Contents

Torque limit table

This tables indicates standard torque limits in Nm for the various screw and bolt qualities and dimensions. The torques are valid for screws on the outside of the components.

Quality class: Dimension	8.8 M (Nm)	10.9 M (Nm)	12.9 M (Nm)
M 8	24	33	40
M 10	47	65	79
M 12	81	114	136
M 14	128	181	217
M 16	197	277	333
M 18	275	386	463
M 20	385	541	649
M 22	518	728	874
M 24	665	935	1120
M 27	961	1350	1620
M 30	1310	1840	2210
M 33	1770	2480	2980
M 36	2280	3210	3850

Quality class: Dimension	8.8 M (Nm)	10.9 M (Nm)	12.9 M (Nm)
3/8" UNC	38	54	68
7/16" UNC	61	87	108
1/2" UNC	93	131	163
9/16" UNC	133	187	234
5/8" UNC	183	259	323
3/4" UNC	322	455	568
7/8" UNC	516	729	909
1" UNC	772	1090	1360
1 1/8" UNC	1090	1550	1930
1 1/4" UNC	1530	2160	2690
1 3/8" UNC	2020	2850	3550
1 1/2" UNC	2650	3750	4680

Quality class: Dimension	8.8 M (Nm)	10.9 M (Nm)	12.9 M (Nm)
M 8 x 1	25	35	42
M 10 x 1,25	48	68	81
M 10 x 1	49	70	84
M 12 x 1,5	83	117	140
M 12 x 1,25	85	120	144
M 14 x 1,5	135	190	288
M 16 x 1,5	204	287	344
M 18 x 1,5	294	413	496
M 20 x 1,5	408	574	688
M 22 x 1,5	546	768	921
M 24 x 2	696	979	1170
M 27 x 2	1000	1410	1690
M 30 x 2	1390	1950	2340
M 33 x 2	1860	2610	3130
M 36 x 2	2350	3310	3970

Quality class: Dimension	8.8 M (Nm)	10.9 M (Nm)	12.9 M (Nm)
3/8" UNF	41	59	73
7/16" UNF	66	93	115
1/2" UNF	99	141	175
9/16" UNF	142	201	250
5/8" UNF	197	279	347
3/4" UNF	344	486	606
7/8" UNF	547	772	963
1" UNF	814	1150	1430
1 1/8" UNF	1170	1660	2060
1 1/4" UNF	1620	2290	2850
1 3/8" UNF	2170	3070	3820
1 1/2" UNF	2840	4000	5000

Bolt quality marking

Strength marking on screws consists of two numerals that may be separated by a point (.). The numerals indicate tensile and yield limits of material in N/mm².

- Numeral 1 denotes a hundredths of the tensile limit in N/mm².
- Numeral 1 x numeral 2 denotes a tenth of the yield limit in N/mm².

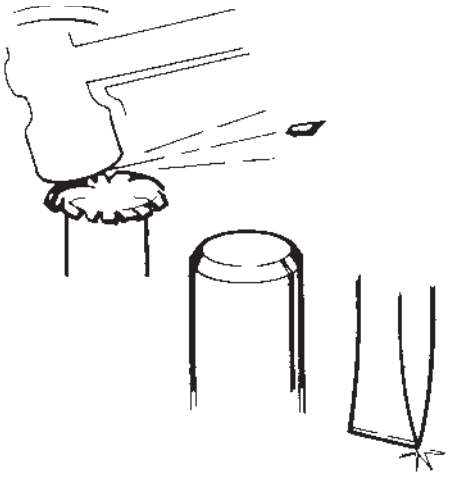
A bolt designated 8.8 thus has tensile limit 800 N/mm² and yield limit 640 N/mm².

Nut quality marking

The designation for nuts consists of one numeral. The numeral denotes that the nut is of equal strength to a bolt with the same first number.
A nut of strength class 8 is thus equally strong to a bolt of class 8.8.

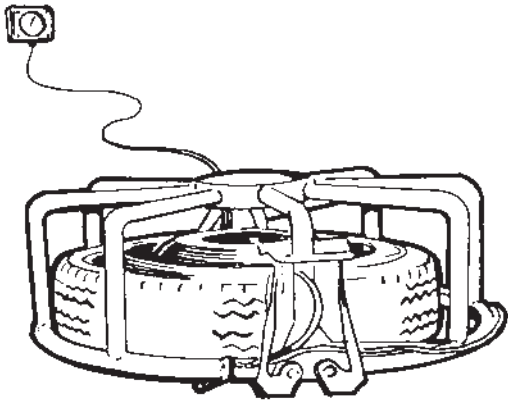
Splinters, flying object When using certain tools

RISKS	PROTECTIVE MEASURES
Burr loosens from drift or chisel.	* Check tools * Grind where necessary
Hammer head loosens from handle.	* Check * Repair or change
Saw jabs or wobbles.	* Keep the supporting hand away from underside of saw
Flying objects when machining (e.g grinding machine, cutting disc, lathe).	* Use protective screen or goggles



When working with tires and wheels

RISKS	PROTECTIVE MEASURES
Removal of tyres: Wheels, rims, lock rings fly off.	* Deflate tyres first of all
Fitting of tyres	* Check that tyres, rims and lock rings are intact. Never repair a damaged ring or lock ring
Inflating tyres: Wheels, rims, lock rings fly off	* Place wheel in protective cage * Tighten inflation hose on tyre valve with tensioner * Step back from the tyre with the pressure gauge during inflation. * Check at the latest by 40 psi (3.bar) that the lock ring is properly lodged
Machine scrubbing, turning: Flyying splinters	* Use protective screen or goggles



Cylinder head - PDE System Tier2

Cylinder head, parts view. PDE Tier2

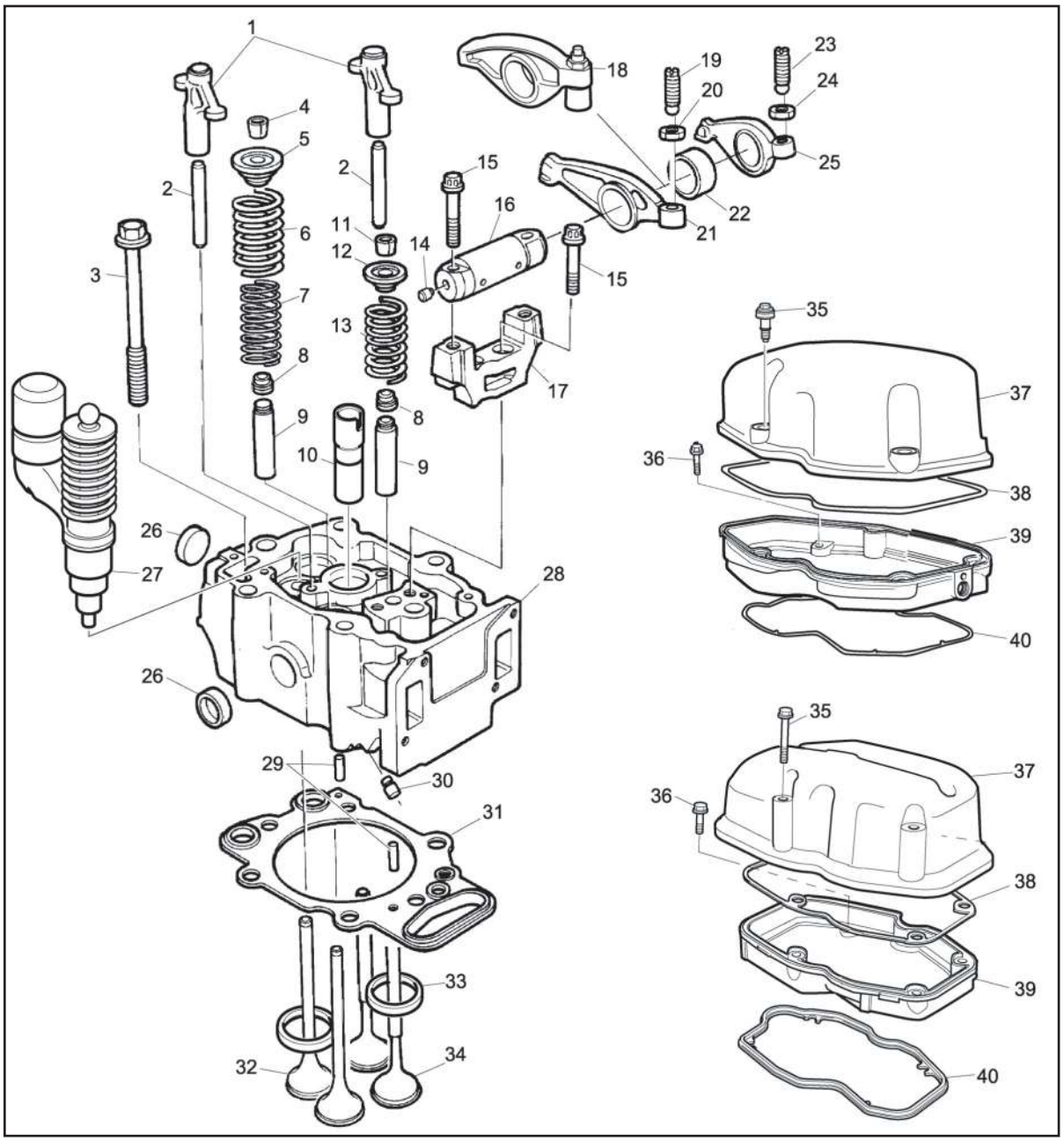


Figure 37

1. Valve bridge
2. Pin
3. Bolt
4. Collet
5. Valve spring collar
6. Valve spring
7. Valve spring
8. Valve stem seal
9. Valve guide
10. Socket
11. Collet
12. Valve spring collar
13. Valve spring
14. Rivet plug
15. Tight-fit screw
16. Shaft
17. Bearing bracket
18. Rocker arm for unit injector
19. Adjusting screw
20. Hexagon nut
21. Rocker arm
22. Spacing sleeve (injection pump)
23. Adjusting screw
24. Hexagon nut
25. Rocker arm
26. Core plug
27. Unit injector
28. Cylinder head
29. Pin
30. Rivet plug
31. Gasket
32. Exhaust valve
33. Valve seat insert
34. Intake valve
35. Flange bolt
36. Flange bolt
37. Rocker cover, upper section
38. Rocker cover gasket
39. Rocker cover, lower section
40. Rocker cover gasket

Connecting rods

The connecting rod and big-end cap consist of a single casting which is split during the machining operation.

To prevent the big-end cap from being displaced in relation to the connecting rod, the contact surfaces are provided with grooves and guide pins. The surfaces are machined together to ensure a precise and accurate fit. The parts are also marked so that they can always be fitted in the same position.

The connecting rod and big-end cap are split obliquely, partly so that the con rod bolts will not be subjected to excessive loads and partly to enable the piston and con rod to be withdrawn through the cylinder.

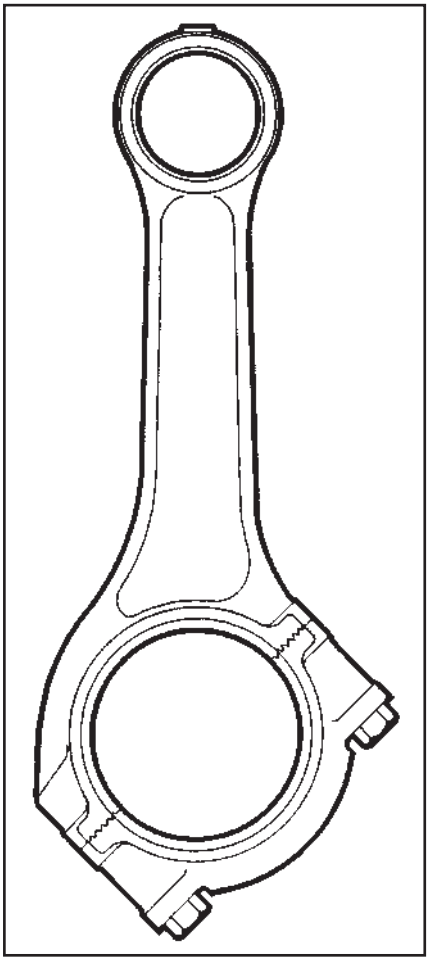


Figure 101

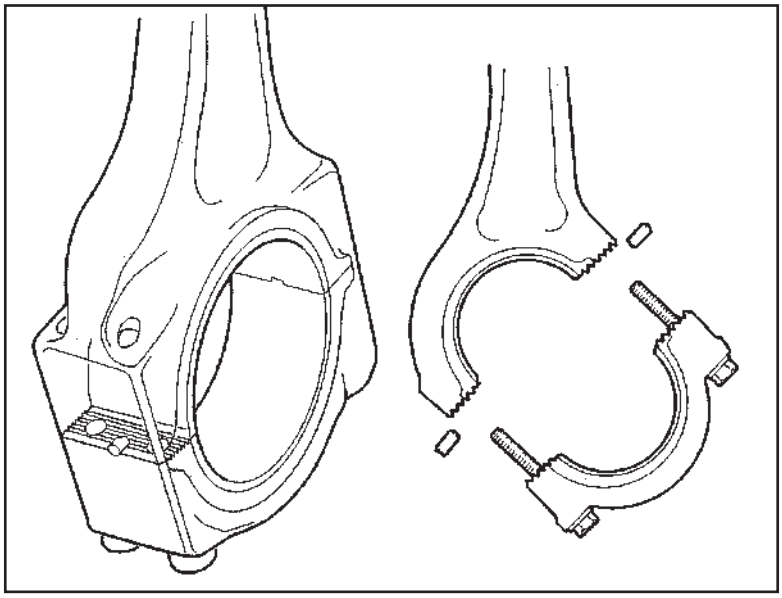


Figure 102

Connecting rod cap: Torx 50Nm + 90°

The upper part of the connecting rod is wedge shaped. This allows a larger journal surface on the underside of the gudgeon pin where load is greatest during combustion.

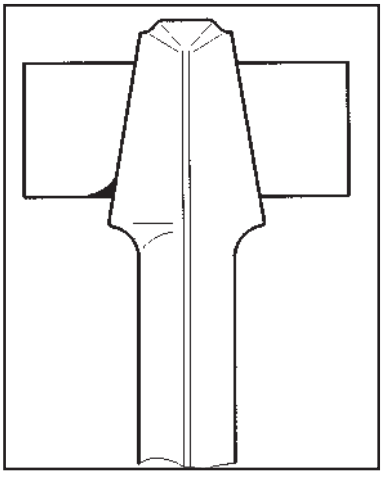


Figure 103

Oil mist separator exploded view

The oil mist separator is driven by oil from the lubrication system. The oil flows into the oil mist separator and is sprayed onto the turbine located on the rotor shaft. The oil then flows out and back to the oil sump.

The rotor consists of a number of tapered plastic plates which are located on top of one another. There is a space for the crankcase gases and oil particles between each plate.

The crankcase gases and oil particles flow into the oil mist separator through the union in the top of the oil mist separator housing. The oil particles stick to the rotating plates and the centrifugal force causes the oil particles to be thrown against the wall of the oil mist separator housing. The oil which has been separated from the crankcase gases runs down along the walls of the oil mist separator housing and then flows out of the oil mist separator via the centrifugal oil cleaner to the oil sump. The centrifugal oil cleaner contains an oil trap. The oil trap is there so that oil from the oil sump is not drawn in the wrong direction.

The cleaned crankcase gases flow out of the oil mist separator via a diaphragm which acts as a pressure regulator. When the vacuum downstream of the oil mist separator is too great, the diaphragm will close the opening until the pressure has risen again.
The oil mist separator does not normally need to be dismantled for cleaning.

NOTE

Remove the oil mist separator from the engine before it is dismantled.

1 Oil mist separator housing (different version for closed crankcase ventilation)
2 O-ring
3 Nipple
4 Heat shield
5 Screw
6 Diaphragm (not used on oil mist separator for closed crankcase ventilation)
7 Diaphragm spring (not used on oil mist separator for closed crankcase ventilation)
8 Cover (different version for closed crankcase ventilation)
9 O-ring
10 Nipple (not used on oil mist separator for closed crankcase ventilation)
11 Screw
12 Screw (not used on oil mist separator for closed crankcase ventilation)
13 Upper bearing retainer
14 Screw
15 Retaining ring
16 Spring
17 Separator
18 Washer
19 Retaining ring
20 O-ring
21 Insert
22 Lower bearing retainer
23 Turbine
24 Retaining ring
25 O-ring
26 O-ring
27 Turbine housing
28 Washer
29 Straight nipple

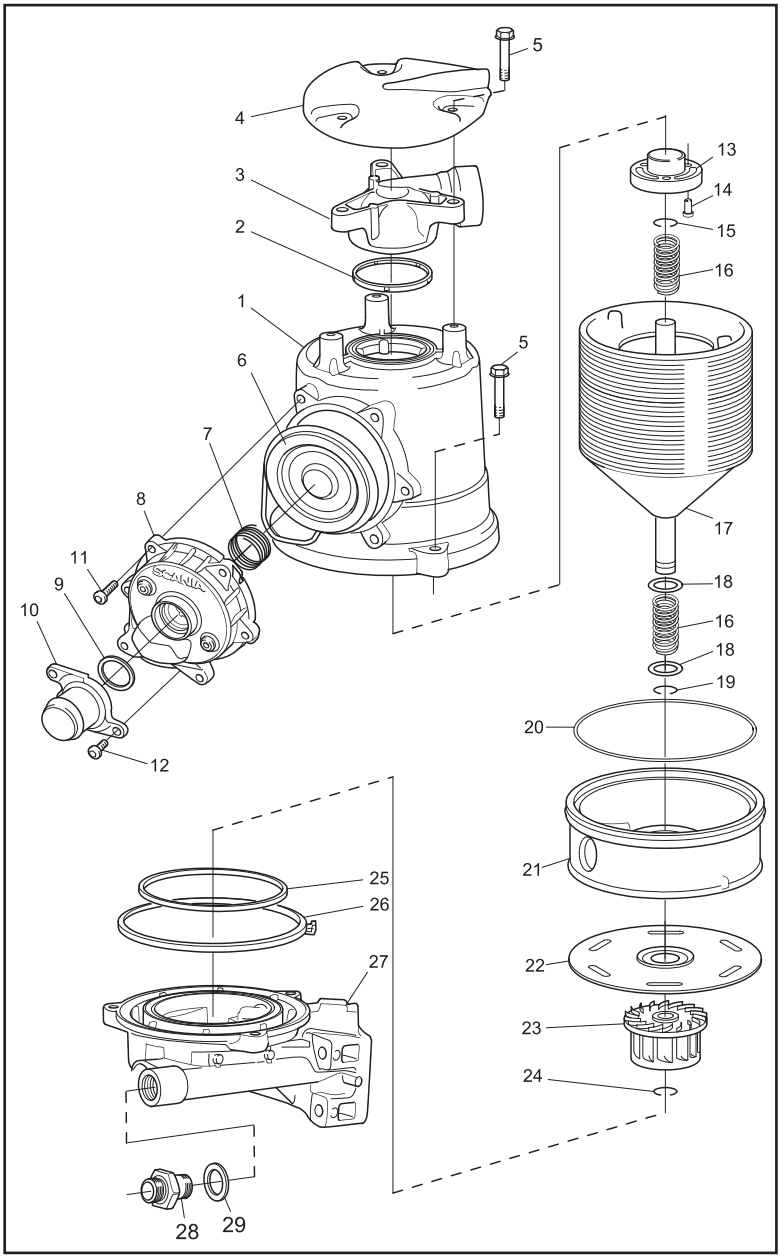


Figure 244

Vibration when the clutch or reverse gear is engaged

Effect	Cause	Trouble shooting	Action
	Imbalance in driven unit		- Balance the unit
	Imbalance in clutch		
	Inadequate alignment between engine and driven unit	Check alignment	- Carry out alignment more accurately
	Unsuitable suspension of engine or driven unit		
	Weak engine bed	Movement at attachment points	- Reinforce the engine bed
	Defective flexible coupling between clutch/reverse gear and driven unit		- Change rubber element in flexible coupling (consumption item)
	Unsuitably mounted propeller shaft, e.g. excessive deflection angle or excessive deviation in parallelism between flanges		- Reposition the engine or driven unit so that the propeller shaft's working range is in accordance with recommendations
	Propeller shaft too long and weak		

Vibration when alternator is in operation

Effect	Cause	Trouble shooting	Action
	Imbalance in generator		
	Imbalance in coupling	Dismantle the coupling. Assemble the coupling halves rotated half a turn relative to each other	
	Bearing damage in alternator		
	Defective flexible coupling between engine and alternator		- Change the rubber element or type of coupling
	Fault in reduction gear		

Turbocharger

The purpose of the turbocharger is to increase the volume of air entering the engine's cylinders. With more air the engine can burn more fuel and so develop more power and achieve cleaner combustion than a corresponding engine without supercharging.

The turbocharger is driven by the engine's exhaust gases and consists of a turbine part and a compressor part. The compressor part compresses the engine's intake air.

The compressor wheel is mounted on the same shaft as the turbine wheel. This shaft runs in a bearing housing between the compressor and turbine.

Higher power output from the engine gives more exhaust fumes and the increased exhaust means that the turbine wheel and therefore the compressor wheel rotate faster. In this way, the quantity of air is adapted to engine requirements without any special control devices.

The turbocharger wheel rotates extremely fast. At full power, speed is about 100,000 rpm. At the same time, the temperature on the exhaust side of the turbine wheel is above 600°C.

This makes big demands on the rotating parts in regard to balance, cooling and lubrication.

The shaft is mounted in two bushings which rotate freely in the bearing housing. The bearing housing seals for the turbine and compressor consist of seals which are similar to piston rings.

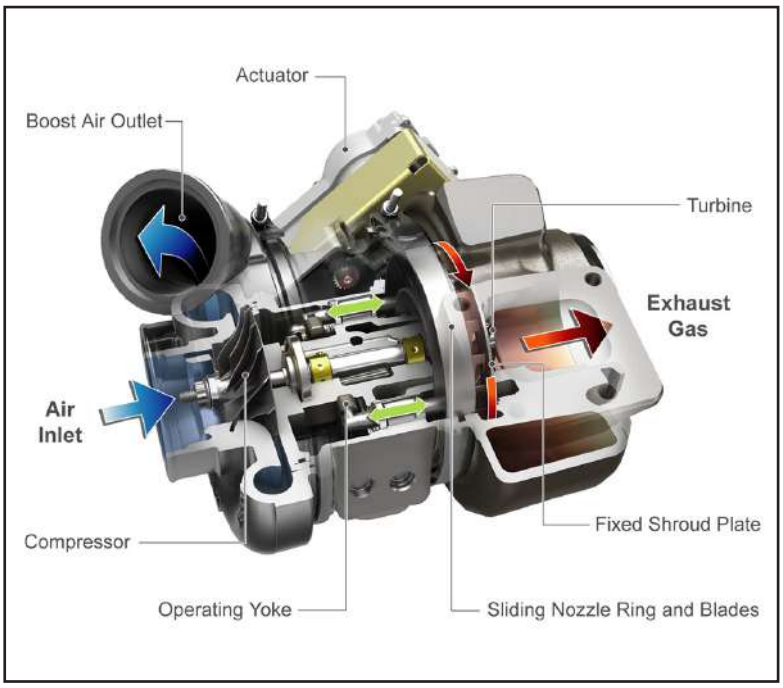


Figure 85

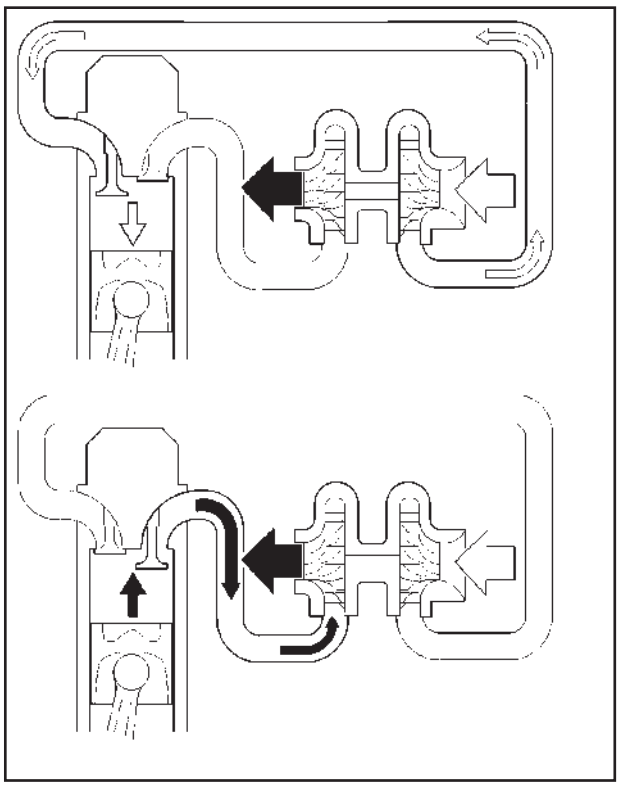


Figure 86

Renewal - bearing and carbon brushes

Specification	Bosch 100 A
Designation	NCB2 28V 40/100A
Output power at 6000 rpm	2800 W
Resistance in rotor	8.5 ohm +/- 5%
Brush length	>1 mm

Engine speed (rpm):	Bosh 100A
500	40
600	60
800	80
1500	100

Max alternator current at an alternator temperature of 20-25 °C

1. Remove the cover washers for the carbon brushes.

Remove the screws holding the carbon brushes.

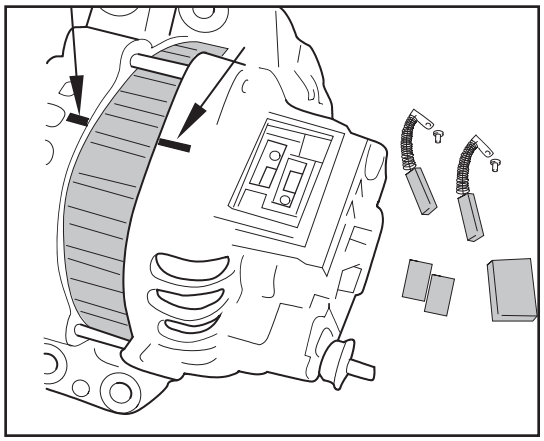


Figure 256

Important!

Mark the front housing against the rear housing to make it easier when assembly the housings.

2. Remove the nut and pulley. The Nut should be tightened with a force of 139Nm on assembly.

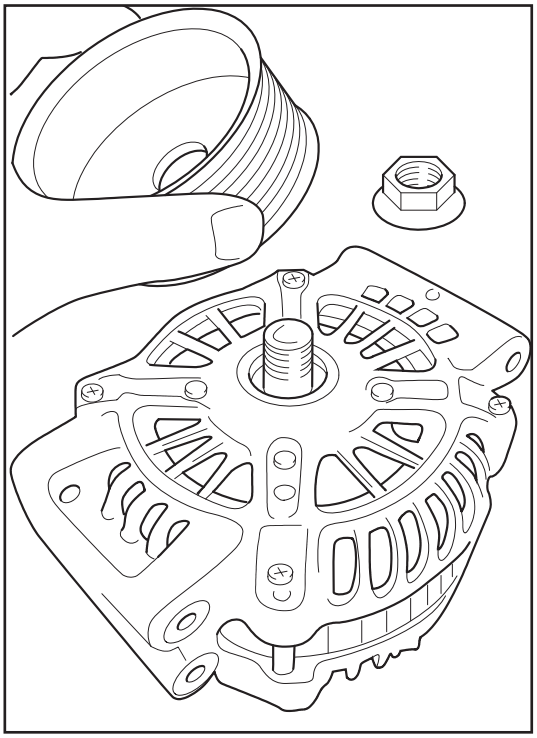


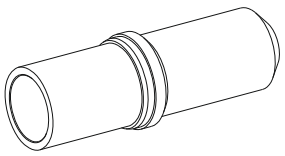
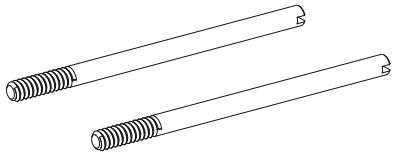
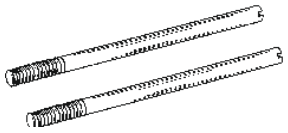
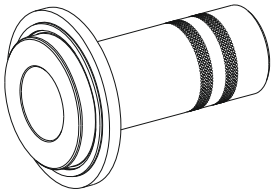
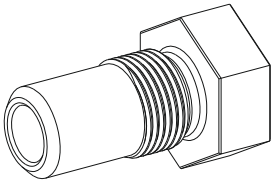
Figure 257

Low oil pressure

Effect	Cause	Trouble shooting	Action
Gauge shows low pressure	Defective sensor/instrument	Take a reading of the oil pressure on warmed-up engine using a mechanical pressure gauge directly on the engine: Minimum 1 bar at 800 r/min. Maximum 6 bar > 800 r/min. Obs! Single-speed engines must not be tested at 800 r/min. Risk of damage to the flexible coupling	
	Incorrectly adjusted oil relief valve		- 1 shim = 0.2 bar (screw adjustment on 14-series engines)
	Broken spring in oil relief valve (14-series engines, earlier version)	Max. oil pressure 2 bar at 2000 r/min	- Check/remedy relief valve
	The piston in the oil relief valve has jammed in open position		
Gauge shows low pressure	Loosened guide plates in the oil cooler prevent passage of the oil		
	Worn/damaged oil pump		
	Plug in cylinder block under the relief valve has come loose (11-series engine)		
	Clogged oil cooler		
	Seized/worn bearings in compressed air compressor, see Compressed air sys.	Pressure varies when compressor charges/ relieves	
	Loose screws in timing gear's intermediate gear		
	Crankshaft bearing/main bearing of wrong size has been fitted on reground crankshaft	Max. oil pressure 2 bar also when engine cold	- Change to bearings of the correct size. Check the bearing seats before assembly
	Excessive play in big-end and main bearings		
	Seizing in camshaft bearings	If the bushing slides all the way out of the bearing seat, the oil pressure warning lamp will come on. The engine throws out oil through the crank case ventilation	

Continuation next page

Specjal tools for disassembly and reassembly
ZF - Ergopower

Cons. No.	Figure	Designation Order no.	Qty.
41		Driver tool 850317-00089	1
42		Adjusting screw 120702-00081	1
43		Adjusting screw 120702-00082	1
44		Driver tool 850317-00090	1
45		Pressure piece 850317-00091	1

Remove the gear (1) and disengage the snap ring (2).

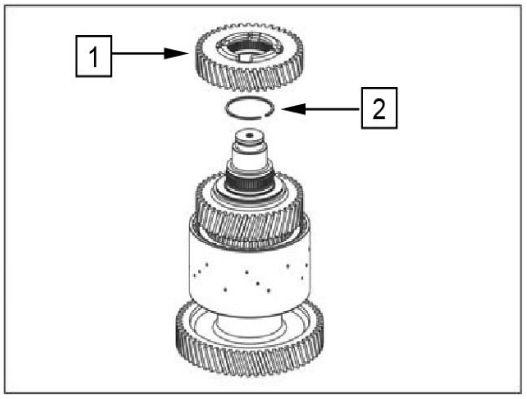


Figure 239

Remove the single parts.

1 = Axial bearing cpl.
*Axial washers
*Axial bearing
2 = Idler
3 = Needle cage
4 = Axial bearing cpl.
*Axial washer
*Axial bearing
*Running disk

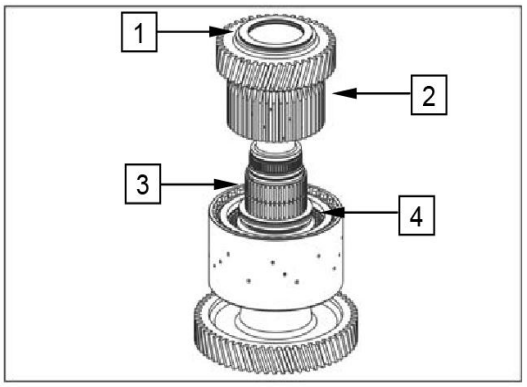


Figure 240

Gear

Pull the bearing inner ring off the shaft.

(S) Grab sleeve 850317-00081

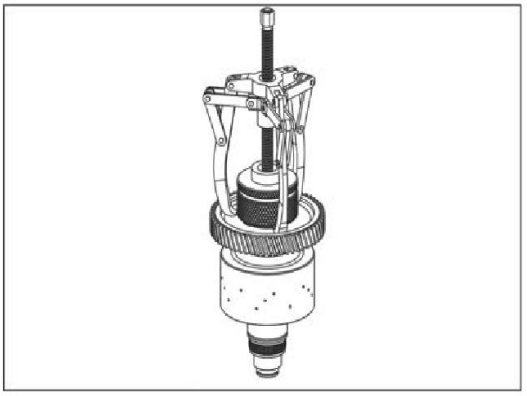


Figure 241

Remove the snap ring Fig. 246.

On the 4 assembly openings of the gear press the snap ring with a screwdriver flush into the annular groove of the shaft (see arrows Figure 243) and pull off the gear by means of the 3-armed puller at the same time.

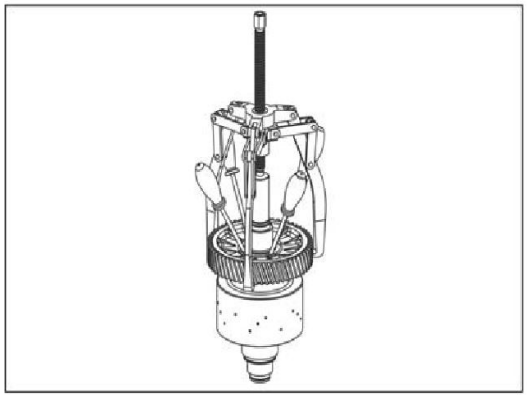


Figure 242

Place slip bushing (S) onto the output shaft.

Assemble cup spring set (1) and L-ring (2).

Installation position of L-ring and cup spring set see Figure 546.

(S2) Slip bushing, see Figure 546.

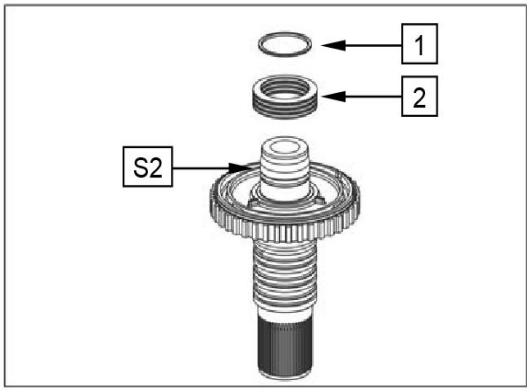


Figure 546

Preload the compression spring by means of assembly aid (S1) and pressure piece (S2) until the L-ring has engaged into the annular groove.

(S1) Assembly aid 860103-01494
(S2) Assembly fixture 850317-00087
(Slip bushing and pressure piece)

CAUTION

Generally, a new L-ring has to be installed!

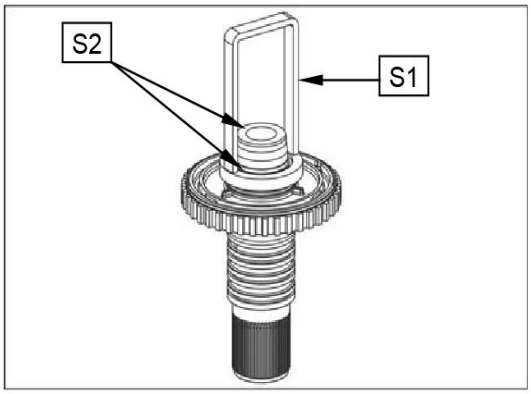


Figure 547

Install the needle sleeve 50x58x20 (1) by means of the pressure piece and oil it.

NOTE

The exact installation position is only obtained when using the specified pressure piece (S)!

(S) Pressure piece 850317-00073

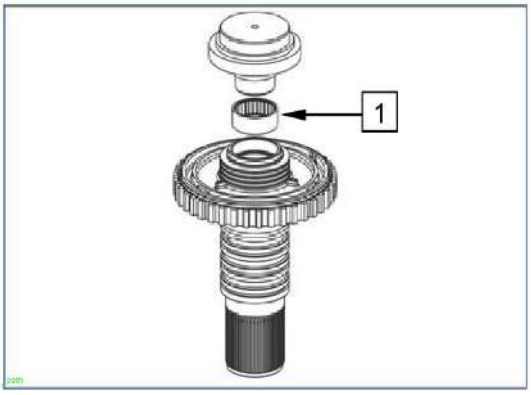


Figure 548

Fasten the needle sleeve with snap ring SB 58 (1).

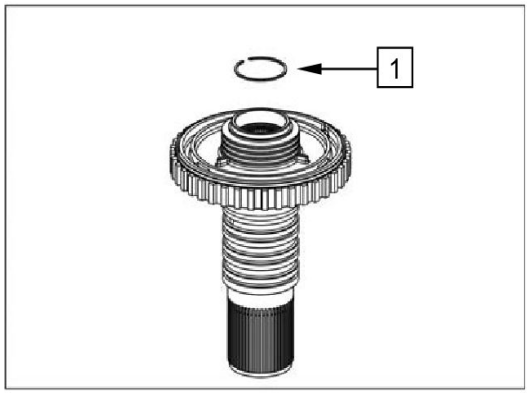


Figure 549

1. Apply LOCTITE 262 to the breather (contact surface with housing).
2. Insert the breather (1) flush with the housing in the direction of the arrow.

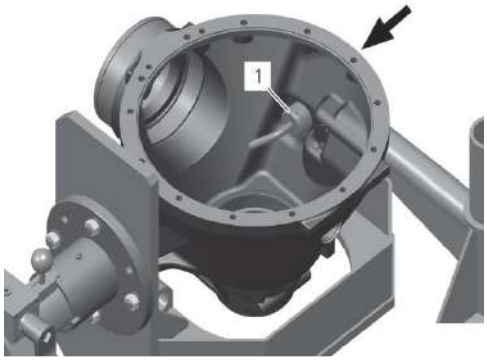


Figure 794

Installing input

Installing disk for contact pattern.

1. Insert shim (1) with e. g. s = 1.0 mm into bearing hole.

When dismantling use disassembled shims. Replace damaged shims by new shims with identical thickness.

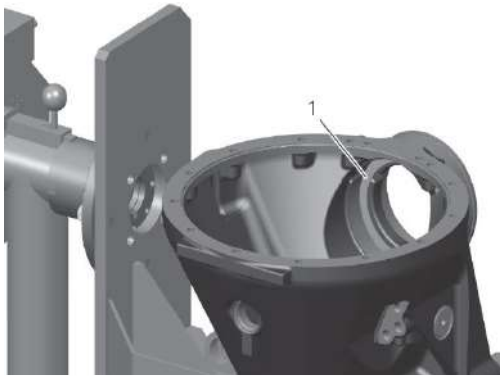


Figure 795

WARNING

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. Wear protective gloves.

2. Heat bearing hole.
3. Insert bearing outer ring (1) in the housing hole until contact is obtained.

Figure 796

WARNING

Risk of burn injuries due to contact with hot surfaces. Slight or moderate injury possible. Wear protective gloves.

4. Heat bearing hole.
5. Insert bearing outer ring (1) in the housing hole until contact is obtained.

Figure 797

Disc

WARNING

You must always replace a damaged disc.

1. When you inspect the brakes, inspect both sides and the outer diameter of the disc for the following conditions:

   - Cracks
   - Heat checking
   - Grooves or scoring
   - Blue marks or bands

2. When you reline the brakes, you must measure the thickness of the disc.

Cracks
When a crack extends deep into a section of the disc, replace the disc.
See (Figure 124).

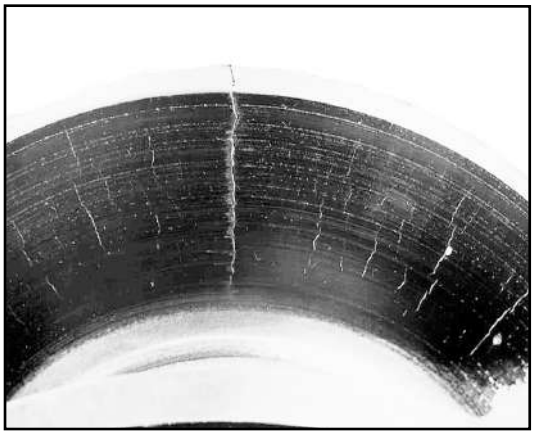


Figure 124

Heat checking
Heat checks are cracks in the surface of the disc caused by heat. Heat checking can be light or heavy.

Light heat checking
Light heat checking is very fine, tight, small cracks. Light heat checking is normal.
You can continue to use a disc with light heat checking.

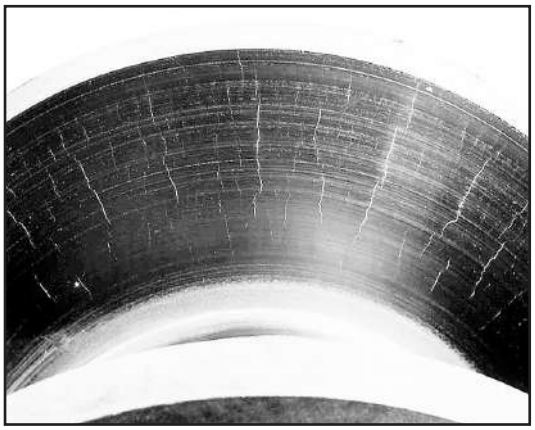


Figure 125

Heavy heat checking
Heavy heat checking is surface cracks with width and depth.
See (Figure 125).
If you find heavy heat checking,
always replace the disc.

Deep grooves or scores
Check both sides of the disc for deep grooves or scores. If the grooves or scores are not too deep, you can continue to use the disc. See (Figure 126).

Figure 126

Blue marks or bands
Blue marks or bands indicate that the disc was very hot.
If blue marks or bands are present, refer to Section 6 to find and correct the cause of the problem.
See (Figure 127).

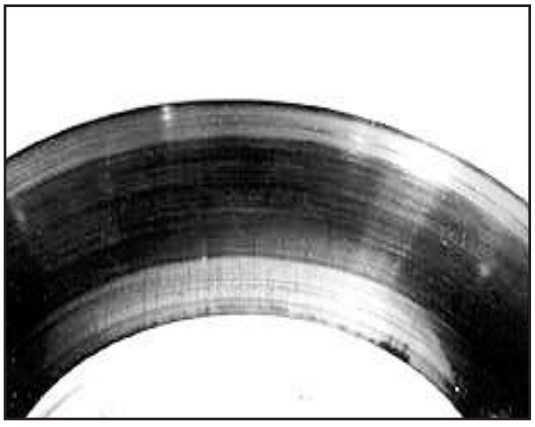


Figure 127