Document Title: **Steering system, description**	Function Group: **600**	Information Type: **Service Information**	Date: **2014/6/24**
Profile: **ART, A40E FS [GB]**			

Steering system, description

The articulated hauler has frame joint steering and a Volvo-unique self-compensating hydromechanical steering system with feedback between the trailer and the steering slide in the steering and dumping valve.

The steering system is coupled in parallel with the dumping system with common hydraulic pumps. The steering system is however prioritised ahead of the dumping system in order that the steering function is safeguarded.

A ground-dependent hydraulic pump in the steering system is used in a reserve function where this secondary steering pump constantly supplies oil to the normal steering system when the machine moves forwards.

The steering valve has a closed neutral position (closed centre) and is controlled by the steering wheel via a rack-and-pinion gear and a linkage system. When the steering wheel is turned the linkage system moves the steering valve spool from its neutral position and the steering valve directs oil to both the steering cylinders.

By means of the linkage system being coupled with the steering joint the steering valve spool is restored to the neutral position when the machine angles in accordance with the movement of the steering wheel. Conversely the steering valve spool is moved from neutral position if the steering angle is changed by external forces when the steering wheel has not changed position. The movement of the steering valve spool is limited by mechanical stops.

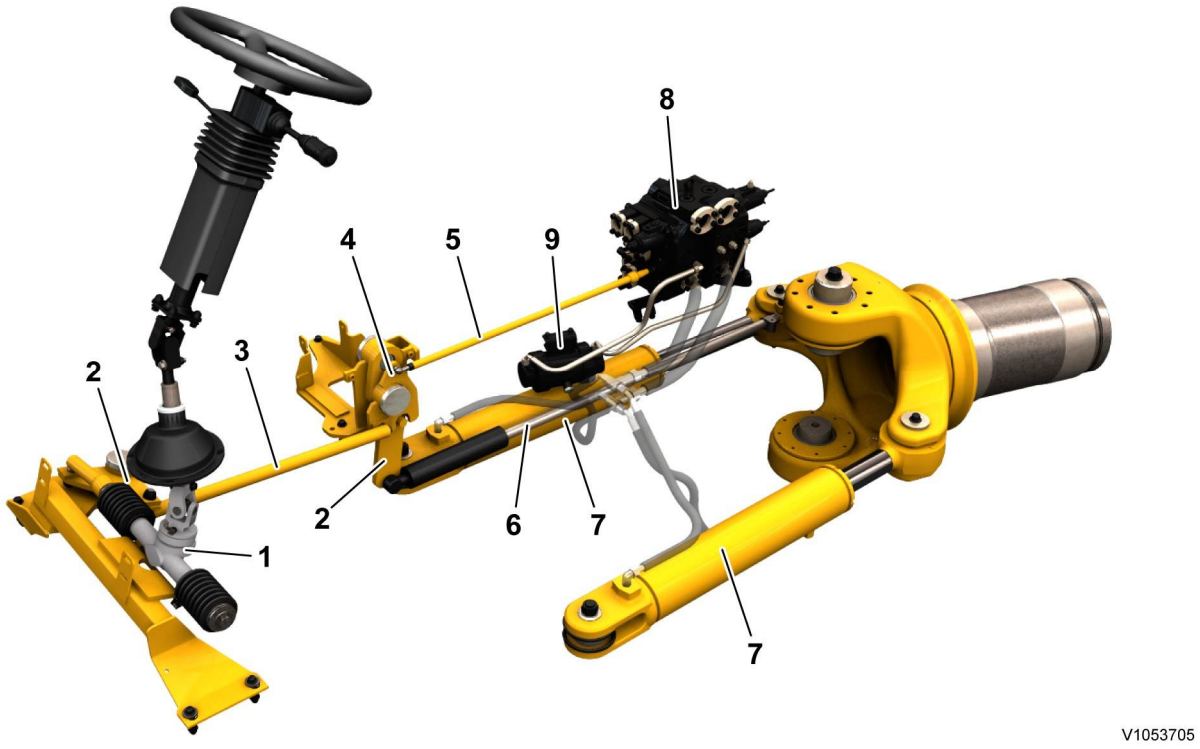

Figure 1
V1053705

1	Steering gear	4	Lever bracket	7	Steering cylinder
2	Lever	5	Control rod	8	Steering and dumping valve
3	Link rod	6	Feedback rod	9	Damping cylinder

VOLVO
Construction Equipment

Service Information

Document Title: **Troubleshooting tips**	Function Group: **600**	Information Type: **Service Information**	Date: **2014/6/24**
Profile: **ART, A40E FS [GB]**			

Troubleshooting tips

Symptom	Probable cause	Troubleshooting	Action
Binding steering	Transverse diff. engaged	Button in position On? Control light on?	Set the button in the off position. Turn the steering wheel to and fro. If the fault remains check the operation of the differential lock.
	At low rpm: different stand-by pressure	Measure pressures in M2.	See 913 Hydraulic pump, checking and adjusting standby pressure
	BVLS5 defective	Measure max. pressure in M2. In case of low max. pressure both Right and Left. Check with the dump body at the top, if max. pressure higher than before then BVLS5 is probably defective.	Remove and check the defective non-return valve. See 912 Steering and dumping valve, removed, reconditioning
	Incorrect max. pressure	Measure pressures in M2.	See 913 Hydraulic pump, checking and adjusting max working pressure
	Binding steering gear	Check the steering gear	See 642 Steering gear, checking and adjusting
	Binding steering linkage	Check the steering linkage	See 643 Steering linkage, checking and adjusting
Binding steering in one direction	BVLS 1 or BVLS 2 not functioning	Measure max. pressures when steering to the left and to the right	Remove and check the defective non-return valve. See 912 Steering and dumping valve, removed, reconditioning
	Defective damping cylinder	Check the pre-load and springs in the damping cylinder.	See 646 Damping cylinder, checking pre-load
	Some working pump has too high neutral position pressure	Check neutral position pressure	913 Hydraulic pump, checking and adjusting standby pressure

Unsteady or jerky steering	Restrictions B-X, A-Y in block	Remove and check the restrictions B-X and A-Y in the block	See 912 Steering and dumping valve, description
	Cross-over valves VV1 and VV2	Remove and check the function	See 912 Steering and dumping valve, description
	Clearance (play) in steering linkage	Check the steering linkage	See 912 Steering and dumping valve, description
Machine self-steers.	Steering slide's neutral position or axial position incorrect.	Check and adjust	See 643 Steering linkage, checking and adjusting
Machine has different steering times to the left and right	Incorrectly adjusted steering link	Check and adjust	
The machine impacts on itself when steering full lock in either direction.	Incorrectly adjusted steering linkage (cylinder goes to end-position).	Check and adjust the steering linkage.	
	Clearance (play) in the steering cylinder mountings.	Check	Change bearing, if needed. See 645 Steering cylinder, replacing bearings

VOLVO
Construction Equipment

Service Information

Document Title:	Function Group:	Information Type:	Date:
Pressure build-up, engine-dependent pumps, description	**640**	**Service Information**	**2014/6/24**
Profile: **ART, A40E FS [GB]**			

Pressure build-up, engine-dependent pumps, description

The pumps are numbered according to the connections to the steering and dumping valve, and the numbers in the text below refer to 990 Hydraulic diagram, complete.

For information on pressure values for the functions described below, see 990 Hydraulic pressure, specifications.

The engine is running and the machine is parked.

The engine-dependent hydraulic pumps suck hydraulic oil from the hydraulic tank and build up a flow to the steering and dumping valve **11** (neutral position). The pumps are connected to each other via channels in the steering and dumping valve. Pump 2 has connection to the dumping valve slide through the steering valve slide's "open centre", but when the steering slide is moved from its neutral position, then BV2 prevents the oil flow from pump 2 from going to the dump function. In this way, steering is prioritized. The remaining engine-dependent pumps are directly connected (past the steering valve slide) to the dumping valve slide and pressure reduction valve R35 for servo pressure to the dump lever **13**.

The pressure is built up to the steering and dumping valve and its non-return valves. The pump's compensator valve is affected through the pump's internal channels, and the pump angles down. Now there is stand-by pressure at the valve. At this point, the pressure is only determined by the spring force in the compensator valve since there is still no pressure obtained from the steering system to the compensator's LS–connection.

In neutral position the steering and dumping valve permits a small, controlled oil flow between its connection P2 and connections A and B to the steering cylinders. An equal oil flow is also permitted between connections A – B and connection T4 for the tank line. The pressure is built up to the steering cylinders **15**, the damping cylinder **16**, the shock valves CHV1 and CHV2 with anti-cavitation valves and the cross-over valves VV1 and VV2. Steering is stabilized by pressurizing the steering cylinders.

The pressure is also built up via non-return valves BVLS1, BVLS2, and BVLS5 to outlet C2 and the compensator's LS–connection on the engine-dependent pumps. The pressure in the pumps increases accordingly. At the same time, oil is forced out from the steering and dumping valve's connections A and B via back-pressure valve (MTRV1) and its spring force to its connection T4 and is returned to the tank.

Pressure is also built up via BVLS3 and BVLS4 when oil is forced out from the steering and dumping valve connections B1- and A1+.

Neutral position pressure at the outlet for the engine-dependent pumps is the sum of the LS-pressure (MTRV1's spring force) and the spring force in the compensator valve.

P = C + F

P = pressure at pump outlet

C = pressure at LS–line

F = spring pressure in the compensator valve

Pressure values for stand-by pressure, neutral position pressure, and back-pressure are found in 990 Hydraulic pressure, specifications

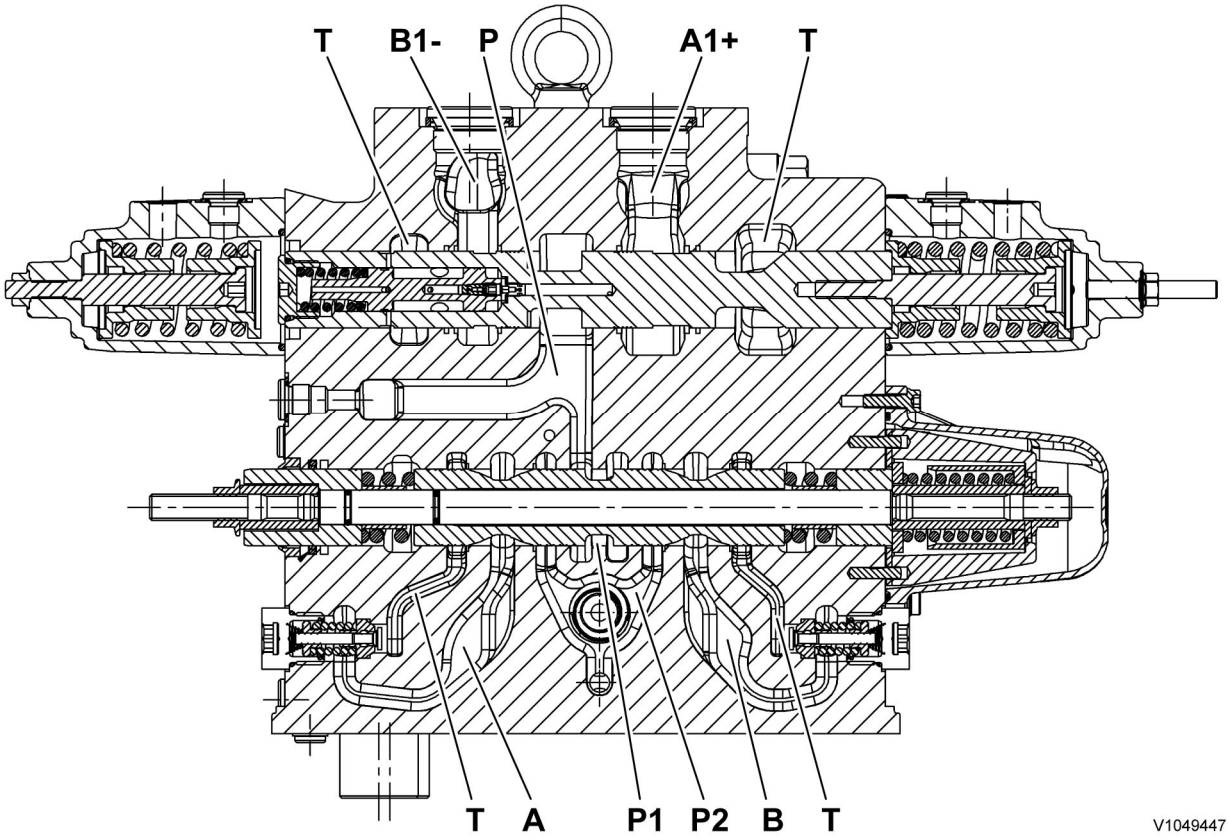

Figure 1

Pos.		Description	Pos.		Description
A		Connection to the steering cylinders	P		Pressure line
A1+		Connection to the hoist cylinders	P1		Pressure line
B		Connection to the steering cylinders	P2		Pressure line
B1-		Connection to the hoist cylinders	T		Connection to the tank

Pressure build-up, ground-dependent pump 8

The engine is running and the machine moves forwards.
The engine-dependent pumps and the ground-dependent pump use common LS–pressure. The operation of the ground-dependent pump **8** is directly connected to the wheels via the drivetrain to the dropbox power take-off. When pump 8 rotates in the correct direction (the machine is driven forward) pressure is built up to non-return valve BV4 in the steering and dumping valve. The pump's compensator valve is affected by via internal channels and the pump angles down as there is no oil flow. The same neutral position pressure now exists at the outlet for all pumps.

Steering function, engine-dependent pumps

The steering valve spool is displaced inwards and the connections P1– P5 from the pumps (also pump 8) are now in connection with the steering cylinders via connection A. Pressure is built up in the cylinders' A–connection and the pistons are acted upon on the plus side and minus side respectively. Pressure is built up simultaneously via the cross-over valves VV1 and VV2 to damping cylinder **16** and to the valve spool end face. The valve spool is stabilised. The same pressure is now also in the LS–line to the compensator's LS–connection. The compensator valve is acted upon and adapts the flow of the pumps to existing requirements.

Pressure sensor SE9102 and SE9103

The hydraulic pressures are monitored by the electronics using pressure sensors SE9102 for engine-dependent pumps and SE9103 for ground-dependent pump. If the difference between the pressure values from the sensors is too high, a warning is generated.

Restrictions C2 and C3 in load signal block 12

If there is a leak on the LS-signal line between C2 and the engine-dependent hydraulic pumps (Red central warning is

activated), the LS-pressure to the secondary steering pump (ground-dependent) can be maintained to a certain extent thanks to restriction C2. Thus, the secondary steering pump can supply required flow to the steering valve.

The opposite applies for C3 if leakage arises on the LS–signal line between C3 and the secondary steering pump.

Load signal block 12

The purpose of this valve block is to deliver the highest LS-pressure from the load & dump system to the hydraulic pumps' LS-connection, so that the pumps can angle out and provide required flow. The block also contains two restrictions that drain the system's LS-pressure to tank.

Anti–cavitation and pressure–limiting valves (shock valves) CHV1 and CHV2

In order to prevent negative pressure (vacuum) or excessively high pressure peaks from occurring in the steering cylinders, the steering valve contains two anti-cavitation and pressure limiting valves.

Pressure values for CHV1 and CHV2 are found in 990 Hydraulic pressure, specifications.

Pressure-limiting valve (shock valve) CHV3

Reduces max. pressure during active lowering. Prevents the load body from lowering if, e.g., body lock is not removed or prevents undesired pressure build-up in the cylinders if the dump lever is held in the position active lowering after the cylinders have been pushed in.

Pressure values for CHV3 are found in 990 Hydraulic pressure, specifications.

Non-return valve with back-pressure function, MTRV1

To ensure refilling of oil in the steering valve as well as steering cylinders, there is a non-return valve with back-pressure function installed in the steering and dumping valve. MTRV1 also has the function to build up the LS–pressure and the servo pressure.

Pressure values for MTRV1 are found in 990 Hydraulic pressure, specifications.

Non-return valve with back-pressure function, MTRV2

To ensure refilling of oil in the dumping valve as well as hoist cylinders, there is a non-return valve with back-pressure function installed in the steering and dumping valve.

Pressure values for MTRV2 are found in 990 Hydraulic pressure, specifications.

Non-return valve function in the steering and dumping valve

The function of the non–return valves BV1, BV2, BV3 and BV4 in the steering and dumping valve is to distribute the oil from the hydraulic pumps to the steering valve spool.

See also, 990 Hydraulic diagram, complete.

Document Title: **Steering gear, check.and adj.**	Function Group: **642**	Information Type: **Service Information**	Date: **2014/6/24**
Profile: **ART, A40E FS [GB]**			

Steering gear, check.and adj.

Op nbr 642-058

This method also includes all required tools and times for the following jobs:

- 191 Service positions

In order to safeguard the function of the steering gear, it should be checked at regular intervals. This is especially important if the machine is operated in a dusty environment.

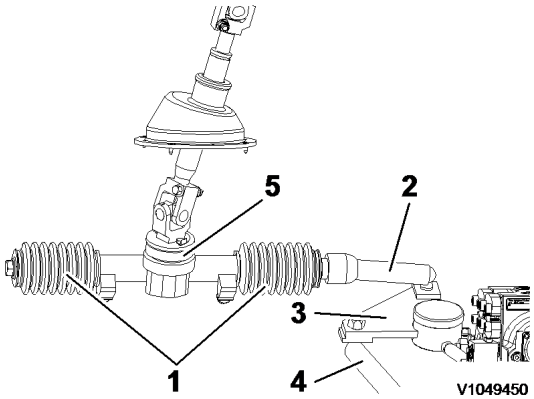

Figure 1

1. Rubber gaiter
2. Steering rod
3. Lever
4. Link rod
5. Steering gear

Check the steering gear as follows:

1. Place the machine in service position, see 191 Service positions.
   NOTE!
   The steering joint should be positioned straight.

2. Turn off the engine and switch off the ignition.

3. Turn the steering wheel to the left until it stops. Release the steering wheel, it should return to its original position, or close to its original position.

4. Repeat the same procedure to the right.

   NOTICE

   If the steering wheel does not return or binds, further checking of the steering gear and steering linkage is required.

5. Remove the mats and the middle floor plate. Pull back the operator's seat.

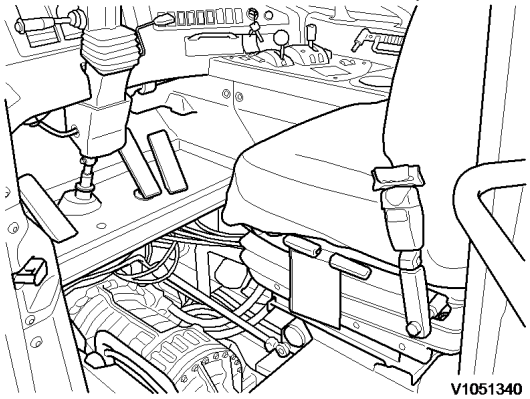

Figure 2

6. Remove the mat for the front floor plate.

7. Disconnect the brake pedal and remove it down through the floor plate.
   NOTE!
   Do not disconnect the hose connections for the brake pedal. Fold it to the side.

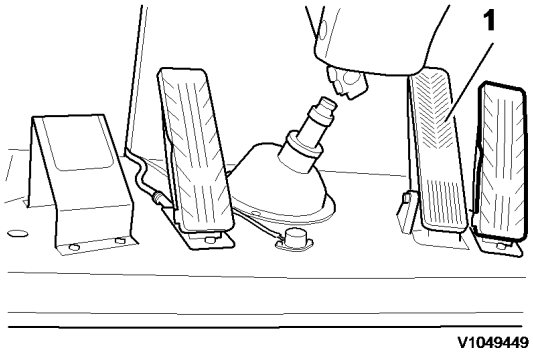

Figure 3

1. Brake pedal

8. Disconnect the steering rod at the front lever. If needed, use puller tool.

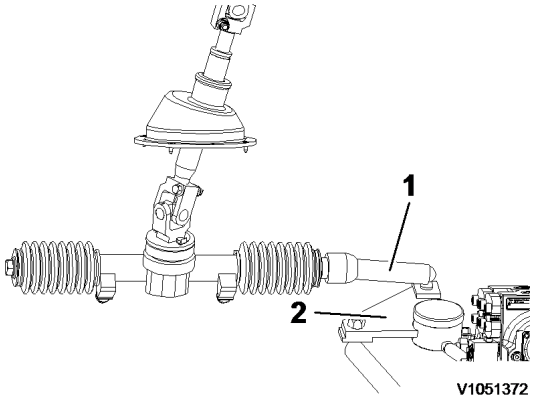

Figure 4

1. Steering rod
2. Front lever

9. Check the steering gear by turning the steering wheel from side to side. If no noticeable clearance/play can be

detected and the steering gear rotates without binding, then it is in good condition. Otherwise, change the steering gear.

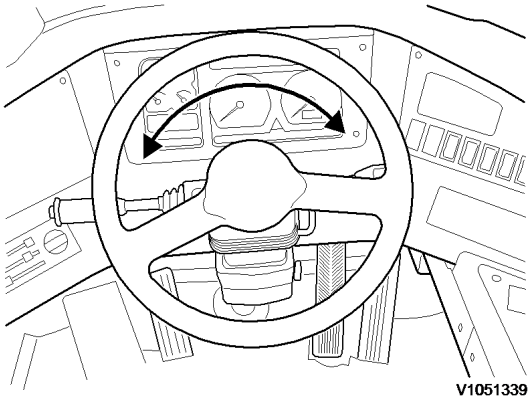

Figure 5

10. Check that the rubber gaiters on the steering gear are intact. Change if needed.
11. Check that the rest of the steering linkage is not loose or binds, change if needed.
12. Install the steering rod to the front lever.
13. If needed, adjust the steering wheel.
14. Loosen the bolt by the upper steering universal joint, under the steering wheel bracket.

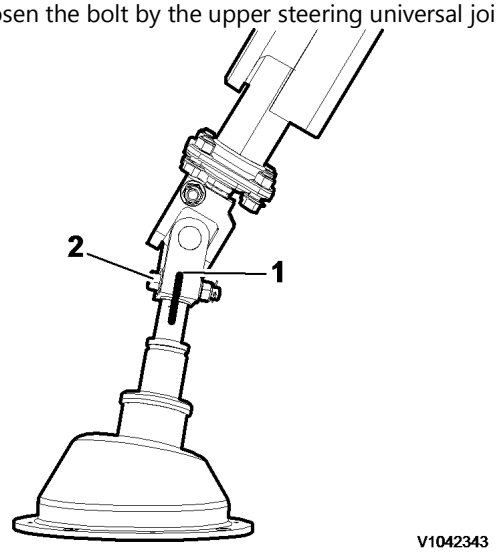

Figure 6

1. Steering shaft universal joint
2. Bolt, steering shaft universal joint

15. Part the steering column.
16. Adjust the steering wheel to the correct position
17. Fit the steering column.
18. Tighten the screw.
19. Fit the brake pedal.

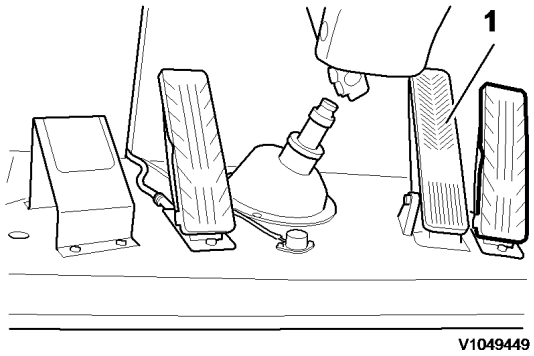

Figure 7

20. Restore floor plates, operator's seat, and mats.

Document Title: **Steering gear, replacing**	Function Group: **642**	Information Type: **Service Information**	Date: **2014/6/24**
Profile: **ART, A40E FS [GB]**			

Steering gear, replacing

Op nbr 642-026

Pin Ø 14 mm (0.512 in)

This method also includes all required tools and times for the following jobs:

- 191 Service positions

Removing

1. Place the machine in service position, see 191 Service positions.
2. Measure on the steering cylinders so that the machine stands straight.

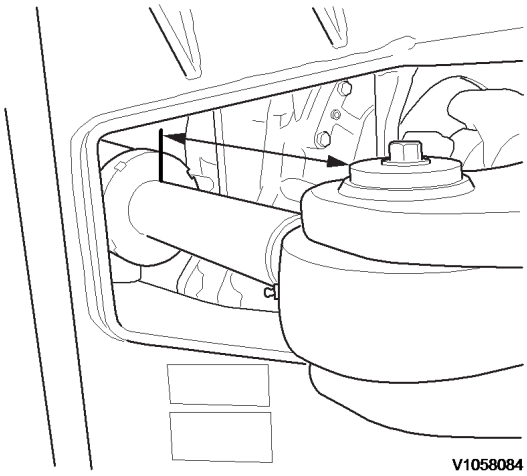

Figure 1

3. Remove the mat and the middle floor plate. Push back the rear floor plate together with the operator's seat.

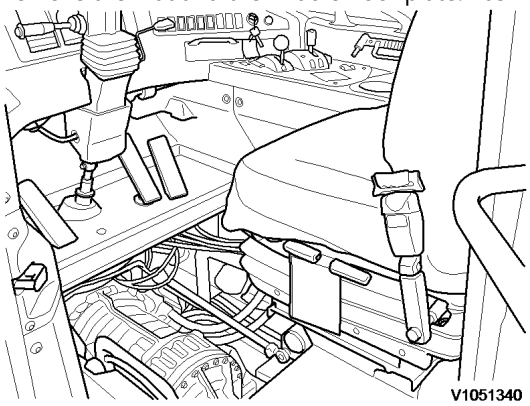

Figure 2

4. Bend out both lock plates that lock the bolts on the flange. Loosen and disconnect the steering wheel linkage.

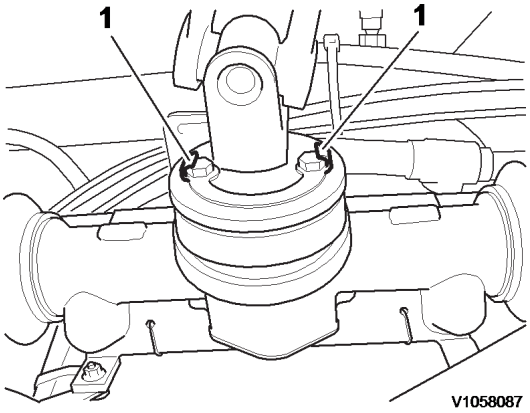

Figure 3

1. Lock plate

5. Mark the position for the steering shaft universal joint and the steering shaft.

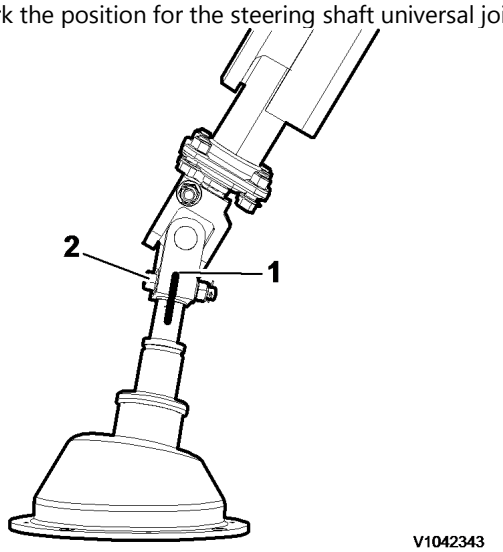

Figure 4

1. Steering shaft universal joint
2. Bolt

6. Remove the lock pin and the bolt for the steering shaft universal joint. Push together the steering shaft.

7. Unplug the connector SW4604 (6–wheel drive).

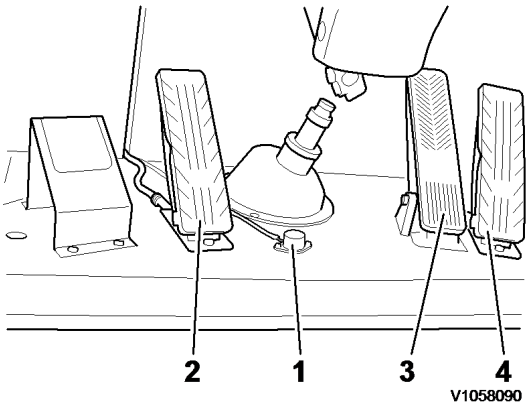

Figure 5

1. Connection SW4604
2. Retarder pedal
3. Throttle pedal
4. Brake pedal

8. Disconnect retarder pedal and throttle pedal, move aside.

9. Disconnect the brake pedal and insert it down through the floor plate.
   NOTE!
   Do not open any hose connections for the brake pedal.

10. Remove the front floor plate together with the steering column.

11. To improve access, cut straps and cable ties, and the connectors for SE5203 and SE5204 can be disconnected from the foot brake valve, so that the brake pedal can be moved aside.

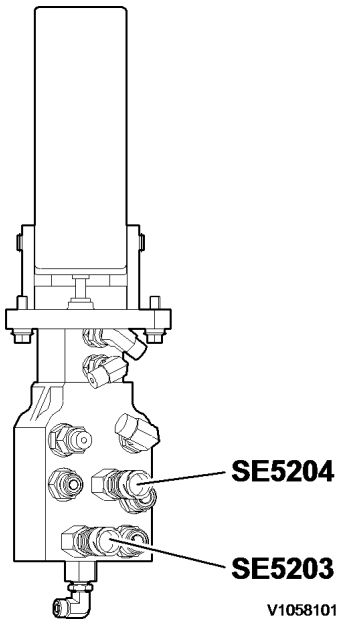

Figure 6

SE5203 – Sensor deployed brake pressure, tractor
SE5204 – Sensor deployed brake pressure, trailer

12. Insert a lock pin or drill bit (Ø 14 mm (0.55 in)) through the holes in the front lever.

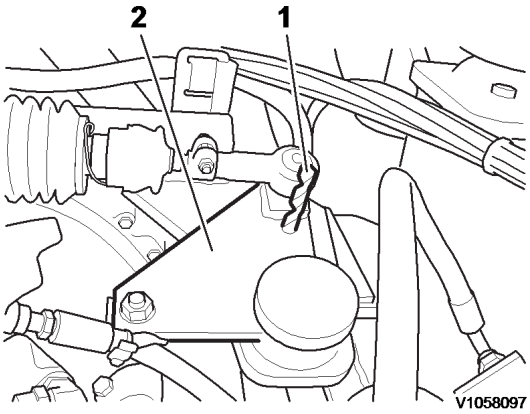

Figure 7

1. Pin Ø 14 mm (0.551 in)
2. Front lever

13. Remove the lock wires on the steering gear's underside.

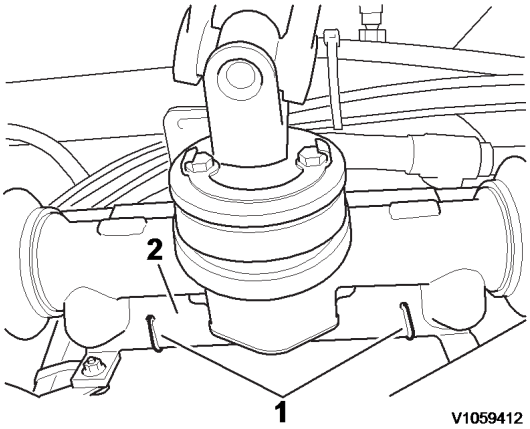

Figure 8

1. Lock wire
2. Bracket

14. Disconnect the steering gear from the bracket.

15. Loosen the clamp on the outer steering joint. Screw out the steering gear from the outer ball joint.

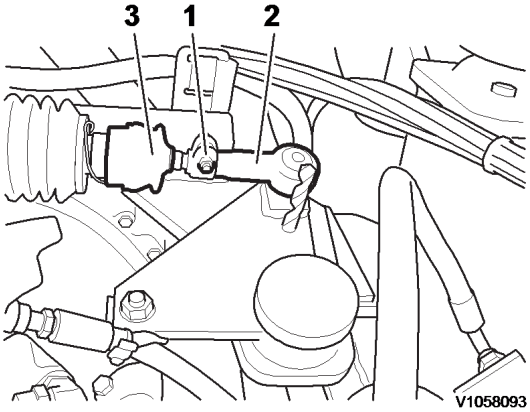

Figure 9

1. Clamp
2. Outer steering joint
3. Steering gear

Installing

16. Work acc. to one of the following alternatives:

    1. Turn the steering gear to max. steering angle in either direction. Count the number of turns, turn back half the total number of turns.
    2. Measure the steering angle on both sides, making sure that both full lock positions are the same.

    Mark the position of the flange when the steering gear stands in the middle position.

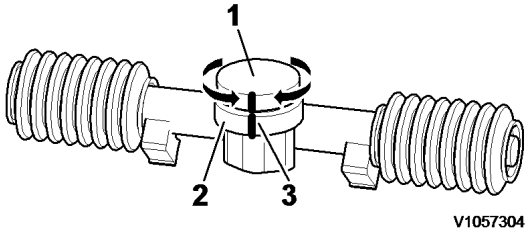

Figure 10

1. Flange
2. Steering gear
3. Marking steering gear's middle position

17. Screw in the steering gear in the ball joint. Do not tighten the clamp yet.

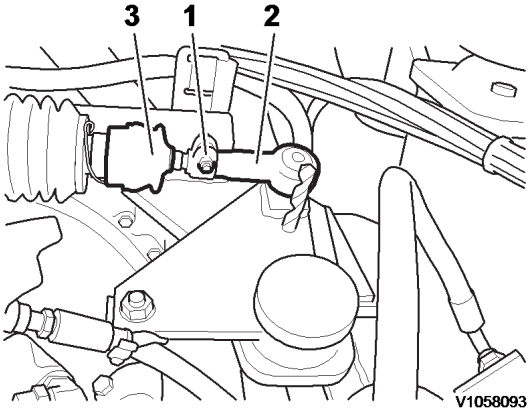

Figure 11

1. Clamp
2. Outer steering joint
3. Steering gear

18. Install the steering gear on the bracket.
    Tightening torque, see 643 Steering linkage, tightening torque
    Secure with lock wire.

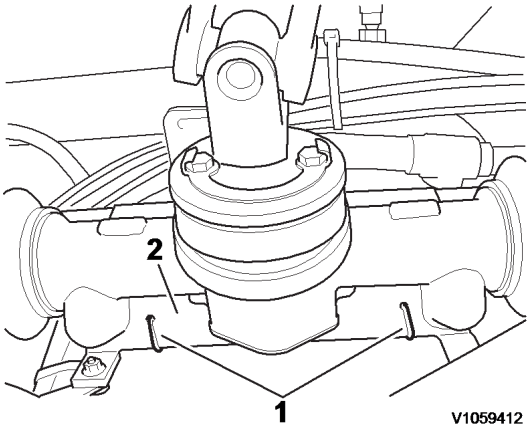

Figure 12

1. Lock wire
2. Bracket

19. Adjust on the outer steering joint so that the marking on the steering gear matches. Lock the ball joint.

20. Plug in sensors, if sensors SE5203 and SE5204 have been unplugged from the foot brake valve. Bundle up the hoses.

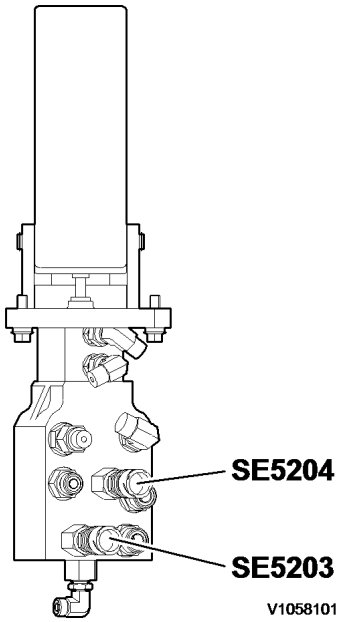

Figure 13

SE5203 – Sensor deployed brake pressure, tractor
SE5204 – Sensor deployed brake pressure, trailer

21. Install the front floor plate.

22. Insert the brake pedal up through the floor and install it.

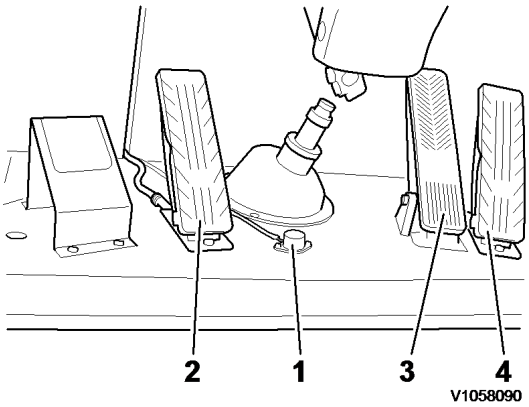

Figure 14

1. Connection SW4604
2. Retarder pedal
3. Throttle pedal
4. Brake pedal

23. Install throttle pedal and retarder pedal.

24. Plug in connector SW4604 (6–wheel drive).

WARNING

This is a safety joint.

25. Connect the steering shaft with the universal joint according to markings made earlier. Install the bolt and the lock pin.
Tightening torque, see 643 Steering linkage, tightening torque

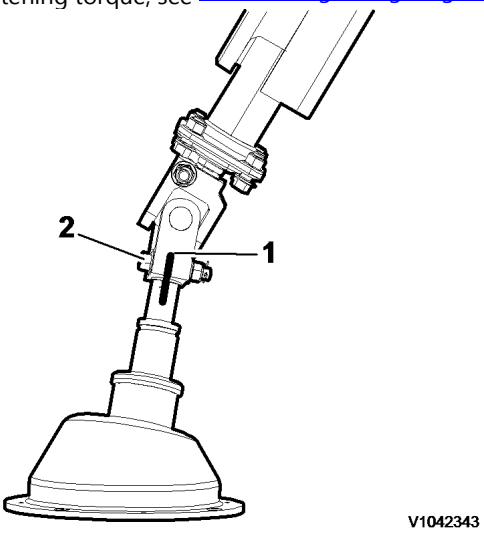

Figure 15

1. Steering shaft universal joint
2. Lock pin and bolt

26. Check that the steering wheel stands straight ahead. Install the drive flange on the steering gear. Bend down the lock plates.

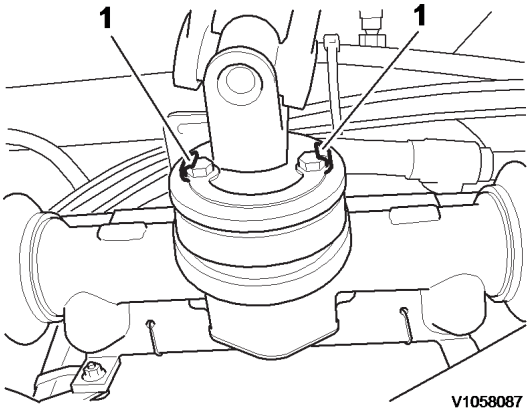

Figure 16

1. Lock plate

27. Remove the pin from the lever.

28. Install the front floor mat.

29. Start the engine and steer to full lock right, and measure left steering cylinder piston. Steer to full lock left, and measure in the same way on the right side. The measurements shall be the same, otherwise see 643 Steering linkage, checking and adjusting

30. Install the middle and rear floor plate together with the operator's seat. Install the mats.

Document Title: **Steering linkage, checking and adjusting**	Function Group: **643**	Information Type: **Service Information**	Date: **2014/6/24**
Profile: **ART, A40E FS [GB]**			

Steering linkage, checking and adjusting

General

Check that the machine does not make abnormal steering movements at when starting. One small steering movement is normal.

Test drive to check that the steering is stable, easily manoeuvred and flexible. No abnormal play may exist in the linkage mechanism.

If the steering is very sensitive and erratic (uncontrolled oscillations) during quick steering movements, it may be due to problems with the damping cylinder or its connections to the steering valve (restrictions A–Y and B–X or cross-over valves VV1 and VV2, see 990 Hydraulic diagram, complete). It may also be that one of the working pumps supplies too high pressure, see 913 Hydraulic pump, checking and adjusting max working pressure.

If the steering feels sluggish at low engine speed, it may be due to the hydraulic pumps' stand-by pressure not being the same, see 913 Hydraulic pump, checking and adjusting standby pressure.

Check that the stroke of the steering cylinders is the same in both directions.

Check using a sudden steering movement when the machine is stationary, then release the steering wheel and check that the machine does not have a tendency to self-steer. If the machine does have a tendency to self-steer, check the steering valve slide's neutral position.

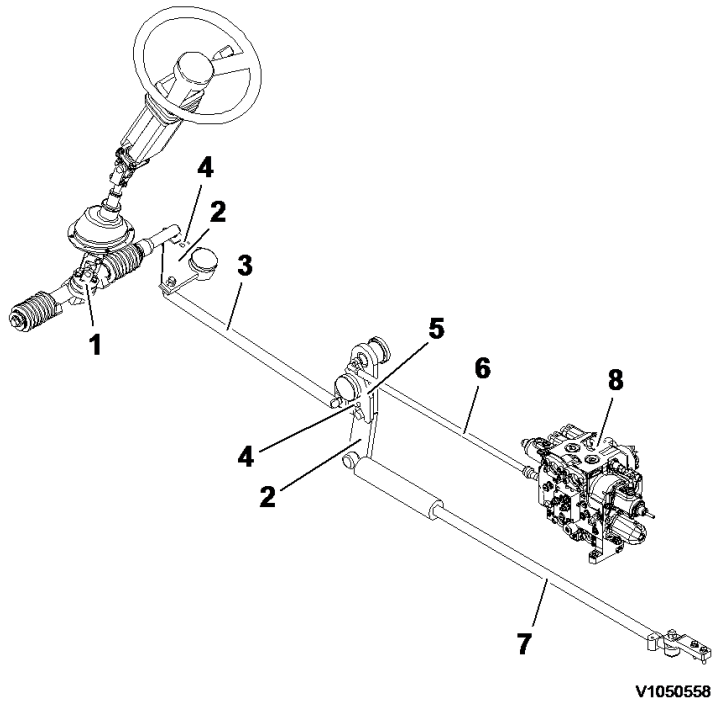

Figure 1
Steering linkage overview

1	Steering gear	3	Link rod	5	Lever bracket	7	Feedback rod
2	Lever	4	Centring hole	6	Control rod	8	Steering and dumping valve