



WORKSHOP MANUAL

SISUDIESEL

320

420

620

8366 40634

634

PARTEK

Sisudiesel

320, 420, 620, 634

engines

Workshop Manual

0909

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**Sisu Diesel Inc. takes no responsibility for any damages caused
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TO THE USER

This Workshop Manual is intended to facilitate workshop operations and repair work.

320, 420, 620 and 634–engines are mainly the same in construction, so the same repair instructions usually apply to different engine types. The differences between the various engine types which affect repair work have been mentioned in technical data and repair instructions. All measurements are in millimetres and valid when the temperature of the parts is +20°C, unless otherwise stated.

Before starting the repair work read the safety instructions in the beginning of this book. Make sure that you have all necessary tools, parts and accessories at your disposal. The special tools mentioned in the work instructions are not all essential, but they speed up and facilitate the work and contribute to successful execution of work. An engine which has undergone repairs must be run in just like a new one.

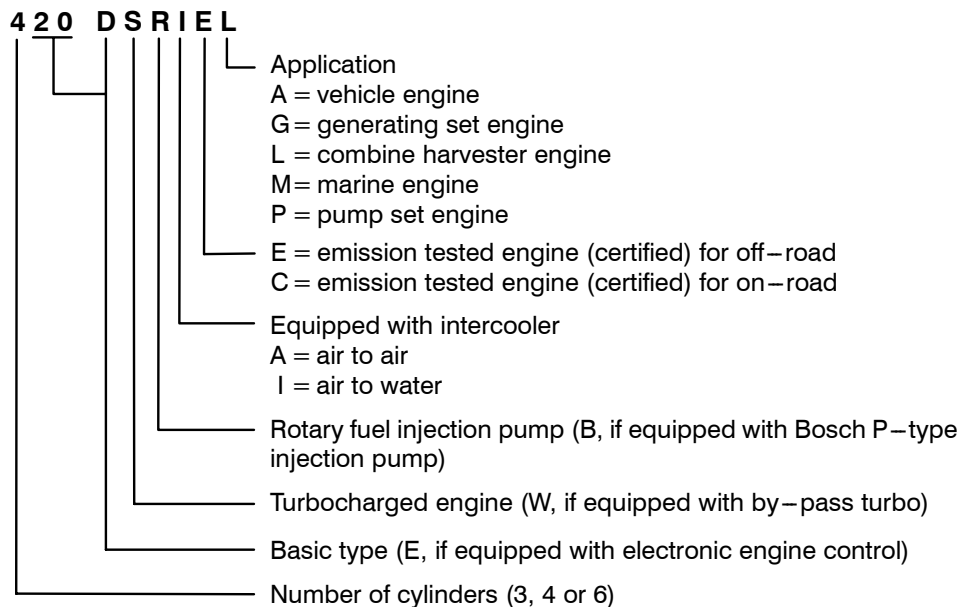
Should the engine require measures not described in this manual, please consult your local agent or the Service Department of Sisu Diesel Inc., Linnavuori, Finland. To facilitate consulting, find out the following facts about the engine before contacting us:

- engine type
- engine number
- application or equipment
- hours operated or kilometres driven.

In this Workshop Manual the regular service procedure is not handled as this is explained in the 20/34–series Operator's Manual.

As Sisu Diesel Inc. is continuously developing the products, all rights are reserved without separate notice to change the adjustments, accessories and service– and repair procedure.

ENGINE TYPE DESIGNATIONS



SAFETY INSTRUCTIONS



In the service – and repair work of the engine there is always the possibility of injury. Before starting the work read and understand the following safety instructions and remarks!



Do not start a repair work that you do not fully handle.



Make sure that the place of the repair and the surrounding gives the possibility for safe working.



Always be sure of the cleanness and the good order of the repairing place.



Do not use faulty or otherwise useless tools.



Remove all finger rings, chains and watch before starting work.



Use up-to-date protection equipment when you work. For example eye protection as working with compressed air for cleaning, grinding, hammering or other work.



Use lifting device for lifting and transporting heavy (over 20 kg) pieces. make sure of good condition of lifting hooks and chains. The lifting ears on the engine must not be applied by side forces when lifting.



Never work under an engine that is left handling under a lifting device or lifted up by a jack. Always use strong supports before starting the work.



Use only genuine **Sisudiesel** spare parts.



Start the engine only by using the starting switch in the cabin.



Do not start an engine if the protection covers are removed. **NOTE!** The fan is difficult to see as the engine is running! Make sure that wide clothes or long hair is not caught in the rotating parts of the engine.



If you start the engine indoors, be sure you have proper ventilation.



Never use aerosol type of starting aid while operating the thermostart device (risk for explosion).



When you are operating the engine or working near it, use hearing protectors to avoid noise injuries.



Stop the engine always before service – or repair work.



Avoid touching the exhaust manifold, turbocharger and the other hot parts of the engine.



Open the radiator cap with care when the engine is hot as the cooling system is pressurised. The cooling liquid and lubrication oil of a hot engine causes injuries when touching the skin.



Open fire, smoking and sparks should not be allowed near the fuel system and batteries. (Specially when loading batteries, explosive.)



Always disconnect the minus (–) wire of the battery when doing service or repair of the electric system.



At temperatures on excess of 300°C, e.g. if the engine is burnt by a fire, the viton seals of the engine (e.g. the undermost o – ring of the oil pressure regulating valve) produce very highly corrosive hydrofluoric acid. Do not touch with bare hands, viton seals subjected to abnormally high temperatures. Always use neoprene rubber or heavy duty gloves and safety glasses when decontaminating. Wash the seals and the contaminated area with a 10% calcium hydroxide or other alkali solution. Put all removed material in sealed plastic bags and deliver them to the point stated by the Authorities concerned. **NOTE!** Never destroy viton – seals by burning!



When checking fuel injectors do not let the jet of high pressure fuel contact your skin. The fuel penetrates the skin causing severe injuries. Contact your doctor immediately!



The fuel, lubricating oil and coolant cause irritation in skin contact for long time.



Avoid unnecessary idling of the engine.



Do not let oil and other liquids drop into the soil when servicing the engine.



All the gaskets of the engine are of non – asbestos material.



Be careful when washing the engine with a high pressure washing machine. Do not use high pressure to wash e.g. the electric and fuel equipment or the radiator because they can easily be damaged.

ENGINE SPECIFICATIONS

Engine type	320D	320DS	420D	420DS	420DW	420DWI	620D	620DS	634DS
Number of cylinders	3	3	4	4	4	4	6	6	6
Displacement (dm ³)	3,3	3,3	4,4	4,4	4,4	4,4	6,6	6,6	7,4
Cylinder bore (mm)	108	108	108	108	108	108	108	108	108
Stroke (mm)	120	120	120	120	120	120	120	120	134
Compression ratio				16,5/18,5:1					
Combustion				direct injection					
Firing order	1-2-3			1-2-4-3			1-5-3-6-2-4		
Compression pressure bar ¹				24					
Weight kg ²	275	280	335	340	340	345	500	510	515
Direction of rotation from the engine front				clockwise					

¹) Minimum value at operating temperature and starting revs. Max permitted difference between cylinders 3,0 bar.

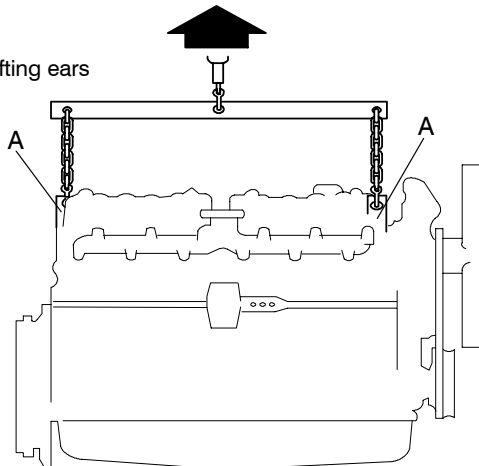
²) Without flywheel and electrical equipment.

LIFTING THE ENGINE

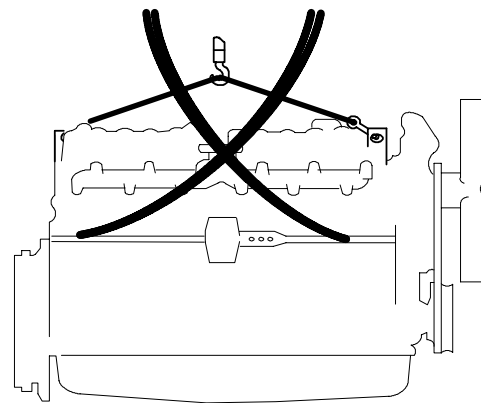
Safe lifting of the engine is done with a lifting device where the lifting force effects the lifting ears vertically.



A = Engine lifting ears



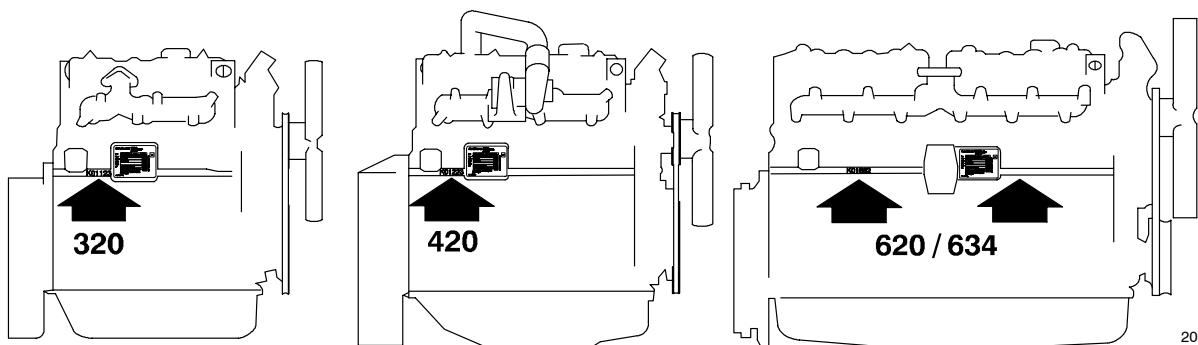
20-4



20-5

Engine weight: see Engine Specifications

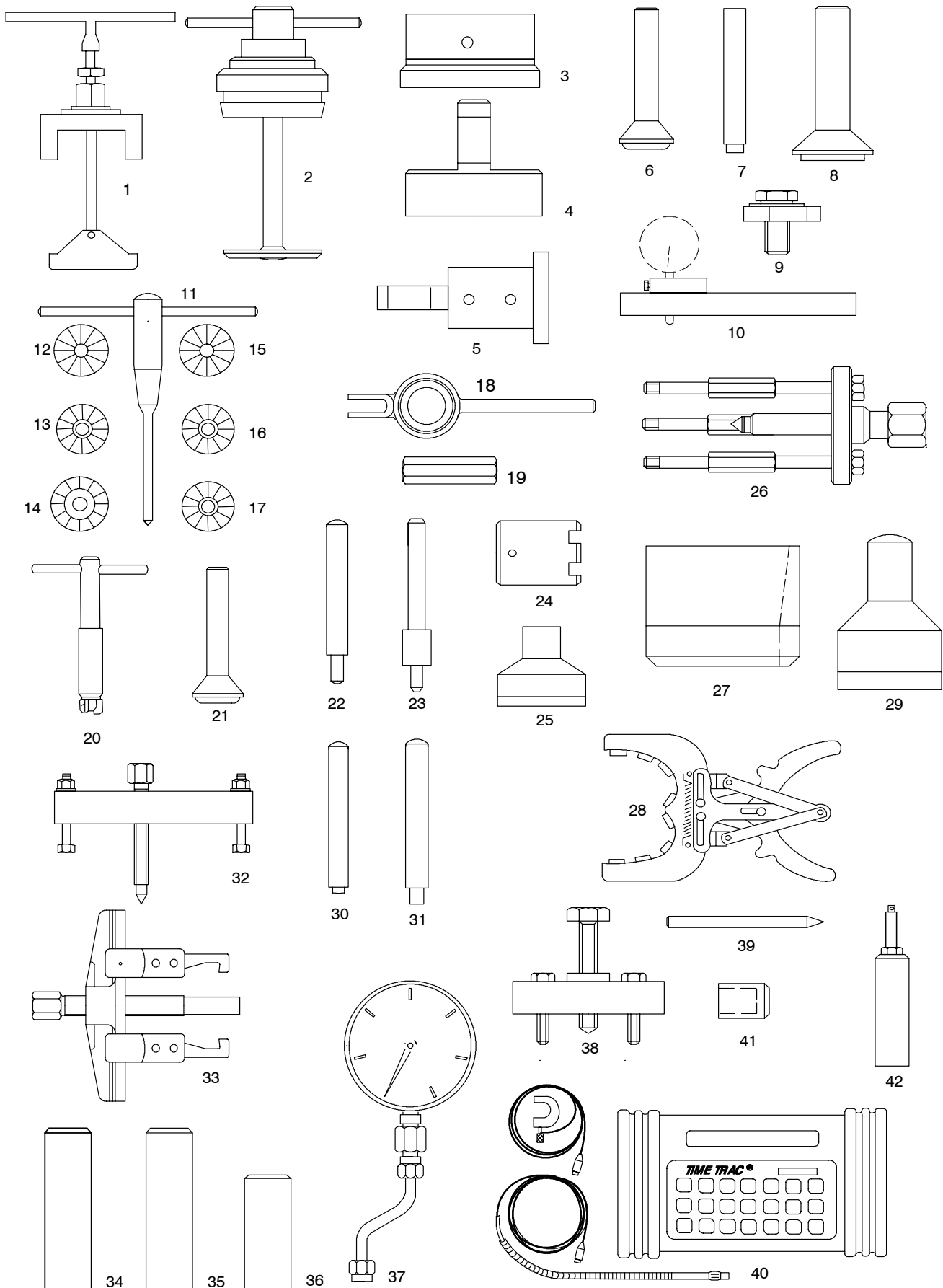
LOCATION OF THE ENGINE SERIAL NO.



20-1

SPECIAL TOOLS

	Order no	Description
1	9051 73100	Puller for cylinder liner
2	9101 65600	Milling cutter for cylinder liner seat
	9045 87600	Spare cutting blade for milling cutter
3	9052 46400	Centring tool for flywheel housing
4	9052 46300	Drift for fitting rear crankshaft seal
5	9030 15200	Drift for fitting front crankshaft seal
6	9052 46620	Drift for 40 mm cup plug
7	9052 46650	Drift for 16 mm cup plug
8	9025 87400	Drift for fitting camshaft cup plug
9	9101 66300	Press tool for cylinder liner
10	9025 79200	Holder for dial gauge
11	9101 66100	T-handle for valve seat milling cutter
12	9101 71100	Milling cutter for facing exhaust valve seat
13	9101 65502	Milling cutter for exhaust valve seat
14	9101 65503	Inner milling cutter for exhaust valve seat
15	9101 75800	Milling cutter for facing inlet valve seat
16	9101 65505	Milling cutter for inlet valve seat
17	9101 65506	Inner milling cutter for inlet valve seat
18	9101 66200	Lever for compressing valve spring
19	9052 47200	Counter nut for lever above
20	9101 66000	Milling tool for injector seat
21	9052 46660	Drift for 36 mm cup plug
22	9101 65800	Drift for removing valve guide
23	9101 65900	Drift for fitting valve guide
24	9024 55800	Spanner for crankshaft nut, 634-engines (620/MF/Steyr-tractors)
25	9101 65700	Spanner for crankshaft nut
26	9052 48800	Puller for crankshaft gears
27	9020 01100	Conical sleeve for fitting pistons
28	9052 46900	Piston ring pliers
29	9025 98900	Drift for fitting dust cover, crankshaft front seal
30	9025 98800	Drift for fitting tension pin in timing gear casing
31	9025 98700	Drift for fitting tension pins in timing gear casing and flywheel housing
32	9101 93200	Coolant pump impeller extractor 620, 634
33	9104 27700	Coolant pump impeller extractor 320, 420
34	9051 40200	Fitting tool for coolant pump axial seal (seal 8353 31202)
35	9051 79300	Fitting tool for coolant pump axial seal (seal 8353 39425)
36	9051 64900	Fitting tool for coolant pump shaft 320, 420
37	9052 47800	Pressure valve testing gauge
38	9052 48900	Extractor for injection pump gear
39	9025 99100	Injection timing check pin (320, 420, 620, 634/Valtra Valmet-tractors)
40	8366 62022	Electronic timing kit
41	9025 99000	Control rod locking bush
42	9051 71300	Extractor for injector



TECHNICAL DATA

Cylinder block

Holes for guide pins	13,250...13,320 mm
Main bearing housing diameter	91,000...91,025 mm
Main bearing housing diameter (with bearing 8361 40950)	92,000...92,025 mm
Cylinder liner location, diameter:	
– upper end	124,514...124,554 mm
– lower end	123,000...123,040 mm
Inner diameter of camshaft bushing (fitted)	50,010...50,070 mm
Height of cylinder block	428,170...428,430 mm

Cylinder liners

Protrusion of cylinder liner above cylinder block top face	0,030...0,080 mm
Max. permissible height difference between liners (under same head)	0,02 mm
Outer diameter of cylinder liner guide:	
– at upper end of liner	124,475...124,500 mm
– at lower end of liner	122,961...122,986 mm
Liner bore	108,010...108,032 mm
Height of cylinder liner flange	9,03...9,05 mm
Height of cylinder liner flange, 1st oversize, part no 8366 47933	9,08...9,10 mm
Height of cylinder liner flange, 2nd oversize, part no 8366 47934	9,13...9,15 mm
Height of cylinder liner flange, 3rd oversize, part no 8366 47935	9,23...9,25 mm
Outer diameter of cylinder liner flange	131,700...131,800 mm

Cylinder head

Height of cylinder head	104,800...105,000 mm
Height of cylinder head after repair grinding (minimum)	104,000 mm
Inside diameter of valve guide (not fitted)	9,000...9,015 mm
Outside diameter of valve guide	16,028...16,039 mm
Diameter of valve guide bore in cylinder head	16,000...16,018 mm
Position of valve guide top above cylinder head surface	21 mm
Depth of valve head face below cylinder head surface:	
– inlet valve	0,7±0,05 mm (max. 2,20 mm)
– exhaust valve	0,6±0,05 mm (max. 2,20 mm)
Angle of valve seat:	
– inlet valve	35° +20'
– exhaust valve	45° +20'
Width of valve seat:	
– inlet valve	2,9...3,7 mm
– exhaust valve	1,3...2,3 mm
Diameter of exhaust valve seat ring	44,070...44,132 mm
Diameter of exhaust valve seat rings recess	44,000...44,025 mm
Diameter of exhaust valve seat ring (overhaul part 8366 52269)	44,270...44,332 mm
Diameter of exhaust valve seal ring recess (overhaul part 8366 52269)	44,200...44,225 mm
Diameter of inlet valve seat ring (8366 47936)	48,570...48,632 mm
Diameter of inlet valve seat ring recess	48,500...48,525 mm
Diameter of inlet valve seat ring (overhaul part 8368 55347)	48,770...48,832 mm
Diameter of inlet valve seat ring recess (overhaul part 8368 55347)	48,700...48,725 mm

(See page 3—3)

Valves, rockers and tappets

With a valve clearance of 1,0 mm:

– inlet valve opens	0° ± 2° B.T.D.C
– inlet valve closes	16° ± 2° A.B.D.C
– exhaust valve opens	39° ± 2° B.B.D.C
– exhaust valve closes	1° ± 2° A.T.D.C

Valve clearance cold and hot:

– inlet valve	0,35 mm
– exhaust valve	0,35 mm

Angle of valve seat in cylinder head:

– inlet valve	35° + 20'
– exhaust valve	45° + 20'

Width of valve seat in cylinder head:

– inlet valve	2,9...3,7 mm
– exhaust valve	1,3...2,3 mm

Angle of valve face:

– inlet valve	35° – 20'
– exhaust valve	45° – 20'

Outside diameter of valve head:

– inlet valve	48 mm
– exhaust valve	41 mm

Max valve movement:

– inlet valve	10,9 mm
– exhaust valve	12,1 mm

Inlet valve stem diameter

8,960...8,975 mm

Exhaust valve stem diameter

8,925...8,940 mm

Inlet valve stem clearance

0,025...0,055 mm

– Reject limit

0,30 mm

Exhaust valve stem clearance

0,060...0,090 mm

– Reject limit

0,35 mm

Inside diameter of valve guide before fitting

9,000...9,015 mm

Outside diameter of valve guide

16,028...16,039 mm

Diameter of valve guide bore in cylinder head

16,000...16,018 mm

Protrusion of valve guide top above cylinder head surface

21 mm

Depth of valve face below cylinder head surface:

– inlet valve

0,7 ± 0,05 mm (max. 2,20 mm)

– exhaust valve

0,6 ± 0,05 mm (max. 2,20 mm)

Valve spring free length

69,8 mm

Spring pressure when spring compressed to a length of:

– 48,6 mm

327 ± 17 N

– 37,4 mm

500 ± 23 N

Rocker arm shaft diameter

19,959...19,980

Inside diameter of rocker arm bearing bush:

– (when fitted in position)

19,990...20,010 mm

Outside diameter of rocker arm bearing bush

23,035...23,075 mm

Diameter of rocker arm bore

23,000...23,021 mm

Max. permissible push rod deflection (when free)

0,4 mm

Free length of rocker arm spring

80 mm

Spring pressure when spring compressed to a length 58 mm

80...100 N

Outside diameter of tappet

29,939...29,960 mm

Diameter of tappet bore in cylinder block

30,000...30,043 mm

Engines from 96 week 34

Rocker arm shaft diameter

22,970...22,990 mm

Diameter of rocker arm bore

23,000...23,021 mm

Camshaft

Diameter of camshaft bearing journal no 1

49,925...49,950 mm

Diameter of camshaft bearing journals (others than no 1)

49,885...49,910 mm

Diameter of camshaft bearing journals nos 2, 3 and 4 (620/634 – engines)

49,865...49,890 mm

Inside diameter of camshaft bearing bushes (when fitted in position)

50,010...50,070 mm

Diameter of camshaft bearing bores (others than no 1)

50,000...50,025 mm

Camshaft clearance in bearing bush no 1

0,060...0,145 mm

Camshaft clearance in bearing bushes (others than no 1)	0,090...0,140 mm
Camshaft clearance in bearing bushes nos 2, 3 and 4 (620/634—engines)	0,110...0,160 mm
Bearing bush tolerance in block (press fit)	0,025...0,080 mm
Diameter of bearing bush bore in block	55,620...55,650 mm
Camshaft end play with 0,5 mm gasket between cylinder block and timing gear housing and between timing gear housing and front cover	0,5...1,0 mm
Cam height (distance between back of cam and tip of cam):	
– inlet valve	41,180...41,430 mm
– exhaust valve	40,080...40,330 mm
Cam lift:	
– inlet valve	7,38 mm
– exhaust valve	8,28 mm
Camshaft max. permissible deflection (total indicator reading)	0,03 mm

Crankshaft

Crankpin diameter:	
– standard	67,981...68,000 mm
– 1. undersize 0,25 mm	67,731...67,750 mm
– 2. undersize 0,50 mm	67,481...67,500 mm
– 3. undersize 1,00 mm	66,981...67,000 mm
– 4. undersize 1,50 mm	66,481...66,500 mm
Crankpin length	40,000...40,160 mm

Main bearing journal diameter:	
– standard	84,985...85,020 mm
– 1st undersize 0,25 mm	84,735...84,770 mm
– 2nd undersize 0,50mm	84,485...84,520 mm
– 3rd undersize 1,00 mm	83,985...84,020 mm
– 4th undersize 1,50 mm	83,485...83,520 mm
Main bearing housing diameter (in cylinder block)	91,000...91,025 mm

Main bearing shell thickness:	
– standard	2,955...2,965 mm
– 1st undersize 0,25 mm	3,080...3,090 mm
– 2nd undersize 0,50 mm	3,205...3,215 mm
– 3rd undersize 1,00 mm	3,455...3,465 mm
– 4th undersize 1,50 mm	3,705...3,715 mm
– bearing 8361 40950 (see page 5—1 instruction B)	3,705...3,715 mm

Main bearing clearance	0,050...0,127 mm
Length of thrust bearing journal (journal nearest to flywheel):	
– standard (2 standard thrust plates)	45,000...45,080 mm
– 1st oversize (one std and one 0,1 mm overthick thrust plate)	45,100...45,180 mm
– 2nd oversize (one std and one 0,2 mm overthick thrust plate)	45,200...45,280 mm
– 3rd oversize (one 0,1 mm and one 0,2 mm overthick thrust plate)	45,300...45,380 mm
– 4th oversize (two 0,2 mm overthick thrust plates)	45,400...45,480 mm

Other crankshaft journals may not be ground longer.

Crankshaft end float	0,100...0,380 mm
Max. permissible ovality and other deformity of crankpins or journals	0,03 mm
Crankshaft unbalance	1,0 Ncm Max.
Balancing unit ring gear location, diameter (420—engines)	150,220...150,260 mm
Balancing unit ring gear I.D. (420—engines)	150,000...150,040 mm

Flywheel

Flywheel ring gear no. of teeth	133 pcs
Interference fit between ring gear—flywheel	0,425...0,600 mm
Before fitting the ring gear, heat up to a temperature of	150...200 °C
Flywheel unbalance	1,0 Ncm Max
Max permissible axial wobble of flywheel clutch face, measured at inner edge of clutch face on diameter 200	0,06:ø200

Balancing unit (420—engines)

Tooth backlash:

– crankshaft ring gear—balancer weight gear wheel	0,1...0,3 mm
– between the balancer weights gear wheels	0,05...0,250 mm
Balancing weights end float	0,1...0,5 mm
Shaft diameter at bearing surfaces	36,000...36,016 mm
Bearing bushing inner diameter (fitted)	36,050...36,075 mm
Diameter of holes in body for shafts, rear end	36,058...36,083 mm
Diameter of holes in body for shafts, front end	35,958...35,983 mm
Shim thickness, cylinder block—balancer unit	0,2 mm

Timing gears

Tooth backlash:

Crankshaft—idler gear	0,05...0,25 mm
Idler gear—camshaft gear	0,05...0,25 mm
Idler gear—fuel injection pump gear	0,05...0,25 mm
Max. permissible side wobble of gears	0,05 mm
Idler gear shaft, diameter	54,951...54,970 mm
Inner diameter of idler gear bushing (fitted)	55,000...55,030 mm
Inner diameter of idler gear hole	60,000...60,030 mm
Camshaft gear hole diameter	32,000...32,025 mm
Camshaft end diameter	32,043...32,059 mm

Timing marks:

Timing marks on gears are in alignment when the 1st cylinder piston is at its top dead centre between compression and power strokes.

On crankshaft gear	2 dots on tooth
On idler gear:	
– against crankshaft gear mark	0 on tooth
– against camshaft gear mark	1 dot on tooth
– against fuel injection pump gear mark	1 dot on notch
On camshaft gear	1 dot on notch
On injection pump gear	1 dot on tooth

Connecting rod

Inside diameter of piston pin bush (with bush pressed into connecting rod)	40,025...40,040 mm
Outside diameter of piston pin bush	44,080...44,120 mm
Outside diameter of piston pin bush (oversize 8353 28326)	44,580...44,620 mm
Interference fit: connecting rod small end bushing—connecting rod	0,057...0,120 mm
Connecting rod small end bore	44,000...44,025 mm
Connecting rod small end bore (oversize bush)	44,500...44,525 mm
Connecting rod big end bore	71,730...71,749 mm

Big end bearing shell thickness:

– standard	1,835...1,842 mm
– 1st undersize 0,25 mm	1,960...1,967 mm
– 2nd undersize 0,50 mm	2,085...2,092 mm
– 3rd undersize 1,00 mm	2,335...2,342 mm
– 4th undersize 1,50 mm	2,585...2,592 mm
Big—end bearing clearance	0,046...0,098 mm
End float (side clearance) at big—end on crankshaft	0,200...0,410 mm
Piston pin bushing location perpendicular to longitudinal axis of connecting rod to be within	0,15:100
Piston pin bushing location and big—end bearing location to be parallel to within	0,05:100
Weight marking (letter) at lower end.	
Max. permissible weight difference between connecting rods in the same engine	20 g
Position of connecting rod; weight marking at valve mechanism side (away from the combustion chamber in the piston)	

Piston, rings and pin

Minimum distance between piston and cylinder head (measured with a piece of lead wire through the injector location hole)	0,900...1,150 mm
Piston diameter:	
– 17 mm from lower edge (320, 420, 620—engines)	107,873...107,887 mm
– 19 mm from lower edge (634—engines)	107,883...107,897 mm
Pin bore in piston	40,003...40,009 mm
Piston pin diameter	39,991...40,000 mm
Width of ring grooves:	
– 1st groove (right-angled ring)	2,560...2,580 mm
– 2nd groove	2,520...2,540 mm
– 3rd groove	4,040...4,060 mm
Side clearance of piston rings in their grooves:	
– 1st ring (right-angled ring)	0,07...0,102 mm
– 2nd ring	0,03...0,062 mm
– 3rd ring	0,05...0,082 mm
– reject limit	0,15 mm
Piston ring height (in direction of cylinder):	
– 1st ring (right-angled ring)	2,478...2,490 mm
– 2nd ring	2,478...2,490 mm
– 3rd ring	3,975...3,990 mm
Piston ring gap (with piston fitted in cylinder)	
– 1st ring (wedge shaped ring)	0,40...0,55 mm
– 1st ring (right-angled ring)	0,30...0,45 mm
– 2nd ring	0,60...0,80 mm
– 3rd ring	0,30...0,60
– reject limit 1st and 3rd ring	1,0 mm
– reject limit 2nd ring	1,5 mm
Max. permissible weight difference between pistons in same engine	25 g
Piston to be heated up to 100 °C before fitting gudgeon pin.	
Piston position in cylinder: combustion chamber of piston to face towards injector.	

Lubricating system

Oil pressure at normal running temperature:	
– at idling speed (min.)	100 kPa (1,0 kp/cm ²)
– at running speed	250–400 kPa (2,5–4,0 kp/cm ²)
Free length of oil pressure valve spring	80 mm
Spring pressure when valve spring is compressed to a length of 52 mm	54+5 N (5,4+0,5 kp)
Diameter of oil pressure valve plunger	19,602...19,635 mm
Diameter of oil pressure valve cylinder	19,700...19,752 mm
Oil filter by-pass valve opens at a pressure difference of	2±0,5 kp/cm ²

Oil pump (320, 420—engines)

Backlash between gears when crankshaft lies firmly against the lower side of main bearings:	
– crankshaft gear–lubricating oil pump gear	0,05...0,25 mm
– between the pump gears	0,16...0,26 mm
Diameter of drive shaft at bearings for body and cover	17,966...17,984 mm
Diameter of shaft holes on body and cover	18,000...18,018 mm
Diameter of gear wheel hole	18,060...18,078 mm
Fixed shaft, diameter	18,028...18,039 mm
Protrusion of fixed shaft end below pump body face	0,5...1,0 mm
Thickness of cover gasket	0,06...0,08 mm

Outside diameter of gear	43,486...43,525 mm
Housing diameter	43,650...43,750 mm
Thickness of gears	24,000...24,027 mm
End play of gears	0,03...0,11 mm
Depth of housing	24,000...24,043 mm
Number of teeth on drive gear (320–engines)	51 pcs
Number of teeth on drive gear (420–engines)	46 pcs

Oil pump (620/634–engines)

Backlash between gears when crankshaft lies firmly against the lower side of main bearings:

– crankshaft gear–lubricating oil pump gear	0,05...0,25 mm
– between the pump gears	0,16...0,26 mm
Diameter of drive shaft at bearings for body and cover	17,966...17,984 mm
Diameter of drive shaft bearing hole on body and cover	18,000...18,018 mm
Hole diameter of gear pressed on drive shaft	18,060...18,078 mm
Diameter of fixed shaft at gear wheel	17,966...17,984 mm
Inner diameter of bearing for gear wheel which rotates on fixed shaft	18,000...18,018 mm
Fixed shaft in pump body, diameter	20,035...20,048 mm
Protrusion of fixed shaft end below pump body face	0,5+0,5 mm
Thickness of cover gasket	0,06...0,08 mm
Outer diameter of gear wheels (620–engines)	43,486...43,525 mm
Outer diameter of gear wheels (634–engines/620–engines J 7891>)	55,824...55,870 mm
Housing diameter (620–engines)	43,650...43,750 mm
Housing diameter (634–engines/620–engines J 7891>)	56,000...56,120 mm
Thickness of gears	32,000...32,027 mm
End play of gears	0,03...0,11 mm
Depth of housing	32,000...32,043 mm
Number of teeth on drive gears	46 pcs

Coolant pump (320, 420–engines)

Outside diameter of bearing	38,087...38,100 mm
Inside diameter of bearing housing in pump body	38,058...38,083 mm
Shaft diameter	15,910...15,920 mm
Impeller hole diameter	15,881...15,899 mm
Diameter of the seal recess in the pump body	36,450...36,489 mm
The impeller is pressed onto the shaft until the distance between the rear face of impeller and the rear face of the pump body is	1,8...2,2 mm
Distance of belt pulley from rear face of body:	
– 320; <E 7535, 420; <E 7054	178,3...178,7 mm
– 320; E 7536>, 420; E 7055>	174,4...174,6 mm
Fan guide diameter	25,00...25,20 mm
Balancing precision of fan	0,3 Ncm max.
Max. permissible eccentricity of fan	±0,3 mm
Belt deflection	15...20 mm

Coolant pump (with separate ball bearings 320– and 420–engines)

Outside diameter of bearing	52 mm
Diameter of bearing housing	51,979...52,009 mm
Shaft diameter at bearing	20,002...20,015 mm
Shaft diameter at impeller	15,907...15,920 mm
Impeller hole diameter	15,881...15,899 mm
Impeller should be pressed onto shaft inside the housing	1,8...2,2 mm
Diameter of fan hub	0,3 Ncm max. (30 pcm)
Max. permissible eccentricity of fan	±0,3 mm
The fan belt tension pushing from the middle, deflection from the line	15...20 mm

Coolant pump (620/634–engines)

Outside diameter of bearing	52 mm
Inside diameter of bearing housing in pump body	51,979...52,009 mm
Shaft diameter at bearing	19,980...19,993 mm
Shaft diameter at impeller	15,907...15,920 mm
Impeller hole diameter	15,881...15,899 mm
Diameter of the seal recess in the pump body	36,450...36,489 mm
Distance between impeller and rear face of pump body	0,8...1,2 mm
Balancing precision of fan	0,3 Ncm max (30 pcm)
Belt deflection	15...20 mm

Pump equipped with reinforced bearing:

Outer diameter of the front bearing	95 mm
Bearing up diameter in water pump wheel	95,000...95,035 mm
Outer diameter of bearings position in pump frame	59,991...60,009 mm

Thermostat

Spare part number	Type	Opening begins at	Fully open at	Max. stroke mm
8361 15646	ø67/79°C	79° ± 2°C	94°C	8
8361 15718	ø67/83°C	83° ± 2°C	97°C	8
8366 59685	ø67/86°C	86° ± 2°C	99°C	8
8360 15156	ø54/79°C	79° ± 2°C	94°C	7,5
8363 31590	ø67/83°C	83° ± 2°C	95°C	8

Turbocharger**Schwitzer S1A (320 DS)**

Shaft end float	max. 0,14 mm
Shaft radial clearance ¹⁾	max. 0,61 mm
Turbine housing attaching bolts	22 Nm
Nut at end of shaft	6,8 Nm

Schwitzer S1B (420 DS) and S1BG by-pass turbo (420DW)

Shaft end float	max. 0,14 mm
Shaft radial clearance ¹⁾	max. 0,51 mm
Turbine housing attaching bolts	22 Nm
Nut at end of shaft	8,1 Nm
By-pass passage opening pressure (S1BG)	1,035 bar

Schwitzer S2B (620/634 DS) and S2BG by-pass turbo (620/634DW)

Shaft end float	max. 0,14 mm
Shaft radial clearance ¹⁾	max. 0,95 mm
Turbine housing attaching bolts	17 Nm
Nut on end of shaft	15,6 Nm

¹⁾ Measured at nut on end of shaft.

TIGHTENING TORQUES

Object	Nm
Cylinder head bolts	80 Nm+90°+90° (see page 3–4)
Cylinder head studs to cylinder block	30
Main bearing bolts	200
Connecting rod bolts	40 Nm + 90°
Crankshaft nut:	
– 320/420	600
– 620/634	1000
Crankshaft counterweight, 320	160
Crankshaft pulley bolts	30
Flywheel bolts, 10.9	140
Flywheel bolts, 12.9	150
Flywheel housing bolts:	
– outer ring M12, 8.8	110
– outer ring M12, 12.9	150
– inner ring M10, 8.8	60
– inner ring M10, 12.9	80
Idler gear bolts:	
– M10	60
– M14	200
Idler gear retaining screws (with ball bearing):	
– the bigger bolt	180
– the bolts for holding the bearing	22
Balancing weights, 420	60
Piston cooling valve (620/634)	30
Oil pump gear nut	60
Oil pump retaining screws	60
Oil cooler connecting piece	60
Coolant pump pulley nut	120
Fan bolts	30
Exhaust manifold bolts	50
Intake manifold bolts	30
Injection pump pressure valve holder	45
Injection pump gear retaining nut	90
Injection pump gear retaining nut (Bosch–P)	200
Injector attaching nuts (on studs)	15
Injector nozzle sleeve	60
Compressor pulley nut (Knorr)	80

Always use the torque values listed in the following tables when specific torque values are not available.

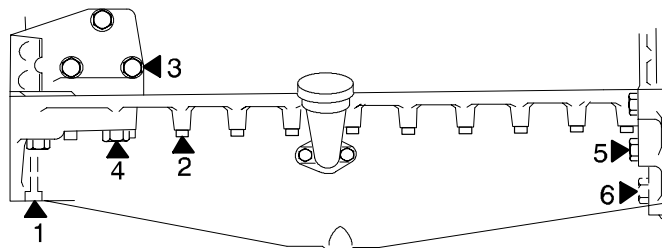
	M8	M10
Cast iron	35±5 Nm	70±5 Nm
Aluminium	25±5 Nm	50±5 Nm

Use a washer with the aluminium parts.

The bolts of a self carrying oil sump

1	M8	12.9	30 Nm
2	M10	12.9	90 Nm
2 ¹⁾	M12	12.9	150 Nm
3	M14	10.9	200 Nm
4	M20	10.9	700 Nm
5	M16	10.9	300 Nm
6	M20	10.9	700 Nm
6	M22	10.9	700 Nm

1) 320 and 420



CONSTRUCTION

General

The Sisudiesel 20/34-series engines (3-, 4-, or 6-cylinders) are water-cooled, four stroke, direct-injection in-line diesel engines. All engines are produced as naturally aspirated engines, turbocharged engines and the four- and six cylinder engines also as intercooled.

The engines have a rigid and ribbed cylinder block. The crank mechanism is designed for supercharging. The cylinder liners are wet and supported at the middle. The cylinder head bolts are high tensile bolts.

The flywheel housing are delivered according to the requirements set, by the engine application and different flywheel housings can be mounted on all engine types.

Cylinder block

The cylinder block is the main body of the engine, to which other engine parts are attached. Wet and replaceable cylinder liners are supported at the middle which reduces vibrations and directs coolant circulation mainly to the upper part of the liners.

The seal between the cylinder liner lower part and the cylinder block is achieved by three o-rings, which are fitted in grooves in the liner. The upper part is sealed by the cylinder head gasket.

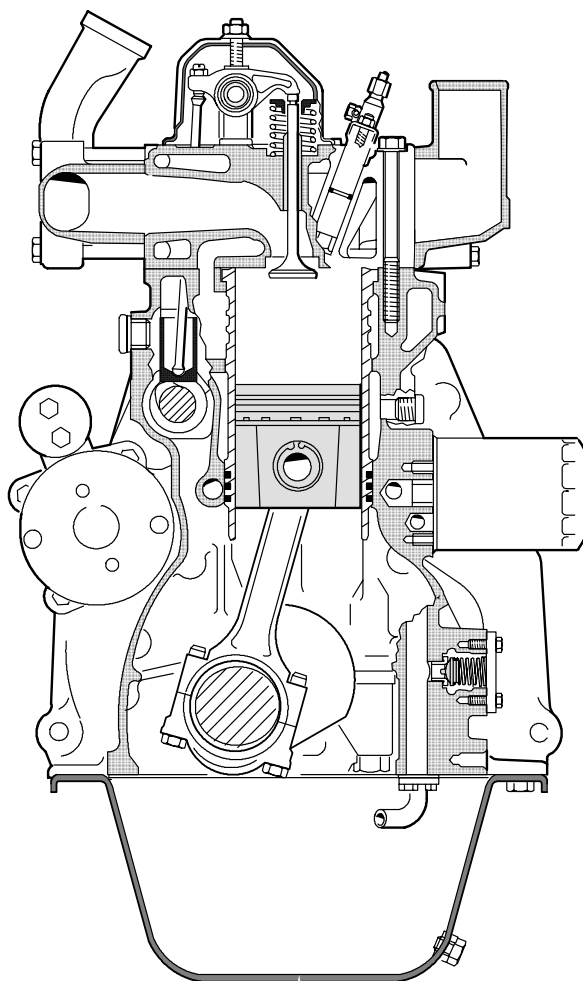
The camshaft is located in the cylinder block. The camshaft front bearing location is fitted with a separate bearing sleeve. The remaining bearing locations are machined directly in the cylinder block. The latest 620/634-engines have separate bearing sleeves in all camshaft bearing locations. The drilling for the camshaft rear end is covered with a plug.

There are spaces on both sides of the rear main bearing for guide bearing shims (the crankshaft thrust bearings).

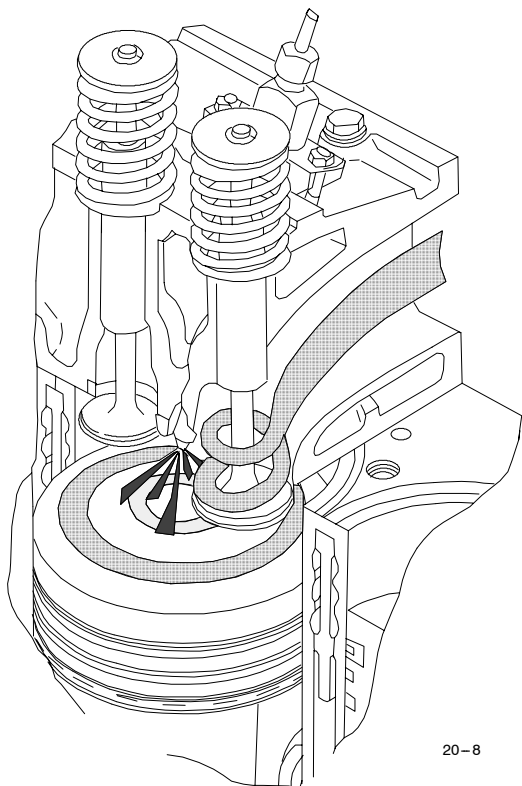
Flywheel housing

The flywheel housing is fitted at the rear end of the cylinder block. The seal for the crankshaft rear end is placed in a bore in the housing. The starter motor fixing point is fitted in the flywheel housing.

The lower face of the flywheel housing functions as a sealing surface for the oil sump gasket. This means that the lower face of the cylinder block must be level with the flywheel housing. When fitting the flywheel housing, its position is determined by tension pins.



20-7



20-8

Cylinder head

320- and 420-engines have one cylinder head. 620/634-engines have two cylinder heads which are exchangeable with each other and also with the cylinder head on the 320-engine. Each cylinder has its own inlet and exhaust ports located on either side of the head. Between hot exhaust valves a cool inlet valve is fitted to balance the thermal load.

Cylinder head bolts are high tensile bolts which are tightened up to yield limit using angle tightening principle. Due to the large stretch the tightening forces are kept constant during the whole lifetime and retightening is unnecessary.

The injector locations are machined directly into the cylinder head. The inlet and exhaust valve guides are identical and can be interchanged. In addition, the exhaust valves are equipped with replaceable valve seat inserts.

Valve mechanism

The valve mechanism is operated by the camshaft which is located in the cylinder block. The drive is transferred with the help of tappets and pushrods. The camshaft gear wheel is fitted with a press fit and fixed with a key. Each bearing is lubricated by the force feed lubrication system through drilled oilways in the motor block.

Crank mechanism

The crankshaft is forged from chrome alloy special steel and is induction hardened at the bearing and sealing surfaces. This makes it possible to grind bearings four times without a new heat treatment. Gear wheels are located at the front end of the crankshaft. They are a press fit, and drive the idler wheel and oil pump. In addition, the front end of the crankshaft has splines for the hub of the V-belt pulley. An oil deflector ring is fitted between the hub and gear wheel, and a dust shield is fitted on the hub in order to protect the seal.

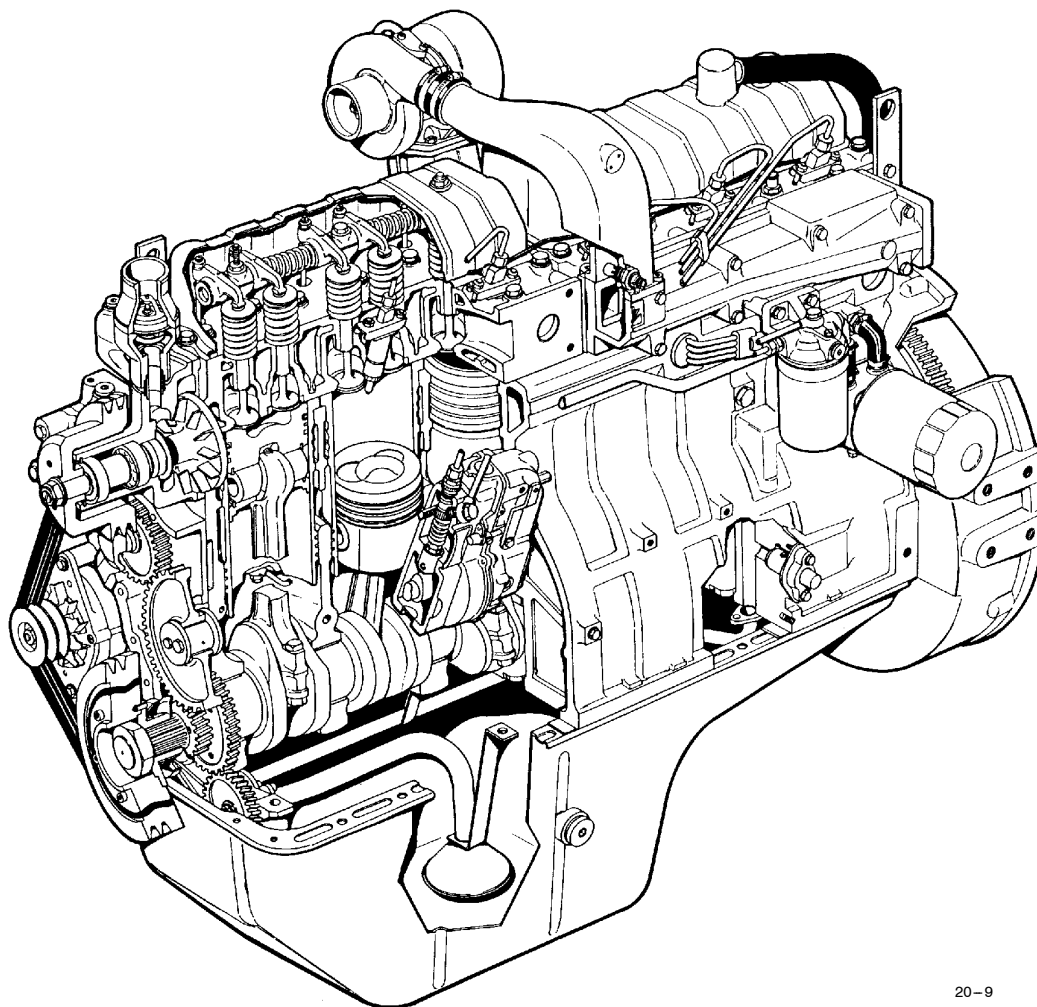
The crankshaft is supported on the cylinder block by main bearings which are placed on both sides of each cylinder. Thus there is one main bearing more than cylinders. The crankshaft thrust washers are placed in both sides of the rear-most main bearing.

At the rear end of the crankshaft there is fitted a flywheel on which is a press-fit starter ring gear. The forged connecting rod has an I-section cross-section. The bearing location at the bottom end of the connecting rod is split, and the bearing cup is secured by two special bolts and nuts. The upper part has a wedge-shaped bearing location, in which the piston pin bearing bushing is fitted with a press fit.

The piston is made of an eutectic aluminium alloy. In the upper face of the piston there is a combustion chamber. The shape of the chamber is intended to maximise the mixture of air and fuel. The piston has three rings. The upper molybdenum-coated ring has a wedge-shaped cross-section. On natural aspirated engines and on slight supercharged engines the upper ring is right-angled. The middle ring is tapered and it fits into its groove. The taper taking up the clearance. The oil control ring is spring loaded and it has a two-stage, chromed scraping edge.

On the turbocharged engines the upper ring location is formed in a cast iron ring which is cast in the piston. In addition, the piston on supercharged engines is graphite coated to ensure correct running-in.

Four-cylinder engines (420) are equipped with a balancer unit. The eccentric weights, which rotate at twice the engine speed, even out the vibration forces exerted by the movement of the pistons and the crank mechanism.



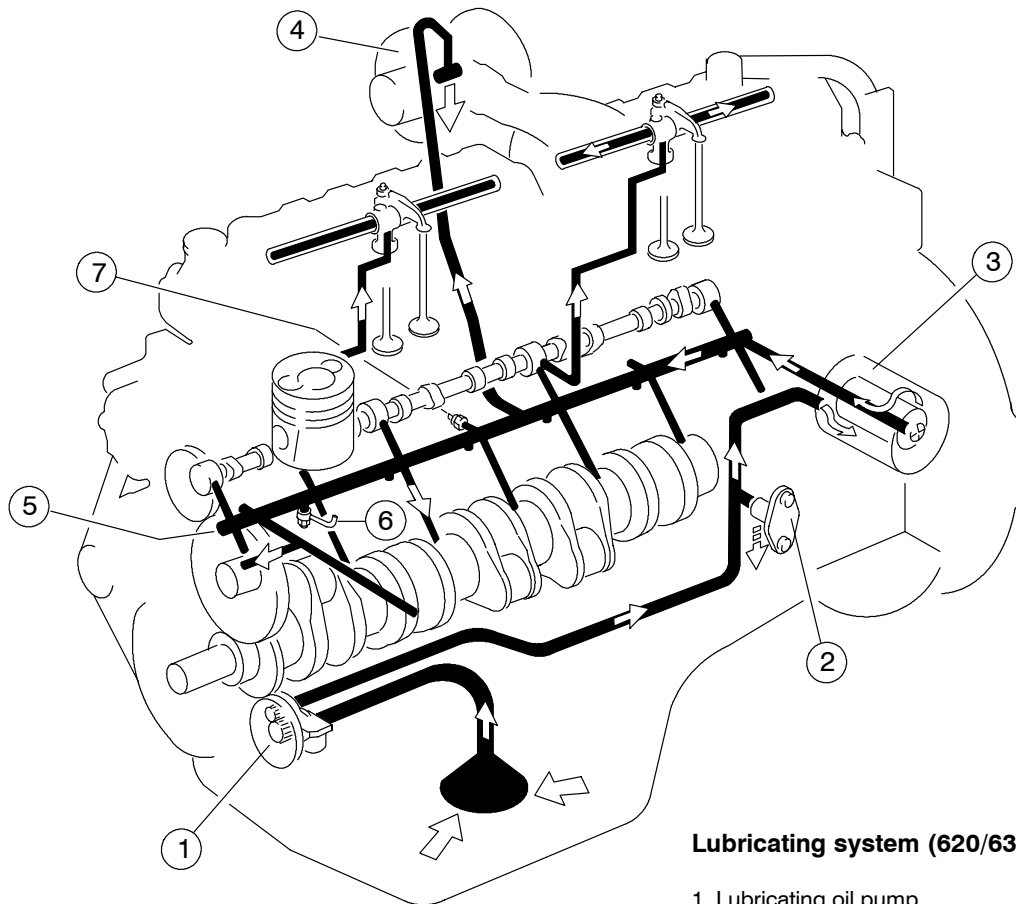
20-9

Timing gears

The timing gear train consists of hardened, helically cut gear wheels. The gears are encased by the timing gear casing which is fitted to the front of the engine. The timing gear drives the camshaft, fuel injection pump and oil pump.

If the engine is equipped with a hydraulic pump, it is driven via a gear or a separate drive unit.

The idler gear is supported with a bearing sleeve/ball bearing (620/634) on the shaft on the front face of the cylinder block. Two different dimensions of gear and shaft is used.

**Lubricating system (620/634-engines)**

1. Lubricating oil pump
2. Pressure-relief valve
3. Oil filter
4. Turbocharger
5. Main oil gallery
6. Piston cooling nozzle
7. Oil pressure sensor

20-10

Lubricating system

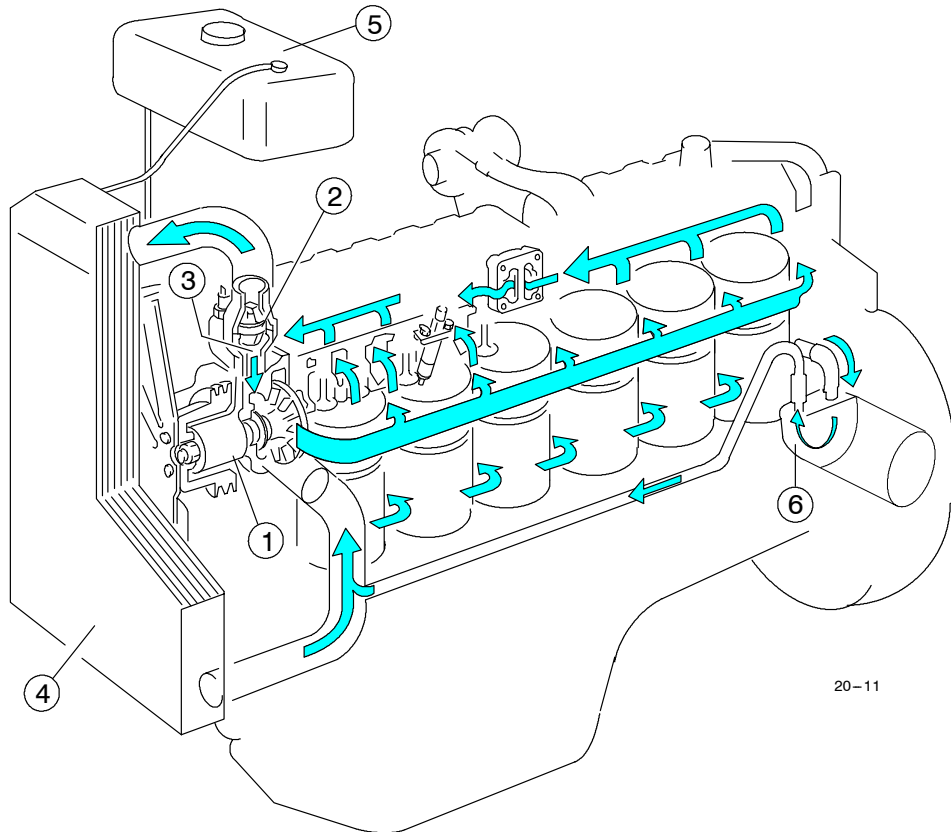
The engine has a pressure lubricating system in which the oil pump (gear pump) is attached to the cylinder block lower face. The oil is sucked up by the pump through a suction strainer. After the pump the oil is led through an oilway to the relief valve and to the oil filter. After the filter, the oil is led through the main oil gallery from which oilways branch out. The oil is led through the oilways in the main bearings and through the crankshaft to the big-end bearings.

The oil is further directed from the main gallery to the injection pump, turbocharger, balancing unit (420) and to a possible compressor. In addition, the idler gear bushing, the camshaft bearing points and the valve mechanism get their lubrication oil via the main oil gallery.

In 620/634-engines, with high power rating, is the bottom of the piston cooled with oil spray always when the oil pressure is higher than 3 bar.

The oil pressure relief valve is located under the oil filter on the left hand side of the engine. The valve regulates the lubricating oil pressure so that it is kept constant, regardless of the engine speed. Oil pressure is about **2,5-4 bar** depending on revs, oil quality and temperature, and at engine idling speed the pressure is min **1,0 bar**.

The oil filter is full-flow disposable type and is fitted on the left-hand side of the engine. A by-pass valve is located at the base of the filter to ensure safe cold-starting or to ensure adequate lubrication in case the filter becomes blocked. In addition, there is a non-return valve which stops the filter from being emptied of oil.



20-11

The cooling system

1. Coolant pump
2. Thermostat
3. By-pass pipe
4. Radiator
5. Expansion tank
6. Oil cooler

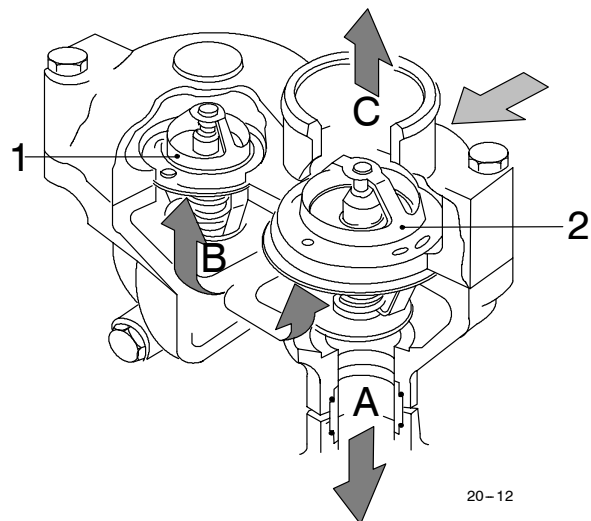
Cooling system

The belt driven, centrifugal type coolant pump is attached at the front end of the cylinder block and the thermostat housing is fitted above the pump. The system has an internal coolant circulation via the by-pass passage and the circulation is controlled by a two-way thermostat. With this is achieved an even warming in all conditions.

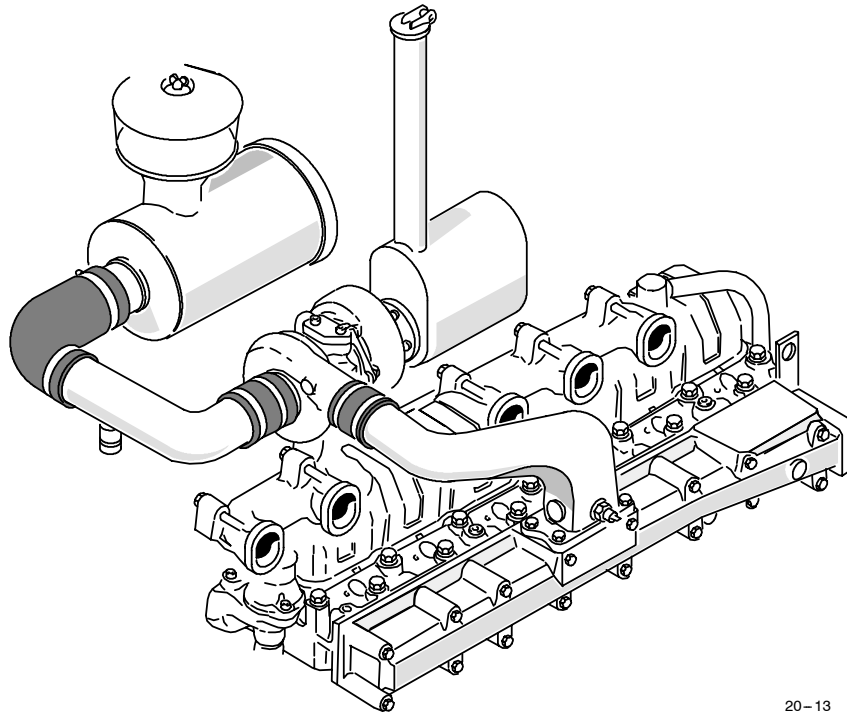
The coolant pump has separate ball bearings or the pump shaft and the bearings are built together to form one unit (320- and 420 engines).

The thermostat opens at 79°C. During a cold season, a thermostat with the opening temperature of 83°C can be used.

In some 620/634-engines there are two separate thermostats where one of them is steering the by-pass of coolant liquid. The thermostats differ in types and opening temperatures. When the coolant temperature is below the thermostat opening temperature the coolant circulates through the by-pass hole into the coolant pump. The smaller, single-acting thermostat opens first (at 79°C) letting one part of the coolant into the radiator. Following the load increase, also the other thermostat opens (at 83°C). This is a double-acting type which closes the by-pass hole when it opens and directs the coolant into the radiator. These engine models do not have any separate winter-type thermostats.



20-12



20-13

Inlet and exhaust system

The filter system for the engine inlet air comprises a cyclone type precleaner, and a paper filter which acts as the main filter. The incoming air is made to rotate in the cyclone precleaner. This causes most of the impurities to settle out and collect in the cyclone precleaner dust collector. The paper filter comprises one or two replaceable filter elements. The paper is corrugated and surrounded by a metal support.

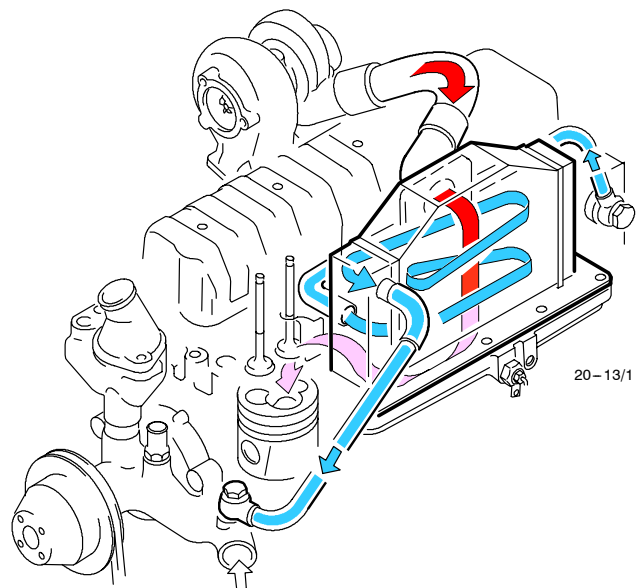
The impurities in the air collect at the larger filter element which can be cleaned when necessary. The inner safety filter prevents impurities from entering the engine should the main filter element break, or be fitted incorrectly.

A mechanical or electrical service indicator can be mounted on the filter housing or on the inlet pipe to show when the filter cartridge is clogged. The inlet system also includes the hoses between the air cleaner and the turbocharger and the turbocharger and the intake manifold.

The exhaust manifold is attached to the cylinder head with high tensile bolts without a separate gasket. Retightening of the manifold bolts is unnecessary.

In the marine – and generator engines a liquid cooled exhaust manifold is used, that is connected to the engine's cooling liquid circulation (so-called freshwater circulation). These exhaust manifolds are sealed from the liquid circulation part with o-rings in 420-engines and with level seals in 320/620/634-engines.

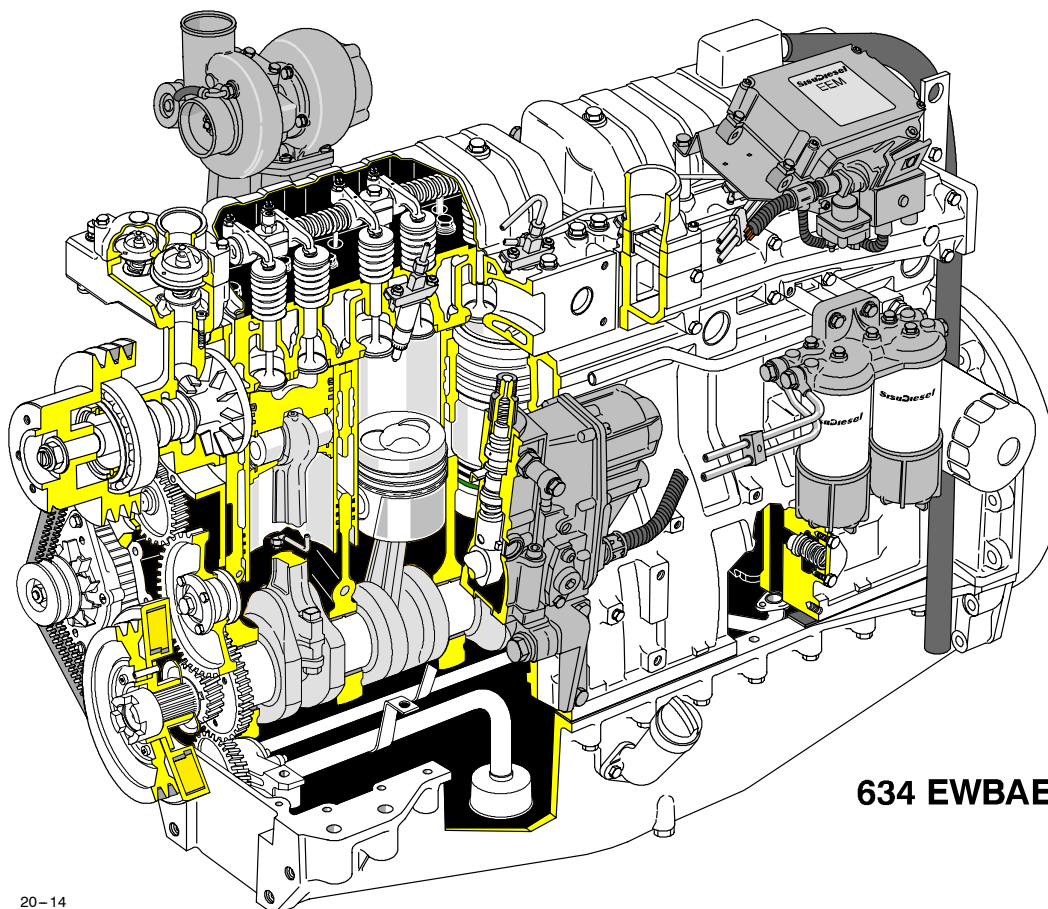
The turbocharger is turbo-compressor driven by exhaust gas. The compact design of the turbocharger is sensitive to react even during low revolutions. The turbocharger is lubricated and cooled by the lubrication system of the engine. DW/DWI engine is equipped with a by-pass turbocharger where the highest air pressure is adjusted by so-called by-pass channel.



20-13/1

The compressed air is cooled by the air to water basis. The air coming from the turbocharger has a temperature about 150°C which is cooled by the cooling water of the engine down to about 95°C.

The cooling cell is installed on the intake manifold and connected to the engine cooling system. The cooling of the compressed air stabilises the combustion, irrespective of the temperature, and minimises the thermal and mechanical load of the engine thus lowering nitric oxides (NO_x).


634 EWBAE

20–14

Electronic Engine Management system (EEM)

The Sisudiesel EEM system is a microprocessor based diesel engine control system to replace the traditional mechanical speed governor on the engine. This system significantly improves the properties of the engine and adds several functions and operational features that could not be realised with mechanical governors. The EEM system is applicable to all kinds of vehicles, on – or off – road.

The system consists of the following components:

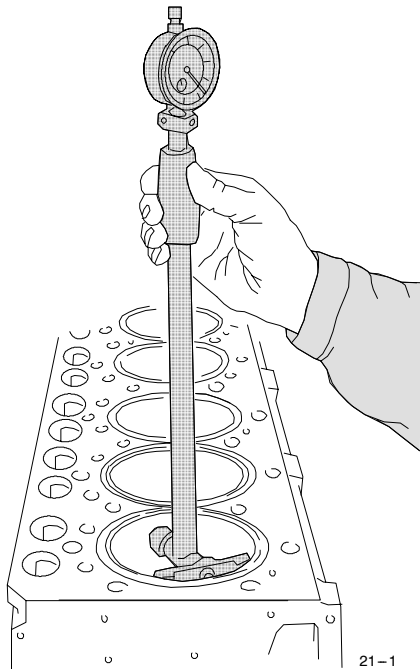
- Fuel injection pump with electrical actuator system
- Electronic control unit
- Sensors for engine parameters and speed demand value
- Wiring harness

WORK INSTRUCTIONS

1. CYLINDER BLOCK

A. Measuring cylinder liner wear

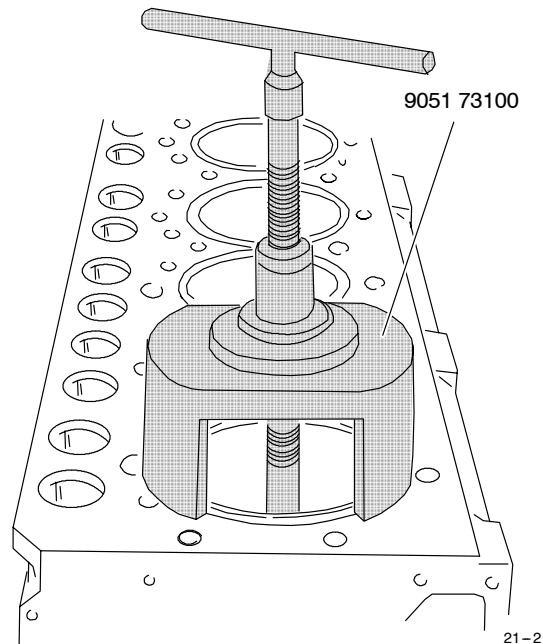
1. Using a micrometer set the dial gauge to zero using a new cylinder liner indicating the initial dimension of the bore: 108,00 mm.
2. Clean the inner surface of the cylinder liner thoroughly before measurement.



3. Perform the measurement crosswise at the liner top end, lower end and middle.
4. Check the gauge reading for maximum wear and ovalness (compare with rated).

B. Removing cylinder liner

1. If the cylinder liners are to be used again they should be marked so that they can be fitted in the same position.
2. Remove the cylinder liners using cylinder liner puller 9051 73100.



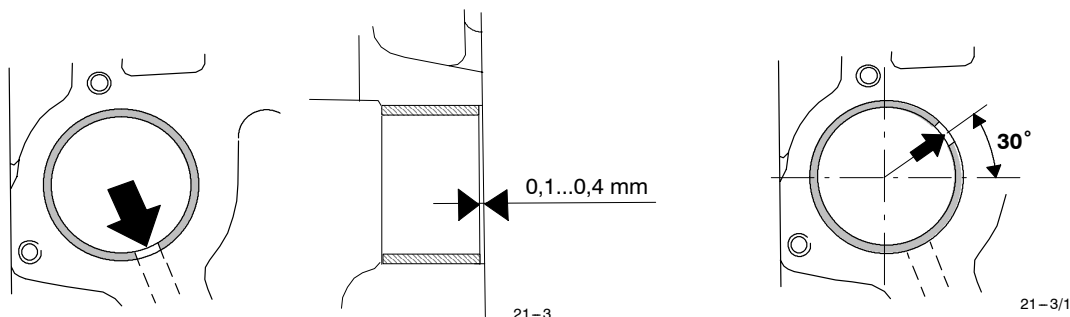
C. Checking cylinder block

1. Clean the cylinder block and all oil ways.
2. Check the cooling channels and remove the scale and sediment to ensure engine cooling.
3. Check the tightness of the cup plugs and threaded plugs in the cylinder block as well as the condition of the cylinder block and sealing faces.
4. Measure the wear of the camshaft bearing points (compare with rated).

Note! If it is necessary to machine the upper face of the cylinder block, the pistons must be shortened by the same dimension. Observe the valve disc spaces on the piston upper face.

D. Changing camshaft bushing

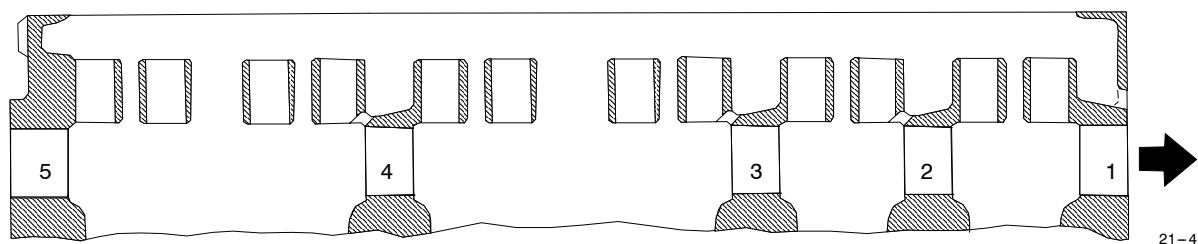
1. Extract the bushing with an internal puller, for example Sykes 854. If the camshaft rear end plug is removed the bushing can be forced out with a long drift.
2. Clean the bushing location carefully.



3. Press in a new bushing. Note the position of the oil hole. It is unnecessary to ream the bushing because it has a correct inner diameter when it is fitted in place.

Note! On the 620- and 634-engines from the engine ser. number C2751, all camshaft bearing points are provided with a separate bearing bushing. Observe the different outer diameters when removing and fitting.

Note! From engine number L 13188 the cam shaft front end bushing is equipped with the oil groove on the outside (the groove was earlier on the cam shaft). As spare part the earlier bushing always be replaced with the new one. Fit the hole of the new bushing in 30° angle from horizontal level as picture shows. The bushing is after assembly in its correct measures (no need for machining).



Order numbers of the camshaft bushings and hole diameters for the bushings on the 620/634-engines.

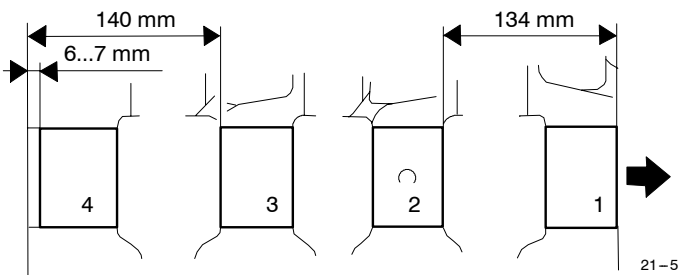
Note! Numbering begins from the front end of the engine.

Order no.	Hole diameter
1. 8363 22610	55,62...55,65
2. 8368 52460	55,42...55,45
3. 8368 52459	55,22...55,25
4. 8368 52460	55,42...55,45
5. 8368 52461	55,64...55,67

E. Oversize bushings for camshaft

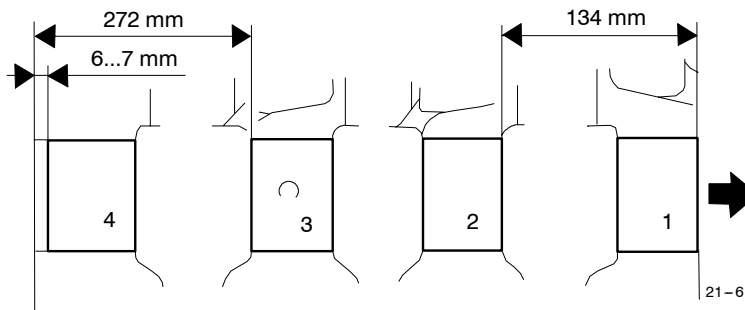
If the location of the camshaft bushing (front bearing) is damaged, a bushing with a **0,4 mm** oversize outer diameter can be fitted. Bushings are available even for other camshaft bearings which do not normally have bushings. Part numbers and machining dimensions for the bushing locations are shown in the figure.

Observe the position of the bushing oil holes. It is unnecessary to ream the bushings after fitting.



Oversize camshaft bushings for 320-engines. Numbering begins from the front end of the engine.

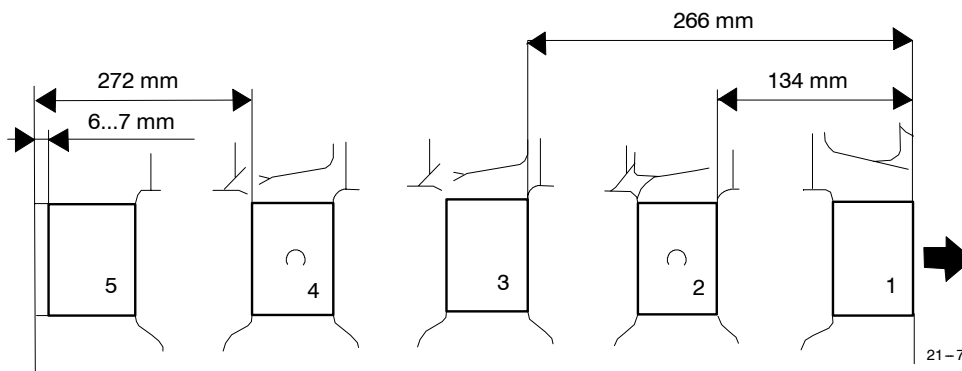
Order no.	Hole diameter
1. 8363 24661	56,02...56,05
2. 8368 52460	55,42...55,45
3. 8368 52460	55,42...55,45
4. 8368 52461	55,64...55,67

**Order no.****Hole diameter**

- 1. 8363 24661
- 2. 8368 52460
- 3. 8368 52460
- 4. 8368 52461

- 56,02...56,05
- 55,42...55,45
- 55,42...55,45
- 55,64...55,67

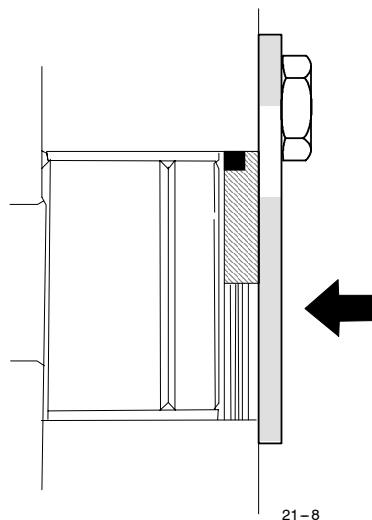
Camshaft oversize bearing bushings for 420-engines.
Numbering begins from the front end of the engine.

**Order no.****Hole diameter**

- 1. 8363 24661
- 2. 8368 52466
- 3. 8368 52460
- 4. 8368 52466
- 5. 8368 52467

- 56,02...56,05
- 55,62...55,65
- 55,42...55,45
- 55,62...55,65
- 55,84...55,87

Camshaft oversize bearing bushings for 620/634-engines.
Numbering begins from the front end of the engine.

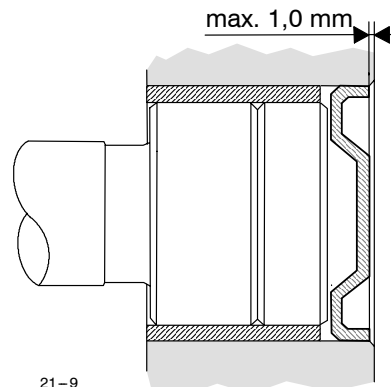


21-8

The camshaft rear end plug is replaced with plug 8363 24391 and o-ring 6146 05125 after machining. Use plate 8361 24210 in those engines where the flywheel housing is not covering the blocking plug.

F. Fitting plug at camshaft rear end

1. Clean the seat for the plug.
2. Apply sealing compound to the contact surface of the plug



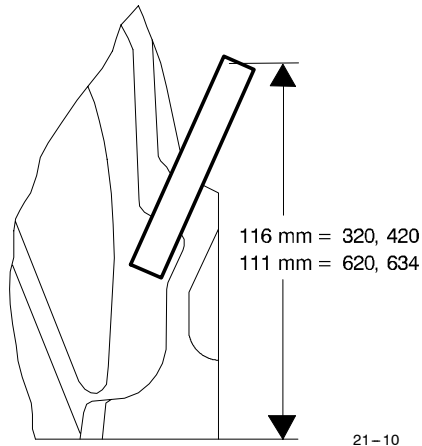
21-9

3. Drive in the plug with fitting drift 9025 87400.

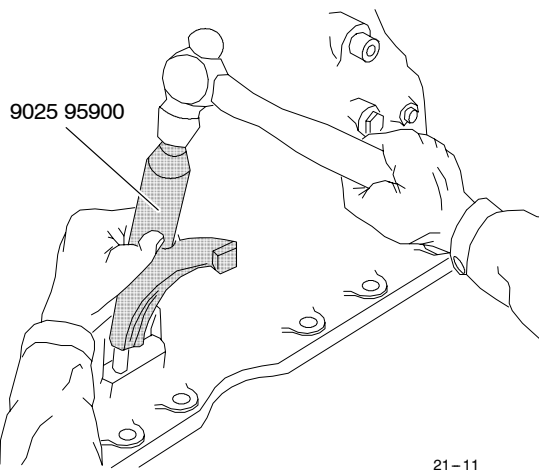
Note! Do not drive in the plug too far because it will affect the camshaft end float.

G. Fitting guide pipe for oil dipstick

1. Clean the seat for the pipe.
2. Apply locking fluid Loctite 601 to the lower end of the guide pipe.



3. Tap the guide pipe in its position at the level indicated in the picture.



4. Tap the guide pipe 8361 29747 (bent pipe) in to the correct fitting height with tool 9025 95900.

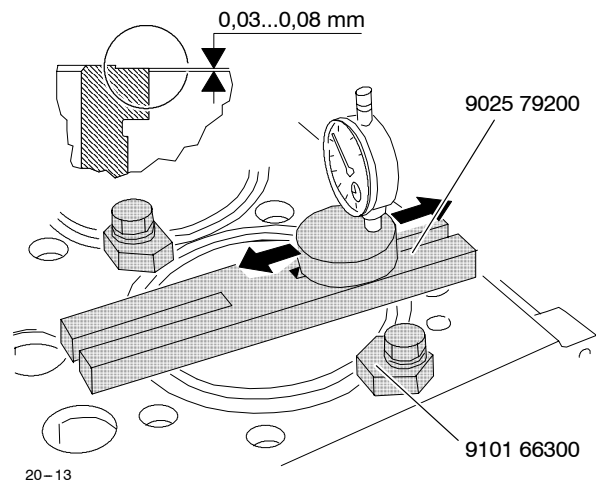
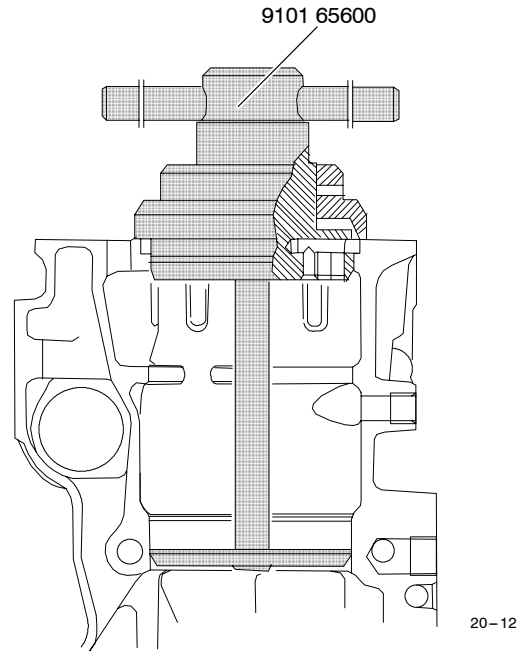
Note! The position of the guide pipe affects an oil level in the engine.

H. Fitting cylinder liner

1. Clean the cylinder liner and its recess in the cylinder block. Without o-rings the liner should rotate easily in its recess.
2. Apply a thin layer of marking paint on the underside of the cylinder liner flange. Fit the cylinder liner without o-rings and turn it forwards and backwards. Lift out the liner and check that paint has been deposited on the whole contact surface.

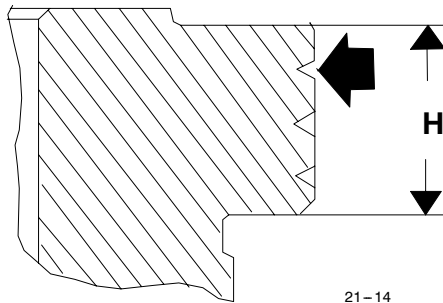
3. If the recess is damaged, or the cylinder liner height (see point 5) needs to be adjusted, use milling cutter 9101 65600. If necessary, a light lapping can be executed after milling with the help of the cylinder liner. Apply lapping paste to the underside of the cylinder liner flange, and twist the liner with twisting tool. Lapping is not suitable for adjusting the cylinder liner height.

4. Clean the contact surfaces.



5. Fit the cylinder liners and fix each liner with two press tools 910166300. Measure the cylinder liner height with a dial gauge and holder 9025 79200. Zero the dial gauge against a flat surface, for example, the cylinder block face. Measure each liner in four places. The height of the liner above the cylinder block face should be **0,03...0,08 mm**. The height difference between cylinder liners under the same cylinder head must not exceed **0,02 mm**, nor must an intermediate cylinder liner lie lower than an outer one.

6. If the cylinder liner height is too low, a liner with a higher flange is fitted.



21-14

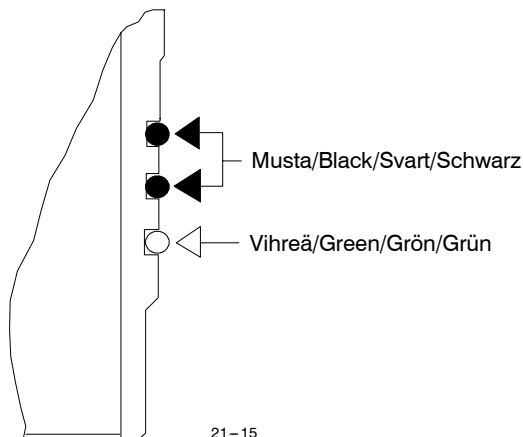
Order no	H	Marking grooves pcs
8366 47420	9,03 ^{+0,02}	— (std.)
8366 47933	9,08 ^{+0,02}	1
8366 47934	9,13 ^{+0,02}	2
8366 47935	9,23 ^{+0,02}	3

Cylinder liners with oversize flanges (higher flanges) are marked with grooves on the outer circumference as follows:

- 1st oversize, 0,05 mm = 1 marking groove
- 2nd oversize, 0,10 mm = 2 marking grooves
- 3rd oversize, 0,20 mm = 3 marking grooves

Note! Recess depth is adjusted with a cylinder liner recess cutter 9101 65600.

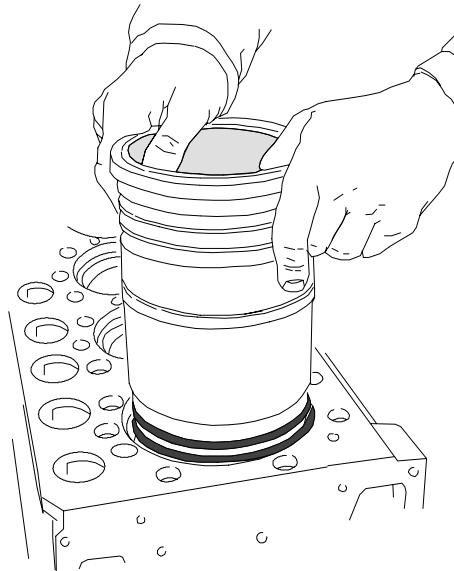
7. If the liner height of a cylinder liner is not the same all the way round, the cylinder liner flange and the cylinder block recess depth should be checked. Cylinder liners with warped flanges should be discarded.



21-15

8. Fit the o-rings into the grooves in the cylinder lower part and lubricate them with a liquid soap (not with engine oil).

Note! Stretch the o-rings as little as possible when fitting them. Max allowable stretching is 6 %.



21-16

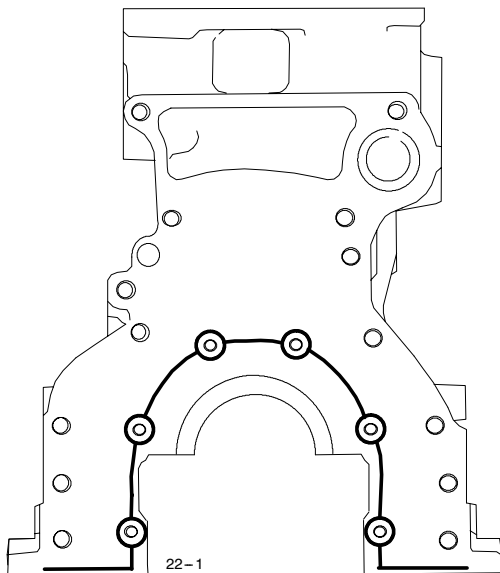
9. Press the cylinder liners into the cylinder block. It should be easy to press them fully home. Make sure that the liners do not rise up after fitting.

2. FLYWHEEL HOUSING

A. Fitting flywheel housing

The flywheel housing is centred on the cylinder block by two tension pins. Even the flywheel housings which are delivered as spare parts have ready-made holes for the pins.

1. Clean the sealing surfaces between the cylinder block and the flywheel housing.



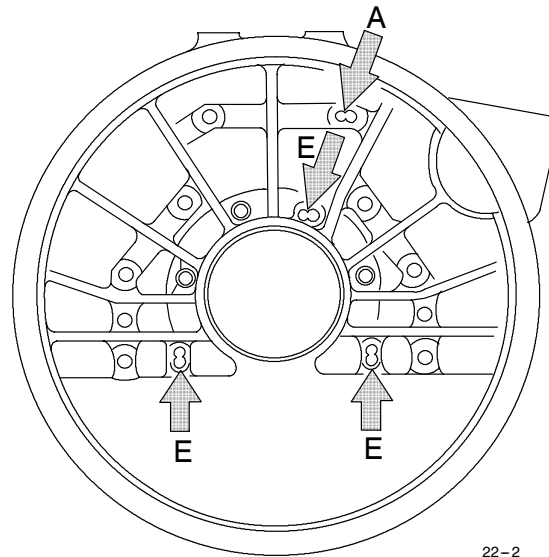
2. Apply silicone sealant as shown in figure above.
3. Lift the flywheel housing into place and fit all the bolts.
4. Centre the housing with centring tool 9052 46400 (**Note!** This is important of the engines with a turbine clutch) and fit the tension pins with drift 9025 98700.
5. Tighten the fixing bolts, the inner ring socket head bolts to **60 Nm (8.8) / 80 Nm (12.9)** and outer ring hexagonal bolts to **110 Nm (8.8) / 150 Nm (12.9)**

NOTE! MODIFICATION OF THE FLYWHEEL HOUSING

All the below mentioned flywheel housings have been in the inner circle added with 3 pcs $\varnothing 11$ mm holes (E) and in the outer circle with 1 pcs $\varnothing 13$ mm hole (A). Under the bolts in the added holes has to be added a spring washer $\varnothing 10$ mm, order no. 5009 51000, 3 pcs (E) and $\varnothing 12$ mm, order no. 5009 51200, 1 pc (A).

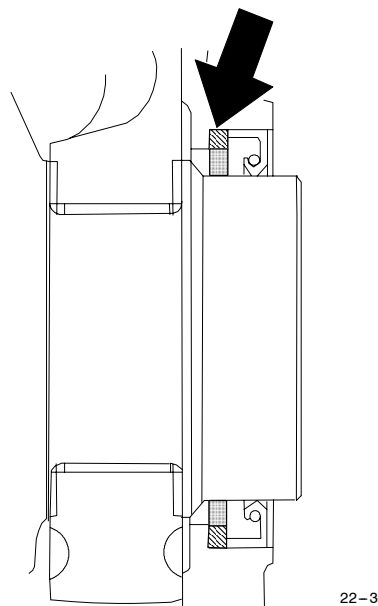
The modified flywheel housings:

8363 46658
8366 47441
8366 47440
8366 47442



B. Changing crankshaft rear oil seal

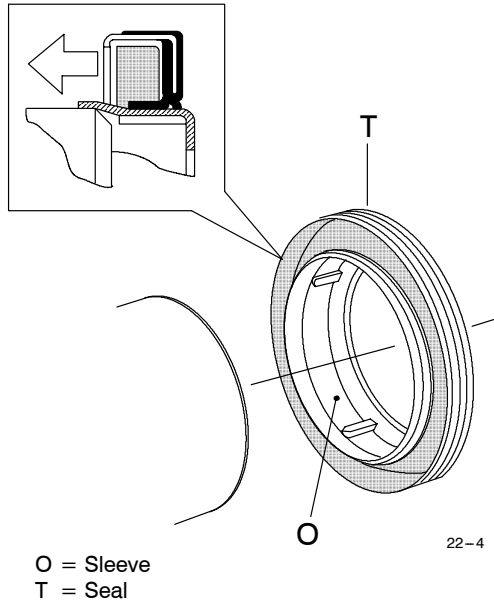
1. Lift out the engine. Remove the clutch assembly (and possible turbine clutch).
2. Remove the flywheel.
3. Remove the oil seal. Do not damage the crankshaft.
4. Clean the seal location and grind off any burrs.



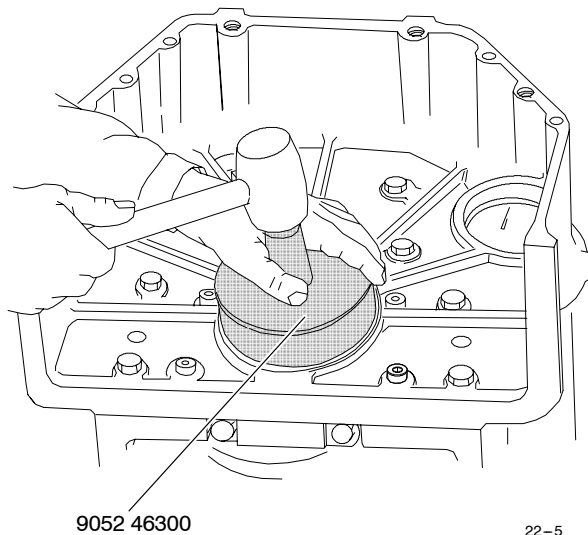
Note! If the crankshaft is worn at the sealing location, a 2 mm spacer ring, part no. 8360 20054, can be fitted in front of the crankshaft rear oil seal.

5. Fit the seal as follows:

- Do not remove the plastic sleeve in before hand.
- **NOTE! FIT THE SEAL DRY, NOT OILED!**



- Put the sleeve against the crankshaft rear end so that the sleeve is on the shaft bevelling.
- Push the seal over the sleeve on the shaft and further against the flywheel housing.



- Remove the sleeve and hit the seal into position with the fitting tool 9052 46300.

3. CYLINDER HEAD

A. Removing cylinder head

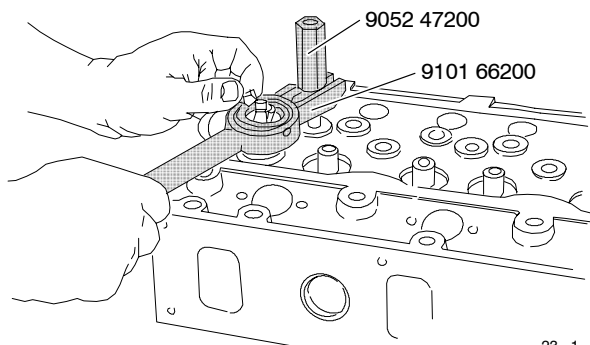
1. Clean the engine externally and drain the coolant. Disconnect the coolant hoses from the cylinder head and the thermostat housing.
2. Remove the suction hoses between the turbocharger and the air filter and between the turbocharger and the inlet manifold.
3. Disconnect the turbocharger pressure and return oil pipes.
4. Remove the pipes to the thermostat fuel reservoir.
5. Remove the injector leak-off fuel pipes and the delivery pipes. Remove the injectors. Fit blanking-off caps on all open connections.
6. Remove the inlet and exhaust manifolds and the thermostat housing.

Note! It is possible to remove the cylinder head even though these parts are attached to the head.

7. Remove the valve cover and the breather hose.
8. Remove the rocker arm mechanism and the push rods.
9. Loosen all the cylinder head bolts first by a 1/4 turn and then remove them. Remove the cylinder head.

B. Removing valves

Ensure that valves which are to be re-used are marked, so that they are fitted in their original locations.

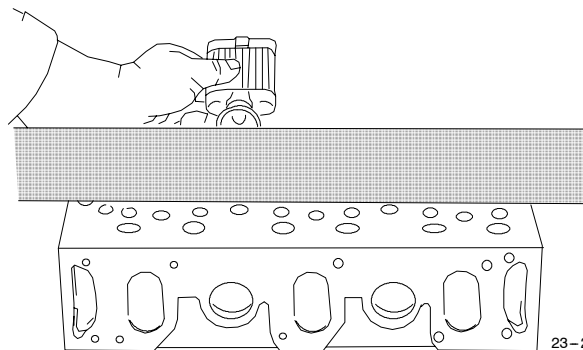


23-1

1. Install the counter screw 9052 47200 for the valve spring installing tool in the rocker arm cover bolt. On the 320- and 620/634-engines there is not a screw stud at the valves for the centre cylinder. A bolt of suitable length should be used instead.
2. Compress the valve springs using lever 9101 66200. Remove the valve cotters, spring guide and spring. Remove the valves.

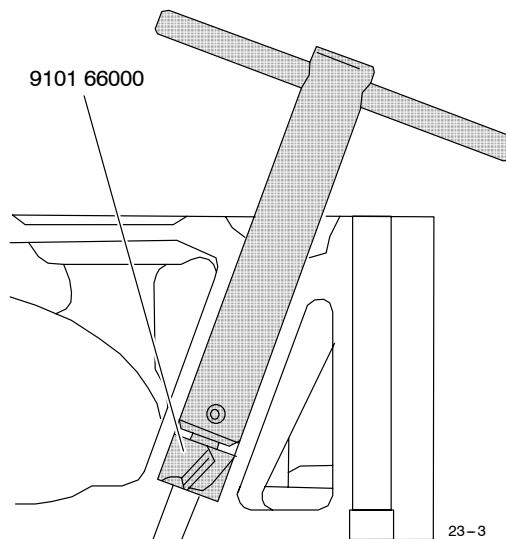
C. Checking cylinder head

1. Remove the soot from the exhaust ports, clean the sealing surfaces and wash the cylinder head.
2. Check for cracks and other damage.



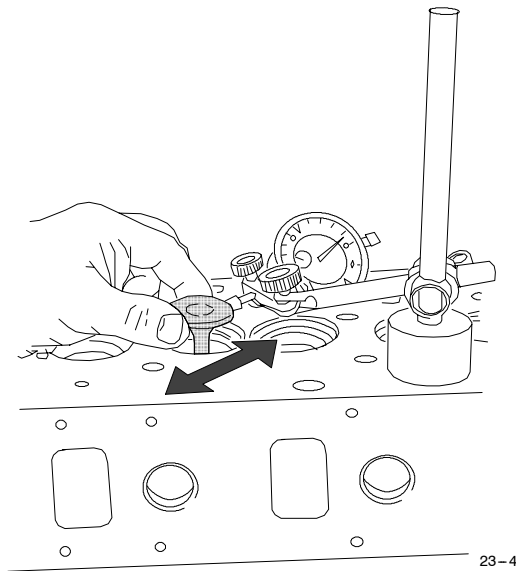
23-2

3. Check the flatness of the cylinder head by using a straight edge. An uneven or warped surface should be surface ground. The height of the cylinder head, after grinding, should not be less than **104,00 mm**. The valve disc depth from the cylinder head surface should be **0,60 mm** for the exhaust valves and **0,70 mm** for the inlet valves.



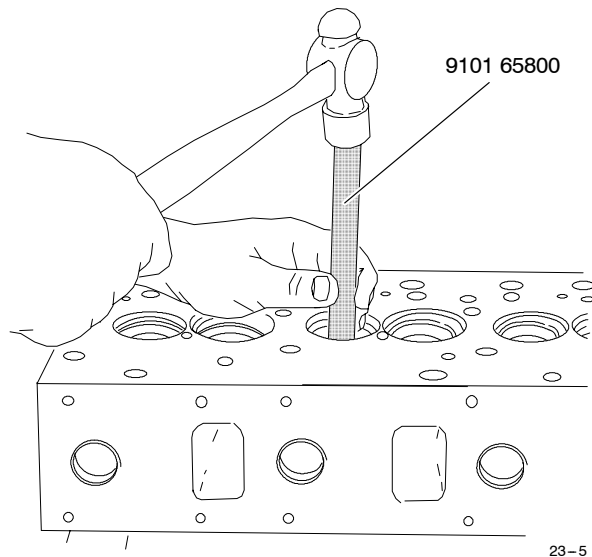
23-3

4. Straighten and clean the injector location seat in the cylinder head with cutter 9101 66000.



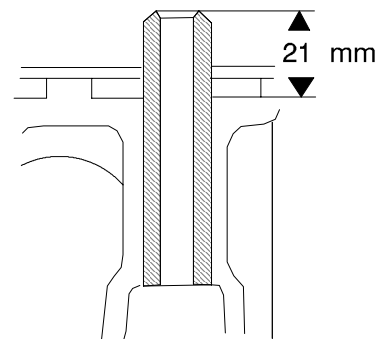
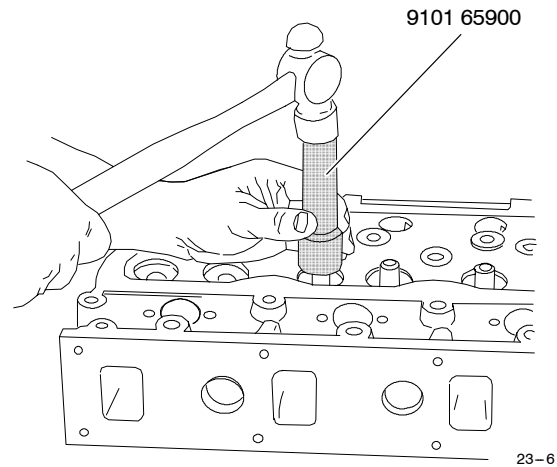
5. Measure the clearance between the valve stem and the valve guide with a dial gauge. Lift the valve so that the valve head is **15 mm** from the face of the cylinder head, and measure the clearance. It must not be greater than **0,30 mm** for the inlet valves and **0,35 mm** for the exhaust valves. In order to establish the valve guide wear, a new valve should be used when measuring.

D. Changing valve guides



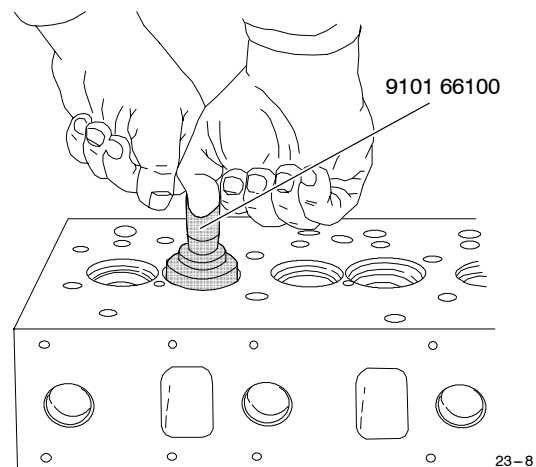
1. Press or knock out the old guides using drift 9101 65800. Clean the valve guide locations.

2. Lubricate the outside of the new guides and fit them using drift 9101 65900, which ensures the correct fitting height (21 mm over the spring face).



3. The guides are the same for the inlet and exhaust valves. Ensure that the steepest chamfer on the guide, faces the valve head. Check that the valves do not bind in the guides.

E. Machining valve seat



Machine the damaged valve seat with milling cutter. If the width of the seat exceeds **2,3 mm** in exhaust and **3,7 mm** in intake, it should be reduced primarily at the outer edge.

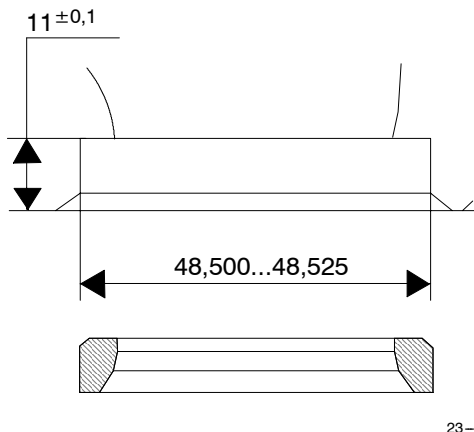
The valve seat angle is $45^{\circ} + 20'$ for exhaust valve and $35^{\circ} + 20'$ for inlet valve.

F. Changing valve seat rings

Exhaust valves are fitted with separate valve seat rings. If the sealing surface is damaged so badly that it cannot be repaired with machining, the seat ring should be changed.

1. Grind the valve head on a discarded valve so that it sits down in the valve seat. Fit the valve and weld it in place in the seat. Cool with water.
2. Turn the cylinder head over and knock out the valve and seat.
3. Clean the valve seat location. Cool the new seat ring in liquid nitrogen until it stops bubbling, or alternatively place it in dry ice.
4. Fit the seat with a suitable drift. Machine the seat.

Note! Where necessary, standard size seats can be replaced by inserts with a larger outer diameter. See technical data, point **cylinder head**.



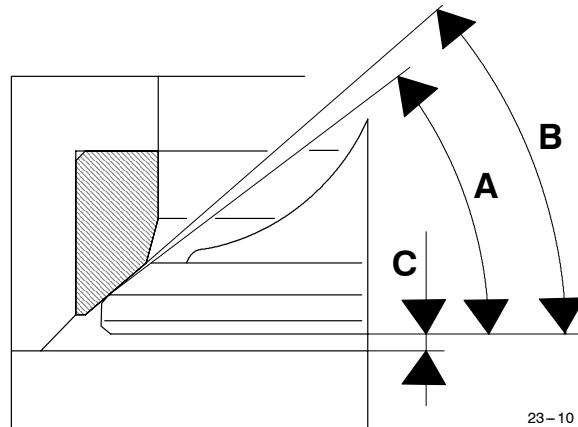
23-9

The inlet valve seat machined direct on the cylinder head, can be provided with a separate valve seat ring, order no 8366 47936. Machine the seat insert location on the cylinder head (see figure above). Fit the insert like a seat of the exhaust valve.

More powerful engine specs are equipped with separate inlet valve seats. Use in these engines when repairing seat ring no. 8368 55347. See technical data, point **cylinder head**.

G. Grinding valves

In order to ensure that there is a proper seal around the valves, there is a difference in the sealing surface angles. Thus there is a very narrow sealing surface which seals effectively even after prolonged running.



23-10

	A	B	C
Inlet	35° -20'	35° +20'	0,7 ± 0,05 mm (max. 2,20 mm)
Exhaust	45° -20'	45° +20'	0,6 ± 0,05 mm (max. 2,20 mm)

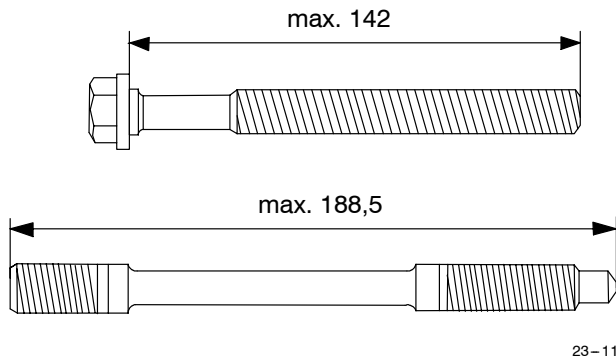
1. Grind the damaged valve disc with a valve refacer. Adjust angles to **45° -20'** for exhaust valves and **35° -20'** for inlet valves.
2. If the edge of the valve head is less than **1,5 mm** after it has been ground, or if the valve stem is bent, the valve should be discarded.
3. If necessary, grind the end of the valve stem.
4. Lap the valves with lapping paste and check the contact surface with marking paint.
5. Clean the cylinder head and valves of any remaining lapping paste.

H. Fitting valves

1. Check the valve springs for straightness, length and tension using a spring tester. Compare with specifications.
2. Lubricate the valve stems and fit the valves in the correct order in the cylinder.
3. Fit the springs, spring guides and valve keepers with the aid of a lever for compressing valve springs, 9101 66200.
4. Tap the end of the valve stems lightly after fitting the valve in order to ensure that they are secure.

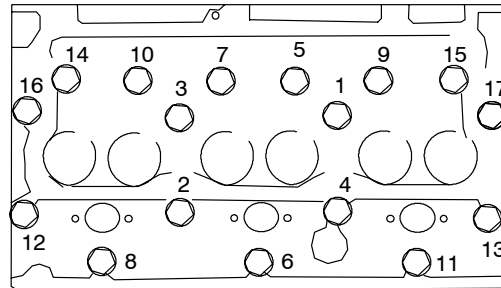
I. Fitting cylinder head

1. Measure the length of the cylinder head bolts. Compare with dimensions shown in figure below. Change too long bolts.



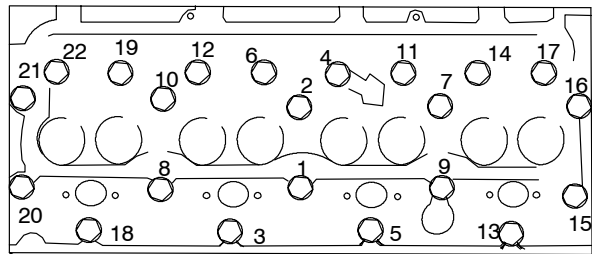
2. Screw the cylinder head stud bolts in to the cylinder block to a torque of **30 Nm**. Fit the valve tappets if removed.

3. Check that the sealing surfaces are clean and fit the cylinder head gasket(s) and the cylinder head(s). Ensure that on the six cylinder engines both cylinder heads are parallel by fastening lightly the exhaust manifold before tightening the cylinder head bolts (the exhaust manifold can damage, if the heads are not parallel). Clean and lubricate and fit the bolts.



320, 620, 634

23-12



420

23-13

4. Pictures above show the correct tightening order of the cylinder head bolts. The order has also been marked on the cylinder heads.

5. Tighten the cylinder head bolts progressively as follows:

1. First tightening to **80 Nm**
2. Tightening of **90°**
3. Tightening again of **90°**.

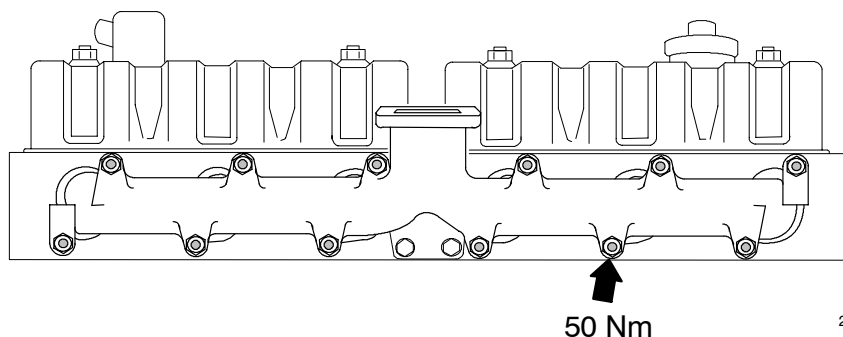
6. Adjust the valve clearances (see instruction **4 C**).

7. Run the engine with a light load to the normal running temperature (~ 75°C).

8. Tighten the bolts **60°** and adjust the valve clearances.

Note! After this the cylinder head does not need retightening.

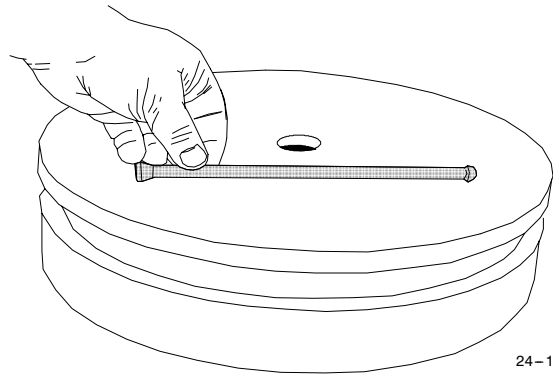
Tighten the exhaust manifold bolts/nuts to **50 Nm**. **DO NOT OVERTIGHT!**



4. VALVE MECHANISM

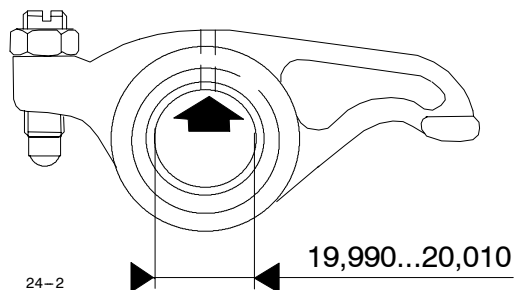
A. Reconditioning valve mechanism

1. Check the valve tappets, especially the contact surface against the camshaft. Worn or damaged tappets should be discarded.

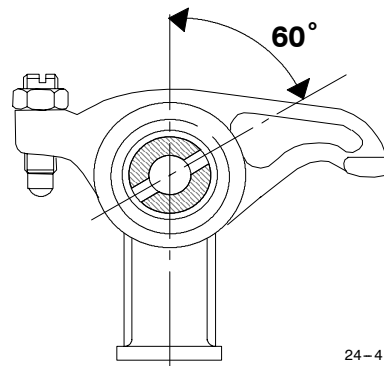
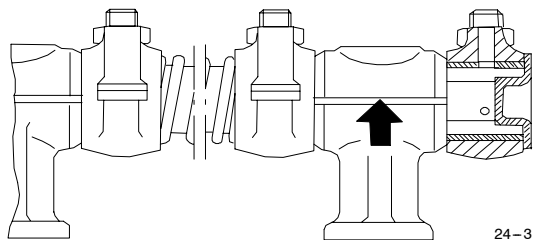


2. Check the straightness of the pushrods by rolling them on a surface table. Check also the spherical surfaces at the ends.

3. Dismantle and clean the rocker arm mechanism. Check the shaft for wear and that the oilways are clean.



4. Check that the rocker arm bushings are not worn. Ensure that the oil hole is positioned correctly when pressing in new bushings. After pressing in the bushings they should be reamed to **19,990...20,010 mm**. Where necessary grind the rocker arm valve contact surface to the correct shape. Do not grind more than necessary as the hardened layer is thin.

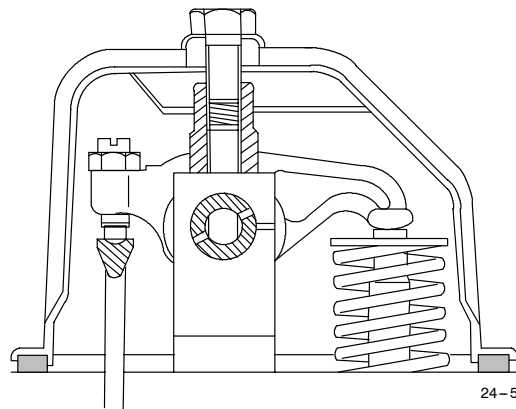


5. Fit the plug to the other end of the rocker arm shaft. Lubricate the shaft and fit various parts in a correct order. Note the correct position of the shaft and the bearing brackets. The split side of the bracket and the shaft oil holes must be turned to the valve side (see figure above). Fit the other end plug.

NOTE! ENGINES FROM 96 WEEK 34

From the above mentioned date a new valve mechanism, push rods and rocker cover fastening taken in use.

The modification effects mainly the under mentioned parts:

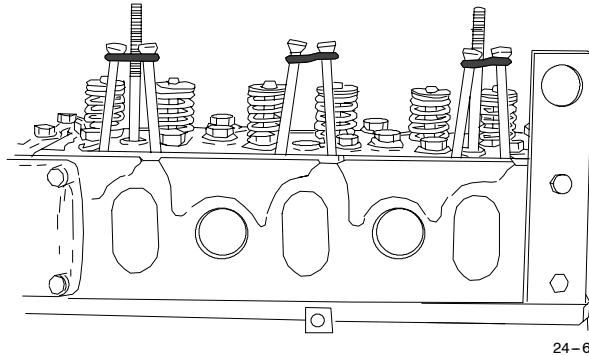


- Valve mechanism shaft diameter grows from 20 ⇒ **23 mm**. The plugs in both ends are replaced by threaded plugs.
- The rocker arm is without bushing. The adjusting screw is modified from M8 ⇒ **M10x1**.
- The push rod top end ball cup is growing from R4 ⇒ **R5**.
- The bracket structure and material is modified.
- The rocker cover studs are shorter and the cover is tightened with hexagon screws.

As spare part the separate parts are not exchangeable. The whole valve mechanism can be replaced with the new one together with the new push rods. The fastening parts do not have to be modified.

B. Changing camshaft/camshaft gear

1. Remove the inlet pipe between the turbocharger and the induction manifold. Remove the valve cover and the breather pipe. Remove the rocker arm mechanism.
2. Remove the radiator, cooling fan, alternator and the v-belt.
3. Remove the crankshaft nut. Remove the V-belt pulley including the hub (on 620-engines the belt pulley must be removed first).
4. Remove the timing gear casing cover (engine front cover).



5. Connect the pushrods in pairs, using o-rings or elastic bands to prevent them from falling through.

Note! Do not connect the pushrods too tightly as this might cause them to bend or snap.

6. Crank the engine until the aligning marks on the idler gear and camshaft gear are facing each other. Extract the camshaft.

7. Separate the camshaft from the gear wheel using a press or suitable drift.

8. Clean the parts which are to be refitted.

9. Fit the key in its groove. Heat the camshaft gear to **200°C** in an oven and fit it on the shaft.

10. Lubricate bearing surfaces and lobes and insert the shaft in the cylinder block. Ensure that the aligning marks on the gears agree.

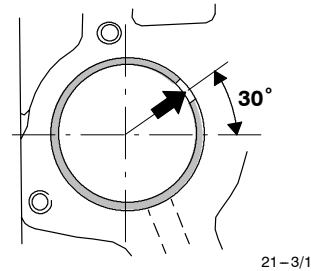
11. Fit the timing gear casing cover and the crankshaft V-belt pulley and hub.

12. Free the pushrods and fit the rocker arm mechanism. Adjust the valves. Fit the valve cover and the breather pipe and the inlet pipe between the turbocharger and the induction manifold.

13. Fit the alternator. Fit the fan and the fan belt. Fit the radiator.

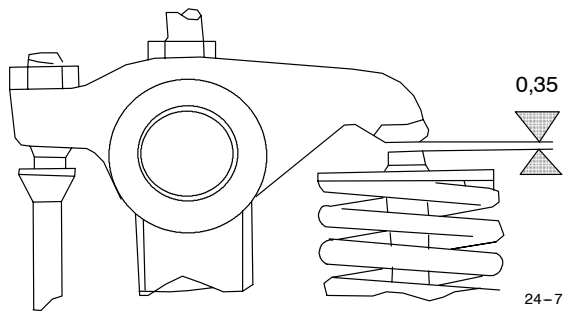
Modification of the cam shaft

From engine no L 13188 all 620/ 634-engines are equipped with a cam shaft where the front end bearing location has no oil groove (the bearing location is so called barrel shape).



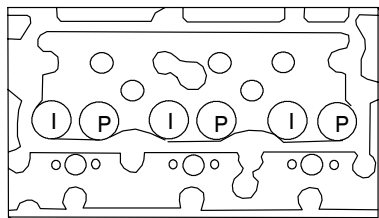
Note! The new cam shaft is not fitting together with any previous bushing. The new bushing is recognised from the position of the oil drilling which is not at the same place as the oil drilling of the cylinder block, **30°** angle upwards from the horizontal level.

C. Adjusting valves

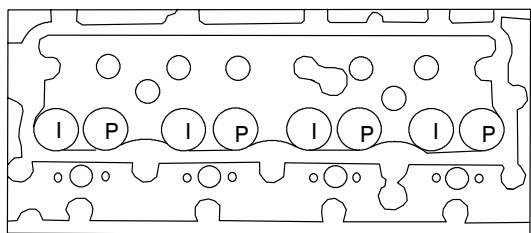


The valve clearance, which can be adjusted on a hot or cold engine, is **0,35 mm** for both inlet and exhaust valves. The clearance is adjusted when the respective piston is at T.D.C. in the compression stroke. The valves for the different cylinders are adjusted in the same sequence as the order of injection.

- slacken the lock nut of the adjusting screw
- measure clearance with a feeler gauge. The clearance is correct when a **0,35 mm** feeler gauge is slightly tight-fitted between the rocker arm and the valve stem end. Adjust clearance by rotating the adjusting screw.
- tighten the locking nut and check the clearance



320, 620, 634



420

24-8

I = Inlet
P = Exhaust

320-engines

Check the valve clearances in the injection order of the engine. Injection order is 1-2-3.

- Check valves in the 1st cylinder, when the exhaust valve of no. 3 cylinder is completely open (valve no. 6).
- Check valves in the 2nd cylinder, when the exhaust valve of no. 1 cylinder is completely open (valve no. 2).
- Check valves in the 3rd cylinder, when the exhaust valve of no. 2 cylinder is completely open (valve no. 4).

420-engines

- Rotate the crankshaft in the running direction until the valves in the 4th cylinder are rocking (exhaust closes, inlet opens). Check the valve clearance of the 1st cylinder.
- Rotate the crankshaft by 1/2 of a turn in the running direction so that valves in the 3rd cylinder are rocking. Check valves in the 2nd cylinder.
- Continue according to the order of injection:

Injection order	1 2 4 3
Valves rock in cyl. no.	4 3 1 2

620/634-engines

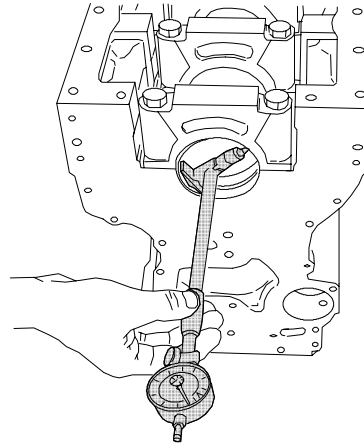
- Rotate the crankshaft in the running direction until the valves in the 6th cylinder are rocking (exhaust closes, inlet opens). Check the valve clearance of the 1st cylinder.
- Rotate the crankshaft by 1/3 of a turn in the running direction so that valves in the 2nd cylinder are rocking. Check valves in the 5th cylinder.
- Continue according to the order of injection:

Injection order	1 5 3 6 2 4
Valves rock in cyl. no.	6 2 4 1 5 3

5. CRANKSHAFT

A. Removing crankshaft

1. Remove the oil sump.
2. Disconnect the balancing unit lubricating oil pipe from the cylinder block and unscrew the balancing unit fixing bolts. Remove the balancing unit and the lubricating oil pipe (**only 420-engines**).
3. Unscrew the lubricating oil pump pressure pipe fixing screws from the cylinder block. Remove the oil pump and the suction and pressure pipes.
4. Remove the flywheel and the flywheel housing.
5. Detach the belt pulley/hub from the crankshaft front end (see instr. **timing gears**).
6. Remove the connecting rod bearing caps and push the connecting rods out of the way of the crankshaft.
7. Remove the main bearing caps and lift out the crankshaft.



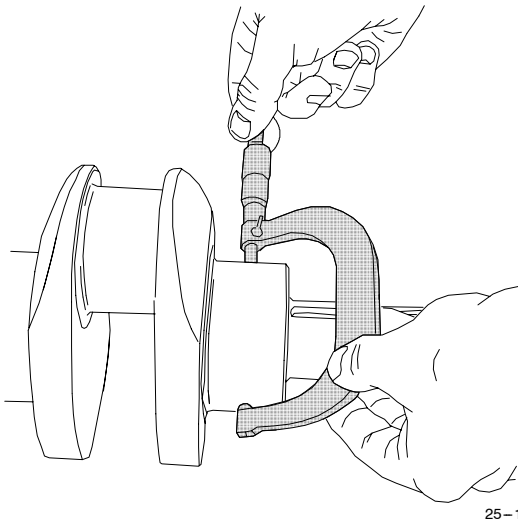
25-2

4. If the bearing clearance exceeds **0,18 mm** for main bearings or **0,14 mm** for connecting rod big-end bearings with new bearing shells, the bearing journals on the crankshaft should be ground. Refer to the specifications for the relevant correct undersize and the corresponding bearings, see technical data, point **crankshaft**. **When grinding note that the journal edges must remain round.**

Note! If needed, also the main bearing can be fitted with outer diameter 1,0 mm oversize and inner diameter 0,5 mm undersize. Ordernumber is 8361 40950 (includes halves 55593 and 55600). The main bearing housing is machined to 92,000...92,025 and crankshaft to 84,485...84,520.

B. Checking crankshaft

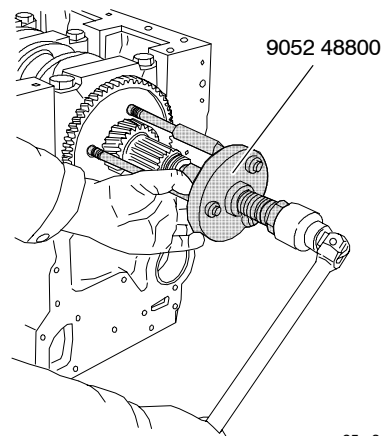
1. Clean the crankshaft. Do not forget the oilways.



25-1

2. Measure the journal wear in several points. Out-of-round, taper or other wear must not exceed **0,03 mm**.
3. Refit the bearing caps with new bearing shells and tighten them to the correct torque. Measure the I.D. with a dial gauge which has been zeroed to the dimensions obtained in point 2. With this method the indicator shows the actual bearing clearance. Measure in several points in case the worn bearing housing is not round.

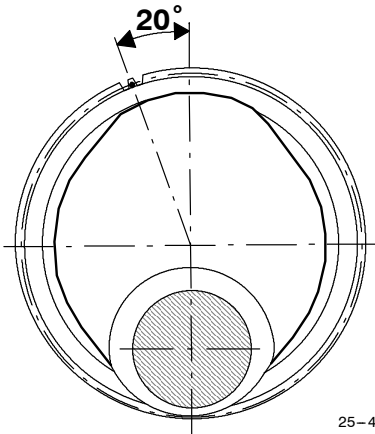
C. Changing crankshaft gears



25-3

1. Apply puller for the crankshaft gears and pull off both gears.
2. Clean the seat on the crankshaft with, for example, a wire brush.
3. Heat the new gears to **200° C**. Tap them onto the shaft with a suitable sleeve or soft drift. Note the position of the key and ensure that the aligning marks on the front gear are visible. Leave it to cool.

D. Changing crankshaft gear rim (420-engines only)

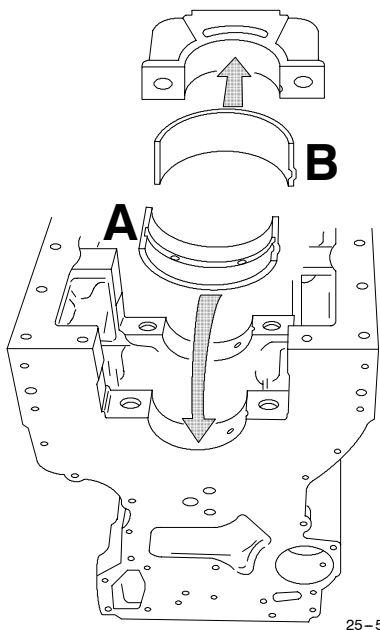


1. Mark the position of the gear rim on the shaft.
2. Heat the gear rim with a welding torch and drive it off using a suitable drift.
3. Heat the new gear rim to max. **250°C**. Fit the gear rim with the chamfer facing the crankshaft flange, and with the teeth according to markings or according to figure above. Tap the gear rim down and leave it to cool.

Note! The figure above shows a rear view of the crankshaft and no 2 cylinder big end bearing journal.

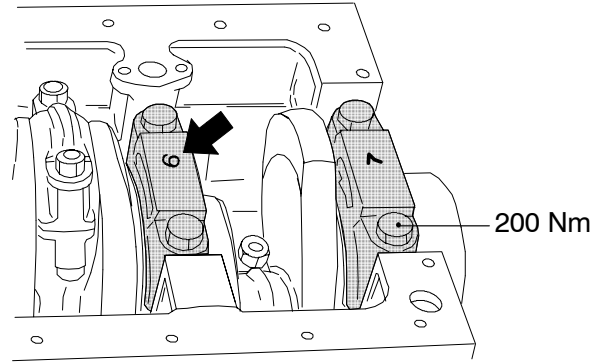
E. Fitting crankshaft

1. Clean the oilways, bearing shells and bearing locations. Check that the crankshaft is clean.

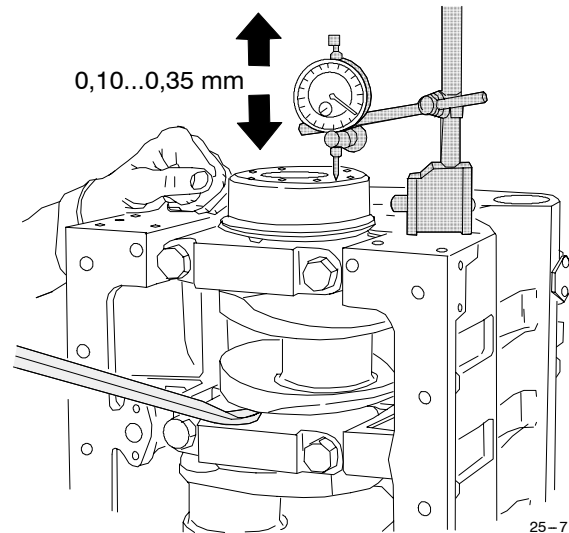


2. Assembly the bearing with oilholes/groove (A) to the cylinder block and the bearing with no hole (B) to the bearing cap. Ensure that the bearing shell clamping claws fit into their notches and that the shells to be fitted in the cylinder block have a hole coinciding with the oil port.

3. Lubricate the bearing surfaces and fit the crankshaft. Fit the crankshaft thrust bearings with the lubricating grooves facing the crankshaft.



4. Fit the main bearing caps according to their numbering (bearing lock in the block and in the cap are on the same side), the rear with thrust bearings provided with guide lugs. Lubricate the bolts and tighten them to **200 Nm**.

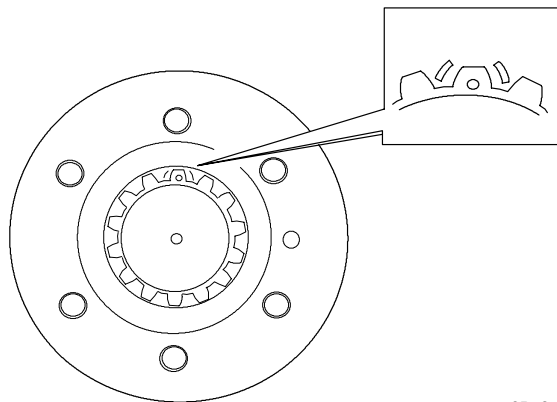


5. Check that the crankshaft can rotate without binding. Check the end float using a dial gauge. The correct end float is **0,10...0,35 mm**. If the end float is too large, oversize thrust bearings should be fitted.

Note! Bearing shells should never be reamed or machined in any other way, nor should the sides of the bearing caps be filed

Note! 320-engines. Tightening torque of screws of crankshaft counterweight is **160 Nm**. Apply locking fluid Loctite 2701 on the screw threads.

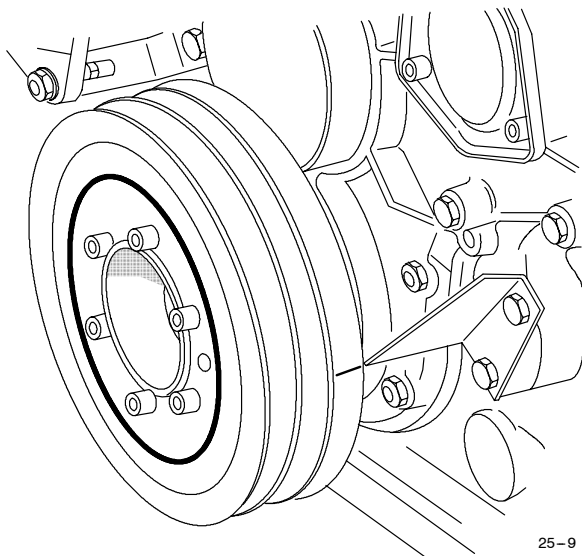
F. Crankshaft hub piece



25-8

When fitting the hub piece to the crankshaft front end note the correct position of the hub. (Engines with the timing mark on the crankshaft pulley/vibration damper.) The hub piece has an installation mark – on two teeth and the corresponding installation mark • of the crankshaft is on one tooth.

G. Changing crankshaft pulley/vibration damper



25-9

1. Loosen the alternator fixing screws and remove the v-belt.
2. Open the bolts of the pulley/vibration damper and remove the parts. The pulley/vibration damper is positioned to the crankshaft hub with a timing indicator (engines with timing mark on the pulley/vibration damper).

3. Fix the new vibration damper/pulley on the crankshaft. Tap the timing indicator in its place and tighten the fixing screws to a torque of **30 Nm**.

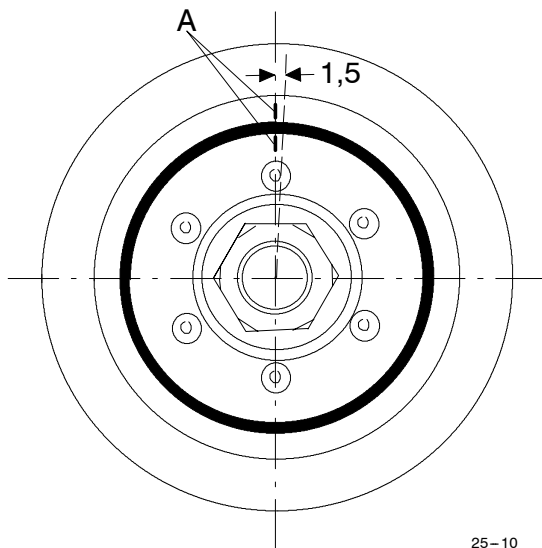
Note! Vibration dampers (pulleys) delivered as spare parts do not have injection timing mark. Make the marking on the new damper in connection with installation.

4. Rotate the crankshaft until the piston of the 1st cylinder reaches its top dead centre. Drop cyl. no 1 inlet valve down against the piston head. Set the dial gauge on top of the valve stem end and zero it at the piston top dead centre. Then rotate the crankshaft opposite to running direction until dial gauge shows about 15 mm below TDC. After that rotate the crankshaft slowly to running direction until the dial gauge shows the figure corresponding injection timing (see table below).

5. Mark the injection timing on the tip of indicator with an electric pen (**do not tap**).

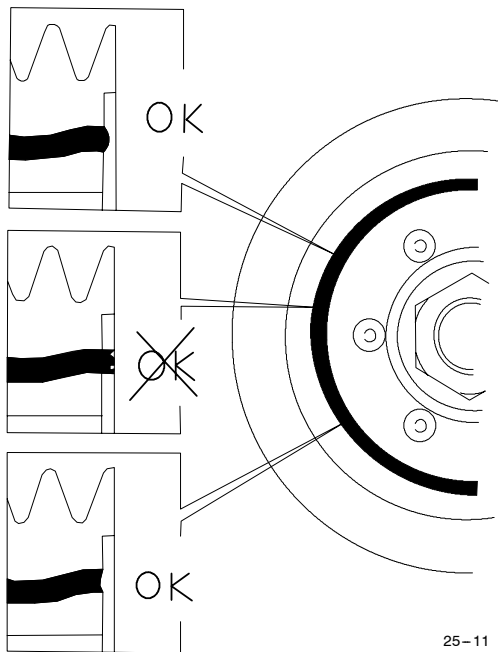
Piston distance from top dead centre vs. crank angle

Grad	320, 420, 620 mm	634 mm
1°	0,012	0,013
2°	0,047	0,054
3°	0,106	0,121
4°	0,188	0,216
5°	0,294	0,337
6°	0,423	0,485
7°	0,576	0,660
8°	0,752	0,861
9°	0,951	1,089
10°	1,173	1,344
11°	1,418	1,624
12°	1,686	1,931
13°	1,976	2,264
14°	2,289	2,623
15°	2,625	3,007
16°	2,983	3,417
17°	3,363	3,852
18°	3,765	4,312
19°	4,188	4,797
20°	4,633	5,307
21°	5,100	5,841
22°	5,587	6,399
23°	6,095	6,980
24°	6,624	7,585
25°	7,173	8,214
26°	7,742	8,865
27°	8,331	9,539
28°	8,939	10,235
29°	9,567	10,952
30°	10,213	11,692

H. Checking element of the rubber damper (620/420)

25-10

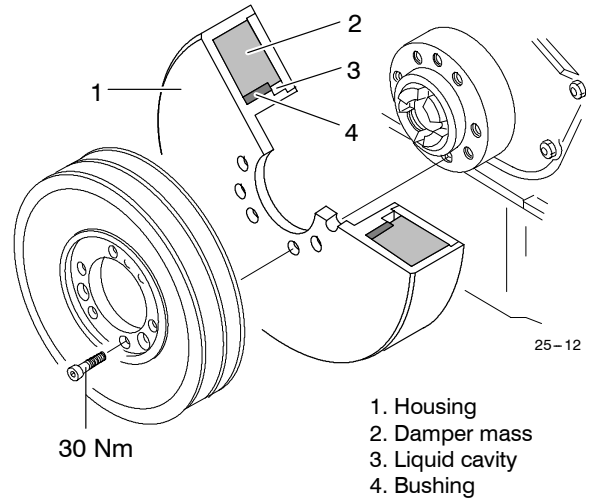
1. Check the alignment marks (A) on both sides of the rubber element. If the difference is more than **1,5 mm**, change the damper for a new one.



25-11

2. Check also the condition of the rubber element. If rubber pieces have been loosened from the element, rubber has been pressed to the depth of more than **3,5 mm** or the outer circumference is slack or it moves in the direction of the shaft, change the damper.

Note! Vibration damper should be replaced every 4000 running hours!

I. Viscose type vibration damper

- 1. Housing
- 2. Damper mass
- 3. Liquid cavity
- 4. Bushing

In the 634-engines and some 620-engine versions there is a vibration damper of so-called viscose type. Inside the damper there is a housing filled with stiff silicone oil in where the damping substance is situated with very small tolerances.

Note! Even a small dent makes the vibration damper inoperative. Do not remove it by turning forcibly and be careful not to damage it when it is loose. If you detect a dent on the outer surface, do not install the damper back in the engine.

Note! Mark the injection timing on the vibration damper with an electric pen (**do not tap**).

6. CONNECTING RODS AND PISTONS

A. Removing pistons together with connecting rods

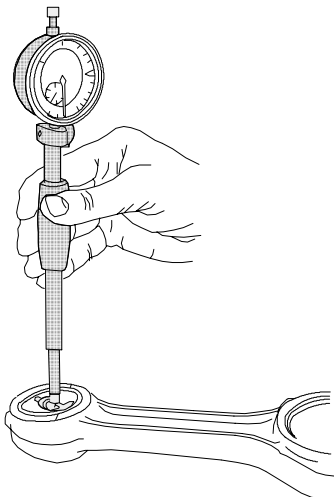
1. Remove the oil sump and the oil inlet and pressure pipes.
2. Remove the cylinder head.
3. Scrape off the possible soot in the cylinder liner. If the turning edge is clearly marked, smooth it down carefully with a scraper.
4. Remove the big-end bearing caps and bearing shells. Place the shells in order if they are to be re-used.
5. Push up the piston and connecting rod with the shaft of a hammer or similar wooden tool.
6. Remove the piston pin snap rings. Push out the pin.

Note! If the piston pin does not move under thumb pressure the piston should be heated to **100°C**.

B. Changing connecting rod bearings

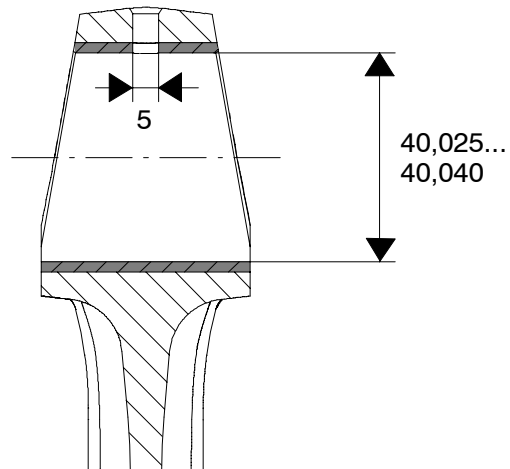
Piston pin bushing

1. Clean the connecting rod and bearing shells.



26-1/1

2. Measure the I.D. of the piston pin bushing using a cylinder gauge.
3. If the piston pin bushing is worn, it should be driven out using a suitable drift.



26-2

4. Press the new bush in its place. Ensure that the oil hole in the bush coincides with the respective hole in the connecting rod. After fitting drill $\varnothing 5$ mm oil hole and ream the bush to attain its correct diameter.

Note! The connecting rod can, if needed, be fitted with a **0,5 mm** oversize bushing (8353 28326). See technical data, point **connecting rod**.

Big end bearing

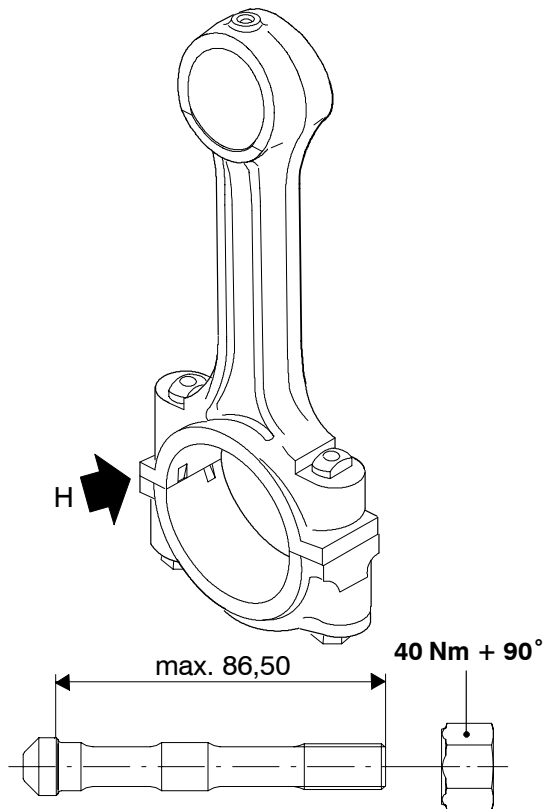
1. Fit the bearing shells together and tighten the screws.
2. Measure the I.D. using a cylinder gauge which has been zeroed to the diameter of the respective bearing journal. If the clearance exceeds **0,14 mm** with new bearing shells, the big end journals require grinding. Refer to the specifications for the correct undersize and the corresponding bearing. Ensure that the radii at the end of the bearing journals is not altered when grinding.

C. Checking connecting rod

The connecting rod is checked in a special fixture, intended for the purpose (e.g. Carl Larsson). See technical data, point **connecting rod**.

Note! If the connecting rod is damaged so that it has to be changed, please note the following:

- The earlier used connecting rod is replaced in production with a new type from engine number **L 11212**. In the new connecting rod the big end is split by the breaking technique.
- Single connecting rods are not interchangeable. As spare part the new connecting rod replaces the earlier only by changing the whole set.

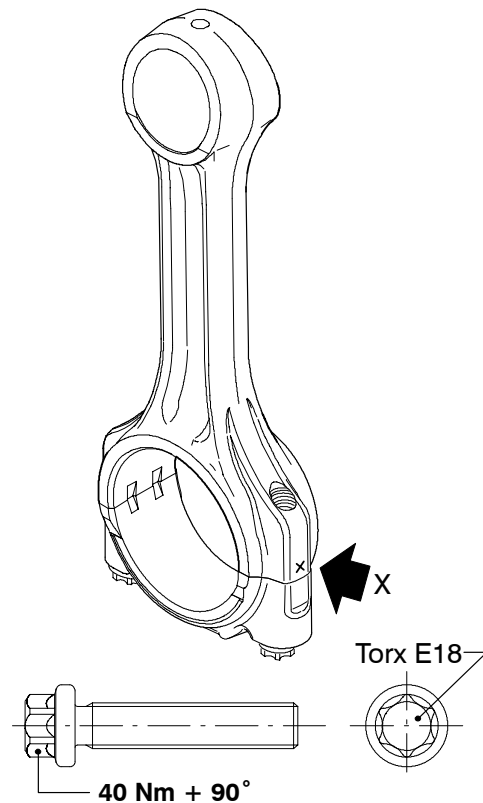
Earlier used connecting rod

Measure the length of the connecting rod screws. The length should be max **86,50 mm**. If the screw is longer, change it with a new one. It is recommended that the screws are always changed when they are unscrewed.

The connecting rods are divided into weight classes with intervals of **20 g**. The weight class (a letter) is stamped on the side face of the connecting rod. All the connecting rods in one engine should be of the same weight class, that is to say the greatest permissible weight difference is **20 g**.

The letters show the weight classes as follows:

Letter	Part no.	Weight
X	8366 47460	2150–2169 g
A	8366 52104	2170–2189 g
B	8366 52105	2190–2209 g
C	8366 52106	2210–2229 g
D	8366 52107	2230–2249 g
E	8366 52108	2250–2269 g
H	8366 52109	2270–2289 g
I	8366 52110	2290–2309 g
J	8366 52111	2310–2329 g
K	8366 52112	2330–2349 g
L	8366 52113	2350–2369 g
M	8366 52114	2370–2389 g
N	8366 52115	2390–2409 g
O	8366 52116	2410–2429 g
P	8366 52117	2430–2449 g
R	8366 52118	2450–2469 g
S	8366 52119	2470–2489 g
T	8366 52120	2490–2509 g
U	8366 52121	2510–2529 g

New connecting rod from engine number L 11212

Note! Always change the screws when opened.

The connecting rods are divided into weight classes with intervals of **20 g**. The weight class (a letter) is stamped on the side face of the connecting rod. All the connecting rods in one engine should be of the same weight class, that is to say the greatest permissible weight difference is **20 g**.

The letters show the weight classes as follows:

Letter	Part no.	Weight
F	8366 66430	1935–1954 g
V	8366 66431	1955–1974 g
X	8366 66432	1975–1994 g
Y	8366 66433	1995–2014 g
W	8366 66434	2015–2034 g
Z	8366 66435	2035–2054 g
G	8366 66436	2055–2074 g

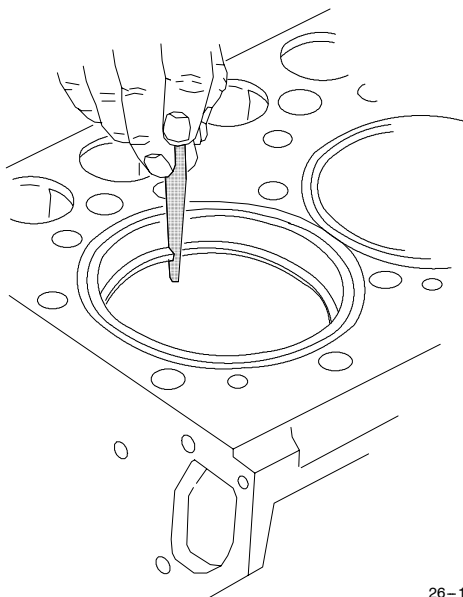
D. Changing piston rings

1. Remove the piston rings with piston ring pliers 9052 46900. Do not open the rings more than necessary. If the rings are to be used again ensure that they are fitted in the same groove.



26-9

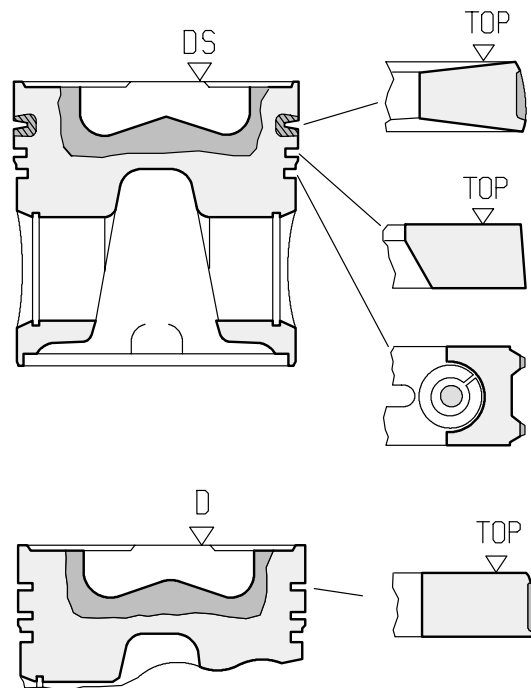
2. Clean the piston ring grooves and measure the piston ring clearance, which must not exceed **0,15 mm**. Determine whether too large a clearance is due to worn rings or a worn groove. Change worn parts.



26-10

3. Measure the piston ring gap by pushing one piston ring at a time into the cylinder bore. The piston ring gap must not exceed **1 mm** on 1. and 3. piston rings and **1,5 mm** on 2. piston ring.

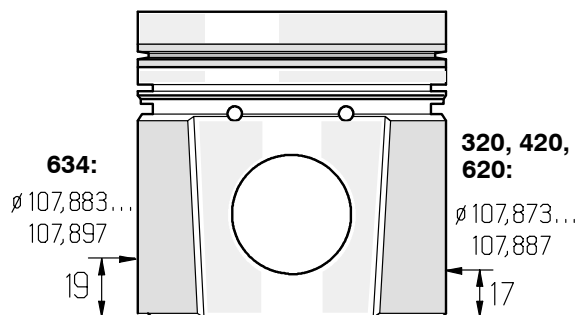
4. Fit the piston rings on the piston using the piston ring pliers. Ensure that the rings are fitted in the correct groove and that "TOP", or the manufacturer's designation, faces upwards.



26-11

E. Checking pistons

Check the condition of the pistons and piston pins. Pay special attention to possible cracks on the edge of the combustion chamber and on the upper edge of the piston pin hole. Measure the diameter of the piston at the point shown in the figure below. Renew a piston if needed.

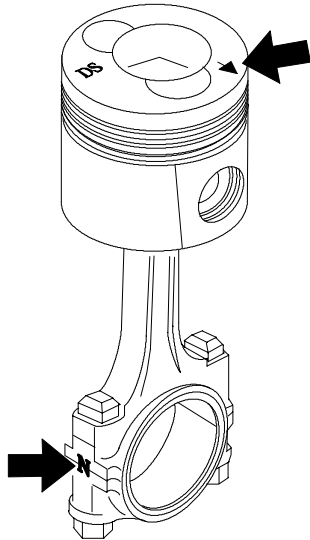


26-12

F. Fitting piston pin

1. Place the connecting rod inside the piston and push the piston pin into place.

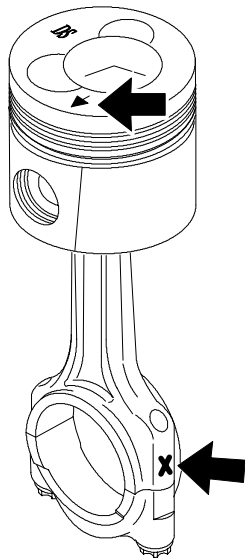
Earlier used connecting rod



26-13

The combustion chamber and the weight class letter should be on opposite sides.

New connecting rod



26-13/1

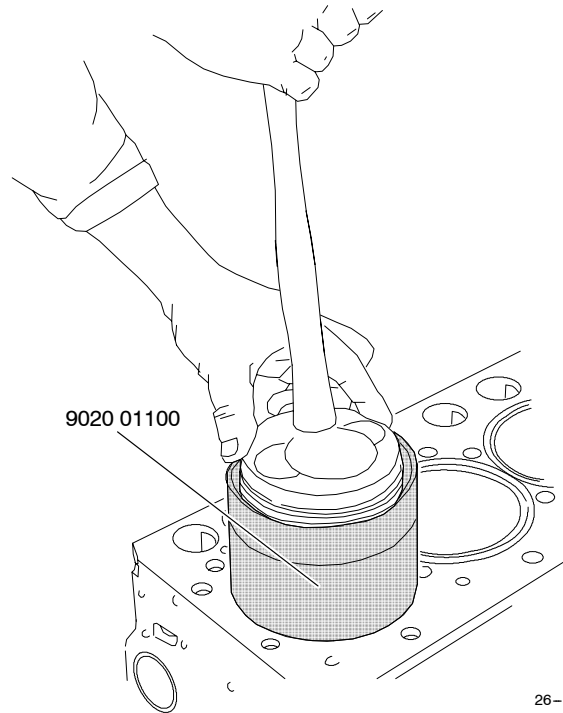
The combustion chamber and the weight class letter should be on same side.

2. Fit the piston pin circlips. Ensure the the circlips are pressed correctly into the grooves. The circlip ends must point upwards.

G. Fitting piston together with connecting rod.

1. Check that the bearing locations are clean and place the bearing shells in the connecting rod and bearing cap. Note the position of the bearing shells.

2. Lubricate piston, rings and cylinder bore. Ensure that the piston ring gaps are spread around the piston.



26-14

3. Use a piston ring strap or preferably a fitting tool. Fit the piston with the marking on the connecting rod (weight class) facing the camshaft (an arrow on the piston must point forward).

4. Lubricate the big-end bearing journal and bearing shells, and push the piston down. Fit the bearing cap so that the notches for the guide lugs are in the same side. Tighten the connecting rod screws to **40 Nm + 90°**.

5. Check that the connecting rod has sufficient end float on the big-end bearing journal.

7. COUNTERBALANCE (420)

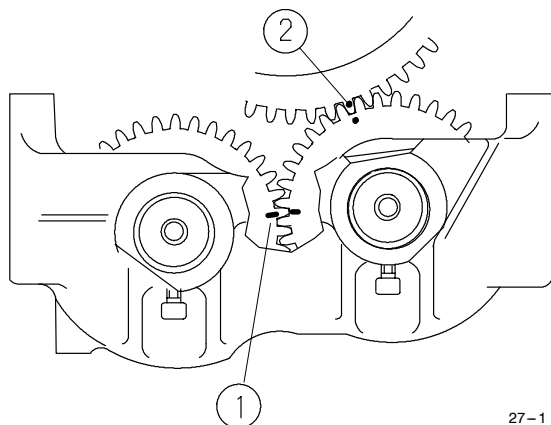
A. Removing and disassembling counterbalance unit

1. Remove the oil sump
2. Disconnect the lubricating oil pipe of the counterbalance unit.
3. Remove the counterbalance unit. Take care of any shims.
4. Loosen the locking screws and press out the shafts in the direction of the locking screws. Remove the counterweights and thrust washers.
5. Clean all parts.

B. Reconditioning counterbalance unit

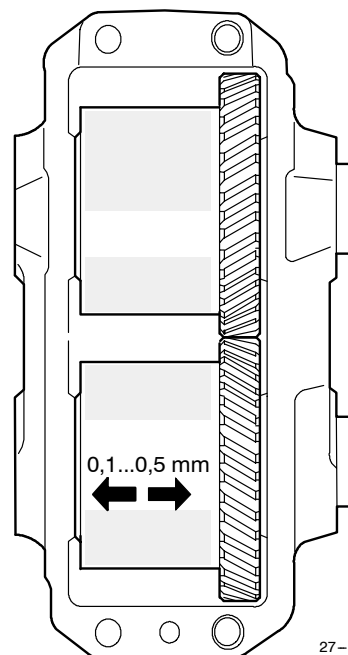
Check the shafts, gear wheels and bushings for wear and damage.

1. If one of the gear wheels is damaged, change both counterweights as a complete unit. The gear wheels are not available separately as a spare part.
2. Remove, if necessary, the old bearing bushings with a suitable drift. Before removing them, mark the position of the bushing oil groove on the counter weigh. Press in new bushings in the correct position. After fitting the bushings should be reamed to a correct dimension, see Specifications.



1. Synchronisation marking (notch)
2. Marking against crankshaft (punch mark)

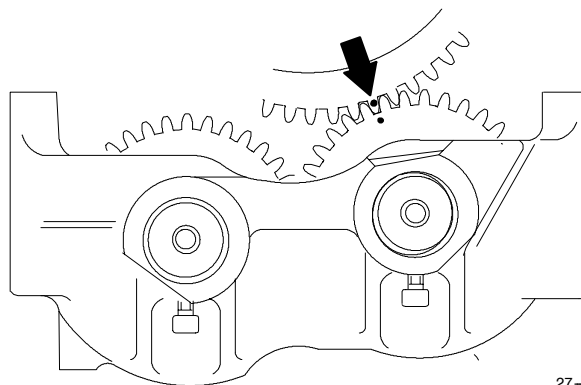
3. Place the weights in the body, observing the notch markings. The gear wheel with the punch mark runs against the crankshaft and should therefore be placed highest. Insert the shafts, remembering the thrust bearings. Apply thread lock fluid Loctite 270 to the locking screws, and lock the shafts.



4. Check that the tooth backlash is **0,05...0,25 mm** and that the end float is **0,1...0,5 mm**

C. Fitting counterbalance unit

1. Fit the tension pins to the cylinder block.



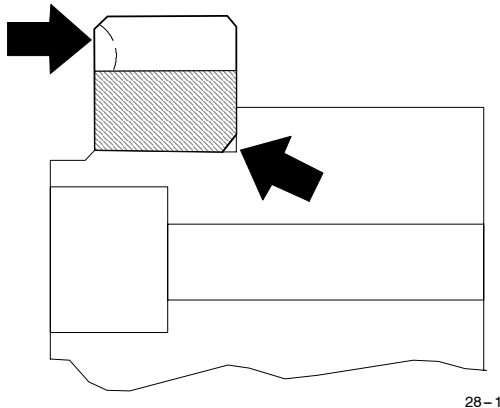
2. Turn the crankshaft and weights so that the markings agree, and lift the unit into place.
3. Tighten the bolts to **60 Nm**. Check that the tooth backlash between the crankshaft and counterweight is **0,1...0,3 mm**. The backlash can be increased by placing shims 0,2 mm thick (order no 8361 19920) between the cylinder block and balancer unit body. One shim (0,2 mm) changes tooth backlash about 0,07 mm.
4. Fit the lubricating oil pipe, using new seals.
5. Fit the oil sump.

8. FLYWHEEL

A. Changing starter ring gear on flywheel

If the ring gear is worn, change it with a new one. The ring gear cannot be turned around because its teeth are chamfered and hardened on the starter motor side.

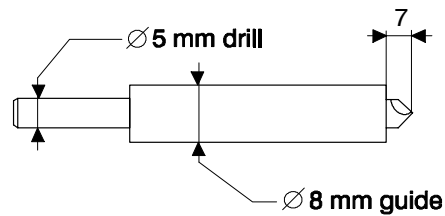
1. Remove the old starter ring by tapping it at various points with a drift. Clean the flywheel contact face with a steel-wire brush.



Note! E-engine's flywheel delivered as spare parts do not have injection register mark. Make the marking on the new flywheel in connection with installation.

– Rotate the crankshaft until the piston of the 1st cylinder reaches its top dead centre. Drop cyl. no 1 inlet valve down against the piston head. Set the dial gauge on top of the valve stem end and zero it at the piston top dead centre. After that rotate the crankshaft slowly to running direction until the dial gauge shows **4,633 mm ATDC** (420, 620) or **5,307 mm ATDC** (634).

– Bore the injection register mark hole by a drill (see picture below) to the flywheel.



2. Warm the ring gear to the temperature of **150...200 °C**. Fit the ring gear with the inner diameter chamfering turned against the flywheel and the teeth chamfering against the starter motor.

3. Allow the ring gear to cool freely without using any coolant.

B. Fitting flywheel

Note! In E-engines the injection register mark is marked on the flywheel. The flywheel has been positioned to the crankshaft with aid of guide sleeve.

1. Clean the contact surfaces on the crankshaft rear flange and on the flywheel.

2. Fasten the flywheel to the crankshaft rear end. As a guide pins can be used studs (M12, 2 pcs) which are screwed in to the flywheel fixing bolt holes. The position of the flywheel is free in engines where the injection timing is marked on the crankshaft front end. In some engine versions one of the retaining screws have been replaced by a guide pin to determine the crankshaft position.

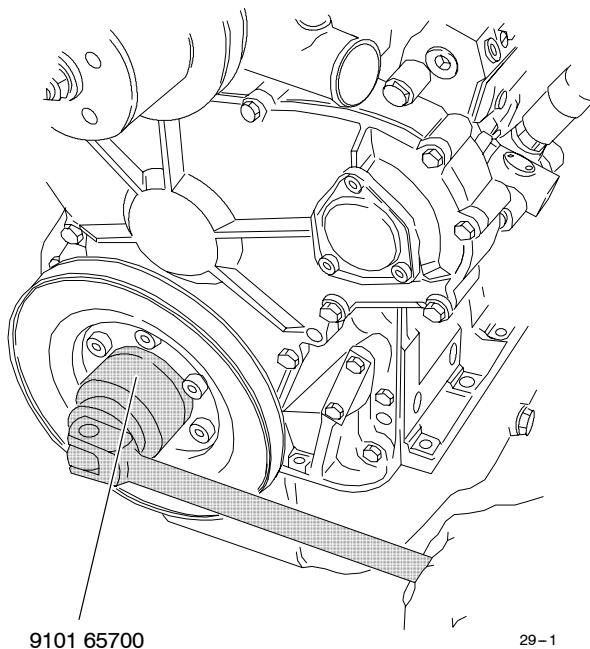
3. Tighten the flywheel retaining screws evenly to a torque of **140 Nm** (10.9) / **150 Nm** (12.9).

9. TIMING GEAR ASSEMBLY

A. Removing timing gear casing

As the timing gear casing bottom face forms a part of the mating face for the oil sump gasket, the casing cannot be removed without first removing the oil sump.

1. Remove the oil sump.
2. Remove the radiator, fan, alternator, belt tensioning and belt (if not removed earlier). If the engine is equipped with a air compressor or air conditioner, it has to be removed.



3. Loosen the crankshaft nut (special tool 9101 65700 for 320, 420, 620-engines and tool 9024 55800 for 634 engines) and remove the belt pulley/hub.

Note! On 620-engines the belt pulley must be removed before unscrewing the nut. If the 620-engine is equipped with a viscose damper, the front end nut is opened with tool 9024 55800.

4. Remove the drive unit and hydraulic pump (if installed).
5. Remove the timing gear casing cover and the oil deflector ring at the front end of the crankshaft.
6. Remove the injection pump.

Note! If the timing gear casing is not to be changed, the injection pump can remain in place. In which case disconnect all leads and pipes from the pump.

7. Unscrew the idler gear bolts (17 and 22 mm). Remove the flange, gear wheel and bearing journal.

8. Extract the camshaft.

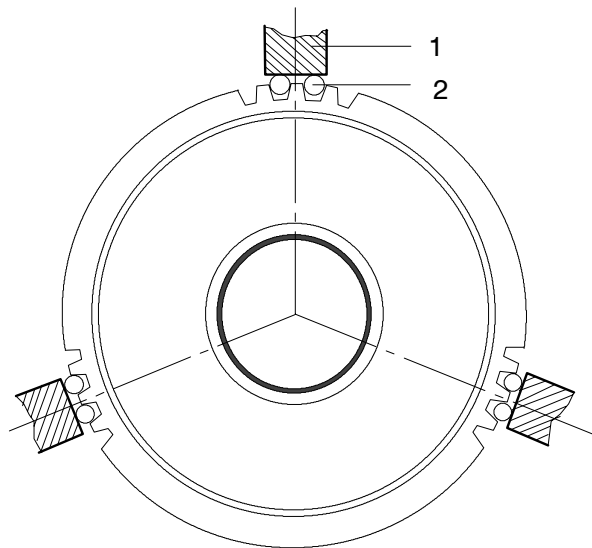
Note! If the cylinder head and valve mechanism have not been removed, the tappets must be prevented from falling down, see instruction point 4 B.

9. Remove the timing gear casing. Ensure that all sealing surfaces are not damaged.

10. Remove the crankshaft front sealing ring from the front casing and clean all the parts that have been removed.

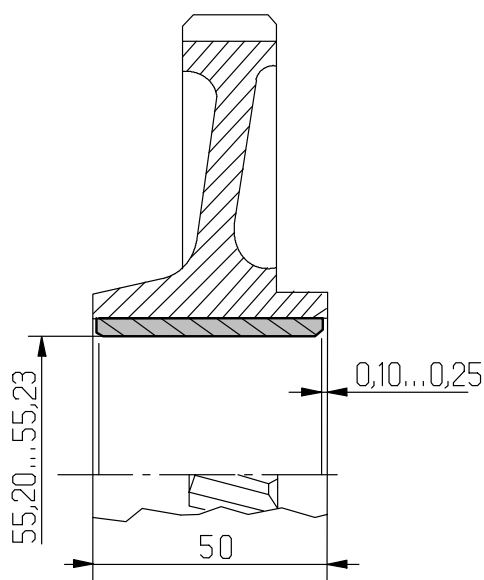
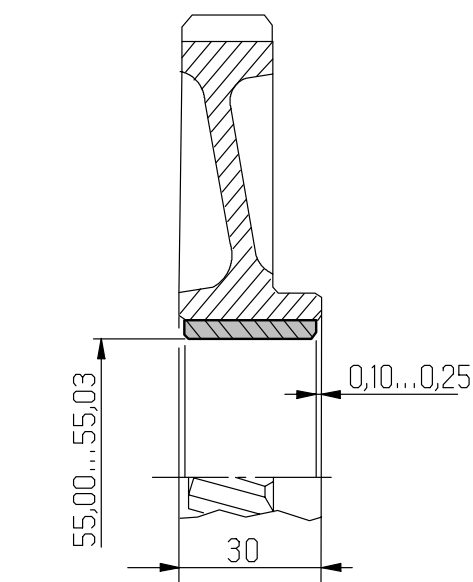
B. Reconditioning idler gear

If the idler gear bushing is changed, press in a new bushing so that its rear edge is **0,1...0,25 mm** inside the gear wheel rear edge (see picture on next page).



1. Chuck of lathe
2. Roller $\varnothing=5$ mm

Machine the idler gear bushing inner diameter to a correct dimension after fitting. Centre the idler gear according to figure above so that tooth backlash is kept the same.

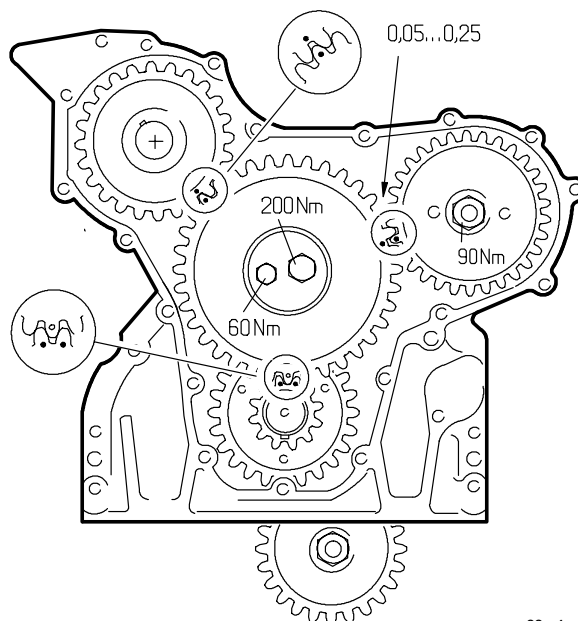


29-3

C. Fitting timing gear casing

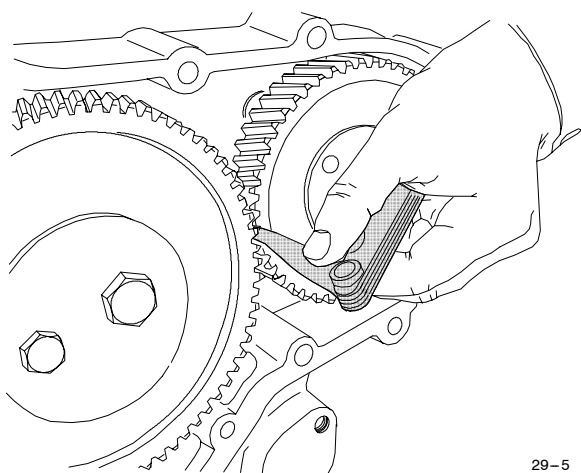
The position of the timing gear casing and cover is determined by two tension pins. Therefore centring should not be undertaken in connection with fitting. However, the tooth backlash between the different gears should be checked. Casing and covers that are delivered as spare parts also have holes for the tension pins already machined.

1. Fit the casing with a new gasket against the cylinder block. Drive in the tension pins with drift 9025 98700. Tighten bolts and nuts.
2. Fit the injection pump together with gear wheel (if removed).
3. Lubricate the camshaft bearings and insert the shaft in the cylinder block. Release the pushrods and tappets if they have been suspended.



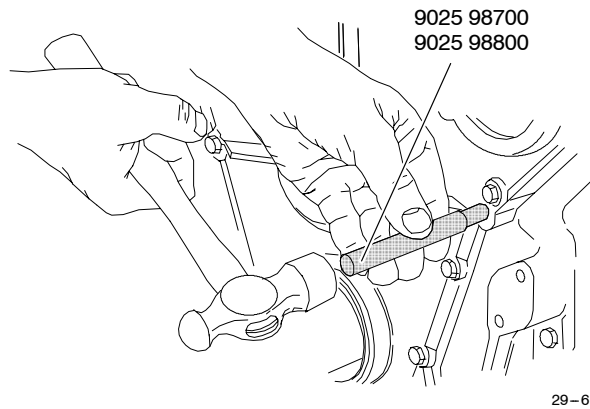
29-4

4. Fit the idler gear with shaft stud and ensure that the markings are in the correct position. Fit the washer and tighten the bolts to the correct torque.

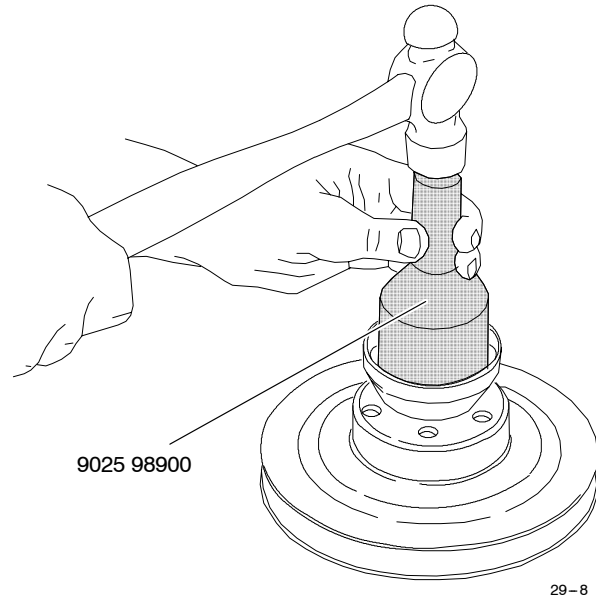


29-5

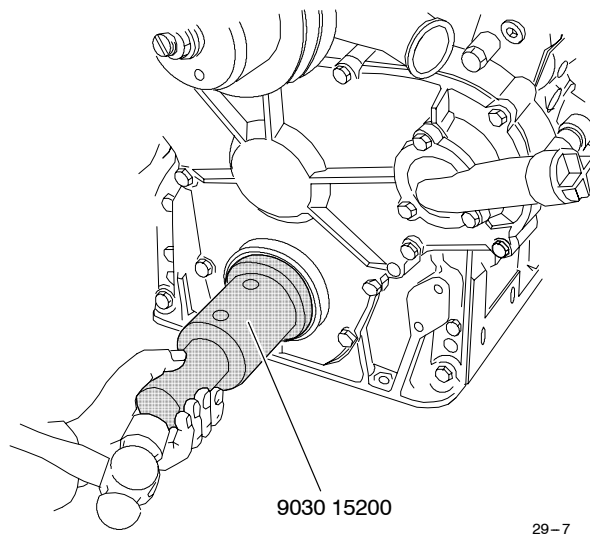
5. Check the tooth backlash which should be **0,05...0,25 mm**.



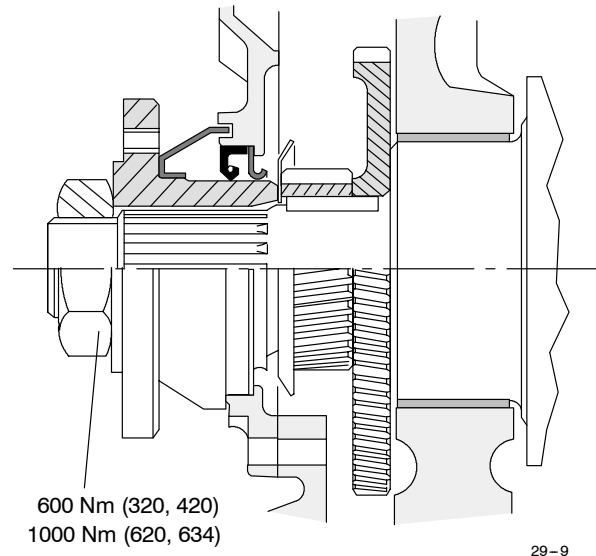
6. Fit the oil deflector ring on the crankshaft and fit the timing gear casing cover using a new gasket. Drive in the tension pins with drifts 9025 98700 and 9025 98800 respectively (the tubular pin round the screw stud). Tighten bolts and nuts.



8. Fit the dust shield on the crankshaft V-belt pulley hub, if it has been removed. Use drift 9025 98900.



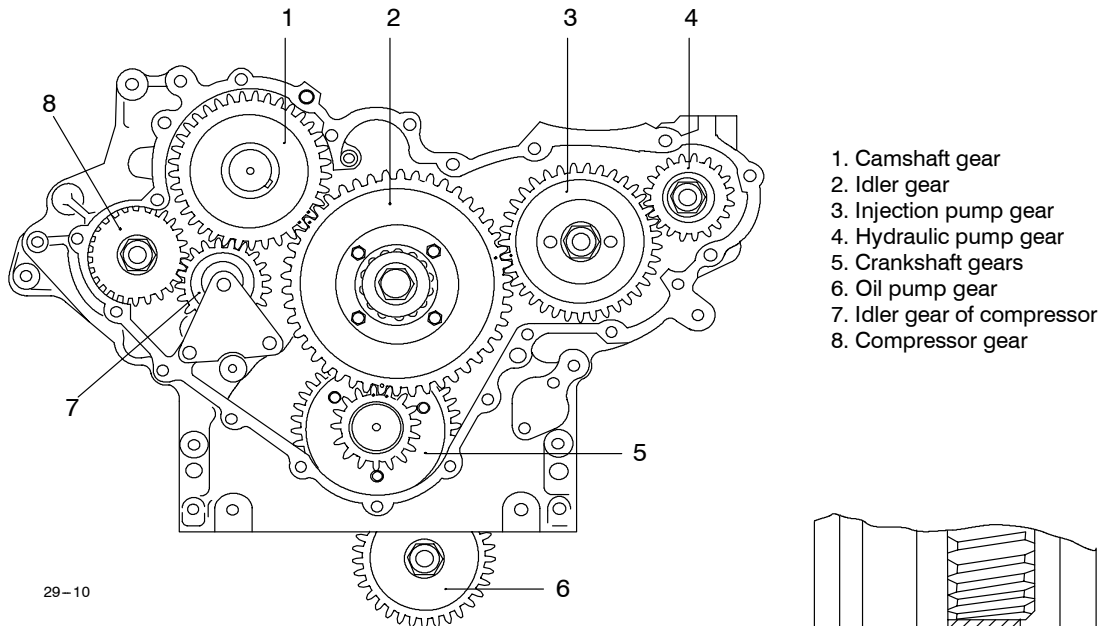
7. Fit the protective plate into the seal location and fit the crankshaft front seal with special tool 9030 15200.



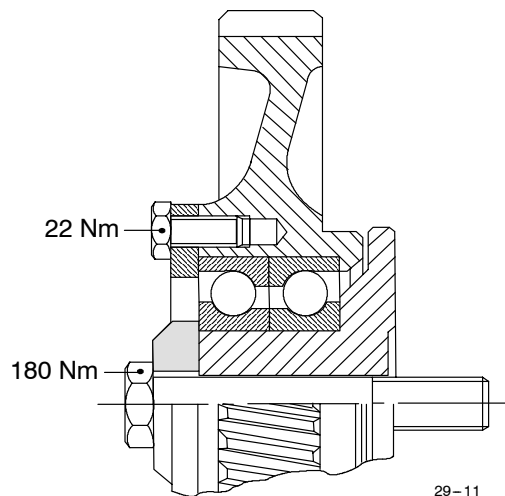
9. Lubricate both the seal and sealing surfaces and fit the crankshaft V-belt pulley with hub.

10. Lubricate the crankshaft nut threads. Tighten the nut to **600 Nm** on 320- and 420-engines and **1000 Nm** on 620 and 634 engines.

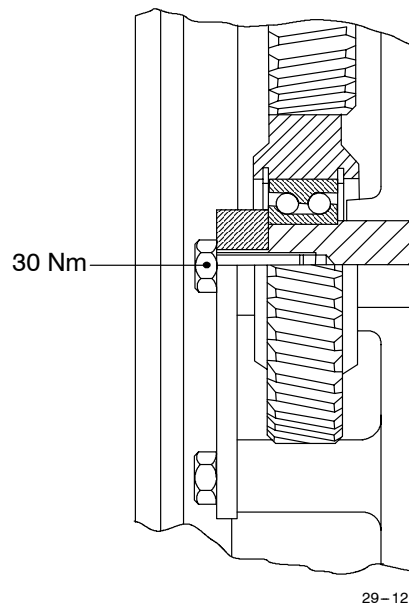
11. Fit the other detached parts.

D. Idler gear with bevelled ball bearings

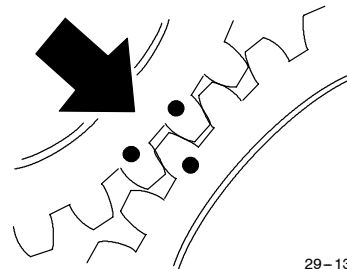
In some 620/634-engines versions bevelled ball bearings are need in the idler gear. The two-cylinder compressor, fitted to the gear housing, is run trough a separate rear.



1. Fit the idler gear bearings, as the picture shows, pressing from the outer ring. Fit the holding ring and tight the bolts, lightly oiled, to **22 Nm**. Press the shaft to its position supporting the bearing from the inner ring. The idler gear screw tightness is **180 Nm**.



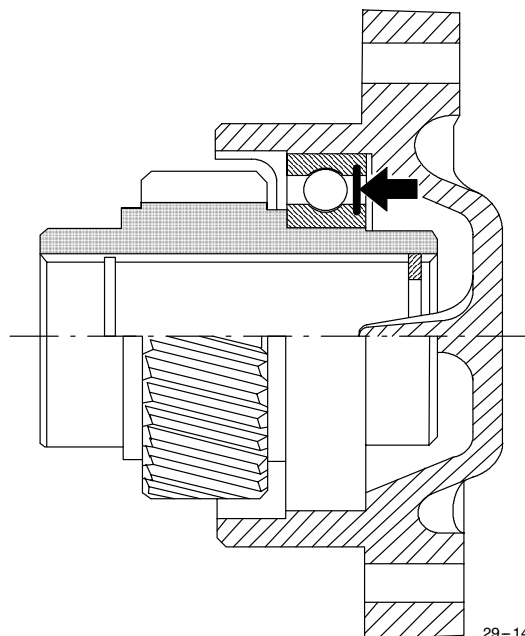
2. If the compressor gear shaft has been removed, apply on its outer face Loctite 601 and hit the shaft in its position so that the shaft and gear housing back surfaces are at the same level. Fit the bearing and the gear so that the groove of the bearing inside ring comes outwards. Remember the lock rings! Fit the retaining ring and tighten the screws to **30 Nm**.



3. Note when assembling the camshaft, the timing mark that differs from the other engines.

E. Power take-off

In the 20/34-series engines is used a transmission that can be equipped with a P.T.O. run from the camshaft gear. The P.T.O. can run e.g. a hydraulic pump.



Note when assembling the P.T.O. the front bearing seal position.

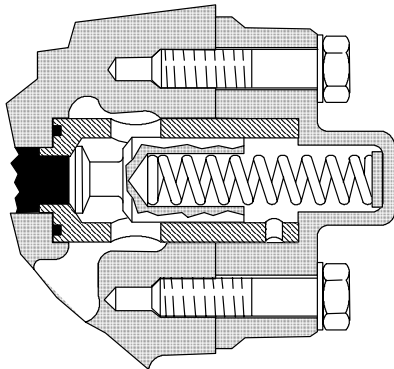
Use molybdenite-sulphide (MoS_2) ball bearing grease (NLGI 2) for the grooves of the hydraulic pump shaft and the coupling sleeve.

Note! Some P.T.O. are equipped with an outer lubricating possibility (pipe). In this case the front bearing is not sealed (like in picture). This P.T.O. is known from the M6x1 thread in the cover.

10. LUBRICATION SYSTEM

A. Reconditioning of oil relief valve for lubricating oil pressure

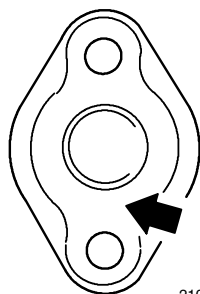
If the engine lubricating oil pressure is insufficient or if it varies, the relief valve should be checked after first checking the oil level.



1. Remove the cover over the valve and spring. Take care of the washer between the cover and spring. Remove the valve insert together with the valve cone and ensure that the o-ring is also removed.

2. Clean the parts and check that the valve cone slides freely in the insert and that the sealing surface are undamaged. Minor damage can be adjusted, but in general, damaged parts should be changed. Scrape off any remains of the gasket.

3. Assemble the valve with a new o-ring and insert it in the cylinder block. Place the washer and spring in the cover and fit it with a new gasket.

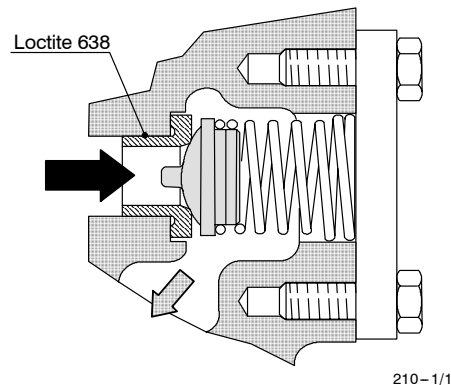


4. Note that the relief valve cover is not symmetrical. The greater distance between the spring housing and bolt should be turned downwards.

Note!

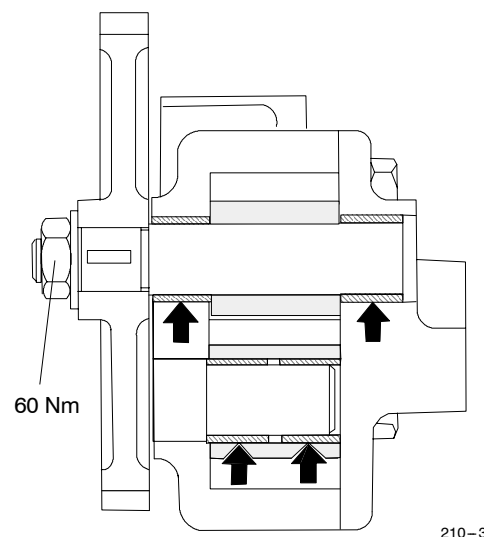
From engine no. J 7595 (engines without oil cooled piston)
From engine no. J 14016 (engines with oil cooled piston)

The engines are equipped with a new type of oil pressure valve. In the construction of the new valve the hydraulic vibrations are damped, it is more reliable and it gives the best, optimised pressure level.



B. Removing and dismantling lubricating oil pump

1. Drain the engine oil and remove the oil sump.
2. Remove the oil pump suction and pressure pipe.
3. Remove the oil pump together with any shims between the pump and the cylinder block.
4. Remove the pump cover and the gasket. Remove the gear on the dead axle.
5. Clamp the pump gear across the teeth in a vice fitted with soft jaws, and loosen the drive gear nut. Knock the gear wheel off by hitting the end of the shaft with a soft hammer. Pull out the drive shaft—gear wheel
6. Clean the parts and check for wear and other damage. Compare with the specifications. Change damaged parts and all seals.



7. On 620/634—engines the bearing points are provided with separate bearing bushings. If You change the bushings, machine them to dimension of **18,000...18,018** after fitting.

Note!

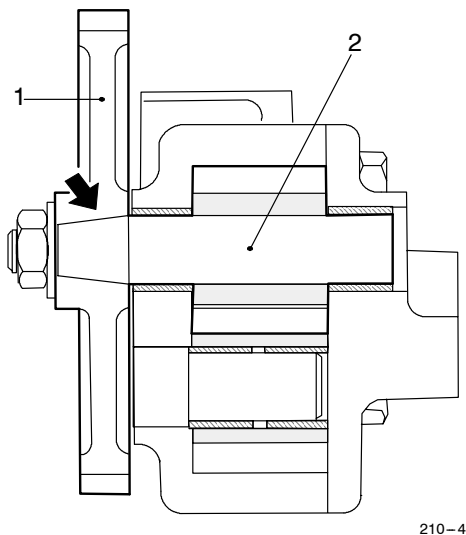
320—engines from engine number C 1474

420—engines from engine number C 1328

620—engines from engine number C 1133

The connection between the gear and shaft in the lubrication oil pump has been modified to a conical connection without key.

The new gear and shaft/gear combination can be used as a pair in pumps of earlier type.



1. Gear
2. Shaft/gear

Note!

620/634 engines from engine number J 7891.

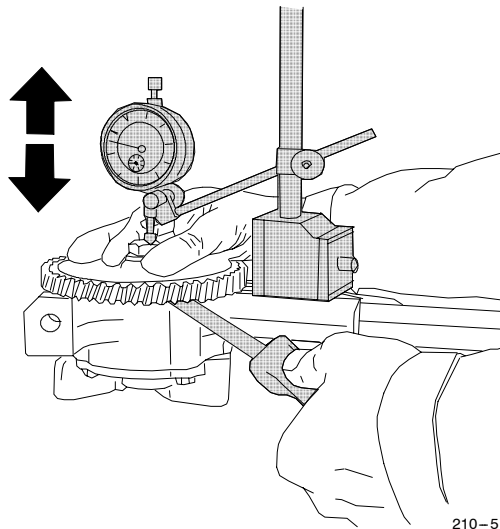
As a part of the standardization process all 6-cyl. engines are now fitted with the same oil pump. The pump 8368 52607 in 620 engines and 8363 38187 in 634 engines has been replaced with 8368 55300.

The new pump can be used also in older 6-cyl. engines, when suction and pressure pipes are replaced as well (location of pipe connection is different in respect to crankshaft center line).

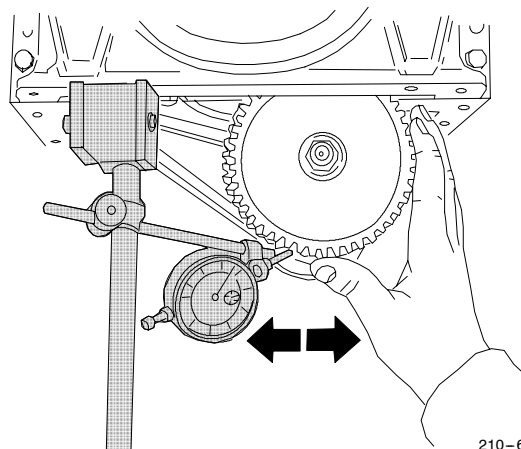
C. Assembling and fitting lubricating oil pump

1. Fit the gear wheels in the pump body. Fit the cover using a new gasket. Partly tighten the bolts. Rotate the pump shaft and tap the side of the cover lightly until the position is reached where the shaft rotates most freely. Tighten the bolts and check that the shaft still rotates freely.

2. Fit the key and drive gear onto the shaft (tapered joint without key on the later pumps). Apply Loctite 242 onto the nut threads and tighten the nut to **60 Nm**. Remember the washer under the nut.



3. Fasten the oil pump in a vice and check the end float between gear and pump housing. The clearance which should be **0,03...0,11 mm**, is adjusted by the number of gaskets between the cover and body.



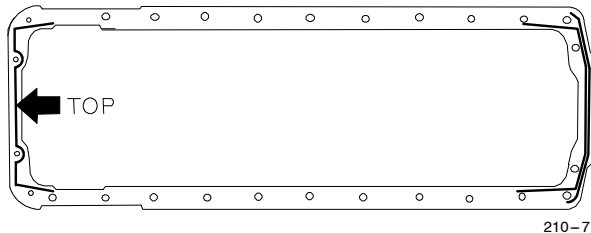
4. Fit the pump and check the tooth backlash against the crankshaft gear. The clearance, which should be **0,05...0,25 mm**, is adjusted with shims between the pump body and the cylinder block (shim 0,2 mm, order no 8360 07871). One shim increases/decreases the backlash about 0,07 mm.

Note! When measuring the tooth backlash, the engine should be the correct way up as the crankshaft bearing clearance affects the tooth backlash.

5. Connect suction and pressure pipes together with new seals. Fit the oil pump and fill in the lubrication oil.

D. Fitting oil sump gasket

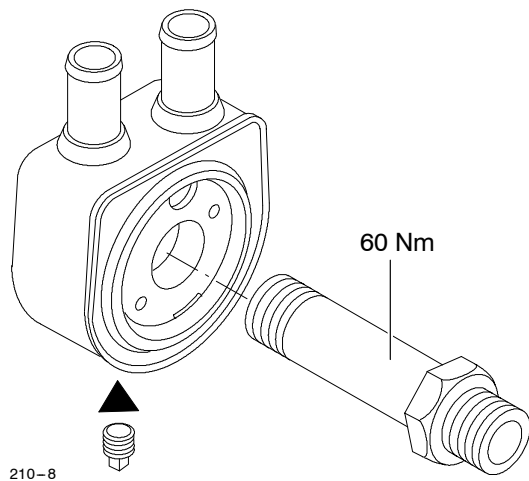
Fit the oil sump gasket with the silicone stripes against the cylinder block (self carrying and casted oil sumps).



E. Lubricating oil cooler

Some engines are equipped with a oil cooler, positioned in between the oil filter and the cylinder block.

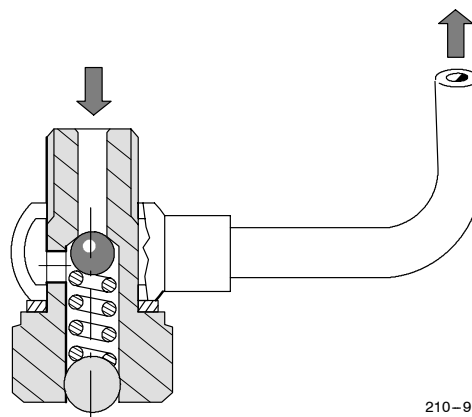
1. The engine coolant should be drained before removing the lubricating oil cooler.



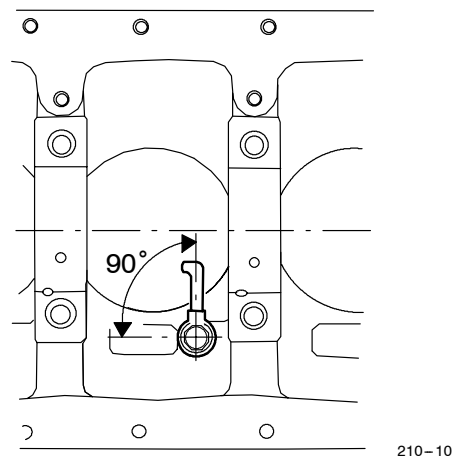
2. Fit new sealing rings. Fit the cooler with draining plug turned downwards. Connect coolant pipes in the correct way.
3. Apply locking fluid to the nipple (the thread which attaches to the filter head) and tighten it to a torque of **60 Nm**.

F. Piston cooling nozzles (620/634)

The cooling nozzles can be removed after removing the oil sump. The nozzles have a ball valve with an opening pressure of **3±0,25 bar**.



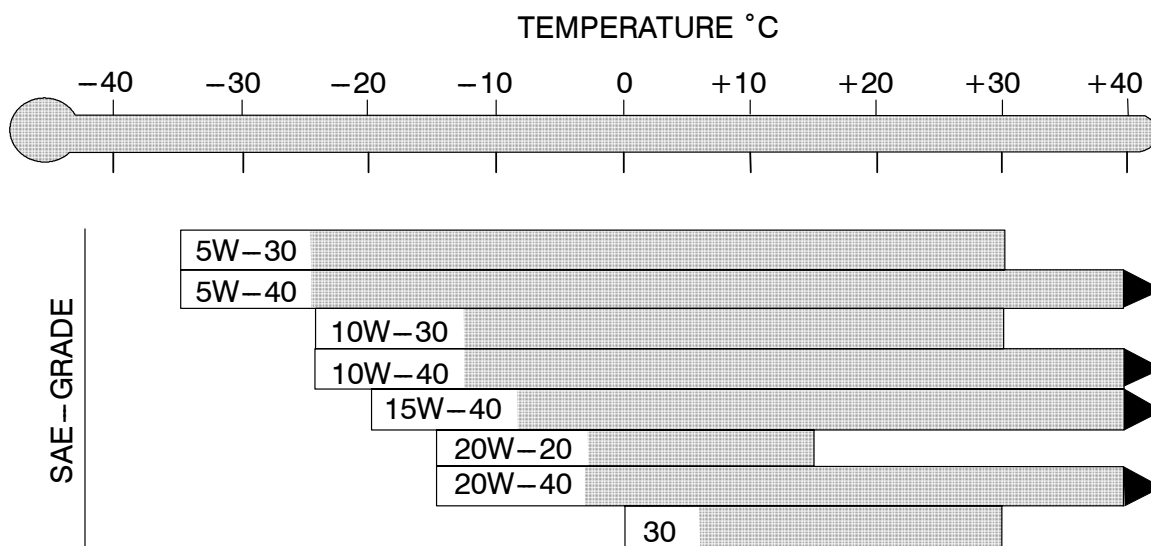
1. Change the valve if necessary. Detach the valve from the engine and remove the nozzle pipe. Fit a new valve.



2. Fit the nozzle pipe at the angle of **90°** to the centre line of the crankshaft according to the above picture. Tighten the valve to **30 Nm**. Ensure that the pipe does not touch the pistons or connecting rods when the engine is running.

G. Lubricating oil quality requirements

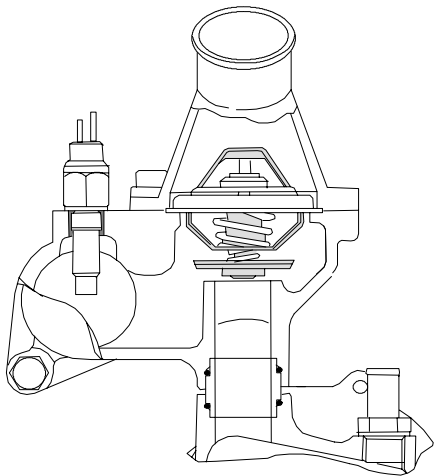
- | | | |
|--|-----------------------------|------------------------------------|
| - Naturally aspirated and turbocharged engines | API CF-4, CG-4, CH-4 | ACEA E2/E3-96, E4-98, E5-99 |
| - Low emission (E) engines | API CG-4, CH-4 | ACEA E3-96, E4-98, E5-99 |



210-11

11. COOLING SYSTEM

A. Thermostat

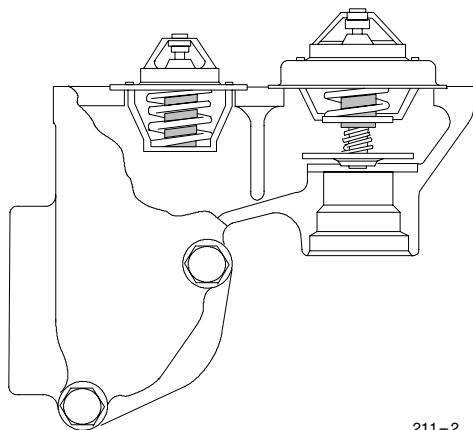


211-1

The thermostat is of a two-way type. Its opening temperature is 79°C. In winter a thermostat can be used with an opening temperature of 83°C.

Check the function of the thermostat as follows:

- Lower the thermostat into a vessel of boiling water so that the thermostat does not touch the sides or bottom.
 - Opening must begin under 20 seconds.
 - The thermostat must be fully open under 50 seconds.
- Stroke, see specifications point **thermostat**.

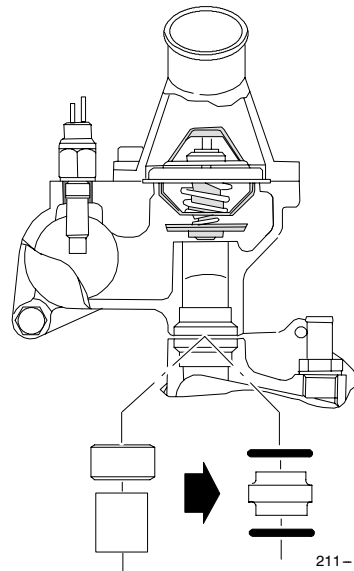


211-2

Some 620/634-engines have two separate thermostats. These are separated from the type of the single thermostat and they are not interchangeable. To these engine there are no separate winter thermostats.

Note! Modification of the by-pass pipe.

320/420-engines from engine number D 3056
620-engines from engine number D 3532

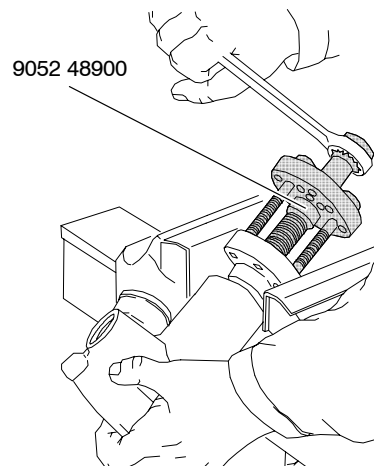


211-3

The rubber seal ring between the coolant pump and the thermostat housing has been modified to two o-ring seals. At the same time also the by-pass pipe is modified. The new parts can, during a repair, be installed instead of the earlier used.

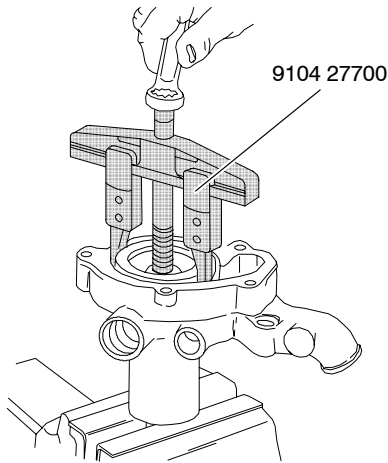
B. Reconditioning coolant pump (320, 420)

1. Drain the engine coolant. Disconnect the water hoses from the thermostat housing and from the coolant pump. Remove the thermostat housing and the by-pass pipe.
2. Slacken the alternator fixing bolts. Remove the fan and the pump belt pulley. Remove the v-belt.
3. Detach the coolant pump. Remove the pump rear plate and clean the sealing surfaces.



211-4

4. Remove the fan hub using puller 9052 48900. Remove the circlip from the pump body.



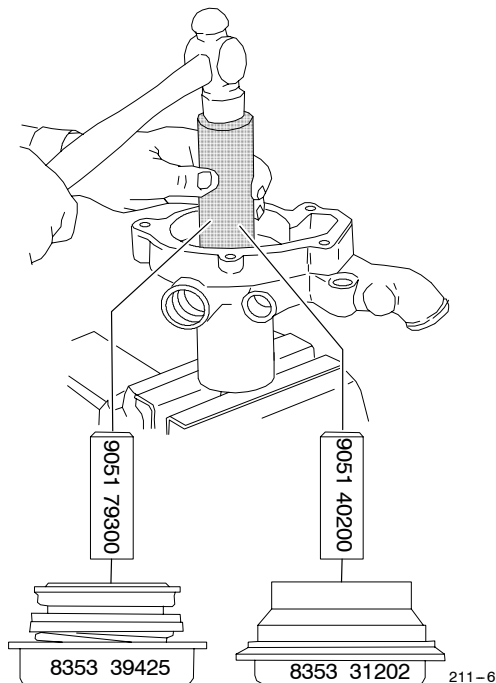
211-5

5. Remove the impeller using puller 9104 27700. Press the shaft out of the pump body in the direction of the fan. Use a hydraulic press. Support the body so that the shaft bearing unit has enough space for releasing.

6. Tap out the axial seal in the body using a suitable drift. Clean all parts and inspect their condition. Replace damaged parts with new ones.

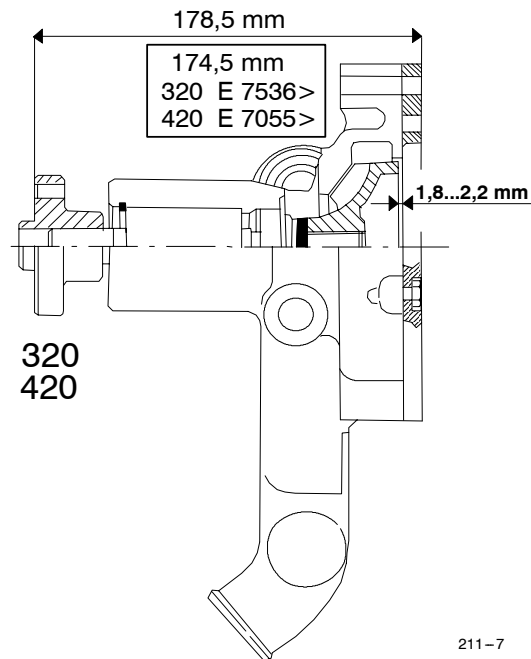
Note! If the pump shaft has to be changed, use a reconditioning kit. This kit also contains all seals (see Parts Catalogue).

7. Press the shaft into its location in the body using special tool 9051 64900 and fit the circlip.



211-6

8. Fit the axial seal. Use as a "lubricating liquid" coolant between the shaft and the seal. Two different seal types are used. Both these seals are fitted with their own drift (see figure above).



211-7

9. Press the impeller and the hub to the correct depth (see figure) and support the shaft at the other end. Ensure that the shaft can rotate freely. Fit the rear plate using a new gasket.

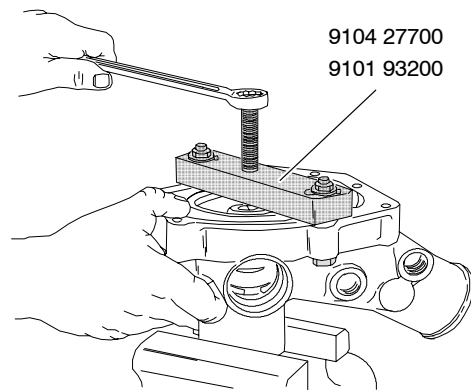
C. Reconditioning coolant pump

(Separate ball bearings 320, 420, 620, 634)

1. Drain the coolant. Remove the thermostat housing, fan and the v-belt.

2. Remove the coolant pump. Detach the pump rear plate and clean the sealing surfaces.

3. Unscrew the belt pulley fixing nut and remove the belt pulley. Use puller 9052 48900 if needed.



211-8

4. Remove the impeller on the shaft with puller 9104 27700 (320/420-engines) or 9101 93200 (620/634-engines).

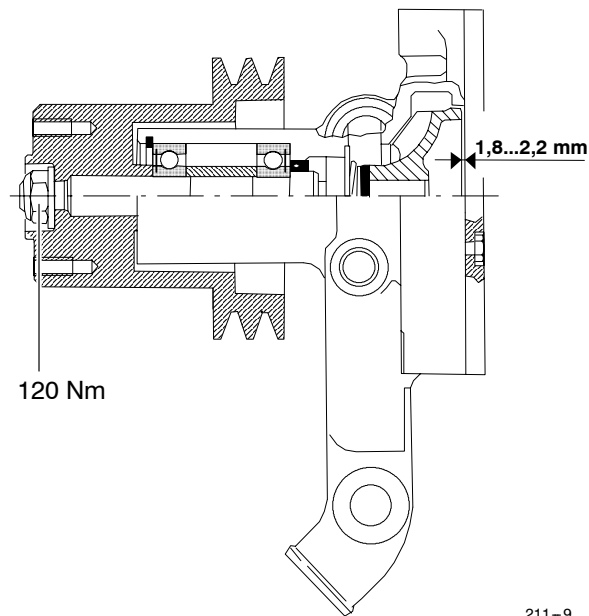
5. Remove the circlip in the pump body. Press the shaft together with bearings in the direction of the fan. Use e.g. a hydraulic press. Support the pump body so that the bearings have enough space for releasing.

6. Tap out axial and shaft seals using a drift. Clean the parts and inspect their condition. Replace faulty or worn parts with new ones.

Note! If the pump bearings have to be changed, use a reconditioning kit. This kit also contains all seals (see Parts Catalogue).

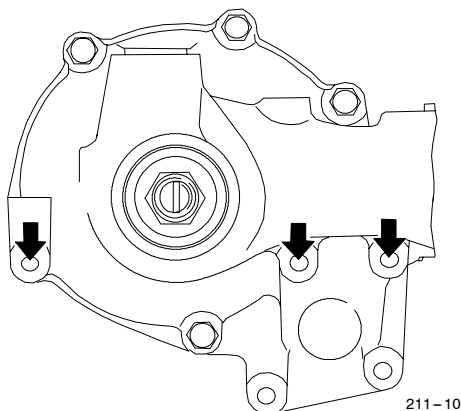
7. Drive in the new shaft seal in the housing using a suitable drift. Put the bearings and the intermediate sleeve onto the shaft. Grease bearings with heat-resistant ball bearing grease. Fit the shaft and the bearings in such a way that the pressing force is not transmitted by the bearing balls. Fit the circlip for the bearing.

8. Fit the axial seal, see instruction 11 B point 8.



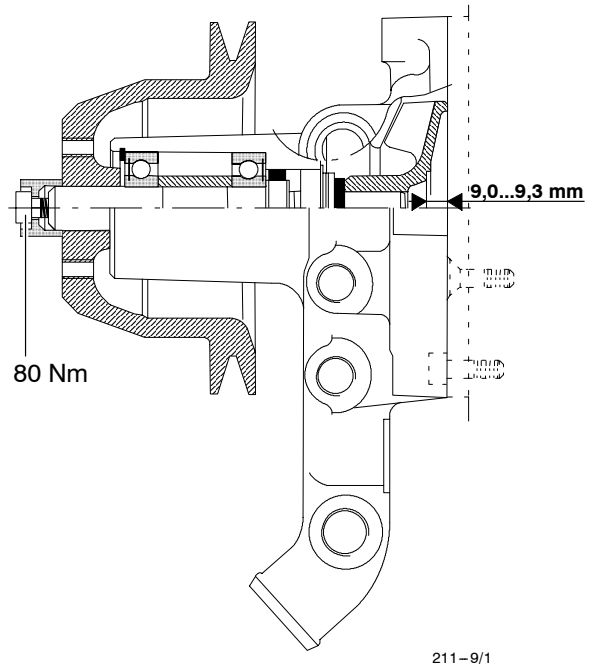
9. Press the impeller into position while, at the same time, supporting the shaft at the other end. The mounting depth of the impeller is in 320/420-engines **1,8...2,2 mm** and in 620/634-engines **0,8...1,2 mm** (see figure above). Make sure that the shaft can rotate freely.

10. Fit the belt pulley and tighten its attaching nut to a torque of **120 Nm**.

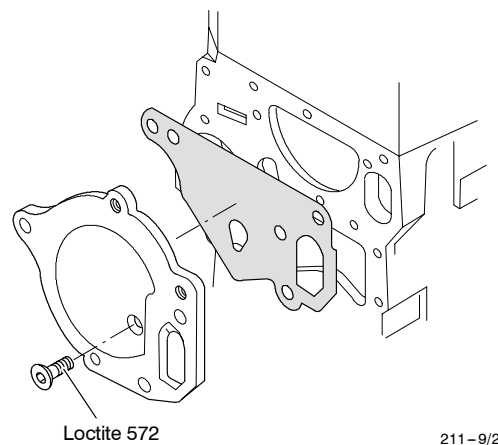


11. Fit the rear plate using new seals. Use in 620/634-engines guide pins ($\varnothing 8,5$ mm) in the holes shown with arrows in the picture 211-10.

Note! Some 320/420-engines are equipped with a new type of coolant pump, where the diameter of impeller has changed $87 > 97$ mm. The reconditioning of this pump is done according to the instruction in part C.



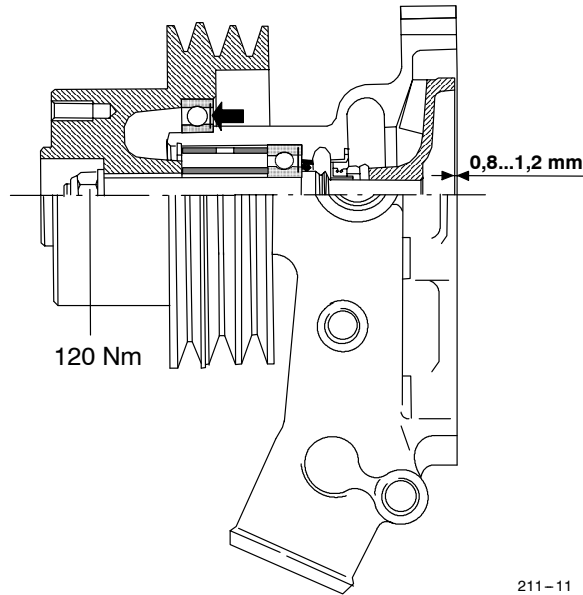
Note specially the left hand thread of belt pulley fixing bolt and the measuring point of position of impeller.



If the rear plate is removed, fit the rear plate to the cylinder block. Apply sealing compound to the thread of screw, see picture above.

D. Coolant pumps with heavy-duty bearings (620, 634)

Some versions of 620/634-engines have a heavy-duty bearings in the coolant pump. The reconditioning of this pump is done according to the instruction in part **C**. Note specially the position of the front bearing as assembling.



E. Quality requirements of coolant

The coolant used must meet the standards ASTM D 3306 or BS 6580:1992.

- Mixing proportion should be 40–60 % of ethylene/propylene–glycol based coolant and the rest water. The best ratio is 50/50 %.
- In warm climates the 30 % mixture ratio gives enough good protection against corrosion.
- Water used should be clean and soft water i.e. that it does not include metals and their salts.
- Check the coolant frost resistance every now and then. Change the coolant every other year.

Note! Never use only water as coolant!

12. INLET AND EXHAUST SYSTEM

An engine that is equipped with a turbocharger is a great deal more sensitive to disturbances and impurities in the inlet and exhaust systems than a naturally aspirated engine. Therefore special attention should be given to the whole inlet and exhaust system.

A. Checking air cleaner

The engine performance and length of service life depend to a great extent on the state of the air cleaner. A defective air cleaner allows impurities to pass through, which in time damage the turbocharger and the engine. A blocked air cleaner lowers the engine output and also causes oil leakage through the sealing ring on the turbocharger shaft.

Note! The safety filter inside the main filter should not be removed unnecessarily, for checking or cleaning. The safety filter must not be cleaned, but should be changed once a year or when necessary (see Operator's Manual)

B. Checking inlet and exhaust pipes

Important! Leaks in the inlet or exhaust system markedly lower the effect of the turbocharger. Because of the pressure, even small leaks in the manifold or in the turbine inlet contact flange quickly increase in size. For this reason all leaks must be dealt with immediately.

1. Inspect the pipes and sealing surfaces between the air cleaner and the turbocharger, as well as between the turbocharger and the intake manifold. If the intake manifold is dusty on the inside, there is a leak in either the air cleaner or the inlet pipes. Remedy the leak.

2. Clean the intake manifold sealing surface. Check that the sealing surface is flat using a straight ruler. If the surface is not flat or it has scratches, machine or renew the intake manifold. On 620/634-engines ensure that the cylinder heads are parallel.

3. Fit a new gasket and fasten the intake manifold. Tighten the manifold fixing screws to a torque of **30 Nm**. Fasten the air pipes carefully.

4. Check that the exhaust manifold is air tight. Tighten the nuts/bolts to **50 Nm** and inspect for any damage (cracks, deformation, corrosion etc.). Check also the connection between the turbocharger and the exhaust manifold.

5. Remove the manifold if necessary. Clean the sealing surfaces and remove any carbon deposits. Check that the sealing surfaces are flat. If the fastening flanges are twisted or there are scratches on the sealing surfaces, machine the flanges or renew the exhaust manifold.

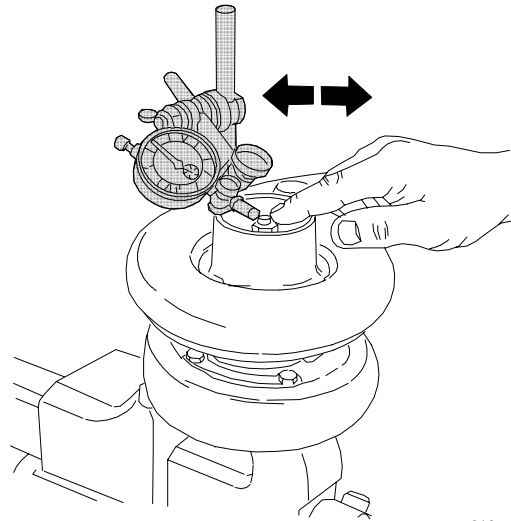
6. Ensure that no loose objects or impurities have entered the exhaust pipe or the silencer. Any such loose objects or impurities can increase the back pressure for the exhaust gases from the turbine wheel.

C. Checking turbocharger

If a fault is suspected in the turbocharger it can be located in the following way:

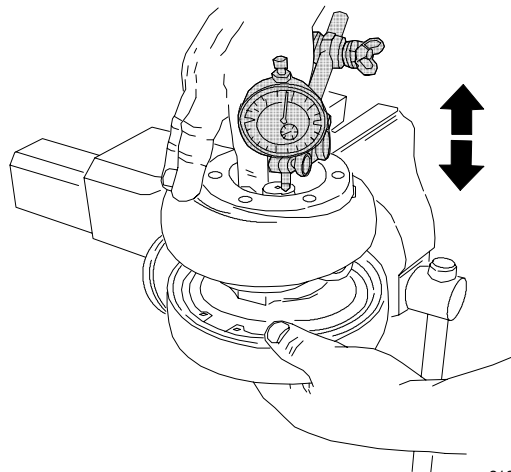
1. Visually inspect the turbine and compressor wheels. The vanes must not show any signs of damage, deformation or wear caused by foreign objects.
2. Investigate any oil leaks through the sealing rings on the shaft in the turbine and compressor housing.

Note! At low idling there is always a certain amount of oil leakage on the compressor side. However, this should not cause too much concern unless the oil consumption is too great.



212-1

3. Check the turbine shaft running clearance. Place the stylus of a dial gauge against the shaft and move the shaft sideways. Refer to the clearance given in the specifications on page **0-12**.



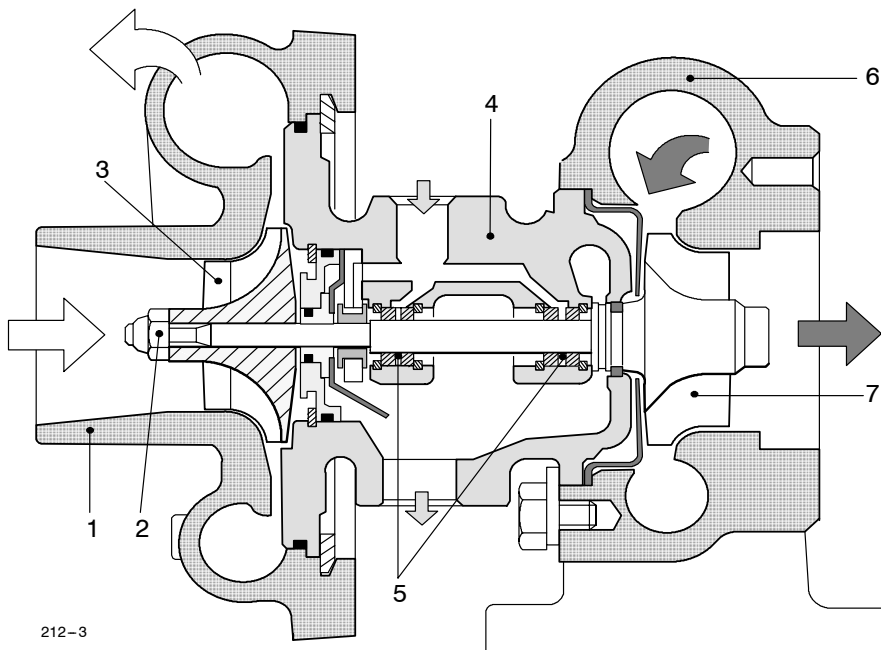
212-2

4. Check the shaft end float. Place the stylus of the dial gauge against the end of the shaft and move the shaft axially. Refer to the clearance given in the specifications on page **0-12**.

If any defects or wear are confirmed, the turbocharger should be reconditioned.

If the engine does not work correctly and the turbocharger is not defective or too worn, the fault could be traced to one of the following items:

- Blocked air filter
- Leakage in the inlet or exhaust systems. Leaking flange seal
- Defective or wrongly adjusted injection pump.
- Wrongly adjusted throttle linkage
- Defective or wrongly adjusted injectors
- Low fuel pressure (e.g. blocked fuel filter)
- Low compression, wrong valve clearance



Turbocharger Schwitzer S1A

1. Compressor cover
2. Lock nut
3. Compressor wheel
4. Bearing housing
5. Journal bearings
6. Turbine housing
7. Shaft and turbine wheel

212-3

D. Fitting turbocharger

Locate the cause of the defects on the turbocharger. Remedy the fault before fitting the new turbocharger.

In order for the turbocharger to work satisfactorily, it is important that the engine oil is in good condition. Likewise the oil should be to the correct quality specification. The air filter and oil filter should be serviced according to the handbook specification.

The setting of the injection pump critically affects the function of the turbocharger. The injection pump should be adjusted according to the manufacturers instructions.

1. Check the tightness of the intake and exhaust manifolds, and that they are securely fastened. Ensure that there are no loose carbon or rust particles, or other foreign objects in the manifolds.

2. Connect the turbocharger to the exhaust manifold and tighten down using a new gasket.

3. Connect the inlet pipe and the exhaust pipe on the turbo.

4. Pour clean engine oil into the bearing housing through the inlet oilway. This is very important in order to ensure that the turbocharger is lubricated at the time of starting.

5. Connect the pressure and return oil pipes. Use a new seal. Check that there are no tensions in the pipes when tightening.

6. Before starting, pull out the stop control and crank the engine over with the starter motor so that the oil pressure rises. Start the engine and check that there are no leaks.

13. FUEL SYSTEM

IN–LINE FUEL INJECTION PUMP

Note! This manual gives only general instructions for repair and service measures related to the fuel system. This applies particularly to the injection pump which can be repaired only by a specially trained person who has the necessary special tools and gauges. All service and repair work related to the fuel system requires special care and cleanliness!

TECHNICAL DATA

Injection pump Bosch–A/Bosch–P

Type (pump/governor)	Bosch PES_A/RSV (PES6P/RSV)
Injection order:	
– 320	1–2–3
– 420	1–2–4–3
– 620, 634	1–5–3–6–2–4
Direction of rotation	clockwise
Diameter of pump piston:	
– Bosch–A	9,5 mm
– Bosch–P	12 mm
Stroke:	
– Bosch–A	8 mm
– Bosch–P	11 mm
Injection advance	see injection pump adjusting values
Oil fillings ¹⁾ :	
– 320	0,3 l
– 420	0,4 l
– 620/634	0,6 l

¹⁾ When fitting fuel injection pump.

Fuel feed pump

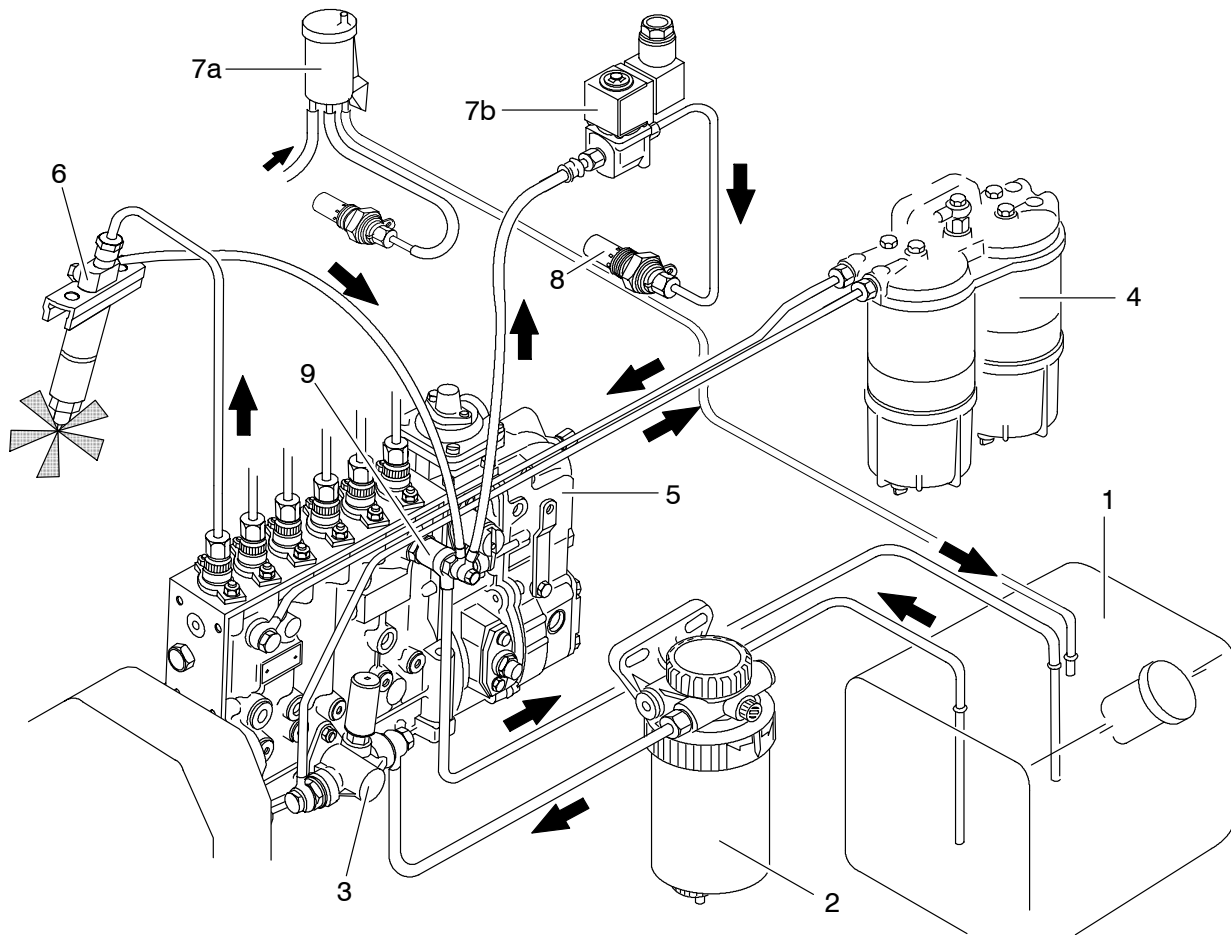
Type:	
– 320	Bosch FP/KSG 24 AD 207
– 420, 620, 634	Bosch FP/KEG 24 AD 504
Construction	piston pump, separate hand pump
Fuel feed pressure (overflow valve opening pressure)	0,7–1,2 bar (70–120 kPa)
Pressure from fuel feed pump (without overflow valve)	2,7 bar (270 kPa)

Injectors

Type	five hole nozzle
Opening pressure	see page 14–10
Sealing ring	8999 01495

Tightening torques

Injection pump gear nut:	
– Bosch–A	90 Nm
– Bosch–P	200 Nm
Overflow valve	30 Nm
Injector nozzle sleeve	60 Nm
Injector attaching nuts (on studs)	15 Nm



1. Fuel tank
2. Prefilter
3. Fuel feed pump
4. Fuel filter
5. Fuel injection pump
6. Injector
- 7a. Thermostart fuel reservoir
- 7b. Magnetic valve
8. Glow plug
9. Overflow valve

213-1

Fuel system, description

Fuel feed pump (3) draws fuel from tank (1) through prefilter (2) and forces it through filter (4) to fuel injection pump (5). The fuel injection pump pumps fuel at high pressure through the delivery pipes to injectors (6) which inject the fuel in the form of a fine mist into the combustion chamber.

The fuel system is often equipped with the Thermostart device to be used in cold conditions. The glow plug (8) receives fuel from a separate reservoir (7a) of the thermostart device or from the overflow valve (9) of the injection pump regulated by the magnetic valve (7b). Excess fuel returns from the fuel injection pump through overflow valve (9) to the fuel tank.

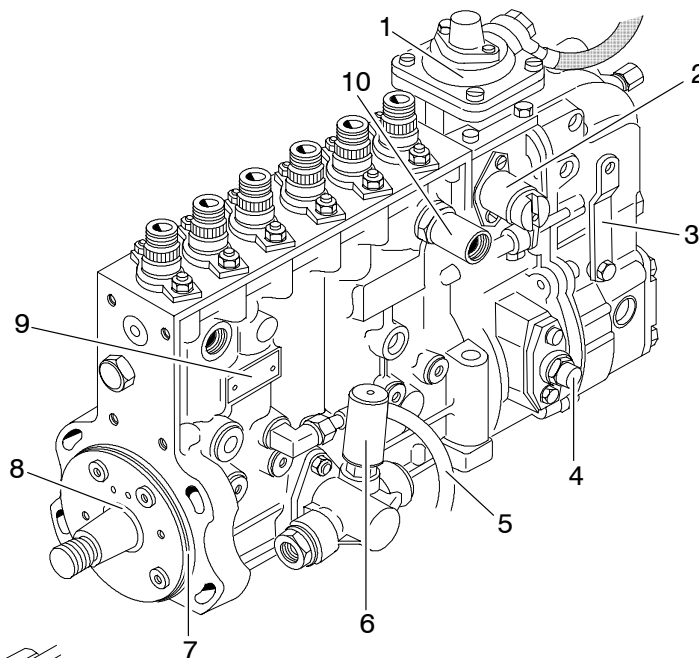
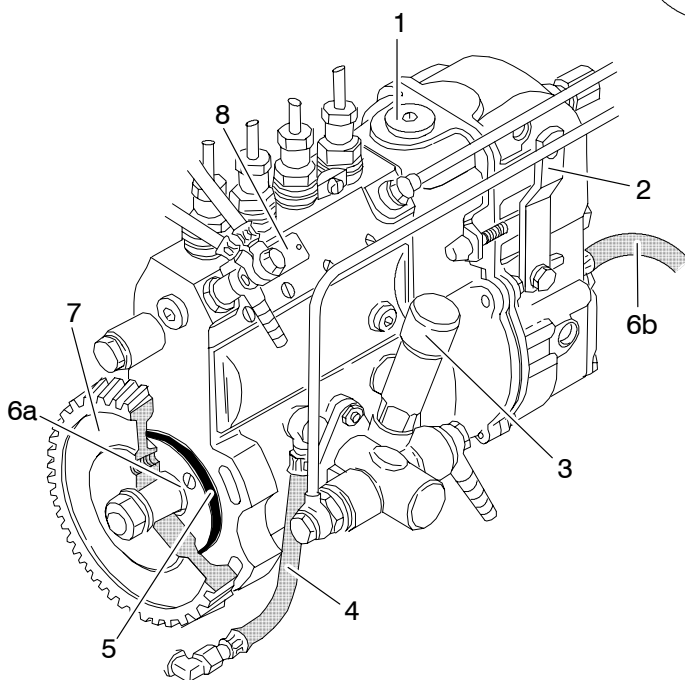
Symptoms of dirty or faulty injectors are:

- Knocking is an indication that one of the injectors is faulty. When a cold engine ticks over a certain amount of knocking is unavoidable. If the engine knocks after it has reached normal operating temperature, it is very likely that one of the injectors is faulty. Air in the fuel system can also cause knocking (which should disappear after the system has been bled of air).
- Smoky exhaust gases may indicate impaired performance of the injectors. However, this can also be caused by other faults such as a blocked air cleaner.

The fuel system should always be bled when the fuel system has been emptied (e.g. the fuel tank has been emptied during driving, in connection with maintenance or repair work or after a long idle period).

Bosch-P injection pump

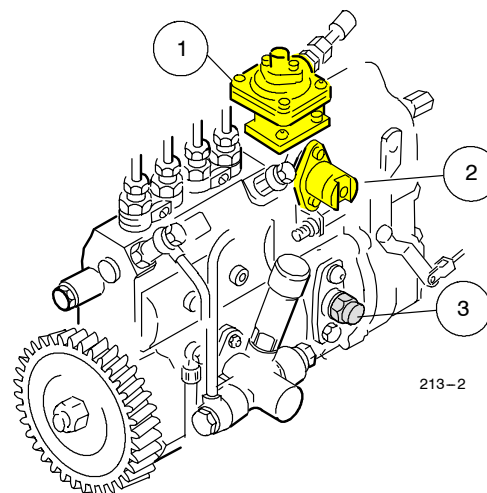
1. Boost control
2. Cold start solenoid
3. Speed lever
4. Injection timing indicator
5. Lube oil into the injection pump
6. Hand pump
7. O-ring seal
8. Return of lube oil to engine
9. Identification plate
10. Overflow valve

**Bosch-A injection pump**

1. Oil filler plug
2. Speed lever
3. Hand pump
4. Lube oil into the injection pump
5. O-ring seal
- 6a. Return of lube oil to engine
- 6b. Alternative oil return to engine
(e.g. aggregate application)
7. Drive gear
8. Identification plate

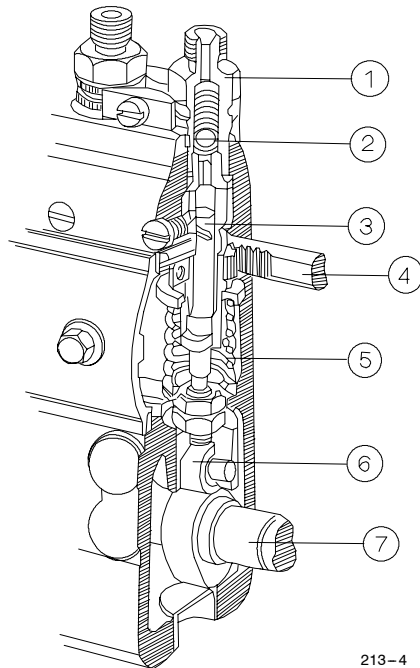
The injection pump is an in-line pump and the basic construction is the same in all engines irrespective of the cylinder number. The fuel injection pump is flange mounted and sealed by one o-ring in the timing gear casing. The injection pump is driven from the crankshaft through an idler gear. The injection pump is connected to the engine force-feed lubrication system through an external pipe. Lubricating oil returns to the engine via the hole at the front end of the injection pump. In some versions, specially locally installed engines, the return of the oil is lead through a hose from the regulator cover to the crankcase.

The fuel feed pressure which fills the high pressure pump elements with fuel is created by a piston pump which is attached to the side of the fuel injection pump. The piston pump is driven from an eccentric on the camshaft of the injection pump. The fuel feed pump supplies more fuel than the injection pump needs. The excess fuel flows through the overflow valve back to the fuel tank. The fuel cools the injection pump and also takes any air bubbles with it back to the tank.

**Injection pump with the boost control**

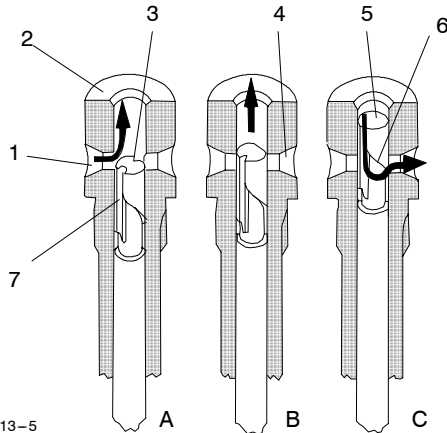
1. Boost control
2. Cold start solenoid
3. Indicator plug for adjusting injection timing

213-2



1. Pressure valve holder
2. Pressure valve
3. Pump element
4. Control rod
5. Return spring for pump plunger
6. Roller tappet
7. Camshaft

The purpose of the fuel injection pump is to meter out fuel to the combustion chamber at the correct time. Plunger (3) which is driven by the pump camshaft (7) via roller tappet (6) forces the fuel through pressure valve (2) and further through the delivery pipe to the injector.



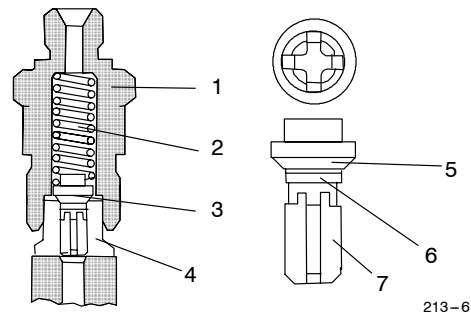
Two-hole pump element (maximum feed)

- | | |
|--------------------------|--------------------|
| A. Bottom dead centre | 1. Inlet passage |
| B. Fuel injection begins | 2. Cylinder |
| C. Fuel injection ends | 3. Starting groove |
| | 4. Release passage |
| | 5. Plunger |
| | 6. Metering edge |
| | 7. Vertical groove |

The pump element consists of one plunger and one cylinder which are a matched pair and because of the fine tolerances the whole element should be changed as a complete unit.

The cylinder has two passages: inlet passage and release passage. Both passages allow fuel to enter the pressure space. The side of the plunger has one vertical groove and one metering edge which are used for adjusting the amount of fuel injected into the combustion chamber of the engine.

The top of the plunger is provided with a starting groove (delay groove) which delays the injection timing by approx. 8° . (This should be borne in mind when checking the fuel injection timing). This groove improves the cold starting properties of the engine. It works fully automatically. When the engine has stopped the control rod in the injection pump turns the plungers so that the starting groove faces towards the release passage. When the engine has started and when the injection pump has reached a certain speed, the governor pulls the control rod back into running position.

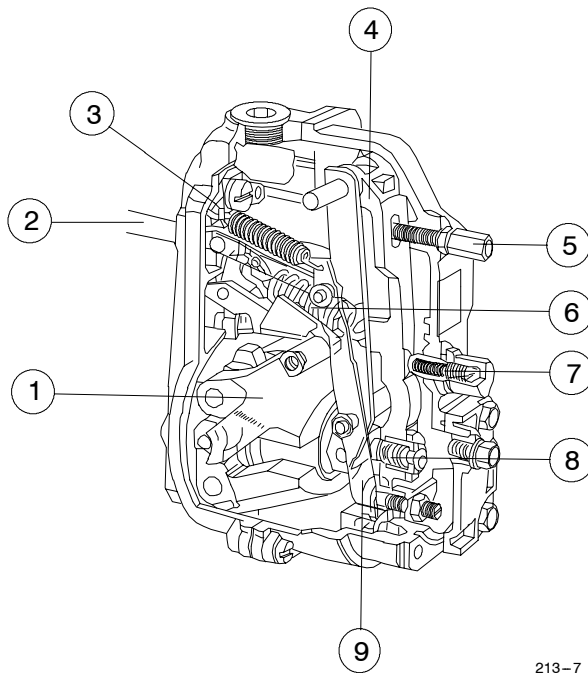


Pressure valve

1. Holder for pressure valve
2. Valve spring
3. Valve cone
4. Valve guide
5. Valve head
6. Pressure-reducing piston
7. Vertical grooves

The pressure valve is fitted on top of the pump element and its purpose is to close the connection between the pump element and the delivery pipe. This happens when the metering edge of the plunger passes the lower edge of the release passage, thus reducing the pressure in the space above the plunger. Its second purpose is to reduce the pressure in the delivery pipe. This is important as it enable the nozzle valve (needle) to close more quickly.

Pressure valve cone contains a pressure-reducing piston which, when the valve closes, is first lowered into the guide and then closes the connection between the delivery pipe and the pump element. The valve head is then pressed against its seat and the fuel in the delivery pipe is given the same space as the displacement of the pressure-reducing piston.

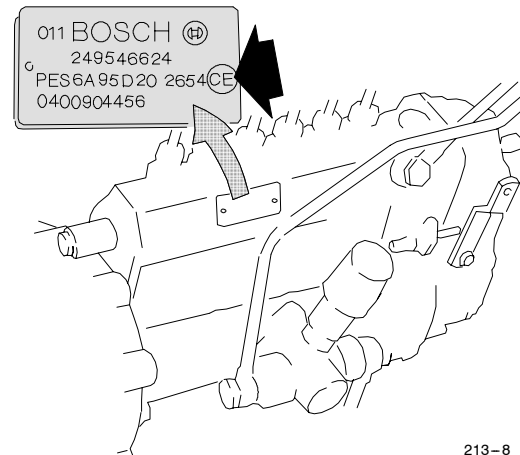
Governor

1. Governor weight
2. Control rod
3. Starting spring
4. Main lever
5. Idler screw
6. Governor spring
7. Additional spring, idling
8. Spring for equaliser
9. Governor control arm

The governor is of the centrifugal type and is fitted at the rear end of the injection pump. The governor controls the rotational speed of the engine throughout the whole speed range, and identifies the rotational speed by means of the governor weights. The position of the governor control and of the governor weights is transferred through the governor lever linkage to the control rod. The governor has one governor spring. Starter spring, which is attached to the upper end of the control lever, it pulls the control rod to the starting position when the engine stops. This means that the amount of fuel injected when the engine is started automatically becomes greater.

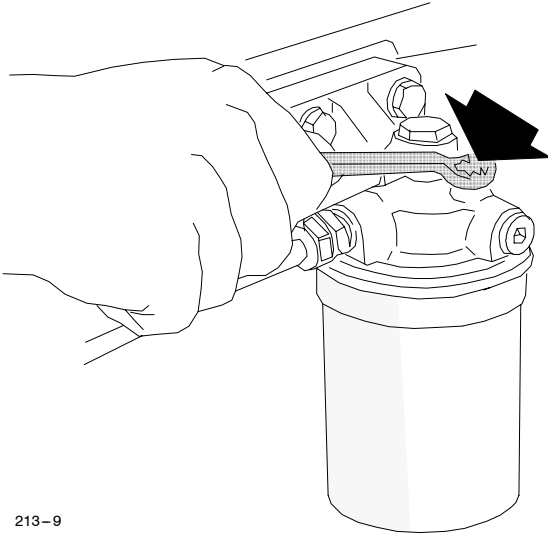
Fuel injection pump type plate

The injection pump type plate shows one particular letter indicating the user application, see figure below. This letter should always be quoted when ordering a replacement pump or when looking for setting values.



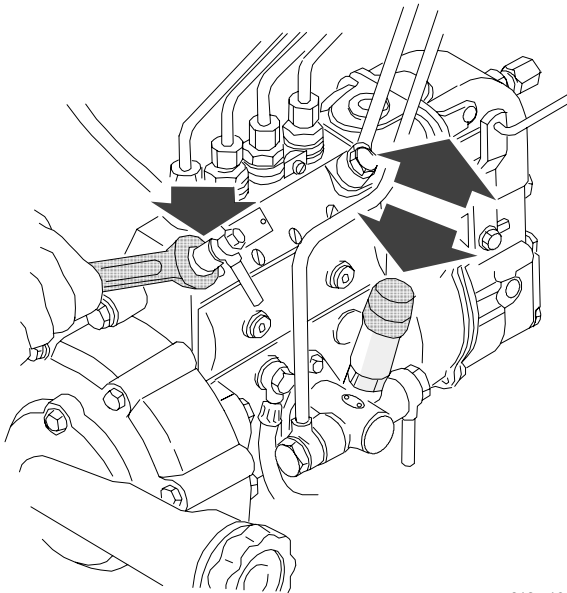
213-8

213-7

A. Bleeding fuel system

213-9

1. Slacken the bleeder screw on the filter head. Pump with the hand pump until the fuel flowing out at the bleeder screw is free from air bubbles. Then tighten the bleeder screw.



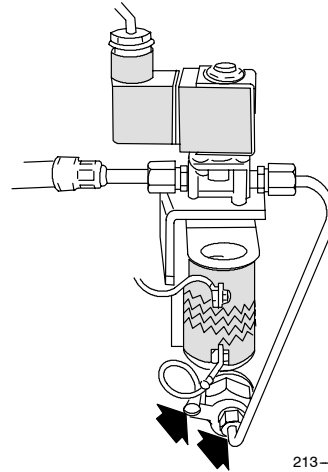
213-10

3. Slacken the injection pump overflow valve. Pump with the hand pump until the fuel flowing out is free from air bubbles. Tighten the overflow.

4. Wipe off any fuel from the engine.

B. Bleeding Thermostart system

Always remove air from the glow plug fuel pipe when the pipe or reservoir has been emptied during repair work etc. This prevents damages to the glow plug caused by lack of fuel during starting.

System with the magnetic valve

213-11

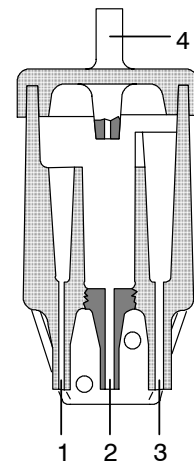
1. Disconnect the electrical wire from the glow plug and the fuel pipe.

2. Connect electricity to the magnetic valve and rotate the engine until fuel comes out from the fuel pipe connection.

3. Tighten the pipe connection and connect the electrical wire.

System with a fuel reservoir

1. Reservoir filling
2. To the glow plug
3. Return the fuel tank
4. Breather



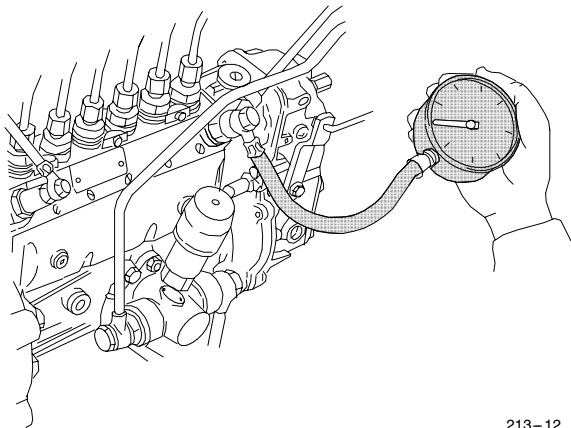
213-11/1

1. If the tank is empty fill it first e.g. through the breather.

2. Open the fuel pipe connection to the glow plug and let the fuel come out. Tighten the pipe.

C. Measuring fuel feed pressure

1. Clean the fuel injection pump and the filter and the pipes between them.



213-12

2. Fit the gauge at the banjo connection on the pump, as shown above (between filter and injection pump).

3. Run the engine at low idling for a while and compare the gauge reading with the prescribed value (**0,6...1,0 bar**).

Note! If the measured pressure is below the prescribed value, this may be caused by:

- faulty overflow valve
- blocked fuel filter
- faulty fuel feed pump
- blocked or leaking fuel pipes or unions

D. Checking overflow valve

If the fuel feed pressure deviates from the prescribed value, check the opening pressure of the overflow valve.

1. Connect a pressure gauge to the banjo union in the same way as in previous instruction **13 C**.

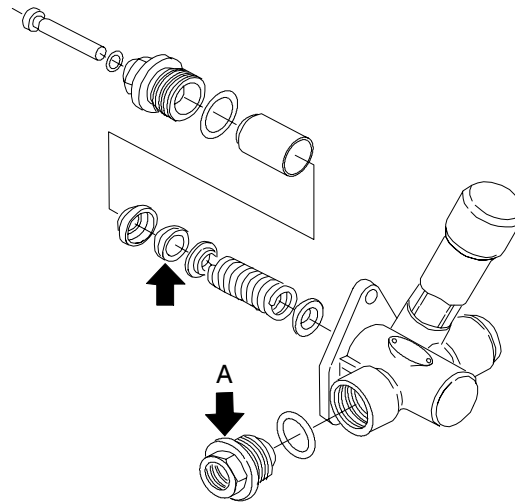
2. Pump with the hand pump until the overflow valve opens. Compare the reading on the gauge at the moment the valve opens with the prescribed value (**0,6...1,0 bar**).

3. If the recorded opening pressure deviates from the prescribed value, the overflow valve should be changed.

Note! If the recorded pressure is considerably lower than the prescribed value, there may be a fault in the hand pump or the fuel feed pump valves.

E. Changing fuel feed pump valves

1. Clean the feed pump. Disconnect fuel pipes to the feed pump. Remove the feed pump.



213-13

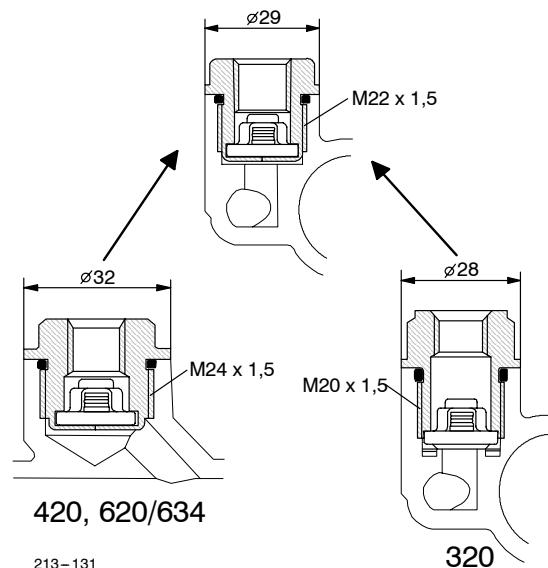
2. Secure the pump in a vice provided with soft jaws. Loosen the tappet body from the pump and remove the piston, seal rings, suction valve and the spring.

3. Detach from the pump body the outlet side threaded connector, in which is placed the pressure valve.

4. Rinse the valves with clean fuel and check the function and possible wear.

5. Change the valve if needed and assemble the pump using new o-rings and gasket.

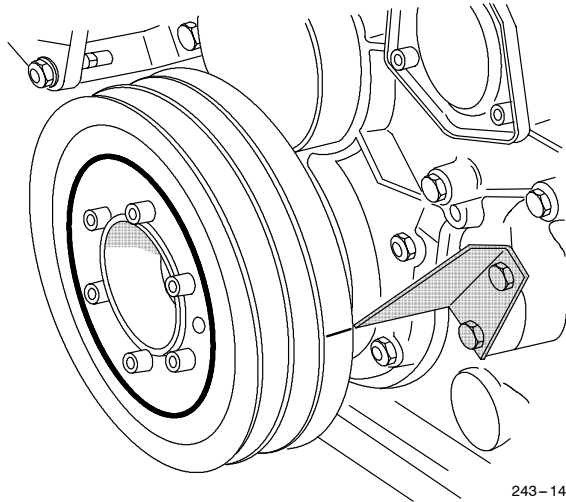
Note! The manufacturer has standardised the pressure valve **A** in different feed pumps. The earlier used M20 and M24 tightening threads are replaced by M22 thread (see picture below). At the same time also the seal rings of the valve are modified.



213-131

320

F. Checking injection timing



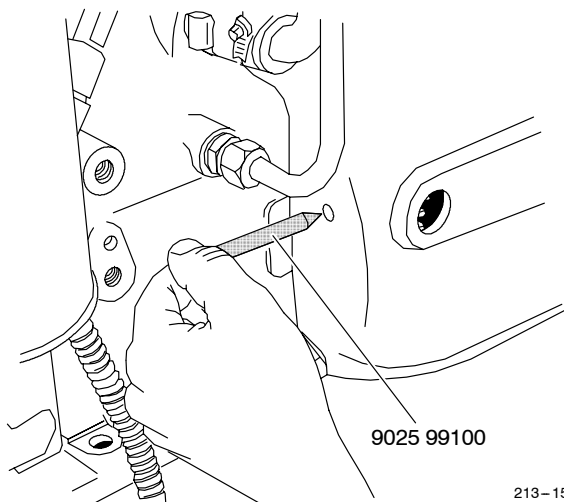
243-14

The injection timing for cylinder no. 1 is marked on the crankshaft pulley. The timing indicator can be on the right or left side of the pulley, depending on engine version. In some tractor versions the timing mark is on the flywheel.

Note! Due to the automatic excess fuel feed of the injection pump the control rod must be moved to drive position before checking the injection timing, otherwise the injection timing will be 8° incorrect!

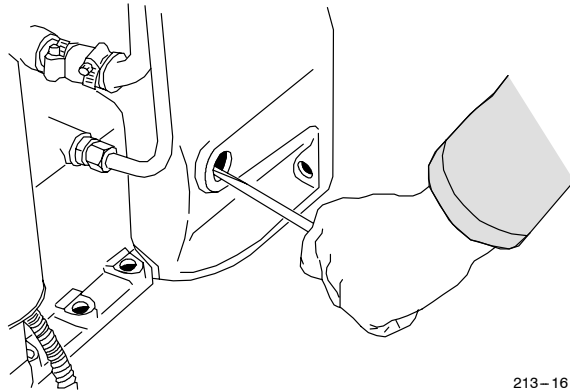
1st way of checking

1. Clean the injection pump and its surroundings carefully.
2. In tractor engines remove the inspection hole rubber plug from the flywheel housing.



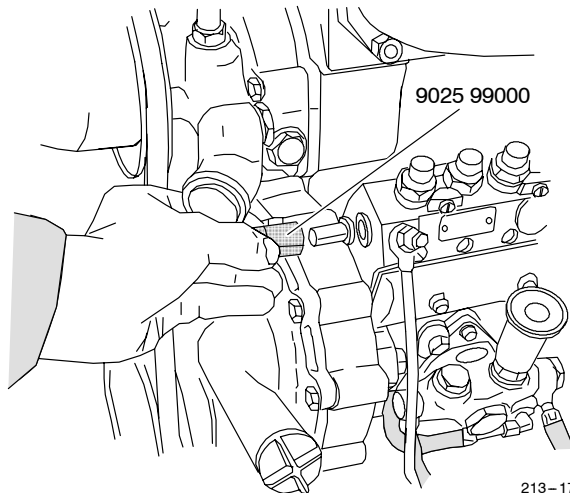
213-15

3. Insert the locator (9025 99100) in the hole on the flywheel housing front face.



213-16

4. Turn the crankshaft to a position where the 1st cylinder piston reaches its compression stroke top dead centre. Then turn the crankshaft backwards until the timing mark on the pulley (flywheel) passes the timing indicator.



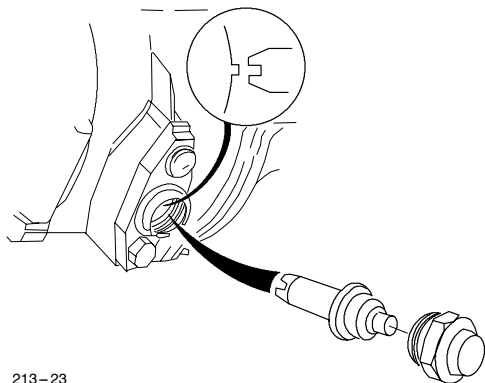
213-17

5. Remove the protecting cap for the control rod on the injection pump front face. Fit adjusting tool (sleeve for limiting control rod travel) 9025 99000. The tool moves the control rod to the "running position".
6. Disconnect the delivery pipe for the number one cylinder injector at the pump.
7. Clean the delivery valve of fuel. Slowly turn the crankshaft in the correct direction of rotation until the fuel level in the delivery valve just begins to rise.
8. Check if the mark on the pulley is at the point of the timing indicator the injection timing is correct. Repeat the check procedure. If the injection pump needs to be adjusted, follow the instructions under heading **13 G**.
9. Fit the delivery pipe and the rubber plug in the flywheel housing. Remove the locator and the sleeve which was used to limit the control rod travel. Start the engine.

2nd way of checking

Note! In some types of injection pumps the injection starting point in the 1st cylinder has been positioned with aid of an indicator pin in the pump governor housing. Do the inspection of injection timing as follows:

1. Turn the crankshaft to a position where the 1st cylinder piston reaches its compression stroke top dead centre. Then turn the crankshaft backwards until the mark on the pulley passes the timing indicator. After that rotate the crankshaft slowly to running direction until the mark on the pulley is at the point of the timing indicator or the timing mark on the flywheel is at the point of locator 9025 99100 (see instruction **13 F**).



213-23

2. Unscrew the plug on the side of the injection pump. Take out the indicator pin.

3. Turn the indicator pin and push it into the hole so that the groove at the end of the pin points towards the pump.

4. If the pin groove fits on the boss on the governor weight assembly, the injection timing is correct. Otherwise, turn the pump to a position where the boss and the pin groove align.

Note! Do not rotate the crankshaft when the groove end of the pin is inside the pump, since the pin end damages easily and plastic pieces remain in the governor housing.

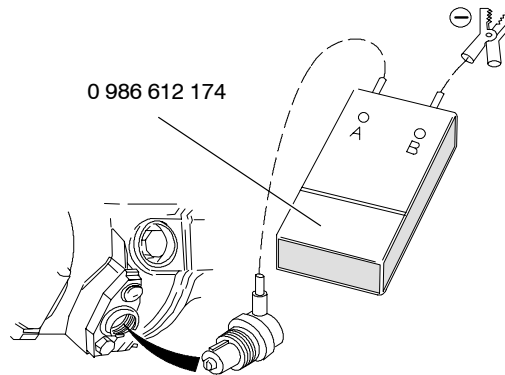
6. When the adjustment is correct, turn the indicator pin so that the groove points outwards (running position) and push the pin into the hole. Refit the plug.

Usage of the electrical inspection device (Bosch KDEP 1601 0 986 612 174)

Also in electrical device can be used to check the timing.

1. Turn the crankshaft to a position where the 1st cylinder piston reaches its compression stroke top dead centre. Then turn the crankshaft backwards until the timing mark passes the dowel pin.

2. Unscrew the plug on the side of the injection pump. Take out the indicator pin.



3. Connect the inspection device sensor into the governor housing. Note the position of the sensor! Connect the – wire into earth.

4. Rotate the crankshaft in running direction until light **A** is on.

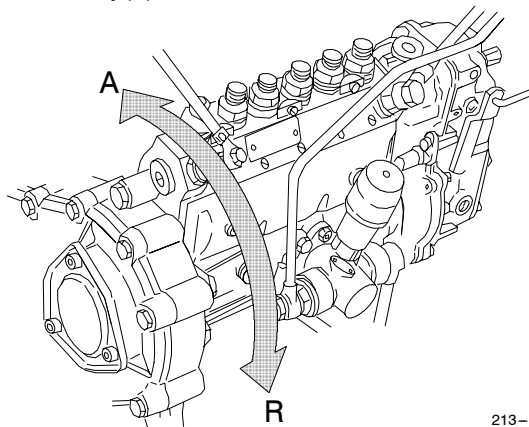
5. Continue rotating the crankshaft in running direction very slowly until light **B** is on.

6. If the mark on the pulley is at the point, the injection timing is correct. If the marks are not at the point, preform the adjustment according to instruction **13 G**.

G. Adjusting fuel injection timing

If the timing is incorrect, adjust as follows:

1. Loosen the retaining nuts of the injection pump and remove the delivery pipes.



213-19

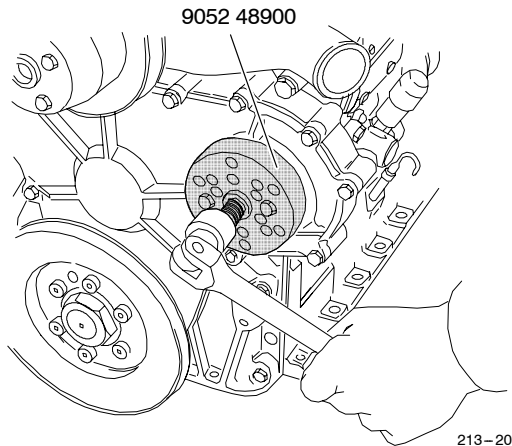
2. If the injection timing is retarded, turn the pump anti-clockwise (viewed from the front end of the pump). If the timing is advanced, turn the pump clockwise.

3. Check once again the injection timing and set again if needed.

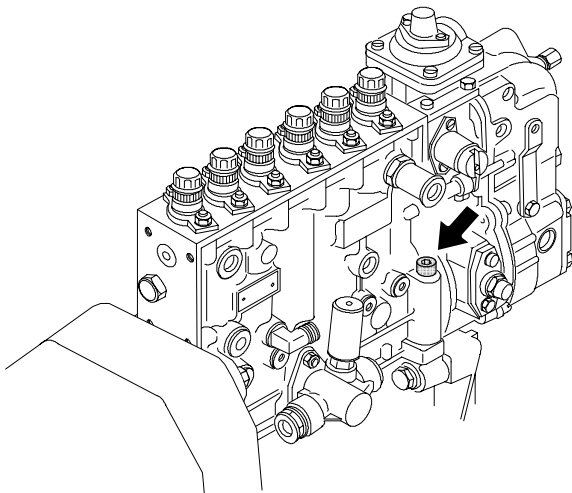
4. When the timing is correct tighten the retaining nuts of the pump and fix the delivery pipes.

H. Removing fuel injection pump

1. Clean the injection pump and surrounding engine parts and the pipes and connectors on the injection pump.
2. Disconnect the delivery pipes and the banjo bolts at the supply and return fuel connections. Disconnect the lubricating oil line. Plug all connections.
3. Detach the oil filler pipe/cover from the front cover. Unscrew the pump drive gear nut.



4. Use puller 9052 48900 and loosen the gear from the injection pump camshaft front end.
5. Remove the injection pump attaching nuts. Remove the injection pump.



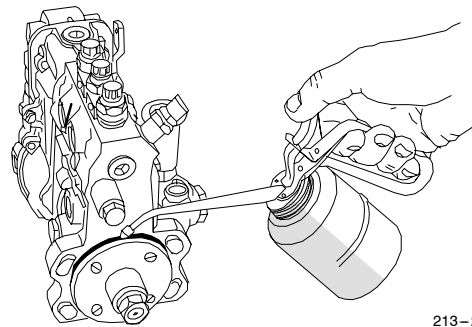
Note! When removing the Bosch–P injection pump, open bottom mounting screws on the both side of injection pump.

Note! If the engine is not to be disturbed while the pump is removed, there is no need to secure the pump gear. The gear rests against the idler gear.

I. Fitting fuel injection pump

Bosch–A injection pump

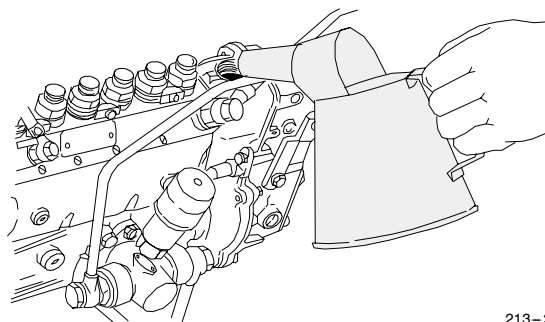
1. Check the condition of the o–ring between the pump and the timing gear casing. Change the o–ring if necessary.



2. Lubricate the o–ring and place the injection pump so that the key on the pump shaft aligns with the key slot inside the gear. Tighten the pump attaching nuts.

Note! The injection pump with adjusting indicator in the governor housing don't have any key slot in the gear.

3. Tighten the gear nut to **90 Nm**. Fix the oil filler pipe/cover.
4. Connect the supply and return fuel lines. Connect the lubricating oil line. Use new sealing washers.
5. Bleed the fuel system (instruction **13 A**).
6. Adjust the injection timing (instruction **13 G**).
7. Fit the delivery pipes.



8. If the injection pump is changed or if the lubricating oil has been drained from the pump, fill the pump with lubricating oil before starting the engine. Open the hexagonal socket plug on the governor housing and pour in oil.

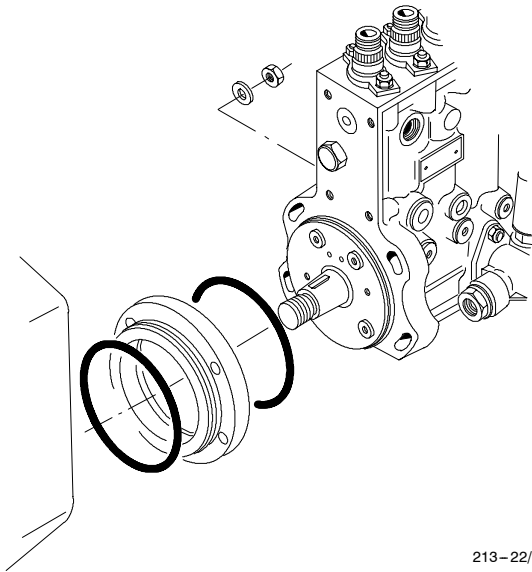
Filling quantity:

320–engines	0,3 l
420–engines	0,4 l
620/634–engines	0,6 l

Same oil specification as in the engine.

Bosch–P injection pump

1. Check the condition of the o–rings between the pump and the timing gear casing. Change the o–rings if necessary.

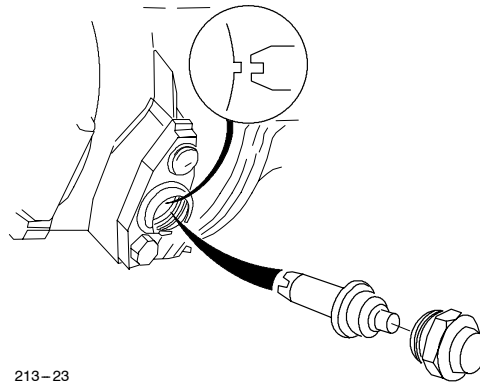


213–22/1

2. Lubricate the o–ring and put the fit ring to the timing gear casing.
3. Lubricate the o–ring and place the injection pump so that the key on the pump shaft aligns with the key slot inside the gear. Tighten the gear nut to **200 Nm** and fit the cover.
4. Adjust the injection timing, see instruction **13 G**.
5. Connect the supply and return fuel lines. Connect the lubricating oil line. Use new sealing washers. Fit the delivery pipes.
6. Bleed the fuel system, see instruction **13 A**.

Note! In some types of injection pumps the injection starting point in the 1st cylinder has been positioned with aid of an indicator pin in the pump governor housing. This type of injection pump is installed as follows:

1. Turn the crankshaft to a position where the 1st cylinder piston reaches its compression stroke top dead centre. Then turn the crankshaft backwards until the mark on the pulley passes the timing indicator. After that rotate the crankshaft slowly to running direction until the mark on the pulley is at the point of the timing indicator or the timing mark on the flywheel is at the point of locator 9025 99100 (see instruction **13 F**).

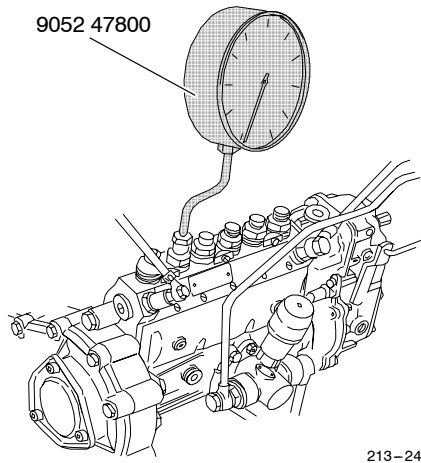


213–23

2. Unscrew the plug on the side of the injection pump. Take out the indicator pin.
 3. Turn the indicator pin and push it into the hole so that the groove at the end of the pin points towards the pump.
 4. Install the injection pump and tighten the installation nuts and the nut on the gear. **Note!** The groove for the key has been left out for the gear.
- Warning!** Do not rotate the crankshaft when the groove end of the pin is inside the pump, since the pin end damages easily and plastic pieces remain in the governor housing.
5. When the adjustment is correct, turn the indicator pin so that the groove points outwards (running position) and push the pin into the hole. Refit the plug.

J. Checking and changing pressure valve

1. Clean the injection pump, injectors and surrounding parts. Disconnect the delivery pipes.



2. Connect the pressure gauge 9052 47800 to the pressure valve holder which is to be checked.

3. Rotate the engine with the starter motor, until the gauge reading is about **330 bar**.

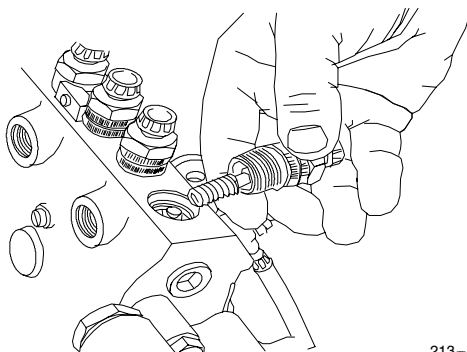
Note! Pressure rises fast, do not damage the gauge. Get ready to pull the stop control out as soon as the gauge reading reaches an adequate pressure value.

4. Let the gauge reading lower at first about **30 bar**. When the gauge shows 300 bar, observe the reading during one minute. During this time the gauge reading must not lower too much (max 30...50 bar). If the pressure lowers faster than specified, the pressure valve must be cleaned or replaced.

Note! The pressure valve plunger and guide should always be replaced in pairs.

5. Open the pressure valve holder locking and holder. Remove the valve spring, plunger and the guide.

6. Rinse the plunger and guide in clean fuel or test liquid and at the same time rotate the plunger in its guide and press the sealing surfaces against each other.



7. Fit the pressure valve into the fuel injection pump. Place the spring in place and tighten the holder.

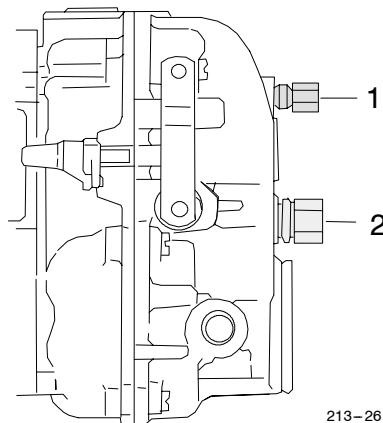
Note! Replace the sealing ring and o-ring.

8. Tighten the holder as follows:

- Tighten first to 30 Nm.
- Open the holder about ½ a turn and tighten to 40 Nm.
- Open the holder about ½ a turn and tighten to **45 Nm**.

K. Adjusting idling speed

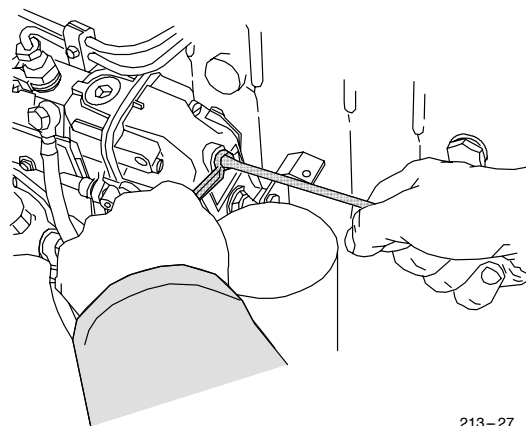
If the idling speed of the engine deviates from the value given in the specifications or if the engine revs vary at the idling speed, adjust the idling speed as follows:



1. Unscrew the idling speed adjusting nut cap (1) and the cap (2) on the idling speed additional spring adjusting screw.

2. Ensure that the throttle lever is in the idling position and that the engine is at normal operating temperature.

3. Start the engine and loosen the adjusting screw of the additional spring so that it does not affect the idling speed.



4. Adjust the idling speed using the adjusting screw to about **20...30 rpm** below rated speed and lock the adjusting screw.

5. Run the engine a few times and ensure that the idling speed remains as set.

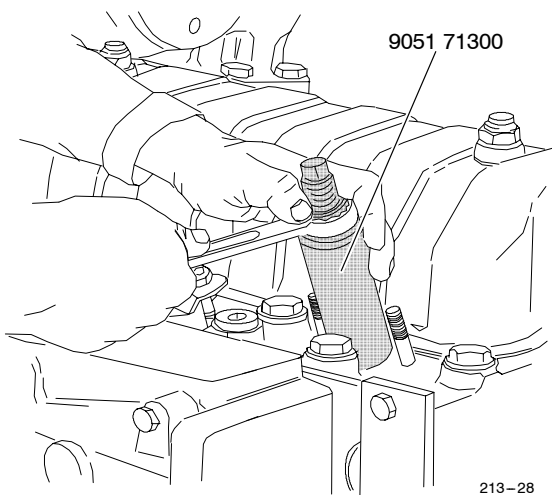
6. Tighten the adjusting screw of the additional spring until the idling speed rises to the rated value. Lock the adjusting screw in this position.

7. Fix the safety caps of the adjusting screws.

Note! Other adjustments (output and max. speed) of the injection pump can only be performed by a specially trained person who has the necessary special tools and gauges available.

L. Removing injectors

1. Clean the injectors and the area around them. Disconnect the delivery pipes and the leak-off pipes.



2. Remove the injector attaching nuts and remove the injector from the cylinder head. Fit protective plugs to all connections. If the injector does not rise by hand, use puller 9051 71300.

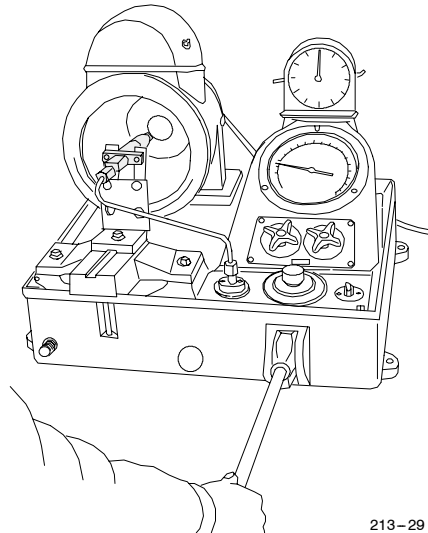
3. Remove the sealing washers from the bottom of the injector location in the cylinder head if they do not come out with the injector.

M. Inspecting injectors



Note! When pressure testing the injectors, it is important to avoid the nozzle end as the fuel jetting out easily penetrates the skin. Also bear in mind that the fuel "mist" is dangerous to inhale.

1. Clean the injector with cleaning fluid and a soft brush. The carbon deposits must not be knocked off or removed in any other way which may damage the nozzle.



2. Secure the injector in a test bench and check the following:

- injector opening pressure
- the properties of the chattering (creaking) sound and the form of the spray pattern
- sealing of nozzle valve against its seat

Opening pressure

Pump a few times to fill the injector. Increase the pressure in the injector until the chattering (creaking) sound becomes audible. Read off the opening pressure of the injector. If the opening pressure deviates from the given value, the injector should be taken apart and checked.

Adjustment is achieved by changing the shim. The thickness of the shims varies from 1,00...1,90 mm and they are available in increments of 0,05 mm. A thicker shim will raise the opening pressure while a thinner one lowers it. A difference in shim thickness of 0,05 mm changes the opening pressure by approx. 5,0 bar. As the opening pressure of the injector drops slightly after adjustment, the opening pressure should be set to approximately 10 bar above the value given in the specifications. This value applies both to new and used injector.

Chattering sound properties

Testing with a hand powered pump does not create the same circumstances as when the injector is fitted in the engine. Only with new nozzles are the test results reliable. With used nozzles, there is no chattering (creaking) sound when the tester is pumped at a certain rate. This has to do with the design of the nozzles.

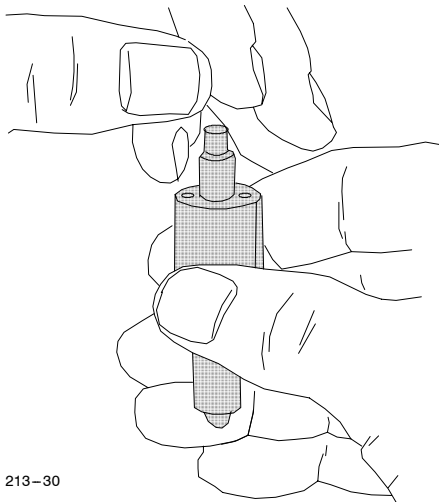
However, with a rapid pumping on the tester handle, it should be possible to hear the chattering (creaking) sound or/and see a mist of the fuel jetting out.

Tightness of nozzle

Press down the tester pump lever until the pressure rises to approx. 20 bar below the adjusting value. Maintain this pressure for approximately 10 seconds and check whether drops of fuel are formed on the point of the nozzle. If the injector leaks, it should be cleaned or the nozzle should be changed.

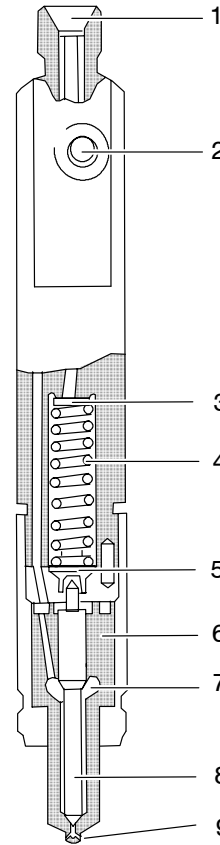
N. Reconditioning injectors

1. Secure the injector in a suitable way.
2. Unscrew the nozzle cap nut. Remove the nozzle and the parts inside the holder.
3. Clean the nozzle in cleaning fluid both inside and outside.
4. Clean the nozzle holes with a needle (including in cleaning set 8360 83288).
5. Test the movement of the nozzle valve as follows:



213–30

Rinse the parts thoroughly in fuel or testing fluid. Pull the valve out of the nozzle body to 1/3 of its length. If the fit is correct, the valve should be able to slide down in the nozzle body under its own weight. Turn the valve slightly and repeat the test. Should the nozzle valve bind slightly, it should be changed.



213–31

Injector

- | | |
|----------------------|---------------------|
| 1. Fuel inlet | 6. Nozzle body |
| 2. Leak-off fuel | 7. Pressure chamber |
| 3. Shim | 8. Nozzle valve |
| 4. Pressure spring | 9. Nozzle hole |
| 5. Valve stop spacer | |

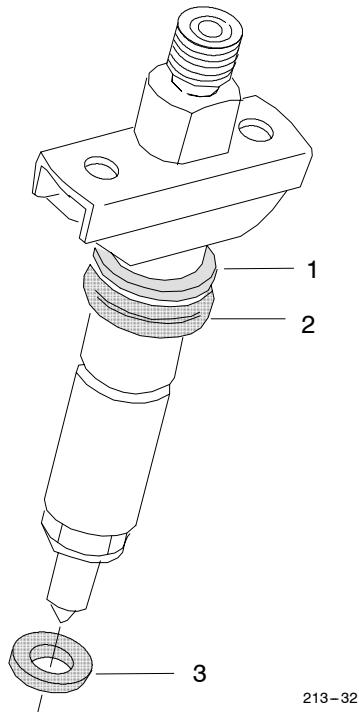
6. Before assembling, all parts should be carefully cleaned in clean fuel or testing fluid.

7. Put the same thickness of shim back as were fitted earlier. Note possible adjustment of the opening pressure. Assemble the rest of the injector. Note the position of the spring guide and the valve stop spacer.

8. Tighten the nozzle cap nut by hand and then to **60 Nm**.

O. Fitting injector in engine

1. Clean the injector sealing surface in the cylinder head. If necessary use a reamer 9101 66000.



1. Washer
2. Rubber ring
3. Sealing washer

2. Fit the injector in the cylinder head using a new sealing washer.

Note! The spray pattern from the injector is not symmetrical on purpose. It is therefore important that the injector is fitted correctly in the cylinder head. The connection for the leak-off line should be facing the valve mechanism.

3. Fit the attaching clamp and tighten the nuts evenly to **15 Nm**.

4. Connect the leak-off line together with new sealing washers and connect the delivery pipes.

Note! The screw studs in the cylinder head for the injectors should only be finger tight. If tools have to be used the studs should be tightened only lightly.

Note! Make sure, that the injector is of a correct type. Wrong injectors cause malfunctions and can damage the engine.

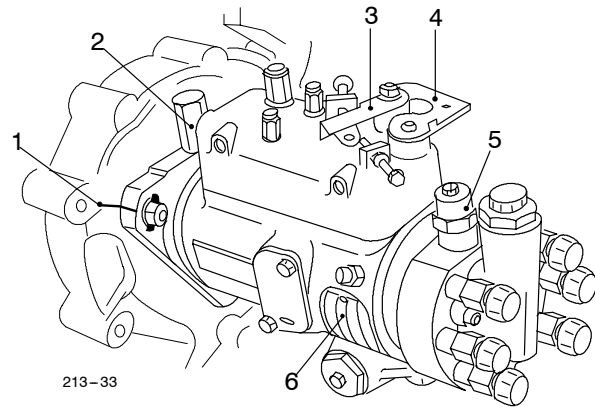
P. Fitting delivery pipes

1. Check the state of the pipes. If there are kinks, damage by chafing, or if the tapered sealing end is damaged, the pipes should be changed.
2. Fit the pipes without tension and check that they are at right angles to the union.
3. Fit the clamps for the pipes.

213-32

CAV DISTRIBUTOR PUMP

Some 420– and 620–engines are having a CAV made DPA–type distributor pump. The pump is equipped with an electrical solenoid (ignition key starting and stopping) and automatic bleeding system. The internal lubrication of the injection pump is done by the fuel it is pumping. The separate feed pump, of diaphragm type, is driven by the camshaft of the engine. The system is also equipped with a Thermostart–device that receives the fuel through the fuel filter.



1. Installation marks of injection pump
2. Overflow flange
3. Throttle lever
4. Stop lever
5. Stop solenoid
6. Identification plate

TECHNICAL DATA

Injection pump CAV

Type	DPA
Injection order	
420	1–2–4–3
620	1–5–3–6–2–4
Direction of rotation	clockwise
Injection advance	see pump installation marks

Fuel feed pump

Construction	diaphragm pump, separate hand lever
Fuel feeding pressure (static)	0,48 bar (48 kPa)
Fuel feeding pressure min. (used pump)	0,20 bar / max. rpm

Injectors CAV

Construction	five–hole nozzle
Control pressure (new injector)	250 ⁺⁸ bar
Control pressure (used injector)	230 ⁺⁸ bar
Sealing ring	8999 01495

Tightening torques

Pump gear retaining nut	90 Nm
Nozzle retaining nut	60 Nm
Injector retaining nuts (for the studs)	15 Nm

A. Dismounting and mounting injection pump

1. Clean the pump and the surrounding parts carefully. Remove the delivery pipes, the throttle cable wire from the revolution lever and the stop solenoid wire from the pump. Fit protective caps on the delivery pipe unions.

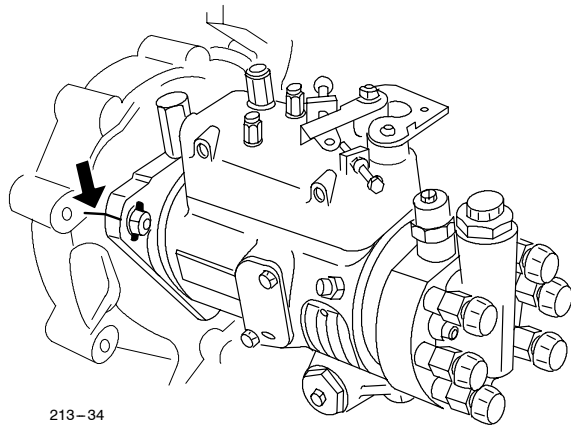
2. Remove the cover of the front covering so that the pump gear wheel becomes accessible.

3. Unscrew the gear wheel attaching nut. Detach the gear wheel by using puller 9052 48900.

Note! If the timing gear casing has not been removed, the injection pump gear wheel remains in contact with the idler gear and it is unnecessary to mark the positions of the gears.

4. Detach the injection pump from the timing gear casing. Clean the sealing surfaces.

5. Place a new sealing ring on the pump flange. Push the pump into place so that the key on the shaft engages with the key slot on the gear wheel.



213–34

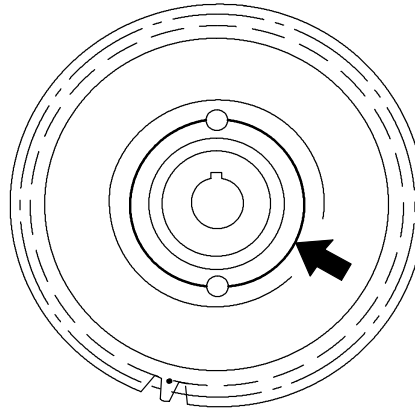
6. Tighten the pump into position, where the timing marks align.

7. Tighten the gear wheel nut to a torque of **90 Nm**. Fasten the pump gear wheel covering.

8. Remove the protective caps from the delivery pipe unions and fit the delivery pipes. Fit the overflow pipe, throttle cable wire and the stop solenoid wire. Bleed the fuel system (see instruction C).

B. Injection pump gear

The engines equipped with a rotary injection pump have a different timing mark on the gear in 420– and 620–engines.



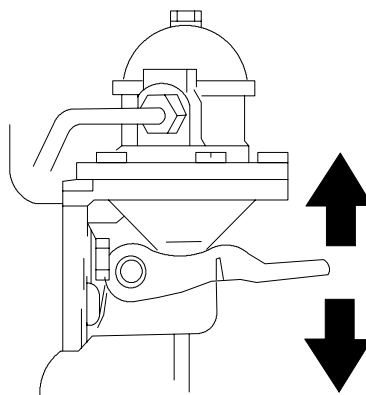
213–35

To identify the gear, in 620–engines the gear has a machined groove shown in the picture. In 420–engines the gear does not have this groove. The gears must not be mixed with each other.

C. Bleeding fuel system

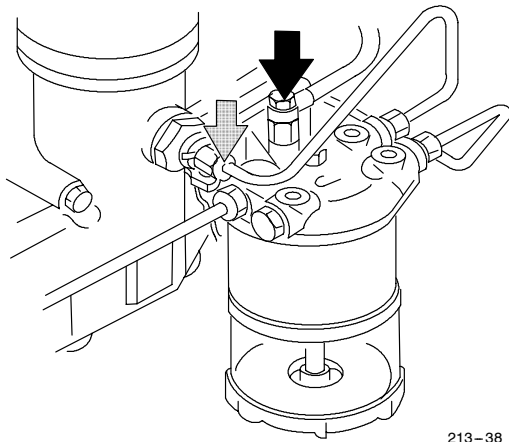
Note! This fuel system removes automatically small amounts of air bubbles from the filter and the pump when the engine is running. However, bleed the system always, when the system has been opened or fuel has been exhausted during driving or a new spare pump has been fitted (to avoid long starting time).

Bleed the fuel filter



213–36

1. Pump by hand the fuel feed pump lever. If the pumping seems to be ineffective, turn the engine a little so that the camshaft cam is not at the feed pump lifter.

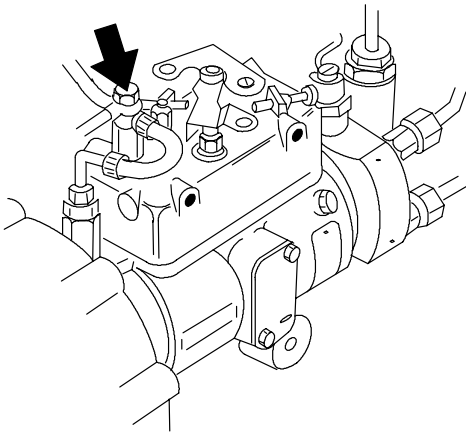


213–38

2. Unscrew the bleed screw on the top of the fuel filter
3. Pump with the hand pump until the fuel running out of the bleed screw is free of air bubbles.
- 4 Close the bleed screw. Clean the engine of leaked fuel.

Bleed the injection pump

1. Turn the ignition key to the position ON (stop solenoid is opening)



213–37

2. Unscrew the bleed screw on the top of the injection pump.
3. Pump with the hand pump until the fuel running out of the bleed screw is free of air bubbles.
4. Close the bleed screw. Switch off the current. Clean the engine of leaked fuel.

Bleed the thermostart system

Always remove air from the glow plug fuel pipe when the pipe or reservoir has been emptied during repair work etc. This prevents damages to the glow plug caused by lack of fuel during starting.

1. Open the pipe adaptor of the glow plug.
2. Pump with the hand pump until the fuel is running out of the pipe adaptor.
3. Tighten the pipe adaptor. Clean the engine of leaked fuel.

D. Feed pump

The feed pump of diaphragm type is not supplied with spare parts separately, replace the complete pump if the feed pressure is very low (min. **0,20 bar**/max. rpm) or the pump has otherwise been damaged.

E. Injector

The inspection and reconditioning of the injector is mainly done in the instruction **13 L...O** on pages **13–13...13–15**. The difference is opening pressure and the adjusting shims.

The new injector has a opening pressure of **250⁺⁸ bar**. An used injector has a opening pressure of **230⁺⁸ bar**.

The adjusting shims are delivered with a 0,02 mm difference, from 0,42 to 0,70 mm thickness. Also 0,30, 1,00, 1,28 and 1,56 mm thick shims are available. A difference of 0,02 mm in the shim thickness changes the opening pressure about 2 bar.

Note! Ensure that always the correct nozzle type is used, because an incorrect nozzle leads to incorrect function of the engine and damages.

STANADYNE DISTRIBUTOR PUMP

Note! This manual gives only general instructions for repair and service measures related to the fuel system. This applies particularly to the injection pump which can be repaired only by a specially trained person who has the necessary special tools and gauges. All service and repair work related to the fuel system requires special care and cleanliness!

TECHNICAL DATA

Injection pump Stanadyne

Type:	
– DB 2	(two pressure plungers)
– DB 4	(four pressure plungers)
Injection order:	
– 320	1–2–3
– 420	1–2–4–3
– 620/634	1–5–3–6–2–4
Direction of rotation	Clockwise
Injection advance	see pump installation marks

Fuel feed pump

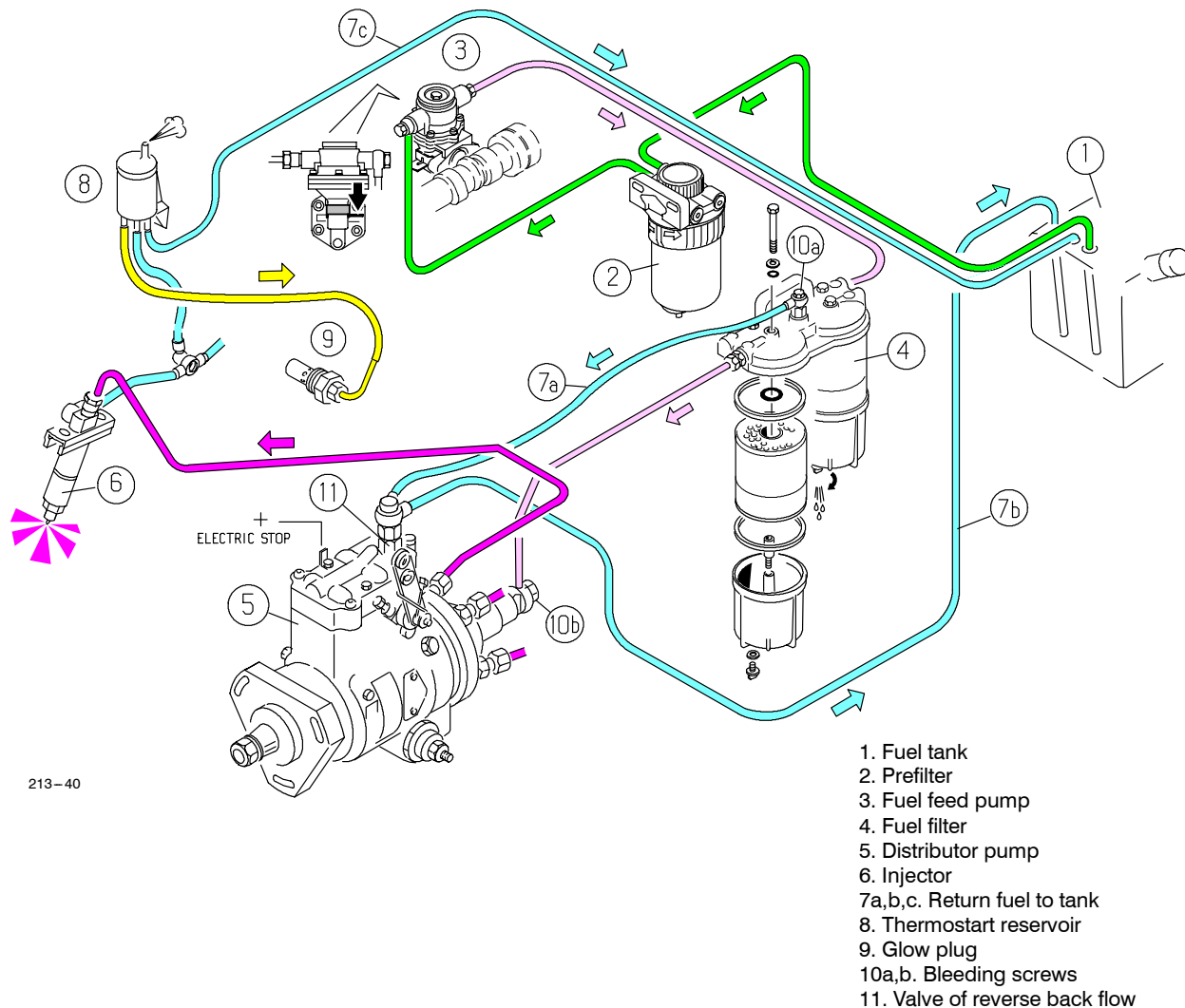
Construction	diaphragm pump, separate hand lever
Fuel feed pressure (static)	0,48 bar (48 kPa)
Fuel feed pressure min. (used pump)	0,20 bar / max. rpm

Injectors

Type	five hole nozzle
Opening pressure	see page 14–10
Sealing ring	8999 01495

Tightening torques

Pump gear retaining nut	90 Nm
Nozzle retaining nut	60 Nm
Injector retaining nuts (for the studs)	15 Nm

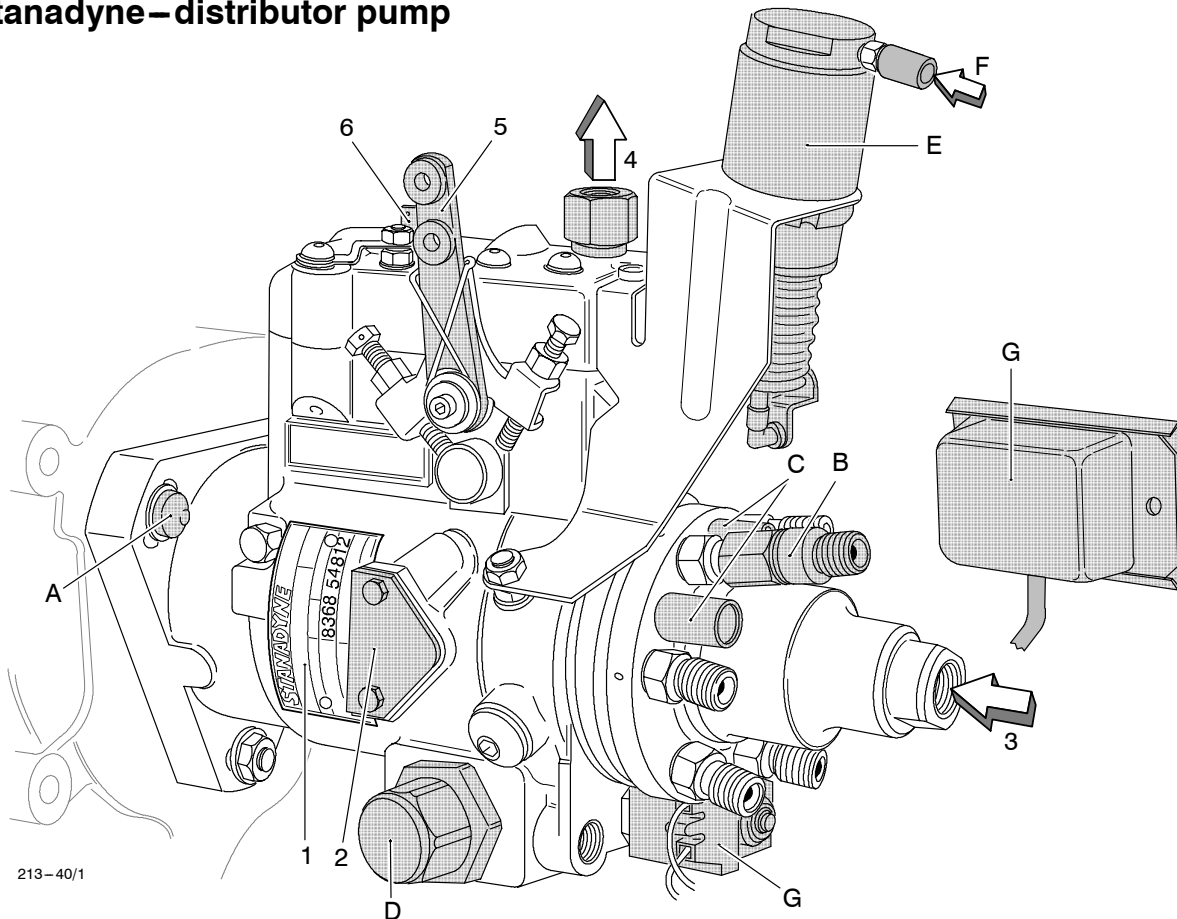
Fuel system with distributor pump

In this fuel system, there is a separate fuel feed pump (3) on the RH side of the engine.

The system includes a separate prefilter (2) and a fuel filter (4). The lower parts of the fuel filter housings have a space for possible impurities and there is a draining tap under both filter housings.

The fuel feed pump has a washable filter. There is also a tapered metal net filter inside the distributor pump in the inlet line before the pump transfer pump.

The fuel system is often equipped with the Thermostart device to be used in cold conditions. The glow plug (9) receives fuel from a separate reservoir (8) of the thermostart device or from the overflow valve of the injection pump regulated by the magnetic valve.

Stanadyne–distributor pump

213–40/1

1. Type plate with pump order number
2. Timing marks under the cover
3. Fuel inlet
4. Return fuel/overflow valve
5. Revolution lever
6. Connector for wire to electric stop solenoid

Eventual injector pump equipment (e.g. E–engines)

A. Interrupted screw (order no 8366 59038)

B. Timing sensor

C. Fuel Limiter **FL**

The fuel limiter FL restricts the injection mostly at low RPM as the air ratio otherwise would be too low.

D. Light Load Advance **LLA**

Adjustment of the injection advance according to the rotating speed and load steered by the fuel delivery pressure after the metering valve.

E. Aneroid Control **AC**

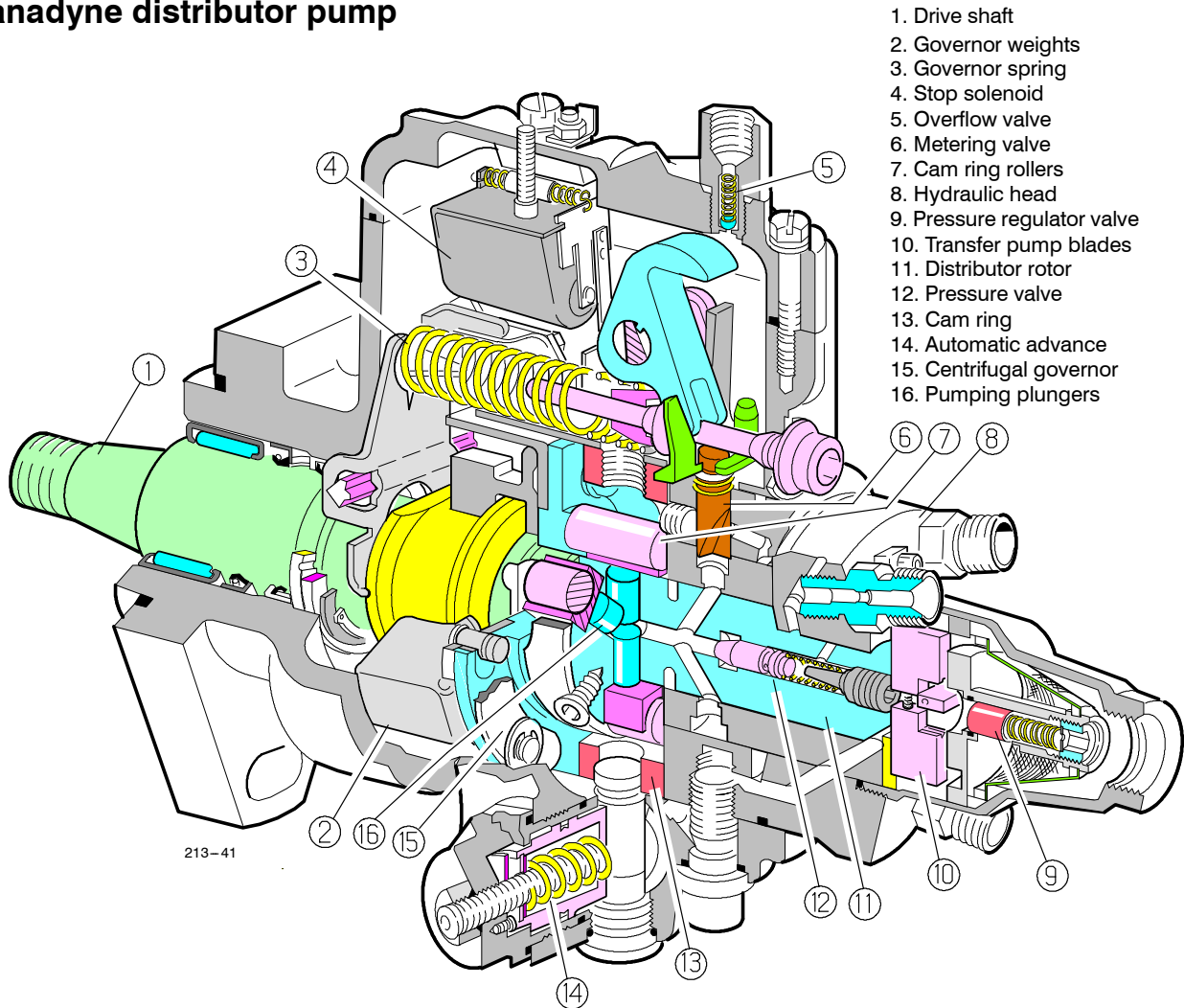
The aneroid control regulates fuel delivery to match turbocharger air flow characteristics at low speeds to minimize smoke during acceleration on low speed.

F. Boost pressure

G. Compact Cold Advance **CCA**

Electrical device for earlier injection advance at start and low load (under 1100 RPM) to minimize the so called cold smoke. The device includes an injector pump solenoid and a separate control unit to follow the engine rotating speed.

Stanadyne distributor pump



Construction

The main rotating components are the drive shaft, transfer pump blades, distributor rotor and governor.

The drive shaft engages the distributor rotor in the hydraulic head. The drive end of the DB2 rotor incorporates two pumping plungers and DB4 four.

The plungers are actuated toward each other simultaneously by an internal cam ring through rollers and shoes which are carried in slots at the drive end of the rotor. The numbers of cam lobes normally equals the number of cylinders (not 3-cyl. engines).

The transfer pump at the rear of the rotor is of the positive displacement vane type and is enclosed in the end cap. The end cap also houses the fuel inlet strainer and transfer pump pressure regulator. The face of the regulator assembly is compressed against the liner and distributor rotor and forms an end seal for the transfer pump.

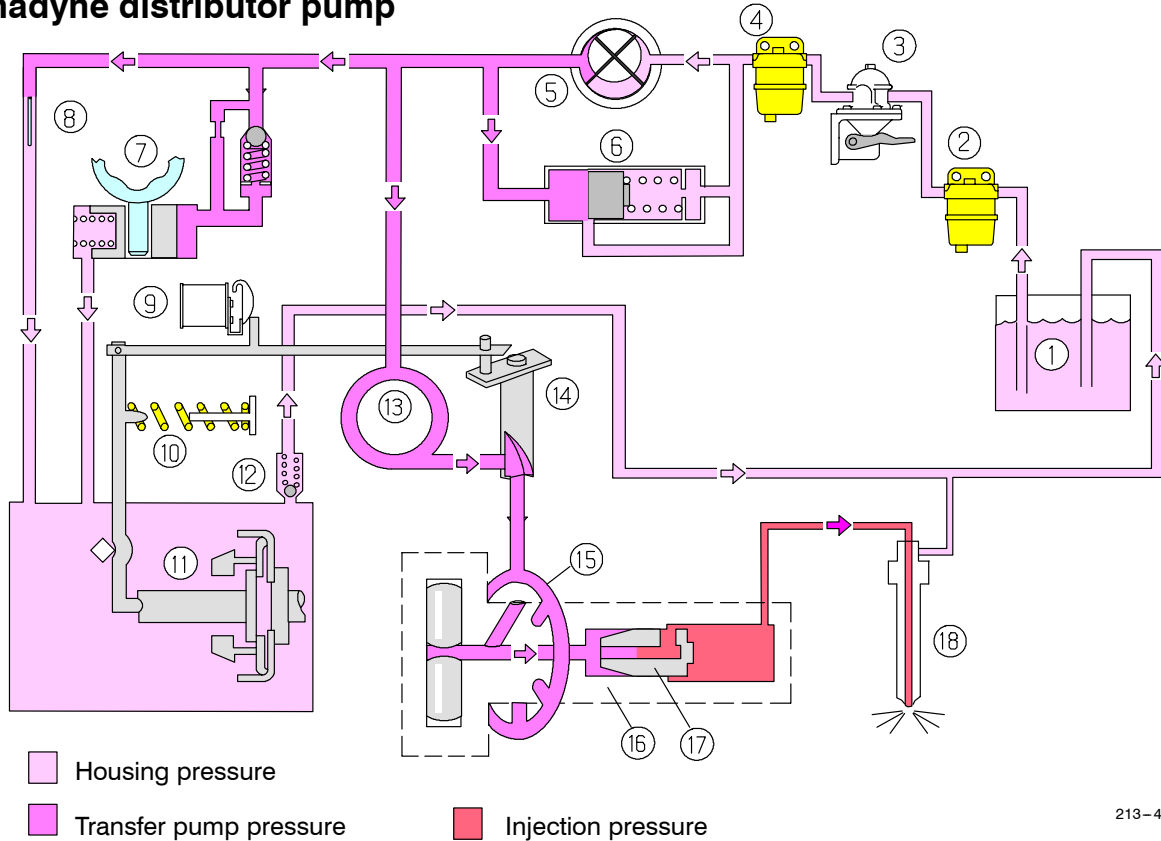
The injection pump is designed so that end thrust is against the face of the transfer pump pressure regulator.

The distributor rotor incorporates two charging ports and a single axial port (pressure chamber), in which is placed the pressure valve. After the delivery valve, there is one discharge port to serve all head outlets to the fuel injection pipes.

The hydraulic head contains the bore in which the rotor revolves, the metering valve bore, the charging ports and the connections to the fuel injection pipes.

The pump contains a mechanical governor. The centrifugal force of the weights is transferred to the metering valve via a linkage. The metering valve can be closed electrically with aid of the solenoid in the pump housing.

The automatic advance is a hydraulic mechanism which turns the cam ring and advances or retards the beginning of the fuel delivery from the pump.

Stanadyne distributor pump

213-42

- | | |
|-----------------------------|---------------------------------------|
| 1. Fuel tank | 10. Regulator spring |
| 2. Water trap | 11. Centrifugal weights |
| 3. Fuel feed pump | 12. Overflow valve |
| 4. Fuel filter | 13. Hydraulic head connecting passage |
| 5. Transfer pump | 14. Metering valve |
| 6. Pressure regulator valve | 15. Hydraulic head charging passage |
| 7. Automatic advance | 16. Distributor rotor |
| 8. Air vent passage | 17. Pressure valve |
| 9. Stop solenoid | 18. Injector |

Function

The fuel feed pump draws fuel from the tank via the water trap and the filter into the fuel injection pump.

In the pump fuel flows through the inlet filter screen into the vane type fuel transfer pump. Some fuel is bypassed through the pressure regulator assembly to the suction side.

Fuel under transfer pump pressure (1–6 bar) flows through the center of the transfer pump into the circular groove on the rotor. It then flows through a connecting passage in the head to the automatic advance and up through a radial passage and then through a connecting passage to the metering valve. The metering valve adjusts amount of injected fuel and position of the metering valve is controlled by the governor (revolution lever) and the stop solenoid. From the metering valve fuel flows to the radial charging passage and further to the head charging ports.

As the rotor revolves, the two rotor inlet passages register with the charging ports in the hydraulic head, allowing fuel to flow into the pumping chamber. With further rotation, the inlet passages close and the port to the injectors opens.

While the discharge post is opened, the rollers contact the cam lobes forcing the plungers together. Fuel trapped between the plungers is then pressurised and delivered by the nozzle to the combustion chamber.

The injection pump is self-lubricating, and it has not been connected to the engine lubrication system.

As fuel at transfer pump pressure reaches the charging ports, slots on the rotor shank allow fuel and any entrapped air to flow into the pump housing cavity. In addition, an air vent passage in the hydraulic head connects the outlet side of the transfer pump with the pump housing. This allows air and some fuel to be bled back to the fuel tank via the overflow valve.

The fuel thus bypassed fills the housing, lubricates the internal components, cools and carries off any small air bubbles. The pump operates with the housing completely full of fuel; there are no dead air spaces anywhere within the pump.

A. Removing pump

1. Clean the pump and the surrounding parts carefully. Remove the delivery pipes, the throttle cable wire from the revolution lever and the stop solenoid wire from the pump. Fit protective caps on the delivery pipe unions.

2. Remove the cover of the front covering so that the pump gear wheel becomes accessible.

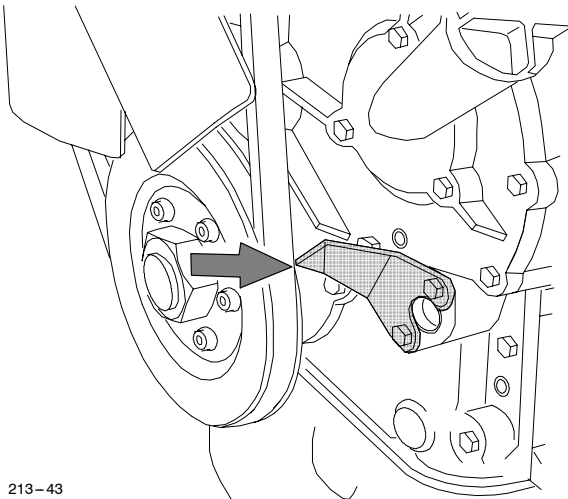
3. Unscrew the gear wheel attaching nut. Detach the gear wheel by using puller 9052 48900.

Note! If the timing gear casing has not been removed, the injection pump gear wheel remains in contact with the idler gear and it is unnecessary to mark the positions of the gears.

4. Detach the injection pump from the timing gear casing. Clean the sealing surfaces.

Note! In E–engines have one retaining screw so–called interrupted screw. Unscrew it with a drift.

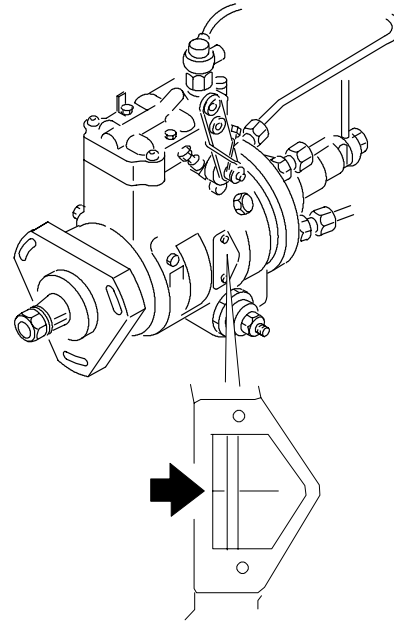
B. Fitting injection pump and adjusting injection timing



213–43

1. Turn the crankshaft to a position where the 1st cylinder piston reaches its compression stroke top dead centre. Then turn the crankshaft backwards until the mark on the pulley passes the timing indicator. After that rotate the crankshaft slowly to running direction until the mark on the pulley is at the point of the timing indicator.

Note! Distance between the piston top face and the top dead center with different crankshaft angles, see page 5–3.



213–44

2. Remove the small cover plate on the side of the injection pump. Rotate the pump shaft until the timing marks align (see arrow in picture above).

3. Place a new sealing ring on the pump flange. Push the pump into place on the timing gear housing. **Note!** key groove in gear left out from beginning of 1996.

4. Tighten the pump into position, where the timing marks align.

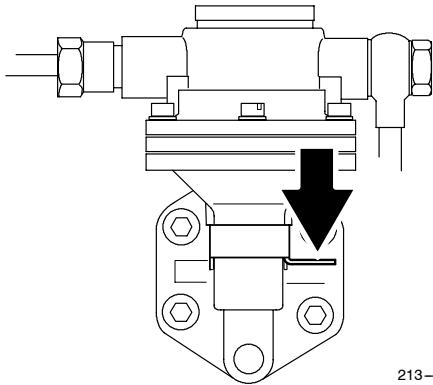
5. Tighten the gear wheel nut to a torque of **90 Nm**. Fit the small cover onto the side of the pump. Fasten the pump gear wheel covering (+ oil filler tube).

6. Remove the protective caps from the delivery pipe unions and fit the delivery pipes. Fit the overflow pipe, throttle cable wire and the stop solenoid wire. Bleed the fuel system (see instruction C).

Note! Lubrication oil is not needed because fuel in the pump lubricates the internal parts.

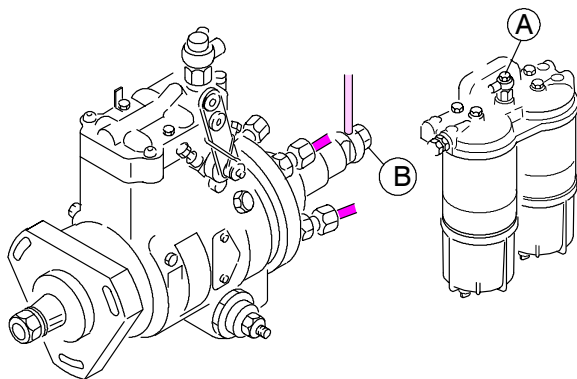
C. Bleeding fuel system

Note! This fuel system removes automatically small amounts of air bubbles from the filter and the pump when the engine is running. However, bleed the system always, when the system has been opened or fuel has been exhausted during driving or a new spare pump has been fitted (to avoid long starting time).



213–45

1. Pump by hand the fuel feed pump lever. If the pumping seems to be ineffective, turn the engine a little so that the camshaft cam is not at the feed pump lifter.



213–46

2. Loosen the bleeding screw **A** on the filter. Pump with the hand pump until no air bubbles flows out of the bleeding screw hole. Tighten the bleeding screw.

3. Pump further with the hand pump and loosen the fuel inlet connection **B** on the pump, until the fuel coming out is free from air bubbles. Tighten the connection.

4. Start the engine and assure, that no leaks exist.

Note! When the bleeding is done in this way, fuel flows immediately into the internal transfer pump when the starter motor is rotating and the distributor pump housing is filled quickly with fuel. In the pump housing there is a stop solenoid, which must not be switched on for longer periods when the pump housing is empty of fuel.

D. Fuel feed pump

For the membrane type fuel feed pump no spare parts are supplied. The feed pump must be changed for a new one, if the feed pressure has dropped noticeably (min. **0,20 bar**/ max. rpm) or if the fuel feed pump has been damaged.

Note! From engine number H 6794 have engines provide with new type fuel feed pump. New pump is fixed to cylinder block with four screws instead of the previous two. The new pump can be used as spares also to earlier made engines using repair kit 8366 62052, see Service information no 50 98.

Measuring fuel feed pressure

- Clean the injection pump, filter and all fuel pipes.
- Connect a pressure gauge between the filter and the injection pump, connect the pressure gauge to the inlet pipe in the middle of the injection pump rear end (point **B** in the previous instruction).
- Allow the engine to run at the idling speed and read off the fuel feed pressure in the pressure gauge.

Note! If the feed pressure value is below the rated value, possible reason can be:

- blocked fuel filter/fuel feed pump metal gauze filter
- faulty fuel feed pump
- blocked or leaked fuel pipes or pipe connections

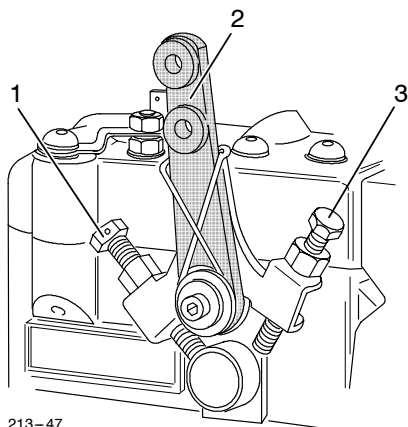
Important! Under the fuel feed pump cover there is a washable filter. If much impurities have gathered on this filter, fuel cannot flow to the feed pump and further to the injection pump and this causes malfunctions in the fuel system. Always when malfunctions appear, the feed pump cover should be removed and the metal gauze filter must be checked and cleaned.

E. Injectors

Injectors are checked and serviced according to instructions **13 L...O** on pages **13–13...13–15**.

Opening and setting pressures of the injectors are on page **14–10**.

Adjustment is achieved by changing the shims. The thickness of the shims varies from 1.00...1.90 mm and they are available in increments of 0,05 mm. A thicker shim will raise the opening pressure while a thinner one lowers it. A difference in shim thickness of 0,05 mm changes the opening pressure by approx. 5,0 bar. As the opening pressure of the injector drops slightly after adjustment, the opening pressure should be set to approximately 10 bar above the value given in the specifications. This value applies both to new and used injector.

F. Adjusting low idling speed

1. Low idling speed
2. Revolution lever
3. Max. revs

The low idling speed can be adjusted with a limiting screw in front of the revolution lever. The adjusting screw for max. revs has been sealed. This adjustment has been done in the factory, and adjustment of max. revs afterwards is prohibited.

Note! The throttle cable is attached to the revolution lever lower hole. To the upper hole is fastened a return spring.

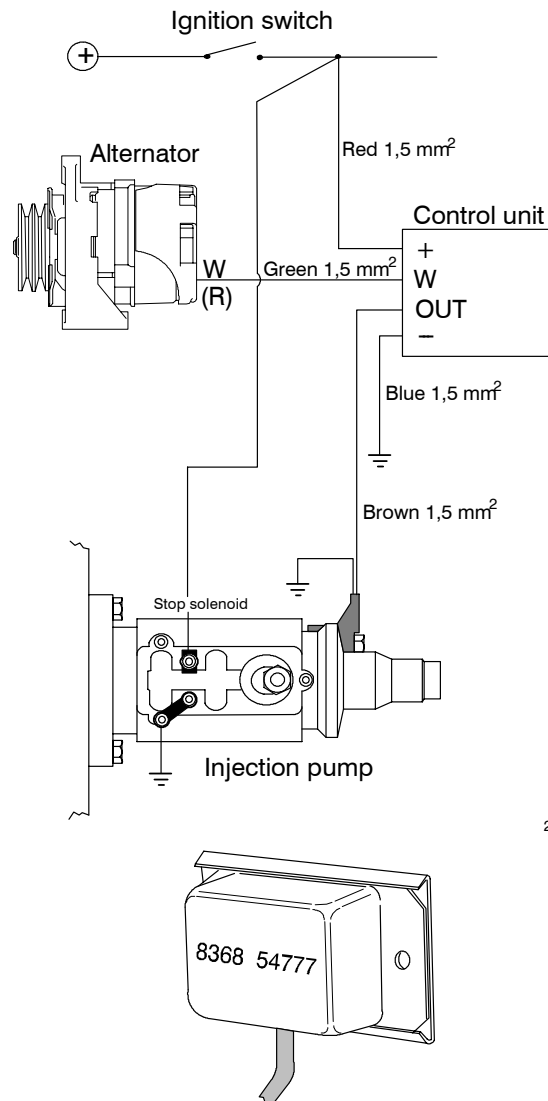
Other information

The injection pump housing upper cover has been sealed to prevent adjustment of engine output afterwards. Also the stop solenoid is fitted under this cover. It is recommended, that all pump repairs are made by an authorised Stanadyne workshop.

G. Bleeding Thermostart system

Always remove air from the glow plug fuel pipe when the pipe or reservoir has been emptied during repair work etc. This prevents damages to the glow plug caused by lack of fuel during starting.

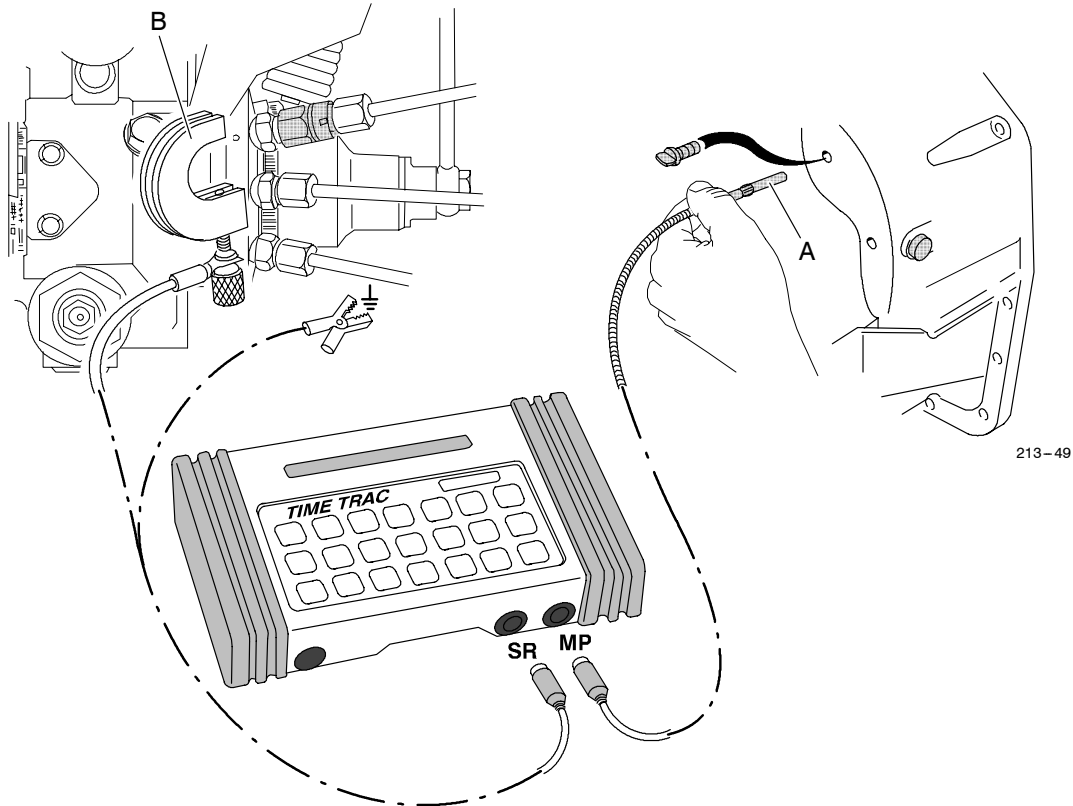
1. If the reservoir is empty, fill it e.g. with a drip pot through the breather hole on the reservoir.
2. Open the glow plug pipe connector and drain fuel from the pipe. Connect the pipe.

H. Wiring diagram of electrical advance (CCA)

The control unit of the electrical advance depends on gear ratio of the alternator.

SPARE PART NO	GEAR RATIO	ALTERNATOR
8368 54777	2.32	12 V MM
8368 54778	2.90	12 V Delco
8368 54817	3.97	12 V Valeo

I. Checking injection timing (dynamic)



1. Warm up engine and fuel injection system.

Note! All connections, including the magnetic probe insertion and removal, must be done with the engine stopped.

2. Remove the protective plug from access hole ($\varnothing 8$ mm) and attach the magnetic probe assembly **A** to the engine by inserting the probe into the access hole (in tractor versions into the upper hole), and the RETRACTING SLIGHTLY (**0,5...1,0 mm**). This must be done to prevent wear of the end of the probe caused by contact with the flywheel. Connect the magnetic probe cable to the meter socket MP.

3. Install the adapter clamp **B** by first placing the clamp assembly around sensor slightly above the brass contact ring and then moving down over the contact ring. Tighten the thumb screw of the clamp ensuring that the end of the screw contacts the ring. Connect the transducer cable to the meter socket SR. Connect the alligator clip to some clean unpainted metallic portion of the fuel system or engine.

4. Turn the meter on by pressing the ON/CLEAR key. The words "Time Trac" and then "Model TT 1000" should appear briefly followed by "R= 0". The meter can be used as a tachometer at this point without further manipulation.

5. Press MAG PROBE. Display shows "Trig Level 30%". Press ENTER leaving the trigger point at 30%.

6. Display shows "Offset 20.0°". Press ENTER leaving the offset at 20,0°.

7. Display shows "Calibrate?". Start the engine and run it at low idle speed. Press ENTER to continue which will cause the

display to read "R= ___ Set RPM".

Note! Before starting engine, make certain that all cables are clear of any moving parts or hot manifold.

8. Once the proper RPM is displayed, press ENTER. The display shows "Calibrating..." for a short period of time.

Note! If for some reason the meter loses the engine speed signal or the engine is not running, the display will show "Eng. Not running", flash this message 3 times, and return to the tachometer mode. To restart the procedure, press MAG PROBE (point 5).

9. If for example the engine were running at 850 RPM and timing were 6° BTDC, display should now read "R=850 MP + 6.0". Now the meter is ready for use.

Note! If for some reason the meter loses the magnetic probe signal the display will show "R=850 No Probe". Once the magnetic probe signal is restored, the display will show the proper timing reading.

10. You can measure the pump timing at high idle speed [TT (HI)]. This value is valid for pump timing setting. Adjust if necessary. The cam advance operation of the injection pump you can check at low idle [TT (LI)].

Setting values are available through Service Department of Sisu Diesel Inc.

Read also manufacturer service manual.

Trouble shooting

If the timing deviates remarkably from given, check the following:

1. Vibrating delivery pipe, hold the pipe with hand.
2. Distance of magnetic probe from flywheel not correct, re-set the magnetic probe.
3. "Offset" or "Trig Level" value wrong, re-set.
4. Disturbing scratches on the flywheel.
5. Alignment of flywheel–crankshaft wrong, remove the flywheel and reassemble correct.

Fuel quality requirement

	Requirement	Test method
Density, +15 °C	0,82...0,86 kg/dm ³	ASTM D 4052, EN ISO 12185
Viscosity, +40 °C	1,2...4,5 mm ² /s	ASTM D 445, ISO 3104
Sulphur content	max. 0,2 % m/m	ASTM D 4294, ISO 8754
Cetane index	min. 45	ASTM D 4737
Water content	max. 200 mg/kg	ASTM D 1744

The fuel should be according to norm EN 590.

Engine output depending on fuel quality

Different fuel qualities like temperature, density and viscosity affect the actual output of the engine. Our output rates use fuel with a density of 0.84 kg/dm³ and specific heat rate of 42,7 MJ/kg at a fuel temperature of +15 °C.

The correction in % caused by the change of fuel qualities is seen in the attached figures.

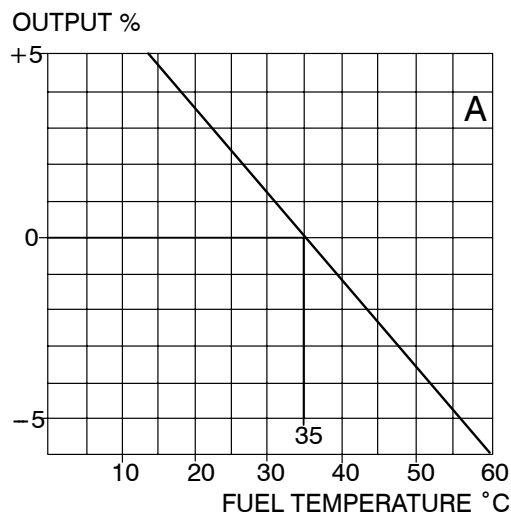


FIG. A. Engine output dependence on fuel temperature. +35 °C is the reference temp (correction 0 %).

The fuel temperature is not only a function of ambient conditions but also varies according to the fuel system of the application (tank size and location, return flow etc.).

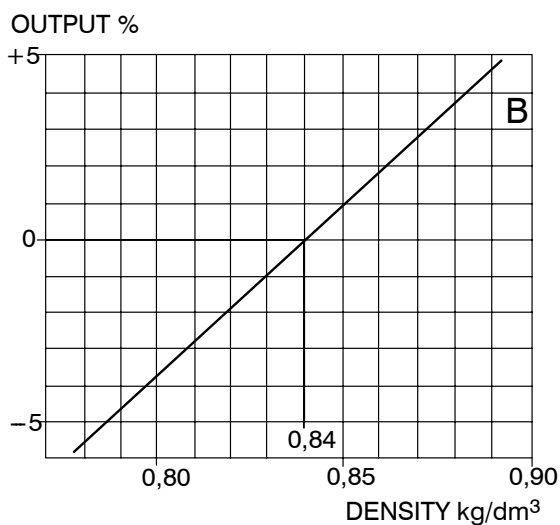


FIG. B. Engine output dependence on fuel density. Normal value is 0,84 kg/dm³ at +15 °C.

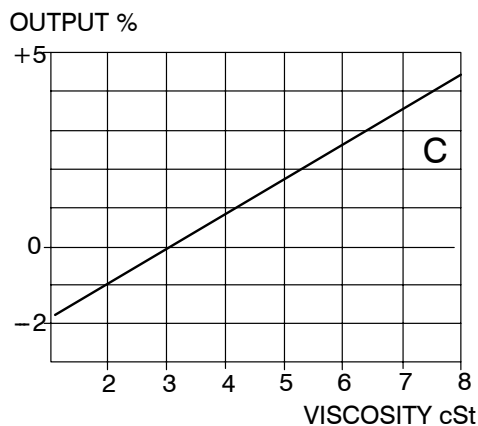


FIG. C. Engine output dependence on fuel viscosity. Normal value is 3 cSt at +20 °C.

Note fig. B and C only if the fuel quality is changed. In fig. A there are all the quality dependencies caused by the change of the temperature. The fuel density and viscosity can be seen in the produce declaration given by the manufacturer.

The output correction is made as follows: Correction percentages from figures A, B and C are summed up. The given rated power is then corrected with the resulting percentage.

**FUEL SYSTEM
EQUIPMENT AND FEEDING TABLE****320**

Test equipment ISO 4008
Fluid ISO 4113
Pipes ø 6 x 2 x 600 ISO 4093

Nozzle ISO 4010 173 bar or
nozzle ISO 7440 207 bar
0,60 orifice plate

Engine	Application	Pump spare part no Fuel adjustment card	Pump Governor	Injection advance° Max. output r/min Idling r/min Output kW	ISO 4010 mm ³	Feed rate mm ³ /stroke rpm	ISO 7440 mm ³	RW mm	Control rod min. -1 mm rpm	Control rod position 4 mm rpm	Element Pressure valve Governor spring
320 DS	Valmet 6100	8366 40199 13.222/1	PES 3A 95D 320 RS 2810 /C RSV 375-1150 A2C 2178-10R	19 2300 750 58	102-104	1150 1000 800 500 375	101-103	12,1...12,5 +0,1...0,2 +0,3...0,4 +0,3...0,4 4,1...4,7	1170-1190	1240-1260	8353 31161 8353 39126 8353 31163
320 D	Valmet 355	8366 40198 13.202/1	PES 3A 95D 320 RS 2810 /B RSV 375-1175 A2C 2178-10R	21 2350 750 45	79-81	1150 950 800 500 325	73-88	10,7...11,1 11,1...11,5 11,6...12,0 11,6...12,0 4,1...4,7	1200	1280-1300	8353 31161 8353 39126 8353 31163
320 DS	Valmet 455	8366 40197 13.223/1	PES 3A 95D 320 RS 2810 /A RSV 375-1175 A2C 2178-10R	19 2350 750 49	79-81	1150 1000 800 500 325	82-84	10,0...10,4 +0,2...0,3 +0,5...0,6 +0,5...0,6 4,1...4,7	1200-1220	1270-1300	8353 31161 8353 39126 8353 31163
320 DS	Valmet 555	8366 40156 13.230	PES 3A 95D 320 RS 2810 RSV 375-1175 A2C 2178-10R	19 2350 750 53	94-96	1175 950 800 500 375	94-96	11,3...11,7 11,3...11,7 12,0...12,4 11,9...12,5 4,1...4,7	1200	1255-1285	8353 31161 8353 39126 8353 31163
320 DG	Aggregate	8366 40382 13.250/1	PES 3A 95D 320 RS 2810 /D RSV 375-750 A2C 2178-10R	21 1500 1570 33	78-80	740 750 760 770 780	82-84	10,9...11,3 10,9...11,3 8,6...9,0 6,1...6,5 3,8...4,2	754-756	778-782	8353 31161 8353 39126 8367 54532

**FUEL SYSTEM
EQUIPMENT AND FEEDING TABLE**

Test equipment ISO 4008
Fluid ISO 4113
Pipes $\varnothing$ 6 x 2 x 600 ISO 4093

Nozzle ISO 4010 173 bar or
nozzle ISO 7440 207 bar
0,60 orifice plate

420

Engine	Application	Pump spare part no Fuel adjustment card	Pump Governor	Injection advance° Max. output r/min Idling r/min Output kW	ISO 4010 mm ³	Feed rate mm ³ /stroke rpm	ISO 7440 mm ³	RW mm	Control rod min. -1 mm rpm	Control rod position 4 mm rpm	Element Pressure valve Governor spring
420 D	Valmet 665 4600	8367 40392 14.212	PES 4A 95D 320 RS 2807 /BE RSV 375-1175 A2C 2178-7R	21 2350 750 59	73-74	1150 1000 900 600 375	77-78	9,8...10,2 +0,4...0,5 +0,8...0,9 +0,8...0,9 3,9...4,5	1195-1205	1270-1285	8353 31161 8353 39126 8353 31163
420 DS	Valmet 6300	8367 40174 14.226/1	PES 4A 95D 320 RS 2807 /B RSV 375-1125 A2C 2178-7R	19 2225 750 63	82-84	1100 1040 800 500 375	87-89	10,7...11,1 10,9...11,3 11,2...11,6 11,2...11,6 4,2...4,5	1130	1200-1210	8353 31161 8353 39126 8353 31163
420 DS	Valmet 6400	8367 40157 14.227/1	PES 4A 95D 320 RS 2807 RSV 375-1125 A2C 2178-7R	19 2225 750 70	84-87	1100 1000 900 500 375	91-93	11,2...11,6 +0,3...0,4 +0,5...0,6 +0,5...0,6 4,2...4,5	1135-1145	1210-1230	8353 31161 8353 39126 8353 31163
420 DS	Valmet 6600	8367 40173 14.228/1	PES 4A 95D 320 RS 2807 /A RSV 375-1125 A2C 2178-7R	19 2225 750 77	98-100	1100 1000 900 800 500 375	101-103	12,3...12,7 ±0,2 +0,4 +0,5 ±0,5 4,2...4,5	1140-1150	1200-1220	8353 31161 8353 39126 8353 31163
420 D	Hymax 8200	8367 40200 14.209	PES 4A 95D 320 RS 2807 /S RSV 375-1000 A2C 2178-7R	21 2000 750 60	83-84	1000 800 600 375	87-88	11,1...11,3 ±0,1 ±0,1 3,9...4,5	1030-1050	1090-1110	8353 31161 8353 39126 8353 31163

**FUEL SYSTEM
EQUIPMENT AND FEEDING TABLE**

Test equipment ISO 4008
Fluid ISO 4113
Pipes ø 6 x 2 x 600 ISO 4093

Nozzle ISO 4010 173 bar or
nozzle ISO 7440 207 bar
0,60 orifice plate

420

Engine	Application	Pump spare part no Fuel adjustment card	Pump Governor	Injection advance° Max. output r/min Idling r/min Output kW	ISO 4010 mm ³	Feed rate mm ³ /stroke rpm	RW mm ISO 7440 mm ³	Control rod min. -1 mm rpm	Control rod position 4 mm rpm	Element Pressure valve Governor spring
420 DS	Hymax 8200T	8367 40203 14.242	PES 4A 95D 320 RS 2807 /V RSV 375-1000 A2C 2178-7R	19 2000 750 80	104-106	1000 800 600 375	104-106 ±0,1 ±0,1 4,0...4,4	1030-1050	1190-1210	8353 31161 8353 39126 8353 31163
420 D	Wille 645 Joonas Lännen C15	8367 40181 14.202/1	PES 4A 95D 320 RS 2807 /J RSV 375-1200 A2C 2178-7R	21 2400 750 62	76-78	1200 1100 1000 900 500 375	78-80 9,6...9,8 +0,1...0,2 +0,2...0,3 +0,4...0,5 +0,4...0,5 4,3...4,7	1230-1150	1290-1310	8353 31161 8353 39126 8353 31163
420 D	Wille 725	8367 40202 14.210	PES 4A 95D 320 RS 2807 /U RSV 375-1100 A2C 2178-7R	21 2200 750 60	77-78	1100 800 500 375	82-83 10,5...10,7 ±0,1 ±0,1 4,5...5,1	1125-1140	1185-1210	8353 31161 8353 39126 8353 31163
420 DS	Wille 745/ 845	8367 40201 14.241	PES 4A 95D 320 RS 2807 /T RSV 375-1200 A2C 2178-7R	19 2200 750 80	97-99	1100 800 500 375	98-100 12,1...12,5 ±0,1 ±0,1 3,9...4,5	1125-1140	1185-1210	8353 31161 8353 39126 8353 31163
420 DSI DW	Valmet 836 838	8367 40180 14.235/1	PES 4A 95D 320 RS 2807 /H RSV 325-1100 A2C 2178-7R	19 2200 750 82	101-103	1000 800 500 325	101-103 12,2...12,6 12,2...12,6 12,2...12,6 4,0...4,4	1120-1135	1185-1200	8353 31161 8353 39126 8353 31163

**FUEL SYSTEM
EQUIPMENT AND FEEDING TABLE**

Test equipment ISO 4008
Fluid ISO 4113
Pipes ϕ 6 x 2 x 600 ISO 4093

Nozzle ISO 4010 173 bar or
nozzle ISO 7440 207 bar
0,60 orifice plate

420

Engine	Application	Pump spare part no Fuel adjustment card	Pump Governor	Injection advance° Max. output r/min Idling r/min Output kW	ISO 4010 mm ³	Feed rate mm ³ /stroke rpm	ISO 7440 mm ³	RW mm	Control rod min. -1 mm rpm	Control rod position 4 mm rpm	Element Pressure valve Governor spring
420 DW DSM	Valmet 828	8367 40399	PES 4A 95D	19	101-103	1200	102-104	12,4...12,8	1230-1240	1330-1350	8353 31161
	836	14.237/1	320 RS 2807	2400		1100		+0,1...0,3			8353 39126
	838		/BF	650		1000		+0,3...0,5			8353 31163
	840		RSV 375-1200	84		900		+0,5...0,6			
	901		A2C 2178-R		11-15	700	11-15	+0,5...0,6			
	Marine					325		4,0...4,4			
420 DSG	Aggregate	8367 40386 14.270/1	PES 4A 95D 320 RS 2807 /BD RSV 375-750 A2C 2178-7R	19	106-108	740	107-109	12,8...13,2	748-750	777-780	8353 31161
				1480		750		11,6...12,0			8353 39126
				1560		760		9,0...9,4			8367 54532
				64		770		6,3...6,7			
						780		3,8...4,2			
420 DS	Lännen C20 C100 C200 James 73 83	8367 40176 14.230/1	PES 4A 95D 320 RS 2807 /D RSV 375-1200 A2C 2178-7R	19	99-101	1200	101-103	12,3...12,5	1225-1240	1285-1310	8353 31161
				2400		800		$\pm$ 0,1			8353 39126
				750		500		$\pm$ 0,1			8353 31163
				82	11-15	325	11-15	3,9...4,5			
420 DS	Lännen S30 M213 T214 M314 T315	8367 40178 14.232/1	PES 4A 95D 320 RS 2807 /F RSV 325-1000 A2C 2178 R	19	94-96	1000	97-99	12,1...12,3	1025-1035	1085-1110	8353 31161
				2000		800		$\pm$ 0,0			8353 39126
				650		600		$\pm$ 0,0			8353 31163
				70		500		$\pm$ 0,0			
					14-17	325	14-17	4,2...4,6			
420 DSI	Lännen M215 M316	8367 40179 14.233/1	PES 4A 95D 320 RS 2807 /G RSV 325-1000 A2C 2178 R	19	110-112	1000	110-112	13,1...13,5	1025-1040	1085-1110	8353 31161
				2000		800		$\pm$ 0,0			8353 39126
				650		600		$\pm$ 0,0			8353 31163
				80	11-15	325	11-15	4,0...4,4			

**FUEL SYSTEM
EQUIPMENT AND FEEDING TABLE****420**

Test equipment ISO 4008
Fluid ISO 4113
Pipes ø 6 x 2 x 600 ISO 4093

Nozzle ISO 4010 173 bar or
nozzle ISO 7440 207 bar
0,60 orifice plate

Engine	Application	Pump spare part no Fuel adjustment card	Pump Governor	Injection advance° Max. output r/min Idling r/min Output kW	ISO 4010 mm³	Feed rate mm³/stroke rpm	ISO 7440 mm³	RW mm	Control rod min. -1 mm rpm	Control rod position 4 mm rpm	Element Pressure valve Governor spring
420 DWI	Ponsse S 15e 14.240	8367 40194	PES 4A 95D	19	106-108	1200	106-108	12,8...13,2 ±0,1	1220-1235	1285-1300	8353 31161
			320 RS 2807	2400		800			8353 39126		
			/R	750		600	±0,1		8353 31163		
			RSV 375-1200 A2C 2178-7R	90	11-15	375	11-15	4,0...4,4			
420 DSI	Ponsse S 15e 14.236	8367 40162	PES 4A 95D	19	95-97	1150	1,0(*)	11,6...12,0 +0,1	1215-1225	1290-1310	8353 31161
			320 RS 2654	2400		1000	1,0			8353 39126	
			/PK	650		800	1,0	+0,3		8353 31163	
			RSV 325-1200 A2C 2218 R	90		700		+0,4			
					500	1,0	+0,4				
				95-98 12-15	800	0,0	11,8...12,0 4,8...5,0		Boost control operation start at 0,45 bar (declining pressure)		
					325	0,0					
			*) boost pressure regulators pressure bar								
420 DS	Lännen C15 14.249	8367 54501	PES 4A 95D	19	86-88	1200	90-92	11,1...11,3 ±0,1	1225-1240	1285-1310	8353 31161
			320 RS 2807	2400		800				8353 39126	
			/BU	750		500	±0,1			8353 31163	
			RSV 375-1200 A2C 2178-7R	74	11-15	375	11-15	3,9...4,5			

**FUEL SYSTEM
EQUIPMENT AND FEEDING TABLE**

Test equipment ISO 4008

Fluid ISO 4113

Pipes ø 6 x 2 x 600 ISO 4093

Nozzle ISO 4010 173 bar or
nozzle ISO 7440 207 bar
0,60 orifice plate**620**

Engine	Application	Pump spare part no Fuel adjustment card	Pump Governor	Injection advance° Max. output r/min Idling r/min Output kW	ISO 4010 mm ³	Feed rate mm ³ /stroke rpm	RW mm ISO 7440 mm ³	Control rod min. -1 mm rpm	Control rod position 4 mm rpm	Element Pressure valve Governor spring
620 D	Valmet 8000	8368 40210 16.205	PES 6A 95D	23	61-63	1100	7,6...8,0	1150-1160	1190-1210	8353 31161
			320 RS 2806	2220		950	8,3...8,7			8353 39126
			/F	750		700	8,8...9,2			8353 31780
			RSV 325-1125 AOC 2178-8R	72	13-16	375	4,0...4,4			
620 D	Valmet 8100	8368 40158 16.203/1	PES 6A 95D	23	73-75	1100	8,9...9,1	1120-1130	1190-1215	8353 31161
			320 RS 2806	2225		980	+0,3...0,4			8353 39126
			RSV 375-1150	750		800	+0,8...0,9			8353 31780
			AOC 2178-8R	88	12-15	500	+0,8...0,9			
620 DS	MF 3670 VA 66 SB	8368 40193 16.232/1	PES 6A 95D	21	101-103	1100	11,4...11,6	1130-1140	1170-1190	8353 31161
			320 RS 2806	2200		1000	+0,3...0,4			8353 39126
			RSV 500-1100	1000		900	+0,4...0,6			8353 31780
			AOC 2178-9R	125		790	+0,5...0,6			
620 DSL	Dr 8400 MF 30	8368 39976 16.223	PES 6A 95D	21	90-93	900	10,4...10,8	1105-1110	1148-1157	8353 31161
			320 RS 2684	2200	18-22	1150	3,8...4,2			8353 39126
			/CO	1000	11-14	500	4,0...4,4			8353 31780
			RSV 325-1110 AOC 2178 2R	110	x=1,5-2 R					
620 DSL	Dr 8700 MF 32 32 RS	8368 40195 16.233	PES 6A 95D	21	116-118	1100	12,5...12,9	1110-1115	1155-1165	8353 31161
			320 RS 2806	2200	20-24	1150	4,0...4,3			8353 39126
			/DA	1000	12-15	500	4,0...4,4			8353 31780
			RSV 500-1100 AOC 2178-9R	129						

**FUEL SYSTEM
EQUIPMENT AND FEEDING TABLE**

Test equipment ISO 4008
Fluid ISO 4113
Pipes ø 6 x 2 x 600 ISO 4093

Nozzle ISO 4010 173 bar or
nozzle ISO 7440 207 bar
0,60 orifice plate

620

Engine	Application	Pump spare part no Fuel adjustment card	Pump Governor	Injection advance° Max. output r/min Idling r/min Output kW	ISO 4010 mm³	Feed rate mm³/stroke rpm	ISO 7440 mm³	RW mm	Control rod min. -1 mm rpm	Control rod position 4 mm rpm	Element Pressure valve Governor spring
620 DSP	VA 66S	8368 40230 16.238	PES 6A 95D 320 RS 2806 /DI RSV 375-1100 AOC 2178-9R	21	83-85	1100	86-87	9,8...10,2	1130-1140	1180-1190	8353 31161
				2200		800		±0,0			8353 39126
				750		500		±0,0			8353 31780
				106	12-15	375	12-15	3,8...4,2			
620 DSA	Sisu-Masi SA 130	8368 40152 16.230	PES 6A 95D 320 RS 2832 /A RSV 375-1250 AOC 2218-1R	21	0,8*	1250	107-109	12,4...12,8	1270-1290	1340-1360	8353 31161
				2500	0,8	1000		±0,0			8353 39126
				800	0,8	600		±0,0			8353 31780
				132	0,0	600	102-104	12,0...12,1			
						LDA					
					0,50	500		12,4...12,5			
					0,45	500		12,2...12,3			
620 DG	Aggregate	8368 40421 16.250/1	PES 6A 95D 320 RS 2806 /DN RSV 740-900 AOC 2178-9R	x=5,0 R	0,0	375	11-15	3,7...4,3			
				23	*) boost pressure regulators pressure bar						
				1760		850		9,8...10,2	897-899	936-938	8353 31161
				1570	67-69	900	71-73	8,6...9,0			8353 39126
				81		910		7,3...7,7			8367 54532
						920		6,0...6,4			
						930		4,6...5,0			
620 DSG	Aggregate	8368 54502 16.274/2	PES 6A 95D 320 RS 2806 /DT RSV 500-1100 AOC 2178-9R	x=5,0 R		940		3,3...3,7			
				21		700		13,9...14,3	748-750	776-778	8353 31161
				1500	130-132	740	133-135	14,0...14,2			8353 39126
				1570		750		13,1...13,5			8368 54727
				110		760		9,8...10,2			
						770		6,4...6,8			
						780		3,0...3,4			

**FUEL SYSTEM
EQUIPMENT AND FEEDING TABLE****620**

Test equipment ISO 4008
Fluid ISO 4113
Pipes ø 6 x 2 x 600 ISO 4093

Nozzle ISO 4010 173 bar or
nozzle ISO 7440 207 bar
0,60 orifice plate

Engine	Application	Pump spare part no Fuel adjustment card	Pump Governor	Injection advance° Max. output r/min Idling r/min Output kW	ISO 4010 mm ³	Feed rate mm ³ /stroke rpm	ISO 7440 mm ³	RW mm	Control rod min. -1 mm rpm	Control rod position 4 mm rpm	Element Pressure valve Governor spring
620 DS	Valmet 860 911	8368 40398 16.237	PES 6A 95D 320 RS 2806 /DE RSV 375-1200 AOC 2178-9R	21 2400 780 130	96-98	1200 1000 800 700 500 390	97-99	11,5...11,9 11,6...12,0 12,0...12,4 12,2...12,6 12,2...12,6 3,7...4,3	1130-1140	1170-1190	8353 31161 8353 39126 8353 31163

12-15
x=12 NAPS, 4,5 R

**FUEL SYSTEM
EQUIPMENT AND FEEDING TABLE****634**

Test equipment ISO 4008
Fluid ISO 4113
Pipes ø 6 x 2 x 600 ISO 4093

Nozzle ISO 4010 173 bar or
nozzle ISO 7440 207 bar
0,60 orifice plate

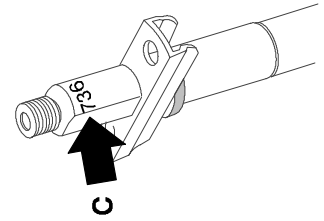
Engine	Application	Pump spare part no Fuel adjustment card	Pump Governor	Injection advance° Max. output r/min Idling r/min Output kW	Feed rate mm ³ /stroke rpm	ISO 7440 mm ³	RW mm	Control rod min. -1 mm rpm	Control rod position 4 mm rpm	Element Pressure valve Governor spring
634 D	Valmet 8200	8368 54570 18.201	PES 6A 95D 320 RS 2806 /EG RSV 500-1125 A0C 2178-8R	22 2225 750 96	1100 1000 900 800 750 600 375	86-88	9,8...10,2 9,9...10,3 10,1...10,5 10,2...10,6 10,3...10,7 10,3...10,7 3,8...4,2	1130	1190-1210	8353 31161 8353 39126 8353 31780
634 DS	Steyr 9190A MF 3690	8368 54524 18.223	PES 6A 95D 320 RS 2848 RSV 500-1100 A5C 2269-R	20 2200 1000 140	1100 1000 900 800 750 600 LDA 500 500 500 500	120-122	13,8...14,2 13,9...14,3 14,1...14,5 14,2...14,6 14,3...14,7 14,3...14,7 14,0...14,4 12,4...12,8 12,2...12,6 6,5...7,5	1115	1180-1200	8353 31161 8353 39126 8353 54532

*) boost pressure regulators pressure bar

**FUEL SYSTEM
INJECTOR**

Order no.	Manufacturer	Type	Nozzle no.	Opening pressure bar	Setting pressure bar ¹⁾	Adjusting plate no. 1,00...2,00 mm	Code (C)
8366 39956	Stanadyne	S	8366 39957	230	240	8366 40104...8366 40122	736
8363 40034	Stanadyne	S	8363 39985	230	240	8366 40104...8366 40122	655
8368 40397	Stanadyne	S	8368 40396	230	240	8366 40104...8366 40122	105
8368 54786	Stanadyne	S	8366 39957	260	270	8366 40104...8366 40122	780
8368 54755	Stanadyne	M	8368 54757	270 ⁺⁸	278	8368 62000...8368 62020	423
8368 54791	Stanadyne	M	8368 54792	270 ⁺⁸	278	8368 62000...8368 62020	876
8368 54831	Stanadyne	M	8368 54832	270 ⁺⁸	278	8368 62000...8368 62020	446
8366 59808	Stanadyne	M	8366 59902	270 ⁺⁸	278	8368 62000...8368 62020	358
8366 40167	CAV		8366 40165	230 ⁺⁸	250 ⁺⁸	8366 40337...8366 40355 (0,30...1,57 mm) –	
8367 64613	Stanadyne	M	8367 64614	270 ⁺⁸	278	8368 62000...8368 62020	927

¹⁾ Value to be used when adjusting the opening pressure of a new or used injector.



15. ELECTRICAL SYSTEM

A. Alternators

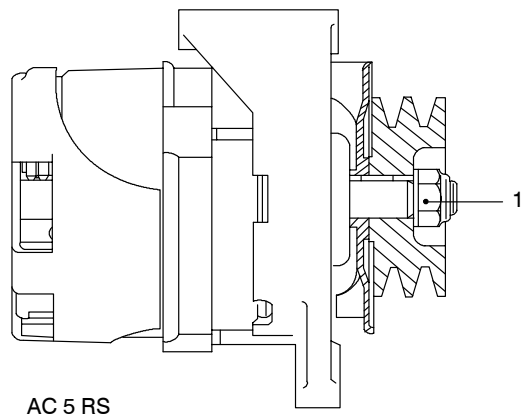
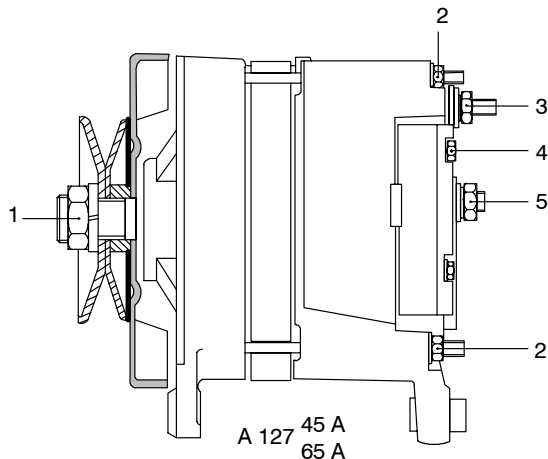
Magneti Marelli A 127 45 A/65 A

(Lucas)

(Sisu Diesel no. 8366 40127 45 A)

(Sisu Diesel no. 8366 40128 65 A)

Nominal voltage	12 V
Max. voltage 6000 r/min	A 127 45 A 45 A
	A 127 65 A 65 A
Earthing	(-) minus
Max. allowed speed	15 000 r/min
Brush length when new	17 mm
Min. brush length	5 mm
Brush spring tension	1,3...2,7 N
Number of stator poles	12
Number of stator phases	3
Stator resistance	A 127 45 A 0,25 ohm
	A 127 65 A 0,18 ohm
Rotor resistance	2,9 ohm
Regulating voltage	13,6...14,4 V
Tightening torques:	
1. Shaft nut	60 Nm
2. Assembling screws	5,5 Nm
3. Phase connection (M5)	4,0 Nm
4. Regulator screws	2,5 Nm
5. Main connection	4,0 Nm



215-1

CAV AC 5 RS 24 V 55 A

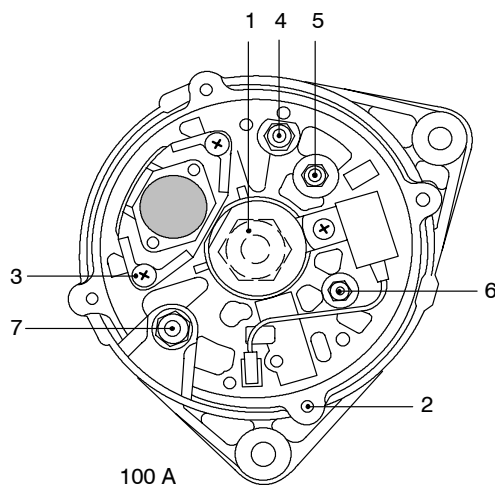
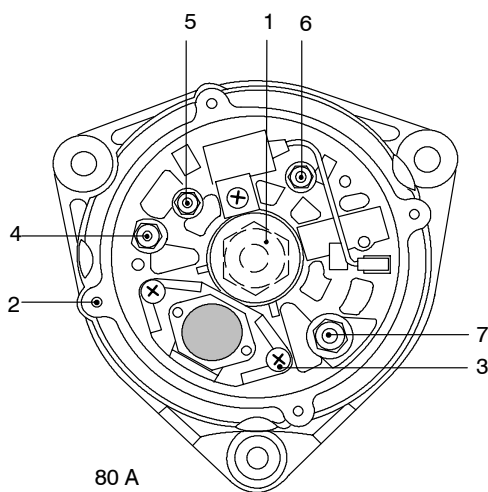
(Sisu Diesel no. 8353 39422)

Nominal voltage	24 V
Output	
2000 r/min	27 A
3000 r/min	42,5 A
4000 r/min	49 A
Charge begins	1250 r/min
Max. allowed speed	10 000 r/min
Min. slip ring diameter	32 mm
Min. brush length	8 mm
Brush spring tension	2,23 N
Rotor resistance	8,0...8,3 ohm
Stator resistance	0,09 ohm
Tightening torques:	
1. Shaft nut	55 Nm

Bosch N1 28 V 10/80 A

(Sisu Diesel no. 8353 39751)

Nominal voltage	24 V
Output	
1500 r/min	≥16 A
2700 r/min	≥53,5 A
6000 r/min	≥79 A
Min. slip ring diameter	26,8 mm
Brush length when new	19 mm
Min. brush length	5 mm
Rotor resistance	7,5...8,2 ohm
Stator resistance	0,057...0,062 ohm
Regulating voltage	28 V
Tightening torques:	
1. Shaft nut	55 Nm
2. Assembling screws	4,1...5,5 Nm
3. Regulator screws	1,6...2,3 Nm
4. Joint B- (M6)	4,8...6,8 Nm
5. Joint W (M5)	2,7...3,8 Nm
6. Joint D+ (M4)	1,6...2,3 Nm
7. Joint B+ (M8)	7,5...8,0 Nm



215-2

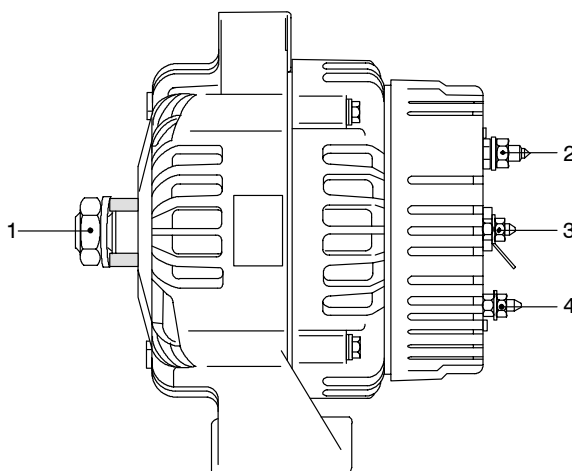
Bosch N1 28 V 0/100 A

(Sisu Diesel no. 8353 40374)

Nominal voltage	24 V
Output (warm generator, testing voltage 26 V)	
2000 r/min	≥26 A
3500 r/min	≥72 A
7000 r/min	≥94 A
Min. slip ring diameter	26,8 mm
Brush length when new	19 mm
Min. brush length	5 mm
Rotor resistance	7,5...8,2 ohm
Stator resistance	0,038...0,041 ohm
Regulating voltage	28,5 V
Tightening torques:	
1. Shaft nut	70 Nm
2. Assembling screws	4,1...5,5 Nm
3. Regulator screws	1,6...2,3 Nm
4. Joint B- (M6)	4,8...6,8 Nm
5. Joint W (M5)	2,7...3,8 Nm
6. Joint D+ (M4)	1,6...2,3 Nm
7. Joint B+ (M8)	7,5...8,0 Nm

Iskra AAK 5118 14 V 95 A(Sisu Diesel no. 8366 40927)
(Sisu Diesel no. 8366 66225)

Nominal voltage	12 V
Output (testing voltage 13 V)	
2000 r/min	≥50 A
4000 r/min	≥84 A
6000 r/min	≥94 A
Charge begins	1100 r/min
Max. allowed speed	15 000 r/min
Min. slip ring diameter	15,3 mm
Min. brush length	5 mm
Rotor resistance	2,7...2,97 ohm
Stator resistance	0,33...036 ohm
Tightening torques:	
1. Shaft nut	50...70 Nm
2. Joint B+ (M6)	4,2...6,0 Nm
3. Joint D+ (M5)	2,7...3,8 Nm
4. Joint W (M 5)	2,7...3,8 Nm



215-3

Bosch NC 14 V 70-120 A

(Sisu Diesel no. 8368 40939)

Nominal voltage	12 V
Output (13,5 V)	
2000 r/min	79 A
4000 r/min	111 A
6000 r/min	120 A
Charge begins	1200 r/min
Max. allowed speed	12 000 r/min
Min. slip ring diameter	14,9 mm
Brush length when new	12,5 mm
Min. brush length	5 mm
Tightening torques (see figure above):	
1. Shaft nut	60...70 Nm
2. Joint B+ (M8)	10 Nm
3. Joint D+ (M5)	5 Nm

Bosch NC 14 V 150 A

(Sisu Diesel no. 8368 64048)

Nominal voltage	12 V
Min. slip ring diameter	14,9 mm
Brush length when new	12,5 mm
Min. brush length	5 mm
Tightening torques (see figure above):	
1. Shaft nut	60...70 Nm
2. Joint B+ (M8)	10 Nm
3. Joint D+ (M5)	5 Nm

B. Starters

Magneti Marelli M 127/2,8 12 V

(Lucas)

(Sisu Diesel no. 8353 31592)

Values, unloaded

Running speed	5500...8000 r/min (max.)
Amperage	115 A
Voltage	11 V

Values, under loading

Running speed	1000 r/min (max.)
Amperage	670 A
Voltage	8,0 V
Torque	20,8 Nm

Values, locked

Running speed	0 r/min
Amperage	1160 A
Voltage	5,0 V
Torque	45,4 Nm

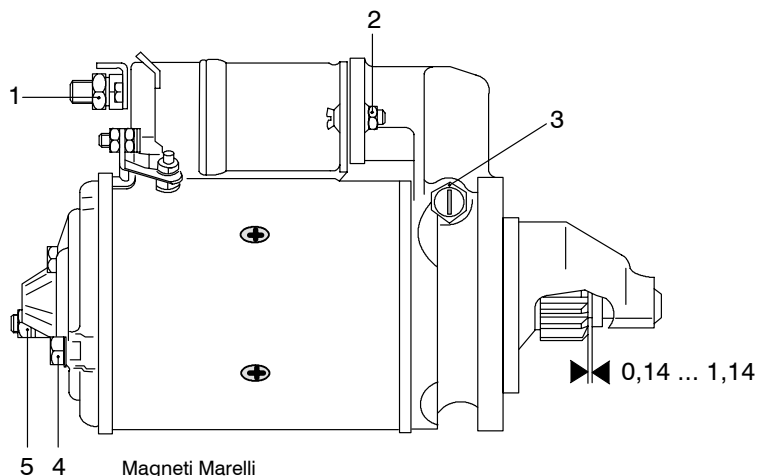
Brush spring tension 11,6...15,5 N

Min. brush length 8 mm

Min. commutator diameter 38 mm

Tightening torques:

1. Solenoid battery jointing	12 Nm
2. Solenoid retaining screws	6 Nm
3. Fork link nut	20 Nm
4. Assembling screws	11 Nm
5. Earth joint	8 Nm



Magneti Marelli

215-4

Bosch JF (R) 24 V 4kW

(Sisu Diesel no. 8353 30965)

Bosch JF (R) 24 V 4 kW, 2-pole

(Sisu Diesel no. 8361 30388)

Values, unloaded

Running speed	> 7000 r/min
Amperage	< 85 A
Voltage	23 V

Values with armature locked

Running speed	0 r/min
Amperage	900...1050 A
Voltage	13,5 V
Torque	> 65 Nm

Solenoid engaging voltage min. 18 V

Min. brush length 8,5 mm

Min. commutator diameter 42,5 mm

End play of armature 0,1...0,3 mm

Iskra AZJ3234 12 V 3,1 kW z11

(Sisu Diesel no. 8366 40949)

Values, unloaded	
Running speed	≤10 000 r/min
Amperage	≤140 A
Voltage	11 V
Values with armature locked	
Running speed	0 r/min
Amperage	≤1660 A
Voltage	5,6 V
Torque	≥45 Nm
Brush length (new)	23 mm
Min. brush length	13 mm
Brush spring tension	40...48 N
Min. commutator diameter	43,5 mm
Tightening torques:	
1. Studs (M6)	5,8 Nm
2. Screws on solenoid (M5)	3,2 Nm
3. Screws on solenoid (M6)	6,0 Nm
4. Pole shoes (M10)	37 Nm
Brush holder	3,2 Nm
Lever pin on engagement lever	12 Nm
Contact screws on solenoid switch (M8)	8,5 Nm
Contact screws on solenoid switch (M10)	13 Nm

Iskra AZJ3247 12 V 3,6 kW z11

(Sisu Diesel no. 8366 40940)

Values, unloaded	
Running speed	≤10 000 r/min
Amperage	≤140 A
Voltage	11 V
Values with armature locked	
Running speed	0 r/min
Amperage	≤1756 A
Voltage	5,3 V
Torque	≥47 Nm
Brush length (new)	23 mm
Min. brush length	13 mm
Brush spring tension	40...48 N
Min. commutator diameter	43,5 mm
Tightening torques:	
1. Studs (M6)	5,8 Nm
2. Screws on solenoid (M5)	3,2 Nm
3. Screws on solenoid (M6)	6,0 Nm
4. Pole shoes (M10)	37 Nm
Brush holder	3,2 Nm
Lever pin on engagement lever	12 Nm
Contact screws on solenoid switch (M8)	8,5 Nm
Contact screws on solenoid switch (M10)	13 Nm

Iskra AZJ3319 12 V 3 kW z10

(Sisu Diesel no. 8366 40949)

Values, unloaded	
Running speed	≤8000 r/min
Amperage	≤90 A
Values with armature locked	
Running speed	0 r/min (max.)
Amperage	≤1375 A
Torque	≥51 Nm
Brush length (new)	23 mm
Min. brush length	13 mm
Brush spring tension	30...35 N
Tightening torques:	
Studs (M6)	5,8 Nm
Screws on solenoid (M5)	3,2 Nm
Screws on solenoid (M6)	6,0 Nm
Pole shoes (M10)	37 Nm
Brush holder	3,2 Nm
Lever pin on engagement lever	12 Nm
Contact screws on solenoid switch (M8)	8,5 Nm
Contact screws on solenoid switch (M10)	13 Nm

Iskra AZJ3256 24 V 4 kW z11 2–pole

(Sisu Diesel no. 8366 64355)

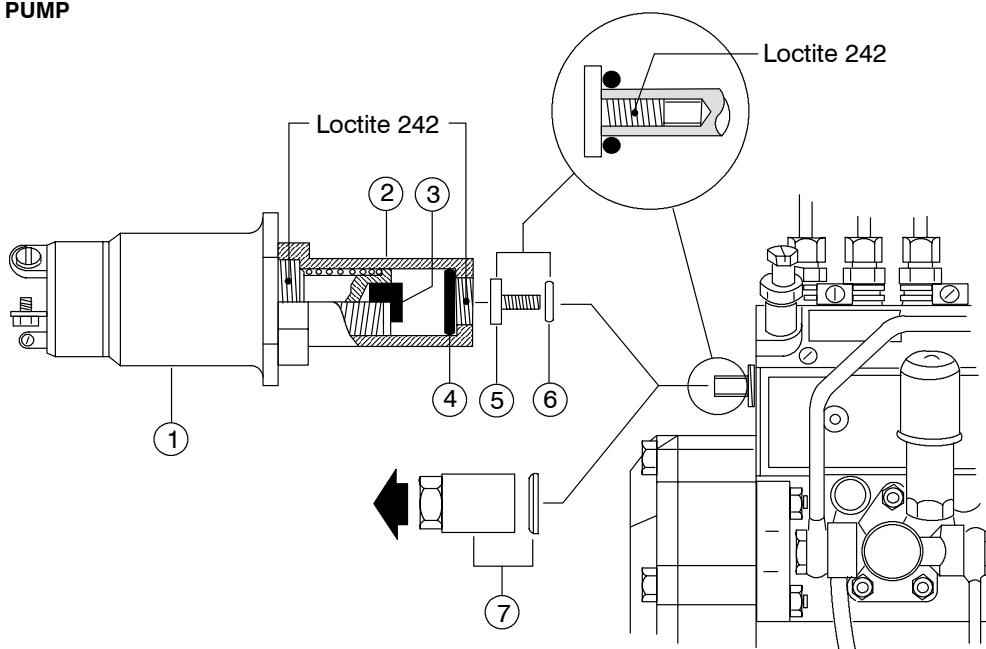
Values, unloaded	
Running speed	≤10 000 r/min
Amperage	≤80 A
Values with armature locked	
Running speed	0 r/min (max.)
Amperage	≤1200 A
Torque	≥70 Nm
Brush length (new)	23 mm
Min. brush length	13 mm
Brush spring tension	30...35 N
Tightening torques:	
Studs (M6)	5,8 Nm
Screws on solenoid (M5)	3,2 Nm
Screws on solenoid (M6)	6,0 Nm
Pole shoes (M10)	37 Nm
Brush holder	3,2 Nm
Lever pin on engagement lever	12 Nm
Contact screws on solenoid switch (M8)	8,5 Nm
Contact screws on solenoid switch (M10)	13 Nm

C. Electric stop device

FASTENING TO INJECTION PUMP

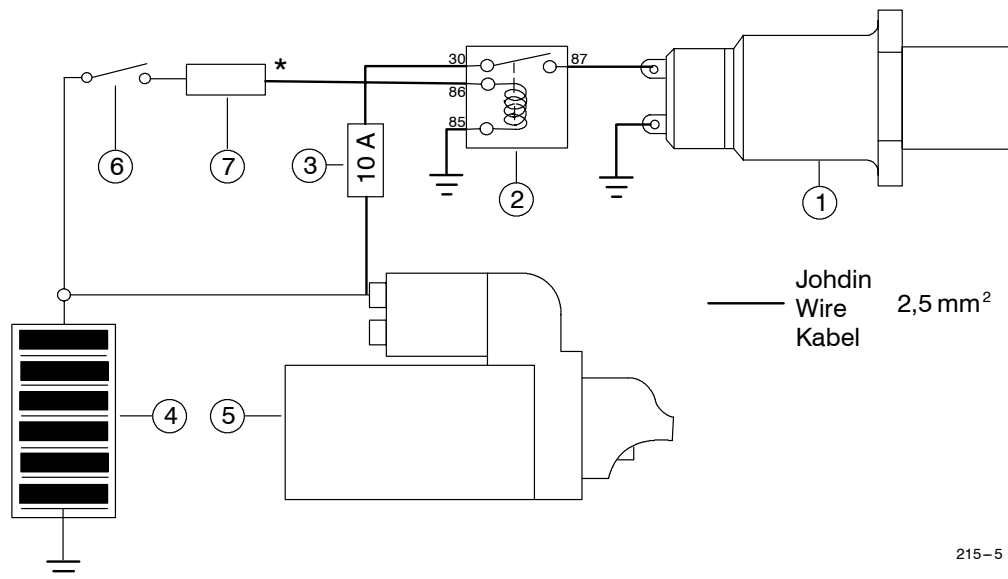
Assembly

1. Solenoid
2. Thread sleeve
3. Rubber bad
4. O-ring
5. Screw
6. O-ring
7. Parts to be removed



Electrical connection

1. Solenoid
2. Relay
3. Fuse
4. Battery
5. Starter
6. Ign. switch
7. Fuse



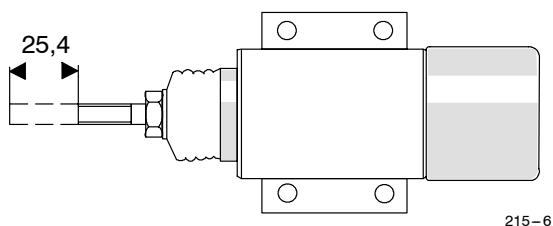
215-5

* Relay control voltage must not break during engine cranking.

- Max. wire length with 2,5 mm² wire:
 - 2,7 m 12 V system
 - 10,4 m 24 V system
- It is not allowed to connect any other power consuming devices to the solenoid feed lines.
- Voltage drop in wiring should not exceed 7 % of rated voltage when pull coil is activated.

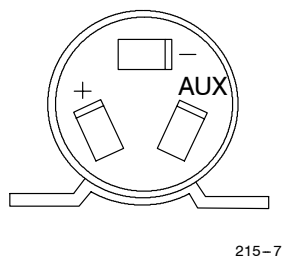
FASTENING TO BRACKET

Checking the solenoid operation (Synchro start)



The solenoid plunger has 25,4 mm motion range. Fix the solenoid and adjust the leverage in such a way that the energised plunger will reach its lock position.

Following are the methods to establish the solenoid plunger being in its lock position when the current is switched on.



A. Connect a voltmeter or a suitable lamp between the solenoid positive pole and AUX-pole. When the current is switched on and the solenoid moves to the end of its motion range, the voltmeter reading should indicate approximately battery voltage or the light should be on. If such is not the case, adjust the leverage or change the position of the solenoid.

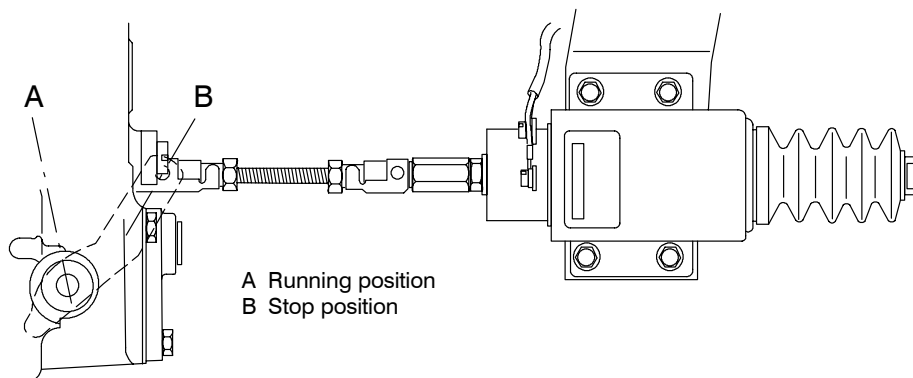
B. Before attaching the drawing lever or the bar, press the plunger in until it is complete down. Measure the solenoid length, e.g. from bottom plate edge to a suitable spot on the plunger rod. Fix the leverage and energise the solenoid. Measure the length again and ensure it remains unchanged.

Testing the external circuit of the solenoid

Measure the voltage between the positive and negative poles of the solenoid when the current is on and the draw coil draws. At the same time measure the voltage between the battery poles. The voltage difference may not exceed 7 % of battery voltage.

Note! Operating the solenoid more than six times within a minute may result in overheating of coils.

Checking the solenoid operation (Elettrostart)



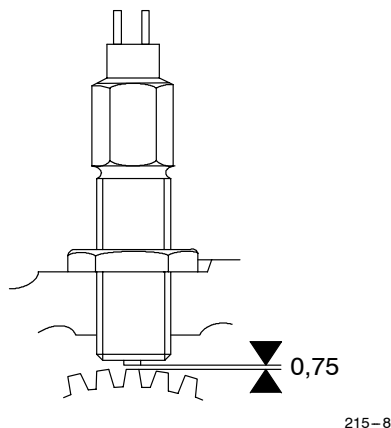
For a correct use of the dual coil solenoid (pull coil and hold coil) the plunger should reach the end of its magnetic stroke at each pulse. In this way, it will press the internal switch which connects the continuous operation second hold coil working without over-heating and with a minimum power absorption.

1. Fit the solenoid energized and adjust the leverage in such a way that the stop lever will reach its position or running position (stop solenoid energized during running).

Note! Energize the solenoid through a battery with suitable voltage and keep it energized during installation.

D. Installation of magnetic pick up

1. Rotate the flywheel to a position so that one of the flywheel ring gears teeth are in front of the pick up installation hole.

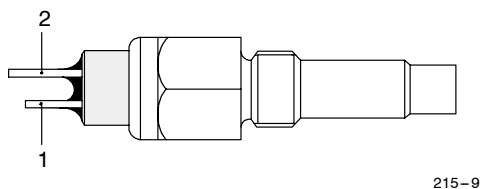


2. Turn the pick up in, until it comes in contact with the tooth.

3. Turn the pick up out $\frac{1}{2}$ turn and tighten the lock nut. This way the pick up end is **0,75 mm** from the tooth.

Note! Clean the pick up end from dirt in the yearly service.

E. Temperature sensor



1. Connection for warning light

2. Connection for temperature gauge

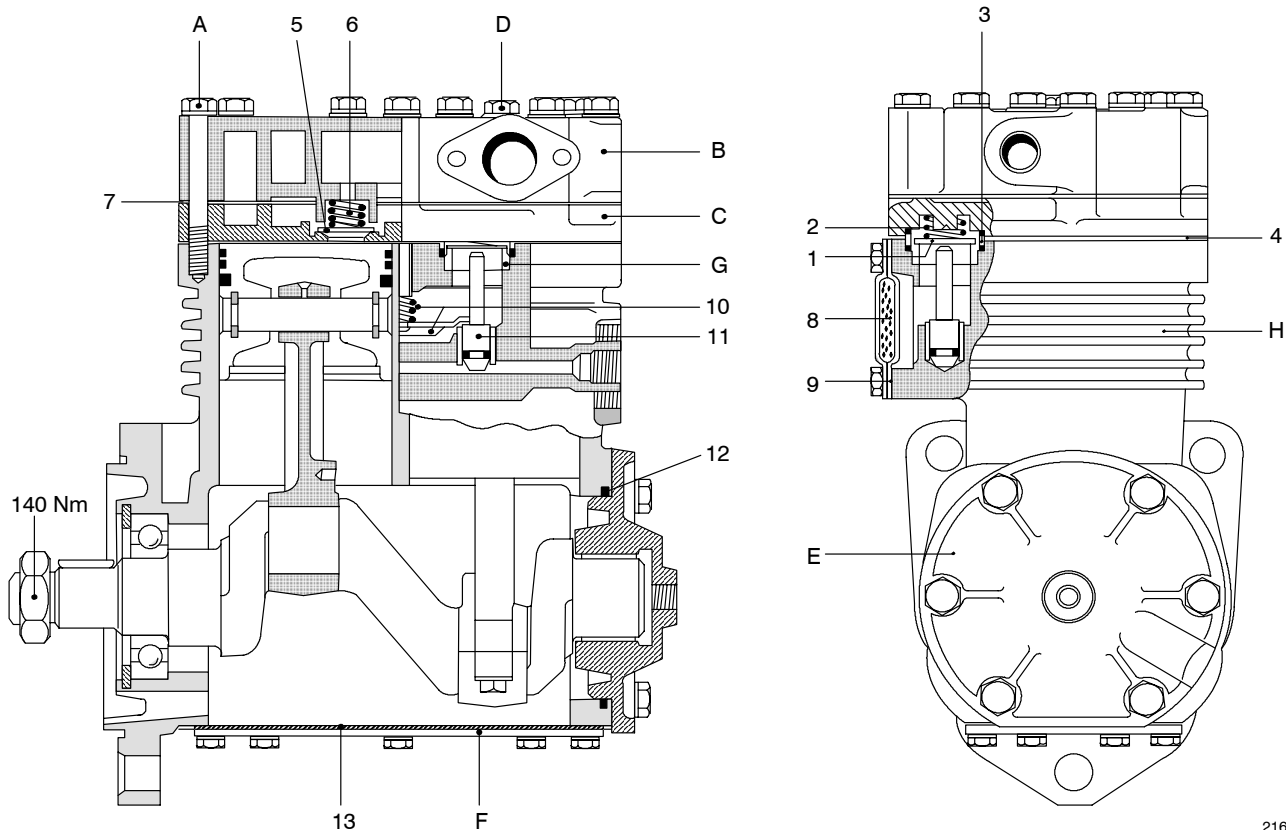
Gauge monitoring resistances:

60°C	134 ± 13,5 ohm
90°C	51,2 ± 4,3 ohm
100°C	38,5 ± 3,0 ohm

Part no.	Alarming temperature
6542 71208	98±3°C
8366 40772	106±3°C
8366 64017	110±3°C

16. OPTIONAL EQUIPMENT

A. Compressor (Bendix)



216-1

- A. Cylinder head retaining screws
- B. Cylinder head
- C. Valve plate
- D. Ventil plate retaining screws
- E. Cover
- F. Bottom cover
- G. Valve seat
- H. Crankcase

Note! The numbered parts (1...13) are included in the repair kit.

- 1. Inlet valve heads
- 2. Spring
- 3. Valve guide
- 4. Gasket
- 5. Delivery valve heads
- 6. Spring
- 7. Gasket
- 8. Air filter
- 9. Gasket
- 10. Unloader saddle and spring
- 11. Piston
- 12. O-ring
- 13. Gasket

DISASSEMBLY

1. Remove the retaining screws (A, 11 pcs.), take off the cylinder head and the valve plate. Remove the inlet valve heads, springs, valve guides and gasket.
2. Loosen the retaining screws (D, 2 pcs.) and detach the cylinder head from the valve plate. Remove the delivery valve heads, springs and gasket.
3. Remove the retaining screws of the air filter (if assembled) and take off the filter and the gasket.

4. Remove the unloader spring and saddle as well as the pistons and the o-rings seals.

5. If necessary, remove the rear end cover and its o-ring seal and the bottom cover with its gasket.

Note! Do not try to remove the valve seats. They are pressed in during manufacture and are integral parts of the crankcase.

INSPECTION

1. Thoroughly clean all removed parts. Ensure that all air and water passages are clear. Clean off any carbon from the piston heads and the cylinder top parts.

2. Check the condition of the inlet and delivery valve seats. Only slight, even wear is permitted. If the delivery valve seats show considerable wear, renew the valve plate. If the inlet valve seats are excessively worn, replace the crankcase. You can also replace the inlet valve seats, but then you need to re-bore the cylinders after the new seats have been fitted.

Note! There are two oversize pistons supplied for the compressor. The oversize are 0,254 mm and 0,508 mm. Bore the cylinders then to the dimensions $\varnothing$ 75,254 mm or $\varnothing$ 75,508 mm.

3. Ensure that the new unloader pistons are a good sliding fit in their guides. If the guides are appreciably worn, renew them.

4. Check the bearings for wear and replace them, if necessary. If needed, the slide bearing in the end cover can be renewed.

REASSEMBLY

1. Fit a new o-ring seal in its groove and place the end cover in its position by pushing from the back. Tighten the cover retaining screws evenly to **17...23 Nm**.

2. Fit the bottom cover with a new gasket in place (if removed). Tighten the cover retaining screws evenly to **8...10 Nm**.

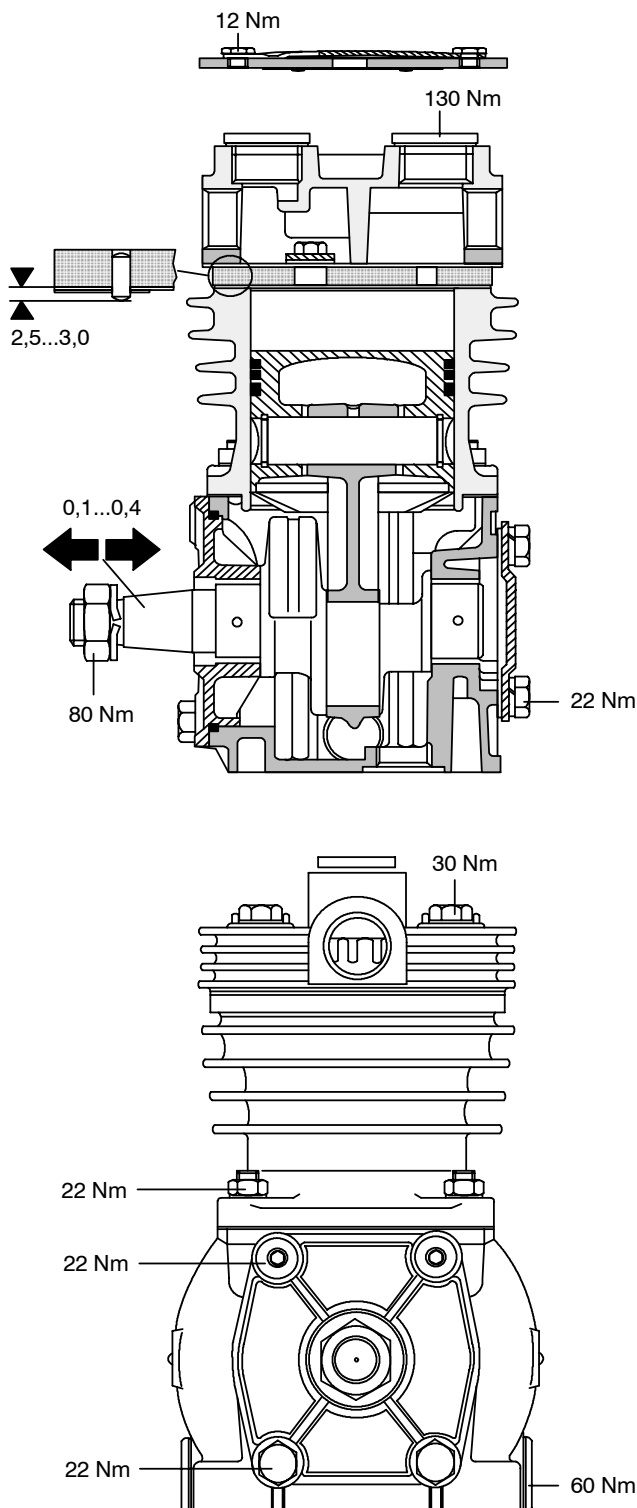
3. Insert new o-rings in the unloader pistons. Lubricate the o-rings and the piston guides lightly with e.g. silicone lubricant. Fit the pistons in their guides and reassemble the unloader saddle and spring. Ensure that the unloader mechanism moves freely.

4. Fit the delivery valve heads and springs into the valve plate. Insert a new gasket and fix the valve plate in the cylinder head. Tighten the screws to **5,4...8,1 Nm**. Ensure that the valve heads move freely. **DO NOT LUBRICATE THE VALVE HEADS OR SPRINGS!**

5. Fit the inlet valve head guides into their recesses with the cut-away sides towards their respective cylinder bores. Assemble the inlet valve heads and the springs. Fit the cylinder head using a new gasket. Tighten the retaining screws evenly to **20,3...23,0 Nm**. Ensure that the valve heads move freely. **DO NOT LUBRICATE THE VALVE HEADS OR SPRINGS!**

6. Attach the air filter (if necessary) and use a new gasket.

B. Compressor (Knorr)

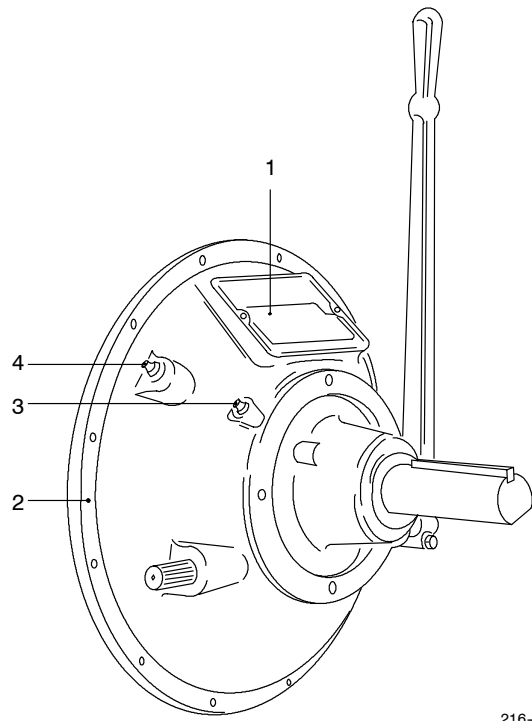


C. Industrial clutch (A.P. Borg & Beck)

SERVICE



Note! Never service or adjust the clutch with the engine running.



216-3

1. Inspection cover
2. Pull-out hole
3. Grease nipple for release bearing
4. Grease nipple for main bearing

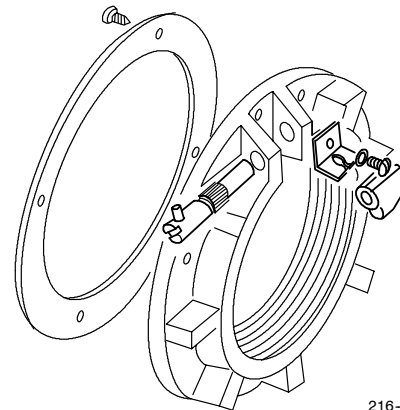
1. Lubricate the release bearing daily and the main bearing at intervals of 50 running hours. Use lithium-based grease for lubrication (e.g. Shell Alvania no. 2).

2. At intervals of 500 running hours lubricate the wrist pins, the yoke ends and the cross shaft bearings with a few drops of engine oil.

ADJUSTMENT

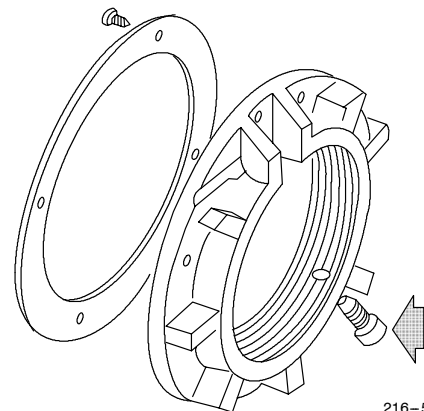
The clutch is correctly adjusted when the engagement load at the end of the operating lever is **34...41 kg** (operating lever length 63,5 cm).

Adjusting rings of the clutch



216-4

1. Remove the inspection cover and release the adjuster lock on the red adjusting ring.



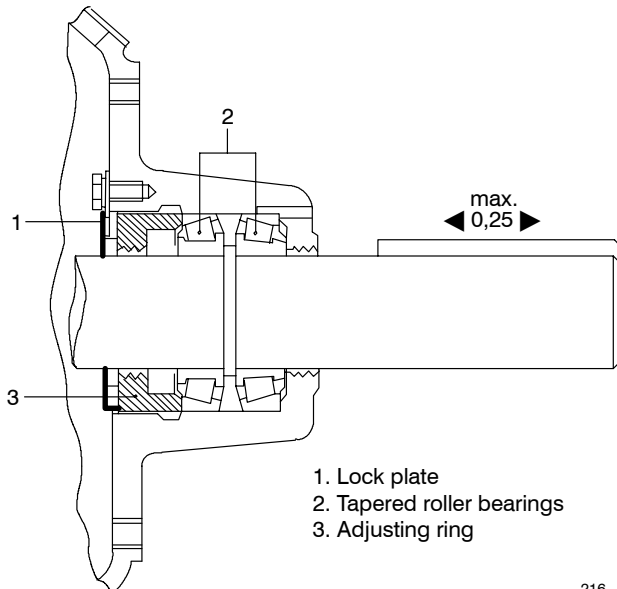
216-5

Note! Some clutches have a socket headed screw to lock the adjusting ring. Remove the screw before adjusting. After adjustment tighten the screw to **13,5...18 Nm** and ensure that the inner end of the screw engages between the splines on the body.

2. Turn the adjusting ring clockwise by hand or by tapping with a light hammer, until the correct adjustment is reached.
3. Fit the adjuster lock and the inspection cover.

Adjusting the main bearing

The tapered roller bearings on the drive shaft must be adjusted when the shaft end play exceeds 0,25 mm.



216-6

1. Remove the inspection cover and take off the lock plate.
2. Using a soft metal drift turn the adjusting ring towards the bearing, until the drive shaft end play is **0,10...0,20 mm**. One notch of the adjuster is equivalent to about 0,09 mm bearing movement.

Note! The bearing will be overloaded and will run hot, if all end play is eliminated. After adjustment ensure that the shaft end play is sufficient (0,10...0,20 mm).

3. Replace the lock plate and the inspection cover.

Removing the power take-off from the engine

1. Disconnect the drive from the clutch and remove the pulley/coupling and the shaft key.
2. Support the weight of the power take-off with e.g. chain hoist. Remove the clutch operating lever.
3. Loosen the clutch retaining screws. The clutch housing flange has pull-out holes (thread 1/2" BSF). Place screws in the holes and tighten them one half of a turn at the time alternately, until the clutch housing is removed from its spigot.