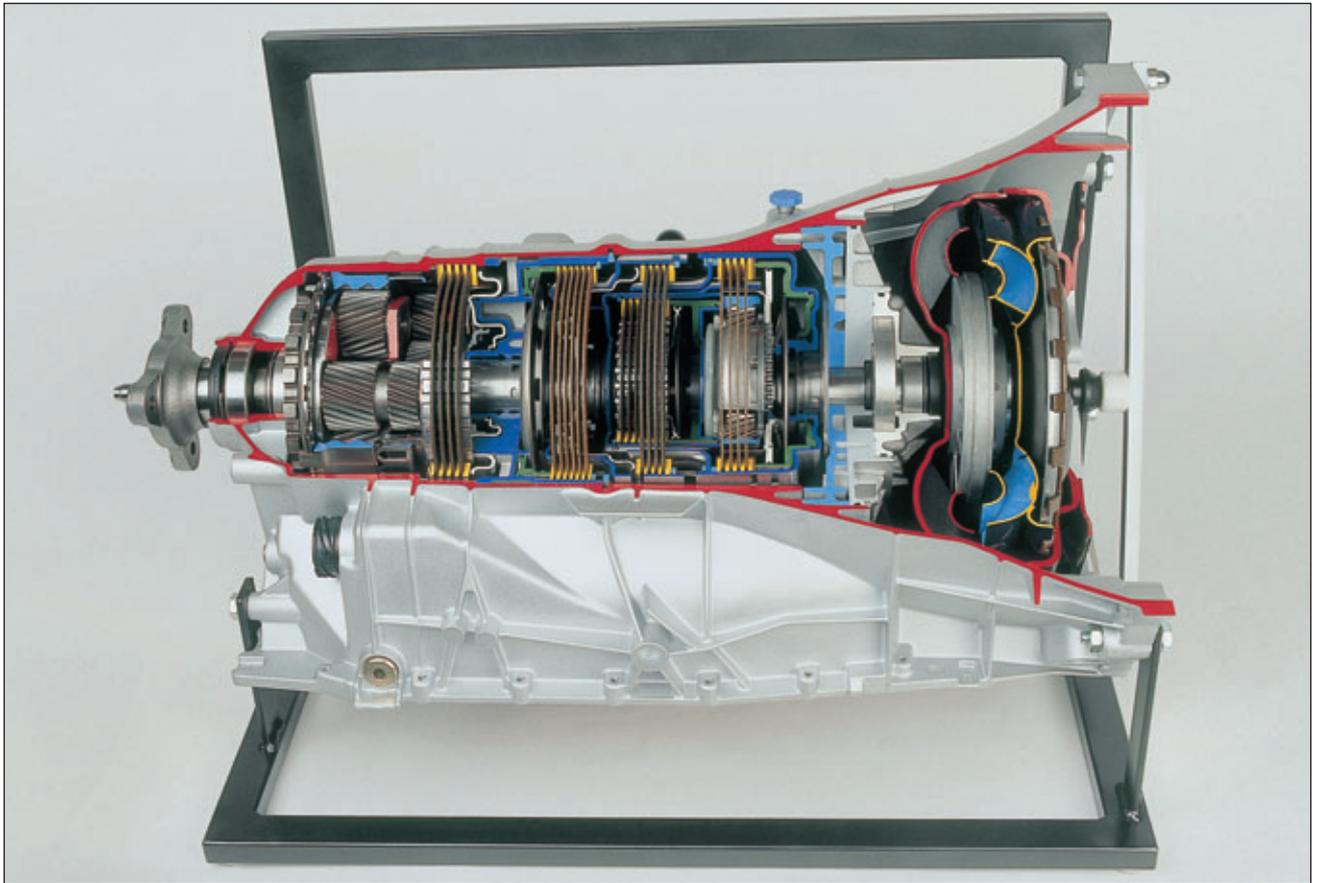
housing, converter, converter lockup clutch, oil pump, all clutches, all 3 planetary gear trains, hydraulic unit.

The model allows for demonstration of the following:

- function of the converter
- function of the freewheels
- function of the parking interlock
- function of the solenoid valves and hydraulic unit
- function of the converter lockup clutch
- function of the oil pump
- function of the clutches and planetary gear trains
- switching of the main control piston via the selector lever

Order no. 1127





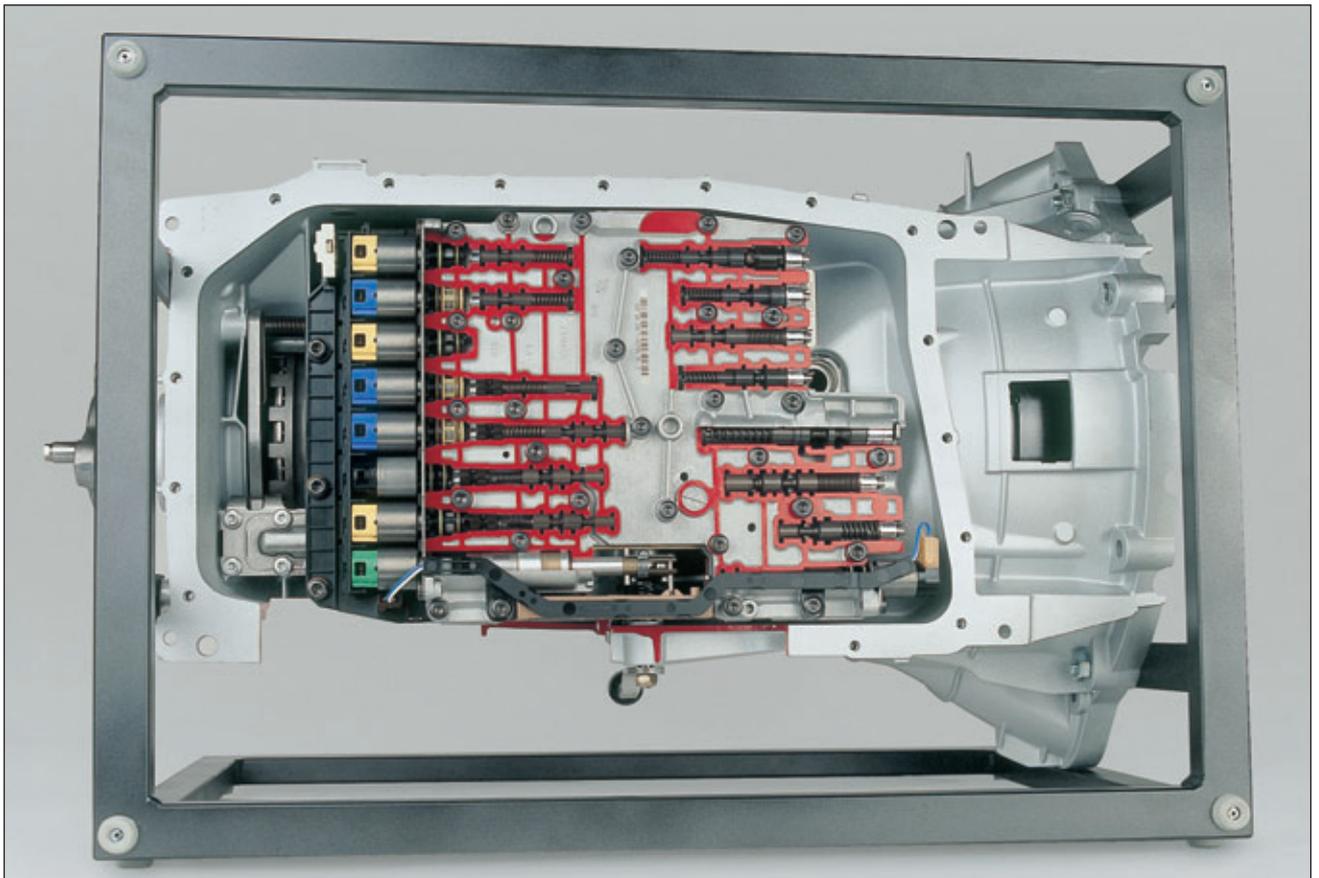
Six-gear automatic transmission and converter with shunting (ZF)

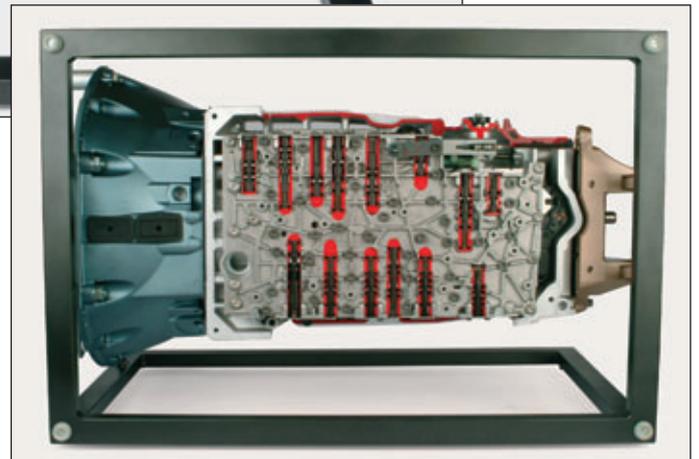
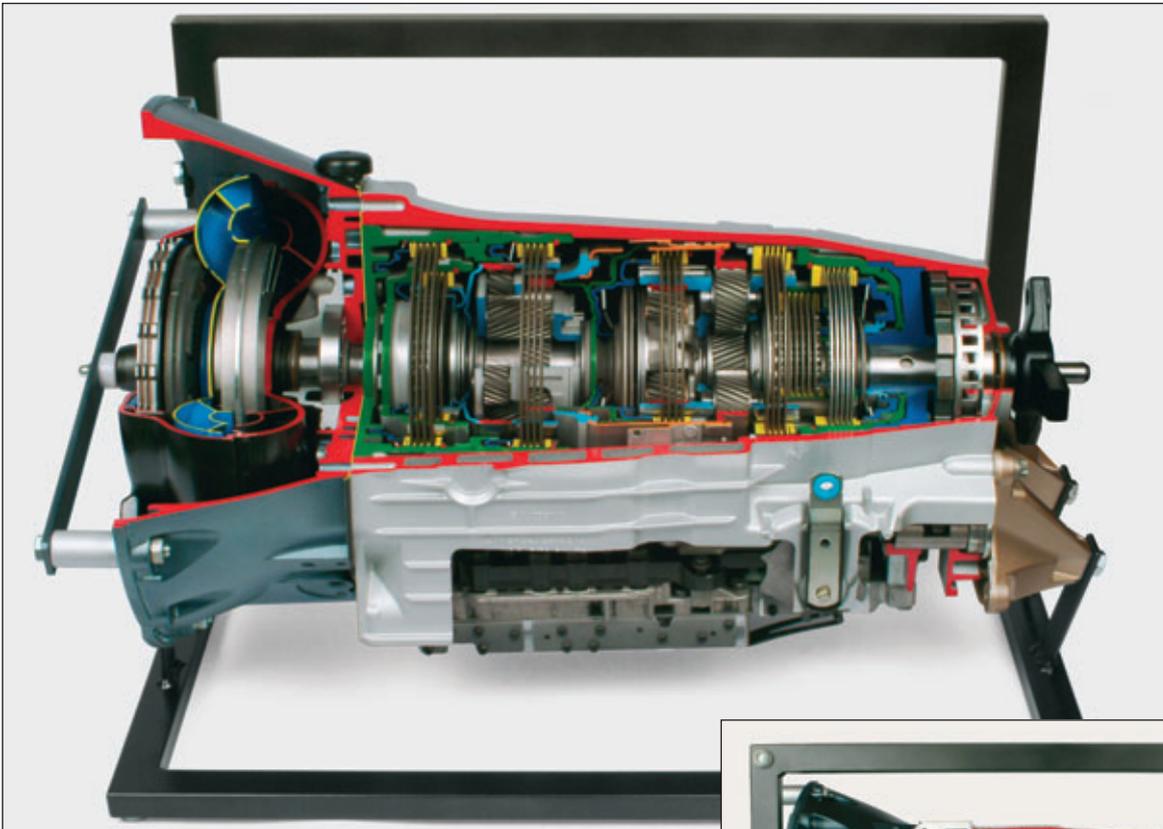
A transmission with superlatives, a latest-generation transmission.

The housing has been cut away to a large extent. In addition, all the clutches with hydraulic pistons, the planetary gear trains, the crescent pump, the converter with shunting and the hydraulic control device with the solenoid valves.

The transmission can be cranked easily.

Order no. 1283





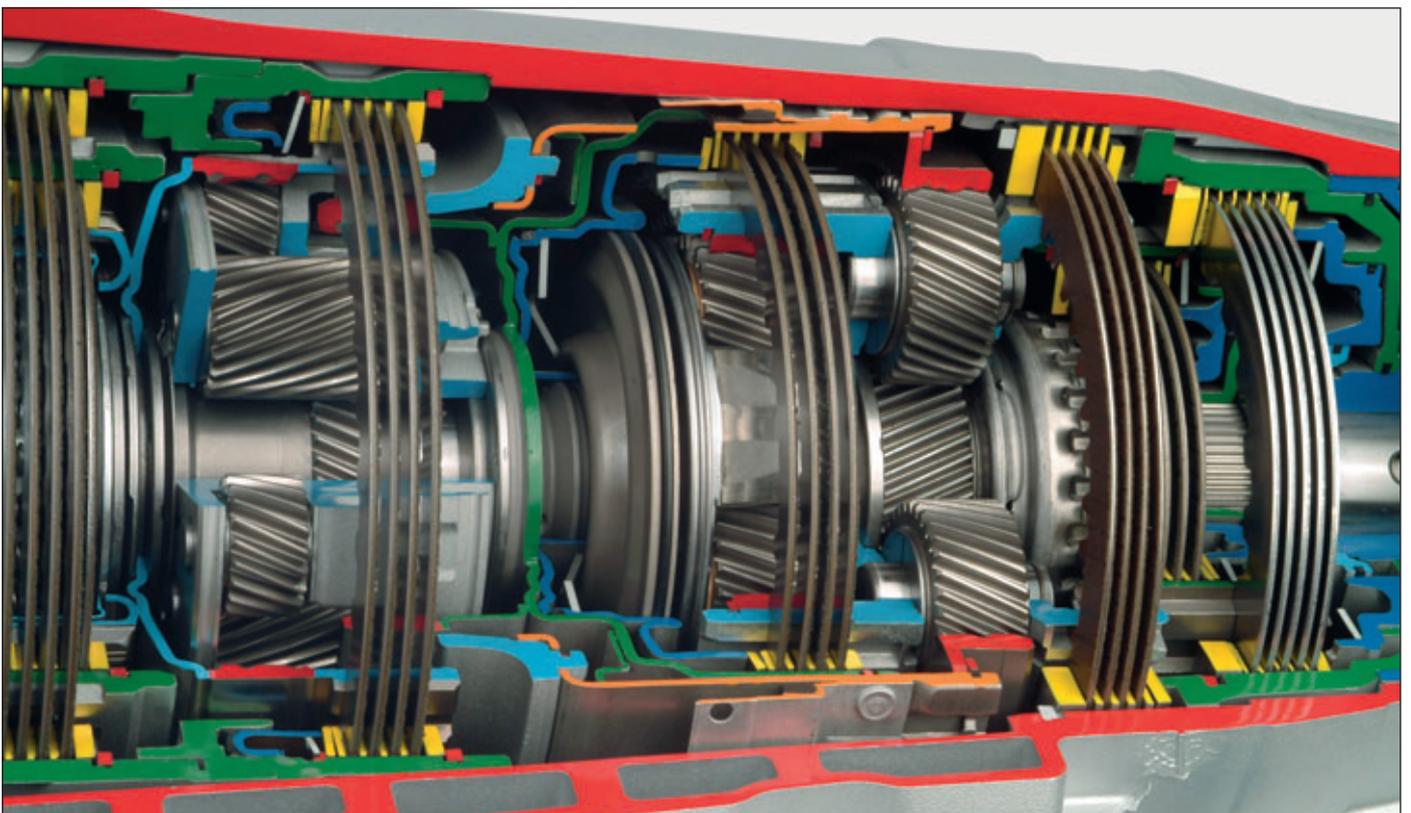
Mercedes-Benz 7-gear automatic transmission

With the 5th generation of Mercedes-Benz automatic transmissions, the following is achieved: high shifting comfort, lightweight construction, fuel savings and increased driving enjoyment. The transmission can be turned easily both from the drive and also from the output side.

The following are visible:

All 7 hydraulic couplings, converter with lock-up clutch, Ravigneaux planetary gear train and 2 simple planetary gear trains, disk springs, parking lock (it can be activated and released), hydraulic control, range selector (can be shifted), solenoid valves and many small construction parts.

Order no. 1310



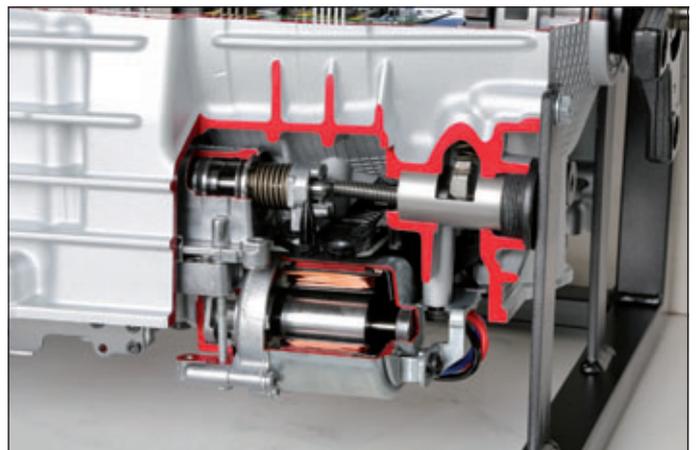
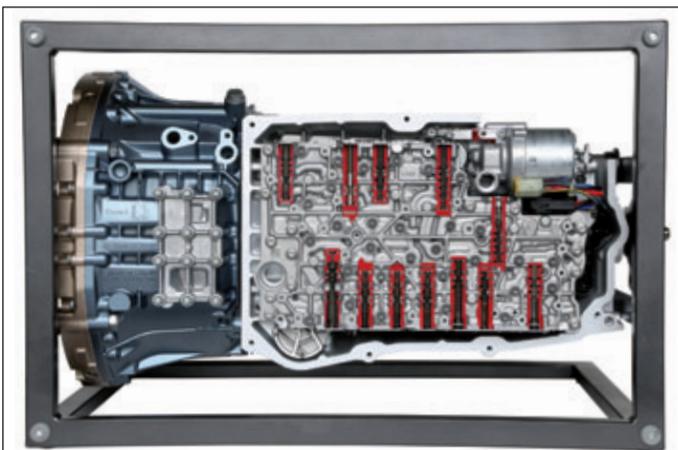
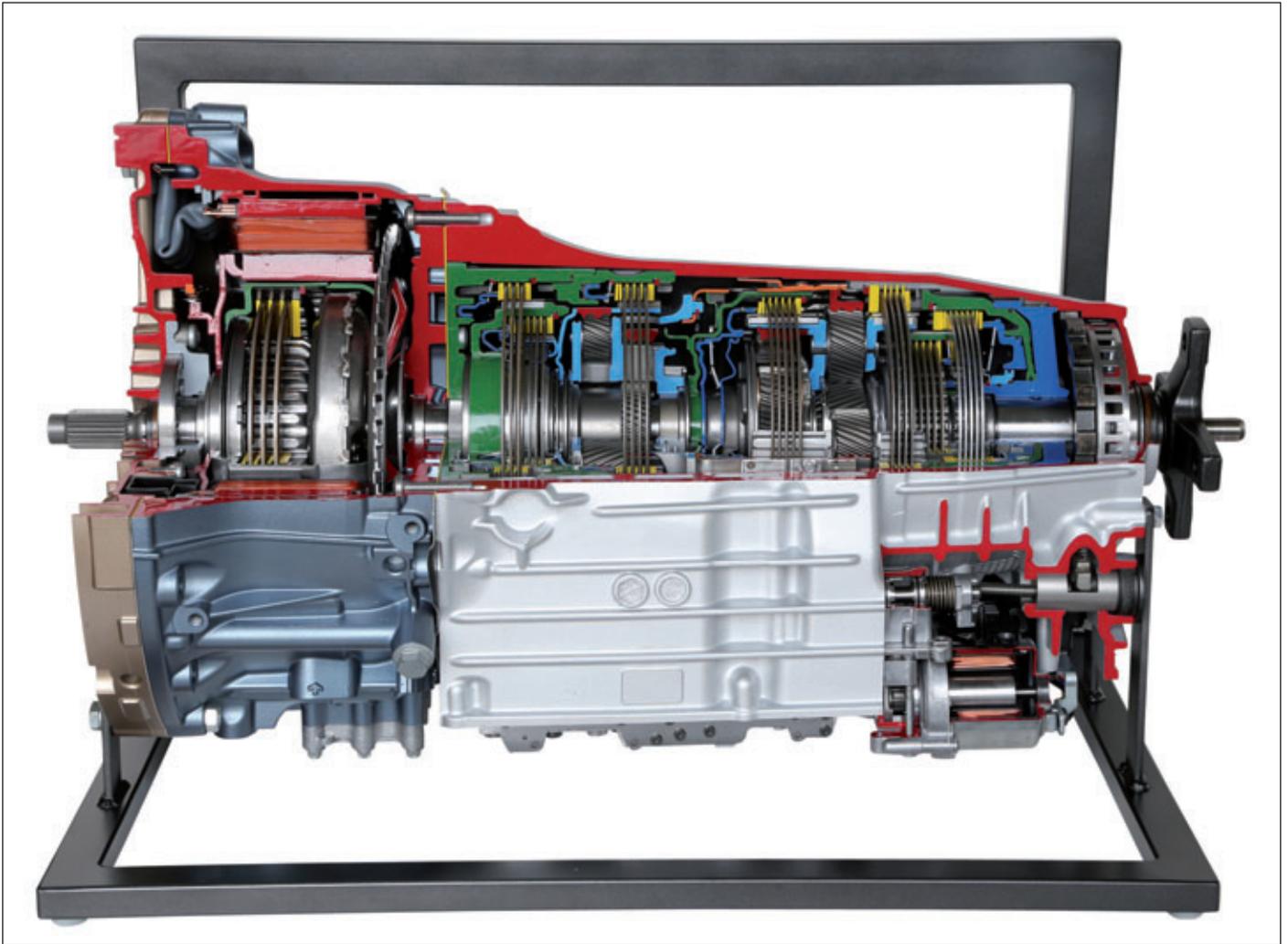
Mercedes-Benz 7-speed automatic transmission (hybrid)

With the 6th generation of Mercedes-Benz automatic transmissions, the following is achieved: High shifting comfort, lightweight construction, fuel savings and increased driving enjoyment. The transmission can be turned easily both from the drive and also from the output side.

The following is visible:

- all 7 hydraulic couplings
- e-motor
- planetary wheel set
- Ravigneaux planetary gear train and two simple planetary gear trains
- disk springs
- parking lock (can be activated and released)
- hydraulic control
- oil pumps
- sport clutch
- solenoid valves
- many small construction parts

Order no. 1351



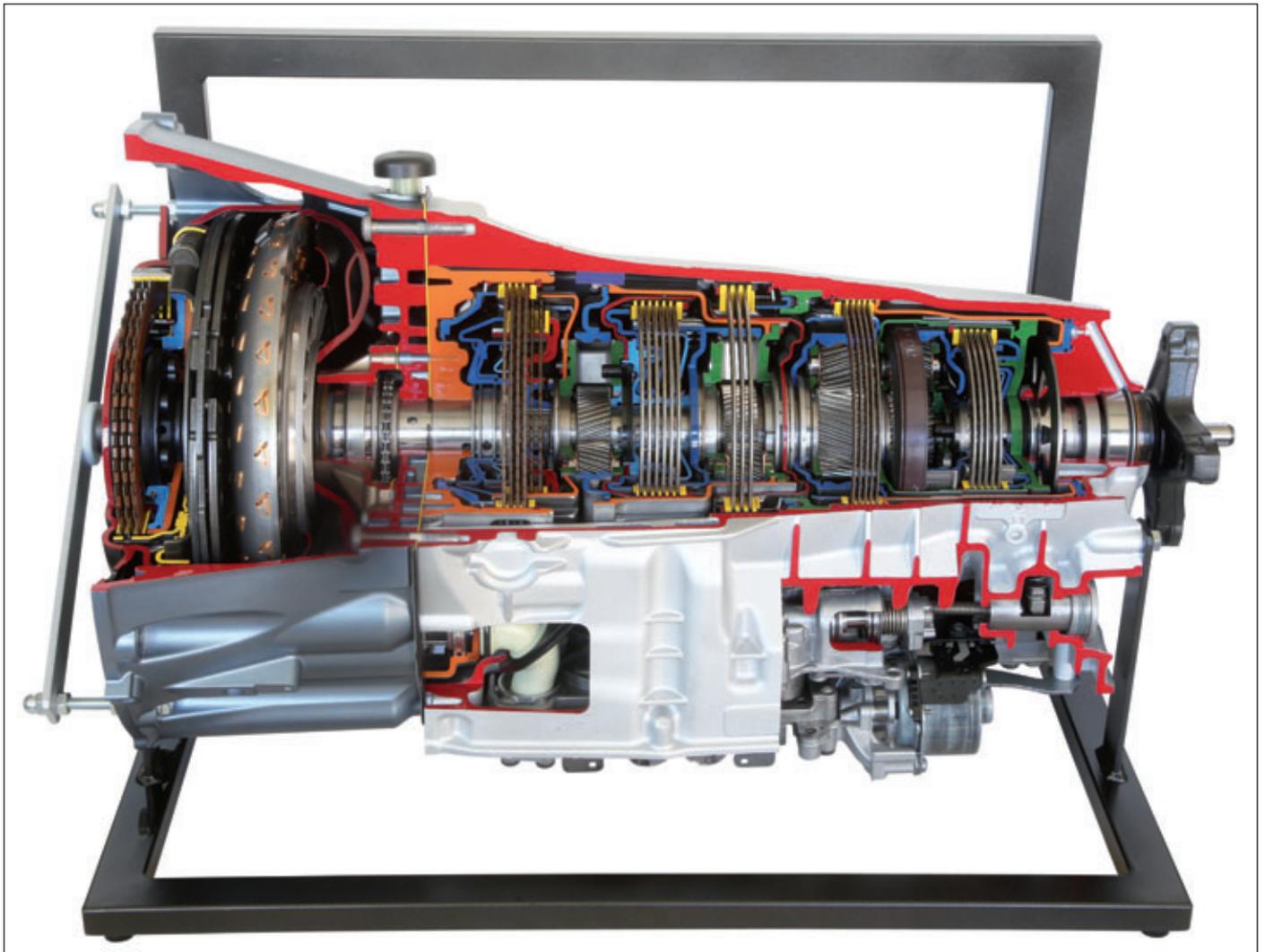
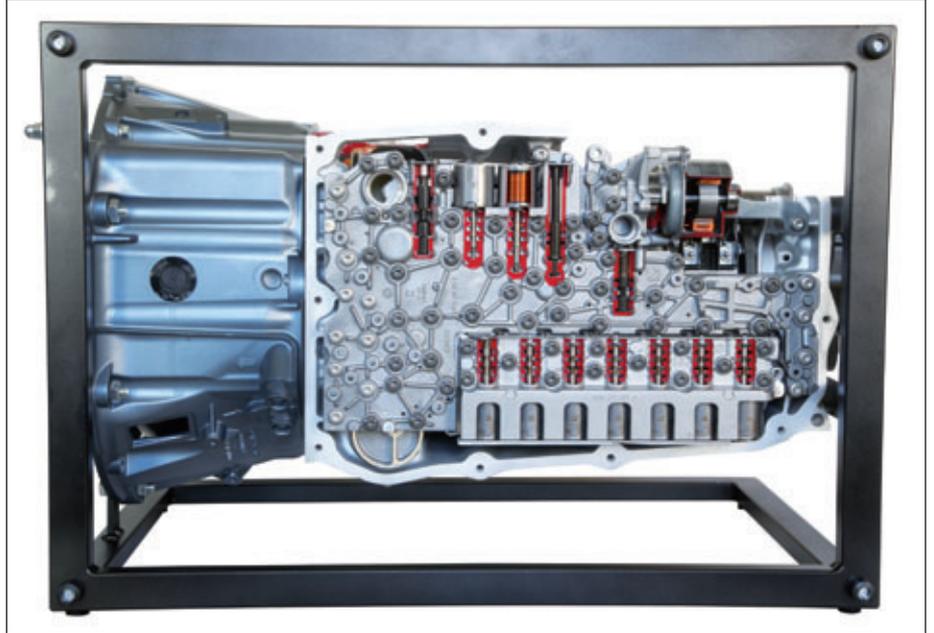
Mercedes-Benz 9-gear automatic transmission NAG 3

The 9G-Tronic is an entirely new electronically controlled automatic transmission with nine forward gears and one reverse gear. The use of the new fully integrated transmission control (VGS) system provides the following additional advantages: high electromagnetic compatibility, increased service life, reduced fuel consumption, maximum shift comfort and a new actuator concept with two pumps.

The following is visible:

- all hydraulic couplings
- all planetary gear trains
- disk springs (cut and uncut) and hydraulic pistons
- parking lock (it can be activated and released)
- hydraulic control
- both oil pumps (rotor pump and vane-type pump)
- converter with lock-up clutch with centrifugal pendulum-type absorber
- solenoid valves
- many small construction parts

Order no. 1352



Mercedes-Benz hybrid electric motor S 400 hybrid

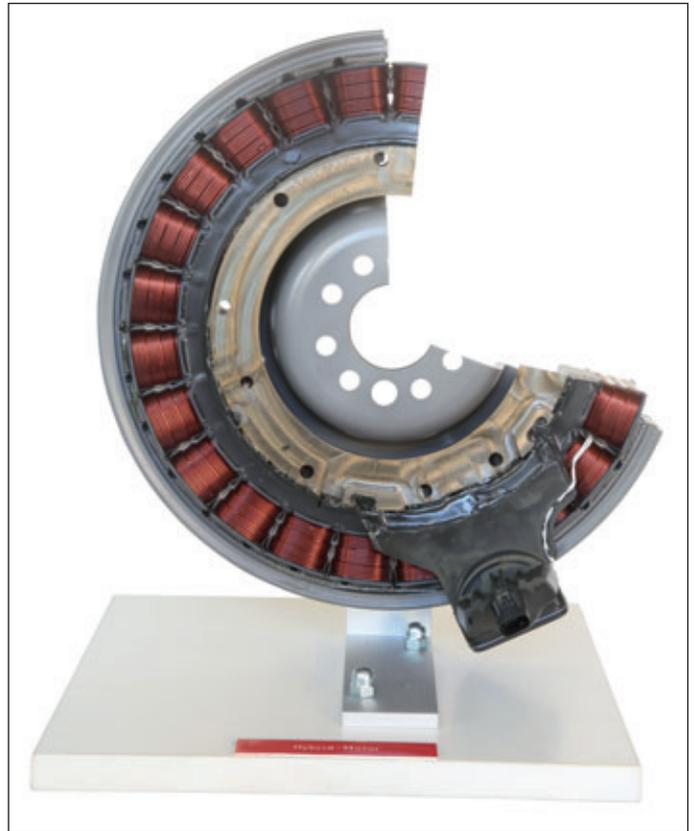
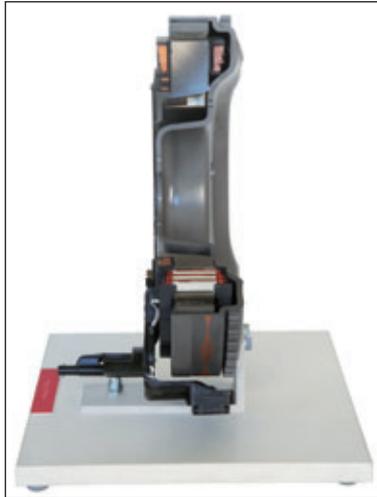
Under this system the electric engine works together with the combustion engine. The electrical machine provides motor torque when boosting or operates as a generator in the regenerative braking phase. It also works as the starter.

The following can be seen:

- stator carrier
- rotor with increment ring and position sensor track
- stator with coil
- electric screw connection and temperature sensor coupling

Attention: This model is not suited for people with a cardiac pace-maker (extremely strong magnetic induction).

Order no. 1355

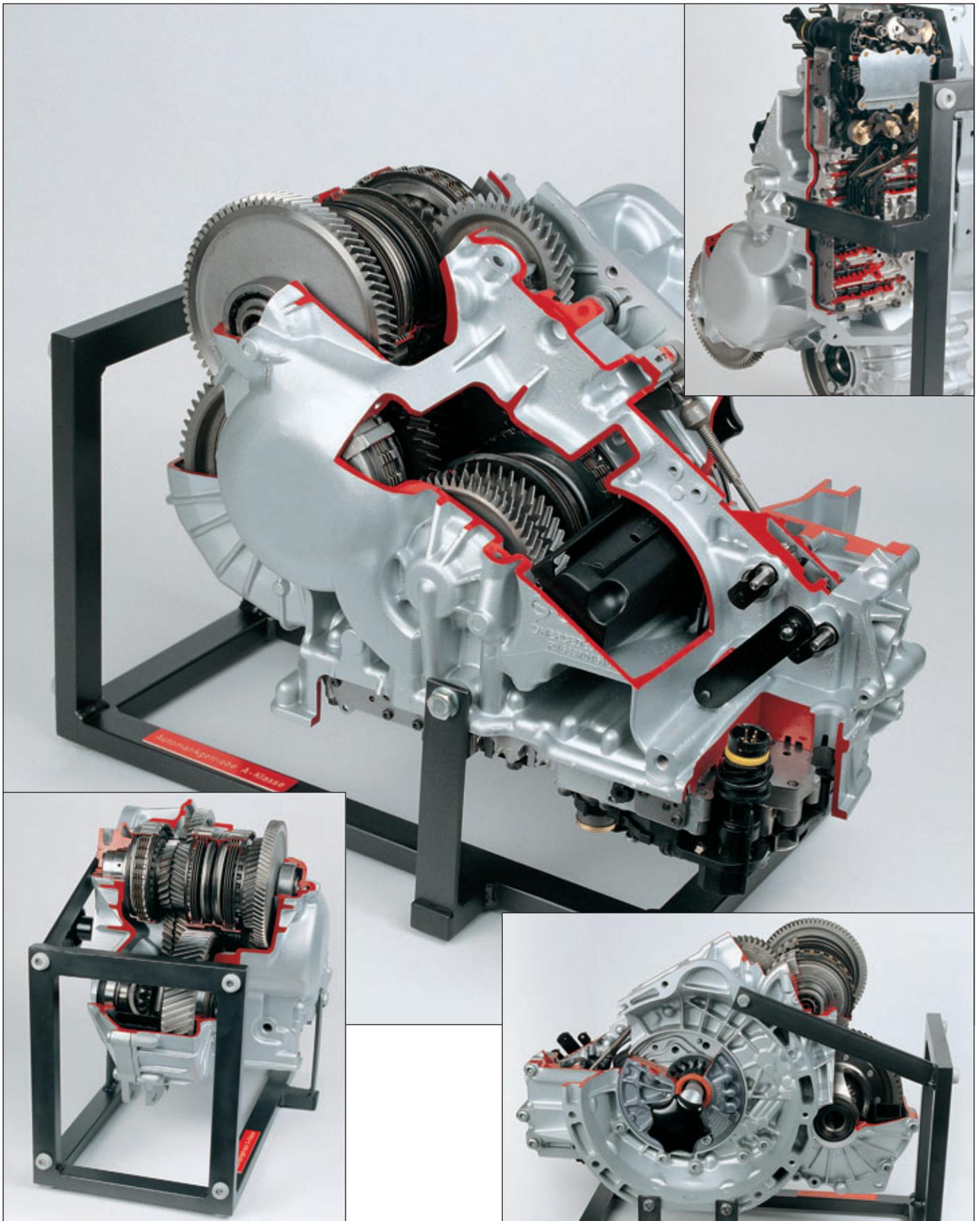


Electric engine (water-cooled)

That is an electric engine that is installed into cars powered purely by electricity. It has between 39 and 50 kW and 200 Nm of torque. The engine can be turned and the thick cables, rotor, stator, water jacket and copper winding are very attractive aspects.

Order no. 1359





Five-gear front automatic transmission Mercedes-Benz A Class without torque converter

The transmissions in the individual gear steps are not implemented with planetary gear trains, but with spur gears. The shifting processes are initiated electronically, with the gears being shifted by hydraulic clutches via the electro-hydraulic control unit.

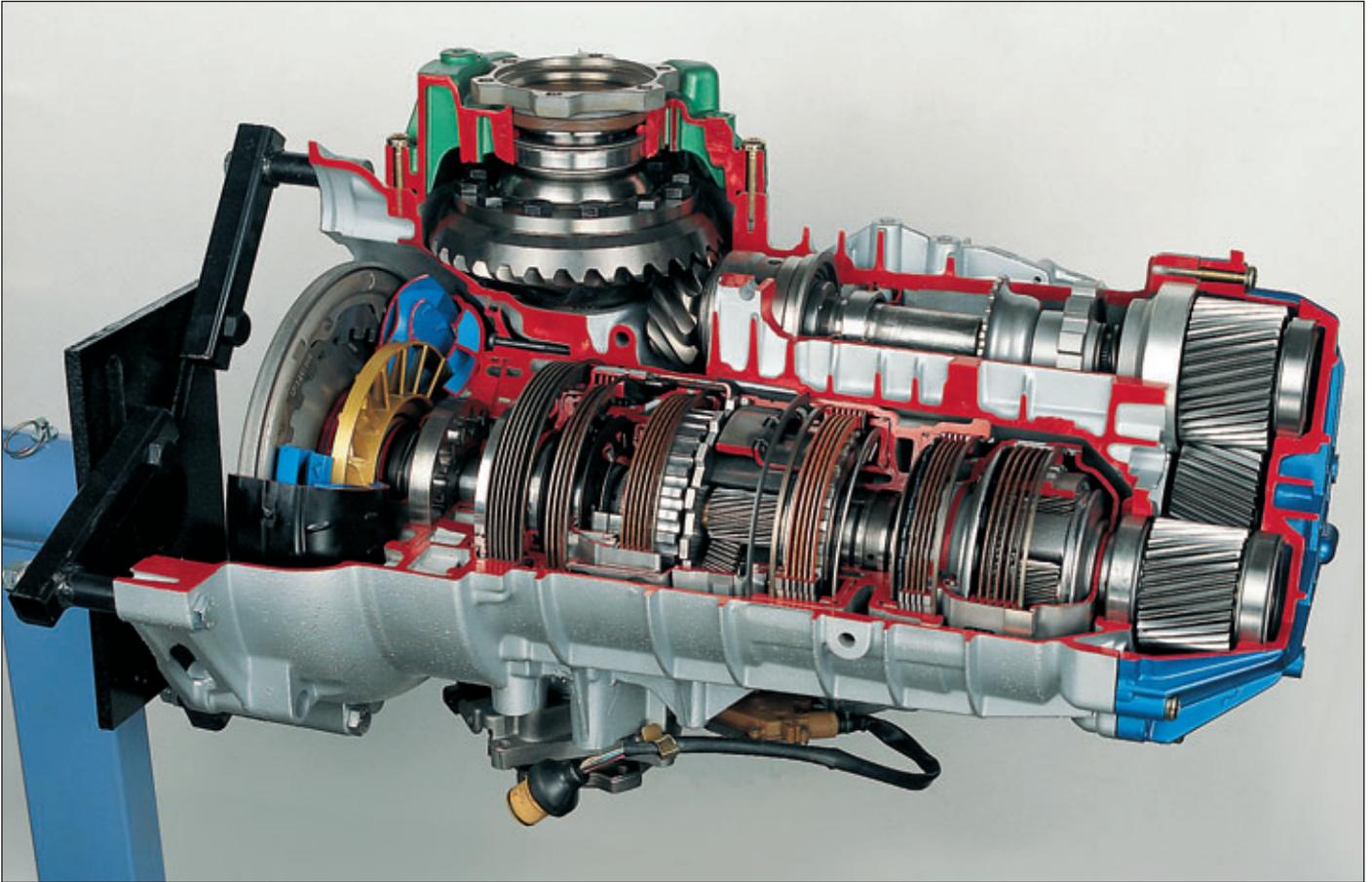
A very extensive description of the function is supplied.
Order no. 1260

Five-gear front automatic transmission Mercedes-Benz A Class with torque converter

The transmissions in the individual gear steps are not implemented with planetary gear trains, but with spur gears. The shifting processes are initiated electronically, with the gears being shifted by hydraulic clutches via the electro-hydraulic control unit.

In the cutaway torque converter, one sees the pump and turbine wheel, the free-wheel and the converter lockup clutch.

A very extensive description of the function is supplied.
Order no. 1261



Five-speed automatic transmission for front-wheel drive (ZF)

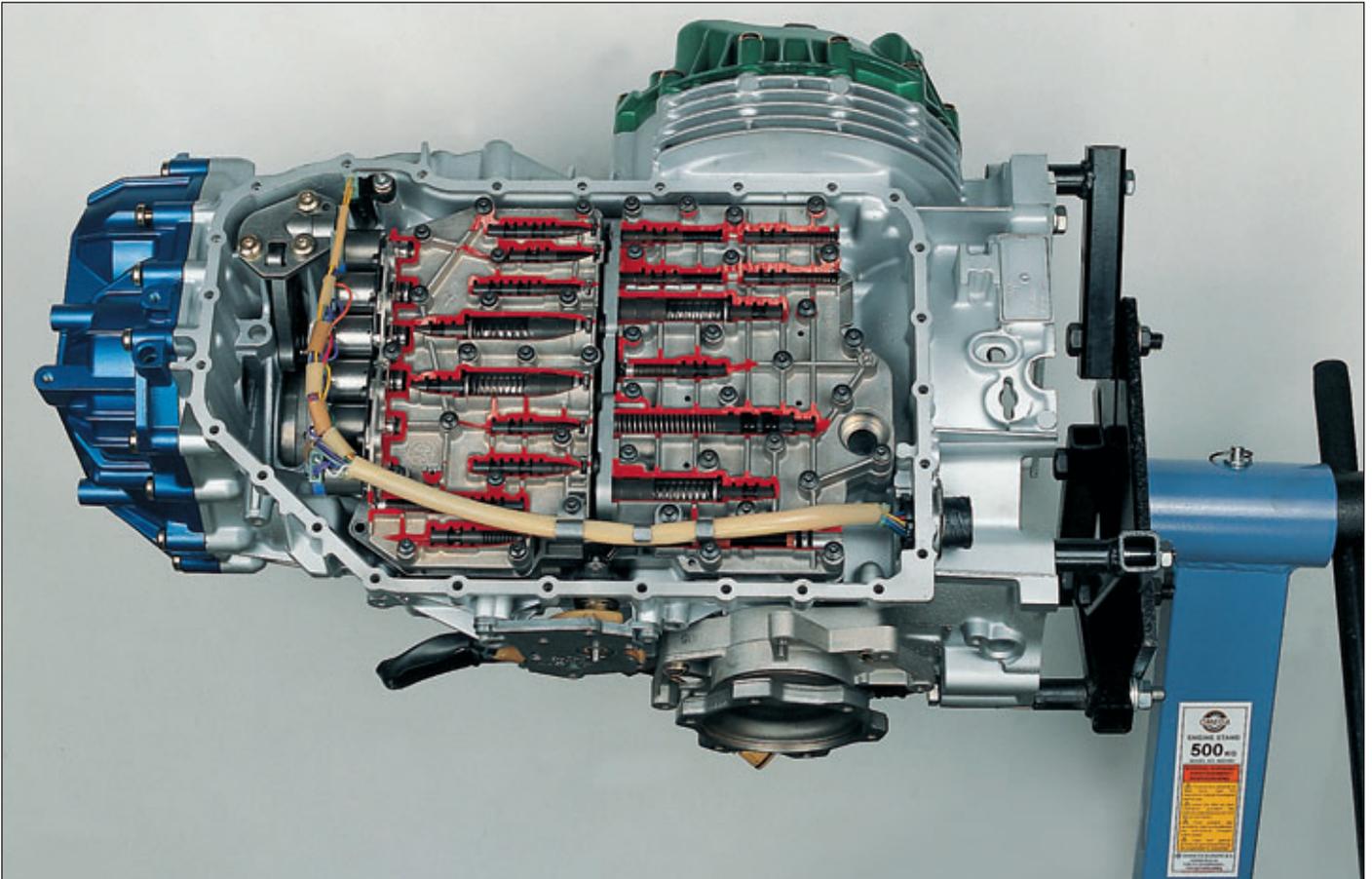
electronically controlled

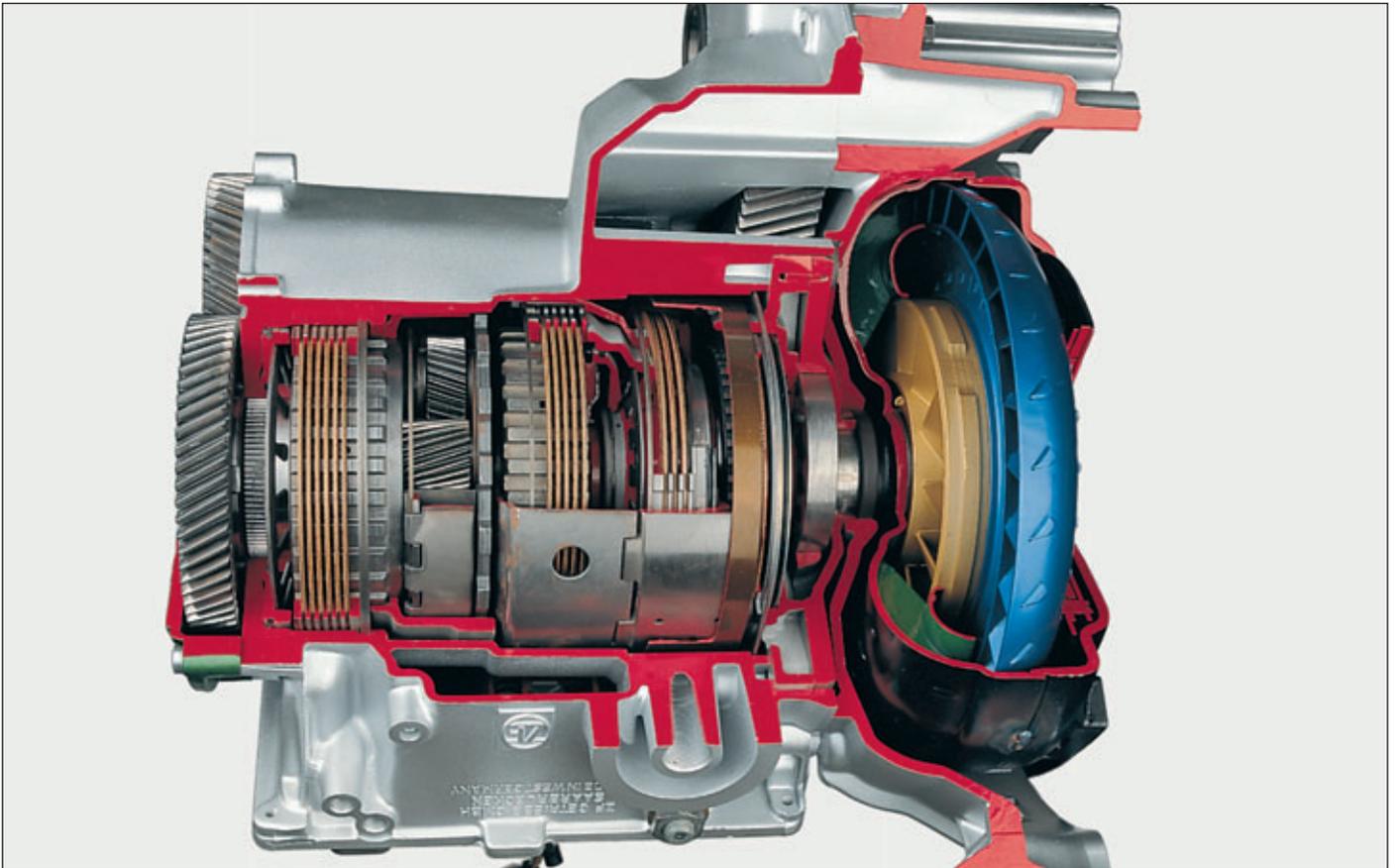
This transmission designed for high performance has the following parts cut away:

Torque converter with lockup clutch, all hydraulic couplings, planetary gear trains, transmission wheels and intermediate gear, drive shaft with pinion, differential and hydraulic control.

The transmission can easily be turned.

Order no. 1223





Four-speed automatic transmission for front-wheel drive (ZF)

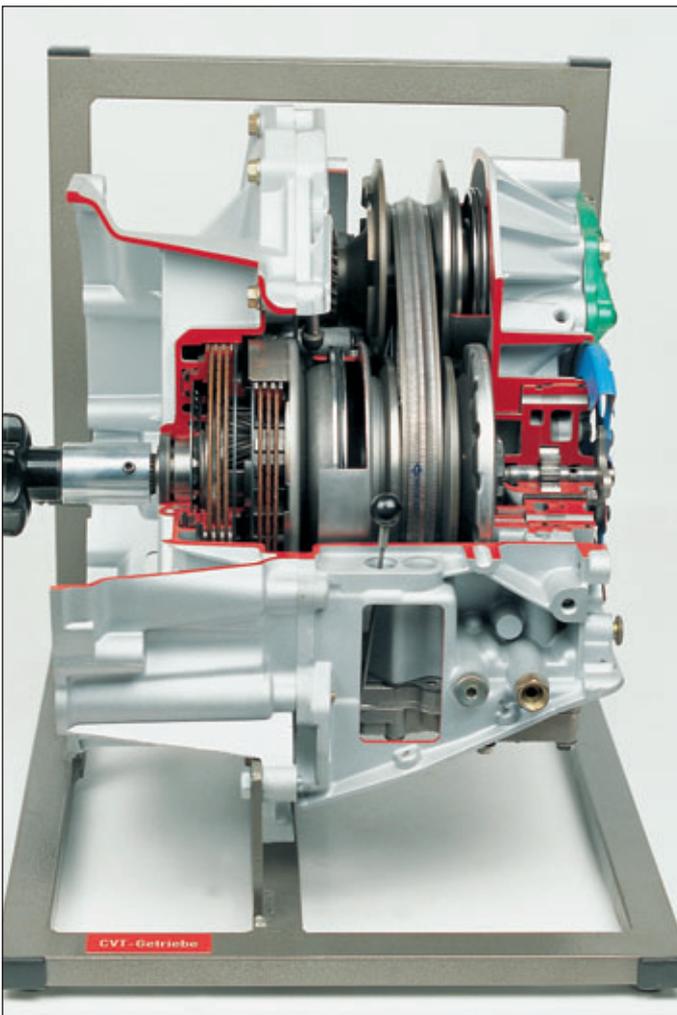
electronically controlled

The cut-away parts are:

Torque converter with lockup clutch, all hydraulic couplings, planetary gear trains, differential and hydraulic control.

The transmission can easily be turned.

Order no. 1222 ▲



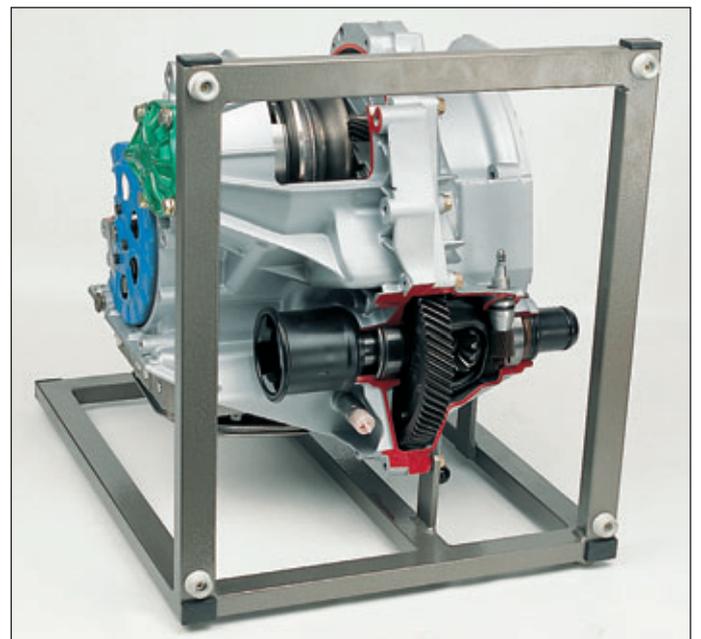
CVT automatic transmission with sliding articulated band

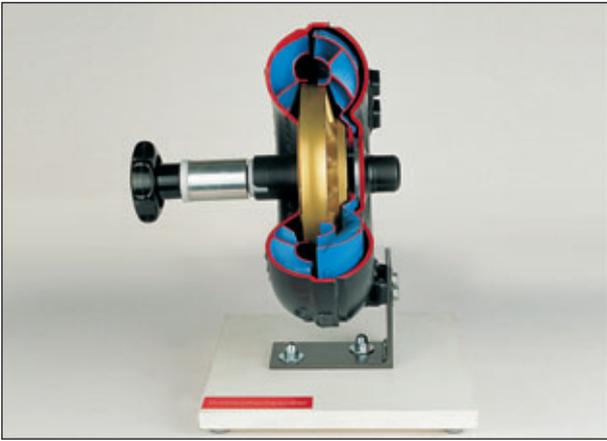
The complete power flow within the CVT automatic transmission can be observed: Input shaft, planetary gear with hydraulic clutch mechanism, primary and secondary conical disk with hydraulic piston, idler gear and differential.

Speed change by movement of the conical disks.

Hydraulic control of the CVT automatic transmission.

Order no. 1198 ▼

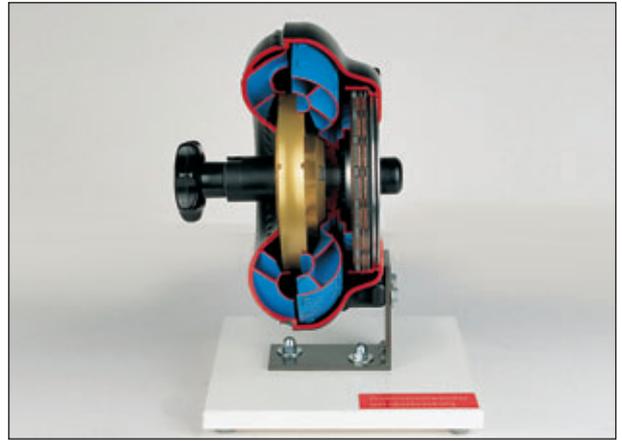




Torque converter

- function of the input and output rotors
- function of the stator with functioning free wheel

Order no. 1158



Torque converter with lockup clutch

- function of the input and output rotors
- function of the stator with functioning free wheel
- function of the lockup clutch by a disk system and a hydraulic piston

Order no. 1159



Torque converter with lockup clutch (ZF)

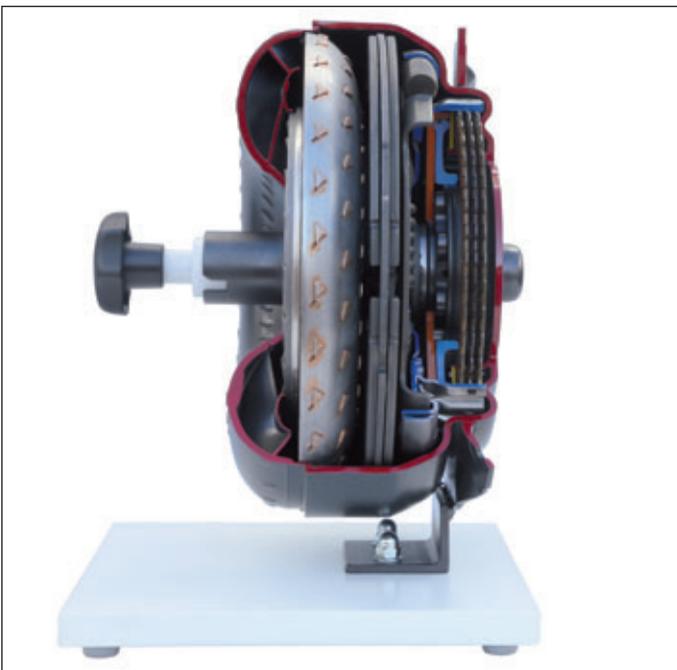
- function of the impeller and the turbine
- function of the stator with functioning freewheeling
- function of the lockup clutch, consisting of a steel clutch disc with friction lining, which is hydraulically pressed on to the impeller

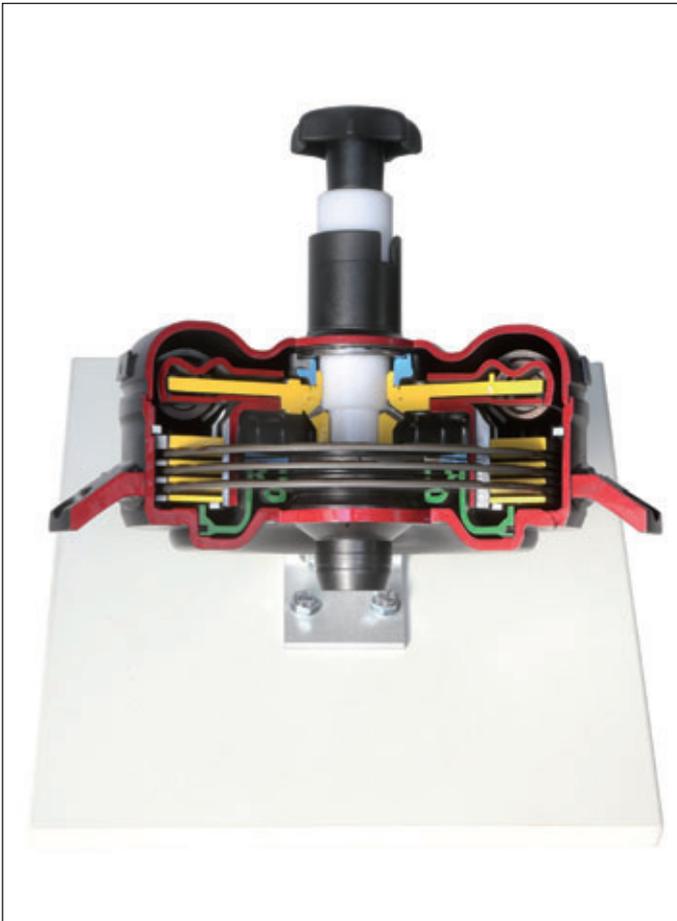
Order no. 1193 ▲

Torque converter with centrifugal pendulum-type absorber

- function of the input and output rotors
- function of the stator with functioning free wheel
- function of the lockup clutch by a disk system and a hydraulic piston
- function of centrifugal pendulum-type absorber and bow springs

Order no. 1347 ▼

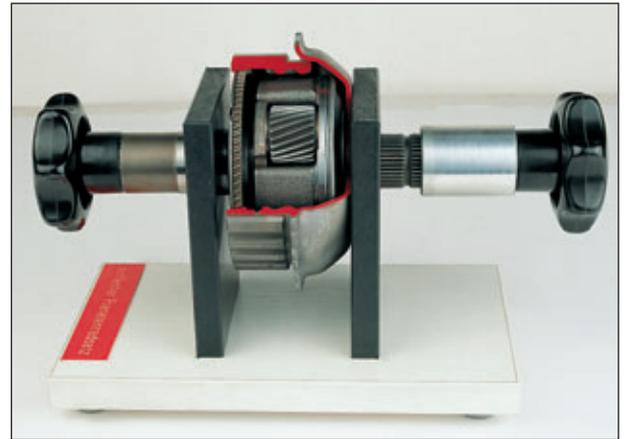




Wet starting clutch

The wet starting clutch is a clutch with a low rotary inertia, making the automatic transmission extremely spontaneous and dynamic without the losses that are typical of power transmission equipment. Additionally, this reduces the consumption of fuel. This is installed in the Mercedes-Benz seven-speed automatic transmission NAG2 (AMG models).

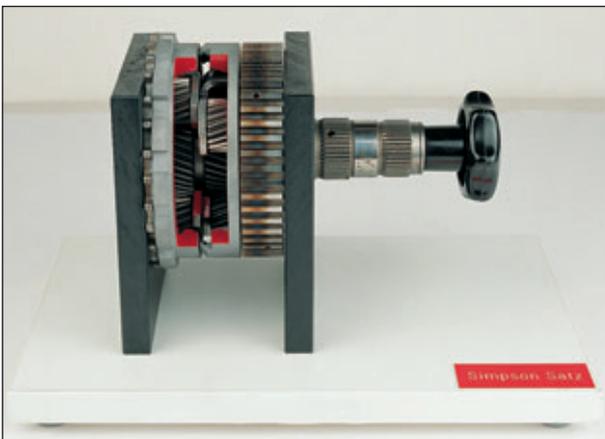
Order no. 1357



Simple planetary gear train

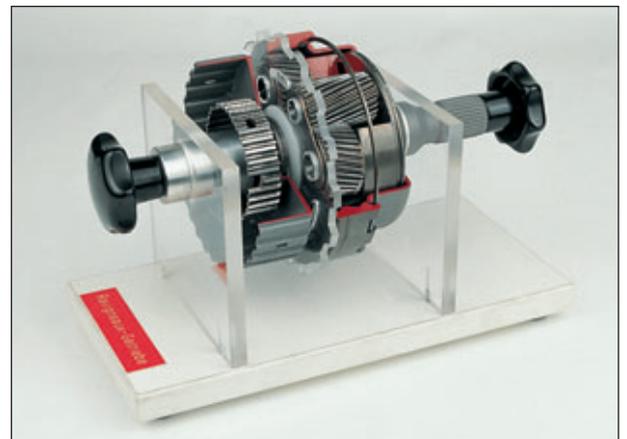
Function of a simple planetary gear train with ring gear, sun wheel, planet carrier with planetary wheels.

Order no. 1164



Planetary gear train - Simpson gear set

Interaction of the components of the planetary gear train.
– function of the two simple planetary gear trains with coupled sun wheels
Order no. 1163



Planetary gear train - Ravigneaux gear set

Interaction of the components of the planetary gear train.
Ring gear, 2 sun wheels and planet carrier with 3 narrow and 3 wide planetary wheels are easily recognised through the Plexiglas screen.
Order no. 1162



Sprag-type clutch, automatic transmission

In automatic transmissions, they have the task of holding certain parts in one direction of rotation and releasing them in the other direction, for example in planetary gear trains and in the torque converter. When the shaft turns, one sees how the sprags move and block or release depending on the direction of rotation.

Order no. 1311



Hydraulic coupling, automatic transmission

The following parts have been cut away:

- coupling housing
- coupling plunger
- return spring (disk spring)
- steel and friction lamellas

Order no. 1303



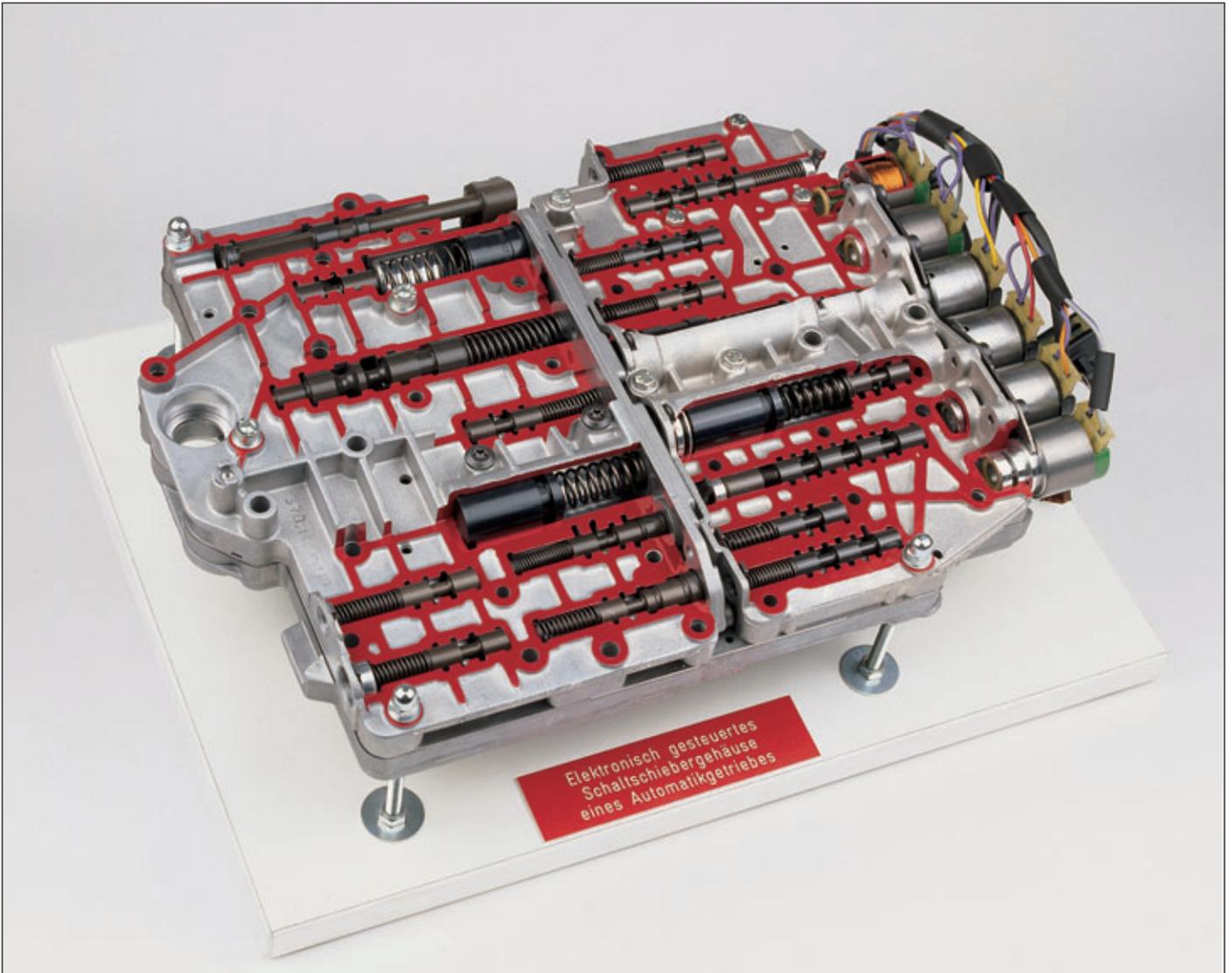
Model case Automatic transmission components

Contains the most important automatic transmission components (some parts cut open). Hydraulic control with shift valve, centrifugal governor, freewheel, internal gear pump, complete planetary gear train (easily dismantled), brake band, 2 hydraulic couplings, park position with ratchet, disk set.
Order no. 1161



Planetary gear train assembly set

Dismantling of the planetary gear train.
Assembly of the planetary gear train.
Assembly diagram supplied.
Shifting of the different gears.
Calculation of the transmission ratios.
Order no. 1156



Electronically controlled shift-valve body of an automatic transmission

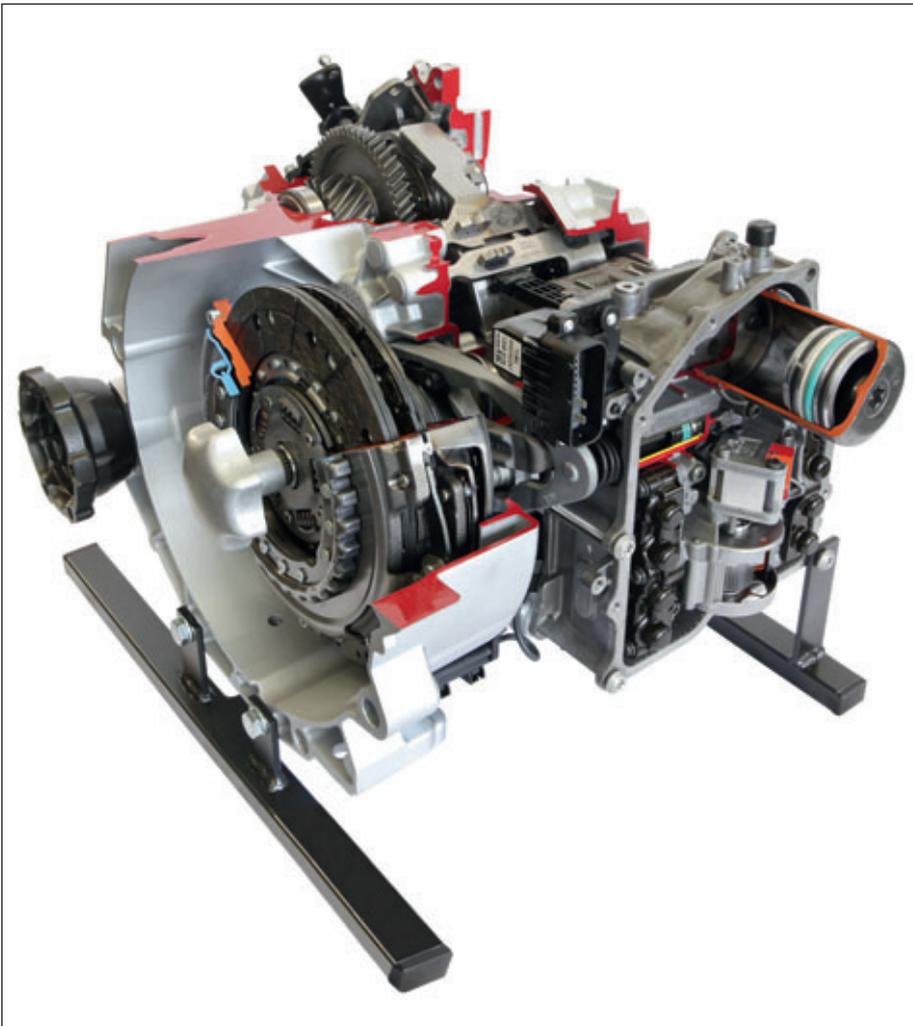
This model gives an insight into the complicated interior of a modern shift-valve body. In the cutaway housing, one sees the control plunger and control springs. An electro-solenoid valve has also been cut away so that its interior can be studied.
Order no. 1294



Six-speed direct shift transmission (VW)

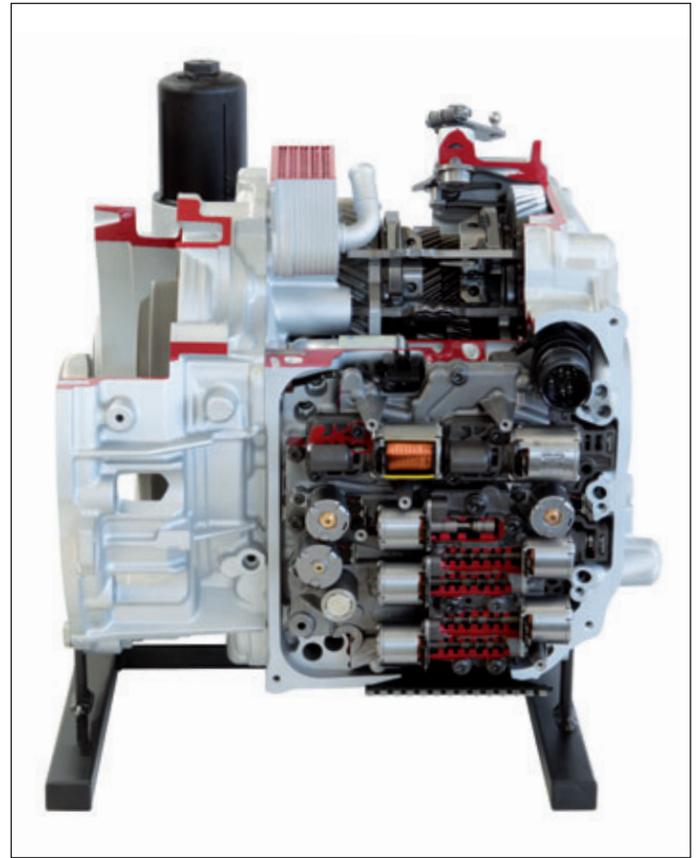
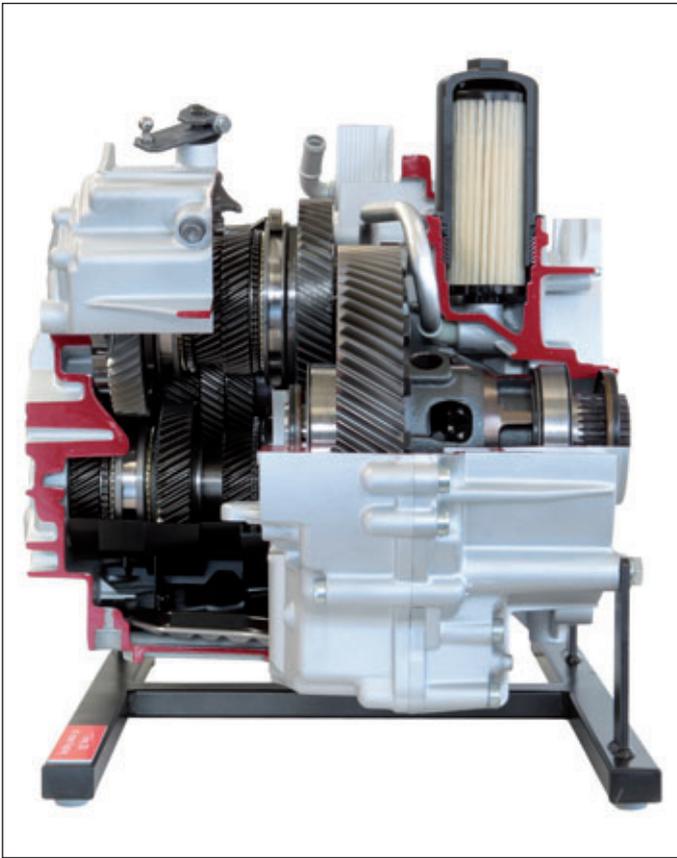
Cutaway are: wet clutch, timing case, transmission case, main shaft, oil cooler, oil filter, oil pump. The transmission can be turned easily, the gears changed by hand and compressed air applied in part. The shift lock is functional. The function of the

clutch can be demonstrated by pressing the disks together. The transmission is mounted on a table stand. Self-study booklet from VW included in the scope of supply. Order no. 1326



Seven-speed direct shift transmission (VW)

Cutaway are: dry clutch, timing case, transmission case, oil pump, main shaft, pressure accumulator, clutch actuation. The transmission can be turned easily, the gears changed by hand and compressed air applied in part. The shift lock is functional. The transmission is mounted on a table stand. Self-study booklet from VW included in the scope of supply. Order no. 1328



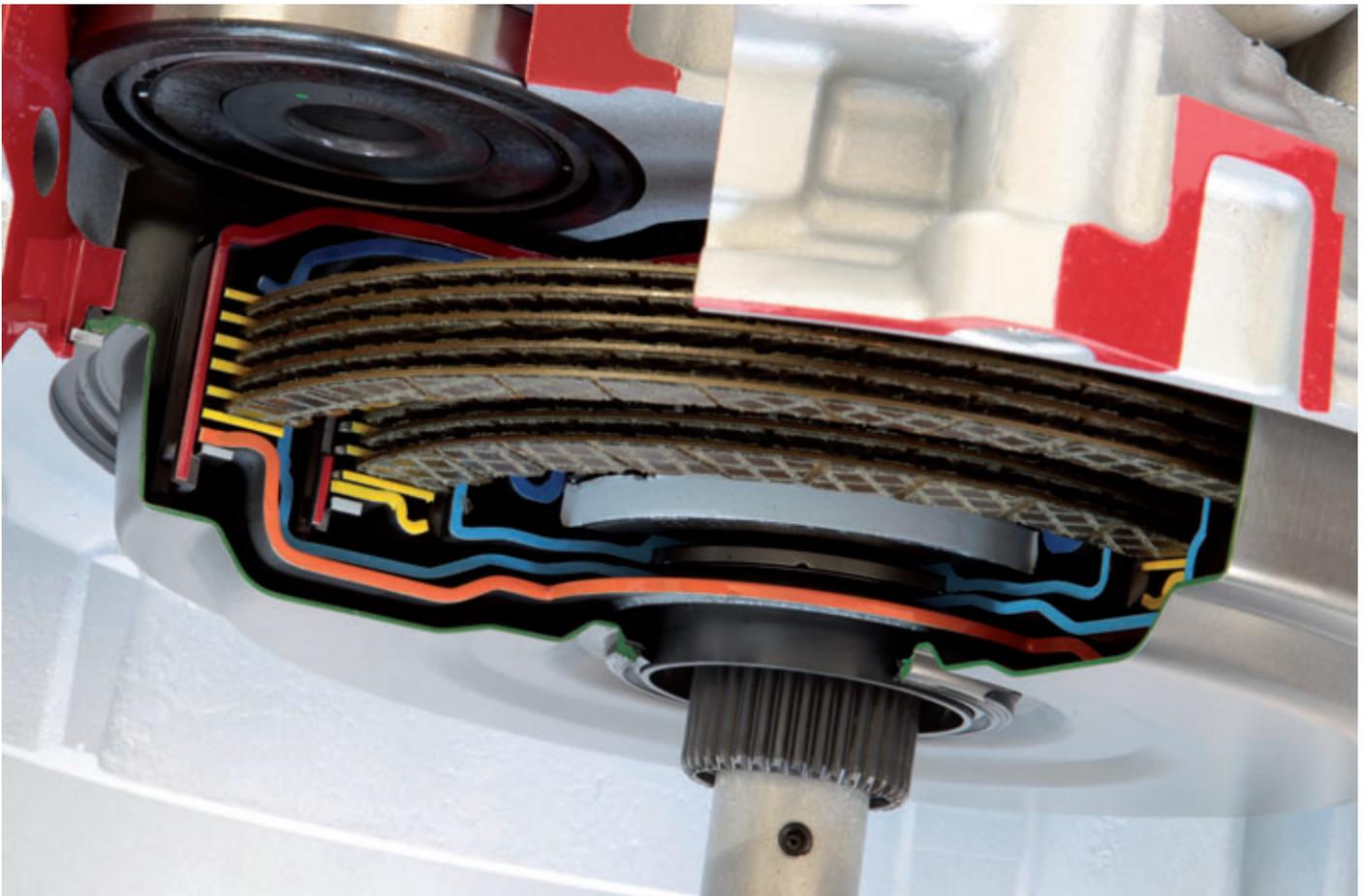
Seven-speed direct shift transmission with wet clutch

Cutaway are: wet clutch, timing case, transmission case, oil cooler, oil filter, parking mechanism

The transmission can be turned easily and the gears can be changed by hand or compressed air. The shift lock is functional. The function of the clutch can be

demonstrated by pressing the disks together. The transmission is mounted on a table stand.

Self-study program from VW included in the scope of supply. Order no. 1335



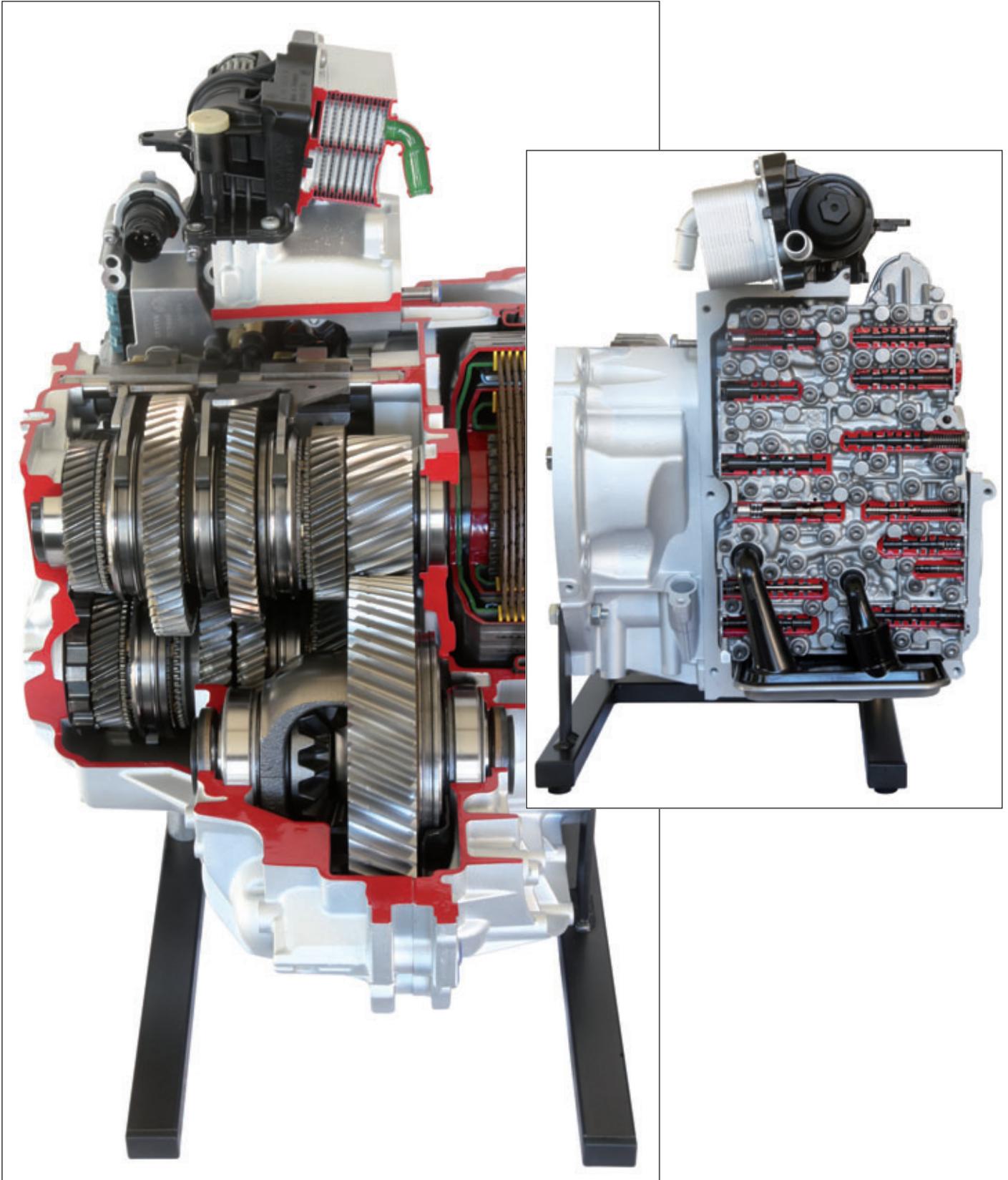
Mercedes-Benz 7-gear dual clutch transmission 7G-DCT

The transmission is currently used in the A and B class of Mercedes-Benz. The transmission can be turned easily and the gears can be changed by hand. The parking mechanism must be pushed down to allow the gearbox to rotate. By compressing the disk package the function of the clutch can be explained. The transmission is mounted on a table stand.

Cut away are:

- wet clutch
- timing case
- transmission case
- oil cooler
- oil filter

Order no. 1353



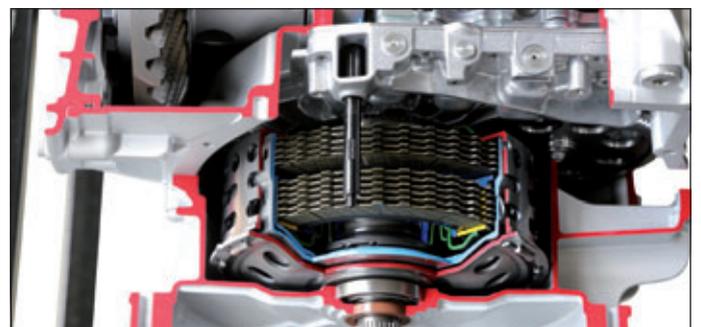
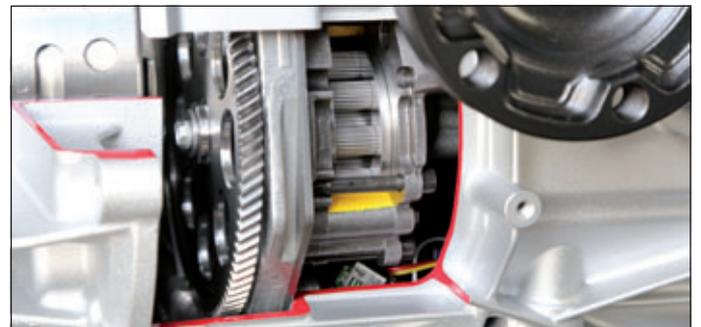
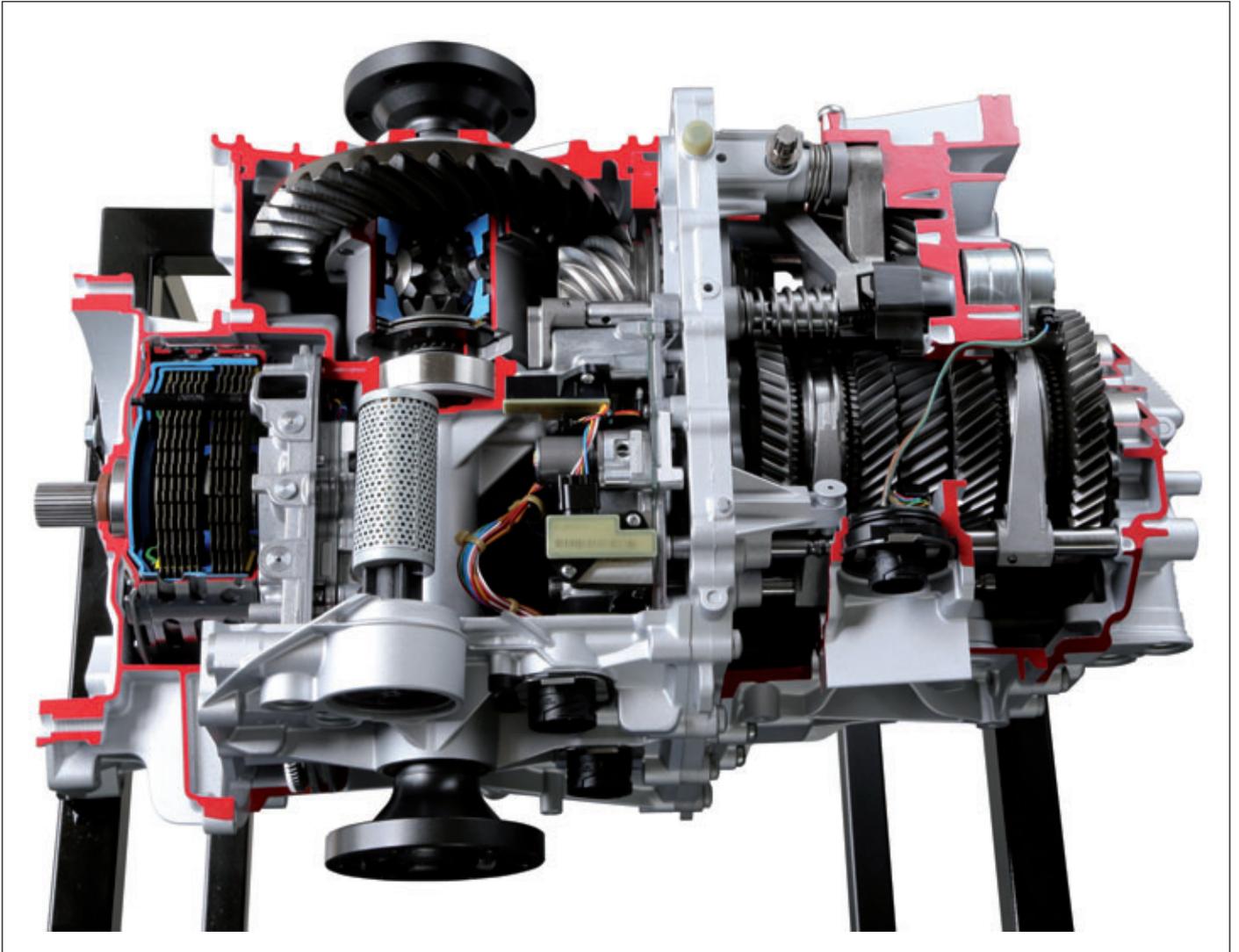
Mercedes-Benz SLS AMG 7-speed dual-clutch transmission

This is a 7-speed dual-clutch transmission from GETRAG in transaxle construction with self-locking differential.

The following are easy to recognize: – self-locking differential – dual clutch – gear wheels – mechatronics – oil filter – oil pump – parking lock – shift forks

Shift forks can be actuated manually. The transmission is rotating, the dual-clutch is also movable and oil pump runs along.

Order no. 1346





Differential gear with hypoid gearing

Possible demonstrations:

- function of the final drive (bevel pinion and crown wheel)
- functions of the differential bevel gears when driving in a straight line and when cornering
- functions of the differential bevel gears when one wheel spins while the other stands still

Order no. 1049



Differential with lock (ASR, ASD)

Demonstration:

- function of axle drive (pinion, crown wheel)
- function of differential spider gears
- locking by hydraulic piston and multiple-disks

Order no. 1092

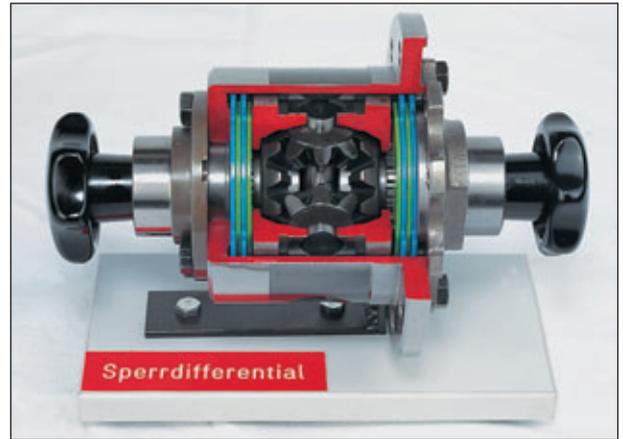


Rear-wheel drive with disk locking system

Demonstrations:

- function of the axle drive (bevel gear - differential ring gear)
- function of the differential when cornering
- function of the locking mechanism in the case of wheel spin
- function of the thrust rings and friction disks

Order no. 1201

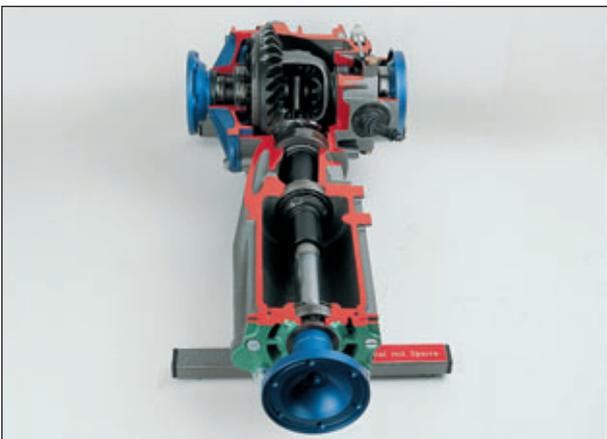


Limited-slip differential with multi-disk clutches (ZF)

Possible demonstrations:

- different speeds of axle shafts when cornering
- function of the friction plates
- function of the thrust rings
- locking

Order no. 1046



Differential with mechanical lock

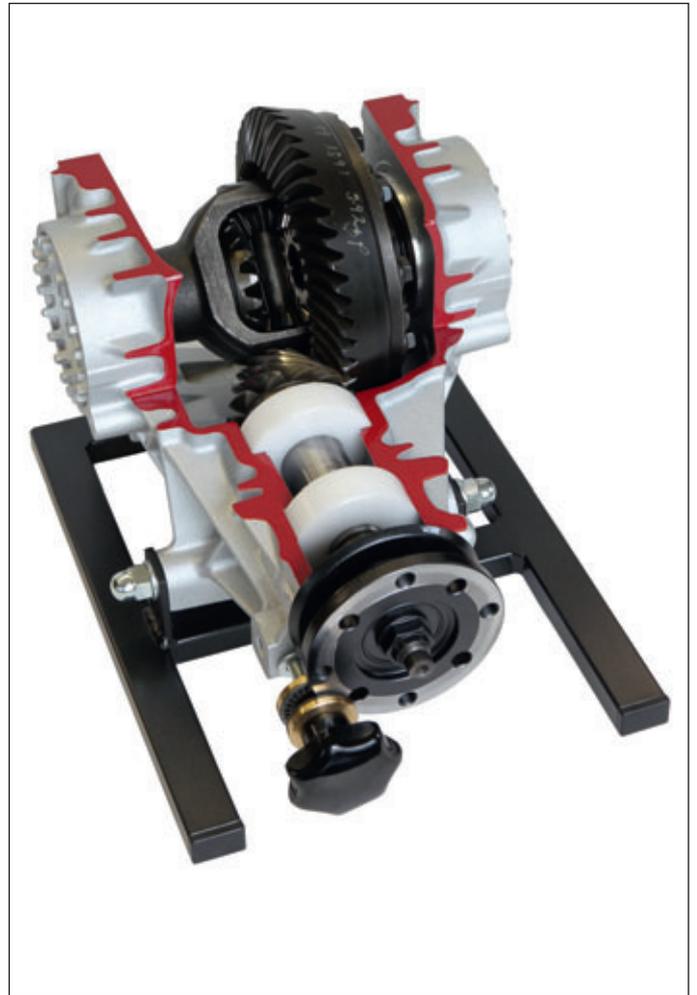
- function of the wheel-drive assembly (bevel gear, differential ring gear)
- function of the differential gear
- compensation of different travels without locking
- differential lock by shifting a claw-coupling over the locking lever

Order no. 1129

Adjustable differential

This differential has been prepared in such a way that both the crown wheel and the bevel gear are continuously adjustable in axial direction. This allows incorrect wear patterns and excessive tooth backlash to be demonstrated.

Order no. 1332



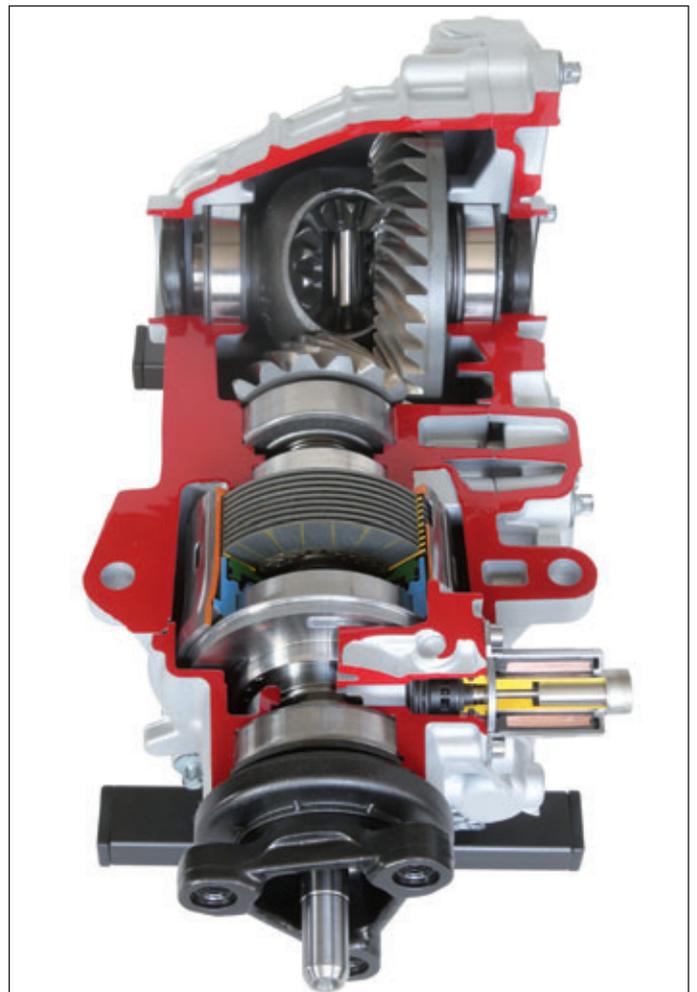
Rear axle differential (electronic traction system) A-class AMG

The electronic traction system is an automatically operating system for improving start-off and acceleration capabilities on different road surfaces.

Cut away are:

- aluminium housing
- multi-disk clutch
- oil pump
- solenoid valve
- hydraulic piston

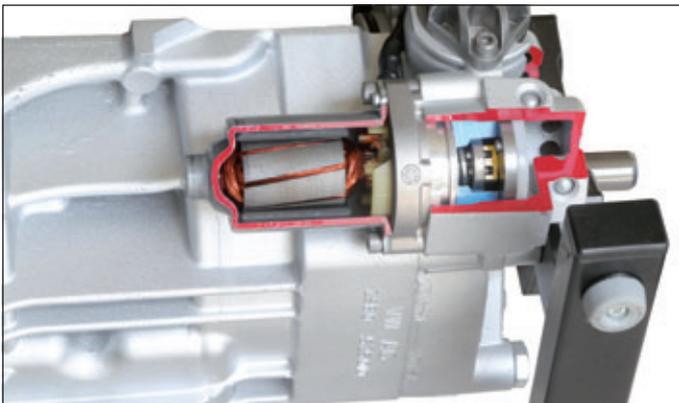
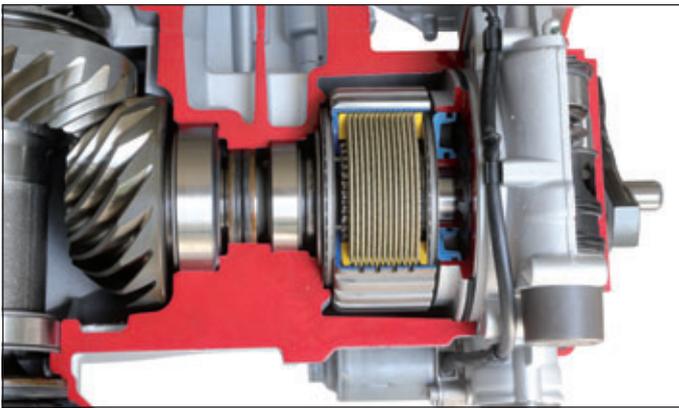
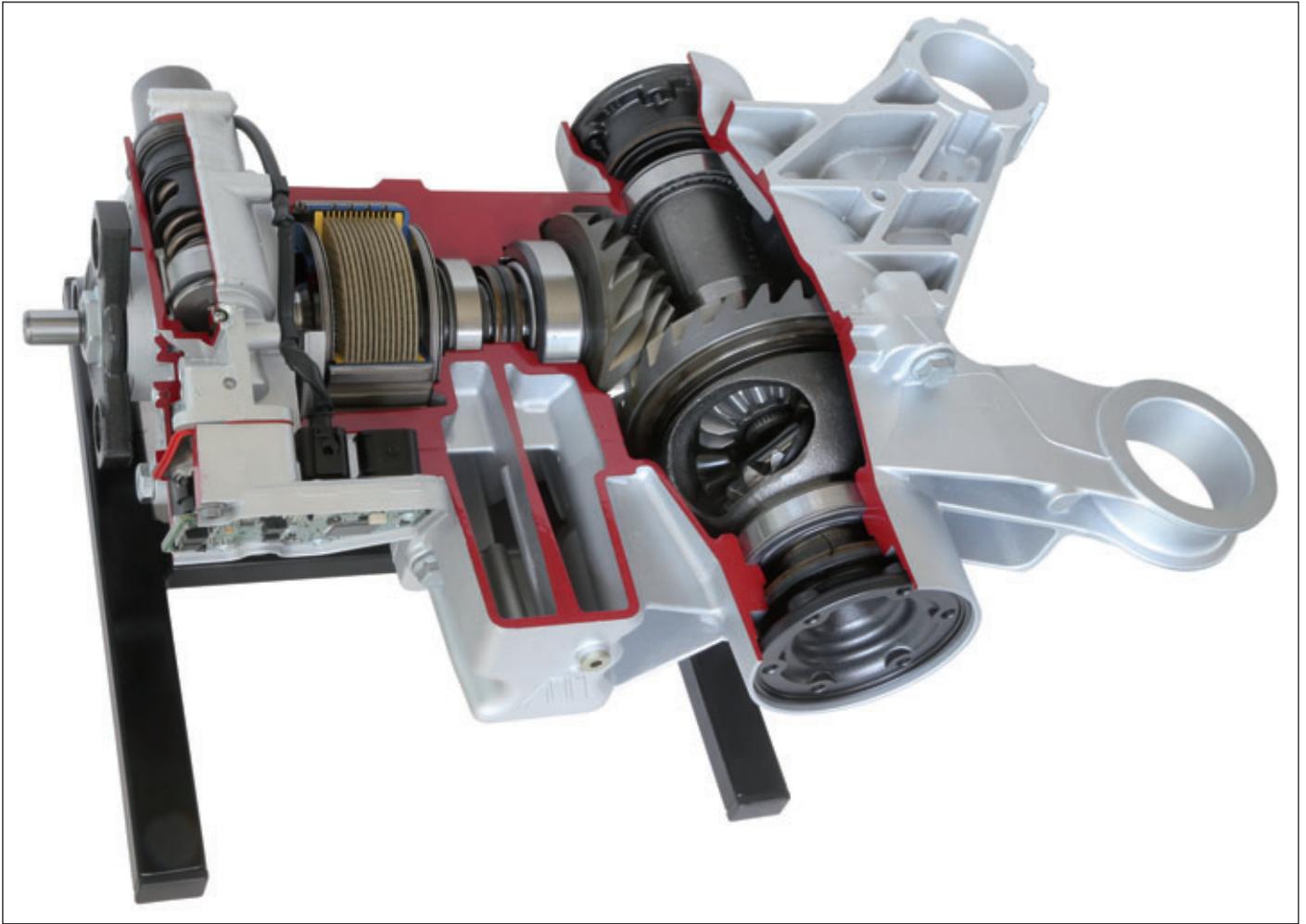
Order no. 1356



Haldex clutch of the fourth generation

Everything can be moved; the function of the clutch can be well demonstrated by pressing the friction disks together. The axial piston pumps can also be turned. The following are easy to recognise: Differential, friction disks, hydraulic pistons, controller, axial piston pump, oil filter and pressure accumulator

Order no. 1358



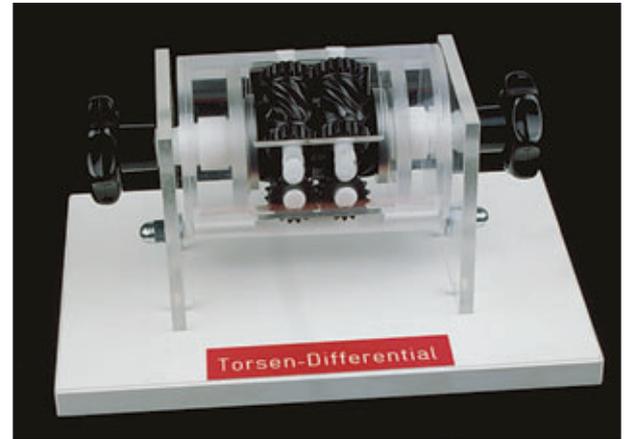


T O R S E N differential gear

Possible demonstrations:

- functions of the worm gears and spur gears
- different speeds of axle shafts when cornering
- locking

Order no. 1043



Torsen differential in plexiglass housing:

Original parts in plexiglass housing, rotary mounting
Order no. 1091

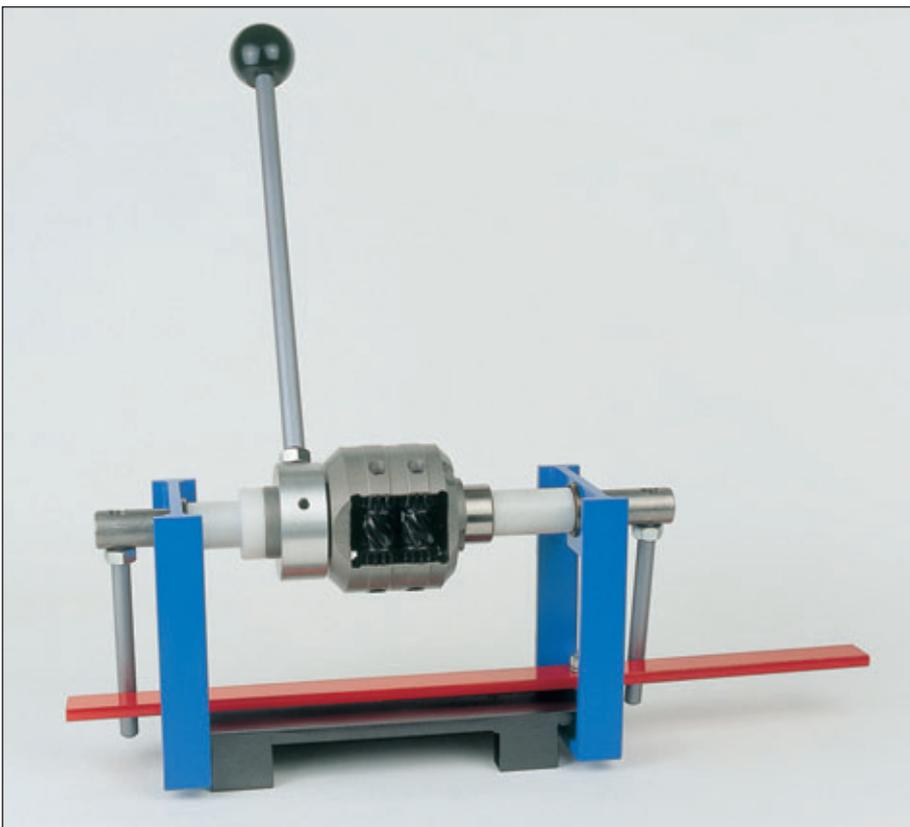


Torsen intermediate axle differential

Intermediate axle differentials are fitted in vehicles with four-wheel drive.

They permit a balance between the front and the rear axle and automatically block if the wheels of one axle spin. They can be installed directly on the transmission outlet for the rear axle.

Order no. 1272



Measurement device to measure the locking figure of differentials

The differential used is a Torsen centre differential from an Audi Quattro. Drive shafts have been installed in both outlets of the differential and provided with lever arms at their ends. The levers are held by an infinitely adjustable balance. If the differential housing is turned with the help of a rotary lever, the levers of the axle shafts contact the lever arms of the balance. Depending on the setting of the lever arms on the balance, the differential blocks until the balance has been adjusted in such a way that the differential slips lever arms. The locking figure of the differential can be determined immediately by reading off the lever arms (law of levers!).
Order no. 1286



Students assembly set Differential

Includes the following:
 2 differential gears with ring gear. 3 differential gears with spur pinion.
 Extremely easy to put together and take apart (no pushing or pulling).
 Order no. 1146



Model case Differential

All components of the differential are clearly visible, they are mounted on a board and are easy to remove.
 Order no. 1136



Assembly of differential gear with crownwheel

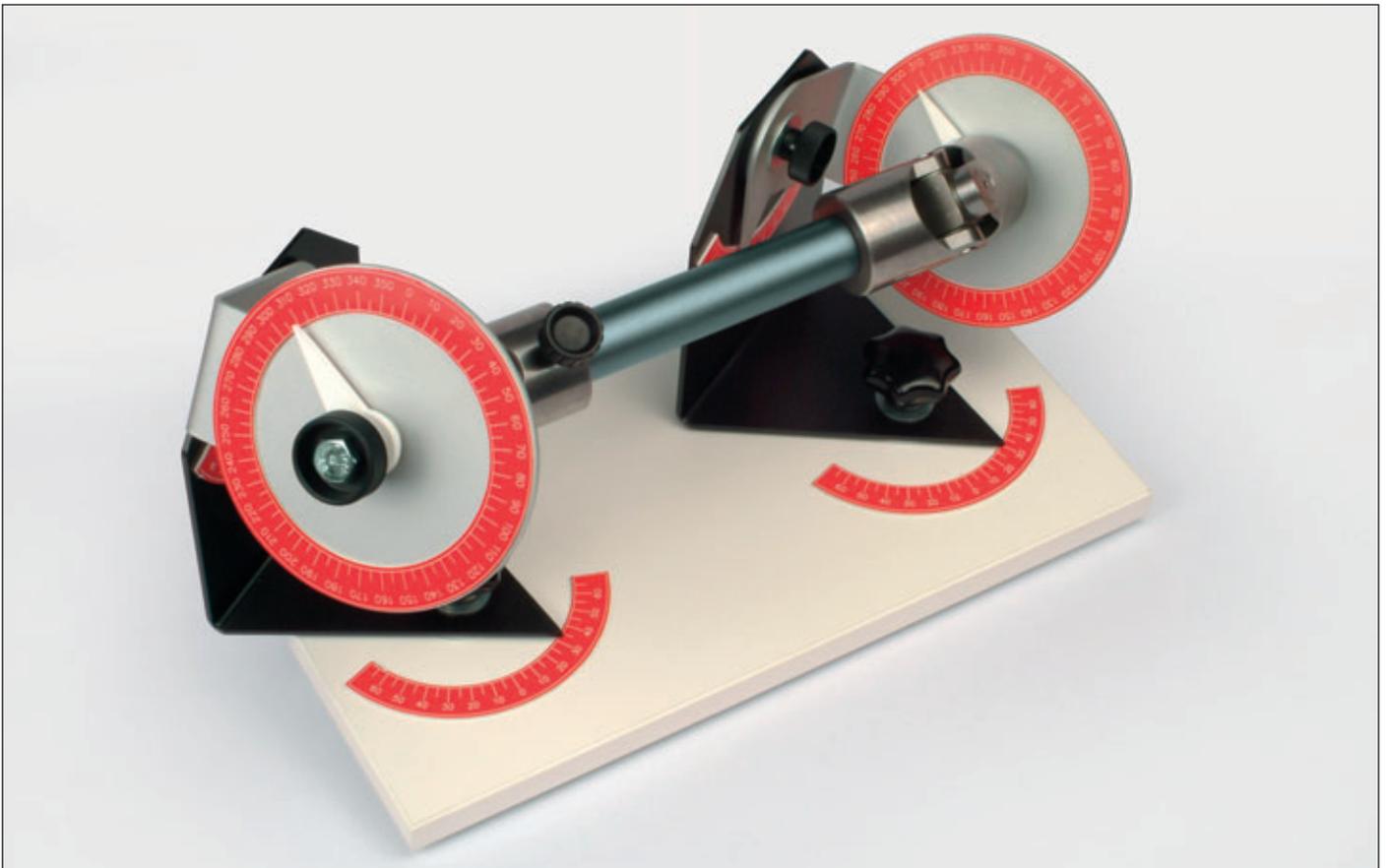
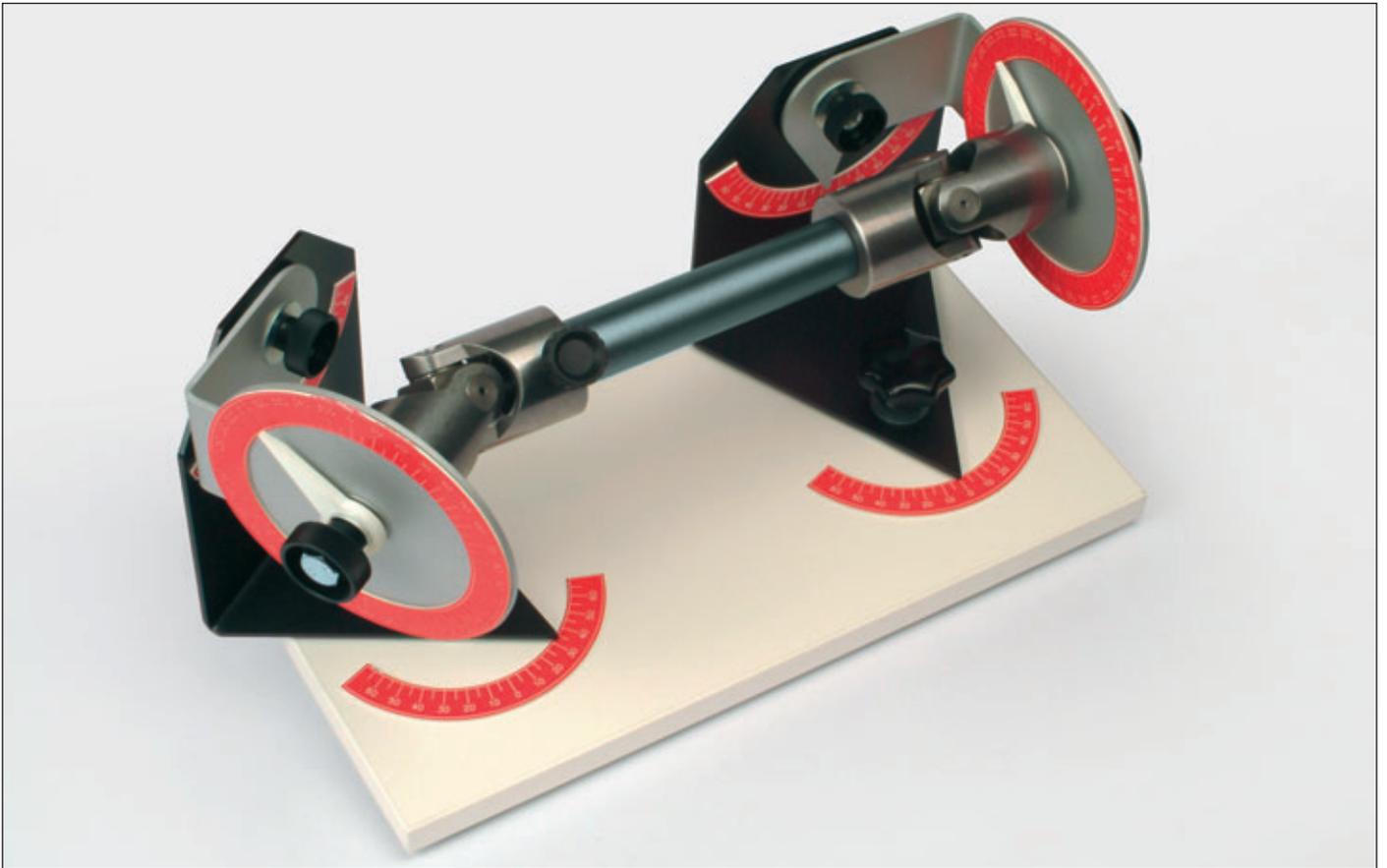
The housing has been prepared so that simple assembly and dismantling is assured.
 Order no. 1105



Assembly of differential with spur gear

The housing has been prepared so that simple assembly and dismantling is assured.
 Order no. 1106





Functional model Universal joints

If universal joints are driven without bending of a part of the shaft, they run with a constant rotary movement. If a bent universal joint is used, an uneven movement results, there is advance or retard on the output side. This can be demonstrated very graphically on the model by the two scales of the drive and the output side being read. If the drive and the output side are bent at the same angle, the advance and retard precisely compensate one another and the output side runs evenly again compared with the drive side. If one joint is offset against the other on the model, for example by 90 degrees, this again results in a strong unevenness. This also happens in practice when drive shafts are put back in the wrong position after repairs.

Order no. 1312



Ball-and-nut power steering

All demonstrations as for no.1050.

Plus:

- displacement of the valve pistons
- function of working piston

Order no. 1052



Recirculating-ball steering (ball-and-nut steering gear)

Possible demonstrations:

- steering gear in motion
- transmission ratio of gear set
- self-locking
- the balls roll in opened guide tubes
- rolling instead of sliding friction
- calculation of transmission ratio and pivoting of the pitman arm

Order no. 1050



Finger steering

- turning of the steering spindle
- stroke of the finger in the screw
- torsion of the steering column control stalk
- play adjustment

Order no. 1120

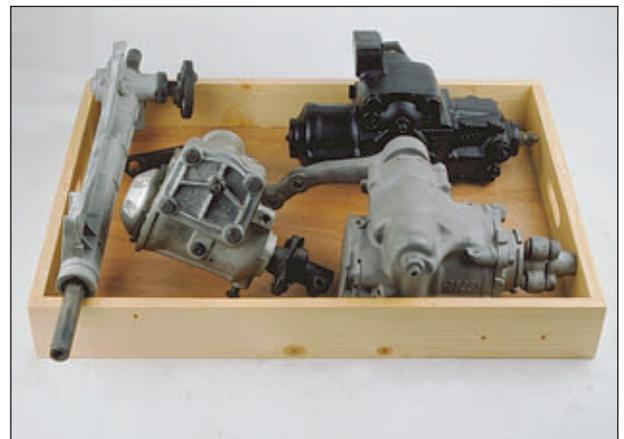


Worm and roller steering gear

Possible demonstrations:

- steering gear in motion
- transmission ratio of the gear set
- interaction of roller and worm
- rolling instead of sliding friction
- calculation of transmission ratio and pivoting of pitman arm

Order no. 1051

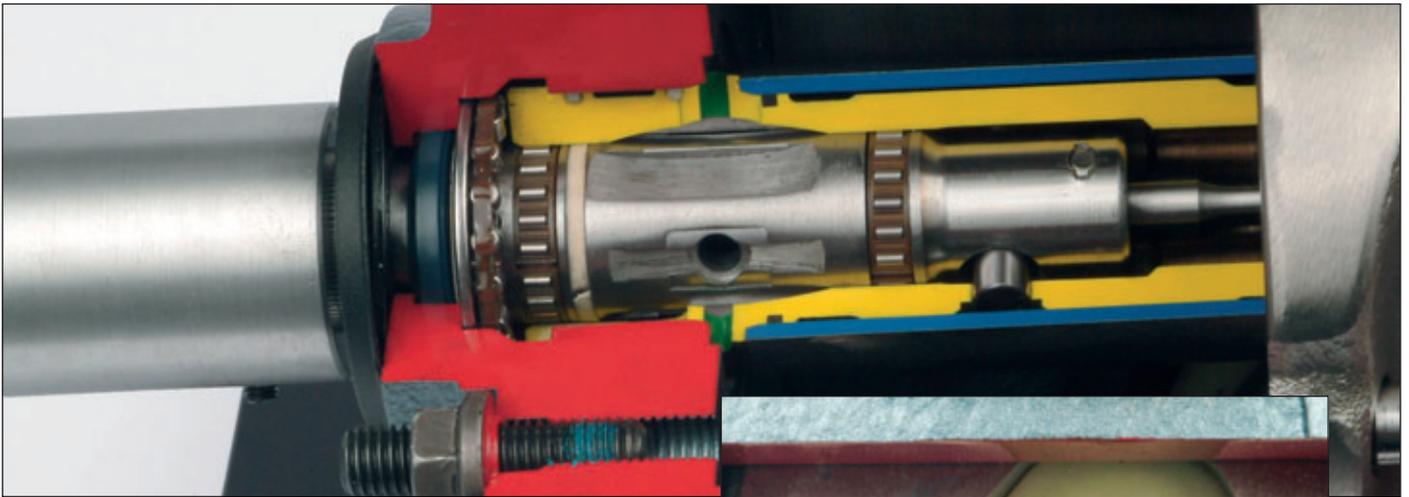
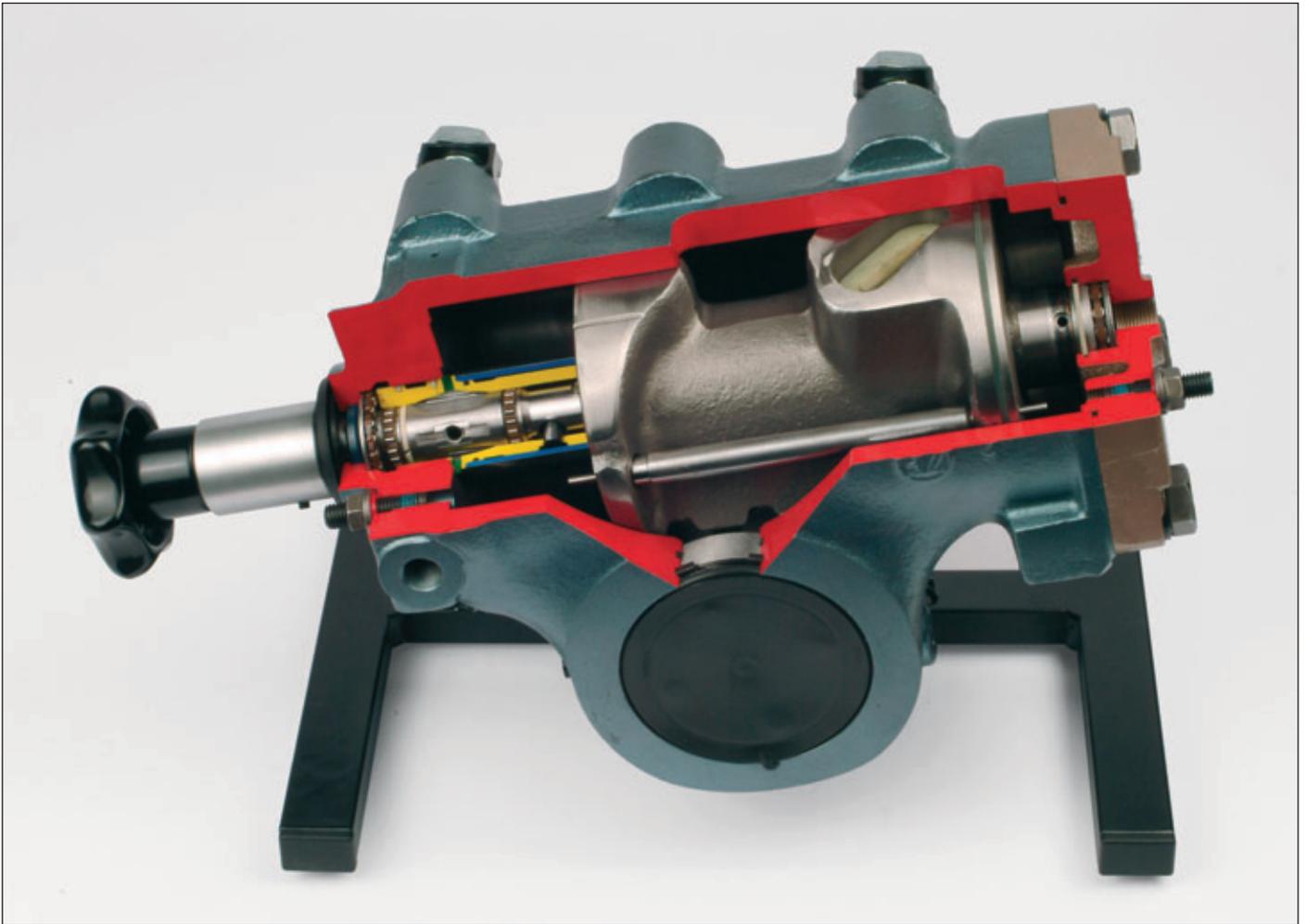


Steering gear test

4 similar or different steering gears prepared for dismantling and assembly

Board-mounted tuition unit

Order no. 1098



Truck ball nut, hydraulic steering gear

Our steering gear is a truck ball nut hydraulic steering, type ZF Servocom. When the steering spindle is turned with the help of the cross button, the steering nut plunger is displaced in the housing cylinder. The steering shaft makes a pivoting movement.

When the steering spindle is turned, one sees the function of the hydraulic control with the torsion bar, rotary valve, control jack and radial grooves.

The following can also be seen: steering stop valve, ball nut plunger with tothing, steering-sector shaft and the balls in the cutaway ball cage.



Order no. 1313



Variable rack-and pinion steering

- movement sequence in steering gear
 - variable transmission ratio via different types of toothing in the gear rack
 - function of the thrust piece with spring: the gear rack is pressed against the pinion thus compensating play and different tooth width
- Order no. 1142



Rack-and-pinion steering gear

- Possible demonstrations:
- movement cycle of steering gear
 - steering gear ratio
 - function of thrust block with cup springs: the rack is constantly pressed against the pinion, therefore no backlash
- Order no. 1053

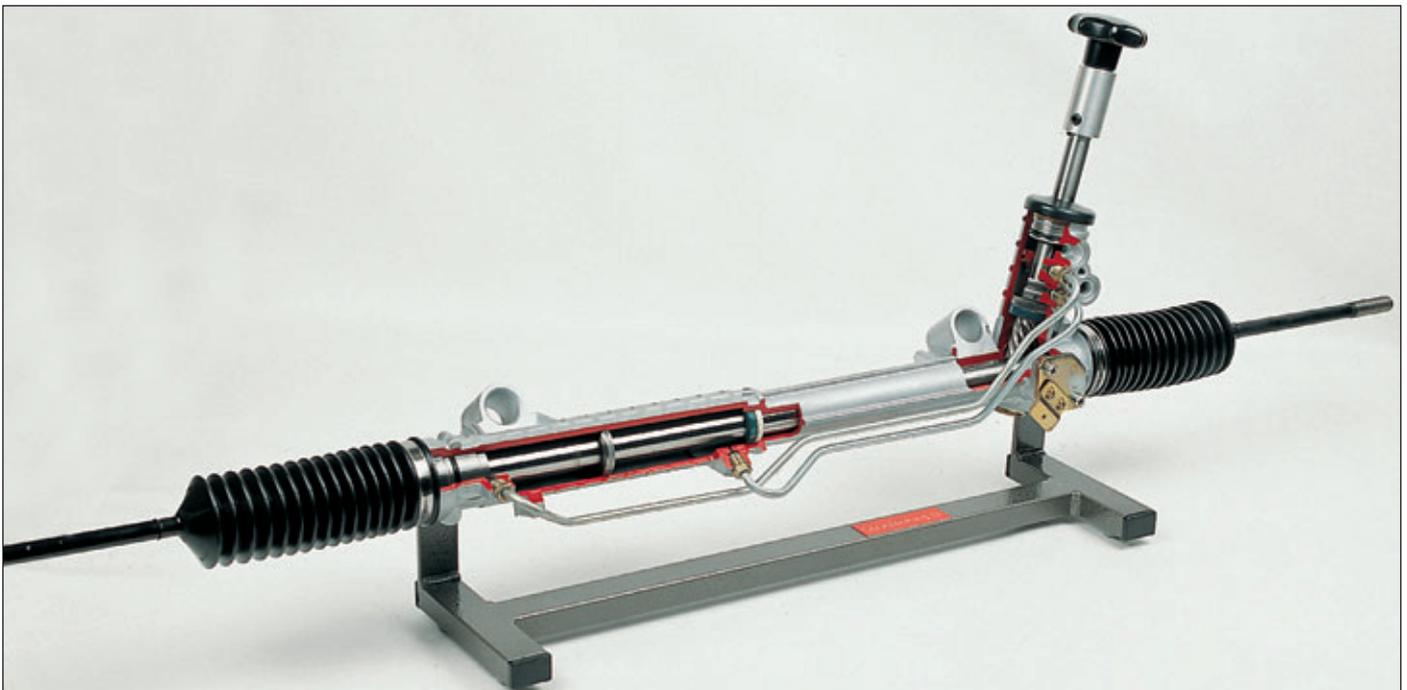


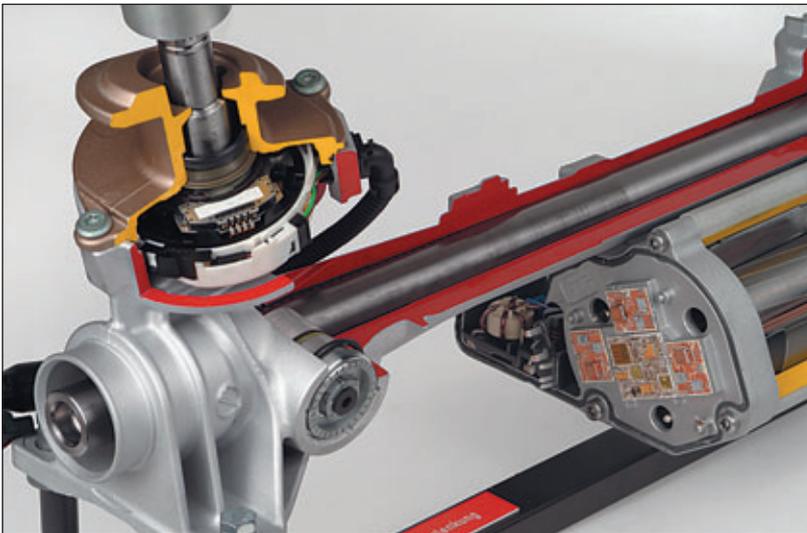
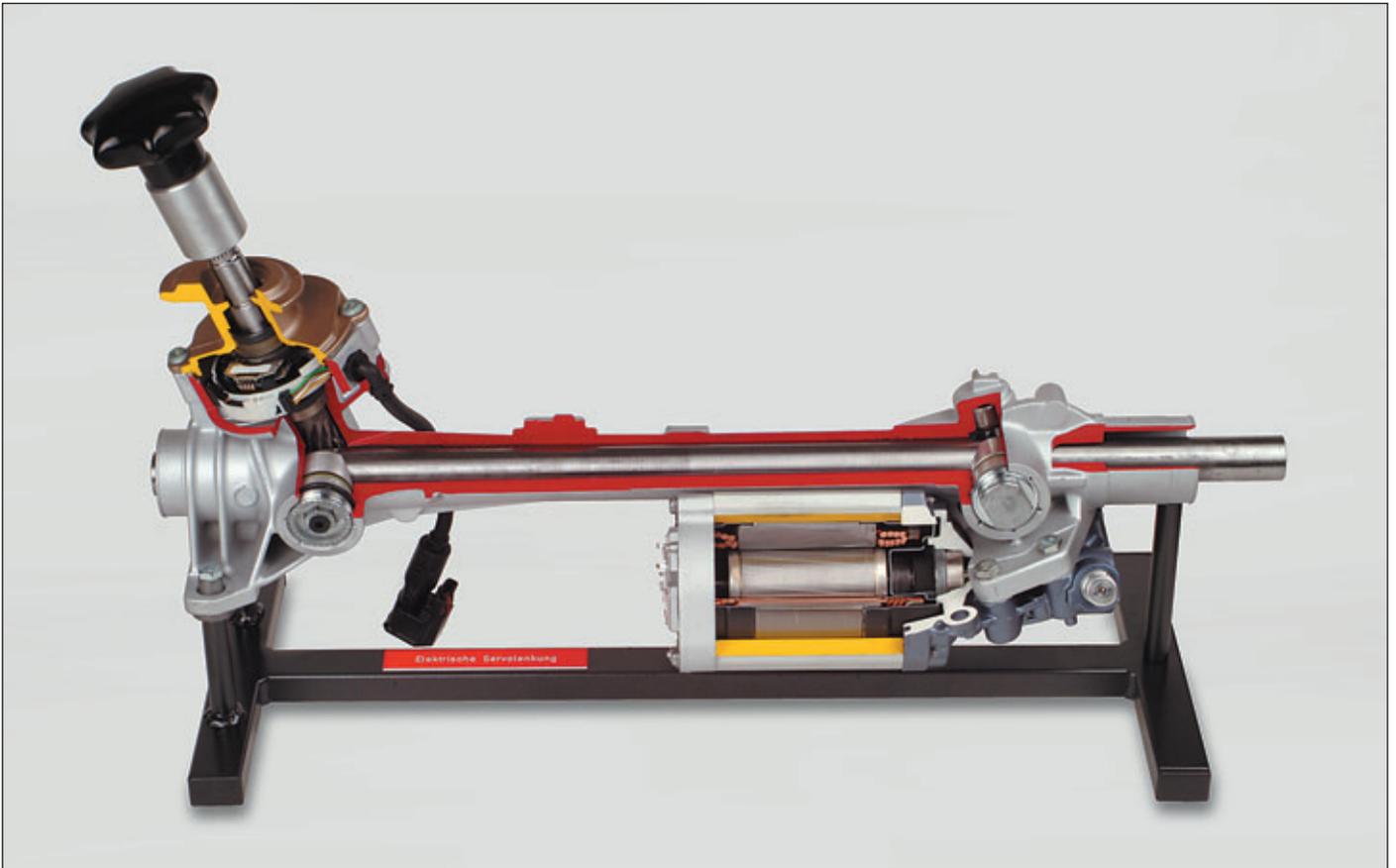
Rack-and-pinion power steering II

- Sequence of movement in the steering gear, transmission ratio in the steering system. Function of the thrust piece and the working piston.
- Change-over of the working piston by means of valve piston and internal ducts. Lateral drive of the steering tie rods on one side of the steering rack.
- Order no. 1228

Rack-and-pinion power steering III

- Sequence of movement in the steering gear, transmission ratio in the steering system. Function of the thrust piece and the working piston.
- Change-over of the working piston by means of rotary-disk valve.
- Lateral drive of the steering tie rods on both sides of the steering rack by means of ball knobs.
- Order no. 1229 ▼



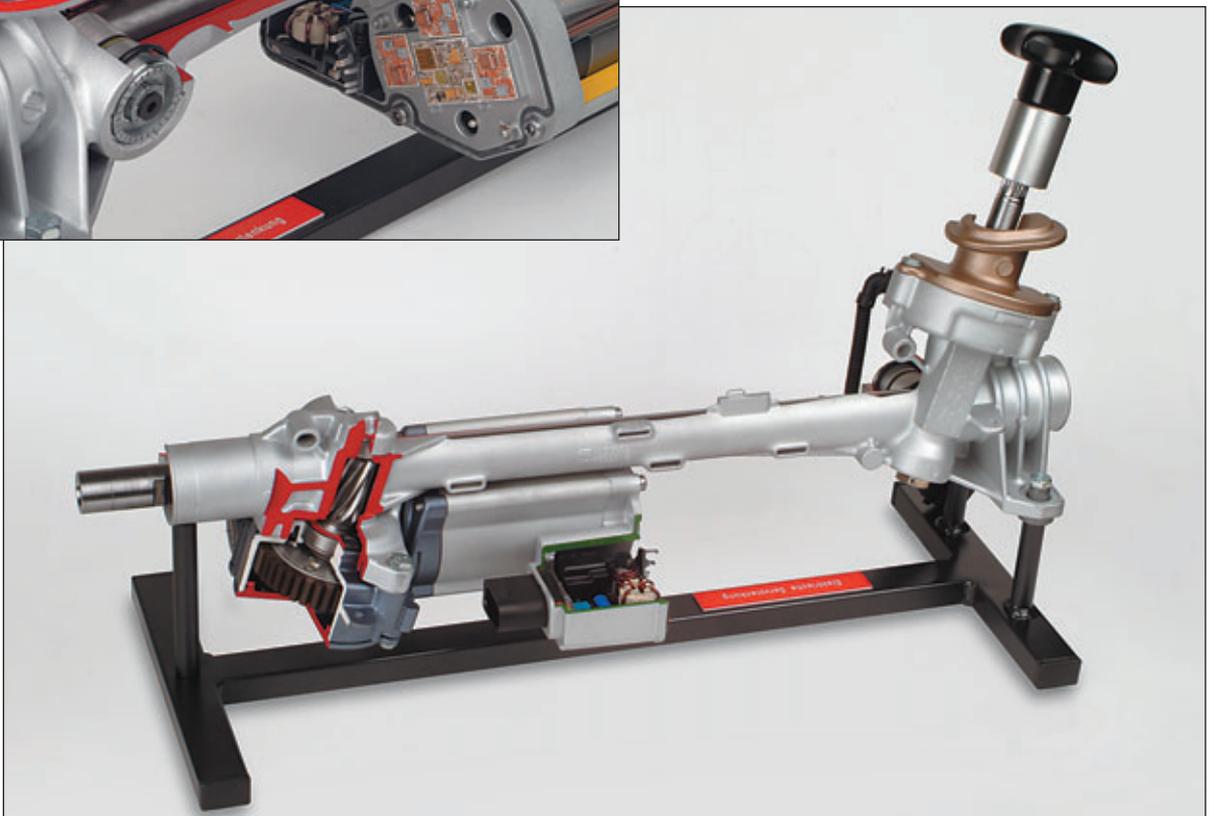


Electrical rack-and-pinion steering

Functions:

- sequence of movements in steering gear
- ratio in steering gear
- support of the steering forces by an electric motor

Order no. 1301



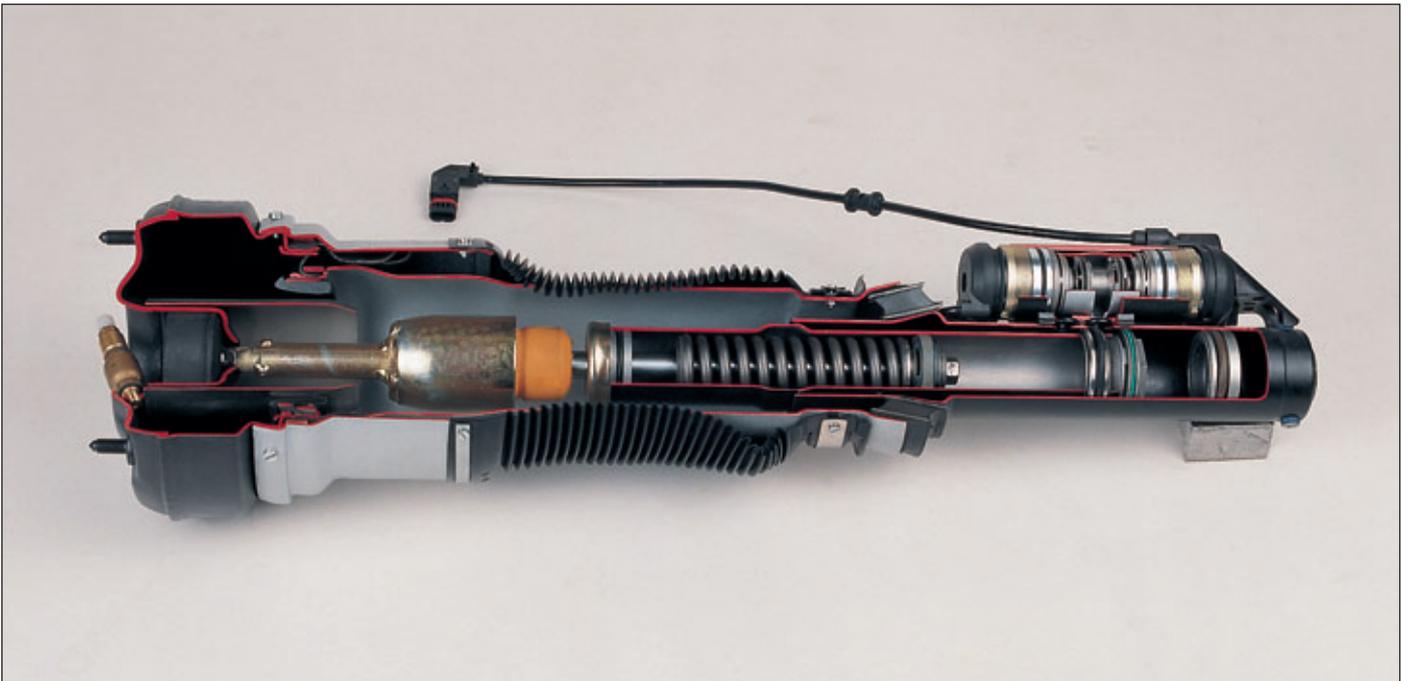
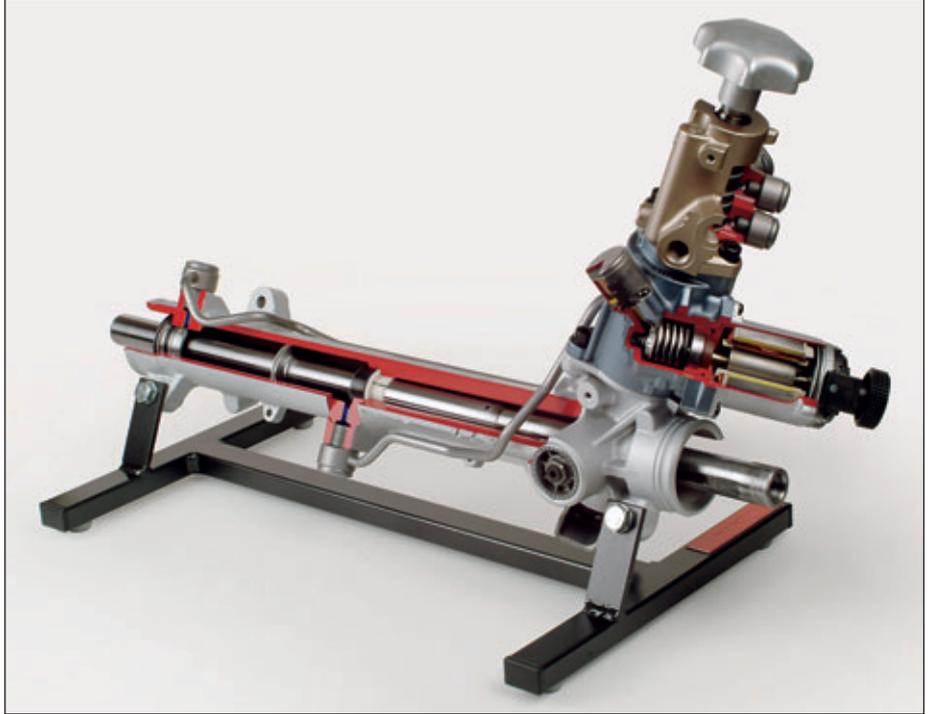
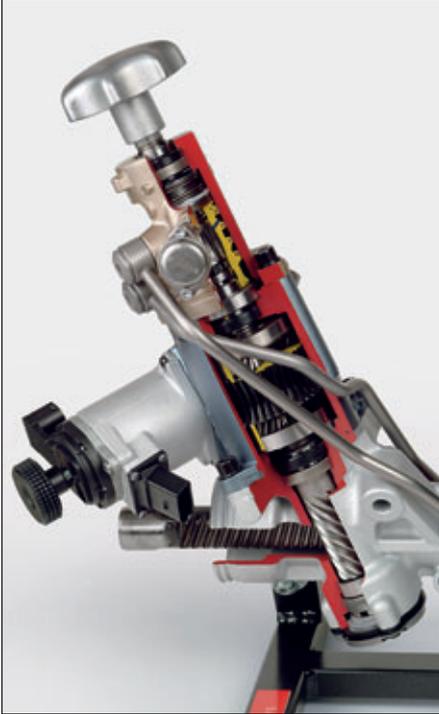
ZF active steering

This system essentially comprises a rack-and-pinion power steering, a planetary transmission, an electric motor, some sensors and a control unit. The additional degree of freedom makes continuous variation of the steering ratio as a function of the situation possible. Depending on the driving situation, the effective steering angle on the wheel is therefore smaller or larger than the one which the driver sets on the steering wheel.

Functions:

- Turn the steering wheel (star handle), function of the rotary sleeve valve, the gear rack is displaced, the piston moves. In this context, the stepped planetary wheels and the sun gear move in the housing, as the worm gear has been locked by the electromechanical block via the worm.
- If the electromechanical block is unlocked (via an electromagnet, here by lifting the anchor), the handle of the electric motor can be turned. Now, the worm gear turns and the drive pinion moves the gear rack. The planetary transmission adds or subtracts an adjustable engine angle to the angle set by the driver. The sum of these two angles then acts on the drive pinion, which generates the steering angle.
- Function of the electromagnetic valve on the Servotronic 2 rotary sleeve valve.
- Connection of the oil lines, function of the rack-and-pinion piston.

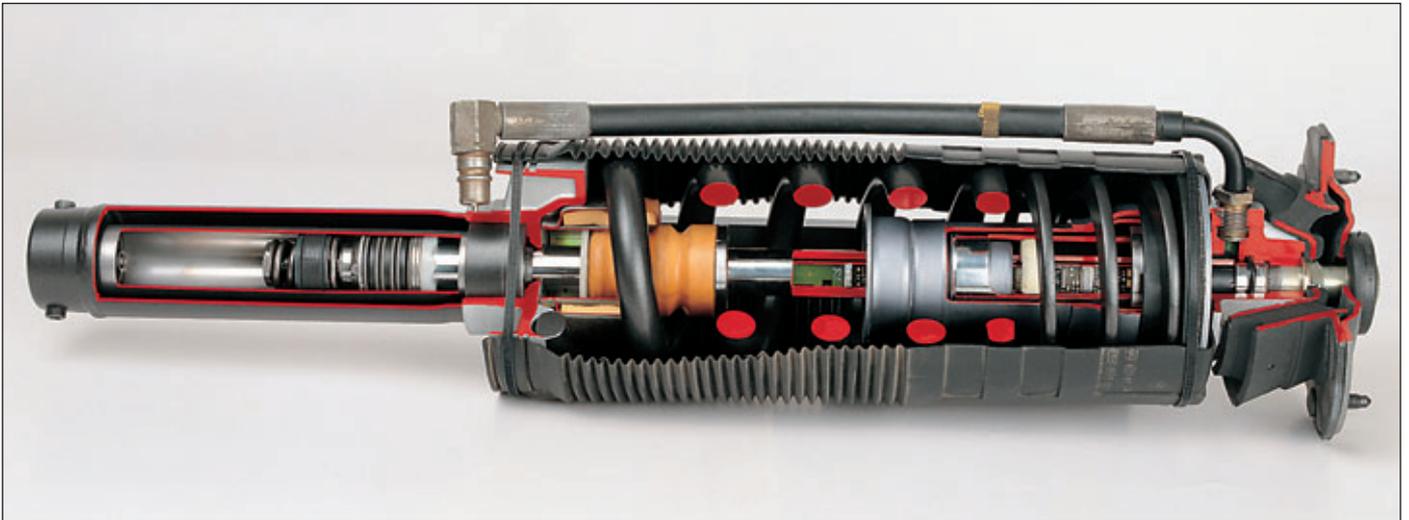
Order no. 1317



Spring leg (air suspension)

In the Mercedes-Benz S class, 4 spring legs are used on the front and rear axle as function elements of the Airmatic. They are connected with one another via a data bus. The following can be clearly seen on the model: Air suspension with inlet valve for level control and lowering of the chassis, damper with bottom valve and gas area, solenoid valves for the regulation of the damping strength.

Order no. 1246



ABC (active body control) suspension strut

Active suspension and attenuation system with hydraulic cylinder, helical spring and attenuator. Behind the cutaway spring, the hydraulic cylinder (plunger) for level regulation, the attenuator and, in the hollow piston rod, the suspension strut control device are easily visible.

Functions in the vehicle:

The level regulation enables manual and speed-dependent automatic lowering and raising of the level of the vehicle.

In bends and on uneven roads as well as in braking and accelerating, rolling and pitching motions are practically completely suppressed.

order no.1275



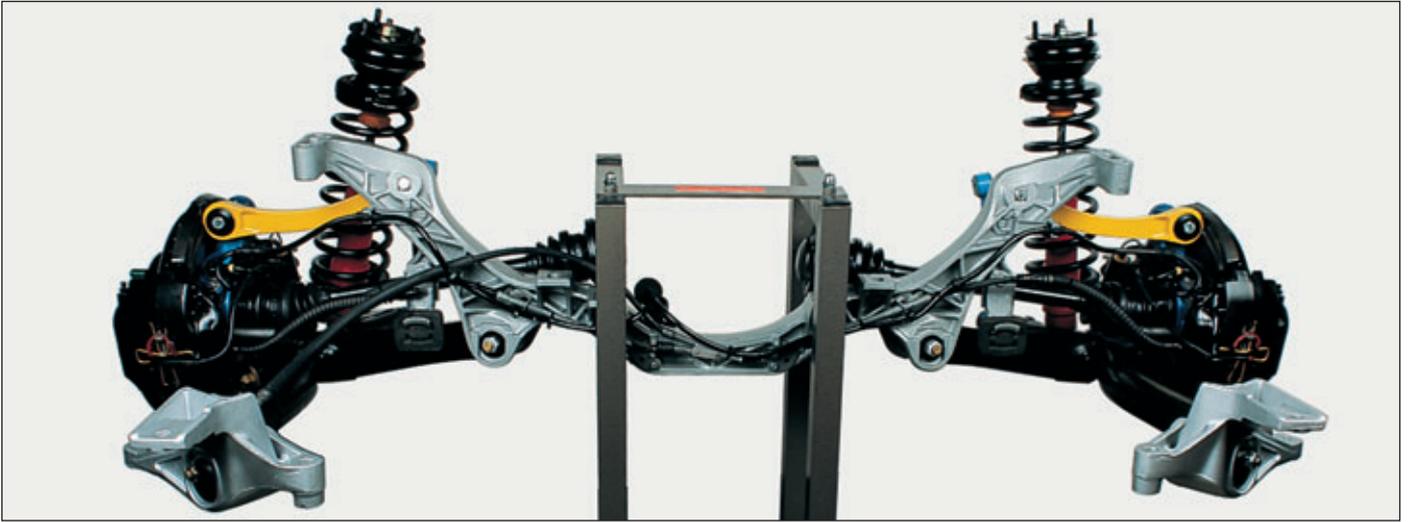
Complete suspension strut with wishbone, drive shaft, disk brake with brake disk

– function of the suspension strut with spring and cut-away shock absorber

– function of the disk brake with cut-away brake caliper

– function of the wishbone and the drive shaft with cut-away ball-and-socket joint

Order no. 1202



Porsche Weissach axle (928)

The axle comes complete with: Axle bracket, double wishbone, axle shafts, internally-ventilated brake disks, four-piston disk brakes, springs and shock absorbers. The compression of the axle can be clearly demonstrated. On request the axle can be supplied with a cut-away Original Porsche five-speed transmission. Order no. 1225



Mercedes-Benz multi-link suspension

The construction of the axle with its 5 links is easily distinguished by the use of colour markings. The axle is complete with brake calipers, brake disks, axle shafts, springs and shock absorbers. The differential and one brake drum for the parking brake are cut away. Order no. 1224





Twin-tube shock absorber

The shock absorber is cut away to such an extent that the inside and outside of the tube with bottom valve and piston can clearly be seen. The piston and the bottom valve are also cut away, so that the valves can clearly be seen. The piston rods can easily be moved in and out.

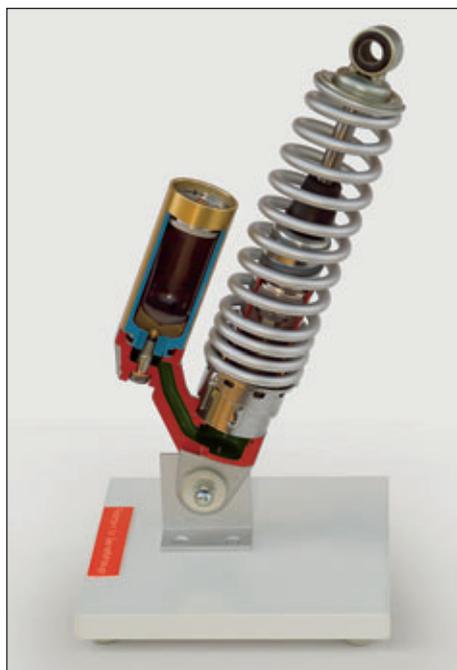
Order no. 1234



Single-tube gas-pressure shock absorber

The shock absorber is cut away to such an extent that the separating piston and the working piston can clearly be seen inside the tube. The working piston is also cut away, so that the valves can clearly be seen. The piston rod can easily be moved in and out.

Order no. 1235



Suspension strut for two-wheel vehicles

In two-wheel vehicles, single-tube shock absorbers are frequently used. A suspension strut with a progressive spring has been used. Blowing or discharge of nitrogen into/out of the compensation container changes the attenuation (hard, soft).

The following can be shown:

- compression by pressing on the suspension strut
- device to change the spring hardness by turning the stepped sleeve on the bottom of the suspension strut or adjusting nut
- movement of the cutaway work piston with finned valves for the pusher and tractor phase
- in the cutaway compensation container, the cutaway dividing piston (rubber membrane), in which the gas cushion can be found, can be seen

Order no. 1325



Ball and socket joint

Design of a ball and socket joint (constant-velocity or homokinetic joint). Function of the balls and the ball cage. The axle journal can be pivoted, but only be moved up and down minimally. Order no. 1262



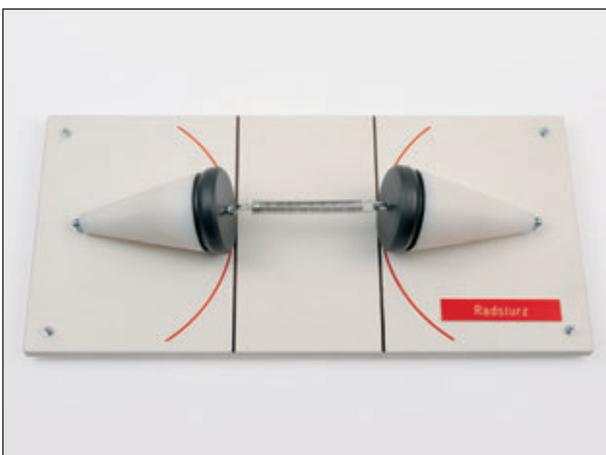
Tropoid joint

Design of a tropoid joint with tropoid star with pinions and idlers. Tropoid joints permit diffraction angles of up to 20 degrees and 30 mm axial displacement. This can be demonstrated very clearly on the model. Order no. 1263



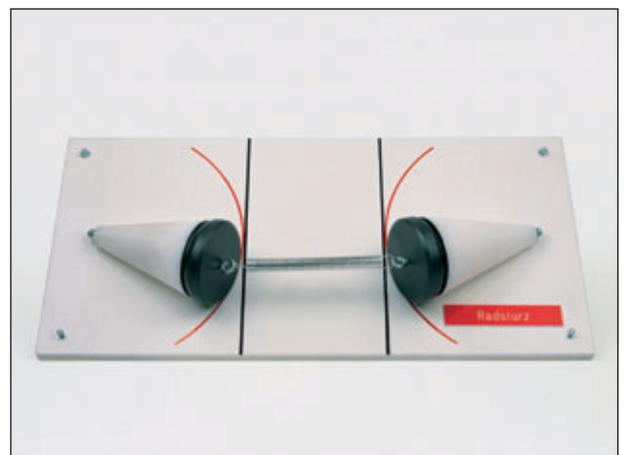
Model case Axle shaft including joints

Cut-away ball-and-socket joint with wide angle of movement. Cut-away tripod joint with length compensation. Cardan shaft with 2 universal joints and cut-away sliding section which is easily moved. Universal joint with polygonal rubber joint. Hardy disk (disk-type flexible coupling). Order no. 1213



Functional model Wheel camber

A wheel at an angle no longer moves on a straight line, but on a circular track. If the wheels are pushed forwards, the wheels make efforts to move apart at the front as a result of the rolling taper.



Thanks to a precisely coordinated selection of the track, the wheel moves straight ahead and the wheel flutter is prevented. Order no. 1270



Aluminium rim

Easily visible:

- well base, rim shoulder and rim flange
- balancing weights and valve
- wheel offset on the moving scale can be read off directly

Order no. 1297



Function model spreading

When the wheel is turned, you recognise the lifting of the vehicle (on the ball)

If you press the ball, the turned wheel immediately goes into the straight ahead position.

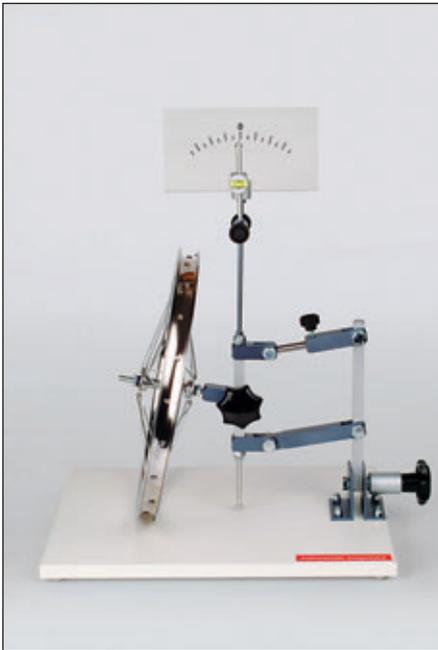
Order no. 1305



Balancing model for wheels

- the wheel axle, which hangs on two chains, is pulled down by springs
- demonstration of a static unbalance: wheels hop. This can be adjusted by putting on a counterweight
- demonstration of a dynamic unbalance: wheels flutter. This can be adjusted by changing weights to the correct side

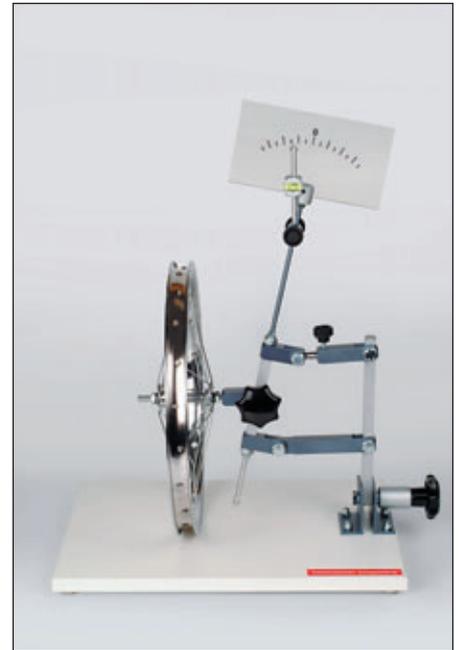
Order no. 1011



Picture 1: negative camber



Picture 2: positive camber



Picture 3: large spreading angle



Picture 4:
large spreading angle and a positive
camber result in a small steering offset



Picture 5: large castor angle



Picture 6:
strong camber change after wheel turn
with large castor angle.

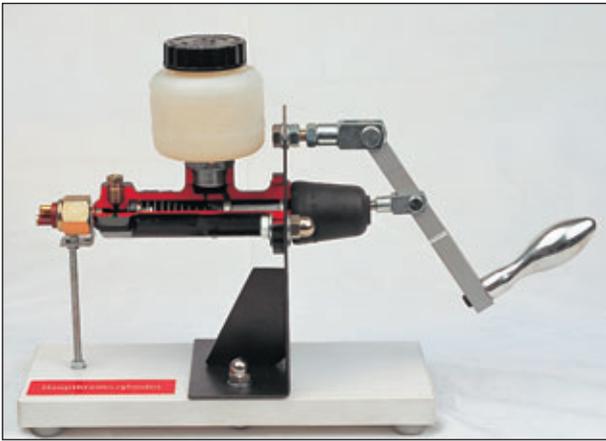
Functional model Axle geometry

(castor offset, camber, toe-in and spreading)

The following can be changed and demonstrated on the model:

- the wheel camber (negative, zero and positive), the spreading, the castor offset and the steering offset
- enlargement of the camber in an enlargement of the castor offset
- reset forces on the turned wheel through the spreading
- change of the steering offset if the spreading and camber are changed

Order no. 1306

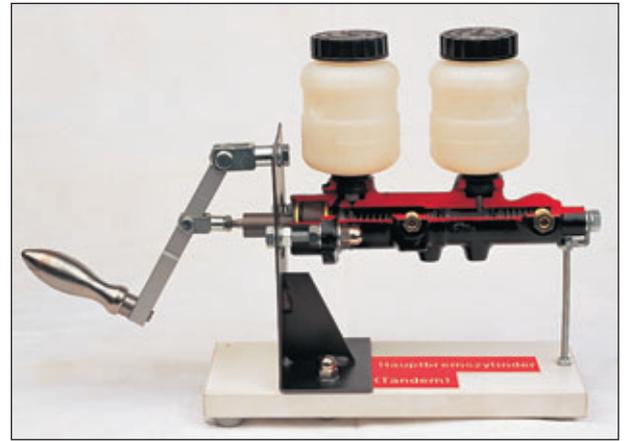


Single Main Brake Cylinder

Demonstration:

- sliding the pressure rod piston
- closing the pressure chamber
- differential and tracking bore function
- pressure build-up
- bottom valve function

Order no. 1036



Tandem Main Brake Cylinder

Demonstration:

- sliding the pressure rod piston
- closing the pressure chamber
- differential and tracking bore function
- pressure build-up
- function in the event of a failure of any brake circuit

Order no. 1037

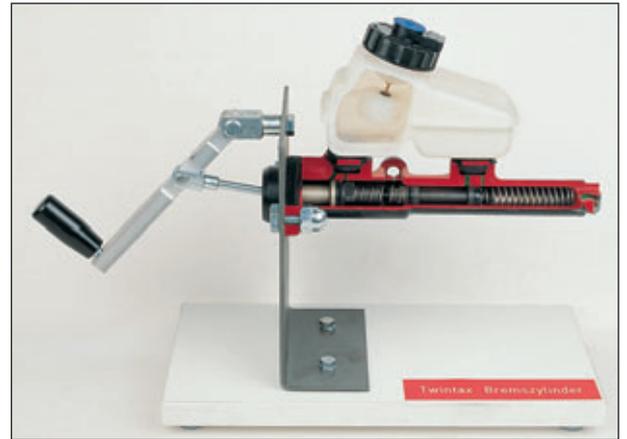


Graduated Tandem Main Brake Cylinder with Central Valve

Demonstration:

- as per Model No. 1037
- plus: failure of the front differential bore (due to regulating with ABS systems)
- opening and closing the central valve

Order no. 1068



Twintax brake master cylinder

- function of both pistons
- function in case of failure of one of the circuits
- securing of the stepped piston
- brake-pressure increase in circuit II in case of failure of circuit I
- shorter pedal travel in case of failure of one of the circuits
- securing of the piston

Order no. 1118



Brake pressure reducer

Function: Movement of stepped piston to reduce brake pressure

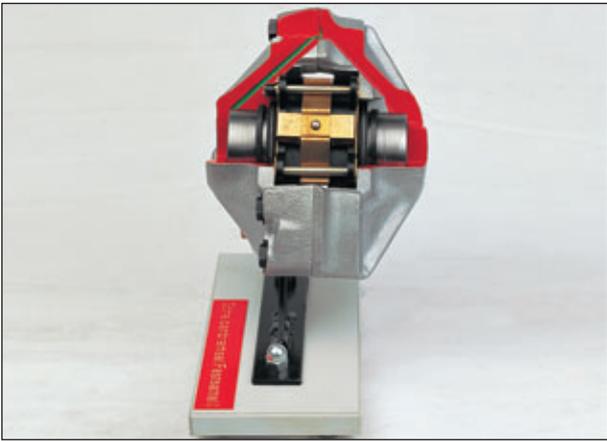
Order no. 1083



Brake pressure regulator

Function: Movement of stepped piston and actuation of conical-seat valve

Order no. 1086



Fixed Calliper Disc Brake

Demonstration:

- brake piston and sealant ring function
- connecting channels between both parts of calliper
- securing pin and split spring function
- brake and bleed bore

Order no. 1039



Fixed Calliper Disc Brake with 4 brake plungers

- function of sealing ring and plunger

- automatic readjustment in case of wear

- function of the connecting ports between both calliper sections

- function of the brake and ventilation bores

- if circuits I or II fail, the front axle always brakes

Order no. 1130



Floating Calliper Disc Brake

Demonstration:

- brake piston and sealant ring function
- sliding the float frame on the retainer
- securing pin and split spring function
- brake and bleed bore

Order no. 1040



Sliding Calliper Disc Brake

Demonstration:

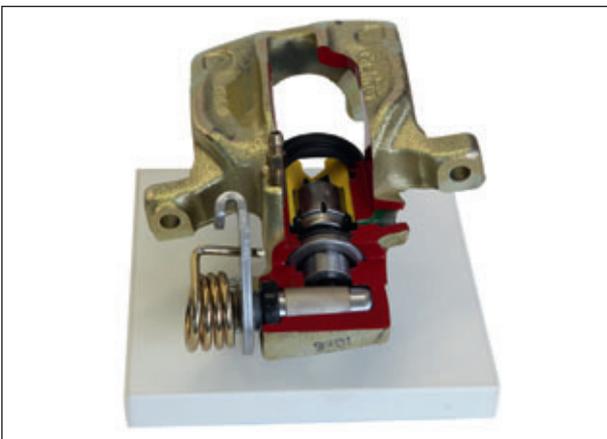
- brake piston and sealant ring function

- sliding the retainer on the housing (calliper)

- securing pin and split spring function

- brake and bleed bore

Order no. 1038



Disc brake with parking brake

Cutaway are: brake callipers, brake piston, adjustment mechanism. The function of the parking brake can be demonstrated by turning the lever.

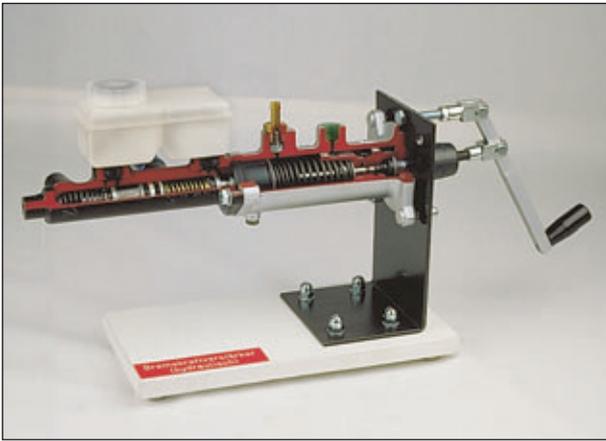
Order no. 1333



Pneumatic brake power assist unit with tandem brake master cylinder

By pressing the lever the outer valve can be seen to open. The piston rod with diaphragm disk moves forward. The pressure rod moves both the pistons in the brake master cylinder and the braking process is started.

Order no. 1236



Hydraulic brake booster with tandem master brake cylinder

Function of reaction piston, spool valve, supply and return bore
Order no. 1096

... without master brake cylinder

Order no. 1104



Drum brake with brake drum

The brake drum and the wheel cylinder are substantially cut away. The brake pistons can be spread using a control lever, thus applying braking pressure to the easily-turned brake drum.
Order no. 1203



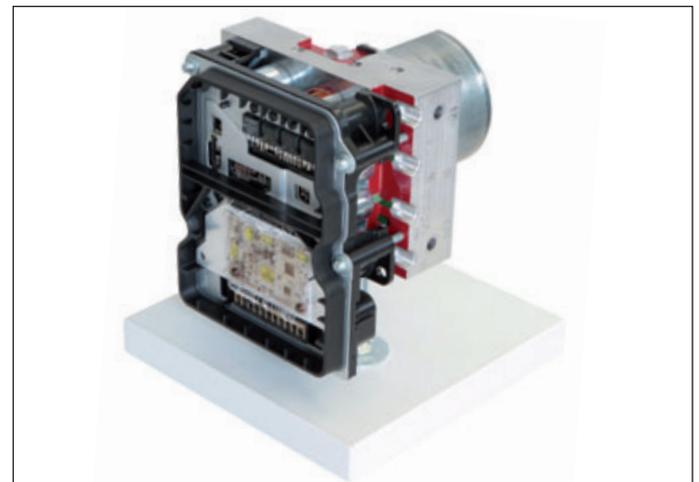
Wheel Cylinder

Demonstration:
– function of sleeve, piston and adjusting ring
Order no. 1035



ABS Hydro Unit

Demonstration:
– function of the electric motor and return flow pump
– pressure reservoir function
– magnetic valve function
Order no. 1030



Hydraulic unit ESP

Cutaway are:
– electric motor of the high-pressure and return pump
– plungers of the pump move when the electric motor turns
– solenoid valve
– miscellaneous oil channels
Order no. 1302



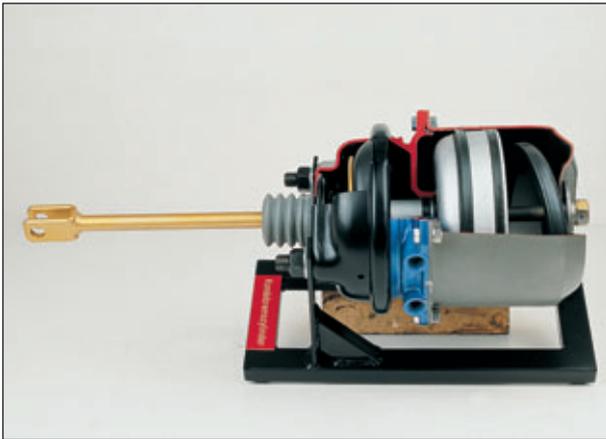
Double-acting compressed air cylinder

Compressed air cylinders are often used in commercial vehicles, for example to shift mechanical transmissions on commercial vehicles. They are also used in the compressed air brakes of commercial vehicles as piston membranes or as combined cylinders. One sees the cutaway cylinder area and the two compressed air connections. The working piston can be pushed back and forth easily.
Order no. 1323



Piston cylinder

Piston extension when the rear chamber is ventilated.
Piston retraction via the force of the incorporated spring.
Order no. 1144



Spring-loaded brake cylinder

- function of the spring-loaded cylinder
- function of the various compressed-air supply lines
- function of both springs
- function of the mechanical release device

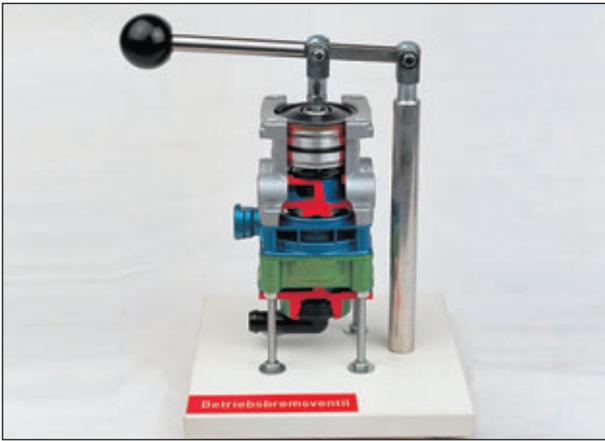
Order no. 1063



Diaphragm cylinder

- connection of both housing sections
- splitting up of housing in two chambers by means of the rubber diaphragm
- piston extension and retraction

Order no. 1131

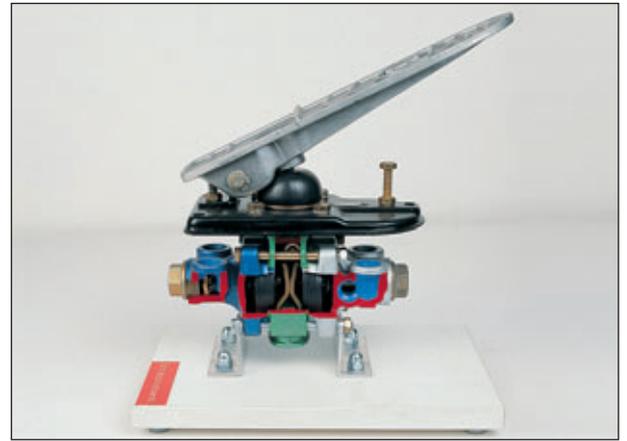


Operating brake valve 1

Demonstration:

- movement of the graduating and control piston
- opening and closing the inlet and outlet
- release, partial braking and full braking position

Order no. 1057



Operating brake valve 2

Order no. 1137



Trailer brake valve

Demonstration:

- activation of the trailer brake system
- emergency braking in the event of pressure loss in the reservoir line
- applying the brake on the coupled trailer
- piston and valve functions

Order no. 1059



Trailer control valve

Demonstration:

- function of both pistons and the valve
- function in the release, partial braking and full braking position
- applying the brake with the help of the safety brake valve

Order no. 1060



Parking secondary brake valve

It has the task of holding the stationary vehicle by purely mechanically generated forces. If the service brake system fails, it acts as a secondary brake.

Functions: driving position, parking brake position, partial braking position, secondary brake.

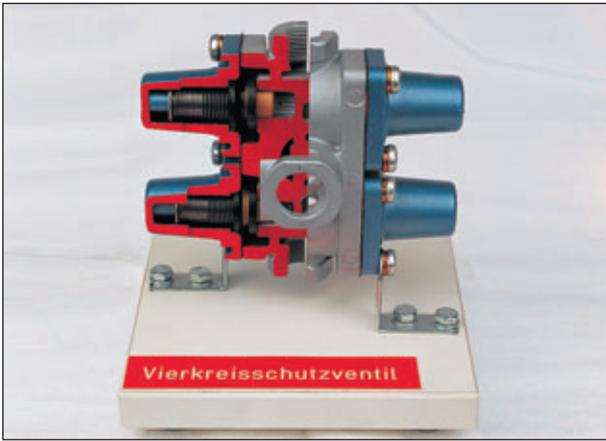
Order no. 1271



Air compressor

- function of the crankshaft drive
- function of the valves

Order no. 1031

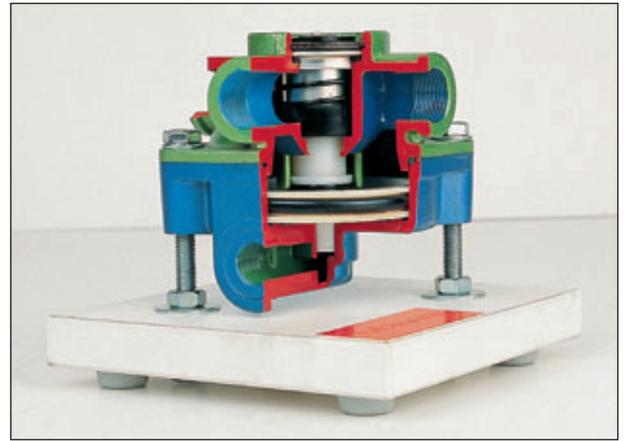


Quadruple circuit shut-off valve

Demonstration:

- distribution of the compressed air to the individual brake circuits
- guarantees pressure to the intact circuit in the event of a pressure loss in a defective brake circuit
- the return and excess flow valve functions

Order no. 1058



Relay valve

- function of the piston
- function of the valve and of the valve spring
- driving position and braking position

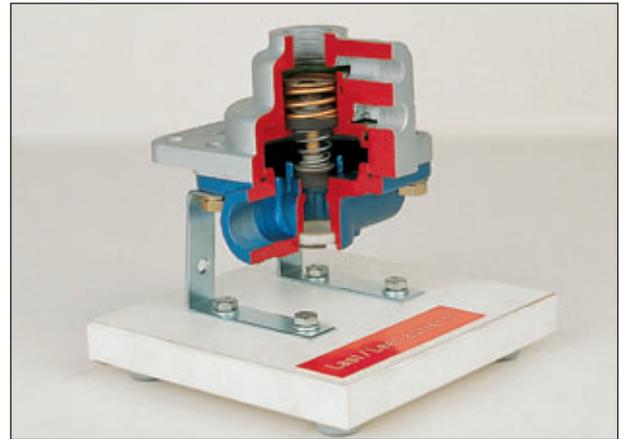
Order no. 1062



Automatic water drain valve

- lifting of the valve's body
- condensed water collection
- cambering of the valve body's diaphragm
- condensed water drainage

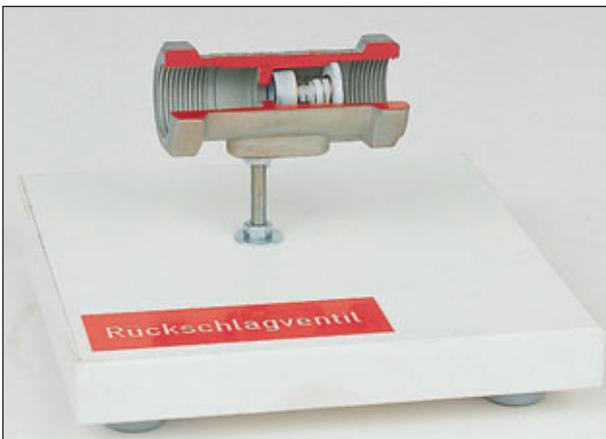
Order no. 1113



Load-idle valve

- function of the piston and valves
- driving position
- actuation of the emergency and parking brake system
- actuation of the service brake system
- corresponding activation and deactivation of the emergency and parking brake system

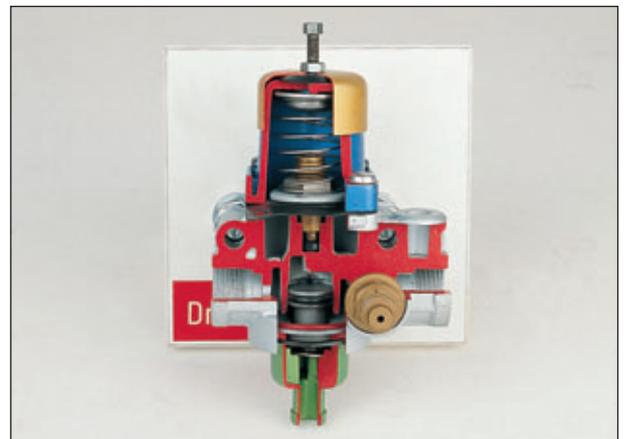
Order no. 1115



Non-return valve

- function of a non-return valve
- air flow only possible in one direction

Order no. 1117



Pressure regulator

- function of the intake and exhaust valves
- function of the diaphragm
- function of the valve's body
- load position, idle position, top-up position

Order no. 1066



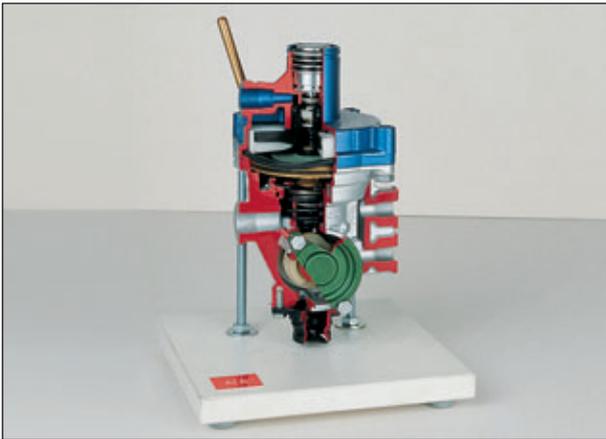
Air dryer

- function of the various valves
 - function of the granulate
 - granulate regeneration
- Order no. 1045



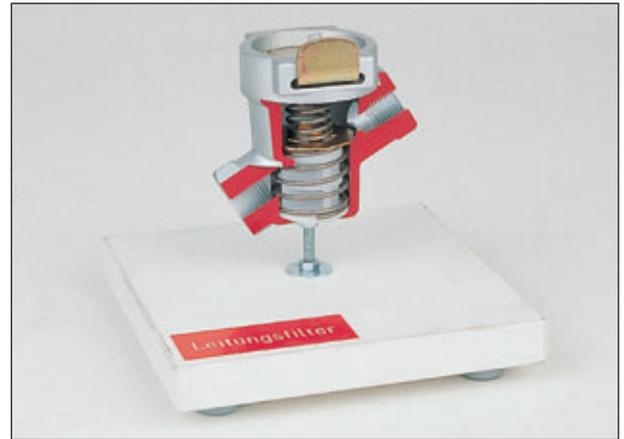
Automatic antifreeze pump

- function of the automatic antifreeze pump
 - automatic injection of the antifreeze agent
- Order no. 1116



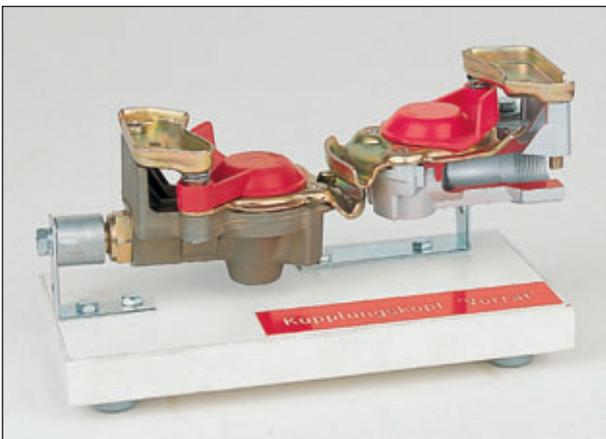
Automatic load-dependent brake power distributor

- function of the control lever
 - release, partial-load and full load position
 - function of the valves
 - function of the plunger
- Order no. 1109



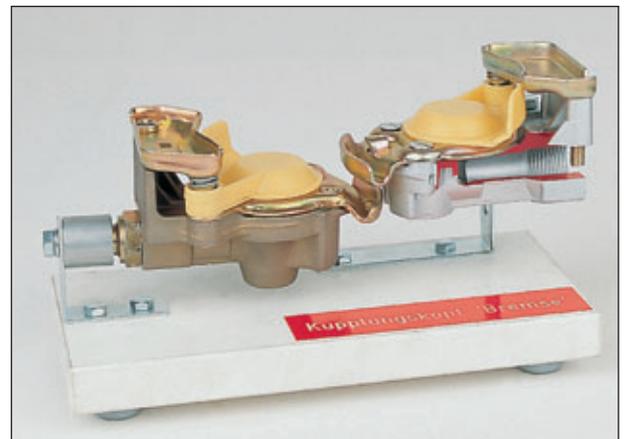
Line filter

- function of the line filter
 - filter cartridge
- Order no. 1114



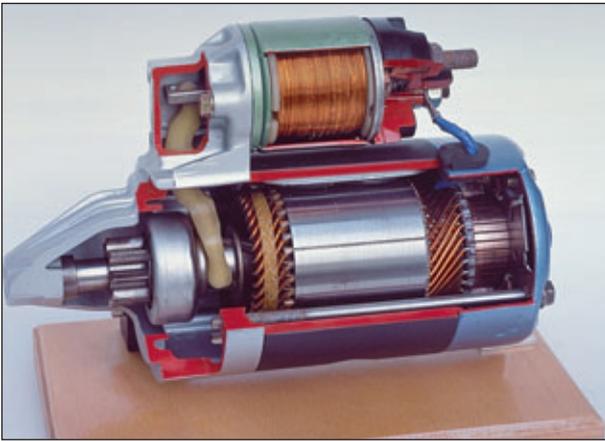
Coupling head, brake air pressure

- Functions:
- clutch engagement, declutching
 - seal function
 - function of the claws on both heads
 - no mix up safety
- Order no. 1110



Brake coupling head

- Functions:
- clutch engagement, declutching
 - seal function
 - function of the claws on both heads
 - no mix up safety
- Order no. 1112

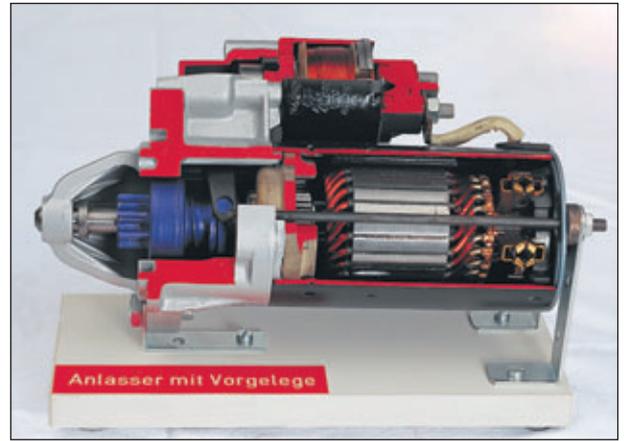


Starter

Parts cut in this model:

- solenoid switch, housing and windings
- armature can be rotated and solenoid switch actuated
- engaging the starter pinion can be demonstrated

Order no. 1003



Starter with back gears

Demonstration:

- as per 1003
- plus: the function of the planetary gearing is easy to identify

Order no. 1056



Sliding-gear starter (truck)

Demonstration of the following functions:

- multi-disk clutch
- turning of the rotor and the pinion
- starter and control solenoid switches
- moving contact and ratchet
- meshing, starting and disengaging

Order no. 1191



Ignition distributor – battery ignition

- function of distributor rotor and contact breaker
- ignition distribution
- centrifugal advance
- vacuum advance (is demonstrated with the aid of a vacuum spray)

Order no. 1093

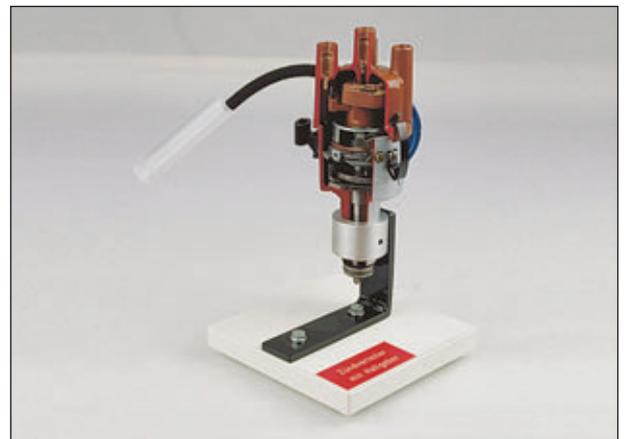


Ignition distributor with induction

Function as no. 1093

In addition: function of induction sensor

Order no. 1094



Ignition distributor with hall sensor

Functions as no. 1093

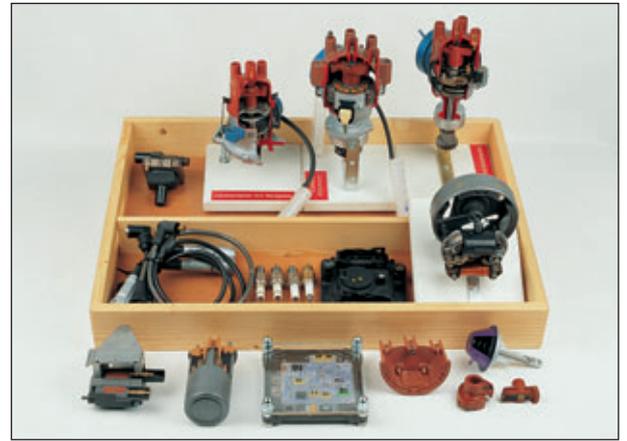
In addition: function of hall sensor

Order no. 1095



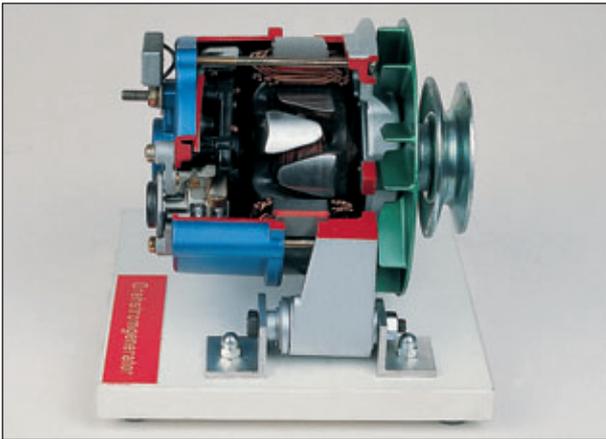
Magneto ignition

Base plate layout:
lighting armature, ignition armature, condenser, contact breaker.
Pole wheel with permanent magnets and contact-breaker cams.
Order no. 1125



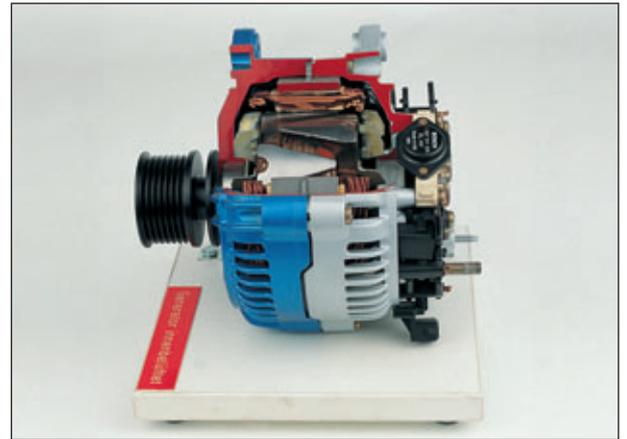
Model case ignition

3 cutaway distributors (induction, Hall, contact breaker), magneto ignition
2 cutaway ignition coils, one uncut
1 cutaway vacuum cell, 2 distributor rotors (one with speed limiting device)
Ignition cable with connector plug and 4 different spark plugs
One cutaway ignition control unit
Order no. 1215



Generator

Visible parts:
– rotor with coil and slip rings
– regulator with carbon brushes
– power and exciter diodes
– stator with stator winding
Order no. 1085



Internally-ventilated generator

The new generation of generators has the following characteristics:
– rotor with windings and commutator rings
– regulator with power and exciter diodes
– stator with stator winding
– ventilation by internal blower wheels
Order no. 1192



Generator, water-cooled

For large outputs (above 2 kW), water-cooled generators are used nowadays.

The following components are easy to recognise:

- water jacket in the outer part of the housing
- field and anchor coiling
- output and exciter diodes
- stand and anchor

The moving parts of the generator are easy to turn.

Order no. 1279



Starter alternator (micro-hybrid)

The following can be seen:

- rotor with windings and slip ring
- stator with stator winding
- ventilation through two interior blower wheels
- the controller is cast in
- the shaft can be turned easily

The STARS system is able to switch the engine off at a red light or in a traffic jam and to restart the engine almost imperceptibly as soon as the brake is released.

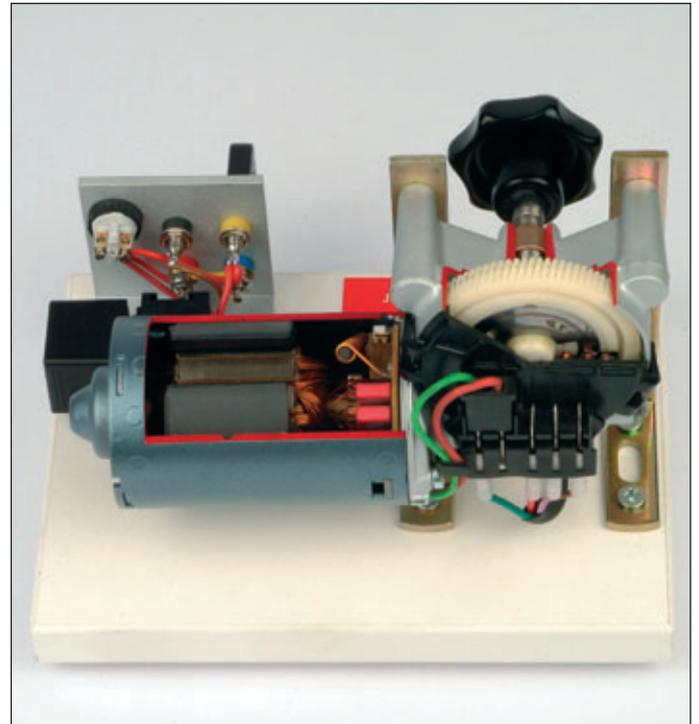
Order no. 1340



Functional model Windscreen wiper motor

The following are easy to recognise on the cutaway model:

- armature with carbon brushes
- field (comprising permanent magnets)
- worm on the armature shaft
- worm gear of nylon of the wiper shaft
- strip conductors for limit switching



Functions:

- allow the motor to run by pushing the button
- limit switching when the button is let go of
- current measurement in idling and under load

Order no. 1309

Xenon-Headlight (BMW)

The model shows a cross-section through a modern Xenon headlight.

The following can be seen:

- control units
- position light and daytime running light over two light rings energized by a light bulb
- lenses
- cable harness
- ignition coil
- gas discharge lamp
- radiation diaphragm
- dynamic headlight range adjustment

Order no. 1348



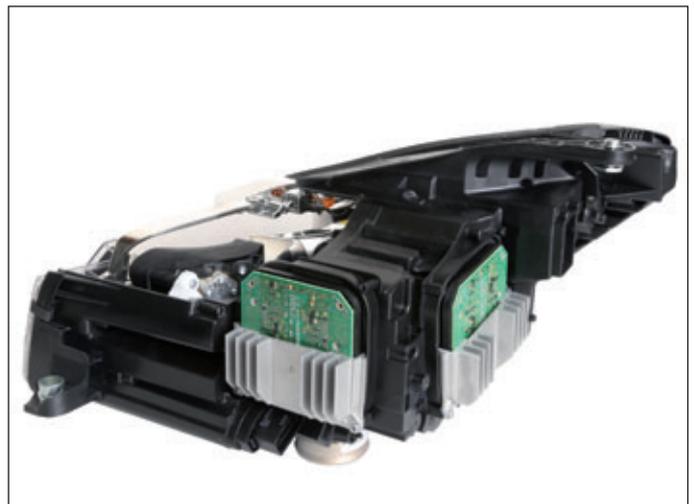
Full-LED-Headlight with dynamic cornering light (Mercedes-Benz CLS)

This model shows a cross section through a modern Full-LED-headlight.

The following can be seen:

- LEDs
- control units
- reflector
- lense (projection system – reflection system)
- cable harness
- turn light

Order no. 1349



Full-LED-Headlight with daytime running light (Audi R8)

This model shows a cross section through a modern Full-LED-headlight.

The following can be seen:

- LEDs
- control units
- reflector
- lense (projection system – reflection system)
- cable harness
- turn light

Order no. 1350





Rear light with LED's

In the housing, a certain number of diodes have been switched together to form a construction unit in accordance with the necessary lighting strength and the required light colour. As a result of this multiple provision, the probability of failure of the overall function is minimised.

Benefits: LED's consume considerably less current,

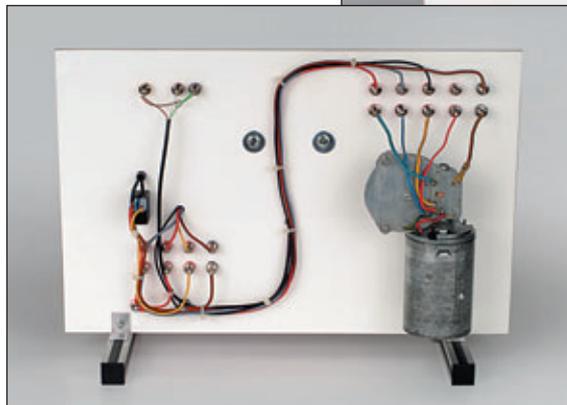
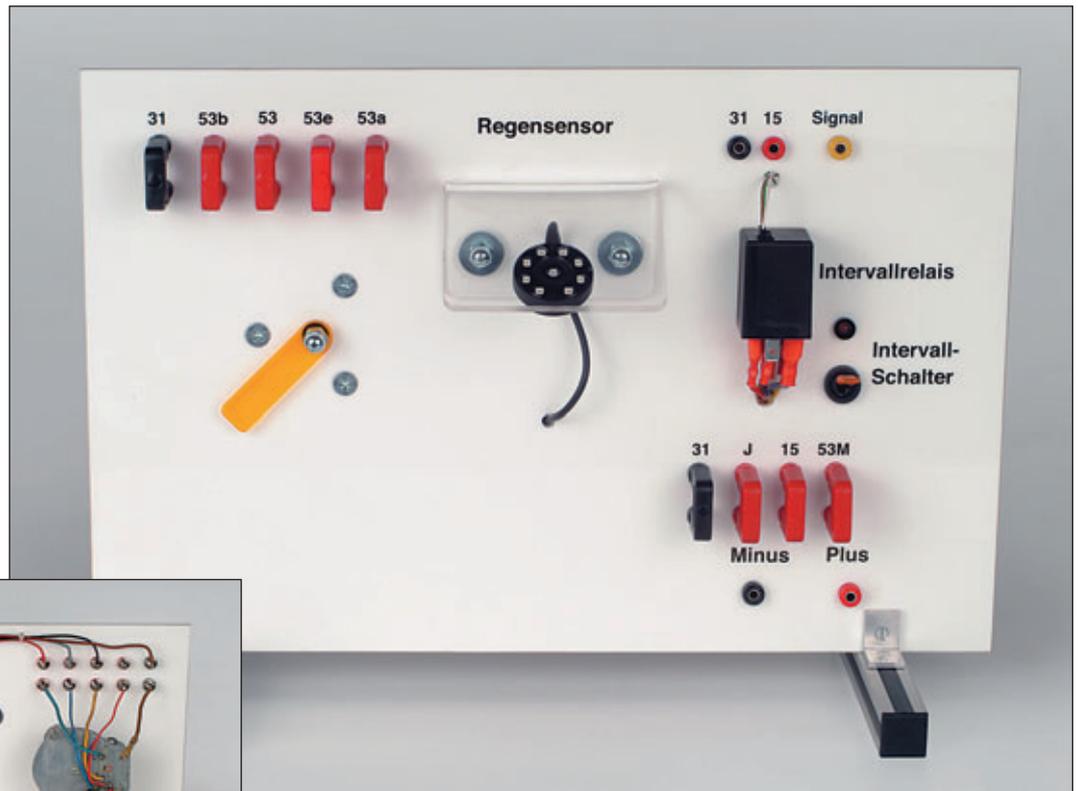
have reached their maximum luminosity after about 2 milliseconds and have a service life of about 10,000 hours.

Demonstration:

- connection to a 12 Volt mains with the help of the black and the red jacks

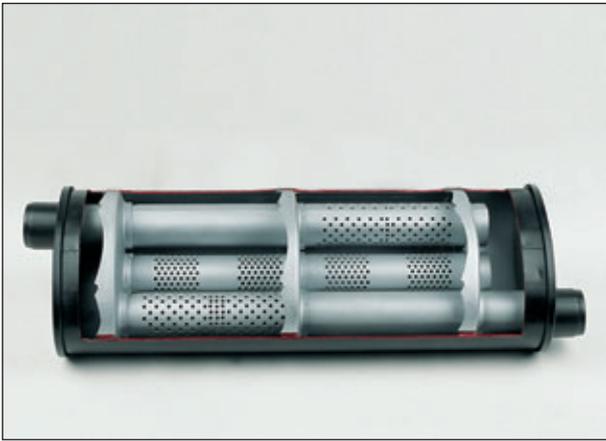
- operation of the indicator (green key)
- operation of the brake light (green key)
- operation of the rear light (green key)
- measurement of the current flowing in each case with the help of the bridge

Order no. 1316



Functional model Rain sensor with wiper motor

- connection of the function model to 12 V power-pack
 - operation of the interval switch
 - spraying of the sensor with water
 - wiper motor runs in interval operation
 - measurements: trigger signal, voltage supply, current and voltage measurements
- Order no. 1304



Silencer

This cutaway silencer enables the inner workings of a silencer to be studied.

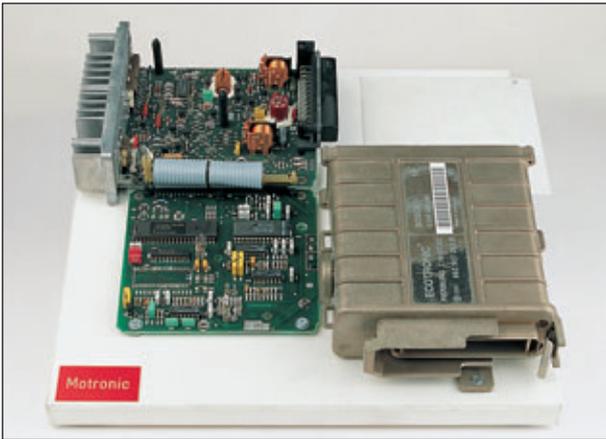
Front Silencer:

Order no. 1216



Main silencer

Order no. 1217



Electronic control unit (MOTRONIC)

Demonstrates the internal workings of a modern electronic control unit for petrol injection and for the electronic ignition.

Order no. 1185