VOLVO
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Course Code: 0819

2004 Model Year Product, Featuring the R-Range

TECHNICAL UPDATE 1

Name:_____ S.S.N./S.I.N.:_____ Retailer/Code:_____ Date:_____

IMPORTANT SAFETY NOTICE

WARNING: Before performing service, diagnosis or troubleshooting procedures on a vehicle equipped with safety devices containing pyro-technical igniters, i.e., airbags, seatbelt tensioners, side impact curtains, etc., **you must be aware of certain precautions, and follow special procedures to help ensure your safety**. Refer to applicable SAFETY SYSTEM service information for these procedures and precautions.

NOTE: The information contained in this manual is intended for technical training purposes **ONLY**. Always refer to appropriate Volvo service information & wiring diagram manuals when performing fault tracing or service procedures.

Following proper service and repair procedures is essential for the safe, reliable operation of motor vehicles, as well as for the personal safety of the individual doing the work. This manual provides general directions for accomplishing service and repair work with tested, effective techniques.

Numerous variations in procedures, techniques, tools and parts for servicing vehicles, as well as the skill of individual doing the work cannot possibly be anticipated or provided for. Accordingly, anyone who departs from instructions provided in this manual must first establish that they compromise neither their own personal safety nor the vehicle integrity by their choice of methods, tools or parts.

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that can help you to complete a particular procedure. CAUTIONS are given to help prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow whenever you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Turn the ignition switch OFF unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific service operation. If you have a manual transmission it should be in NEUTRAL unless instructed otherwise for a specific service operation.
- Operate the engine only in a well-ventilated area to avoid the danger from carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the cooling fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind your head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time even with the ignition turned OFF.

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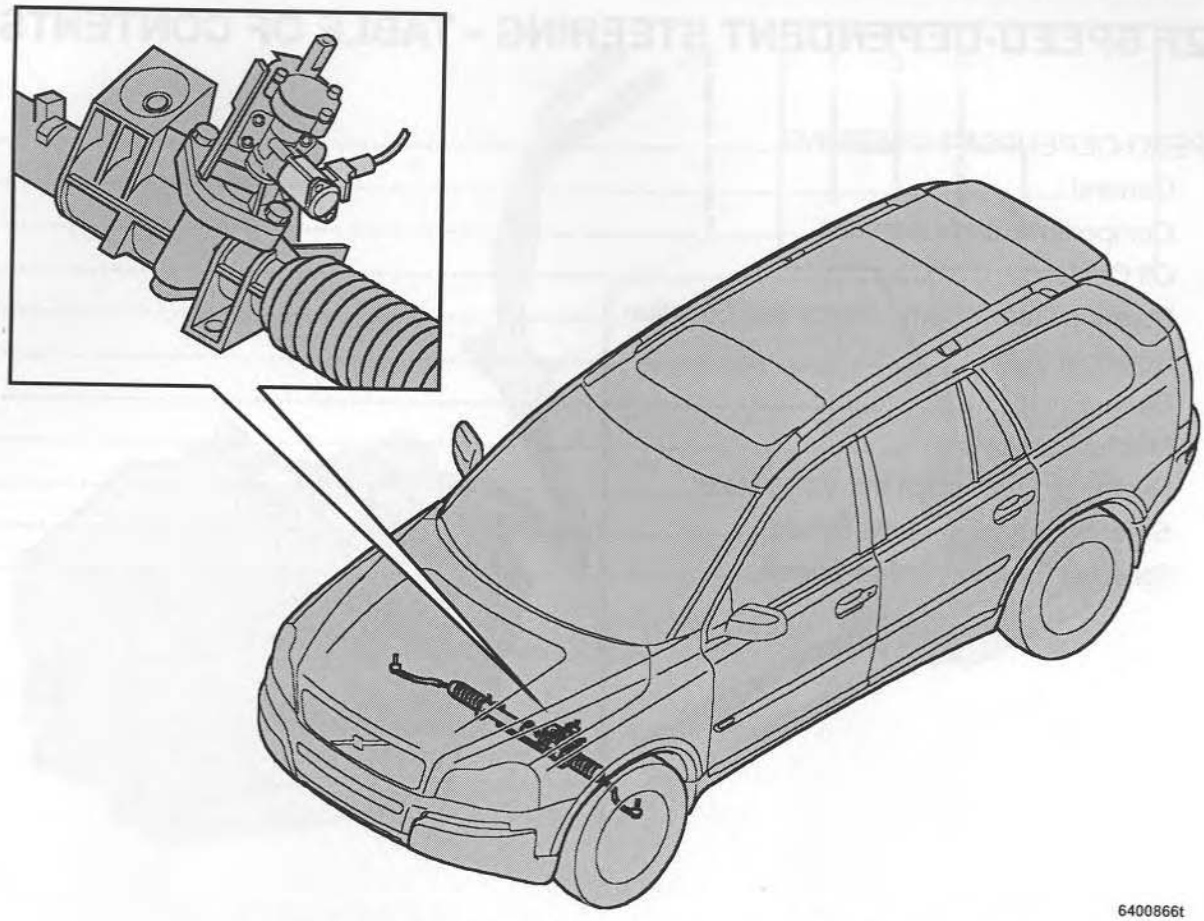

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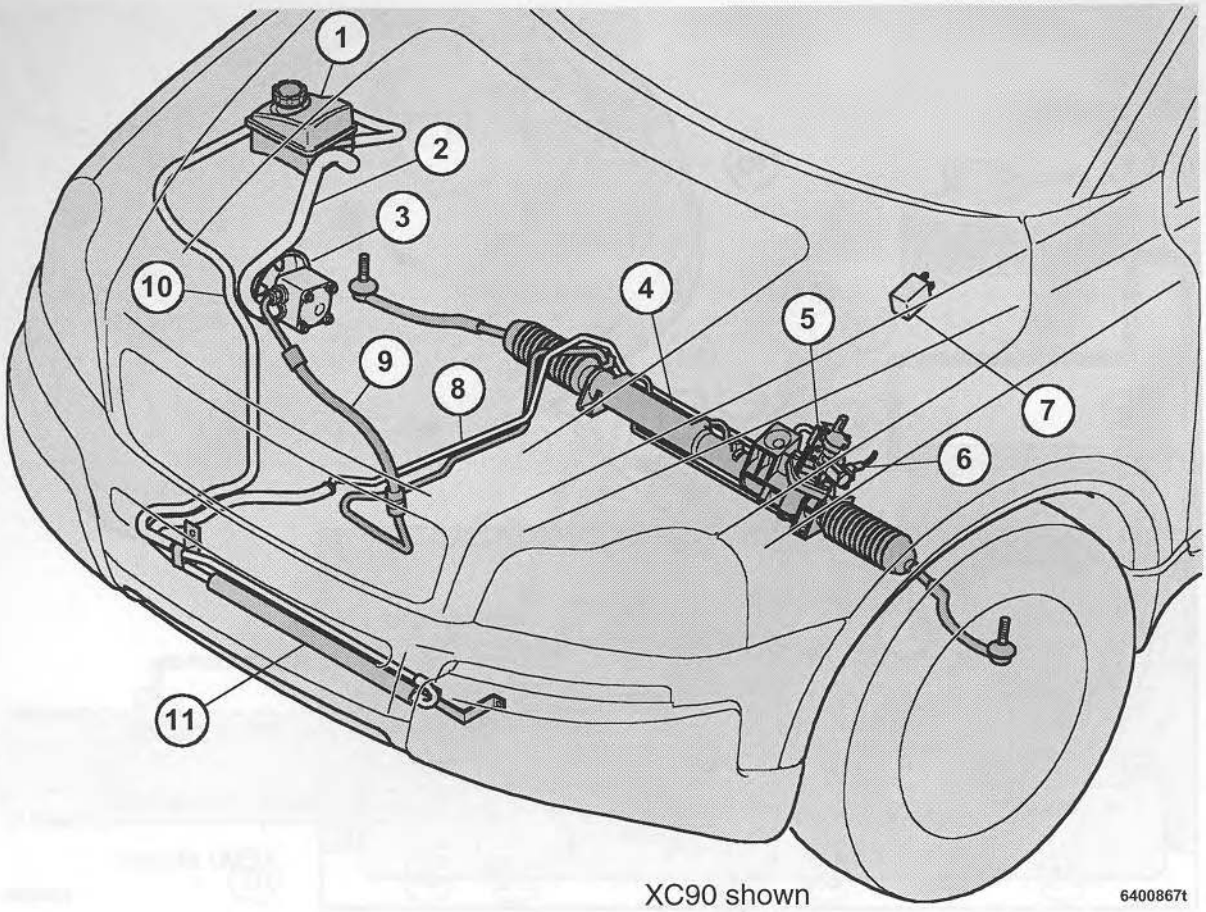
ZF SPEED-DEPENDENT STEERING

GENERAL

The servo assistance consists of a mechanical steering gear, shift control valve and an integrated steering servo cylinder.
ZF Speed-dependent steering replaces the previous speed-dependent steering gear.
ZF Speed-dependent steering available on all P2 platforms.
The differences between them are as follows:

ZF Speed-Dependent Steering	Previous Speed-Dependent Steering
Communication BCM (Brake Control Module)/ CEM (Central Electronic Module) + separate control module	Communication via BCM (Brake Control Module) /CEM (Central Electronic Module)
Electrical system troubleshooting only	Diagnostics and troubleshooting (CAN)
Controlled by an actuator solenoid	Controlled by a step motor
Separate control module	Integrated function in CEM (Central Electronic Module)
Single-piece steering-column housing	The intermediate section of the steering column is made of steel
Servo oil cooler (front-mounted)	Cooling coil on return pipe to oil reservoir



XC90 shown

COMPONENTS and LOCATION

1	Servo oil reservoir	**5**	Valve housing	**9**	Feed line to steering gear
2	Inlet pipe to servo pump	**6**	Solenoid valve	**10**	Return line to oil reservoir
3	Steering servo pump	**7**	Steering control module	**11**	Oil cooler
4	Steering gear	**8**	Return line to oil cooler		

Steering Servo Pump (3)

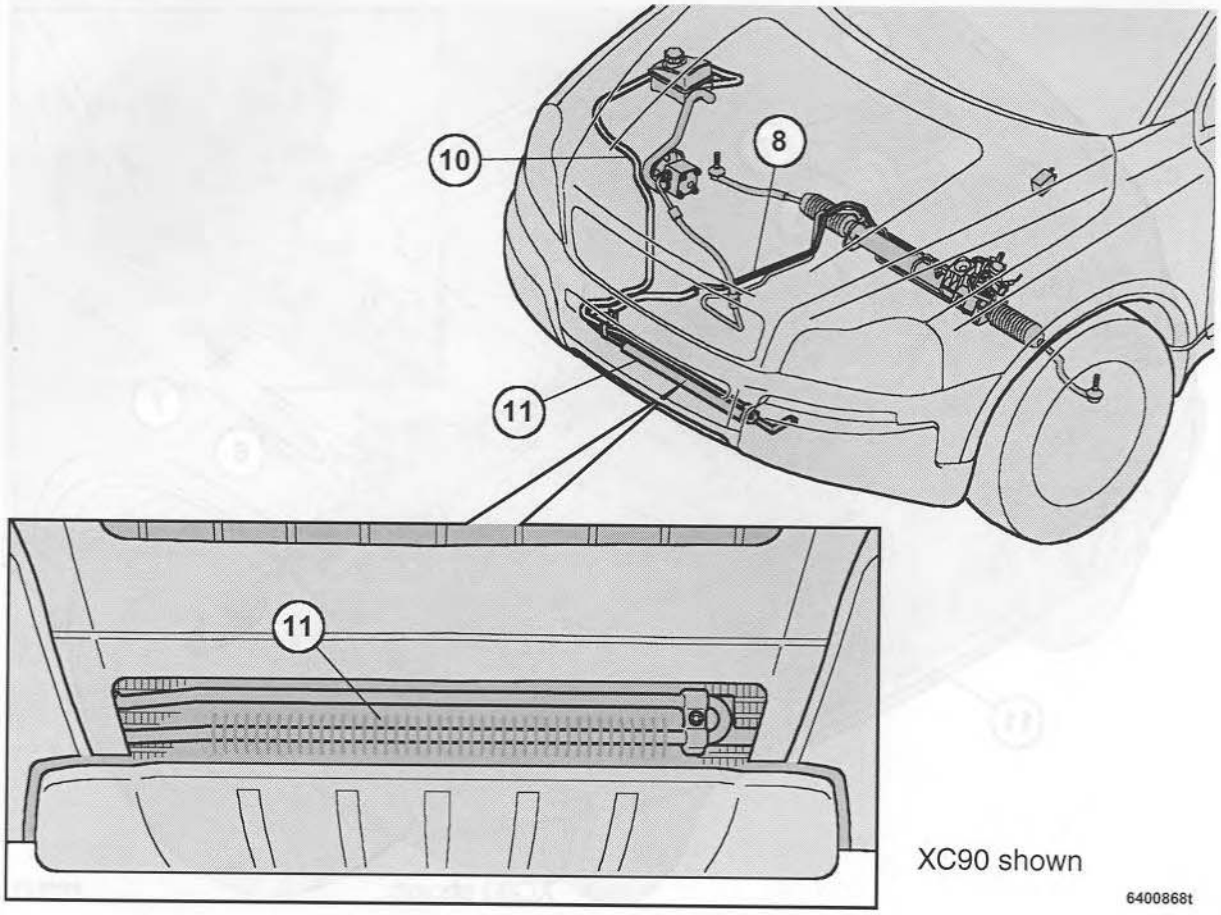
- Vane pump has 10 vanes.
- Oil flow is: 8.5 liters/minute (2.25 gallons/minute), 120 bar (XC90, S60R/V70R, S80).
- Pulley is smaller 10.2 mm (0.4 in.), new shorter drive belt.
- The pressure pipe between the pump and the steering gear is made of steel; other pipes are made of aluminum.

Steering Gear (4)

- The movement limiter is fitted inside the steering gear.
- The movement limiters are of different lengths on the left and right sides.

Oil Cooler (11)

- An oil cooler is used to reduce the fluid temperature.



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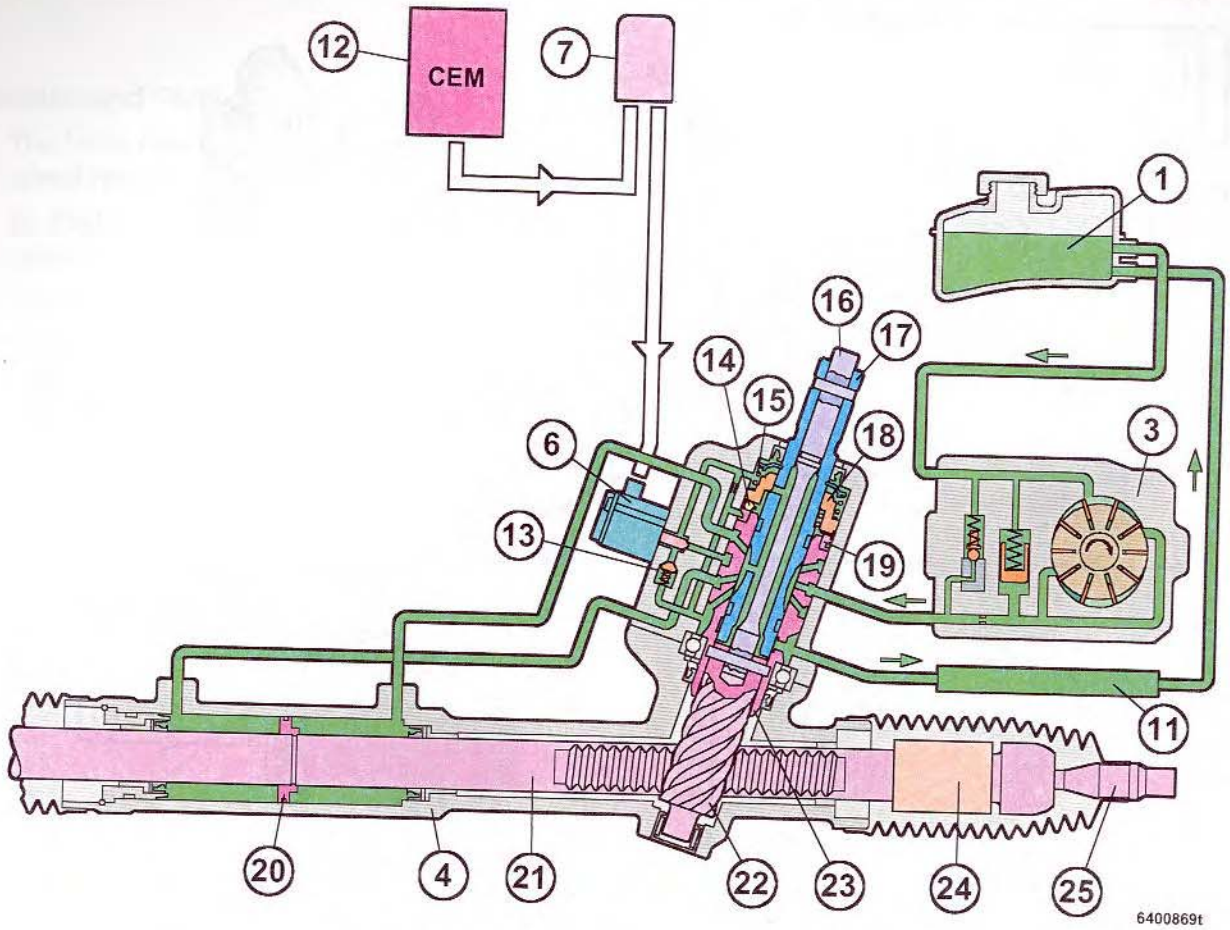
OIL COOLER

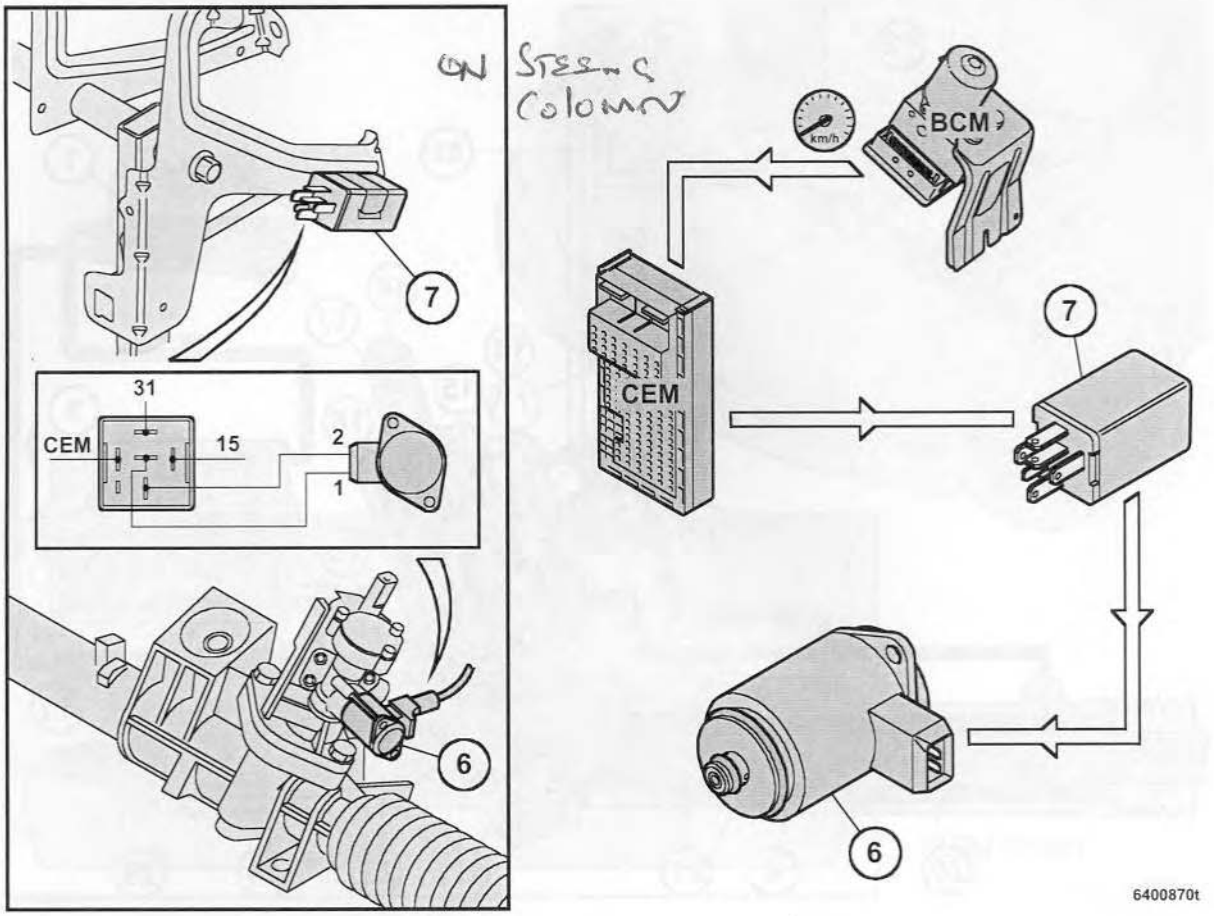
11	Oil cooler	**8**	Inlet pipe to oil cooler	**10**	Return pipe to oil reservoir

- The oil cooler (11) is made of aluminum.
- The oil cooler is available as a spare part.
- The connections are located behind the front plate.
- The front fascia / bumper has to be removed to remove the oil cooler.



STEERING GEAR – COMPONENTS and LOCATION

1	Servo oil reservoir	13	Overflow valve	20	Piston
3	Steering servo pump	14	Ball	21	Rack
4	Steering gear	15	Compression spring	22	Pinion
6	Solenoid valve	16	Torsion bar	23	Valve sleeve
7	Speed-dependent steering control module	17	Rotor valve	24	Movement limiter
11	Oil cooler	18	Reaction piston	25	Steering rod
12	CEM	19	Centering part		



SOLENOID VALVE

6	Solenoid valve	7	Speed-dependent steering control module

The speed signals from the BCM/CEM are analyzed by the speed-dependent steering control module and converted into an electrical current which actuates the solenoid valve located on the valve housing. The solenoid valve has infinite variable control.

ZF SPEED-DEPENDENT STEERING – SAFETY

In the event of a voltage failure or any other electrical fault, the steering gear function remains intact.

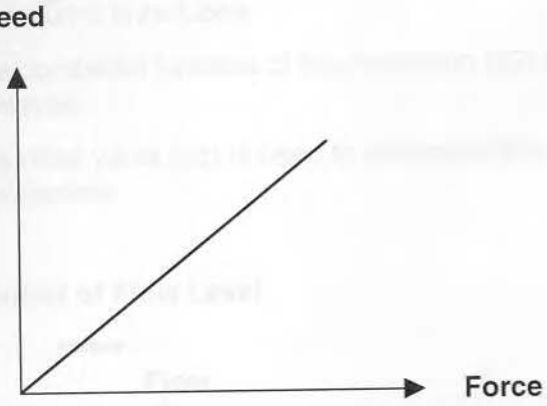
Under such conditions, ZF speed-dependent steering operates with maximum hydraulic reaction (high-speed position) because the solenoid is forced to open mechanically in this instance.

When the speed signal fails while the vehicle is being driven due to a bad contact or broken wheel sensor, the control module will calculate and transmit a constant control current to the solenoid based on the last reliable speed signal received.

When the engine is restarted, the maximum hydraulic reaction will be resumed. This reaction corresponds to the high-speed characteristic, the same reaction position as in a voltage failure.

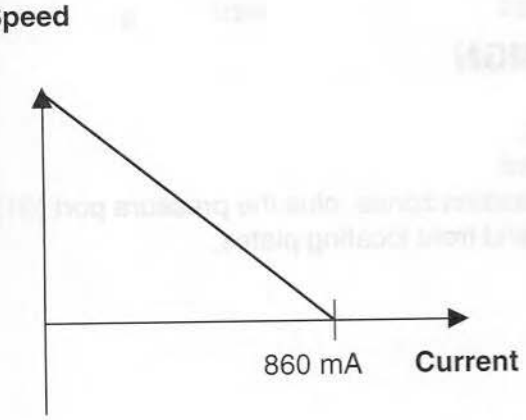
Pressure and Flow

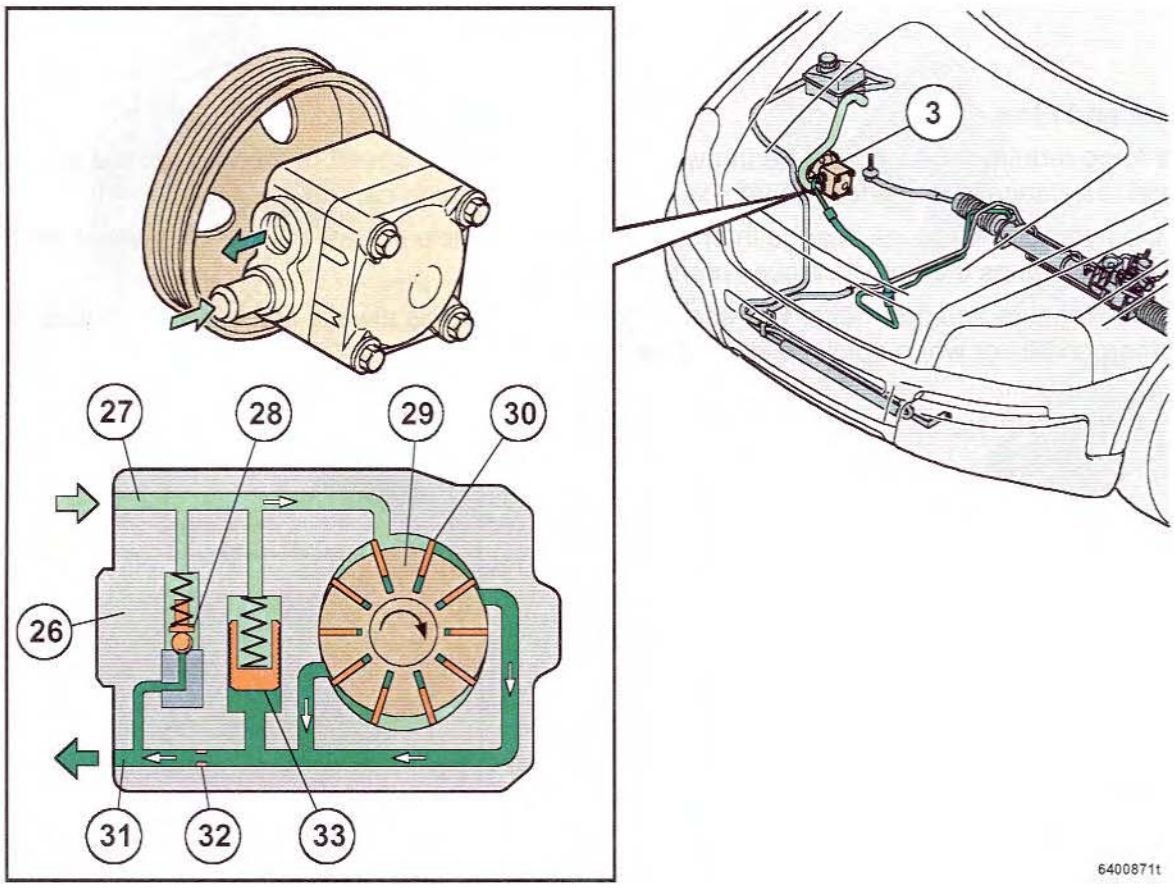
- The force required to turn the steering wheel is relative to the speed of the vehicle: the steering wheel resistance is low when the vehicle is stationary or being parked.
- As the hydraulic reactions change in proportion to the vehicle speed, the steering wheel resistance also increases as the vehicle moves more quickly.
- The oil pressure and flow never fall, ensuring that full power is always available for immediate use in emergencies or when quick action is necessary.



Speed Signal

- At 0 mph, the current is at its maximum, 860 mA.
- If the control module is disabled or wiring is damaged,
  - the current is 0 A.
  - the steering is always set to the high-speed position, (the steering is heavy).





SERVO PUMP

3	Steering servo pump	**28**	Relief valve	**31**	Outlet/pressure port
26	Housing	**29**	Rotor	**32**	Restriction
27	Inlet/suction port	**30**	Vanes Restriction	**33**	Flow valve

MECHANICAL DESIGN

The shaft in the pump housing is combined with the rotor (29).
The ten vanes (30) are located in the radial grooves on the rotor.
There are connections between the suction port (27) and the suction zones, plus the pressure port (31) and the pump chambers' pressure zones via ports in the rear and front locating plates.

FUNCTION

From the pressure chamber, the pressurized oil passes through the restriction (32) to the feed line and the built-in relief valve (28)/flow valve (33).

The rotation of the input shaft and rotor (29) means that the vanes (30) are forced radially onto the groove, on the fixed outer ring by centrifugal force.

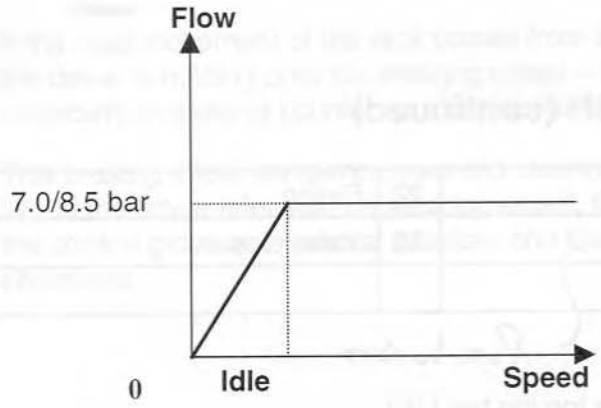
This movement is amplified by the pressurized oil which flows from the pressure chamber via ports to the inner surfaces of the vanes.

Ten independent pump cells are formed between the ten vanes which pull oil into the two half-moon shaped pump chambers when the volume increases and force it out into the pressure chamber when the volume is reduced.

The combined function of the restriction (32) and the flow valve (33) permits the desired flow level to be achieved.

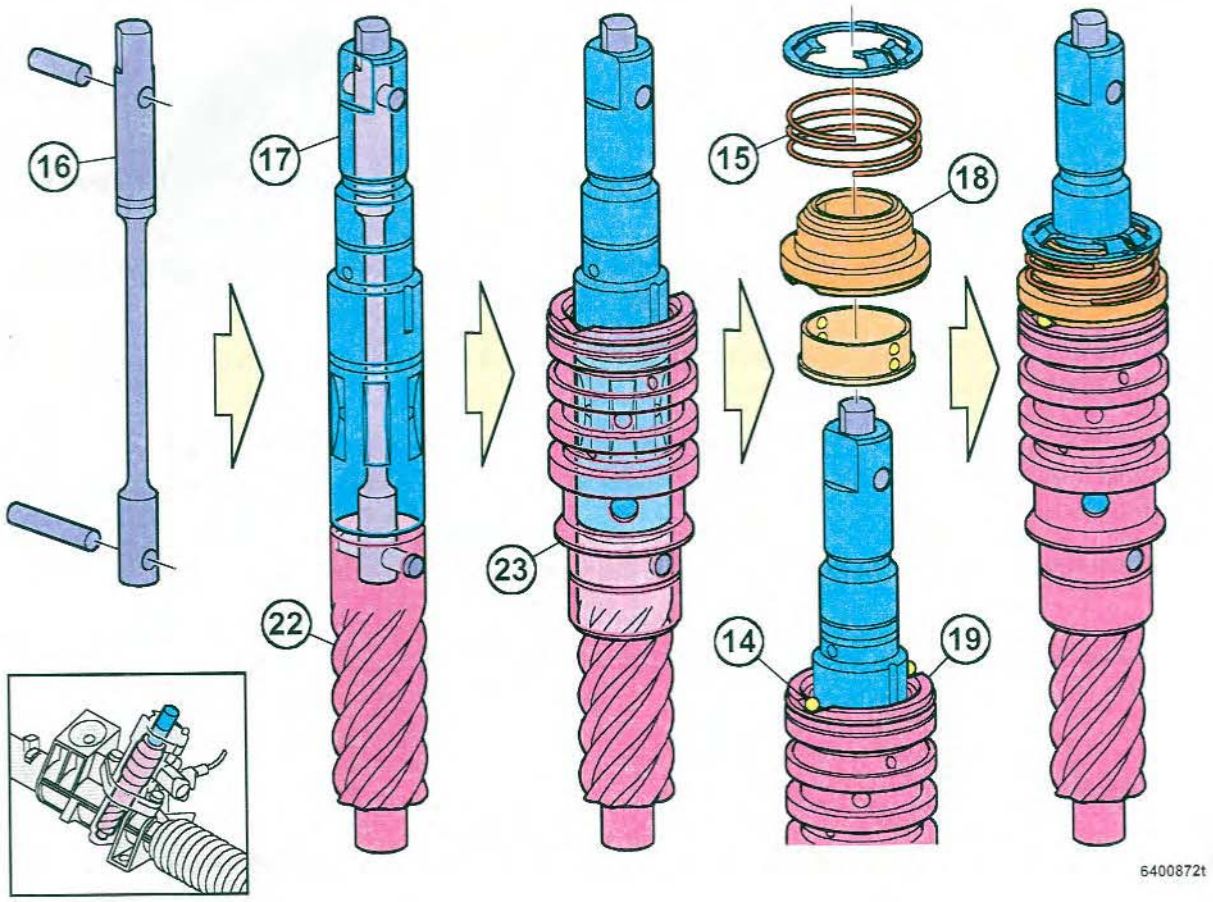
The relief valve (28) is used to determine the upper limit for the oil pressure to the power steering mechanism.

Control of Flow Level



The pump has a constant flow level that feeds an almost constant oil flow to the power steering mechanism.

This works over the entire speed range for the vehicle's engine and at a limited maximum pressure.



MECHANICAL DESIGN (continued)

14	Ball	**17**	Valve rotor	**22**	Pinion
15	Compression spring	**18**	Reaction piston	**23**	Valve sleeve
16	Torsion bar	**19**	Centering part		

Pre load

Pinion

The pinion (22) is connected to the valve rotor (17) with a torsion bar (16).
The torsion bar converts the turning torque of the steering wheel into axial torque in the rack.

Rotor Valve/Valve Sleeve

The task of the valve rotor is to control the oil pressure. The valve consists of the valve rotor (17), which is provided with six control grooves, and the valve sleeve (23), which is connected to the pinion (22).

The valve sleeve bore is provided with axial grooves that fit the control grooves on the valve rotor.

The central (neutral) position of the valve rotor is attained by a torsion bar (16) that at the same time connects the valve rotor, pinion and valve sleeve. This is reinforced by the prism-controlled balls (14) between the centering part (19) which is attached to the valve sleeve and the reaction piston (18) and is pressurized by the compression spring (15). These balls actuate the hydraulic reaction function.

Two control balls are located axially between the piston and the valve to prevent rotation of the reaction piston. If the torque from the steering wheel or the steered wheels is transferred to the valve rotor or the pinion/valve sleeve connection, rotation occurs between the valve rotor and the valve sleeve which is affected by the torsion bar and the combination centering and reaction unit.

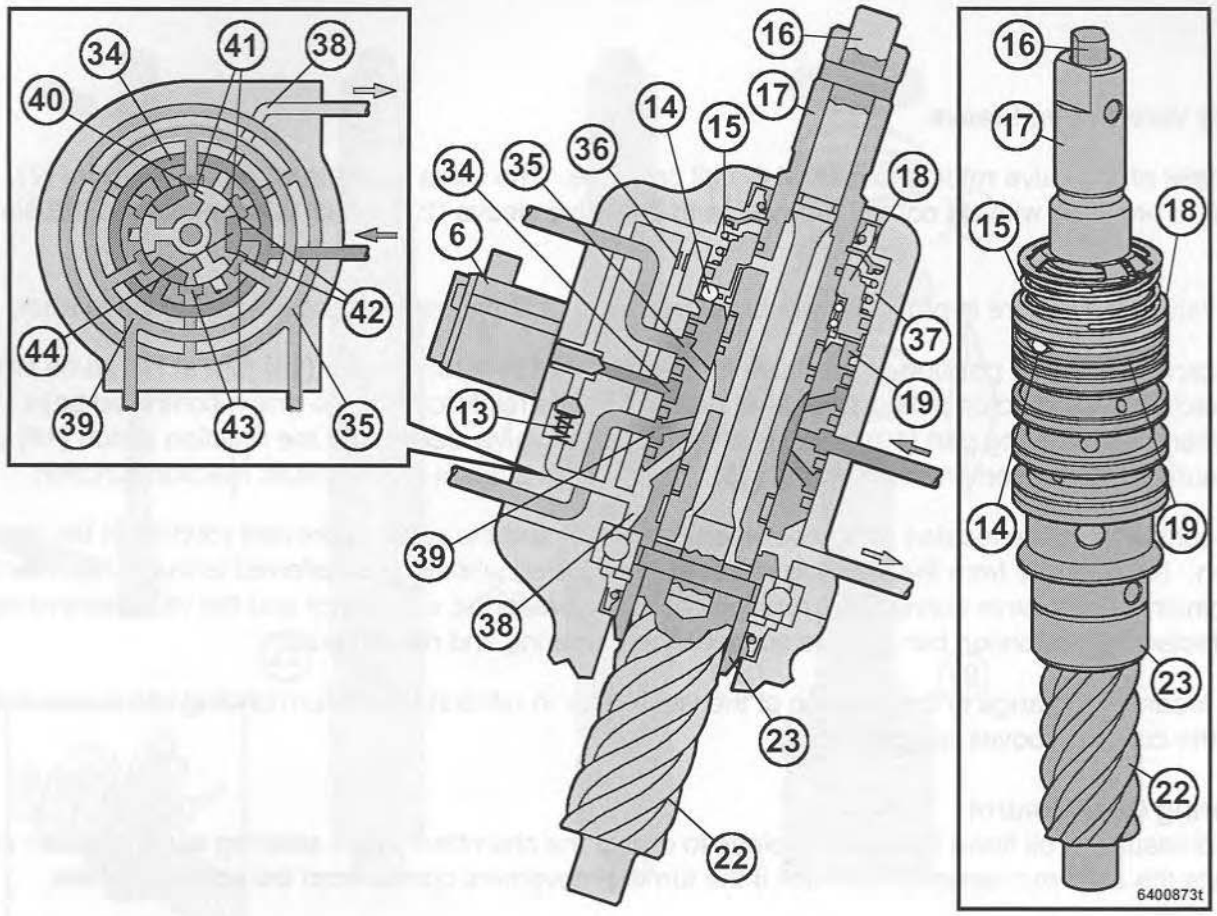
This leads to a change in the position of the valve rotor in relation to the surrounding valve sleeve such that the control grooves are displaced.

Steering Gear Control

The pressurized oil flows through the pipes to one of the chambers in the steering servo cylinder and assists the axial movement of the rack if the turning movement comes from the steering wheel.

If the axial movement of the rack comes from the wheels, the steering servo valve – even though the driver is holding onto the steering wheel – will feed the servo oil to the respective steering servo chambers in order to counteract axial movements in the rack.

This braking effect dampens unwanted steering wheel movements caused by an uneven road surface. When the driver releases the steering wheel, the self-centering effect of the turned torsion bar returns the control grooves to neutral position, and the pressure will be equalized between the steering servo chambers.



HYDRAULIC FUNCTION of the VALVE ROTOR

Control of Oil Flow – Neutral Position

The hydraulic fluid from the steering servo pump (3) flows through the port in the valve area via the radial grooves for feed oil (34) and the transverse ports in the valve sleeve (23) to the control grooves for oil feed (44) on the valve rotor.

When the valve is in neutral position, the oil flow passes over all open feed oil ports (42) to the axial grooves on the valve sleeve (43), and then on to the open oil ports (41) and on to the control grooves for return oil on (40) the valve rotor.

Control of Oil Flow – When Steering Wheel is Turned

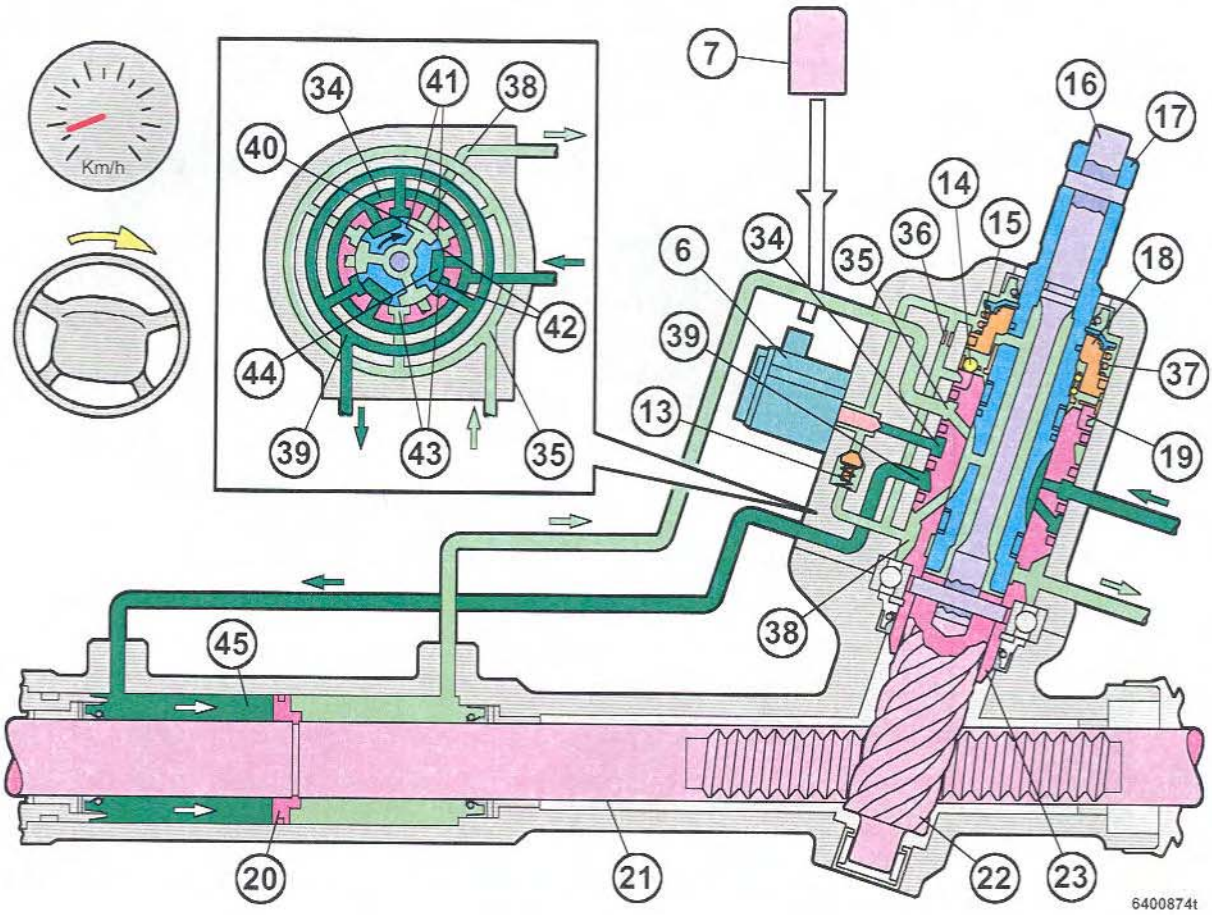
When the steering wheel is turned, the rack (21) with the integral piston (20) in the steering servo cylinder is moved.

When the valve rotor rotates, the pressure oil is fed via the open feed oil port (42) and on to the relevant connected axial groove (43). This takes place via the ports for the radial groove (39) and a pipe to the steering servo cylinder.

At the same time, the outflow of pressure oil to the pressurized axial grooves is limited by the closing of the return oil ports (41).

From the connecting axial grooves, the oil is fed to the control grooves for return oil (40) via the control oil ports (41) for return oil, which are now more open.

The return oil flow is fed via the control oil ports and connecting ports to the return oil chamber (38) and is finally fed on to the oil reservoir (1).



STEERING FUNCTION – LOW SPEED

6	Solenoid valve	**19**	Centering part	**37**	Reaction chamber
7	Speed-dependent steering® 2 control module	**20**	Piston	**38**	Return oil chamber
13	Overflow valve	**21**	Rack	**39**	Radial grooves
14	Ball	**22**	Pinion	**40**	Return oil on valve rotor
15	Compression spring	**23**	Valve sleeve	**41**	Return oil from rotor valve
16	Torsion bar	**34**	Feed to the radial grooves	**42**	Feed to rotor valve
17	Valve rotor	**35**	Radial grooves	**43**	Valve sleeve
18	Reaction piston	**36**	Restriction	**44**	Feed to valve rotor

At low speeds, such as when the vehicle is being parked, signals are sent from the wheel sensor via the BCM and CEM to the control module for the speed-dependent steering gear (7).
The control module analyzes these signals and transmits an equivalent adapted control current to the solenoid valve (6).

Depending on the maximum current for the present driving position, the solenoid valve is closed and prevents the flow of oil from the radial oil feed groove (34) to the reaction chamber (37).
A restriction (36) guarantees that the return oil pressure in the reaction chamber will be maintained. As the reaction is eliminated, the turning resistance is very small and the steering wheel can be moved with ease.

When the frequency of the speed signals increases, the converted signals from the control module mean a reduction in the control current transmitted to the solenoid valve.

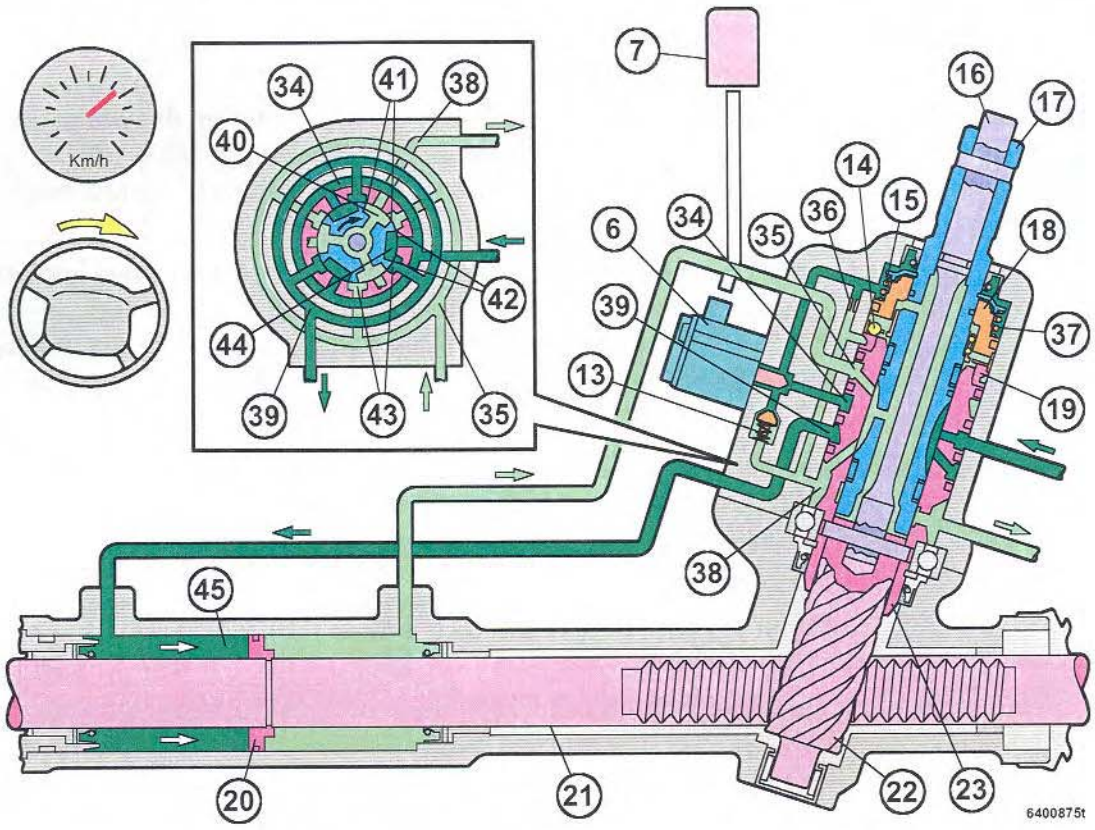
This opens the solenoid valve, which adopts a position to suit the current vehicle speed, and the pressure increases in the reaction chamber (37).

A restriction (36) prevents a greater oil flow to the return oil chamber (38), which results in higher pressure building up in the reaction chamber.

The higher oil pressure acting on the reaction piston (18) in turn leads to increased compression on the prism-controlled balls (14) located between the reaction piston and the centering part (19), which are attached to the valve sleeve (23).

When the control valve is actuated, this results in turning resistance to the rotation of the valve rotor for balls subject to a higher pressure.

As the hydraulic reaction takes place in this operating position, a higher torque is required to turn the steering wheel until a specific hydraulic effect is achieved in the right or left chambers of the steering servo cylinder.



6	Solenoid valve	**7**	Speed-dependent steering® 2 control module	**13**	Overflow valve
14	Ball	**15**	Compression spring	**16**	Torsion bar
17	Valve rotor	**18**	Reaction piston	**19**	Centering part
20	Piston	**21**	Rack	**22**	Pinion
23	Valve sleeve	**34**	Feed to radial grooves	**35**	Radial grooves
36	Restriction	**37**	Reaction chamber	**38**	Return oil chamber
39	Radial grooves	**40**	Return oil on valve rotor	**41**	Return oil from rotor valve
42	Feed to rotor valve	**43**	Valve sleeve	**44**	Feed to valve rotor
45	Left cylinder				

STEERING FUNCTION – HIGH SPEED

When driving at higher speeds, such as on freeways, the solenoid is fully open due to an extremely low or non-existent control current to the solenoid valve.

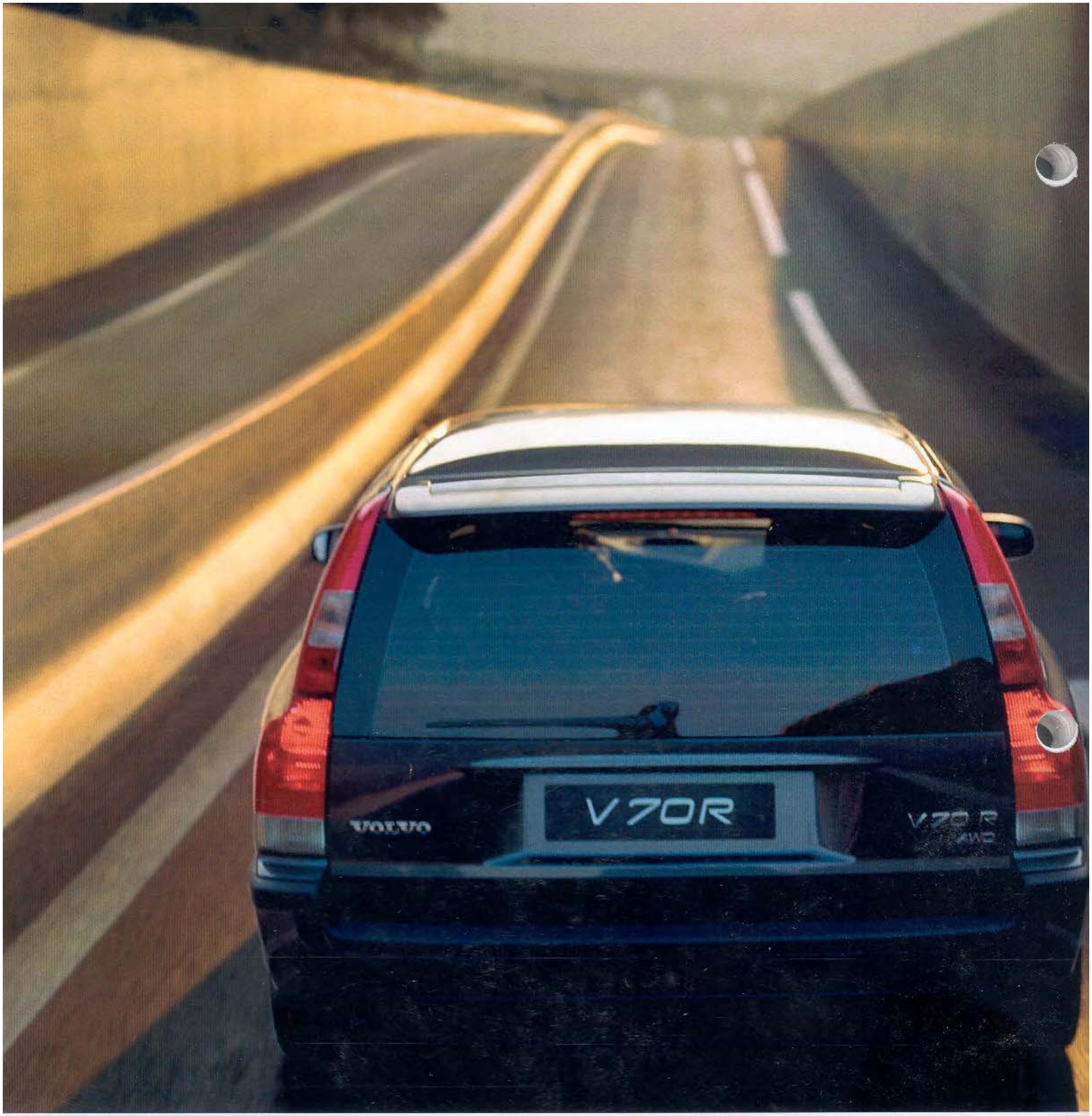
This means that maximum oil pressure feed from the radial groove (34) is transferred to the reaction unit.

When the steering wheel is turned clockwise, the reaction pressure increases in accordance with the existing operating pressure and the reaction piston in the reaction chamber is pressurized (37).

When the reaction pressure attains its upper limit, the oil is fed to the return oil chamber (38) via the overflow valve (13) which opens to prevent an increase in reaction pressure. The torque achieved in the steering wheel will not increase any more, which means safe driving due to optimum contact with the road.

GLOSSARY

ABS	**A**nti-lock **B**raking **S**ystem
A/C	**A**ir **C**onditioning
ACS	**A**ctive **C**hassis **S**etting
AUX	**AUX**iliary
AWD	**A**ll **W**heel **D**rive
AYC	**A**ctive **Y**aw **C**ontrol
BCM	**B**rake **C**ontrol **M**odule
BGC	**B**rake **G**rip **C**ontrol
BRC	**B**ump and **R**ebound **C**ontrol
CAN	**C**ontroller **A**rea **N**etwork
CCC	**C**lose **C**oupled **C**atalyst
CCM	**C**limate **C**ontrol **M**odule
CEM	**C**entral **E**lectronic **M**odule
CM	**C**ontrol **M**odule
CVVT	**C**ontinuously **V**ariable **V**alve **T**iming
DBC	**D**ynamic **B**ody **C**ontrol
DCC	**D**ynamic **C**ornering **C**ontrol
DDM	**D**river **D**oor **M**odule
DEM	**D**ifferential **E**lectronic **M**odule
DIM	**D**river **I**nformation **M**odule
DLC	**D**ive and **L**ift **C**ontrol
DSTC	**D**ynamic **S**tability and **T**raction **C**ontrol
DTC	**D**iagnostic **T**rouble **C**ode
DVD	**D**igital **V**ersatile/**V**ideo **D**isc
EBA	**E**mergency **B**rake **A**ssistance
ECM	**E**ngine **C**ontrol **M**odule
FOUR-C	**C**ontinuously **C**ontrolled **C**hassis **C**oncept
FWD	Front Wheel Drive
GDL	**G**as **D**ischarge **L**ightning
IR	**I**nfra **R**ed
ISM	**I**nclination **S**ensor **M**odule
KIR	**K**ey **I**ntegrated **R**emote
LDC	**L**oad **D**ependable **C**ontrol
LED	**L**ight **E**mitting **D**iode
LEV	**L**ow **E**mission **V**ehicle
LSM	**L**ight **S**witch **M**odule
MHz	**M**ega**H**ertz
MLS	**M**ulti **L**ayer **S**ealing
MMS	**M**ass **M**ovement **S**ensor
MOST	**M**edia **O**riented **S**ystems **T**ransport
PDM	**P**assenger **D**oor **M**odule
PEM	**P**ump **E**lectronic **M**odule
Prog-mode	Programming mode
PRV	**P**ressure **R**egulation **V**alve
PVV	**P**ressure **V**entilation **V**alve
PWM	**P**ulse **W**idth **M**odulated
RSC	**R**oll **S**tability **C**ontrol
REM	**R**ear **E**lectronic **M**odule
SAS	**S**teering **A**ngle **S**ensor
SBL	**S**econdary **B**oot**L**oader
SC	**S**tability **C**ontrol
SCM	**S**iren **C**ontrol **M**odule
SRS	**S**upplementary **R**estraint **S**ystem
SULEV	**S**uper **U**ltra **L**ow **E**mission **V**ehicle
SUM	**SU**spension **M**odule
TCM	**T**ransmission **C**ontrol **M**odule
TCV	**T**urbo **C**ontrol **V**alve
TRACS	**TRAC**tion Control **S**ystem
UEM	**U**pper **E**lectronic **M**odule
VADIS	**V**olvo **A**ftersales **D**iagnostics & **I**nformation **S**ystem
WHC	**W**heel **H**op **C**ontrol



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Service Training and Development Department

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