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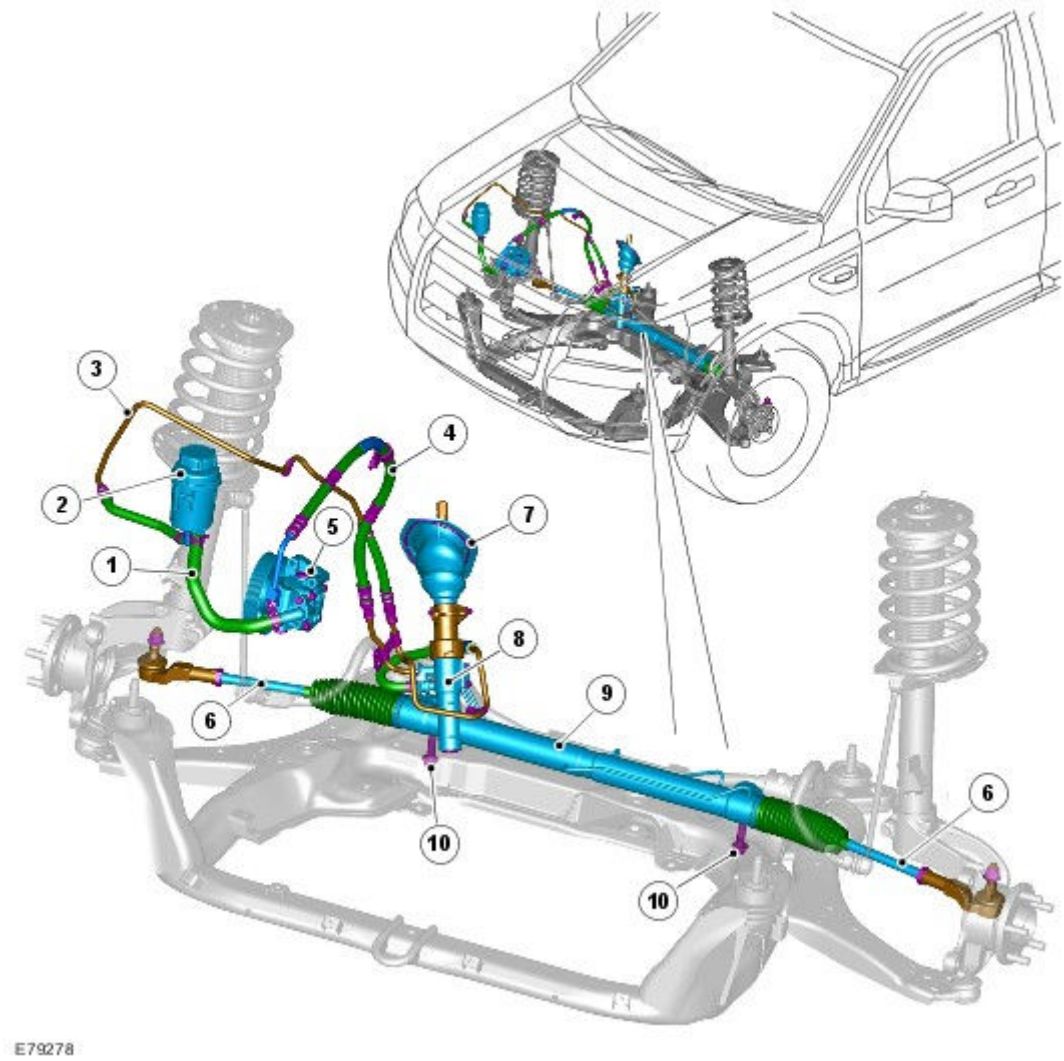
Power Steering

COMPONENT LOCATION - TD4 DIESEL

NOTE:

Right Hand (RH) drive shown, Left Hand (LH) drive similar



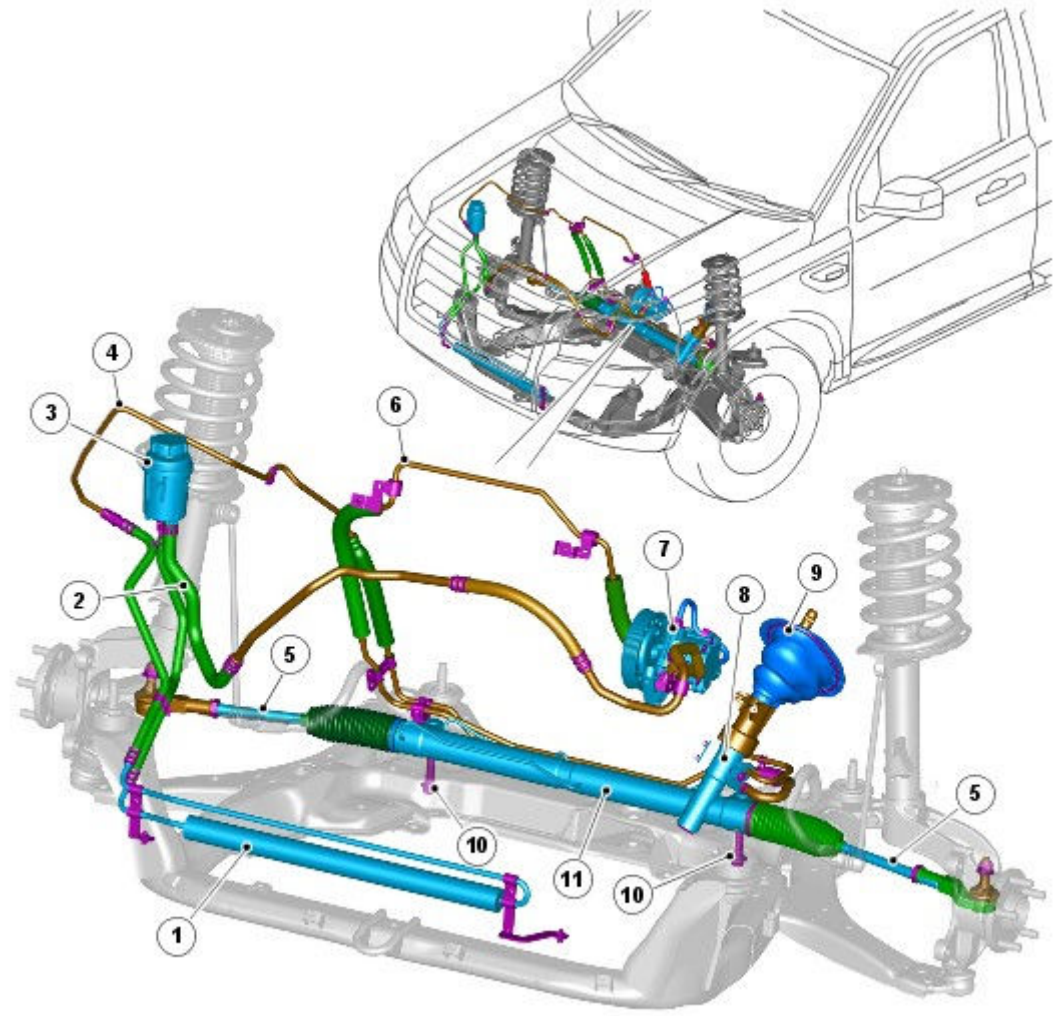
E79278

Item	Part Number	Description
1		Suction hose - reservoir to pump
2		Reservoir
3		Fluid return pipe - steering gear to reservoir
4		High pressure feed pipe - pump to steering gear
5		Power steering pump
6		Tie-rod
7		Bulkhead seal and gasket
8		Valve unit
9		Steering gear
10		Bolt

COMPONENT LOCATION - i6 PETROL

NOTE:

LH drive shown, RH drive similar



E79279

Item	Part Number	Description
1		Fluid cooler
2		Suction hose - reservoir to pump
3		Reservoir
4		Fluid return pipe - steering gear to cooler
5		Tie-rod
6		High pressure feed pipe - pump to steering gear
7		Power steering pump
8		Valve unit
9		Bulkhead seal and gasket
10		Bolt
11		Steering gear

OVERVIEW

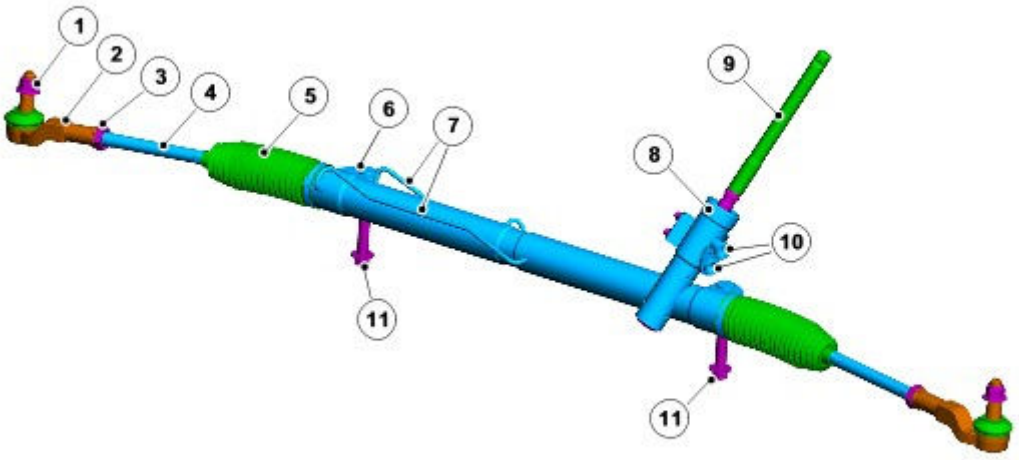
The power steering system comprises a hydraulic steering gear, a power steering pump, reservoir and a fluid cooler on petrol engine derivatives.

The steering gear is a conventional end take-off, rack and pinion power assisted unit, mounted on the rear of the subframe.

Different power steering pumps are used on the TD4 diesel engine and the i6 petrol engine. A variable displacement vane pump is used on the diesel engine to give improved engine economy. A fixed displacement vane pump is used on the petrol engine to provide refinement and responsiveness. Both pumps have high flow rates which enhance the steering performance.

Petrol engine vehicles are fitted with a fluid cooler to cool the power steering fluid from the fixed displacement pump.

STEERING GEAR



E83411

Item	Part Number	Description
1		Locknut
2		Tie-rod end
3		Locknut
4		Tie-rod
5		Steering gear boot
6		Steering gear casing attachment lugs
7		Pressure/return pipes
8		Valve unit housing
9		Input shaft
10		Pressure/return connection to/from pump
11		Attachment bolts

The steering gear, manufactured by Visteon, is located at the rear, top face, of the front subframe. It is solidly bolted to the subframe with two bolts. The bolts are passed through from the underside of the subframe, to improve service access, and are screwed into threaded bosses on the steering gear body.

The steering gear is a conventional end take-off, rack and pinion power assisted unit with lock to lock requiring 2.6 turns of the steering wheel. This gives a steering ratio (ratio of steering wheel angle to road wheel angle) of 16.7:1 which provides very quick and responsive reaction to driver inputs. The steering gear features large diameter tie-rods which optimize feedback and feel to the driver.

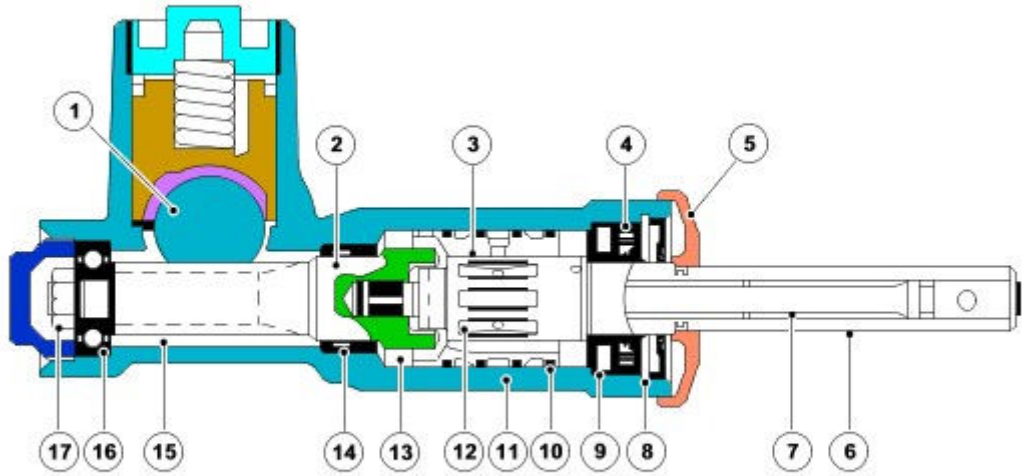
The steering gear comprises a steel, welded and machined, one piece housing which contains a mechanical steering rack, a valve unit and an integrated hydraulic power unit. The steering gear uses a rack with an integrated piston which is guided on plain bearings within the rack housing. The pinion, which is attached to the valve unit, runs in bearings and meshes with the rack teeth. The rack is pressed against the pinion by a spring loaded yoke which ensures that the teeth mesh without any play. The pinion is connected to the valve unit via a torsion bar. The rotary motion of the steering wheel is converted into linear movement of the rack by the pinion and is initiated by the valve unit. This movement is transferred into movement of the road wheels by adjustable tie-rods.

The piston of the hydraulic power unit is located at one end of the gear housing. Each side of the piston is connected to fluid pressure or fluid return via external metal pipes which are connected to the valve unit. Each end of the gear has a threaded hole which provides for the fitment of the tie-rod. The external ends of the steering gear are sealed with boots which prevent the ingress of dirt and moisture and allow for vertical movement of the tie-rods with the suspension in addition to linear movement when the steering wheel is turned. The boots are serviceable items and are retained on the gear housing and the tie-rod with ties.

Valve Unit

NOTE:

Typical valve unit shown



E46943

Item	Part Number	Description
1		Rack
2		Pinion shaft
3		Outer sleeve
4		Oil sleeve
5		Dirt seal
6		Input shaft
7		Torsion bar
8		Circlip
9		Oil seal
10		PTFE ring
11		Steering gear housing
12		Slots
13		Pin - pinion shaft to outer sleeve
14		Oil seal
15		Pinion shaft teeth
16		Bearing
17		Pinion shaft nut

The valve unit is an integral part of the steering gear. The principle function of the valve unit is to provide power assistance (i.e. when parking) to optimize the effort required to turn the steering wheel. The pinion housing of the valve is an integral part of the main steering gear assembly.

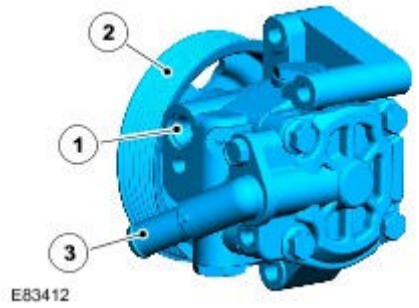
The pinion housing has four machined ports which provide connections for pressure feed of the power steering pump, return fluid to the reservoir and pressure feeds to each side of the cylinder piston. A non-return valve and seal is fitted in the pressure feed port from the power steering pump. The valve unit comprises an outer sleeve, an input shaft, a torsion bar and a pinion shaft.

The valve unit is co-axial with the pinion shaft which is connected to the steering column via the input shaft. The valve unit components are located in the steering gear pinion housing which is sealed with a cap. The outer sleeve is located in the main bore of the pinion housing. Three annular grooves are machined on its outer diameter. PTFE rings are located between the grooves and seal against the bore of the pinion housing. Holes are drilled radially in each annular groove through the wall of the sleeve. The bore of the outer sleeve is machined to accept the input shaft. Six equally spaced slots are machined in the bore of the sleeve.

The ends of the slots are closed and do not continue to the end of the outer sleeve. The radial holes in the outer sleeve are drilled into each slot. The input shaft has two machined flats at its outer end which allow for the attachment of the steering column intermediate shaft yoke. The flats ensure that the intermediate shaft is fitted in the correct position to maintain the optimum phase angle. The inner end of the input shaft forms a dog-tooth which mates with a slot in the pinion shaft. The fit of the dog-tooth in the slot allows a small amount of relative rotation between the input shaft and the pinion shaft before the dog-tooth contacts the wall of the slot. This ensures that, if the power assistance fails, the steering can be operated manually without over stressing the torsion bar.

The central portion of the input shaft has equally spaced longitudinal slots machined in its circumference. The slots are arranged alternately around the input shaft. The torsion bar is fitted inside the input shaft and is an interference fit in the pinion shaft. The torsion bar is connected to the input shaft by a drive pin. The torsion bar is machined to a smaller diameter in its central section. The smaller diameter allows the torsion bar to twist in response to torque applied from the steering wheel in relation to the grip of the tyres on the road surface. The pinion shaft has machined teeth on its central diameter which mate with teeth on the steering gear rack. A slot, machined in the upper end of the pinion shaft mates with the dog-tooth on the input shaft. The pinion shaft locates in the pinion housing and rotates on ball and roller bearings.

POWER STEERING PUMP - TD4



Item	Part Number	Description
1		Pressure output port (to steering gear valve unit)
2		Pulley
3		Suction port (from reservoir)

The pump is a variable displacement, vane type pump which supplies the required hydraulic pressure to the steering gear valve unit. The pump is located at the front of the engine and is driven by the Front Engine Auxiliary Drive (FEAD) Poly Vee belt which is directly driven from the crankshaft. The output from the pump increases proportionally with the load applied to the steering valve unit. A self-adjusting tensioner is fitted to maintain the correct tension on the belt.

The pump consists of a cartridge set which consists of 11 vanes and a rotor. These are mounted on the input shaft and are surrounded by a variable displacement cam ring. The vanes rotate within the cam ring and are driven by the shaft. As the vanes rotate, the cam ring causes the space between the vanes to increase. This causes a depression between the vanes and fluid is drawn from the reservoir via the suction hose into the space between the vanes. As the shaft rotates, the inlet port is closed to the vanes which have drawn in fluid, trapping the fluid between the vanes. The cam ring causes the space between the vanes to reduce and consequentially compresses and pressurizes the hydraulic fluid trapped between them. Further rotation of the shaft moves the vanes to the outlet port. As the vanes pass the port plate, the pressurized fluid passes from the pump outlet port into the pressure hose to the steering gear.

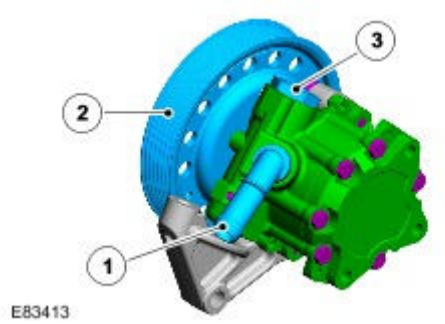
The cam ring can move within the valve body. By moving the cam ring it is possible to vary the eccentricity of the shaft and the vanes in relation to the cam ring. As the eccentricity is decreased, the volume of hydraulic fluid trapped between the vanes decreases, maintaining a constant fluid output. This reduces the power and torque required to

turn the pump and therefore improves engine economy. The pump has an internal regulating valve which controls the eccentricity of the cam ring and therefore varies the flow rate according to demand.

At low engine speeds, the internal displacement of the variable displacement pump is at its maximum to generate the controlled fluid output. As the pump speed increases with engine speed, the increased flow inside the pump generates a back pressure within the pump. This back pressure causes an internal regulating valve to move the the cam ring and reduce the internal displacement of the pump to maintian the constant fluid flow from the pump.

A regulating, pressure relief valve within the pump limits the maximum pressure supplied to the steering gear to 115 bar (1667 lbf in^2) ± 4 bar (58 lbf in^2) and also limits the maximum flow to 8.8 l/min (1.93 gal/min) ± 0.5 l/min (0.1 gal/min) at 10 bar (145 bf in^2). The pump has a displacement of 9.6 cc/rev (0.58in^3/rev).

POWER STEERING PUMP - i6



Item	Part Number	Description
1		Suction port (from reservoir)
2		Pulley
3		Pressure output port (to steering gear valve unit)

The pump is a fixed displacement, vane type pump which supplies hydraulic pressure to the steering gear valve unit. The pump is located at the rear of the engine and is driven by the Rear Engine Auxiliary Drive (READ) Poly Vee belt which is indirectly driven from the camshafts. The pump supplies a constant flow rate, therefore the output is independent of pump/engine speed. A self-adjusting tensioner is fitted to maintain the correct tension on the belt.

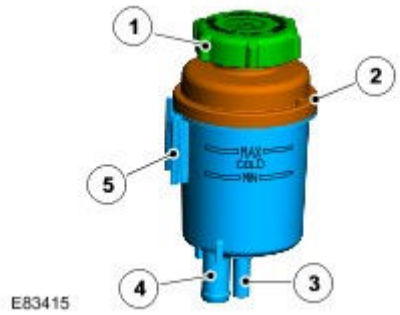
The pump contains a number of vanes which rotate within a cam ring and are driven by the input shaft. As the vanes rotate, the cam ring causes the space between the vanes to increase. This causes a depression between the vanes and fluid is drawn from the reservoir via the suction hose into the space between the vanes. As the shaft rotates, the inlet port is closed to the vanes which have drawn in fluid, trapping the fluid between the vanes. The cam ring causes the space between the vanes to reduce and consequentially compresses and pressurizes the hydraulic fluid trapped between them. Further rotation of the shaft moves the vanes to the outlet port. As the vanes pass the port plate the pressurized fluid passes from the pump outlet port into the pressure hose to the steering gear.

The pressurized fluid is subject to control by a flow control and pressure relief valve. The flow control valve maintains a constant flow of fluid supplied to the steering gear irrespective of engine speed variations. The pressure relief valve limits the maximum pressure on the output side of the pump. A metering orifice is included in the discharge port of the pump.

If the pressure in the orifice reaches a predetermined level, a spring loaded ball in the centre of the flow control valve is lifted from its seat and allows pressurized fluid to recirculate within the pump. The pressure relief valve will operate if the discharge from the pump is restricted, for example, steering held on full lock. If the output from the pump is blocked, all output is recirculated through the pump. In this condition, as no fresh fluid is drawn into the pump from the reservoir, the fluid temperature inside the pump will increase rapidly. Consequentially, periods of operation of the steering gear on full lock should be kept to a minimum to prevent overheating of the pump and the fluid within it.

The pump has an internal pressure relief valve which also incorporates a flow control valve. The pressure relief valve limits the maximum pressure supplied to the steering gear to 125 bar (1812 lbf in^2) ± 4 bar (58 lbf in^2). The flow control valve limits the maximum flow to 8.8 l/min (1.93 gal/min) ± 0.5 l/min (0.1 gal/min) at 10 bar (145 bf in^2) The pump has a displacement of 11 cc/rev (0.67 in^3/rev).

RESERVOIR



Item	Part Number	Description
1		Cap
2		Body
3		Return connection (DW12 - from steering gear) (i6 - from fluid cooler)
4		Suction connection (to power steering pump)
5		Bracket attachment mouldings

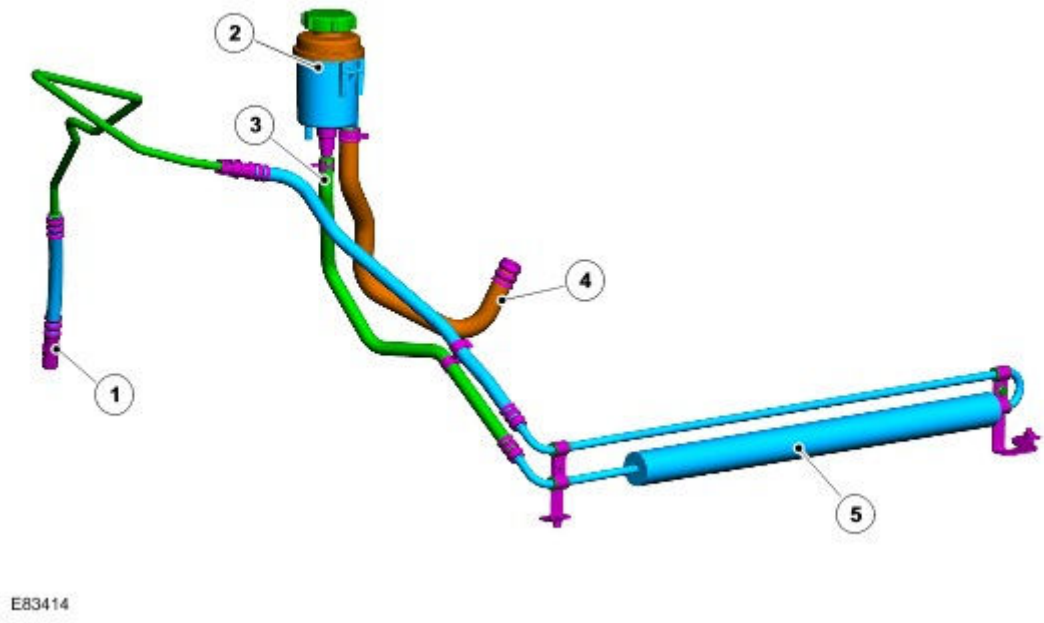
The fluid reservoir is located on a bracket in the RH side of the engine compartment, behind the headlamp assembly. The reservoir comprises a body, cap and filter. The purpose of the reservoir is to contain a surplus of the hydraulic fluid in the system to allow for expansion and contraction of the fluid due to temperature variations.

The fluid level ensures that the supply connection on the bottom of the reservoir is covered with fluid at all operating vehicle attitudes. Any air which is present in the system is exhausted from the system in the reservoir.

The body is a plastic moulding with two ports at the bottom which provide for the connection of the suction supply and return hoses. Moulded markings on the side of the reservoir denote the upper and lower fluid levels. A non-serviceable, 100 micron nylon mesh filter is fitted in the body. The filter removes particulate matter from the fluid before it is drawn into the pump supply connection. Maximum and minimum fluid levels are moulded into the body and assist checking fluid levels when the hydraulic fluid is cold.

The cap is rotated counterclockwise to release from the body. The cap is fitted with an O-ring to prevent fluid leakage and incorporates a breather hole to allow for changes in fluid level during operation and prevent vacuum or pressurization of the reservoir.

FLUID COOLER (i6 ONLY)



Item	Part Number	Description

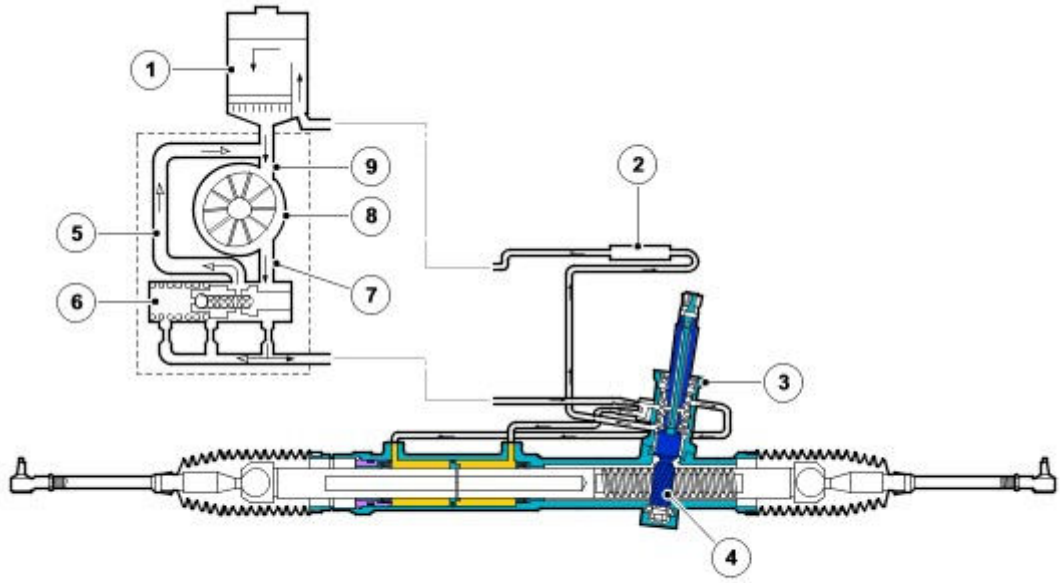
1		Fluid return (from steering gear)
2		Reservoir
3		Fluid return (from fluid cooler)
4		Suction hose (to power steering pump)
5		Fluid cooler

The fluid cooler is located in the return line from the steering gear to the reservoir. The cooler comprises flexible hoses which connect between the reservoir and the return pipe from the steering gear. The cooler is an integral part of the hoses and cannot be replaced as a separate component.

The cooler is a fabricated aluminum tube, through which the power steering fluid passes and is located in front of the engine cooling radiator and the Air Conditioning (A/C) condenser. The outer diameter of the cooler tube has aluminum loops attached to it which dissipate heat. Cool air entering the front of the vehicle passes over the cooler and flows through the loops. The loops act as heat exchangers, conducting heat from the fluid as it passes through the tube.

PRINCIPLES OF OPERATION

Fixed Displacement Pump Schematic - Typical



E46944

Item	Part Number	Description
1		Reservoir
2		Fluid cooler
3		Valve unit
4		Steering rack and pinion
5		Flow control/pressure relief - return
6		Flow control/pressure relief valve
7		Output port
8		Power steering pump
9		Low pressure suction line

When the engine is started the power steering pump draws fluid from the reservoir into the low pressure suction line. The fluid passes through the pump and emerges as pressurized fluid at the outlet port. The high pressure hose passes the pressurized fluid to the steering gear valve unit.

If no steering effort is applied, there is minimal restriction within the system and the supply pressure from the pump is

low. Minimal pressure is applied, via the valve unit, to each side of the piston in the hydraulic cylinder and the full flow from the power steering pump returns to the reservoir via the fluid cooler.

When steering effort is applied in either direction, the return flow of fluid to the reservoir is restricted by the valve unit, causing the supply pressure from the pump to increase. The pressurized fluid is directed by the valve unit to the applicable side of the piston in the hydraulic cylinder, providing the power assistance required to reduce the steering effort. Fluid displaced from the low pressure side of the cylinder is returned via the valve unit and fluid cooler to the reservoir. The fluid cooler reduces the fluid temperature improving fluid performance and also prolongs the life of hoses and seals in the system.