



Section H

Steering

Service Manual - 3000 XTRA Series Fastrac

[Section 1 - General Information](#)

[Section 2 - Care and Safety](#)

[Section 3 - Routine Maintenance](#)

[Section A - Hitches and Attachments](#)

[Section C - Electrics](#)

[Section E - Hydraulics](#)

[Section F - Transmission](#)

[Section G - Brakes](#)

[Section H - Steering](#)

[Section S - Suspension](#)

[Section T - Engine](#)



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Contents	Page No.
Steering SYSTEM	
Introduction	H1-1
Technical Data	H1-2
Operation Overview	H1-3
Hydraulic Operation and Schematics	H1-4
Fault Finding	H1-5
Introduction	H1-5
Fault Finding Tables	H1-5
Pressure Testing - Steering Pump	H1-8
Limit Valve Setting	H1-10
Wheel Alignment	H1-12
Steering Box	
Introduction	H2-1
Operation Overview	H2-2
Removal and Replacement	H2-3
Dismantling and Assembly	H2-5
Fitting the Input Shaft Nut and Star Nut	H2-8
Steering Shafts	
Introduction	H3-1
Inspection	H3-2
Universal Joints and Phasing	H3-2
Intermediate Shafts and Bearings	H3-2
Bulkhead Shaft	H3-3

Steering SYSTEM

Introduction

This topic contains information about a machine SYSTEM. The system has some devices that connect either mechanically, hydraulically or electrically. Make sure you are referring to the correct system..

Descriptions and procedures relate to the system and not the individual devices.

This topic is intended to help you understand what the system does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

[⇒ *Technical Data* \(□ H1-2\)](#)

[⇒ *Operation Overview* \(□ H1-3\)](#)

[⇒ *Fault Finding* \(□ H1-5\)](#)

[⇒ *Pressure Testing - Steering Pump* \(□ H1-8\)](#)

[⇒ *Limit Valve Setting* \(□ H1-10\)](#)

[⇒ *Wheel Alignment* \(□ H1-12\)](#)



Technical Data

Pump	
Type	Rear section (P2) of gear type pump, driven by gearbox
Controlled flow at 1500 rev/min and system pressure	18 litres/min (4 UK gal/min, 4.8 US gal/min) +15% -10%
Relief valve pressure at 1500 rev/min engine speed	135 bar (1958 lb/in ²) <i>Important: DO NOT set the pressure above this value.</i>

Operation Overview

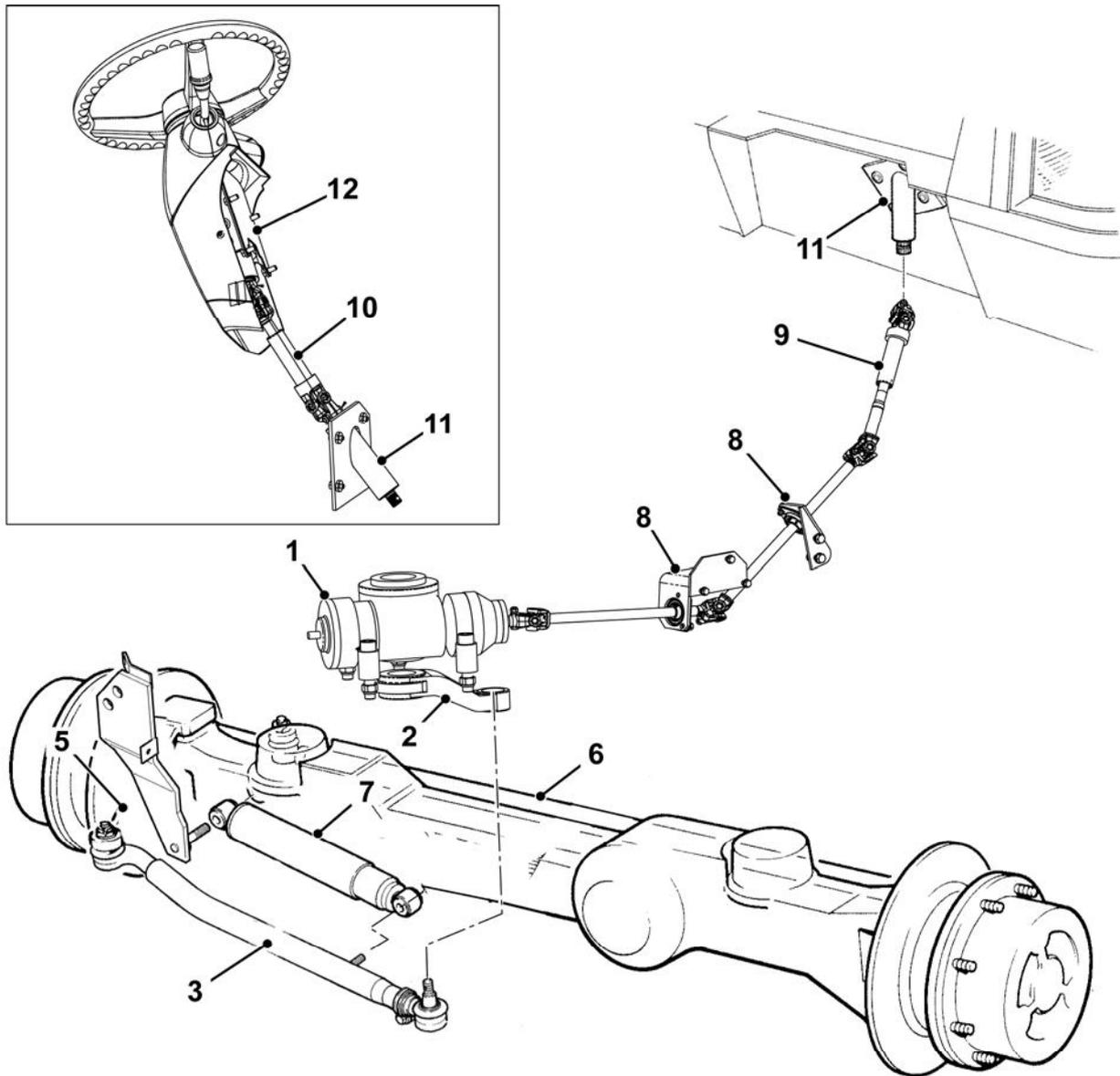


Fig 1.

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The front axle is steered by a recirculating ball hydraulically power assisted steering box 1. Drop arm 2 and drag link 3 transmit the steering effort to the right hand steering swivel 5. This is linked to the left hand steering swivel by track rod 6.

Steering damper 7 connects between drag link 3 and the chassis. The damper reduces steering kick back on uneven ground.

The steering input shafts are supported by bearings and chassis mounted brackets 8. Input shafts 9 and 10 are telescopic. Steering column assembly 12 is adjustable for angle and reach.

Hydraulic Operation and Schematics

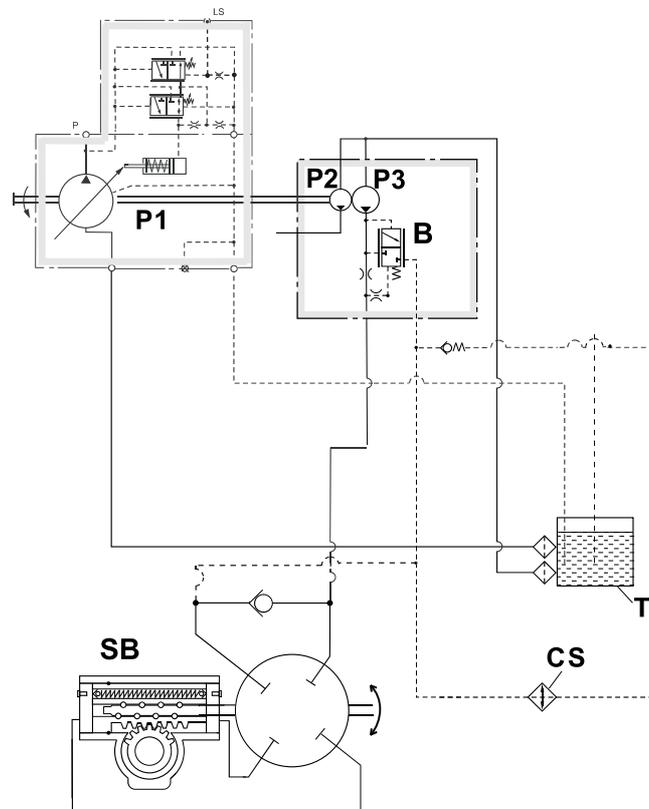


Fig 2.

C097030

P3 is the rear section of the gearbox-driven hydraulic pump which draws fluid from tank **T** to supply steering box **SB**. An adjustable pressure and flow control valve **B** is built into the rear cover of the pump. Fluid exhausted from the steering box joins with the pump by-pass flow and returns to tank via cooler **CS** which is part of the machine cooling pack.

Fault Finding

Introduction

Before assuming that the steering box or the pump is the cause of a steering problem, ensure that all other steering system faults have been rectified.

Before using the fault finding tables carry out the following checks:

- 1 Question the operator and drive the machine to establish the exact nature of the fault.
- 2 Check that the hydraulic oil is clean and to the correct level and that there are no signs of oil leakage from the circuit.
- 3 Check that the steering box mountings and all steering and suspension linkages are correctly tightened.

Fault Finding Tables

⇒ [Fault - Heavy Steering \(□ H1-6\)](#)

Table 1. Fault - Heavy Steering

CHECK		ACTION	
1	Is the front axle overloaded?	YES:	Reduce load
		NO:	Check 2
2	Are the correct tyres fitted and correctly inflated?	YES:	Check 3
		NO:	Replace / inflate tyres
3	Is the 4WD clutch releasing correctly?	YES:	Check 4
		NO:	See Section F, Fault Finding
4	Is the front differential operating correctly?	YES:	Check 5
		NO:	See Section F, Fault Finding
5	Are the steering swivels and linkages free?	YES:	Check 6
		NO:	Lubricate and free off
6	Is the oil cooler free of air blockage?	YES:	Check 7
		NO:	Clean out debris
7	Is the pump relief valve pressure too low?	YES:	Check for dirt at relief valve
		NO:	Check 8
8	Is the pump flow rate too low?	YES:	Check for flow control valve sticking and check 11
		NO:	Check 9
9	Is the steering column turning freely?	YES:	Check 10
		NO:	Free off / check universal joint phasing
10	Is front wheel alignment correct?	YES:	Check 11
		NO:	Adjust
11	Are suspension and steering geometry correct?	YES:	Check 12
		NO:	Renew parts as required
12	Is steering box leaking oil?	YES:	Renew seals
		NO:	Check 13
13	Is oil temperature high?	YES:	Check cooler and pipework for free flow
		NO:	Suspect fault in steering box

Table 2. Fault - Steering Wander or Free Play

CHECK		ACTION	
If the fault is wander, start at check 1. If the fault is free play, start at check 4.			
1	Is the rear axle overloaded?	YES: NO:	Reduce load. Check 2.
2	Are the correct tyres fitted and correctly inflated?	YES: NO:	Check 3. Replace / inflate tyres.
3	Is the front wheel alignment correct?	YES: NO:	Check 4. Adjust.
4	Are the column or steering linkages worn or loose?	YES: NO:	Tighten or renew. Check 5.
5	Is the pump flow correct?	YES: NO:	Check 6. Check condition of flow control.
6	Is air trapped in the hydraulic oil?	YES: NO:	Bleed out air. Turn the steering wheel from lock to lock 3 times and then back to straight ahead (with engine running at idle). Suspect fault in steering box.

Pressure Testing - Steering Pump

- 1 Park the machine on firm, level ground and apply the parking brake. Jack up the front of the machine until the wheels are clear of the ground and support it using axle stands placed under the axle. Ensure that the wheels can turn fully from lock to lock without fouling the axle stands.

WARNING

Jacking

A machine can roll off jacks and crush you unless the wheels have been blocked. Always block the wheels at the opposite end of the machine that is to be jacked. Do not work underneath a machine supported only by jacks. Always support a jacked-up machine on axle stands before working underneath it.

INT-3-2-8

- 2 Connect a 0-400 bar (0-6000 lbf/in²) pressure gauge to test point Y.

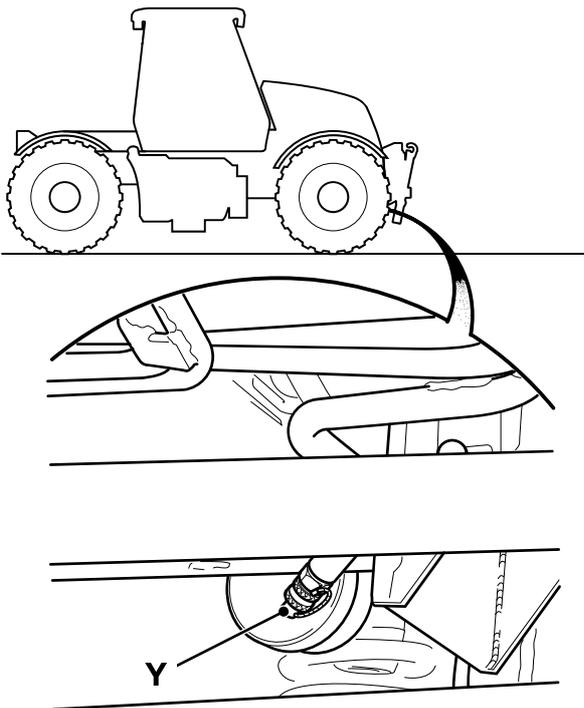


Fig 3.

418540-C1

- 3 Fit a 30 mm lock stop (part number 476/40702) at the left-hand side.
- 4 Run engine at 1500 rev/min, turn the steering wheel to full left lock and hold while checking the gauge reading against the pressure given in Technical Data.
- 5 If the gauge reading is not correct, the fault is likely to be in the pump relief valve which should be removed for cleaning (see **Section E**).
- 6 If after cleaning the pressure is still not correct it can be adjusted, but the pressure MUST NOT under any circumstances be set higher than the setting given in Technica Data. Proceed as follows:

⇒ Fig 4. (H1-9) The pressure setting is controlled by an adustable relief valve cartridge located in the pump end cover (shown at X).

- a Make sure that the engine cannot be started. Remove the retaining cover 1. Pull out the valve cartridge 2.
- b Grip the cartridge and turn the adjusting screw 3 no more than 1/4 turn, clockwise to increase the pressure setting and anticlockwise to decrease.
- c Replace the cartridge and refit the retaining cap 1. tighten the cap to the correct torque. DO NOT start the engine unless the cartridge 2 and retaining cap 1 are correctly fitted.
- d Start the engine and check the pressure setting. If further adjustment is required stop the engine and repeat the above from step 'a'.

Table 3. Torque Settings

Item	Nm	Kgf m	lbf ft
1	30 - 35	3.0 - 3.5	22 - 26

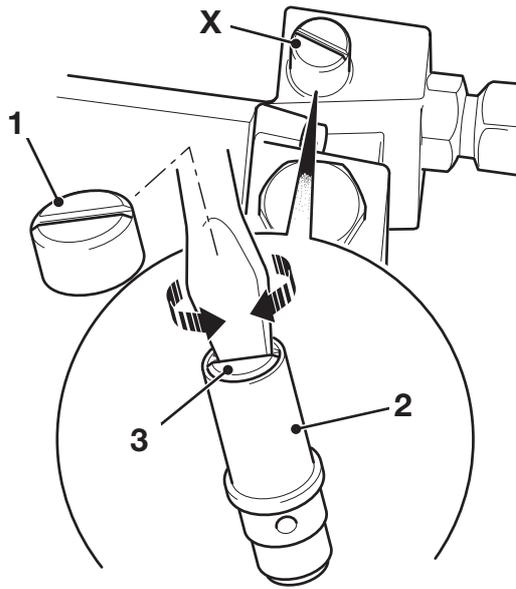


Fig 4.

A1122-C1

Limit Valve Setting

⇒ **Fig 6.** (□ **H1-11**) In the event of altering wheel width and lock stop sizes, fitting a new steering box or if the adjusting screws E or F have been disturbed, the limit valves must be set as follows:

- 1 Park the machine on firm, level ground and apply the parking brake. Jack up the front of the machine until the wheels are clear of the ground and support it using axle stands placed under the axle. Ensure that the wheels can turn fully from lock to lock without fouling the axle stands.
- 2 Check that the correct lock stop **D** (varies in length according to track width and tyre specification) plus a 2 mm flat washer is fitted at each side of the machine. Lock stops to suit the tyres/track width of new machines are factory fitted. See Tyres and Wheels, Lock Stops in Section 3 for details for other tyres/track widths.

WARNING

Jacking

A machine can roll off jacks and crush you unless the wheels have been blocked. Always block the wheels at the opposite end of the machine that is to be jacked. Do not work underneath a machine supported only by jacks. Always support a jacked-up machine on axle stands before working underneath it.

INT-3-2-8

- 3 Connect a 0-400 bar (0-6000 lbf/in²) pressure gauge to test point **Y**.

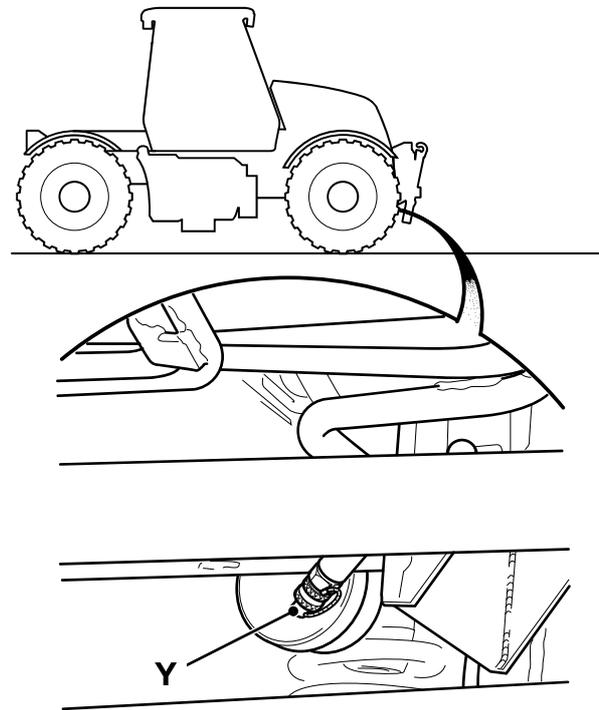


Fig 5.

418540-C1

- 4 Run the engine until the temperature of the oil in the hydraulic tank is at least 20 °C and then set the speed to 1500 rpm.

once) then re-check the pressure. Adjust if necessary. Repeat this process until the pressure remains constant (four or five times is normal to achieve this). If the pressure will not remain constant, ensure that the lock stops, steering box, axle and suspension mounting points are all secure.

WARNING

Due to the proximity of engine revolving parts and the possibility of getting trapped between the wheel and the chassis, rear limit valve screw adjustments should not be attempted until the engine has been switched off and stopped. Remove the starter key.

HYD ST-5-4

- 7 Turn the steering to full right lock and repeat steps 4 and 5, reading right lock instead of left lock and viceversa. Adjust rear limit valve screw **F** using a flexible shaft screwdriver.
- 8 Once the pressure settings have been completed, remove the lock stops **D** and the 2 mm flat washers. Re-install only the lock stops.

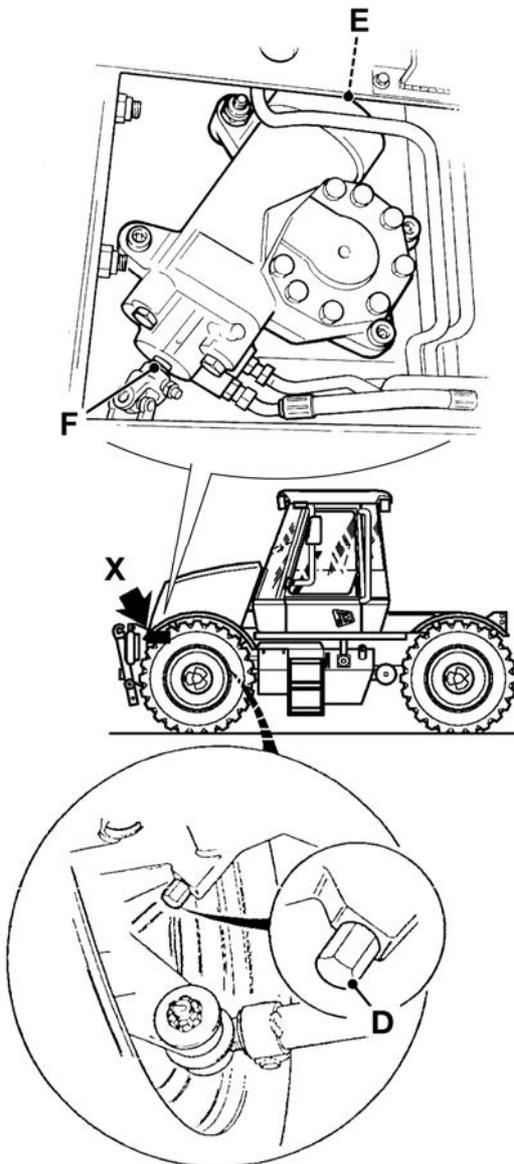


Fig 6.

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- 5 Turn the steering to full left lock. Set the pressure to 38- 40 bar (550-580 lbf/in²) by adjusting the front limit valve screw **E**. Use a long thin screwdriver through the hole in the front cross-member as shown by the arrow **X**. Turn clockwise to decrease the pressure and anti-clockwise to increase.
- 6 Release the steering wheel and turn it back and forth (fully onto left lock 5 times and onto right lock at least



Wheel Alignment

For the wheel alignment procedure refer to **Section 3, Routine Maintenance.**

Steering Box

Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

Descriptions and procedures relate to the device and not related systems.

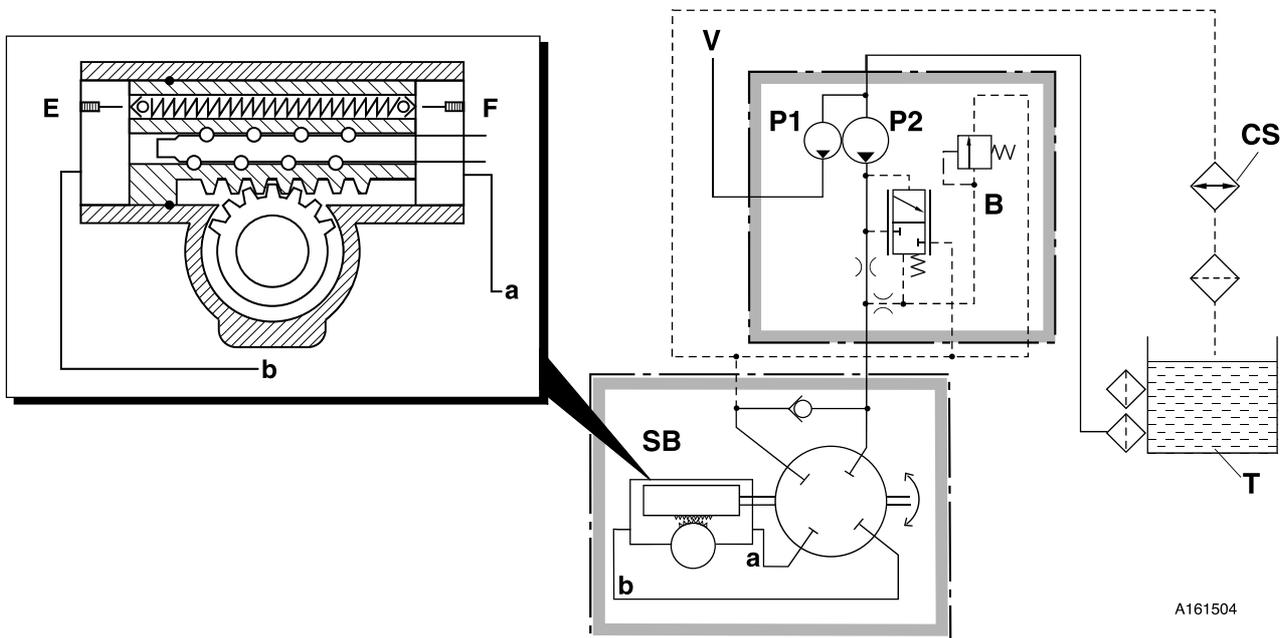
This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

[⇒ *Operation Overview* \(□ H2-2\)](#)

[⇒ *Removal and Replacement* \(□ H2-3\)](#)

[⇒ *Dismantling and Assembly* \(□ H2-5\)](#)

Operation Overview



A161504

A161504-B1

Fig 1.

The steering box incorporates pressure limit valves **E** and **F** (see schematic diagram below). The valves operate just before the steering rack reaches full lock to vent the power assist pressure to the exhaust side of the rack.

Removal and Replacement

⇒ Fig 3. (H2-7)

Note: Before assuming that the steering box is the cause of a steering problem, ensure that all other steering system faults have been rectified (see **Steering SYSTEM**).

Remove the cooling pack to gain access to the top of the steering box.

The numerical sequence shown on the illustration is intended as a guide to removal.

For replacement the sequence should be reversed.

WARNING

Make the machine safe before getting beneath it. Park the machine on level ground and lower the attachments. Stop the engine and remove the starter key. Make sure the park brake is engaged. Disconnect the battery to prevent the engine being started. Block all four wheels before getting under the machine.

3-3-1-1

WARNING

Do not weld, hammer or apply heat to the drop arm or its shaft. These actions will cause weakness and may result in steering failure.

HYD ST-5-1

When Removing

WARNING

The drop arm will be very tight on the splines. Take great care when pulling off the arm as it is likely to be released suddenly with considerable force.

HYD ST-5-2

Note the positions of index marks **X** and **Y** on shaft and drop arm.

Use a suitable ball joint splitter when removing drag link **5**.

Do not disturb the length adjustment of drag link **5** which is preset to 930 mm (36.6 in) between centres of ball pins.

Use puller adapters **A** with a 20 tonne general purpose hydraulic ram **B** to remove the drop arm **6**. (See Service Tools for details of the tools.)

Before disconnecting pipes, label them to assist correct refitting. Blank the open ports to prevent loss of oil and entry of dirt.

When Replacing

It is absolutely critical that the steering box mounting bolts are tightened to the torque setting specified below. Failure to do this may result in erratic steering.

Before fitting pinch bolt **9**, ensure that the steering shaft universal joints are correctly aligned (see **Steering Shafts**) and that the steering shaft is not exerting any end load on the input shaft of the steering box.

After fitting pipework and before fitting drop arm, purge air from the hydraulic system by turning the steering wheel from lock to lock 3 times and then back to straight ahead (with engine running at idle).

When fitting drop arm, align marks **X** and **Y** on shaft and drop arm.

Tighten drag link nut **4** to specified torque setting and then on to next split pin hole before fitting split pin.

After fitting the steering box, ensure that lock limit valves are correctly set, see **Steering SYSTEM**.

Table 1. Torque Settings

Item	Nm	Kgf m	lbf ft
1	16 - 18	1.7 - 2.0	12 - 15
2	915	93	675
4	135	13.7	100
9	75	7.6	55
10⁽¹⁾	500	51	370

(1) Torque value for Dacromet fasteners, coloured mottled silver

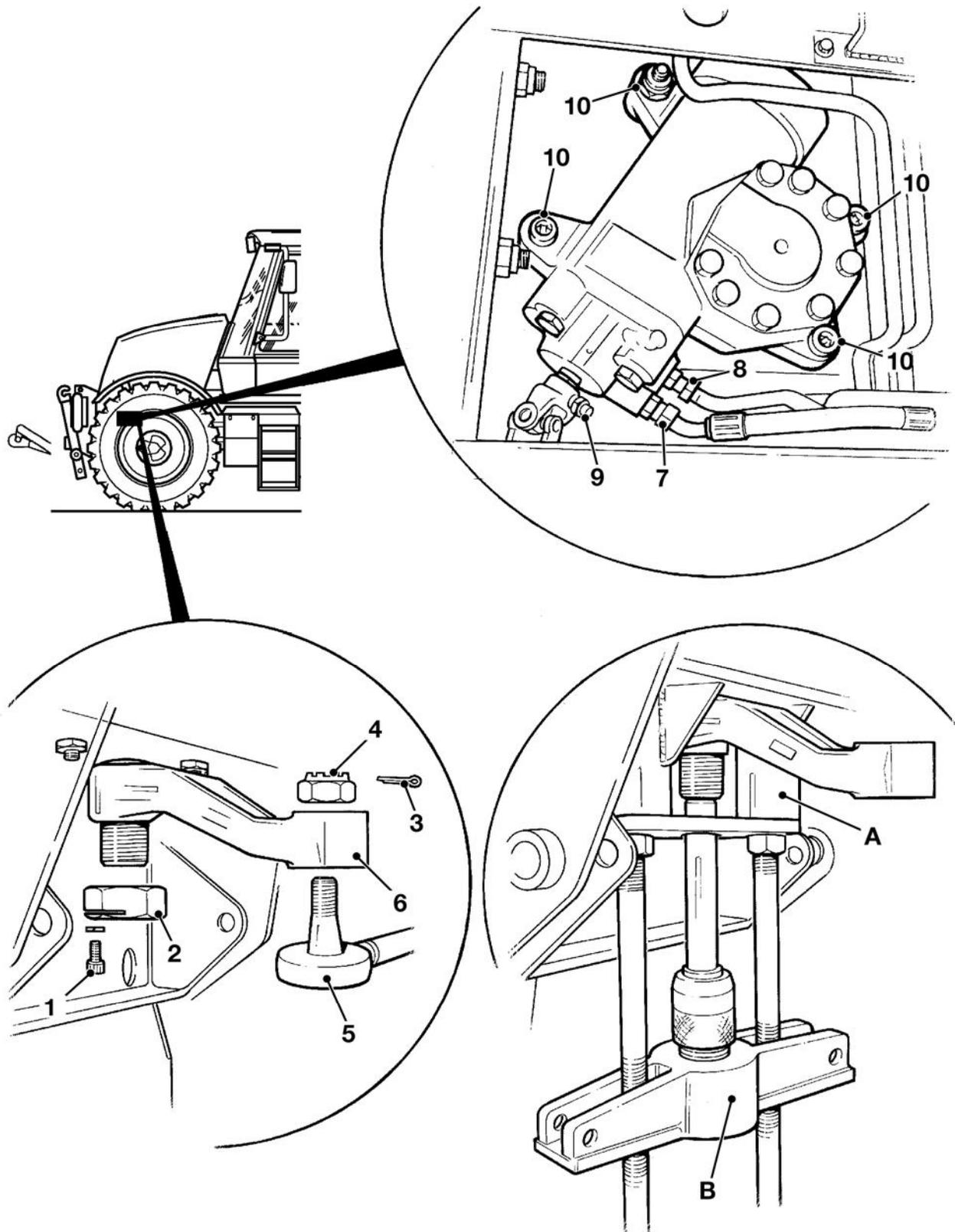


Fig 2.

S301830-C1

Dismantling and Assembly

⇒ [Fig 3.](#) ([H2-7](#))

The numerical sequence shown on the illustration is intended as a guide to dismantling.

For assembly the sequence should be reversed.

Note: Input seals **43** and **44** may be replaced by unscrewing bolts **40** and removing cover plate **42**.

When Dismantling

Remove screws **10** and **11** to prevent them being damaged. They must be re-set after fitting the steering box. See **Steering SYSTEM**.

When cover **2** has been removed ensure that there are timing marks on adjacent teeth of the sector shaft **5** and piston rack.

With the steering box positioned so that ball retainer cap **17** is pointing upwards, carefully withdraw bearing cap and shaft assembly **X** and the piston **20** from the main housing as one unit. If this is not done carefully, balls **19** may fall out.

When the piston is out of the housing, remove cap **17** and split race **18**, rotate the input shaft **31** to release the balls (**24** off) and separate the piston from the bearing cap assembly. This will allow seal **21** to be removed.

Do not remove plugs **C** and **D** from the piston.

Renewal of rotary valve seals **25** and their energising rings **26** is not necessary unless they are cut or damaged.

To renew input shaft seals **35** and **36** the bearing cap and shaft assembly (items **27** to **37**) must be dismantled.

Note: Special spanners will be required to tighten star nut **27** and shaft nut **28** to their correct torque settings.

To allow star nut **27** to be removed it may be necessary to split it with a chisel. Take appropriate safety precautions when using the chisel.

Note: The gear is secured to the sector shaft **5** by means of dowel **39** and roll pin **38**. These should not normally be removed as the gear and shaft would be renewed as an assembly.

When Assembling

Remove any burrs from the piston using a fine hand stone.

Apply a light coat of grease to the seals, thrust bearings and thrust washers.

When fitting shaft seal **36** ensure that the lip faces towards the inside of the steering box and that the seal bottoms in the bearing cap bore. Fit the shaft seal **35** until it is flush with the face of the bearing cap.

When renewing seals **25**, ensure that the piston grooves are free of nicks and burrs. Install energising rings **26** into the grooves first with the seals **25** over the top as shown at **W**. Before inserting the input shaft into the bearing cap, compress the seals into their grooves using a piece of thin sheet steel rolled into a tubular form. Do not rotate the input shaft when fitting it into the bearing cap as this is likely to damage the seals.

Fit the shaft nut, star nut and check bearing preload as detailed on the next page.

When fitting new seals to the piston, position back-up 'O' ring **23** in the groove and position new seal ring **22** over the 'O' ring. Due to the nature of the seal material, it will stretch as it is fitted but will contract over a period of time to allow entry into the bore of the housing.

If shortage of time does not allow sufficient contraction of the seal, use a suitable piston ring clamp to compress the seal.

Enter the piston **20** into the housing bore with the ball cavity **Y** uppermost and just exposed at the end of the bore.

Enter the input shaft into the piston so that the bearing cap **37** is within 75 mm (3 in) of the end of the piston **20**. Slowly turn the bearing cap assembly inwards whilst inserting balls at **Y** until balls start to appear at **Z**. Insert split race **18** and press home. Insert final balls and fit cap **17**.

CAUTION

Do not turn the steering wheel to the left with a 0 - 40 bar pressure gauge connected. Doing this would damage the gauge due to the high pressure at the test point during a left turn.

HYD ST-5-3

When sliding the piston through the housing bore, take care to avoid damaging seals as they pass the edges of the housing bore for sector shaft **5**. Position the timing mark on the piston rack on the centre-line of the sector shaft bore.

Install the sector shaft so that the timing mark on the sector shaft gear tooth aligns with the timing mark on the piston rack. Tap the end of the sector shaft with a soft hammer to ensure full tooth engagement.

Table 2. Torque Settings

Item	Nm	Kgf m	lbf ft
1	249 - 263	24.8 - 26.8	184 - 19
12	72 - 85	7.3 - 8.6	53 - 63
16	249 - 263	125.4 - 26.8	184 - 190

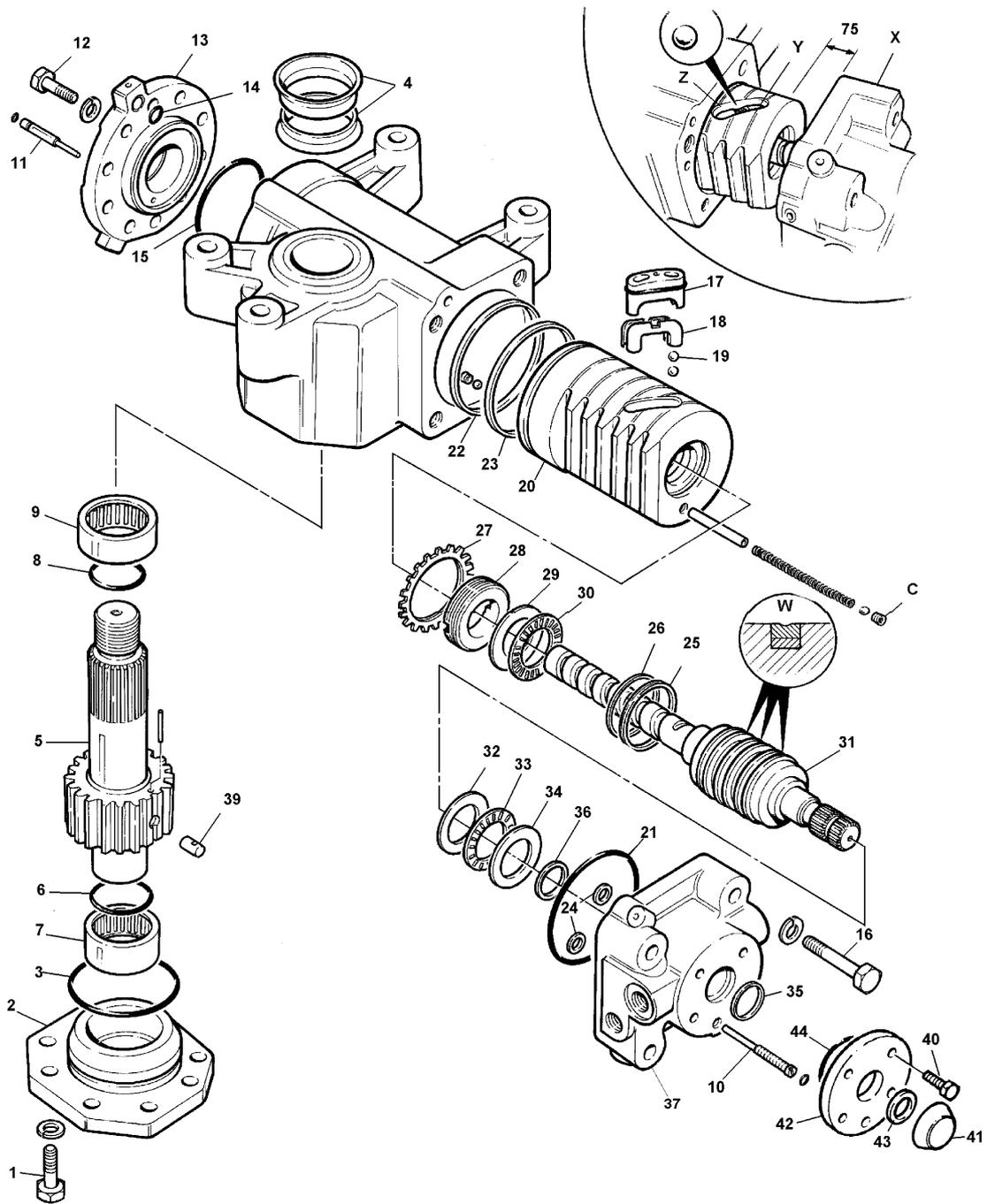


Fig 3.

S222451A-C1

Fitting the Input Shaft Nut and Star Nut

- 1 Ensure that the input shaft, thrust bearings and thrust washers are correctly installed in the positions shown on the assembly illustration. Using spanner **A**, part no. 892/00883, tighten the shaft nut 28 to 2.8-4.7 Nm (2-3 lbf ft).

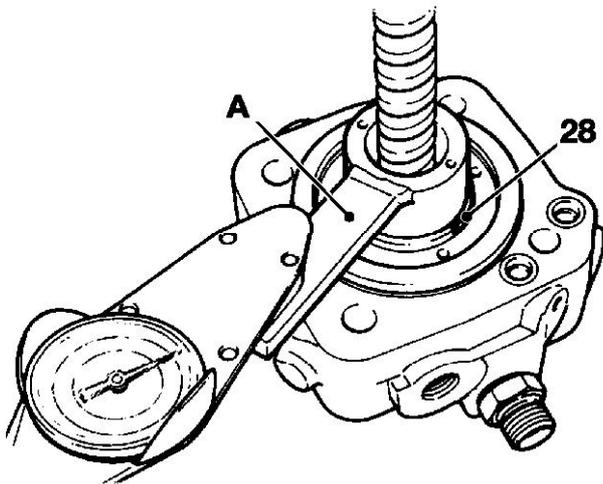


Fig 4.

222460-B1

- 2 Fit a new star nut 27. While preventing the shaft nut from turning using spanner **A**, tighten the star nut to 14-16 Nm (10-12 lbf ft) using spanner **B** (part no. 892/00884). Continue tightening the star nut until two of the tangs align with the two plain holes in the bearing cap as at **C**.

Note: Do not use the threaded hole in the bearing cap. This is for the lock limit screw.

Turn the bearing cap over in the vice. Rotate the splined end of the shaft using a torque meter and a suitable socket. The reading should be less than 2.8 Nm (2 lbf ft). If this figure is exceeded, re-check the torque on the shaft nut.

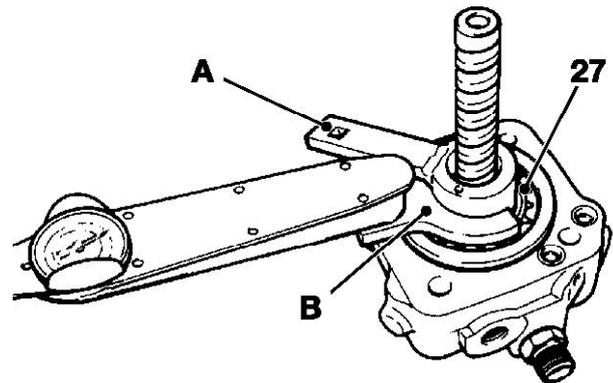


Fig 5.

222470-B1

- 3 Bend two tangs of the star nut into the two plain holes in the bearing cap as at **C**.

Stake the star nut into the shaft nut at the two notches **D**.

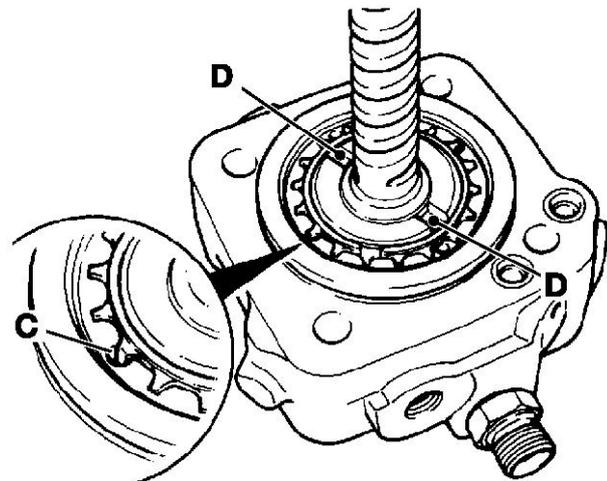


Fig 6.

222480-B1

Steering Shafts

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[⇒ Inspection \(□ H3-2\)](#)

[⇒ Universal Joints and Phasing \(□ H3-2\)](#)

[⇒ Intermediate Shafts and Bearings \(□ H3-2\)](#)

[⇒ Bulkhead Shaft \(□ H3-3\)](#)

Inspection

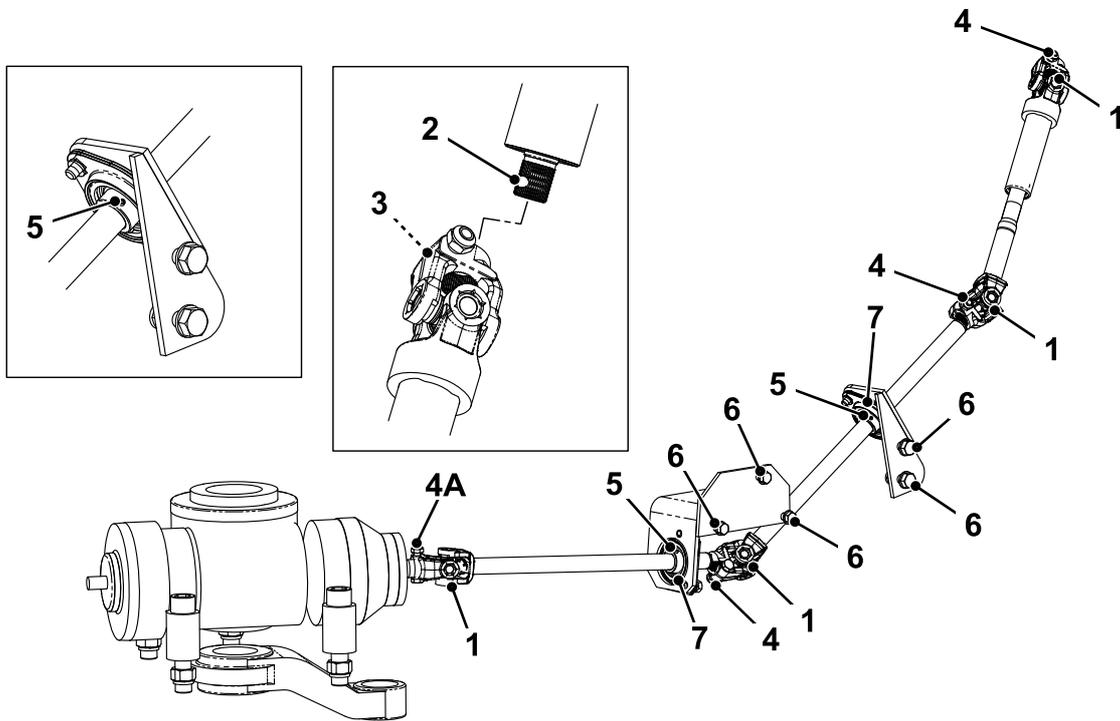


Fig 1.

C097110

Universal Joints and Phasing

Check for stiff (seized) or worn universal joints (UJ) **1** on the steering shafts. Make sure that the shafts are not rubbing against any other components, (for example hoses or pipework).

Note: It is important that high pressure water jets are not pointed at universal joints during cleaning. The universal joints have grease nipples which should be greased if steering becomes stiff or if a new shaft is fitted.

Shafts with worn or seized universal joints must be replaced.

The phasing of the shaft universal joints is fixed by means of location slots **2**. Align the shaft splines so that the universal joint clamp bolt holes **3** align with the slot in the shafts. The clamp bolts can not be installed if the phasing is not correct.

When installing shafts make sure bearing grub screws **5** are loose. Install and tighten the shaft universal clamp bolts **4** and bearing bracket support bolts **6**. Tighten the bearing grub screws **5** last.

Intermediate Shafts and Bearings

If the steering wheel does not turn smoothly inspect the bearings **7**. Check that the bearing has not seized.

If necessary remove the shafts together their bearings to help determine which bearing is defective.

Table 1. Torque Settings

Item	Nm	Kgf m	lbf ft
4	37	3.8	27
4A	75	7.6	55

Bulkhead Shaft

Replace the bulkhead shaft **1** if it is defective. The shaft bearings can not be replaced. Replace the sliding shaft **6** if the universal joints are defective.

- 1 Remove the dash board shroud.
- 2 Remove clamp bolt **5** and uncouple the sliding shaft **6**
- 3 Uncouple the sliding shaft at the opposite end of shaft assembly **1**.
- 4 Remove four bolts **2** and pull out the shaft assembly **1** from outside the cab.

Table 2. Torque Settings

Item	Nm	Kgf m	lbf ft
2	22.5	2.3	17
5	37	3.8	27

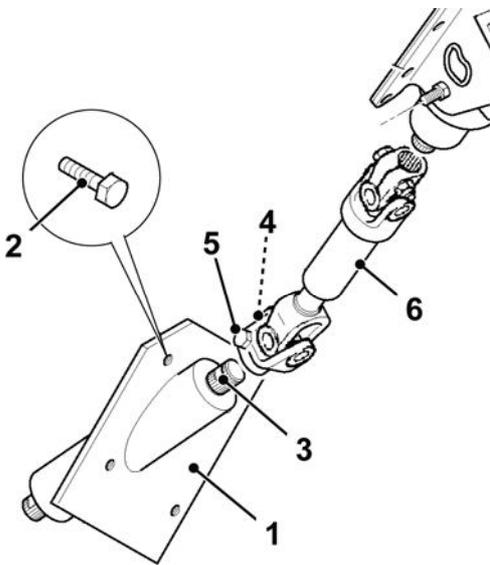


Fig 2.

C097140

When replacing:

- Seal the shaft plate **1** to the cab bulkhead with sealant DP2205.
- Align the shaft splines so that the universal joint clamp bolt hole aligns with the slot **3** in the shaft. The clamp bolt **5** can not be installed if the phasing is not correct.



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