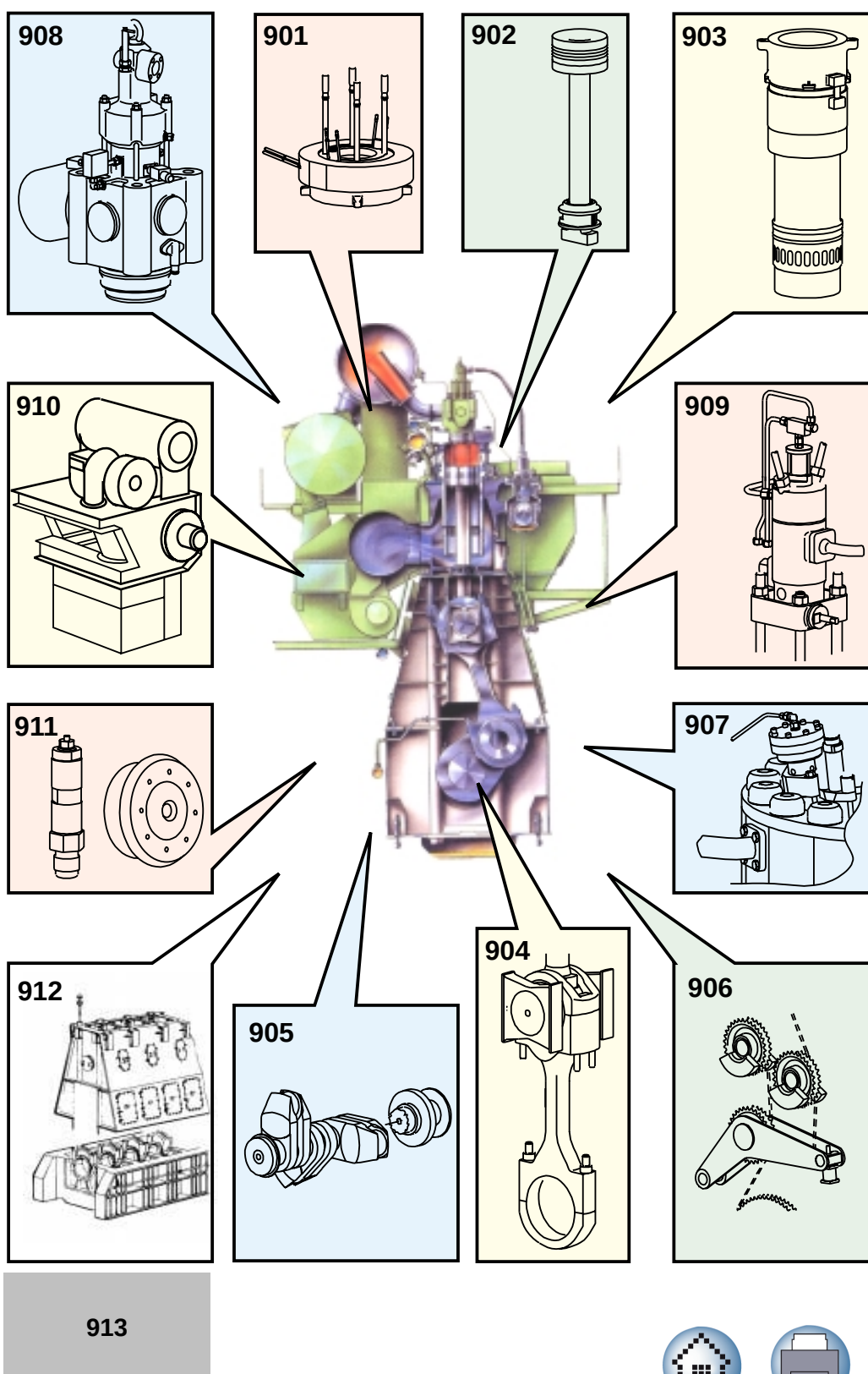


Index for Maintenance Manual

(Volume II)



Instructions for Main Engine

Type S70MC

This book forms part of a set of books consisting of three volumes entitled:

Vol. I OPERATION

Vol. II MAINTENANCE

Vol. III COMPONENTS, DESCRIPTIONS

The purpose of these books is to provide general guidance on operation and maintenance and to describe the constructional features of a standard version of an HSD ENGINE Co., Ltd. main diesel engine. Deviations may be found in a specific plant. In addition, the books can be used for reference purposes, for instance in correspondence and when ordering spare parts.

It is essential that the following data is stated in spare parts orders as it is used by us to ensure the supply of the correct parts for the individual engines:

1. Name of vessel
2. Engine No. built by
3. Plate No.
4. Part No.
5. Quantity required (and description)

Example: M/S Nybo – 7730 B&W – P90201-0036 – 059
 10 off (piston ring)

Furthermore, to ensure optimum efficiency, reliability and lifetime of the engine and its components, only original spare parts should be used.

The designation “D” used in texts and illustrations refers to the information given on the data sheets inserted in the respective books.

As reliable and economical operation of the diesel engines is conditional on the correct operation and maintenance, it is essential that the engine room personnel are fully acquainted with the contents of this book.

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HSD ENGINE Co., Ltd.

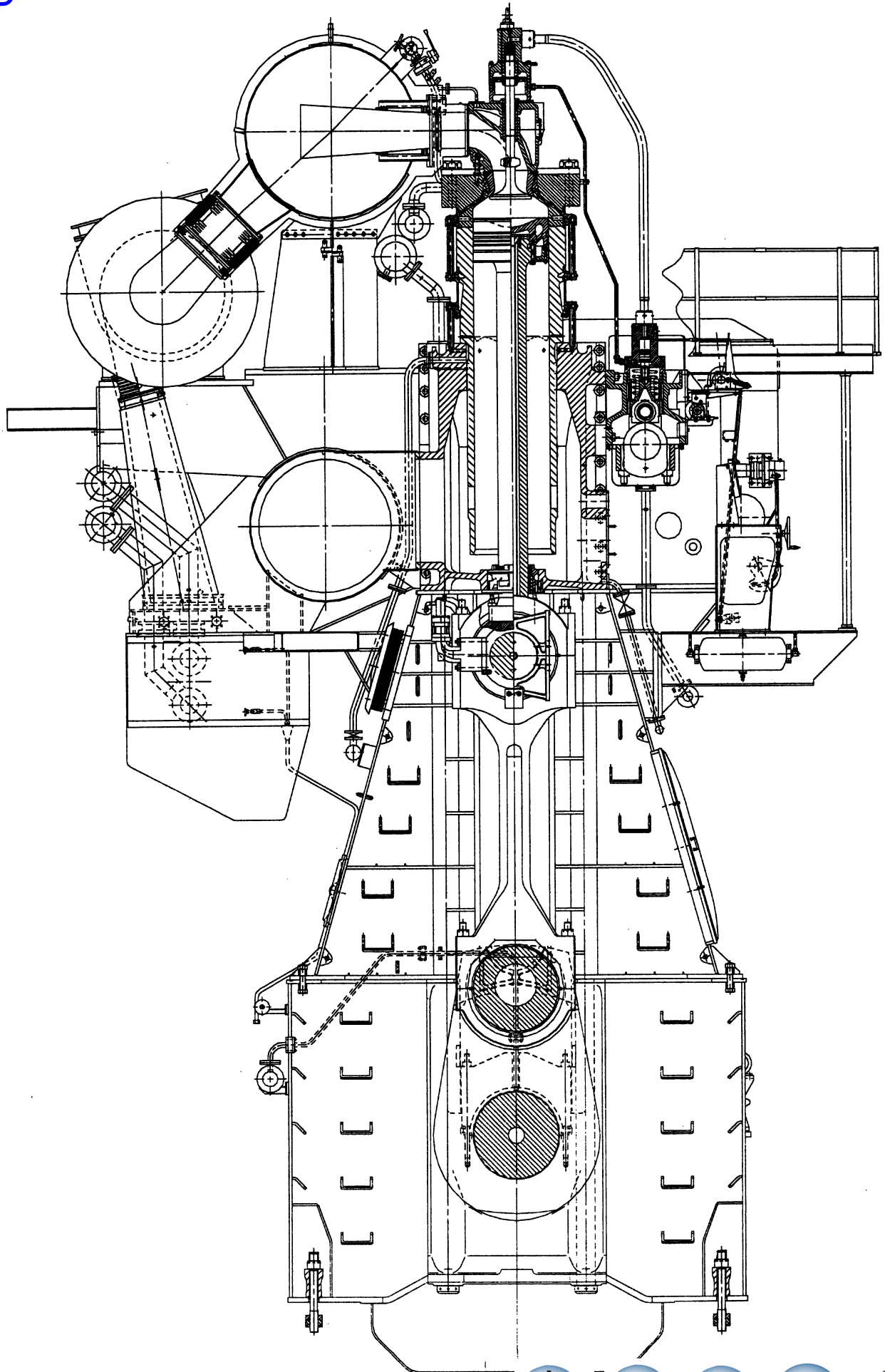
69-3, Sinchon-dong,
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Kyungnam, Korea

Technical Service : +82 55 260 6181
Parts Sales : +82 55 260 6374
Telefax : +82 55 260 6772/3



BLANK





BLANK



The Checking and Maintenance Programme indicates the intervals at which it is deemed appropriate to inspect the individual components of the engine and to carry out overhauls, if necessary, based on the engine condition or on time criteria.

The procedures contained in the instruction book are arranged in a logical order, and the following Checking and Maintenance Programme can be used as a table of contents.

The stated 'Normal hours of service' are only to be used as a guidance, as difference in the actual service conditions, the quality of the fuel oil, lubricating oil, treatment of cooling water, etc. will decisively influence the actual service results, and thus the intervals between necessary overhauling.

Design modifications may necessitate a revision of the instructions, and in that case the revised instructions and changed overhauling intervals, if any, will apply and supersede those originally issued (*see e.g. our Service Letters*).

Under 'Procedure' the word 'Replacement' has been used also:

1. Where exchange to another ready-made spare part will shorten the stop time of the main engine considerably, for instance by mounting another piston complete with piston rings and stuffing box.
2. Where overhaul and replacement to a new spare part is the same procedure as, for instance, inside inspection of piston crown (*see procedure 902-4.1*).

Thus 'Replacement' to a new spare part usually only takes place due to wear or possible damage.

The procedures are divided into three categories:

A. Condition checking procedures,

marked under the heading 'Normal hours of service' by **C**, deal with the service condition of a number of engine components, and form the basis for estimating whether further overhauling is necessary. In a number of cases the condition checking procedures refer to Volume I, OPERATION, in which more detailed descriptions and working procedures can be found.

Where a procedure number is stated under the heading 'Related procedure', it will be appropriate to carry out this procedure at the same time.

B. Condition-based overhauling procedures

are those procedures which under the heading 'Normal hours of service' are marked by **O**, and opposite which, under the heading 'Overhaul to be based on procedure No.', a procedure number is stated.

This procedure number normally refers to one of the above condition checking procedures which form the basis of the overhaul. For this reason, the intervals stated are for guidance only.

Where several procedures are to be carried out on the same estimation basis, and these belong together with regard to the work, this is stated under the heading 'Related procedure'.

C. Time-based overhauling procedures,

also marked by **O** under the headings 'Normal hours of service' or 'Based on observations', are the procedures where an actual basis for estimation is lacking. It is recommended, therefore, to carry out these procedures at the overhauling intervals stated as a basis.

Where a symbol **O** or **C** is indicated under the heading 'Based on observations', this is due to the fact that special service condition



S/L70MC		CHECKING AND MAINTENANCE PROGRAMME		Overhaul to be based on procedure No.: or to refer to:	Check new/overhauled parts after 500 - 1500 hours	Normal hours of service							900-1		
		*) : See Vol. I Operation **) : See maker's instructions ***) : There are no specific instr. C : Check the condition O : Overhaul to be carried out A : Adjustment to be carried out				2000 hours	4000 hours	6000 hours	8000 hours	12000 hours	12000-16000 hours	16000 hours	4 years (survey)	Edition 51	
														Page 2 (8)	
														Based on observations	Related procedure
No.	PROCEDURE														
901	CYLINDER COVER														
-1	Replacement of cylinder cover												902-2		
-1.1	Dismantling														
-1.2	Mounting														
-2	Replacement of valves on cyl. cover												909-6		
-2.1	Fuel valve												909-7		
-2.2	Starting valve												907-4		
-2.3	Exhaust valve												908-2		
-2.4	Safety valve (see 911-1)												908-1		
-3	Overhaul of cylinder cover														
-3.1	Overhaul of cylinder cover														
-3.2	Replacement of cooling jacket														
902	PISTON WITH ROD AND STUFFING BOX														
-1	Inspection of piston and rings through scavenge ports	*)	C	C									903-1		
-2	Replacement of piston complete with stuffing box	902-1											901-1		
-2.1	Dismantling														
-2.2	Mounting														
-2.3	Tilting														
-3	Checking of piston and piston rings														
-4	Overhaul of piston														
-4.1	Replacement of sealing rings, piston crown and cooling oil pipe														
-5	Overhaul of piston rod stuffing box														
-5.1	Removed from engine														
-5.2	Inside the engine	902-1													
903	CYLINDER LINER AND CYLINDER LUBRICATION														
-1	Inspection of cylinder condition through scavenge ports (Remove sludge from scavenge box and clean scavenge ports)	*)	C	C									902-1		



S/L70MC		CHECKING AND MAINTENANCE PROGRAMME		Overhaul to be based on procedure No.: or to refer to:	Check new/overhauled parts after 500 - 1500 hours	Normal hours of service						900-1	
		*) : See Vol. I Operation **) : See maker's instructions ***) : There are no specific instr. C : Check the condition O : Overhaul to be carried out A : Adjustment to be carried out	2000 hours			4000 hours	6000 hours	8000 hours	16000 hours	4 years (survey)	Edition 51		
											Page 3 (8)		
											Based on observations	Related procedure	
No.	PROCEDURE												
-2	Cylinder liner												
-2.1	Inspection, measuring and reconditioning of cylinder liner								O		902-2		
-2.2	Inspection of cylinder liner, with mounted cylinder cover								O				
-3	Replacement of cylinder liner	903-2											
-3.1	Replacement of cylinder liner									O	901-1		
-3.2	Transportation of cylinder liner												
-4	Checking and adjustment of cylinder lubricators	*(**)								O			
904	CROSSHEAD WITH CONNECTING ROD												
-1	Check oil drain from crosshead bearings	*)	C		C								
-2	Crosshead bearings												
-2.1	Checking of crosshead bearing clearance								C		904-6		
-2.2	Inspection and replacement of crosshead journal and bearings	904-1								C	905-2		
-2.3	Inspection and replacement of crosshead journal and bearings (piston removed)												
-4	Dismantling/mounting of crosshead									O			
-5	Checking of reciprocating parts									O			
-6	Checking, inspection and replacement of crankpin bearing		C						C		904-2		
-6.1	Checking of crankpin bearing clearance										905-2		
-6.2	Inspection and replacement of crankpin bearing												
-7	Dismantling/mounting of connecting rod									O	904-4		
905	CRANKSHAFT, THRUST BEARING AND TURNING GEAR												
-1	Checking deflection of crankshaft	*)	C						C				
-2	Checking and adjustment of clearance in main bearings	905-1	C						C	A	904-2 904-6		



S/L70MC		CHECKING AND MAINTENANCE PROGRAMME		Check new/overhauled parts after 500 - 1500 hours	Normal hours of service						900-1		
		*) : See Vol. I Operation **) : See maker's instructions ***) : There are no specific instr. C : Check the condition O : Overhaul to be carried out A : Adjustment to be carried out			Overhaul to be based on procedure No.: or to refer to:	2000 hours	4000 hours	6000 hours	8000 hours	16000 hours	4 years (survey)	Edition 51	
												Page 4 (8)	
												Based on observations	Related procedure
No.	PROCEDURE												
-3	Inspection of main bearings	905-2								C			
-4	Checking of clearance in thrust bearing			C					C				
-5	Replacement of thrust bearing segments	905-4								C			
-6	Balancing arrangement fore and aft (where used)												
-7	Axial vibration damper										C		
-7.1	Mechanical check of axial vibration damper										C		
-7.2	Monitoring check of axial vibration damper										C		
-7.3	Overhaul of axial vibration damper										C		
906	MECHANICAL CONTROL GEAR												
-1	Checking of chain drive, guideways, bolt connections, and lubrication	*)		C					C				
-2	Chain drive(4½" & 1" chains)										A		
-2.1	Checking and adinsting tension of 4½"chain												
-2.3	Disassembling and assembling of chains (4½" & 1"chains)												
-3	Inspection of running surfaces on cams								C				
-4	Checking of bolts in camshaft couplings								C				
-5	Camshaft bearings												
-5.1	Checking clearance in camshaft bearing									C		908-4	
-5.2	Inspection of camshaft bearing									C			
-7	Check adjustment (timing) of control gear			C							C		
-8	Adjustment of camshaft because of chain wear	906-7									A		
907	STARTING AIR SYSTEM												
-1	Lubrication of all moving parts	***)							O				
-2	Checking and overhaul of starting air distributor												
-2.1	Checking of starting air distributor			C					C				
-2.2	Overhaul of starting air distributor										O		



S/L70MC		CHECKING AND MAINTENANCE PROGRAMME		Check new/overhauled parts after 500 - 1500 hours	Normal hours of service							900-1		
		*) : See Vol. I Operation **) : See maker's instructions ***) : There are no specific instr. C : Check the condition O : Overhaul to be carried out A : Adjustment to be carried out			Overhaul to be based on procedure No.: or to refer to:	2000 hours	4000 hours	6000 hours	8000 hours	12000 hours	16000 hours	4 years (survey)	Edition 51	
													Page 5 (8)	
													Based on observations	Related procedure
No.	PROCEDURE													
-3	Inspection and overhaul of main starting valve (ball valve)	**)	C				C							
-4	Overhaul of starting air valve							O					901-2	
-5	Governor, exchange of oil	**)			O									
-6	Functional check of overspeed device	**)					C							
-7	Functional check of speed-setting system (engine with bridge control system)	**)			C									
908	EXHAUST VALVE													
-1	Overhaul and adaptation of high-pressure pipe										C			
-2	Overhaul of exhaust valve *) When new exhaust valve is fitted						C*)			O			901-2	
-3	Overhauling of hydraulic exhaust valve actuator									O				
-4	Inspection of roller guide		C							C			908-5	
-5	Lifting of roller guide for exhaust valve	*)									O			
-6	Emergency running with open exhaust valve										C			
-7	Checking exhaust cam adjustment										C			
909	FUEL OIL SYSTEM													
-1	Checking and adjustment of fuel pump lead	*)									C			
-1.1	Checking of fuel pump lead													
-1.2	Adjustment of fuel pump lead										A			
-1.3	Adjustment of pilot valve										A			
-2	Adjustment of fuel pump cam	909-1									A			



S/L70MC		CHECKING AND MAINTENANCE PROGRAMME		Overhaul to be based on procedure No.: or to refer to:	Check new/overhauled parts after 500 - 1500 hours	Normal hours of service						900-1	
		*) : See Vol. I Operation) : See maker's instructions) : There are no specific instr. C : Check the condition O : Overhaul to be carried out A : Adjustment to be carried out				2000 hours	4000 hours	6000 hours	8000 hours	16000 hours	4 years (survey)	Edition 51	
												Page 6 (8)	
												Based on observations	Related procedure
No.	PROCEDURE												
-3	Overhaul of fuel pump barrel assembly										O		
-3.1	Replacement of fuel pump barrel assembly												
-3.2	Replacement of sealing rings on pump barrel												
-3.3	Overhaul of top cover complete										O		
	Overhaul of suction valve					C		O					
	Overhaul of puncture valve (where used)					C		O					
-3.4	Overhaul of piston for 0-position of index rack (where supplied)												
-4	Inspection of fuel pump shock absorber								C				
-5	Setting and testing lifting gear for fuel pump roller guide				C				C				
-6	Overhaul of fuel valve (C means pressure test only)				C	C		O				901-2	
-6.1	Overhaul of fuel valve												
-6.2	Overhaul of spindle guides												
-6.3	Overhaul of non-return valve												
-6.4	Pressure testing of fuel valve												
-7	Overhaul of fuel oil high-pressure pipes										O	901-1	
-7.1	Overhaul of fuel oil high-pressure pipes, type I												
-7.2	Overhaul of fuel oil high-pressure pipes, type II												
-8	Overhaul of pneumatic reversing mechanism										O		
910	TURBOCHARGER SYSTEM												
-1	Replacement of filter elements in turbocharger inlet	*)									O		
-2	Overhaul of turbocharger	**))						O					
-3	Inspection and overhaul of protective grating for turbocharger gas inlet	*(**)						C					
-4	Cleaning of turbine side of turbocharger	*(**)									O		



S/L70MC		CHECKING AND MAINTENANCE PROGRAMME		Overhaul to be based on procedure No.: or to refer to:	Check new/overhauled parts after 500 - 1500 hours	Normal hours of service							900-1	
		*) : See Vol. I Operation **) : See maker's instructions ***) : There are no specific instr. C : Check the condition O : Overhaul to be carried out A : Adjustment to be carried out	2000 hours			4000 hours	6000 hours	8000 hours	12000 hours	16000 hours	4 years (survey)	Edition 51		
												Page 7 (8)		
												Based on observations	Related procedure	
No.	PROCEDURE													
-5	Air cooler													
-5.1	Cleaning of air cooler	*)				O						O		
-5.2	Replacement of air cooler element and water mist catcher											O		
-5.3	Dry cleaning of turbocharger turbine													
-5.4	Cleaning of turbine of ABB turbocharger	**)												
-6	Replacement of non-return valve			C								O		
-8	Replacement of auxiliary blower											O		
911	SAFETY EQUIPMENT													
-1	Overhaul and setting of safety valve						C		O					
-2	Relief valve, functional test									C				
-3	Functional test of alarm system for thrust bearing and slow down/shut down system	**)		C	C									
-4	Checking and adjustment of pressure gauges	**)						C						
-5	Checking and adjustment of thermometers	**)						C						
-6	Checking and adjustment of thermostats	**)						C						
-7	Checking and adjustment of pressurestats	**)						C						
-8	Checking and adjustment of turning gear switch	**)												
912	ASSEMBLY OF LARGE PARTS													
-1	Retightening of holding down bolts, and end chock bolts			C				C						
-1	Retightening of holding down bolts, and end chock bolts (EPOXY)			C				C						
-2	Retightening of bolts for cylinder frame	***)								C				
-3	Retightening of stay bolts			C				C						



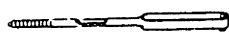
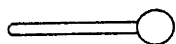
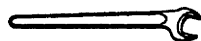
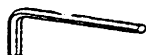
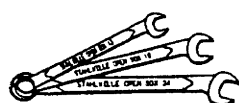
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		*) : See Vol. I Operation **) : See maker's instructions ***) : There are no specific instr. C : Check the condition O : Overhaul to be carried out A : Adjustment to be carried out				2000 hours	4000 hours	6000 hours	8000 hours	16000 hours	4 years (survey)	Edition 51	
												Page 8 (8)	
												Based on observations	Related procedure
No.	PROCEDURE												
913	GENERAL TOOLS												
-1	Application of hydraulic tools												
-1.1	Loosening of nut												
-1.2	Tightening of nut												
-1.3	Subsequent checking of bolt tightening												
-1.4	Hydraulic tools – Maintenance												
-2	Hydraulic nut												
-5	Tightening with torque spanner												
-6	Tightening according to tightening gauge												
-7.1	Locking of screws and nuts												
-7.2	Locking of screws and nuts with wire												
-10	Emergency procedures for dismounting the hydraulic ring												
-11	Lubricating procedure												



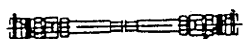
SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☒ Shut off cooling water
- ☒ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☒ Lock turbocharger rotors

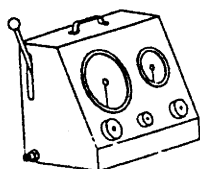
Standard tools: see Section 913



40-200 Nm
140-760 Nm

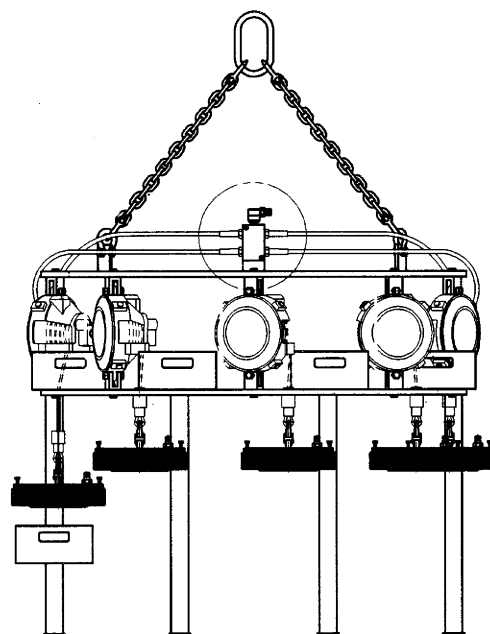
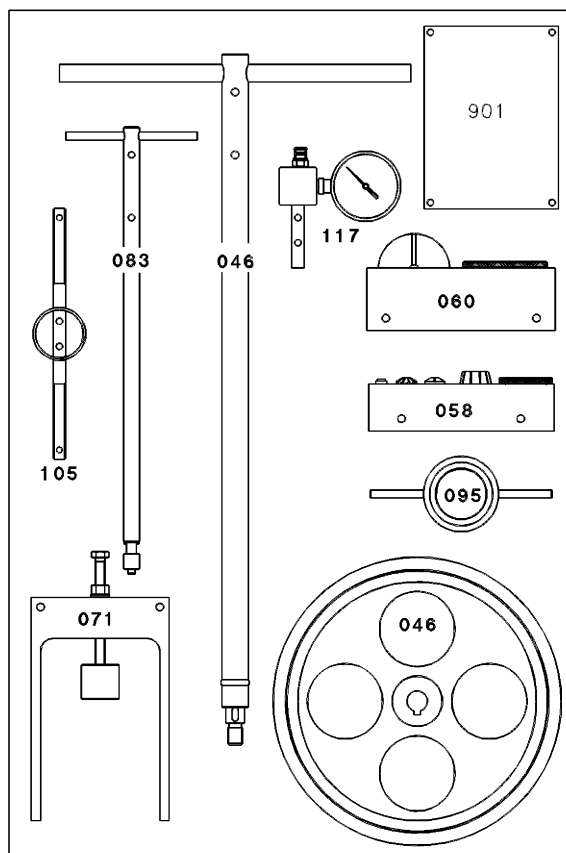


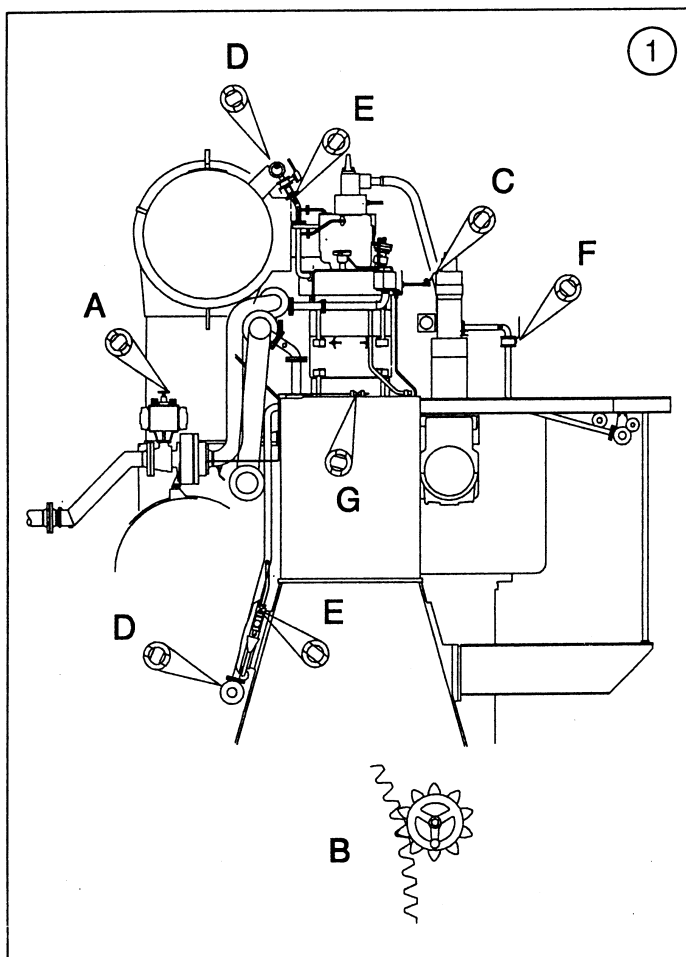
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DATA:

- D-1 Hydraulic pressure for cylinder cover:
 – dismantling..... 900-990 bar
 – tightening..... 900 bar
- D-2 Weight of high-pressure pipe (exhaust valve)..... 62 kg
- D-3 Weight of cylinder cover complete..... 4700 kg
- D-4 Tightening torque – fuel oil high-pressure pipe (fuel pump/fuel valve)..... 190 Nm
- D-5 Tightening torque – high-pressure pipe (exhaust valve)..... 80 Nm
- D-6 Weight of fuel oil high - pressure pipe (fuel pump/fuel valve) 20 kg





1. A. Set the blocking device on the main starting valve in the BLOCKED position.
 - B. Engage the turning gear.
 - C. Open the indicator cocks.
 - D. Close the inlet and outlet valves for cooling water.
 - E. Open the vent and drain cocks for cooling water. As soon as the cylinder cover has been emptied of water, close the drain cocks again.
 - F. Close the fuel oil inlet valve.
 - G. Shut off the control air supply and safety air supply before venting the manoeuvring system through the ball valve.
- Also shut off the air supply on the reduction unit for the hydraulic/pneumatic exhaust valve, and vent the system.
- H. Valve for checking of water level, when cooling water is drained during exchange of cylinder cover or piston.



2. Remove the cooling water outlet pipes from the exhaust valve and cylinder cover.

Remove the screws which fasten the high-pressure pipe to the oil cylinder on the exhaust valve and the hydraulic activator, and lift away the high-pressure pipe.

Dismount the drain oil pipe between the exhaust valve and the hydraulic activator.

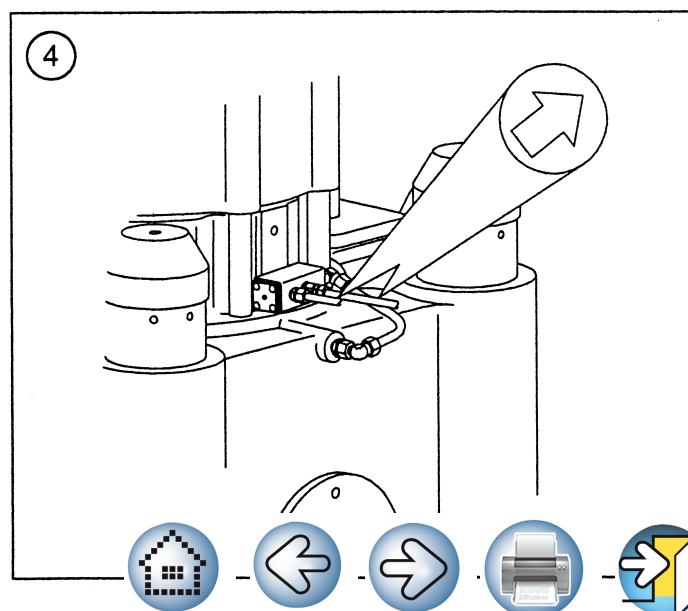
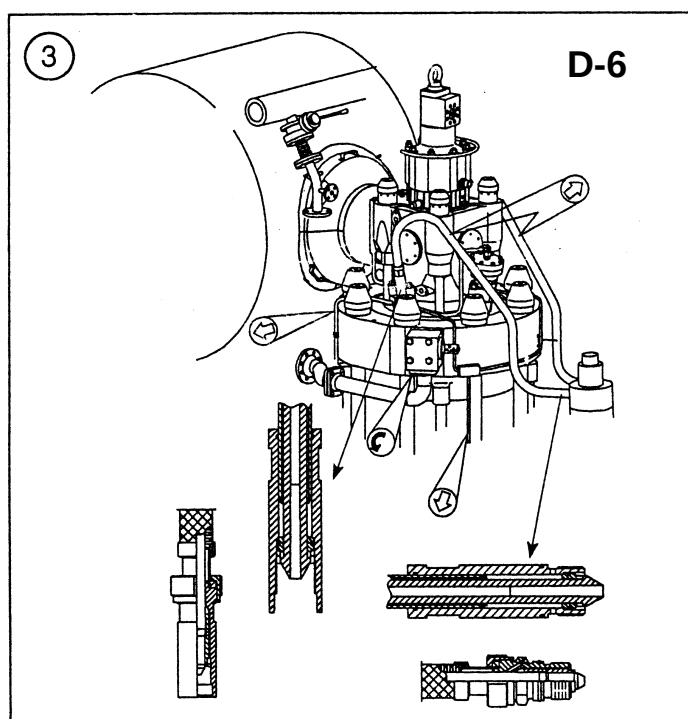
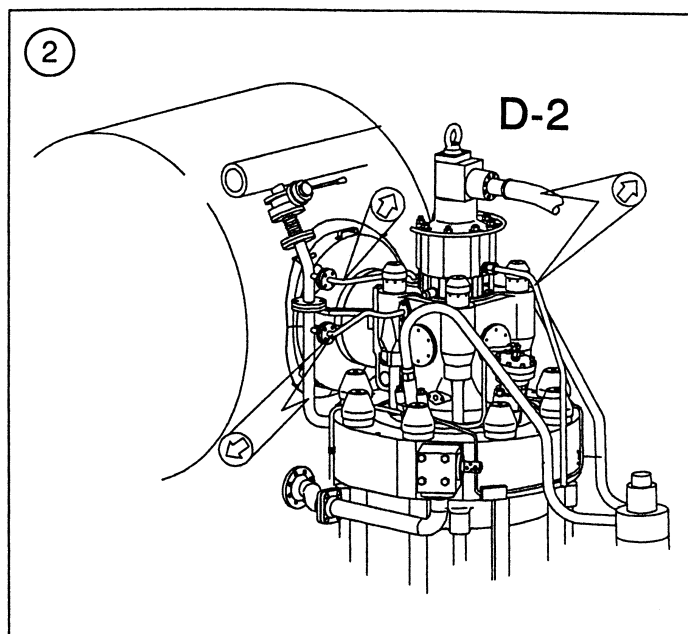
3. Dismount the high-pressure fuel pipes between the fuel pump and the fuel valves.

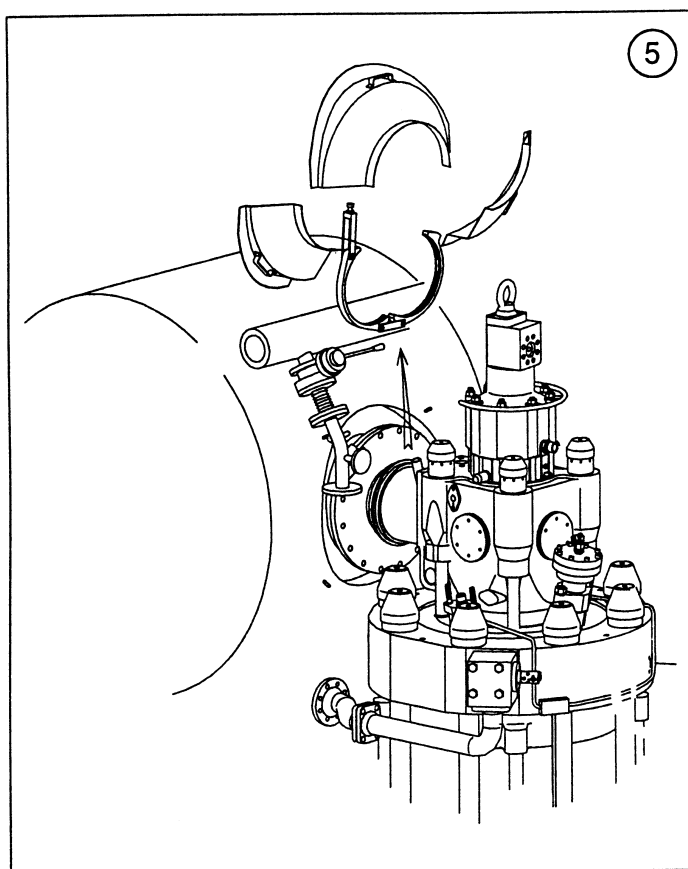
Dismount the return oil connection from the fuel valves at the fuel pump.

Dismount the control air pipe from the starting valve.

Remove the screws in the flange connection for the starting air pipe.

4. Dismount the air pipes for the sealing air control unit.





5. Remove the plate cover and the insulating material from the exhaust receiver and intermediate pipe.

Dismount the clamp from the exhaust pipe/intermediate pipe flanges.

Remove the caps from the cylinder cover nuts.

6. Position the cylinder cover tightening tool over the cylinder cover.

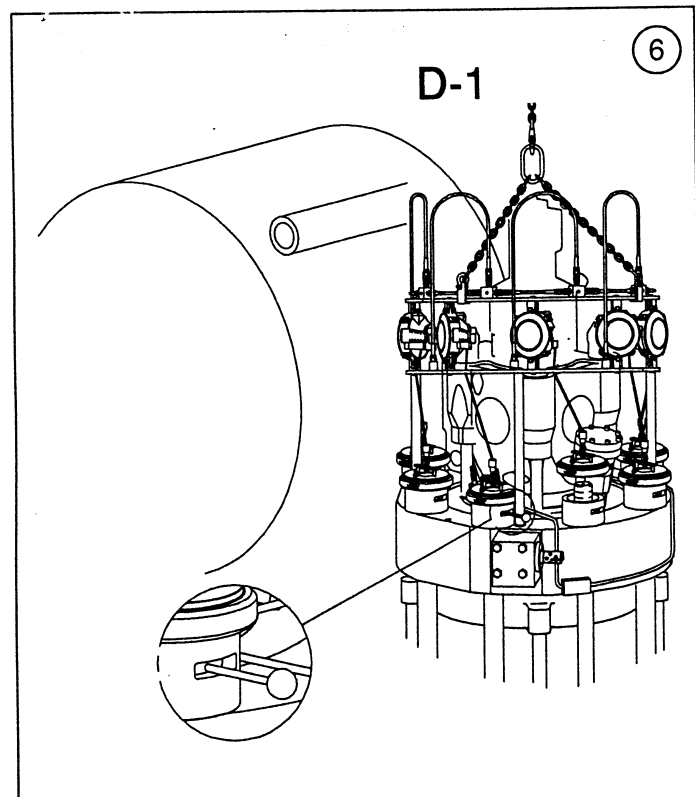
Place the spacer rings over the nuts.

Pull down the hydraulic jacks of the tightening tool and screw the jacks on to the studs.

Connect the hydraulic hoses to the jacks and raise the pressure to the level stated in Data. Loosen the nuts with a tommy bar.

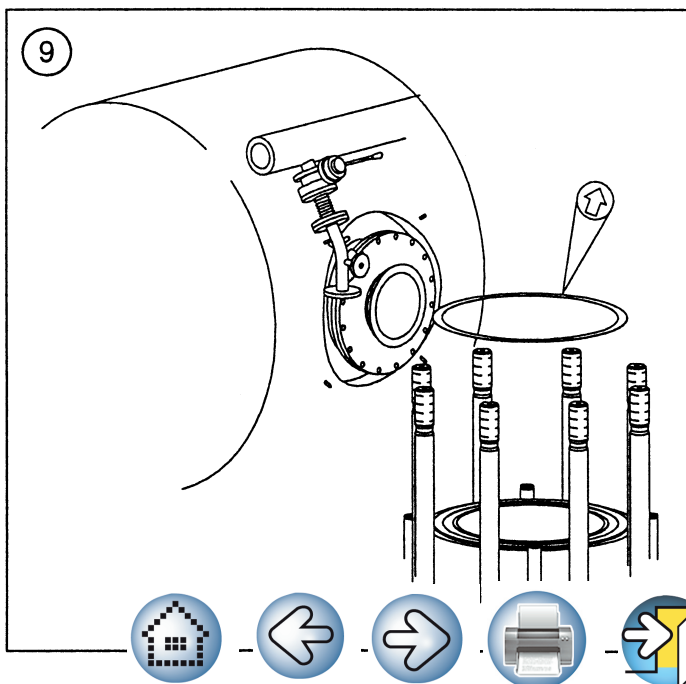
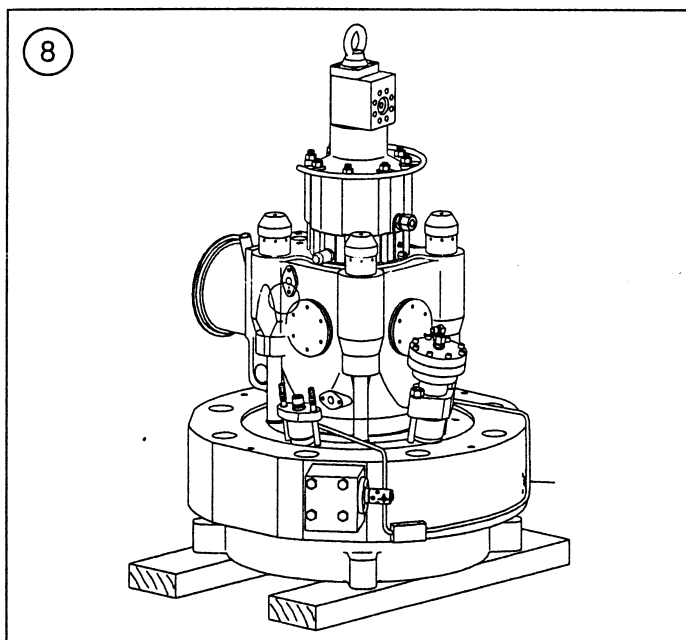
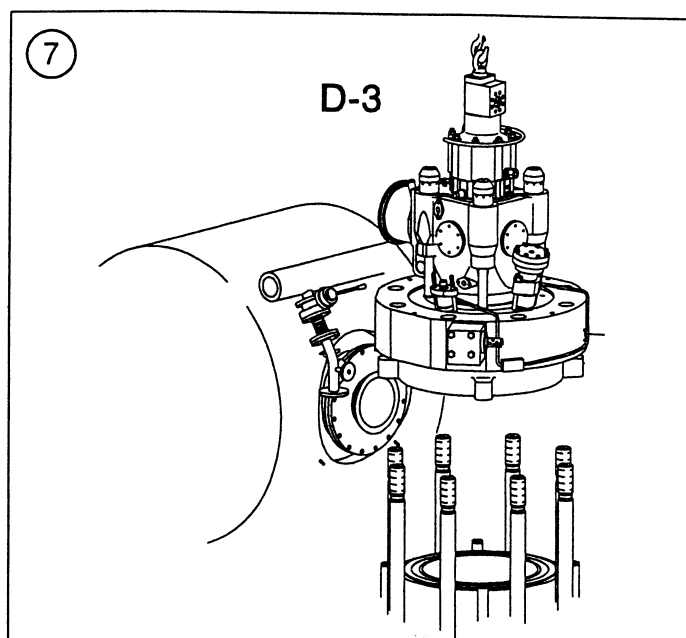
Release the pressure.

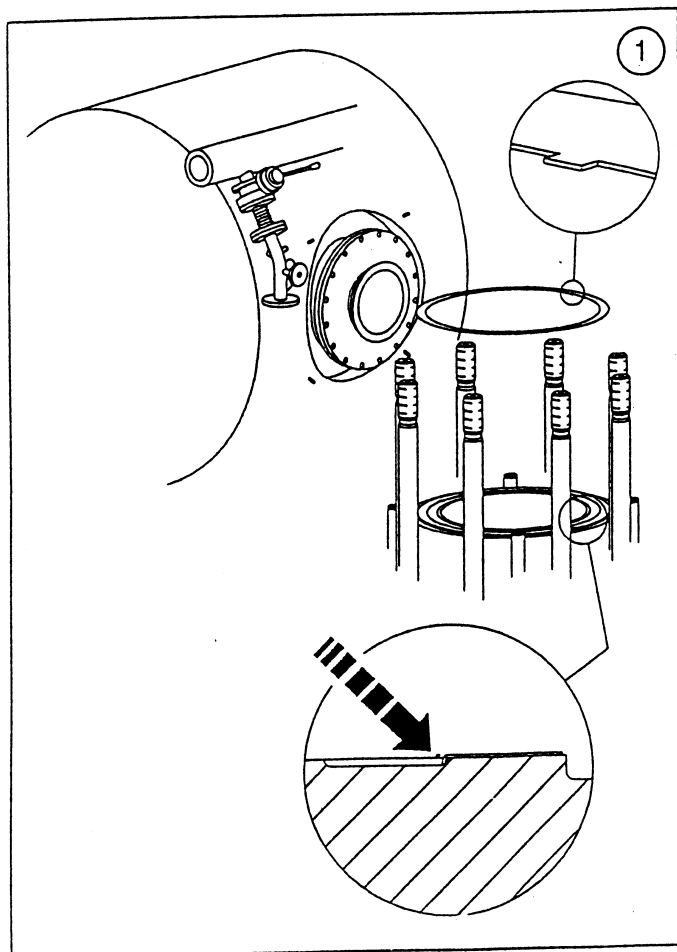
Remove the hydraulic jacks, the spacer rings and the nuts.



7. Hook the engine room crane on to the lifting attachment on top of the exhaust valve.
8. Lift away the cylinder cover complete and land it on, for instance, a couple of wooden planks.
9. Remove and discard the sealing ring between cylinder cover and cylinder liner.

For overhaul of cylinder cover, see Procedure 901-3.





1. Place a new sealing ring on top of the cylinder liner and bend the three tabs on the sealing ring by means of a lead hammer.
2. Lift the cylinder cover by means of the crane and carefully wipe the contact surface which faces the cylinder liner.

Provide the cooling water connecting pipes with new O-rings, lubricating them with grease or soft soap.

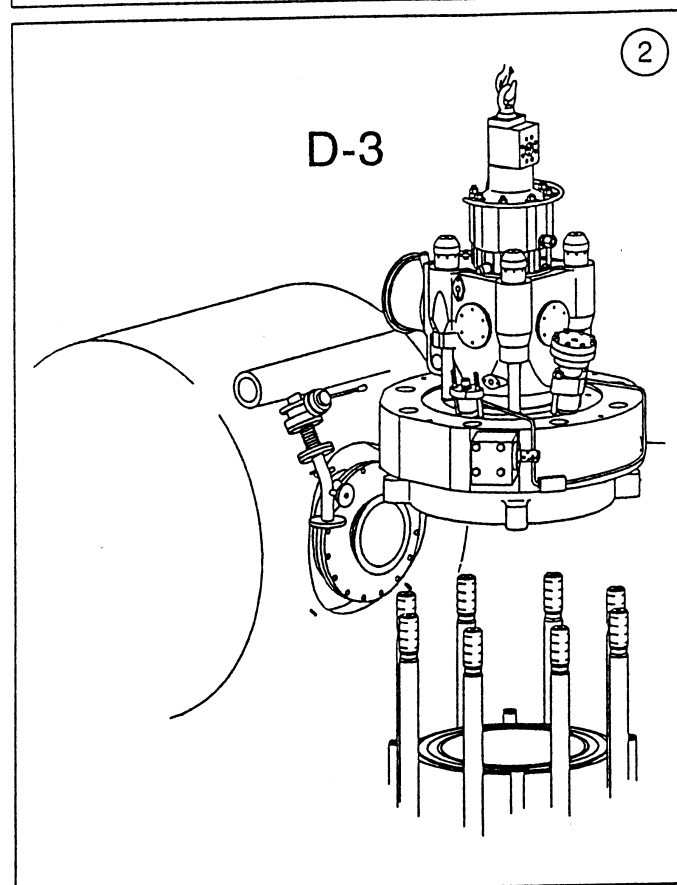
Lower the cover **carefully** into position.

During the landing, **carefully** check that the cooling water connecting pipes engage correctly with the cooling water connections.

Note !

To facilitate mounting and dismantling of the flange clamps, and to prevent seizure on account of heating, apply a coat of 'Never Seez NS 160' or a corresponding preparation to:

- the contact faces of the flanges (exhaust pipe/intermediate pipe),
- the inside of the clamp,
- the thread of the clamp screw,
- the screws of intermediate pipe/exhaust valve



3. Mount all eight nuts on the studs and screw them down to the cylinder cover.

Place the eight spacer rings over the nuts.

Position the cylinder cover tightening tool over the cylinder cover.

Pull down the hydraulic jacks of the tightening tool and screw the jacks on to the studs.

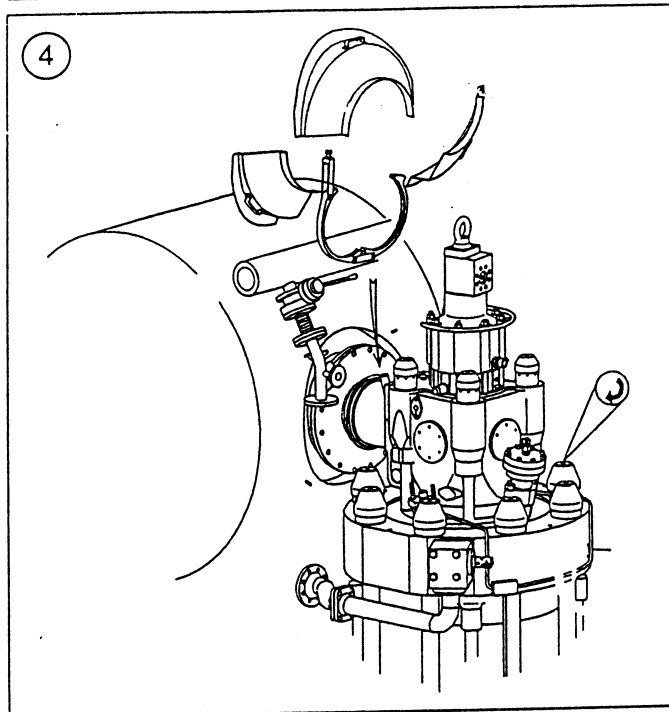
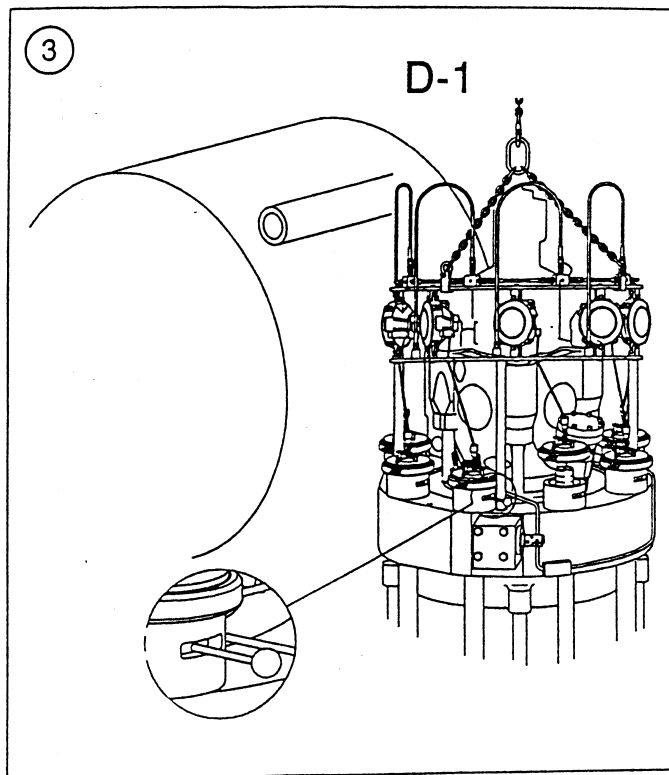
For operation of hydraulic jacks, see Procedure 913-1.

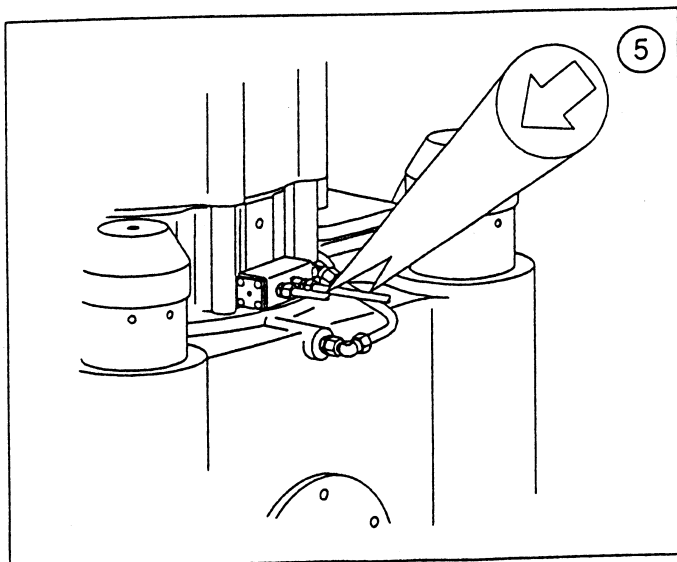
Connect the hydraulic hoses to the jacks and raise the pressure to the level stated in Data. Tighten the nuts with a tommy bar.

Release the pressure. Remove the hydraulic jacks and the spacer rings.

4. Mount the insulating material and the cover plate on the intermediate pipe.

Mount the caps on the cylinder cover nuts.



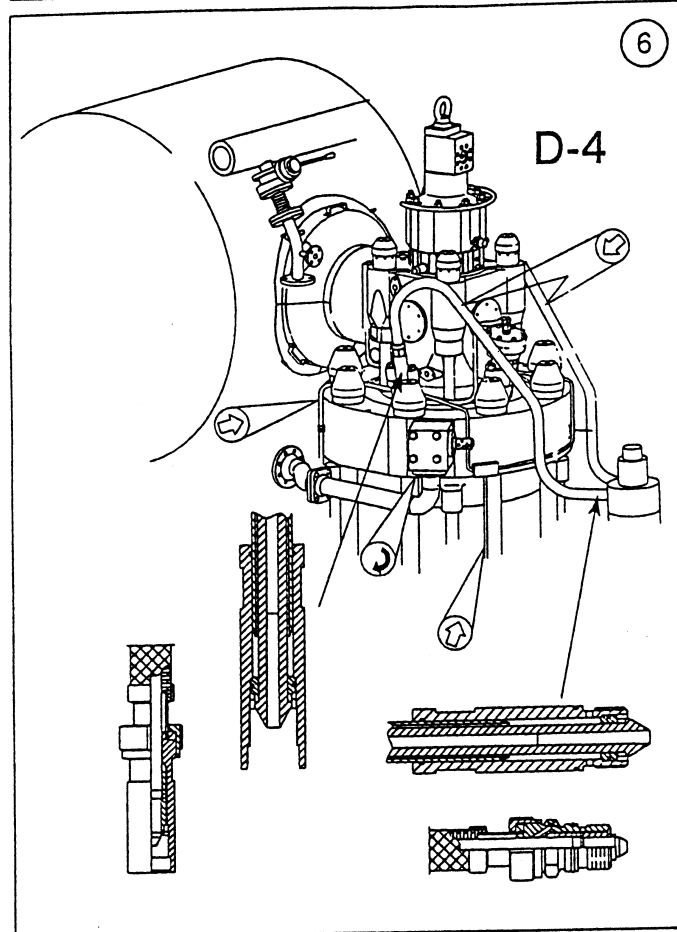


5. Mount the air pipes for the sealing air control unit on the exhaust valve. Open the air supply.

Warning !

The air supply to the exhaust valve must always be connected **before** starting the camshaft oil pumps.

This is **very** important, because otherwise the valve will open more than intended.



6. Mount the fuel oil high-pressure pipes between the fuel pump and the fuel valves. Check that the pipes fit properly at the seats and that all parts are clean and provided with new O-rings.

Lift up the union nuts on the pipes and tighten the coupling pieces with the special spanner head and the torque spanner (see *Data*).

Lower the union nut and screw it on to the coupling piece by means of the hook spanner.

Connect the outlet pipes for the return oil connection on the fuel valves.

Connect the air hoses and outlet pipes to the fuel oil alarm system.

Mount the control air pipe for the starting valve and fasten the starting air pipe.



7. Mount the high-pressure pipe for the hydraulic valve gear. *See Procedure 908-1.*

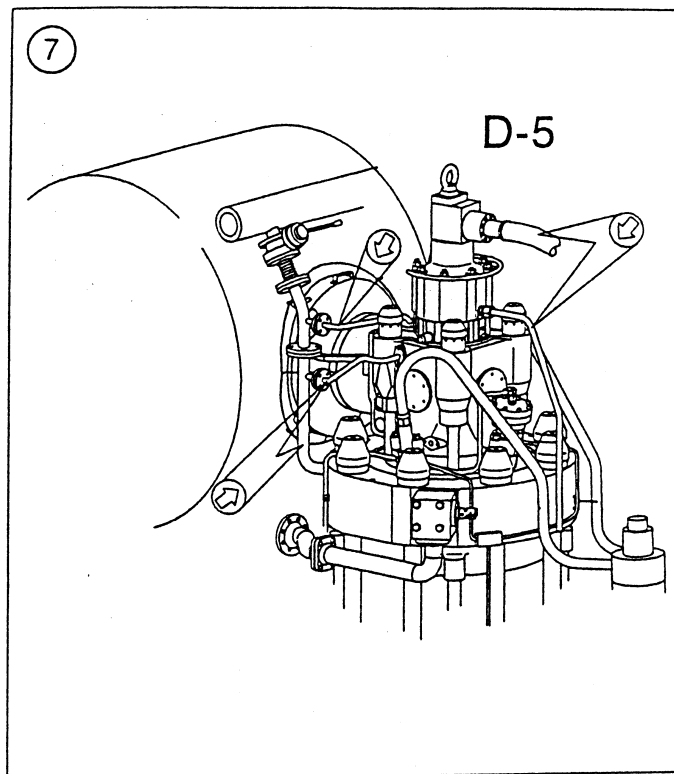
Mount the return oil pipe between the exhaust valve and the hydraulic actuator.

Mount the cooling water outlet pipes.

8. Shut the drain valves and open the cooling water inlet.

After venting the cylinder section, shut the vent cocks and open the cooling water outlet valve.

Open the fuel oil, lubricating oil and air valves.



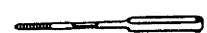
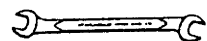
BLANK



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☒ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

Standard tools: see Section 913



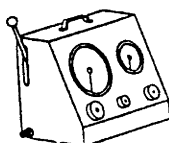
40-200 Nm
140-760 Nm



1500 kg

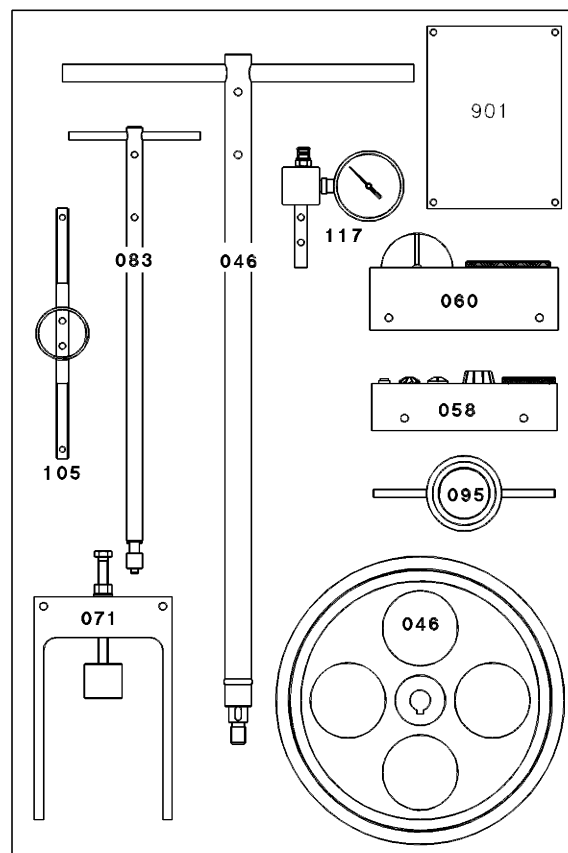


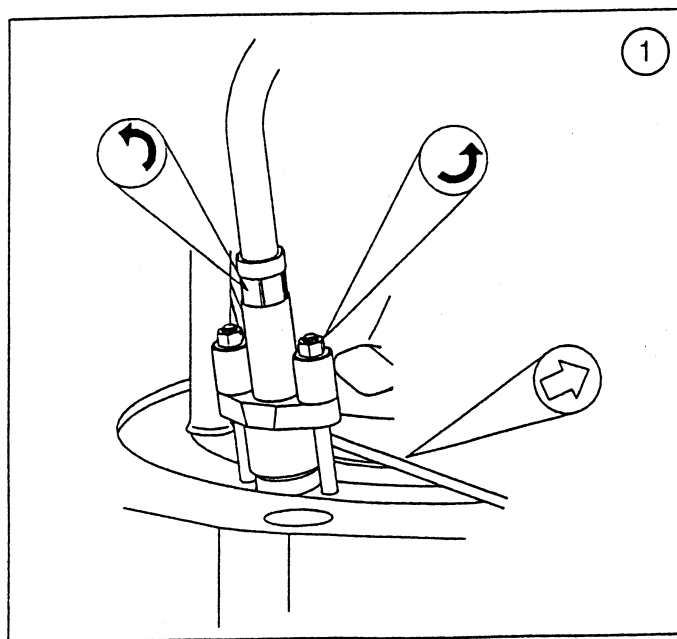
4 x 1 m
1 x 3 m



DATA:

- D-1 Hydraulic pressure for exhaust valve
 - dismantling..... 900-990 bar
 - tightening..... 900 bar
- D-2 Weight of high-pressure pipe (exhaust valve)..... 62 kg
- D-3 Weight of exhaust valve.... 1146 kg
- D-4 Weight of starting valve.... 58 kg
- D-5 Tightening-up angle..... 66°
- D-6 Tightening torque – fuel oil high-pressure pipe (fuel valve/fuel pump)..... 190 Nm
- D-7 Tightening torque - high-pressure pipe (exhaust valve)..... 80 Nm





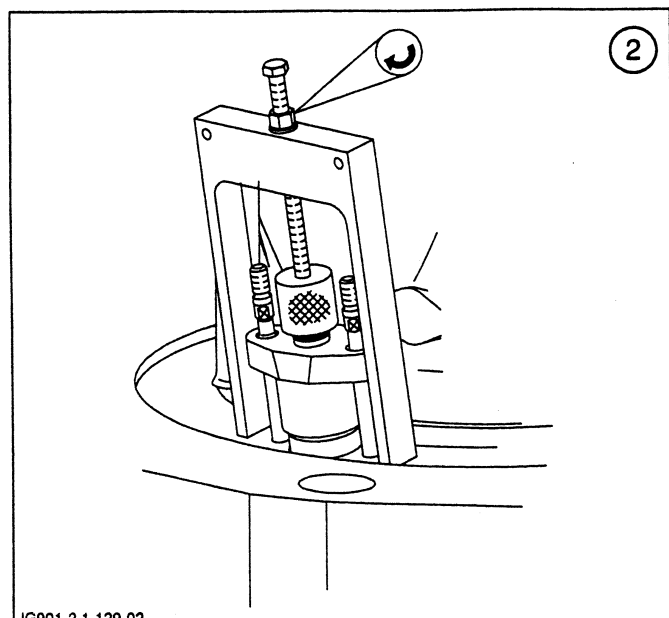
1. Close the fuel oil inlet and outlet valves, and drain the high-pressure pipe.

Unscrew the coupling piece at both ends of the pipe (fuel valve and distributor block ends).

Remove the high-pressure pipe.

Disconnect the return oil pipe from the fuel valve.

Unscrew the nuts on the spring housings and remove the housings.



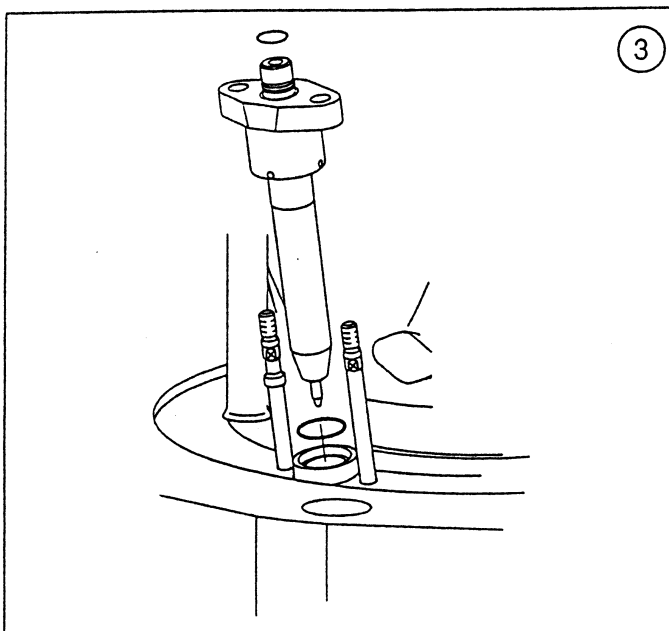
2. Take out the valve. If the valve is sticking, use the two lifting tools (the illustration shows how to place and use one of these tools).

3. Thoroughly clean the valve bore in the cylinder cover and check the seating in the bore for marks which, if any, must be eliminated.

(For reconditioning of valve bore in cylinder cover, see Procedure 901-3).

After reconditioning of the seating in the bore, and thorough cleaning of bore and seating, make an overhauled fuel valve ready (for overhaul, see Procedure 909-6) by providing it with new O-rings, and lubricating it with molybdenum disulphide (MoS_2).

Mount the valve in position in the cylinder cover.



4. Check that the locking/indicating pin in each spring housing has not been bent or broken off. This to ensure that overtightening has not taken place. In case of overtightening, discard the spring housing and replace it by a new one.
5. Fit the spring housings and tighten the fixing nuts till the top face of the pressure disc is flush with the top face of the spring housing. This must be done with great care, as the spring tension in the housing determines the correct tightening of the fuel valve to the cylinder cover as well as the correct compression of the fuel valve.

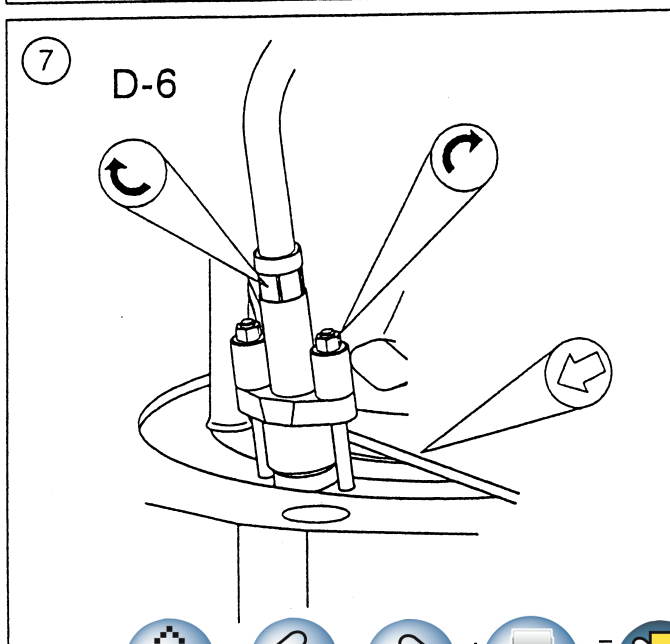
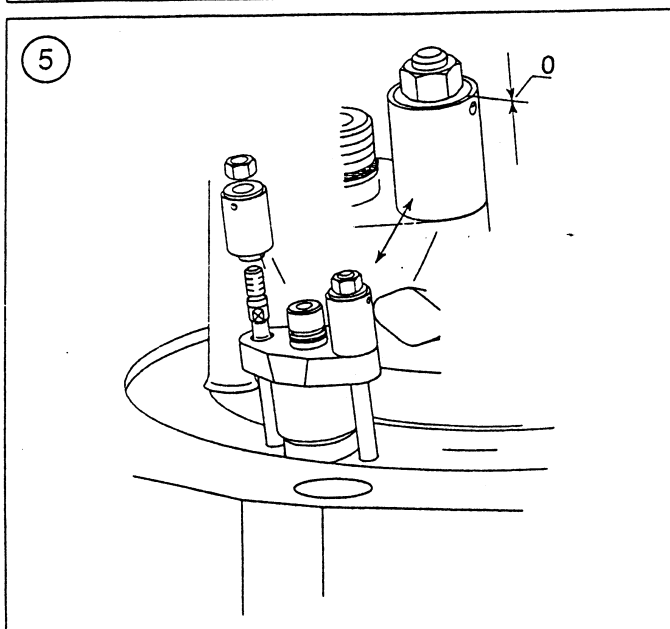
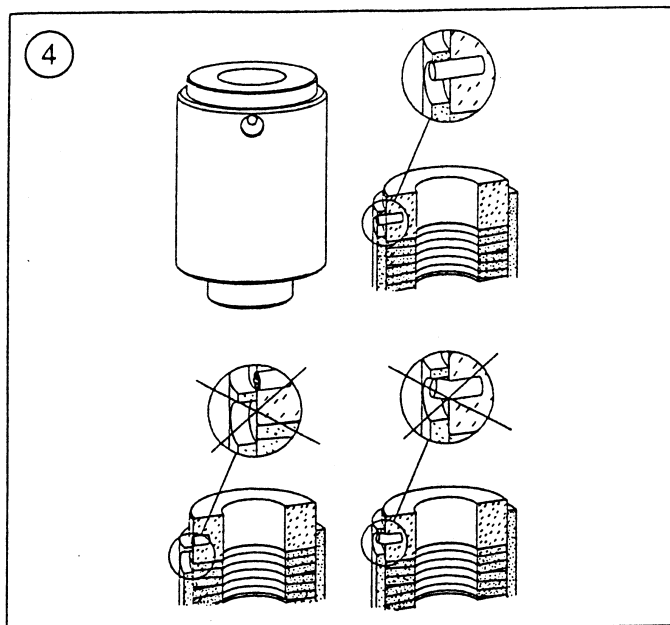
Caution !

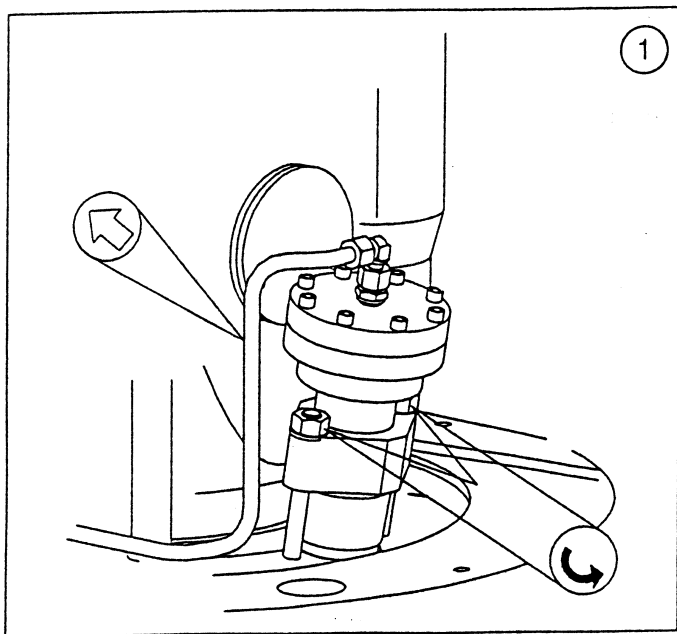
If the fuel valves are not correctly tightened by the spring housings, this can lead to malfunction of the fuel valve and, ultimately, to cracked nozzles and high-pressure pipes.

6. Check the fuel oil high-pressure pipe for marks on the seating surfaces, replace the O-rings on the high-pressure pipe.
For overhaul of the high-pressure pipe, see Procedure 909-1.
For overhaul of the puncture valve and for reconditioning of seating in the top cover, see Procedure 909-3.
7. Check the adjustment of the high-pressure pipe, *see Procedure 909-7*, and reconnect the pipe. Tighten the coupling pieces to the torque indicated on the Data sheet.

Reconnect the return oil pipe to the fuel valve.

Turn on the fuel oil supply.





1. Shut off the starting air and control air inlet.

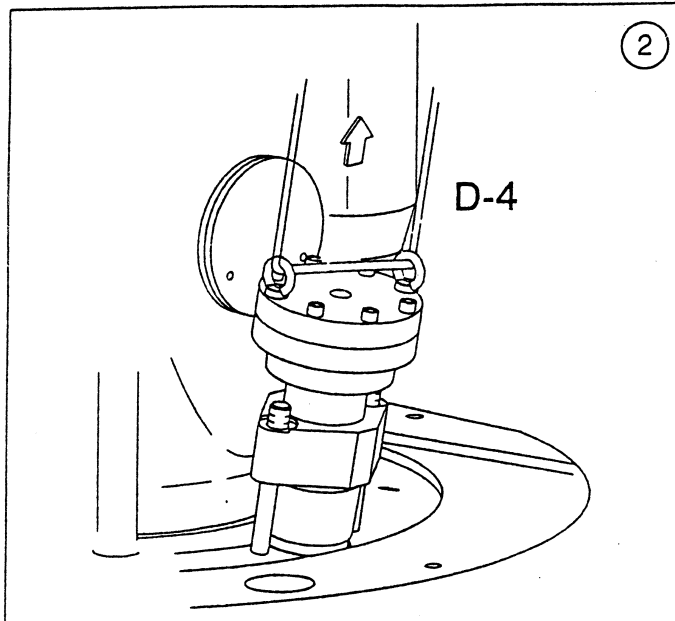
Dismount the control air pipe.

Unscrew the fixing nuts of the starting valve flange.

2. Mount two eye screws in the top cover of the valve. By means of a wire rope, lift away the starting valve.
3. Carefully clean the starting valve bore in the cylinder cover and, if necessary, recondition the seat for the starting valve in the bore, see *Procedure 901-3*.

After fitting a new O-ring, lubricate an overhauled starting valve with molybdenum disulphide, (MoS_2), (for overhauling, see *Procedure 907-4*).

Then mount the valve in the bore of the cylinder cover.

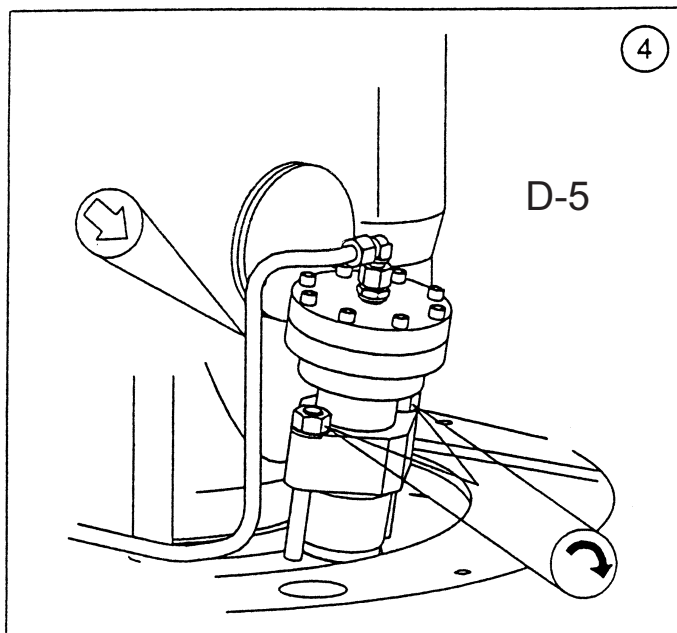


Tightening Sequence

4. Mount the nuts and tighten-up alternately, in at least three steps, to an angle of 40° .

Loosen the nuts again and repeat the procedure to reach the full tightening angle/torque, see *data*.

Mount the control air pipes and turn on starting air and control air.



Dismantling

1. Close the cooling water inlet and outlet, and drain the exhaust valve.

Dismount the high-pressure pipe for the hydraulic valve activation.

Disconnect the cooling water outlet pipe from the exhaust valve.

Dismount the return oil pipe and the sealing air pipe from the exhaust valve.

Dismount the air pipes for the sealing air arrangement and for pneumatic closing of the exhaust valve.

Warning !

Do not disconnect the air supply to the sealing air arrangement until **after** the camshaft oil pumps have been stopped.

Remove the plate jacket with insulation from the intermediate pipe, and remove the clamp ring.
See Procedure 901-1.1.

2. Remove the protective caps from the exhaust valve studs, and mount the four hydraulic jacks.

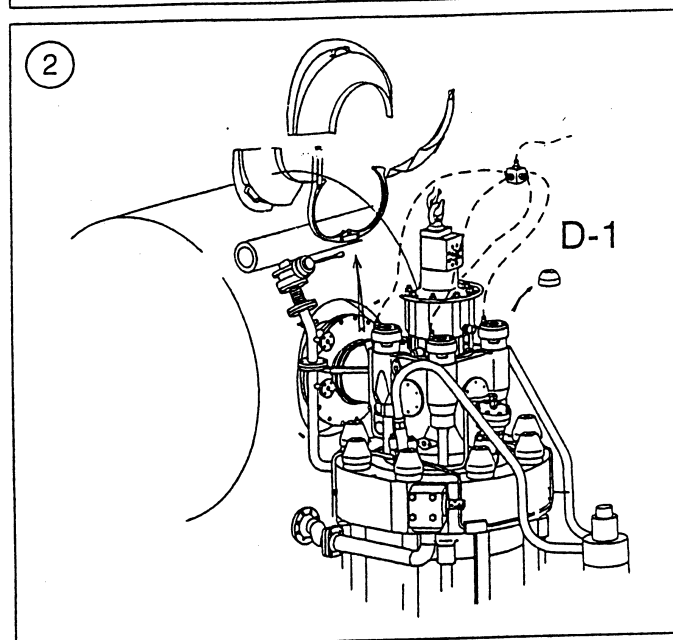
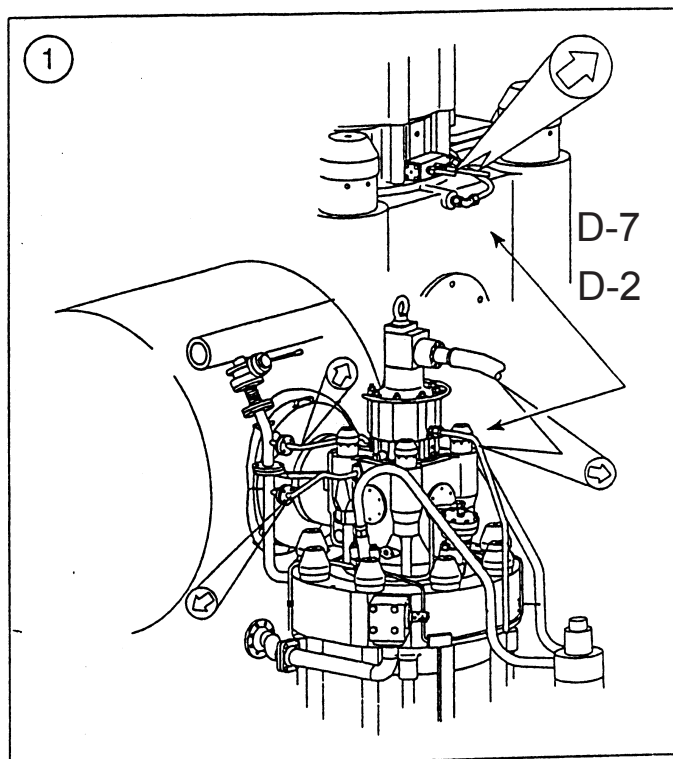
Connect the high-pressure pump to the jacks by means of the distributor block and four high-pressure hoses.

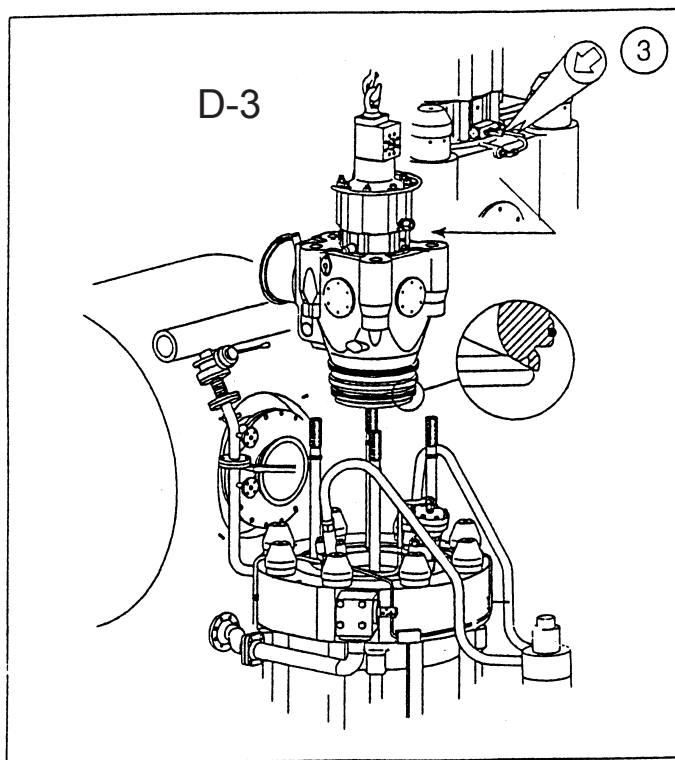
Bleed the hydraulic system and raise the pressure as indicated in Data. Then loosen and remove the nuts.
See Procedure 913-1.

Attach the crane to the lifting tool on top of the valve and lift it away.

Carefully clean the exhaust valve bore in the cylinder cover and recondition the seating and sealing surfaces of the bore, if required. *See Procedure 901-3.*

For overhaul of the exhaust valve, see Procedure 908-2.





Mounting

3. Lift the overhauled exhaust valve, provided with new O-rings on the seat. Loosen the screws for the water connections and fit new O-rings. Lubricate all O-rings with molybdenum disulphide (MoS_2).

Caution !

Before mounting the valve on the engine, connect compressed air to the pneumatic piston to keep the exhaust valve closed during the mounting.

Position the valve in the cylinder cover bore, guiding it in accordance with the exhaust flanges and the water connections.

4. Mount the nuts and the hydraulic jacks. Raise the pressure to the value indicated in Data and tighten the nuts. Relieve the system of pressure, remove the pump and the high-pressure pipe, and fit the protective caps.

Attach the insulation jacket, mount the cooling water outlet pipe, and fasten the water connections on the exhaust side.

Mount the return oil pipe, the sealing air pipe and the air pipe for pneumatic closing of the exhaust valve.

Open the lub. oil supply and the cooling water supply to the exhaust valve.

Disconnect the compressed air and connect the normal air supply.

Caution !

The air supply to the exhaust valve must always be connected **before** starting the camshaft oil pumps.

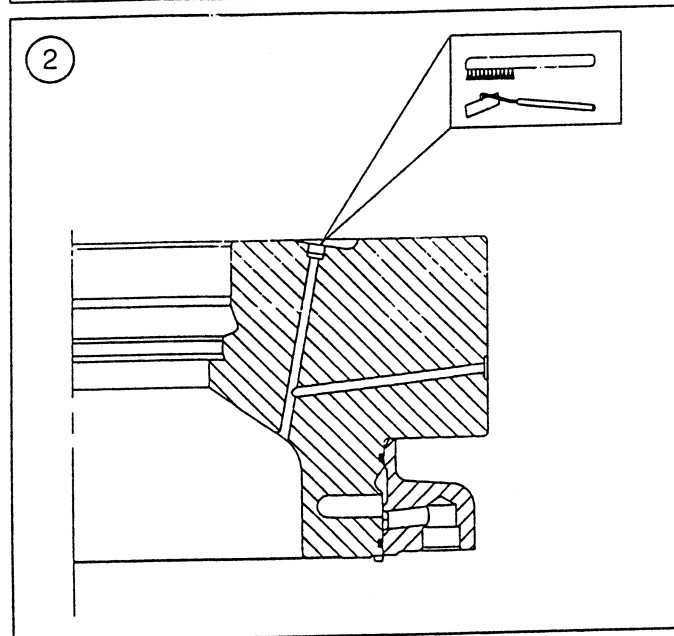
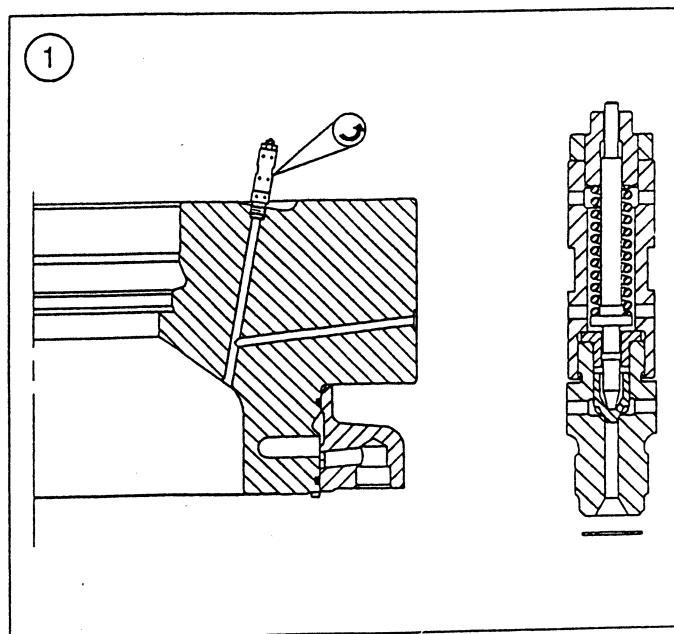
This is **very** important, because otherwise the valve will open more than normal.



1. Unscrew the safety valve from the cylinder cover.

For overhauling of safety valve, see Procedure 911-1.

2. Pierce the bore in the cylinder cover, and blow it clean.
3. Mount a new or overhauled safety valve in the cylinder cover.



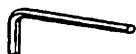
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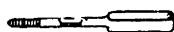
SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☒ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

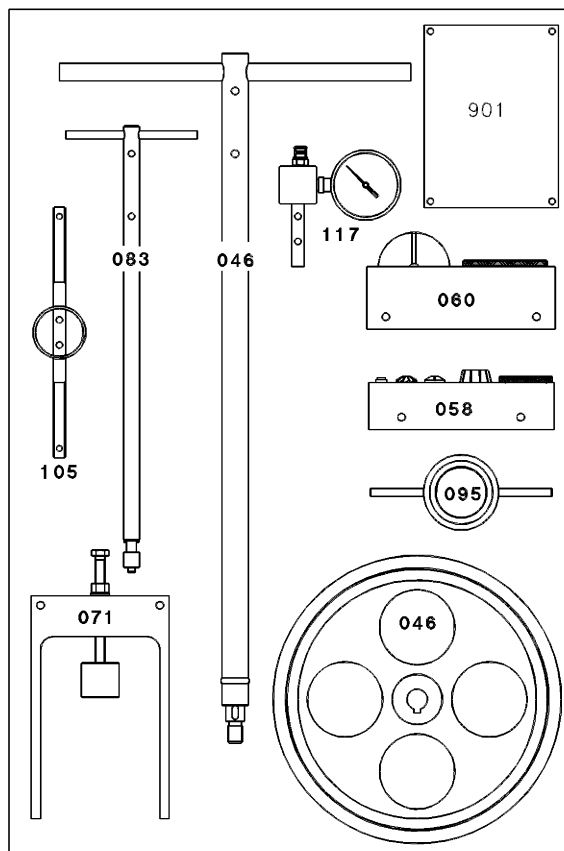
Standard tools: see Section 913



4 × M24

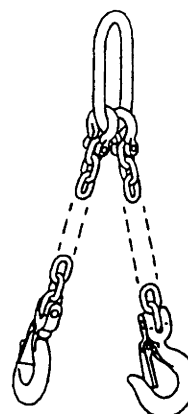


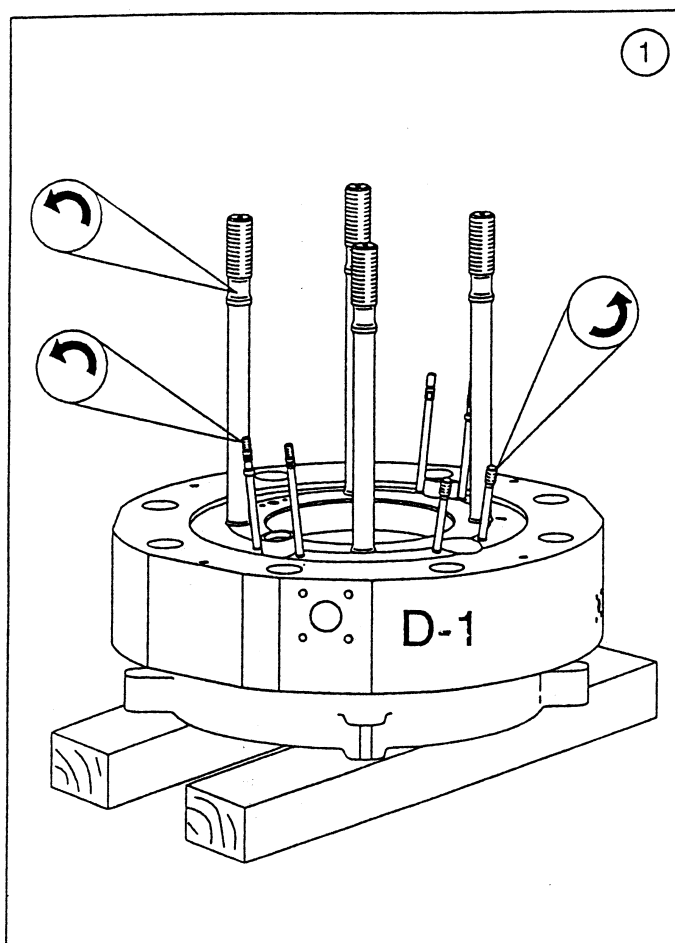
40-200 Nm
140-760 Nm



DATA:

D-1	Weight of cylinder cover complete.....	3128 Kg
D-2	Weight of cylinder cover	2940 Kg
D-3	Weight of cooling jacket	100 kg
D-4	Screwing-in torque – exhaust valve studs.....	450 Nm
D-5	Screwing-in torque – starting valve studs	240 Nm
D-6	Screwing-in torque – fuel valve studs.....	140 Nm
D-7	Check measurement	252 ± 2 mm

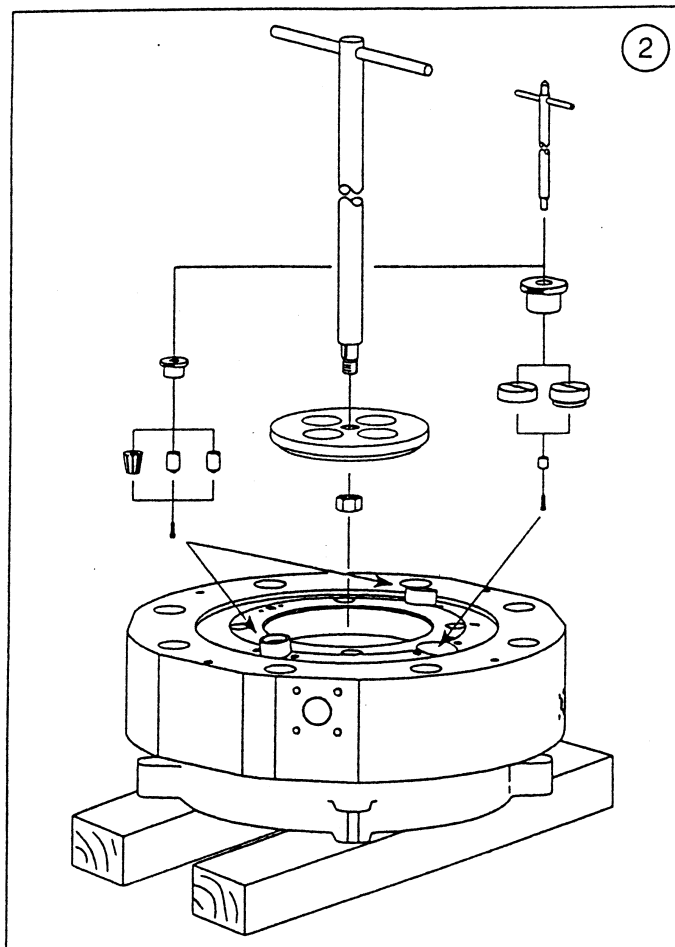




1. Dismount all valves and pipes on the cylinder cover.
See Procedure 901-2.

Dismount all studs on the top of the cylinder cover.

2. Recondition the valve bores as described in the following.
3. Replacement of the cooling jacket.
See Procedure 901-3.2.



Fuel valve bore

4. The tool consists of a common spindle with handle, and of a guide, a carbon cutter, a seating face cutter, and a grinding mandrel.

Clean the fuel valve bores, using the carbon cutter. If required, recondition the fuel valve seating using the appropriate cutter.

Grind the seating with the grinding mandrel and a grinding compound (e.g. Carborundum No. 200).

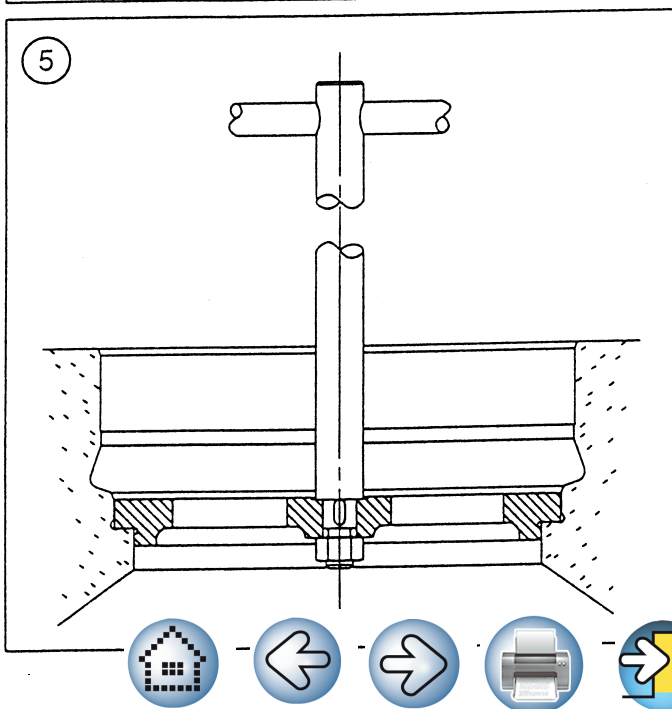
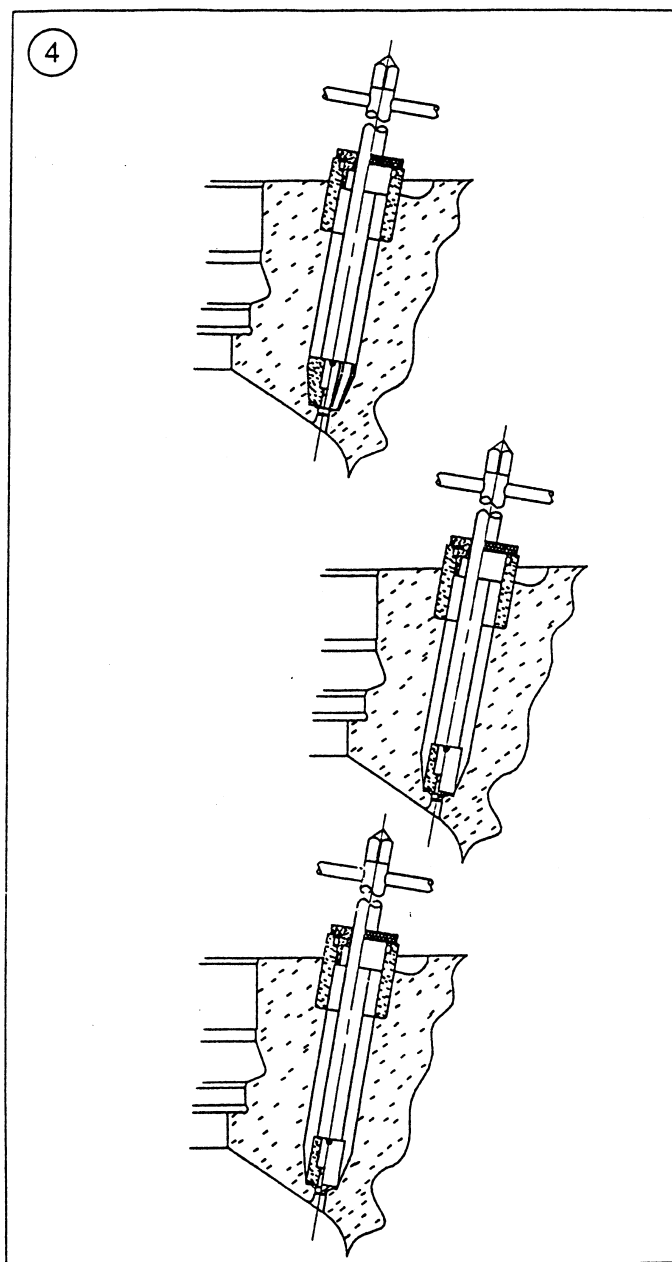
After the milling/grinding, clean the bore and seating carefully, and check that the seating is not damaged.

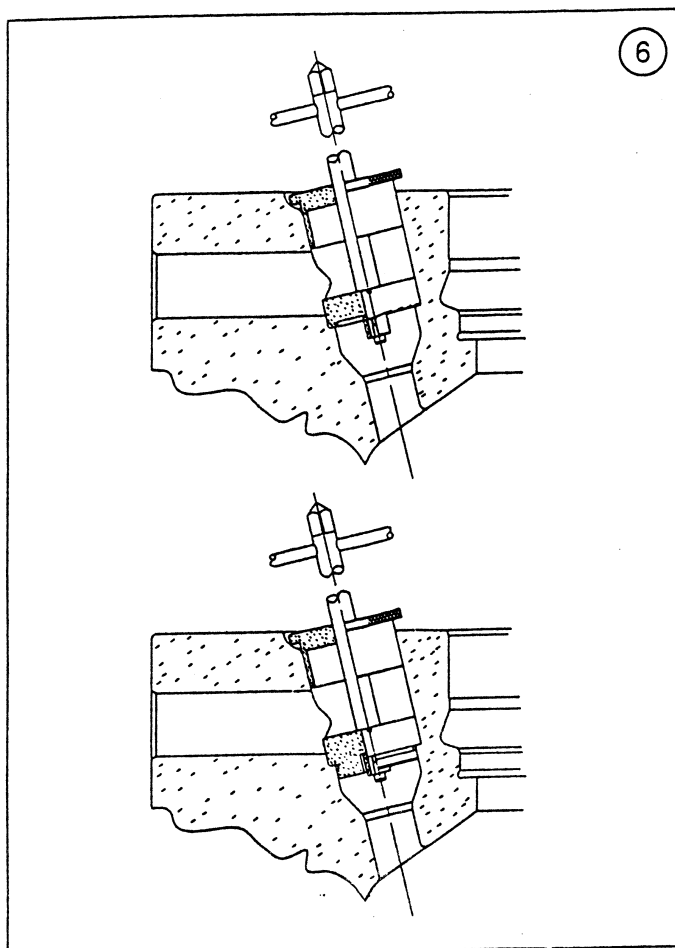
Exhaust valve bore

5. The tool consists of a spindle with handle and a grinding disc.

After cleaning the valve bore and seating, grind the seating with the grinding disc and a grinding compound (e.g. Carborundum No. 200).

After the grinding, clean the bore and seating carefully, and check that the seating is not damaged.





Starting valve bore

- The tool consists of a guide, a cutter, and a grinding disc.

Recondition the starting valve bore and seating in the same way as described for the fuel valve bore.

When replacing valves on a cylinder cover that is mounted on the engine (901-2), recondition the valve bores/seating in the same way as described here, but without dismantling the studs.

- Lubricate the threads with 'Never Seize' or Molybdenum Disulphide (MoS_2) and mount the valve studs.

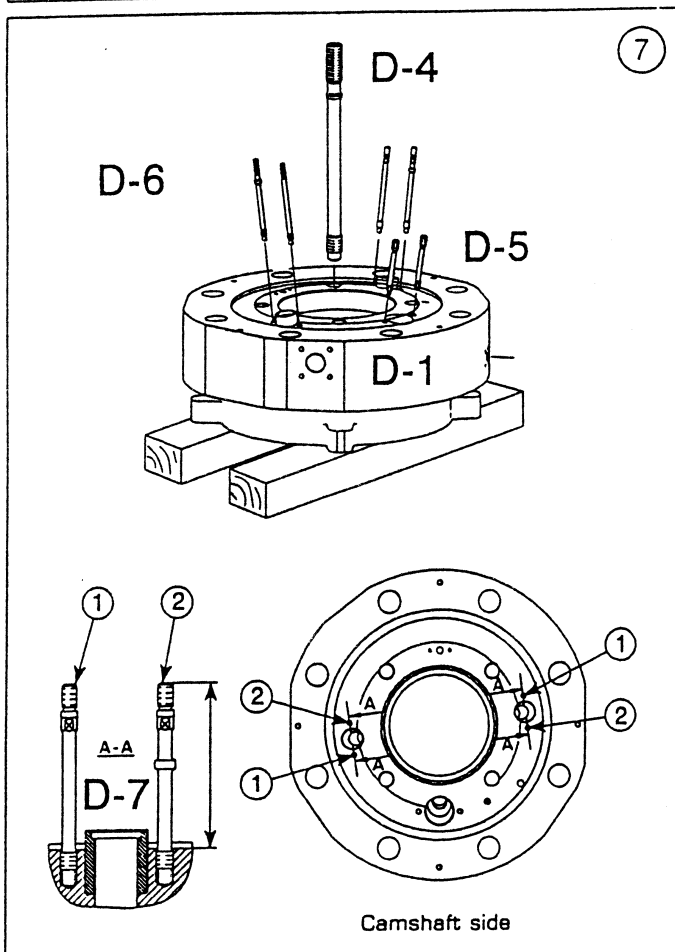
Tighten up the studs in accordance with the screwing-in torque stated on the data sheet. Make sure that the fuel valve studs are correctly mounted.
See Data and illustration.

Protect the bores and seatings for the exhaust valve, the starting valve and the fuel valves.

Provide the water connection flanges with new gaskets, and keep the cylinder cover ready for replacement.

Always fit new or overhauled valves when a cylinder cover is mounted on the engine.

For mounting of valves, see Procedure 901-2.



1. Unscrew the four screws which secure the cooling jacket to the cylinder cover.
2. Lift the cylinder cover free from the cooling jacket and land the cover on a couple of planks.

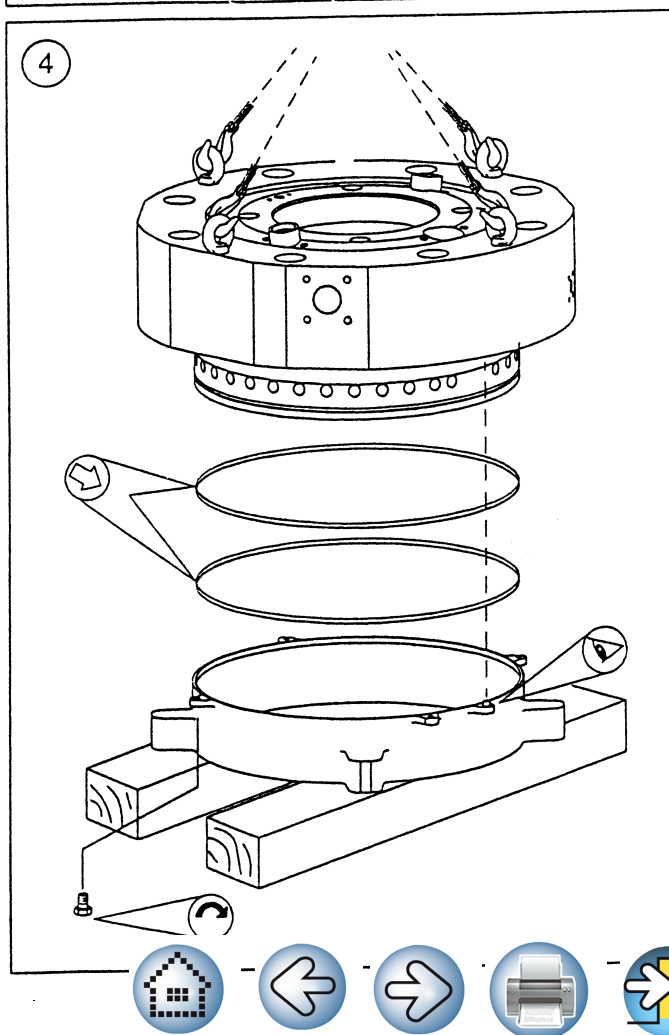
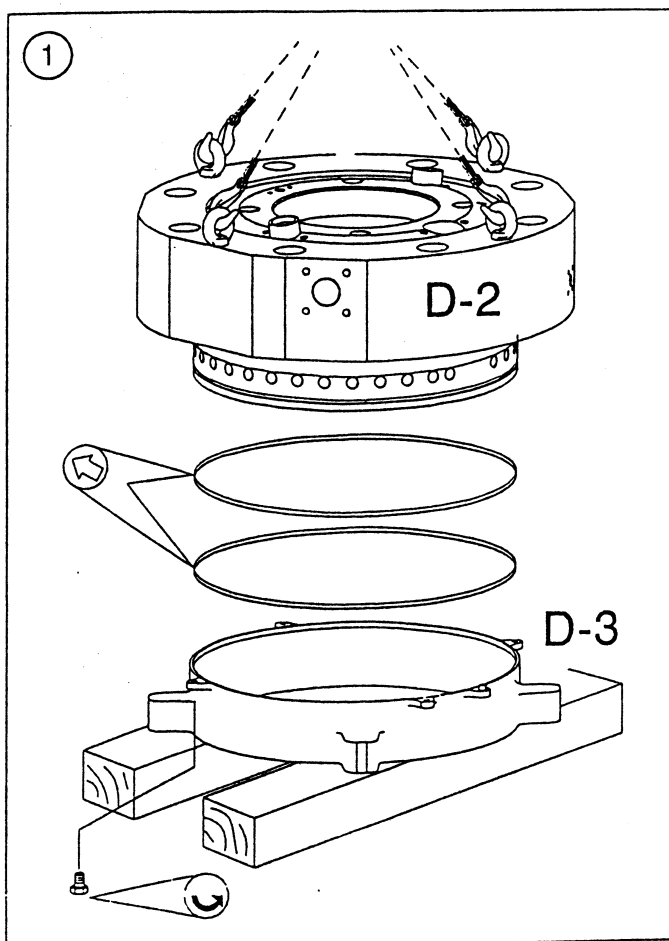
If the cooling jacket has become stuck, use dismantling screws to force the jacket/cover apart.

3. Discard the O-rings from the cover and carefully clean the cooling jacket and the cylinder cover.

Provide the cylinder cover with new O-rings, well lubricated with oil.

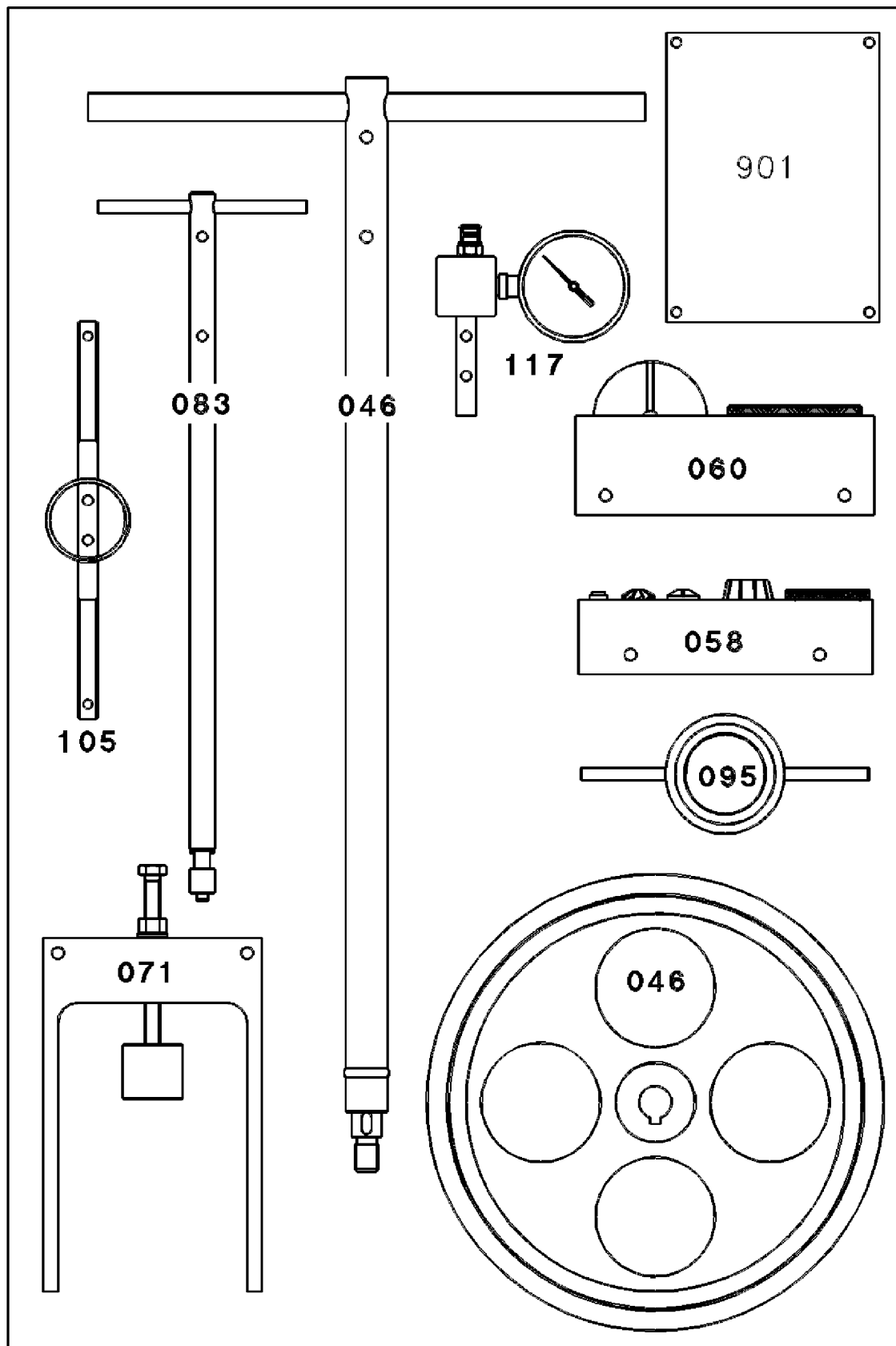
4. Lift the cylinder cover and guide the jacket/cover into position, using the guide pin as reference (camshaft side).

Mount and tighten the screws for the cooling jacket.



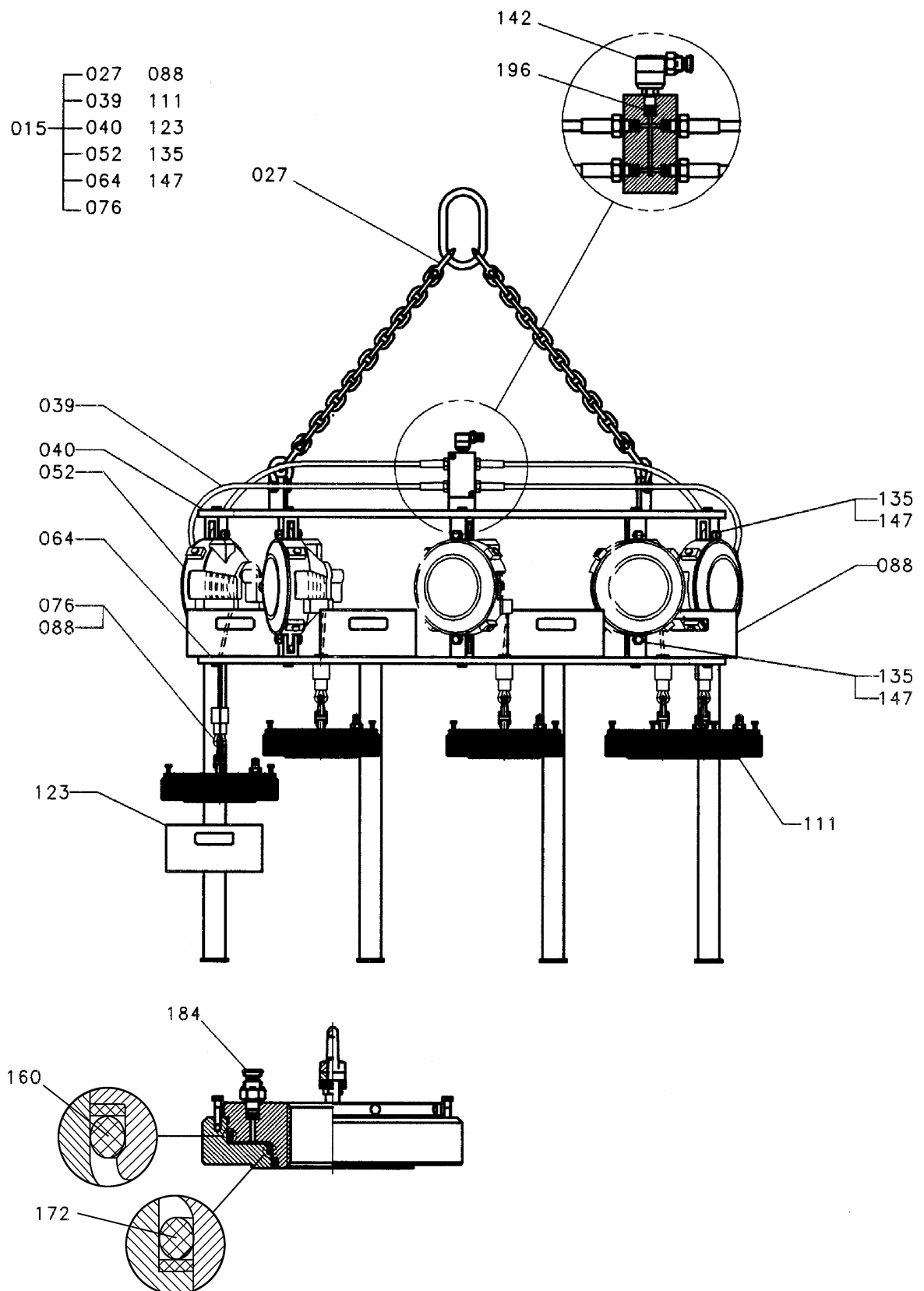
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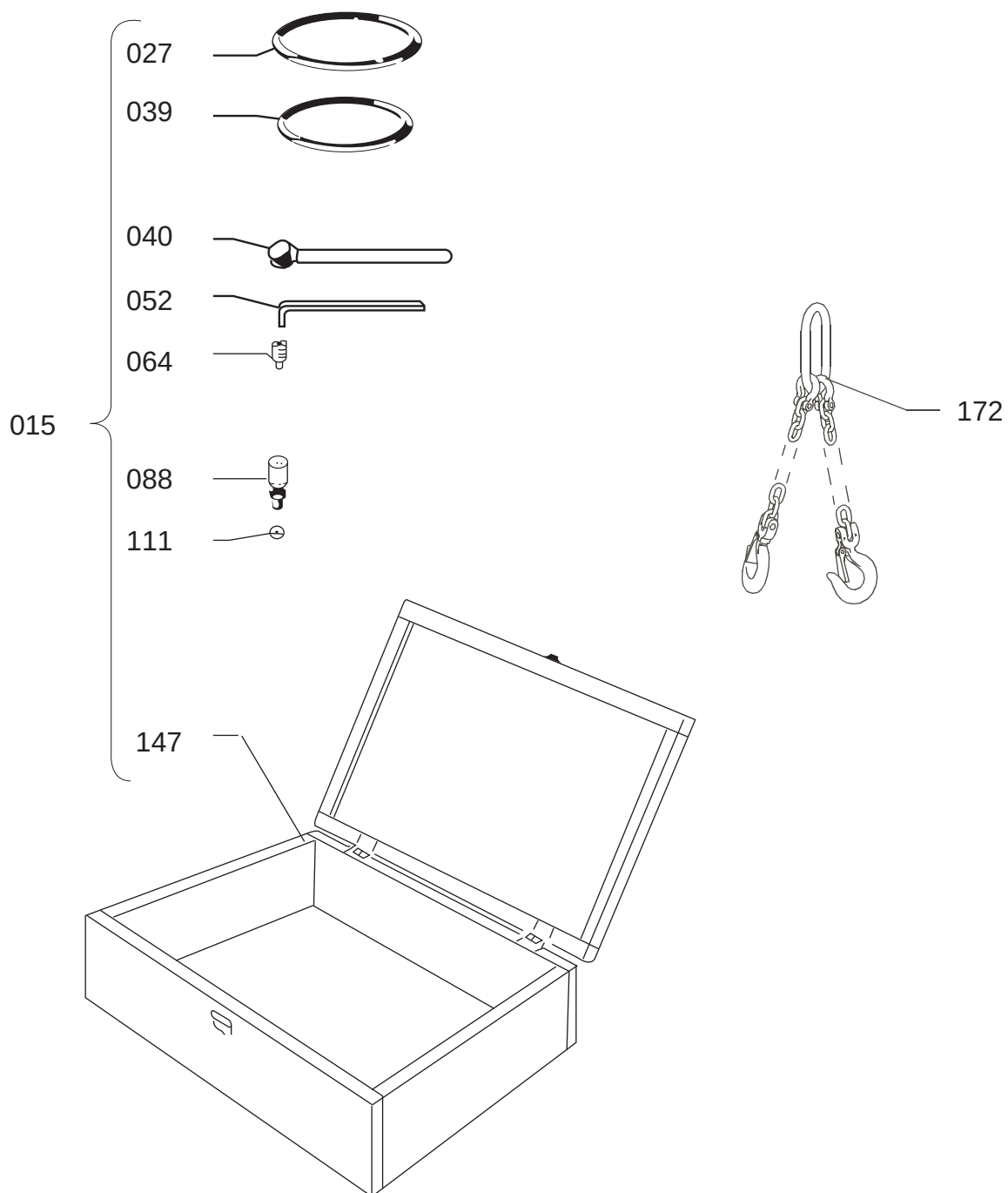
Item No.	Item Description	Item No.	Item Description
901	Tool panel *)		
046	Grinding tool for Exh. valve seat		
058	Milling and grinding wheel for fuel valve seat		
060	Milling and grinding wheel for starting valve seat		
071	Dismantling milling for fuel valve		
083	Handel for sundry type		
095	Granding ring for starting valve		
105	Grinding wrench for starting valve		
117	Testing device for safety valve		
901	Tool panel, completer		
117	with tools *)		
	*) Optional extras		





Item No.	Part Description	Item No.	Part Description
015	Tighening tool, complete		
027	Lifting decvice		
039	Hose with unions		
040	Balancing ring, upper		
052	Spring balance		
064	Balancing ring, lower		
076	Heart - shaped thimble		
088	Wire lock		
111	Hydraulic jack, complte		
123	Spacer ring		
135	Screw		
142	Scewed connection 90°		
147	Nut		
160	O- ring with back - ring, 120/130 mm		
172	O- ring with back - ring, 200/210 mm		
184	Quick coupling, complete		
196	Gasket		

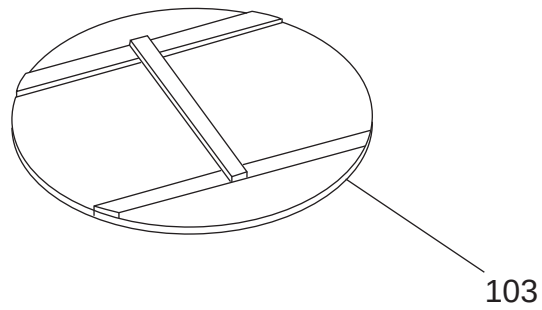
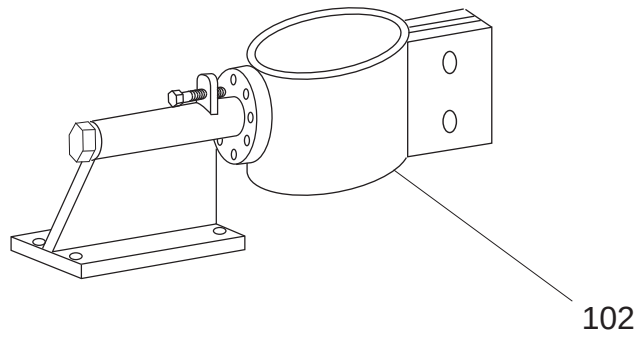




Item No.	Part Description
015	Spacer parts for hydraulic ring
027	O-ring with back-up ring, 200/210 mm
039	O-ring with back-up ring, 120/130 mm
040	Tommy bar
052	Wrench
064	Bleeder screw
088	Coupling, male
111	Gasket
147	Wooden box
172	Lifting chains for cylinder cover

Item No.	Part Description



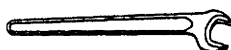


Item No.	Part Description	Standard No.	
102	Dism stand for starting valve		
103	Cover for Exh, valve bore		

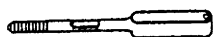
SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☒ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

Standard tools: see Section 913



65, 80 mm



40-200 Nm

140-760 Nm

750-2000 Nm

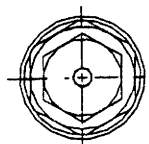
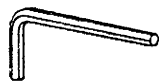


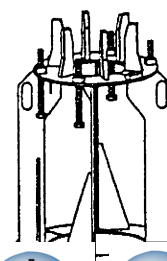
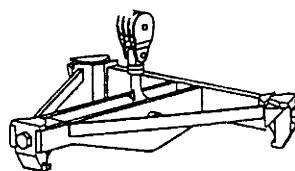
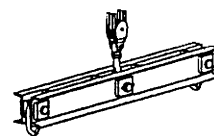
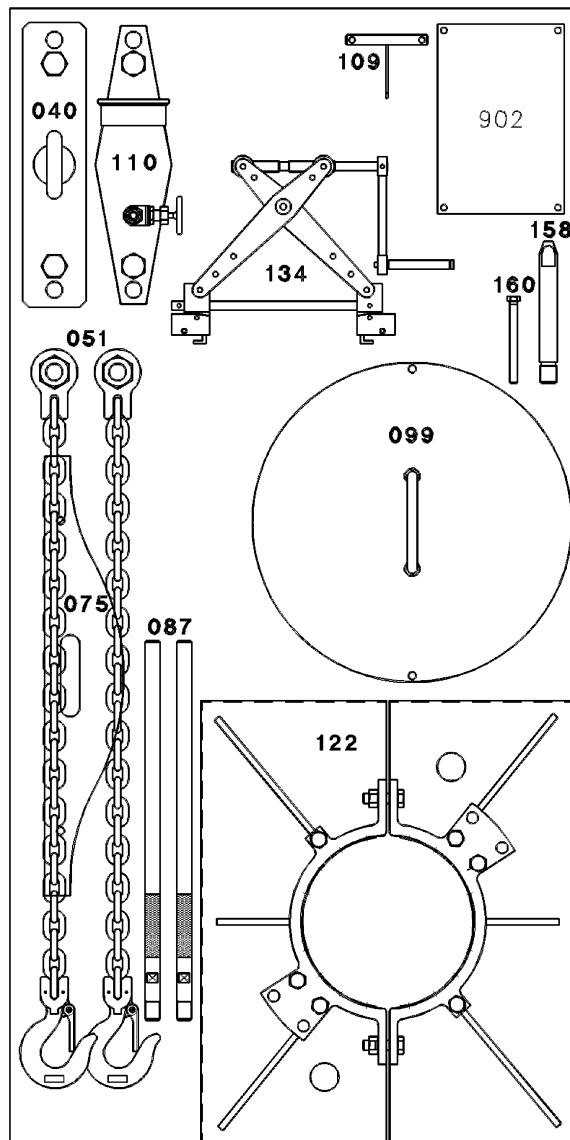
Plate
90451-53

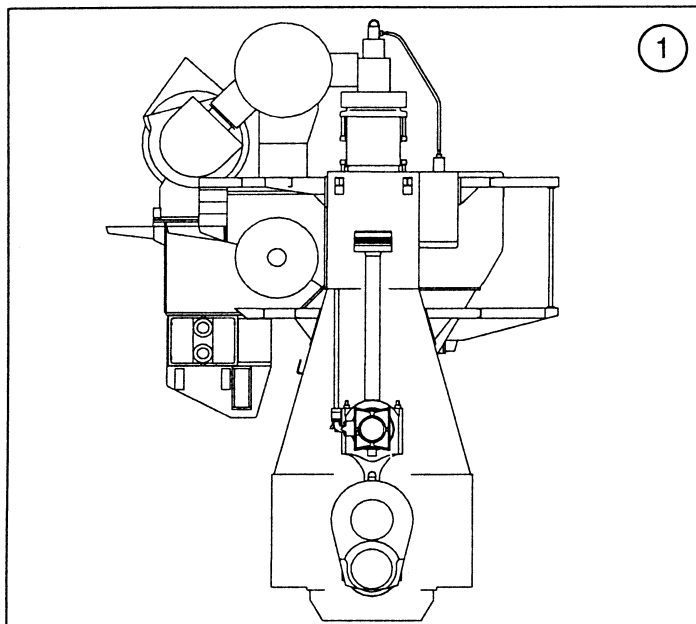


084

DATA:

- | | | |
|-----|--|-------------|
| D-1 | Piston complete..... | 2330 kg |
| D-2 | Hydraulic pressure for piston: | |
| | - dismantling..... | 900-990 bar |
| | - tightening..... | 900 bar |
| D-3 | Telescopic pipe..... | 48 kg |
| D-4 | Tightening torque -
telescopic pipe..... | 170 Nm |
| D-5 | Screwing-in torque -
cylinder cover studs | 1100±110 Nm |
| D-6 | Tightening torque -
inner screws..... | 200 Nm |

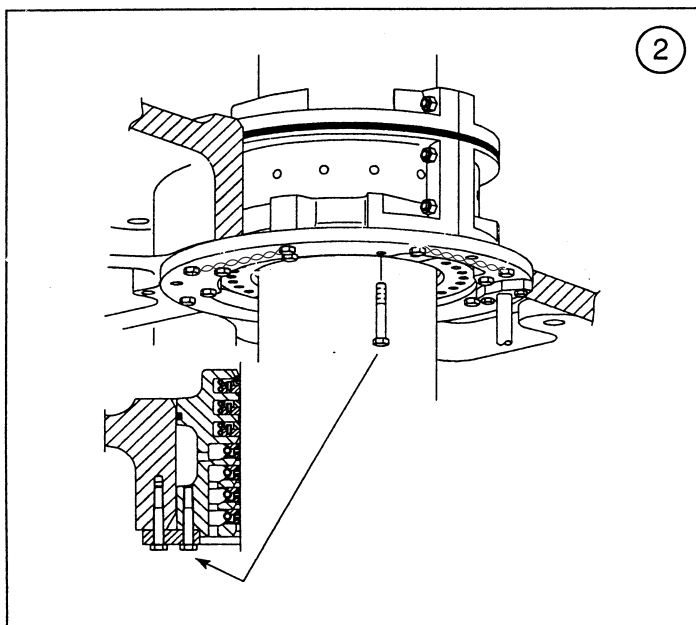




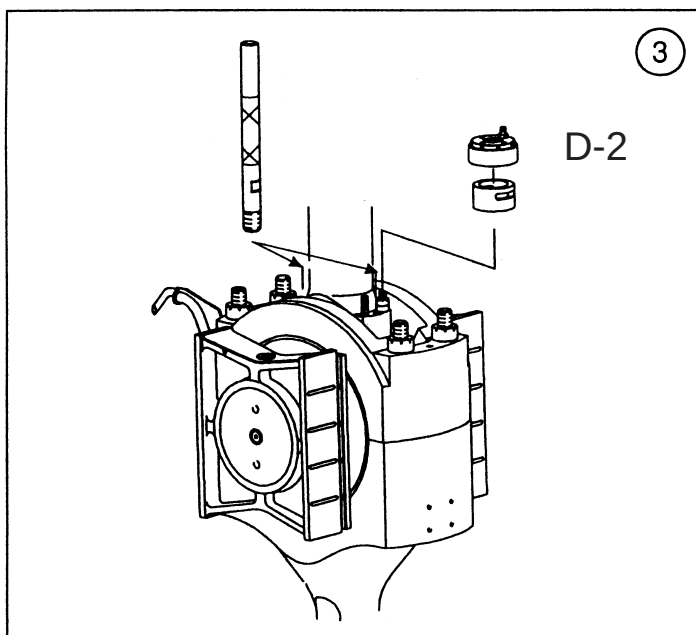
1. Turn the crosshead down far enough to give access to the piston rod stuffing box, the tightening screws for the piston rod, and to the telescopic pipe.
2. Release the stuffing box by removing the innermost screws from the stuffing box flange.
3. By means of the spacer rings and the hydraulic jacks, loosen the nuts of the piston rod studs.

For operation of the hydraulic jacks, see Chapter 913.

Remove the hydraulic tools and unscrew the nuts and remove the distance pieces.



Mount the two distance pieces on the piston rod foot (for guiding the stuffing box).



4. Dismount the cylinder cover, see *Procedure 901-1.1*.

Carefully smooth out any wear ridges at the top of the cylinder liner by using a hand grinder, see *Procedure 903-2.1*.

5. Loosen and remove the four screws which tighten the telescopic pipe to the bend.

Remove one screw from the stuffing box housing and mount the special tool for suspending the telescopic pipe.

Turn the crosshead to TDC, while checking that the guide pins of the distance pieces enter the holes in the stuffing box.

Suspend the telescopic pipe from the distance piece by screwing a nut on to the special stud.

When turning downwards, remove the distance tube from the bend.

Warning !

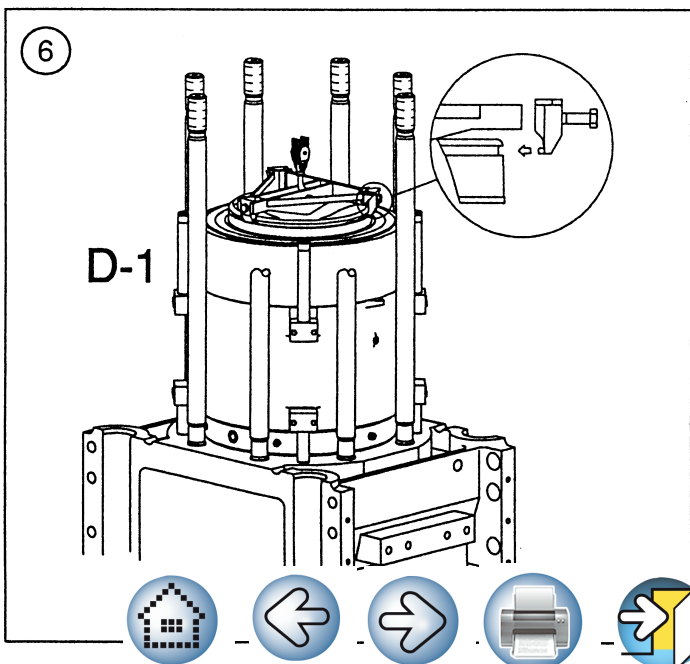
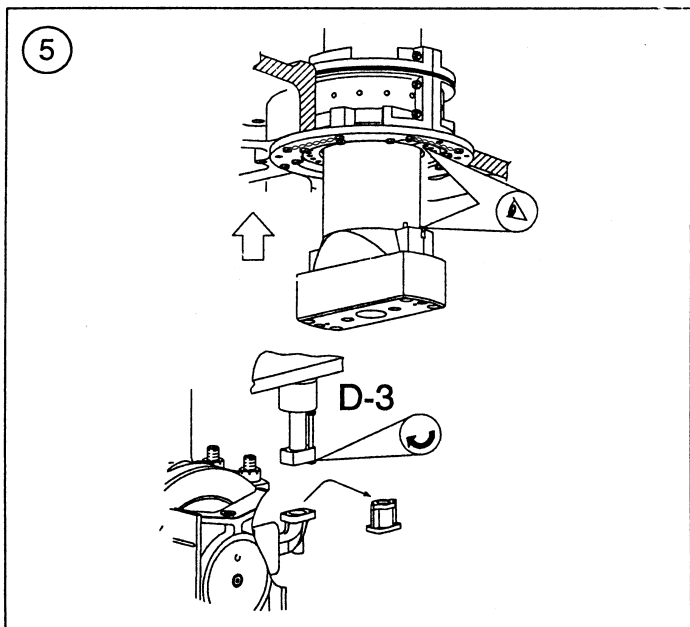
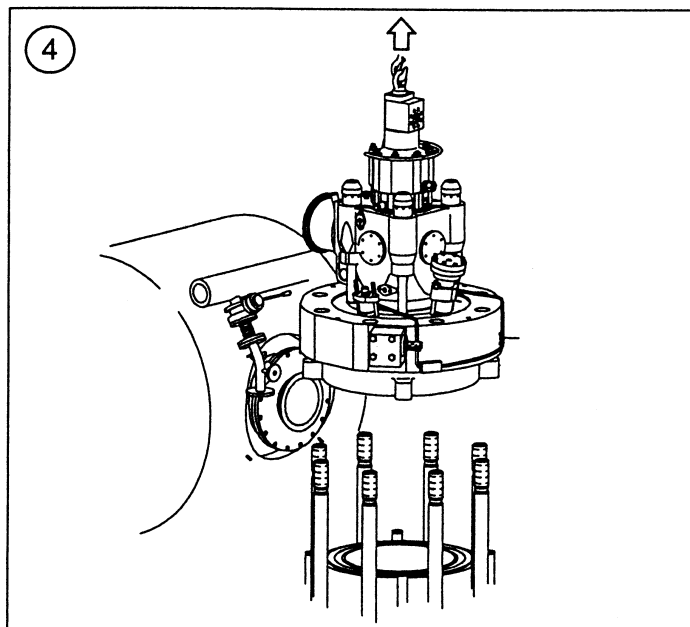
When a piston is dismantled, **never** turn the engine without first dismantling the telescopic pipe from the crosshead.

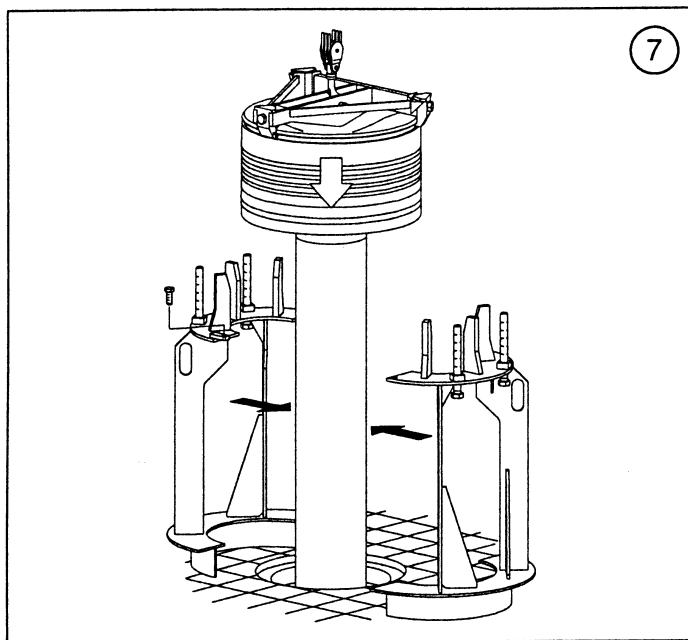
6. The top of the piston is now free of the cylinder liner.

Remove one or two cylinder cover studs.

Clean the lifting groove of the piston crown and mount the lifting tool in such a manner that the two 'fixed' claws of the tool fit into the lifting groove of the piston.

Fit the third, adjustable claw of the tool to the lifting groove and tighten it up against the stop of the tool.



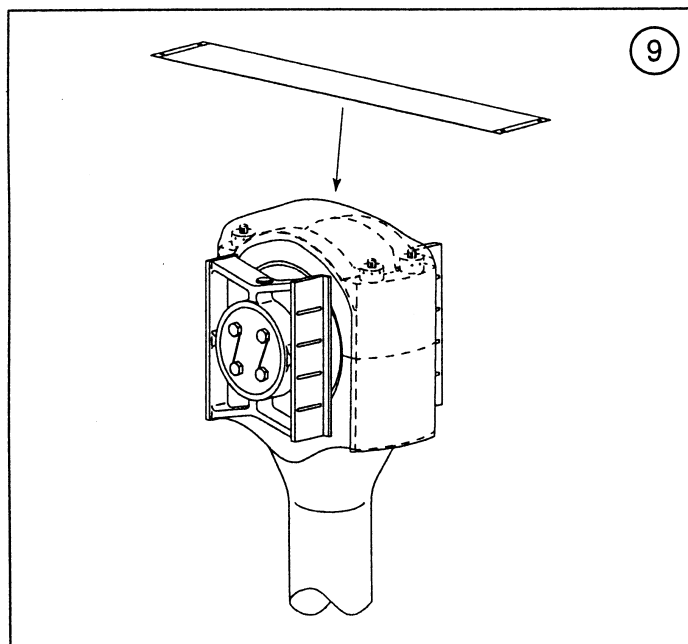
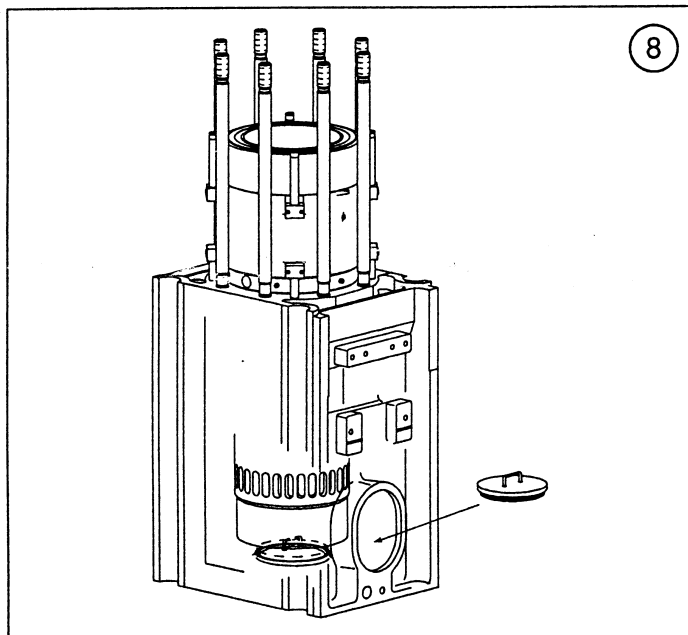


7. Lift out and land the piston with stuffing box in the support placed beforehand over one of the openings in the platform.

8. Place a cover over the opening for the piston rod stuffing box in the bottom of the cylinder unit.

Clean, measure and recondition the cylinder liner, *see Procedure 903-2.1*.

9. Turn the crosshead down far enough to place the protecting rubber shield over the crosshead bearing cap.



1. Mount the piston rings in the grooves.

Caution !

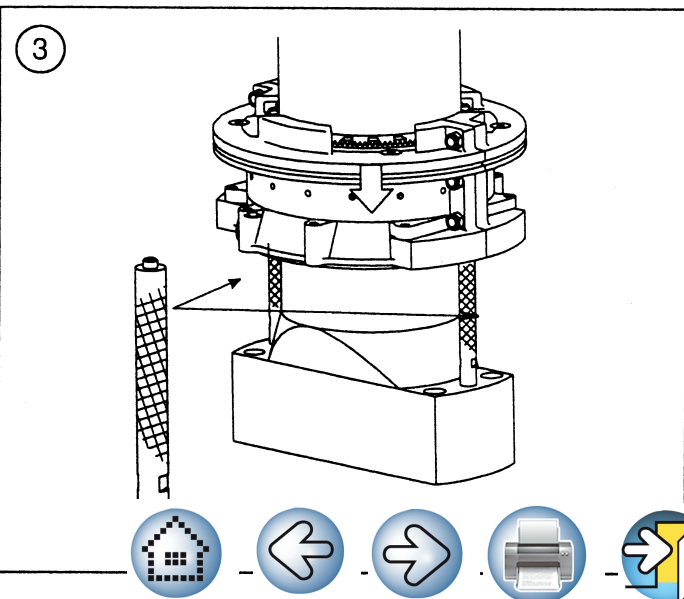
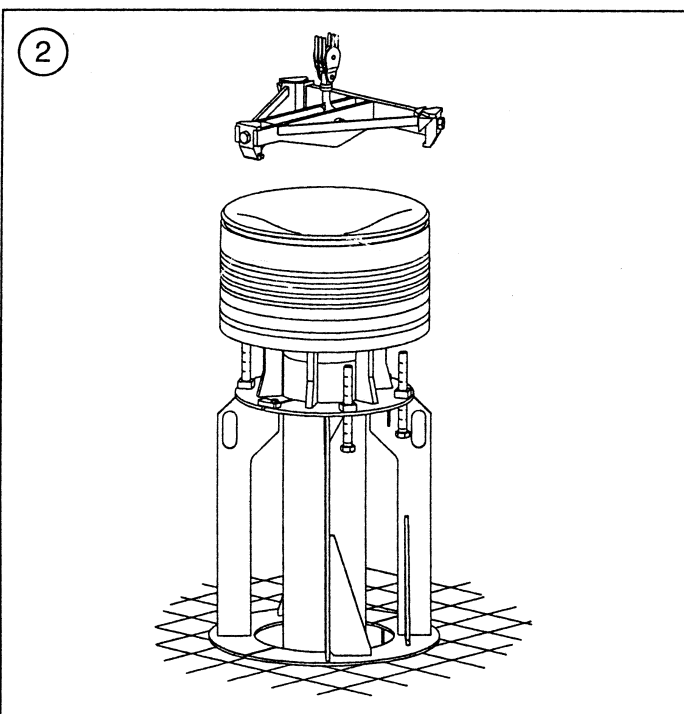
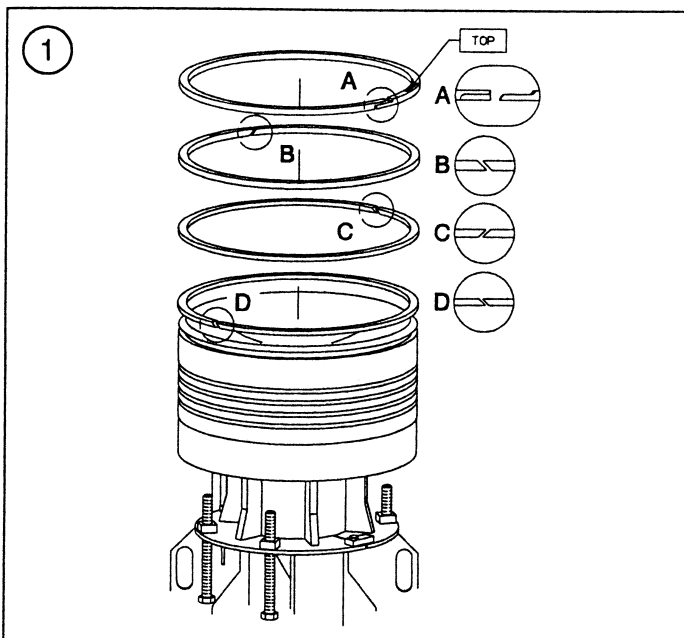
Be sure the **TOP** mark and **MAN B&W** face upwards.

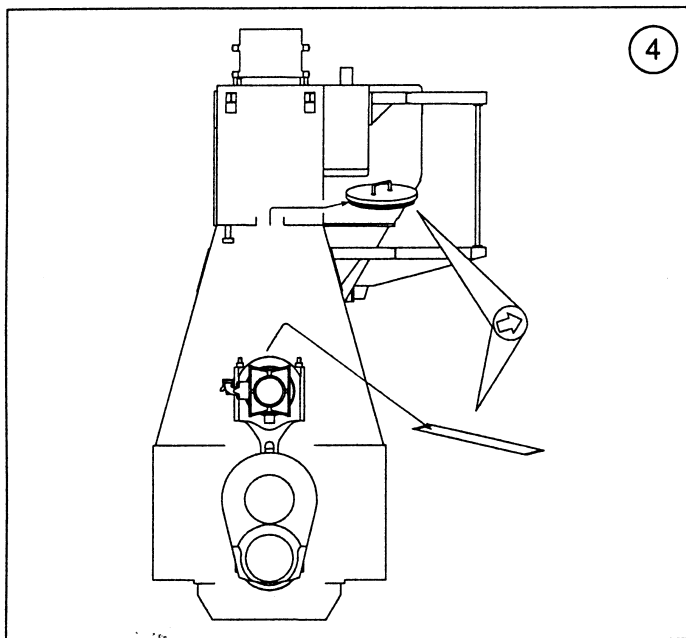
Arrange the piston rings (alternately with right-hand and left-hand cuts) so that the ring gaps are staggered 180°.

Coat the piston rings and the cylinder liner with oil.

2. Mount the lifting tool on the piston crown.
3. Ensure that the stuffing box is correctly positioned over the guide pins in the distance pieces which are mounted on the piston rod foot.

Coat the O-rings of the stuffing box with oil.



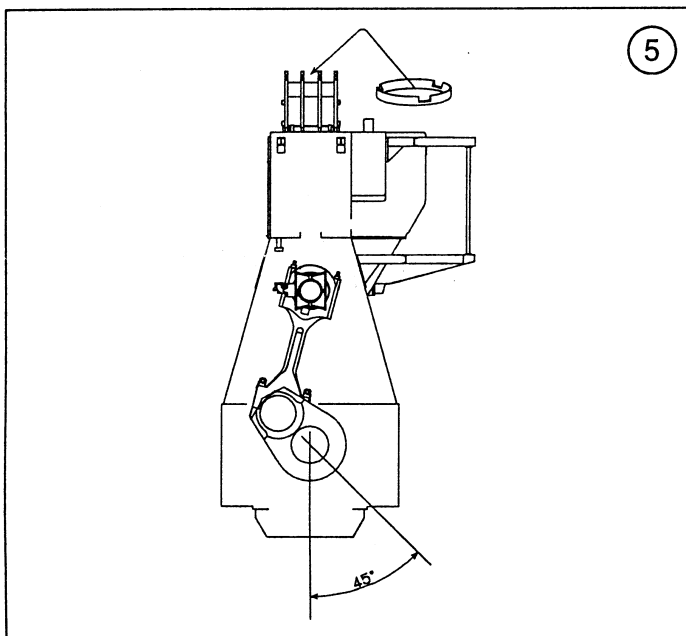


4. Remove the rubber shield from the crosshead bearing cap.

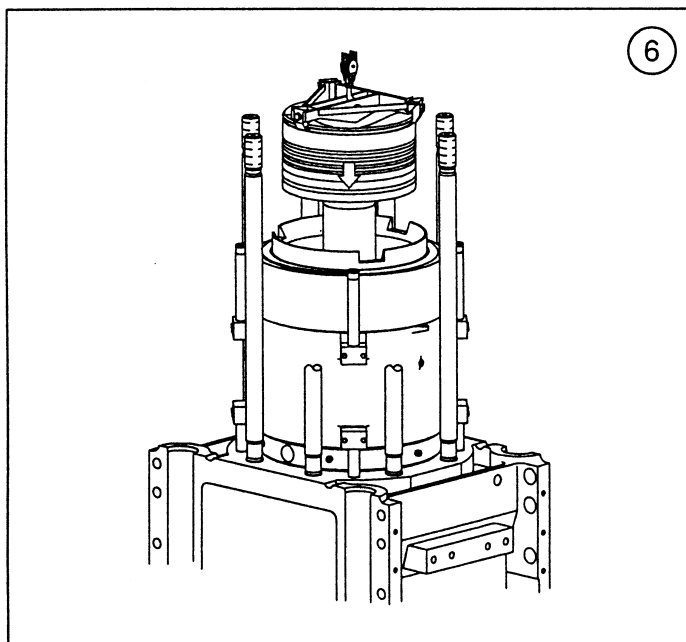
Dismount the cover from the piston rod stuffing box opening in the bottom of the cylinder unit.

5. Turn the crosshead to a position 45° from TDC.

Mount the guide ring for piston rings on the cylinder liner.



6. Lower the piston into the cylinder liner – while guiding the piston rod foot through the cut-out in the stuffing box flange – until the piston rings are inside the liner, corresponding to the lifting tool lacking about 30 mm in landing on the guide ring.



7. Mount the distance tube on the bend.

Turn the crosshead into TDC while checking that the guide ring of the crosshead enters the centre hole in the piston rod.

8. After turning the piston fully into TDC, unscrew the adjustable claw of the lifting tool and pull the lifting tool free of the lifting groove in the piston.

Remove the lifting tool and the guide ring for piston rings.

Release the telescopic pipe from its suspension and land it on the distance tube.

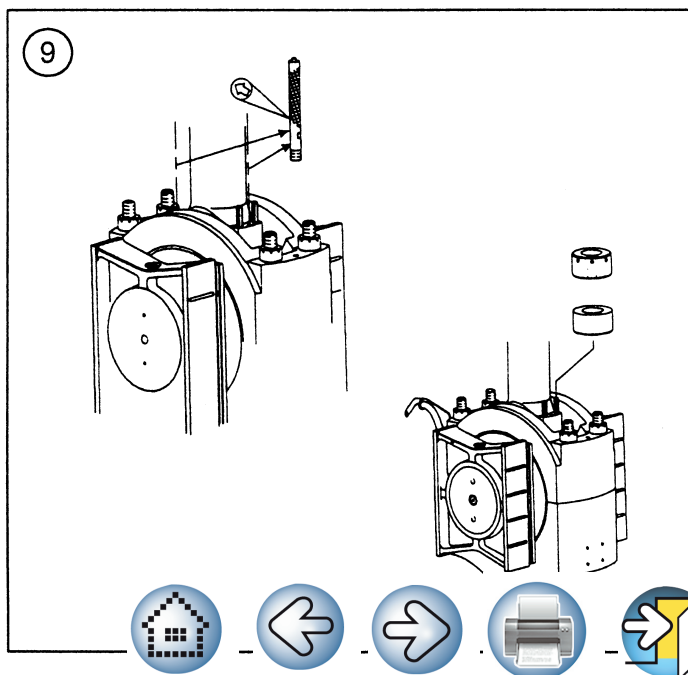
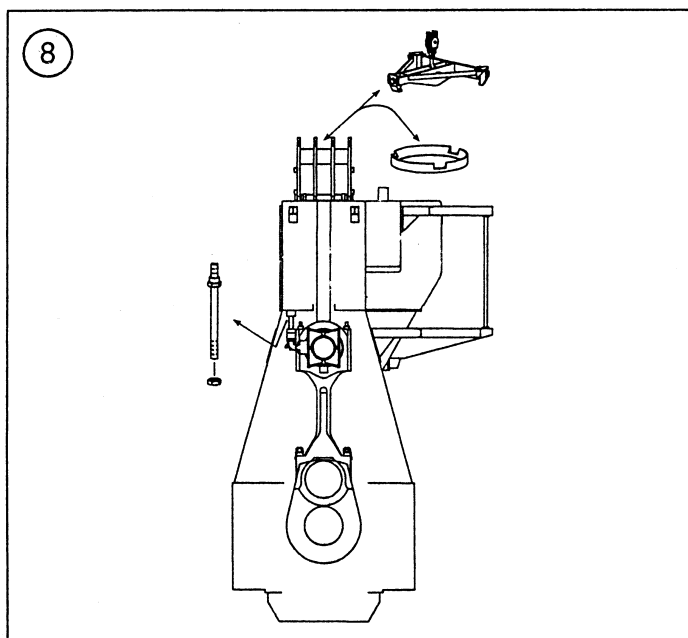
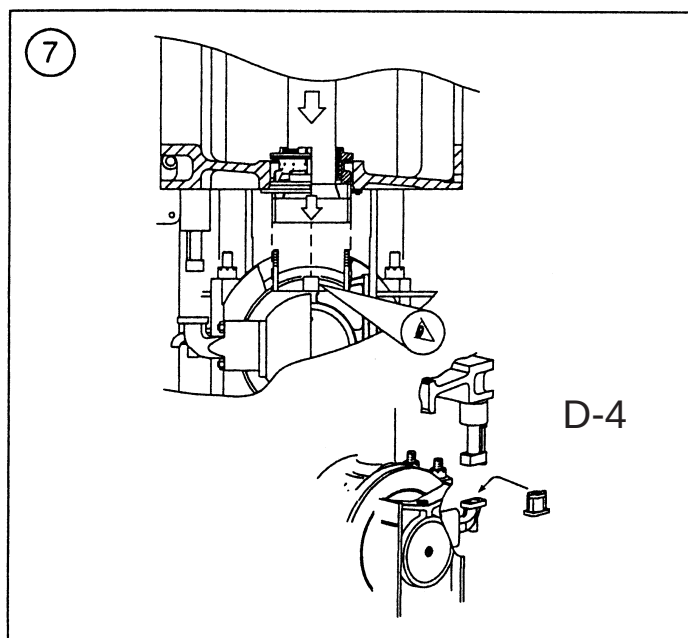
Remove the lifting tools for the telescopic pipe.

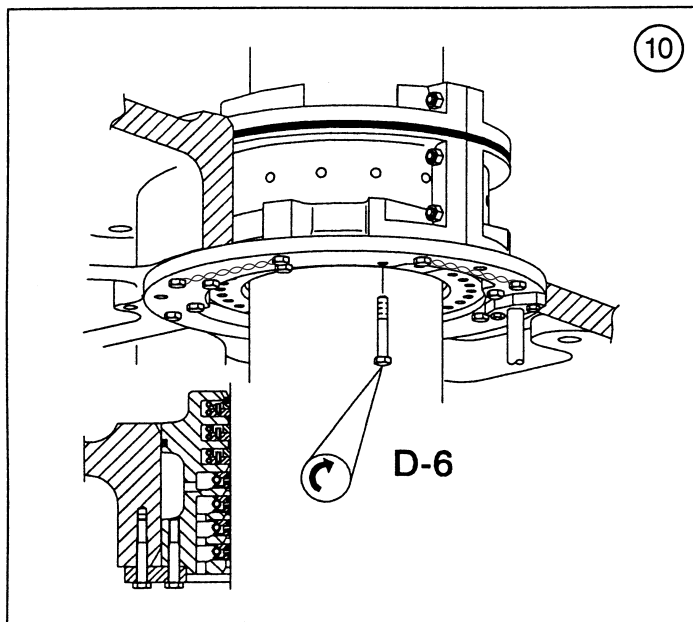
9. Turn the crosshead with the piston rod and the telescopic pipe down far enough to permit tightening the screws for the telescopic pipe.

Remove the distance pieces from the piston rod foot.

Mount and tighten the screws for the piston rod. *See Data.*

Mount the washer and nuts on the piston rod studs and tighten the nuts for the piston rod. *See Data.*





10. Tighten down the piston rod stuffing box by means of the screws through the inner holes in the stuffing box flange.

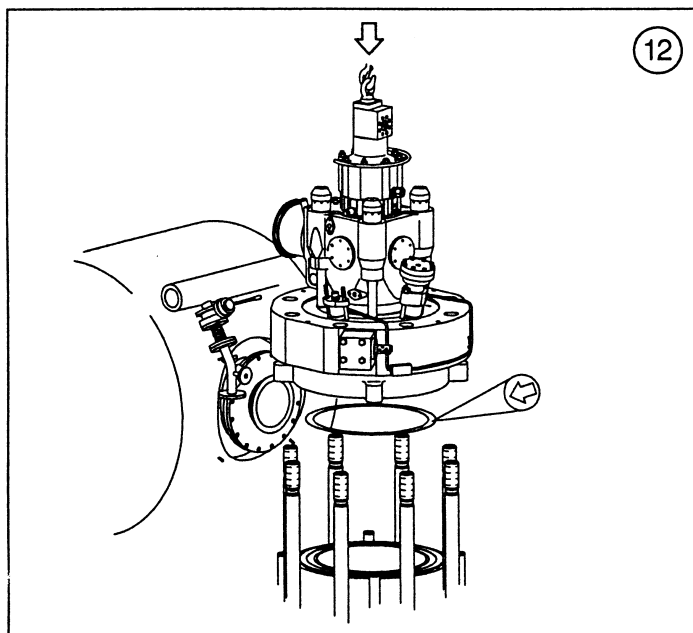
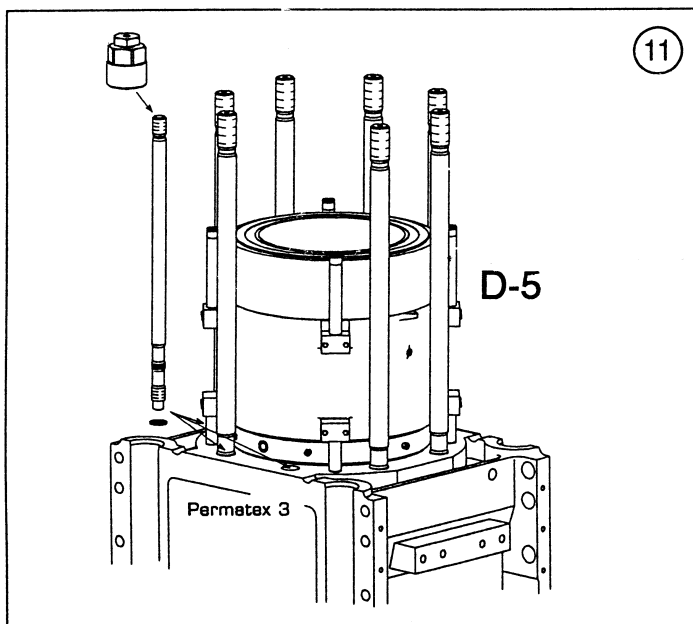
11. Mount the cylinder cover studs by means of the stud setter. See Data.

12. Smear the piston rod with molybdenum disulphide, then turn the crankshaft a couple of revolutions.

Mount the cylinder cover.
See Procedure 901-1.2.

13. Start the engine and keep it running for approx. 15 minutes at a number of revolutions corresponding to very slow.

Then stop the engine and inspect the piston rod and stuffing box.



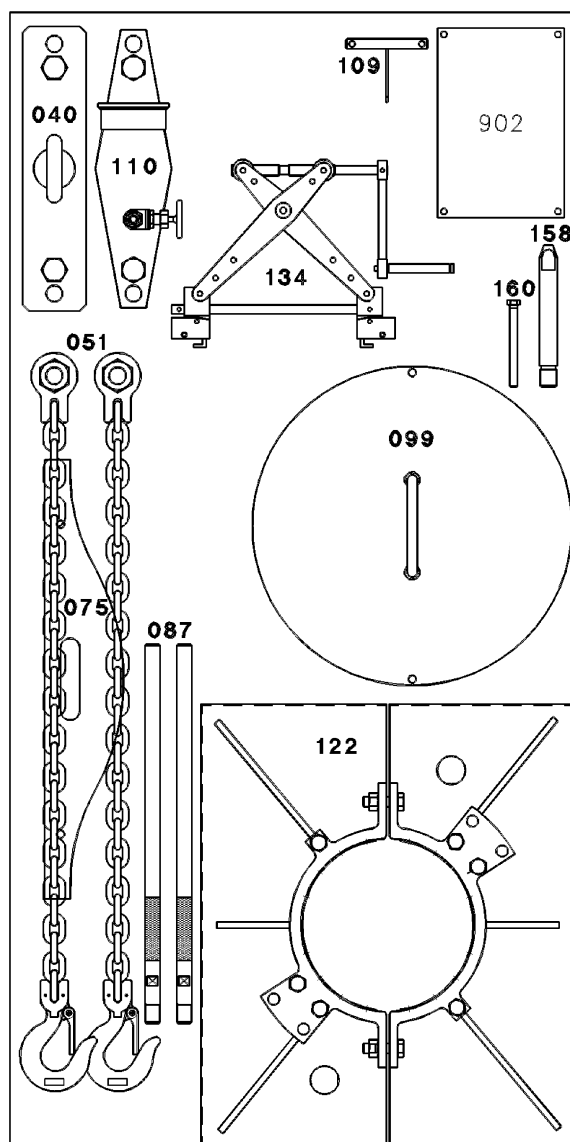
SAFETY PRECAUTIONS

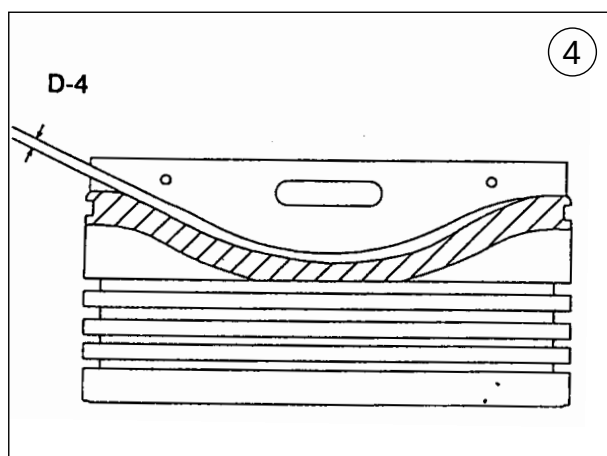
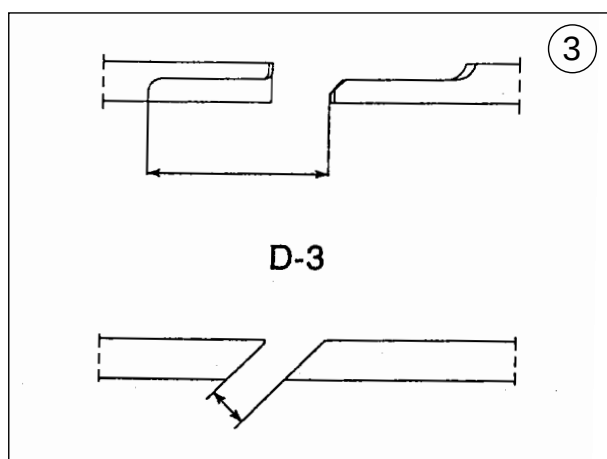
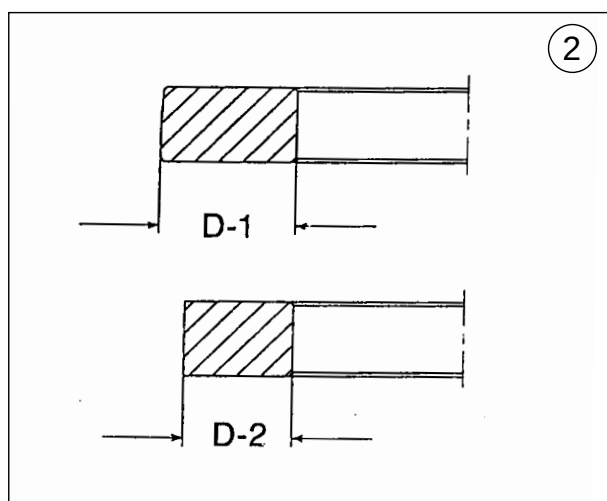
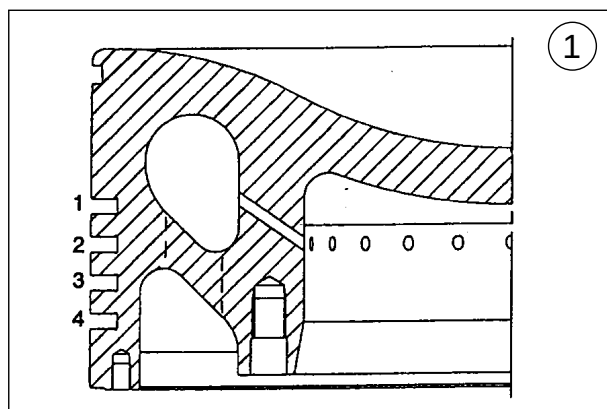
- ☐ Stopped engine
- ☐ Block the starting mechanism
- ☐ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

Standard tools: see Section 913

1. Check whether the piston rings are sticking or broken. If so, see *Volume I, OPERATION, Chapter 707*.
2. Take off the piston rings by means of the ring expander and measure the radial width D-2.
3. Measure the piston ring gap D-3. Insert the piston ring either in a new cylinder liner or in the bottom of a used cylinder liner during the measuring.
4. Clean the piston crown and check the burn-away by means of the template indicating the maximum permissible burn-away, see D-4.

Check the burn-away on the whole circumference of the piston crown.
5. Clean the ring grooves and check these for burnings or other deformation. Measure the ring grooves by means of a dial gauge or a caliper gauge. See D-5. Also see *Volume I, OPERATION, Chapter 707*.
6. Fit the piston rings (alternately right-hand and left-hand cuts with the ring gaps staggered 180° and with the "TOP" mark upwards) by means of the ring expander. The ring expander prevents unintended deformation of the rings.





1.

	Nominal height
Ring grooves Nos. 1 and 2	16 mm
Ring grooves Nos. 3 and 4	12 mm
Piston ring Nos. 1 and 2	16 mm
Piston ring Nos. 3 and 4	12 mm

2. Worn rings must be replaced if the radial width D-2 is less than 20 mm.
New piston ring D-1 = 23.3 mm.
Worn piston ring D-2 = 20 mm.

3. Effect the ring gap checking in either a new cylinder liner or at bottom of a used liner.
Working ring gap D-3 = 3.4 mm.
(ring No. 2, 3, 4)

Working ring gap for Controlled Pressure Relief(CPR) ring (ring No. 1) D-3 = 4.8 mm

4. Maximum permissible burn-away of piston top D-4 = 18 mm.



Clearance in piston ring grooves:

- The maximum vertical height in a worn ring groove **must not** exceed D-5:

Groove Nos. 1 = 16.9 mm

Groove Nos. 2,3 and 4 = 12.9 mm

The groove is also worn out if there is no chromium layer.

If the maximum vertical height is exceeded, the piston crown must be sent to an MAN B&W authorized repair shop for reconditioning.

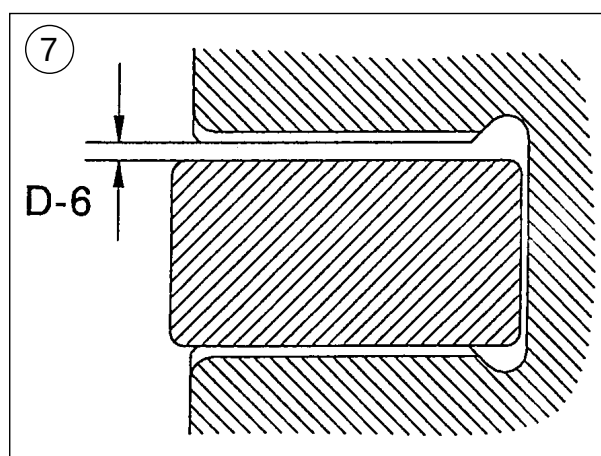
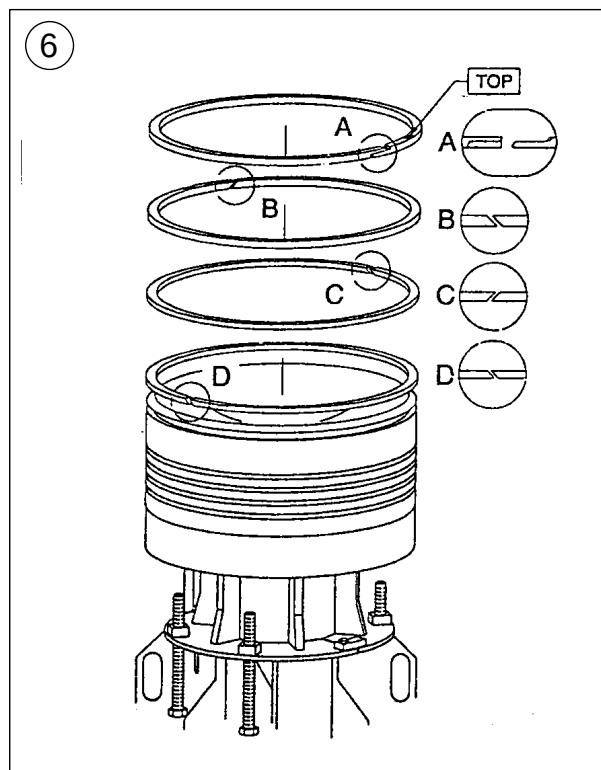
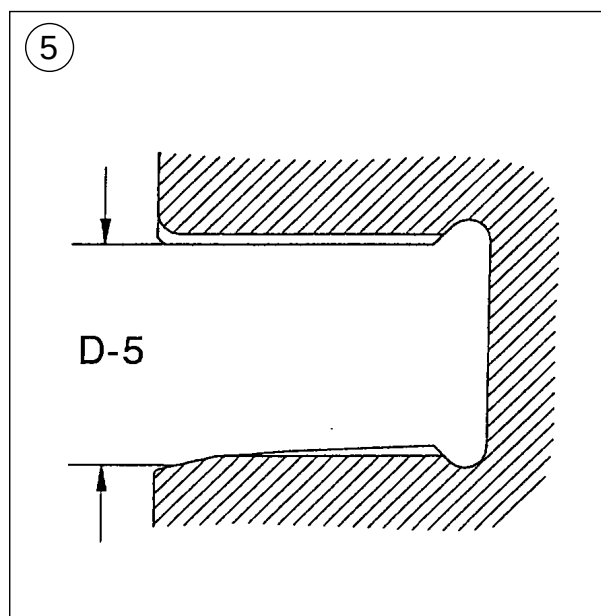
- Mount of piston rings.
See also procedure 902-2.

Note !

When handling and mounting a new Controlled Pressure Relief (CPR) ring (ring No. 1), be careful not to damage the edge of the ring.

- Vertical clearance, new piston ring and new or reconditioned ring groove :

D-6 = 0.4-0.45 mm.



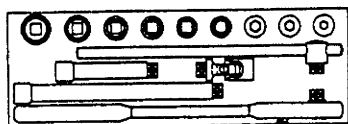
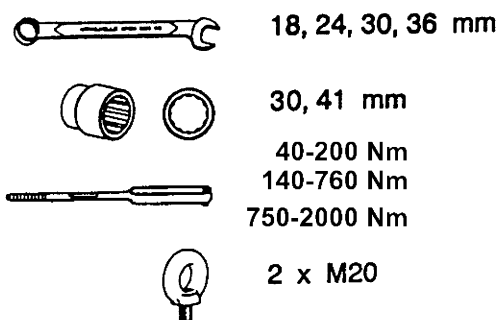
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SAFETY PRECAUTIONS

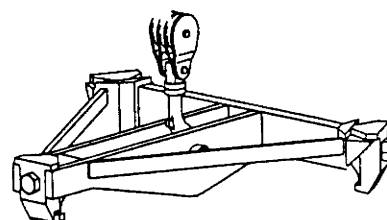
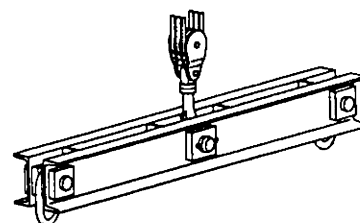
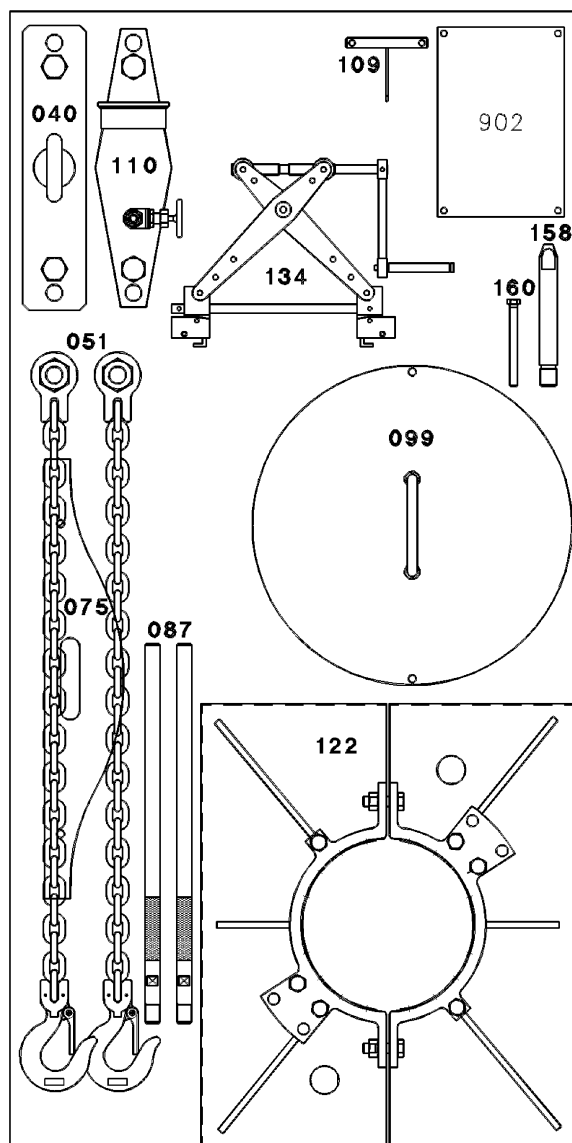
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☒ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

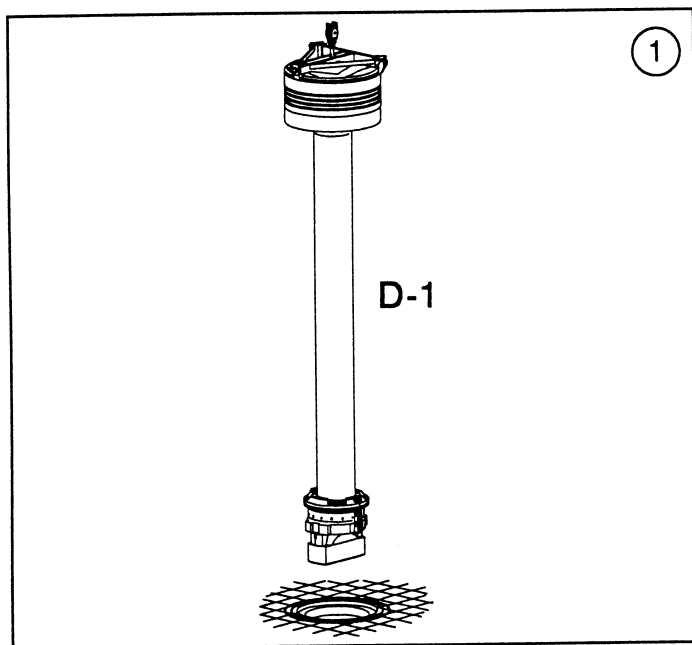
913



DATA:

D-1	Piston complete..	L70MC: 2175 kg S70MC: 2325 kg
D-2	Piston crown.....	565 kg
D-3	Piston skirt.....	124 kg
D-4	Pipe for piston cooling.....	45 Kg
D-5	Tightening torque - piston skirt.....	190 Nm
D-6	Tightening torque - piston crown/rod.....	800 Nm
D-7	Tightening torque - cooling pipe.....	190 Nm
D-8	Test pressure.....	7 bar





1. Position the O-rings on the floor over the hole for the support.

2. Ease the piston down so that the stuffing box is below the floor.

Lift the O-rings and mount the support.
Position the O-rings on the support.

3. Dismount the screws in the skirt – if the skirt will not budge, free it by means of two dismantling screws.

4. Now screw the four screws in the support down until the skirt rests on the support.

Dismount the old sealing rings.

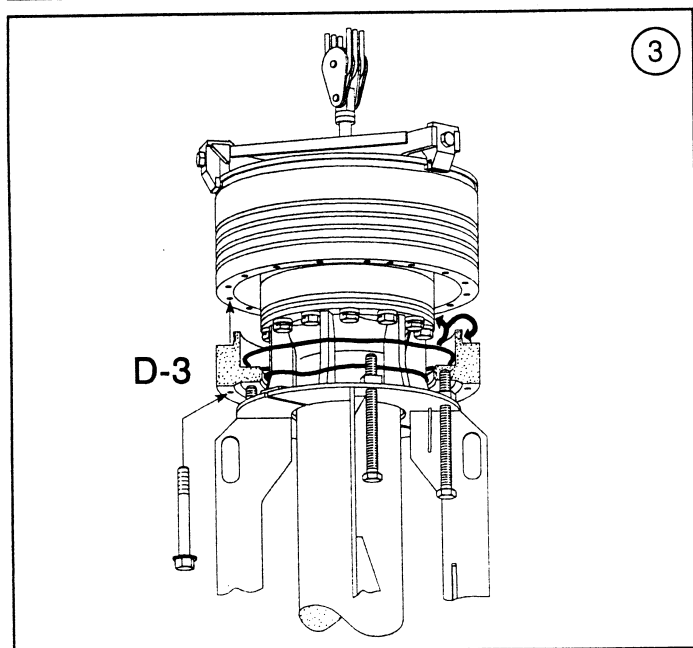
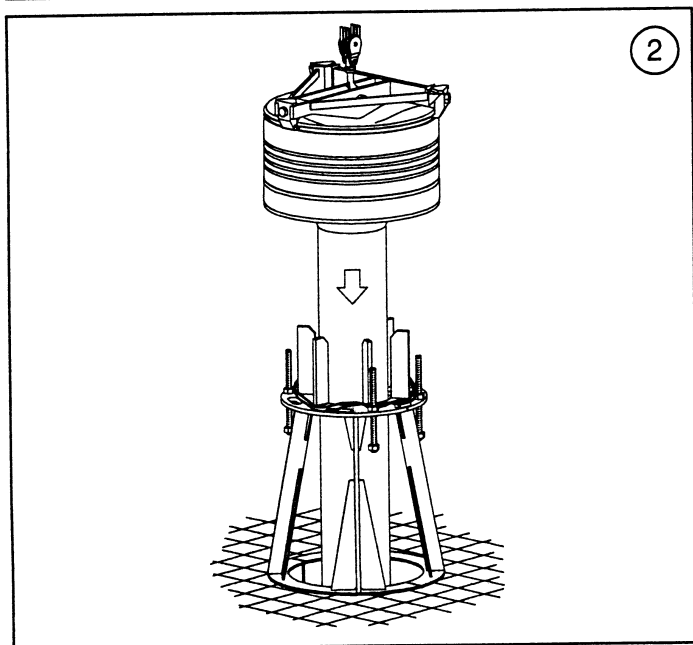
Pull the new rings into position and coat with a little lubricating oil.

5. Mount in the reverse order – lift the skirt up by means of the four screws on the support.

Coat the screws with a mixture of oil and graphite.

Screw to the torque stated on the data sheet.

6. Pressure-test the piston.
See Procedure 902-4.3.



1. Mount the lifting tool on the piston.

Dismount the locking wire and the innermost screws between the rod and the piston crown.

Lift the piston crown away – if difficult to budge, free it by means of the four screws on the support.

2. Dismount the locking wire the cooling oil pipe flange screws.

Mount the lifting tool and lift out the cooling oil pipe.

3. Mount in the reverse order.

4. See the data sheet for the torque required to tighten the cooling oil pipe.

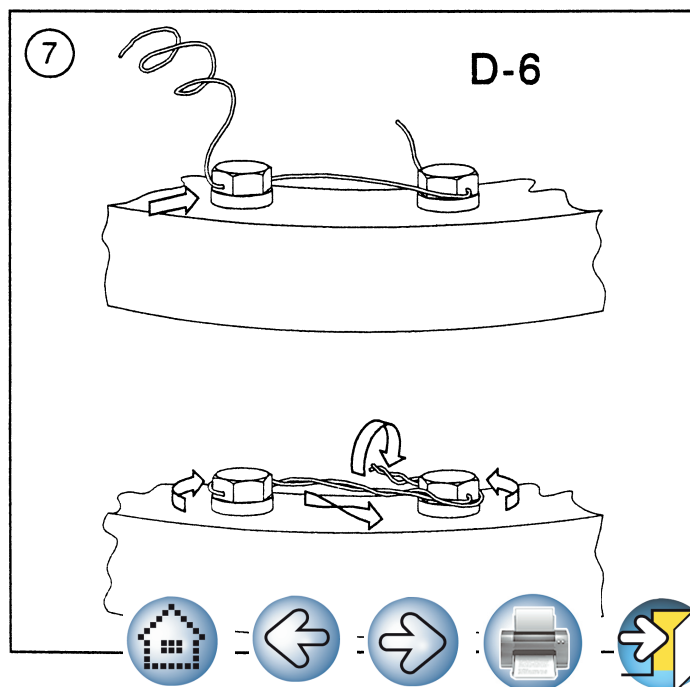
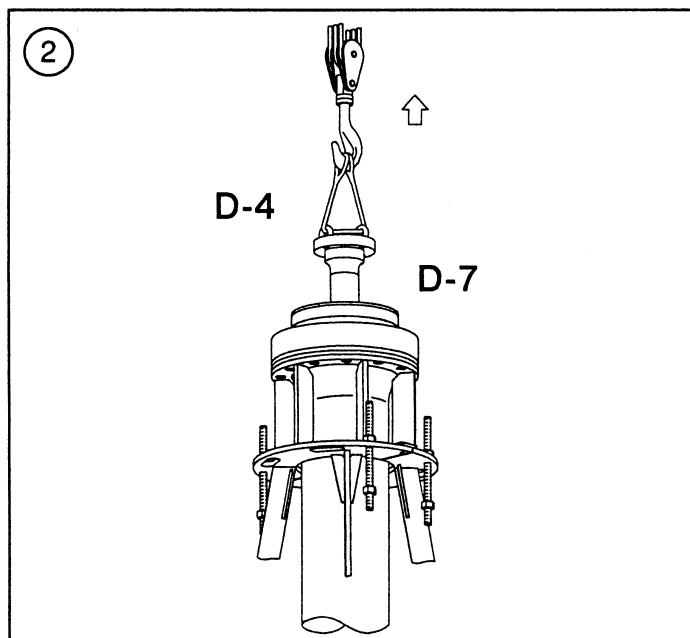
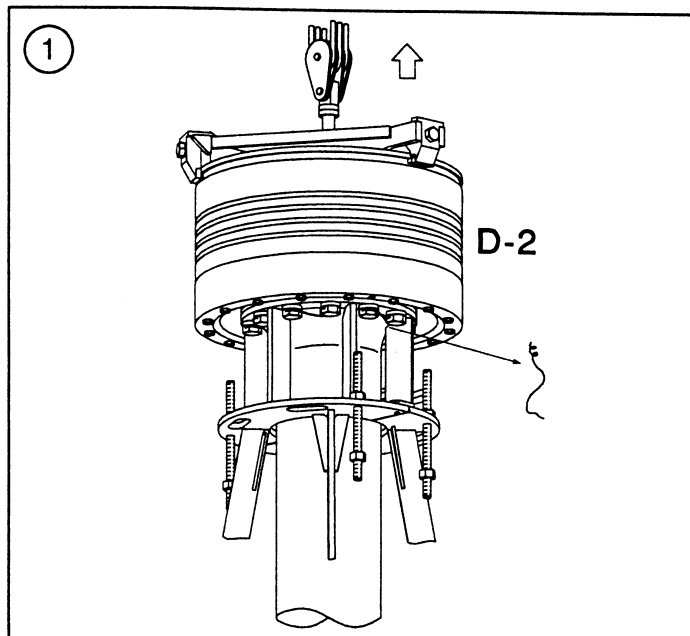
5. Before mounting the piston crown, provide the piston rod with a new sealing ring coated with a little lubricating oil.

6. Coat the screws with a mixture of oil and graphite.

Screw to the torque stated in Data.

7. The locking wire is to be mounted in such a way that the wire is tightened if one of the screws works loose. *See Procedure 913-7.2.*

8. Pressure-test the piston. *See Procedure 902-4.3.*



1. Remove the screws in the skirt and mount two eye screws in the holes intended for dismounting screws. The skirt can now be lifted up and landed on a couple of planks.

The piston crown can now be cleaned internally or replaced by a new one.

Before assembling the piston crown and piston rod, mount the guide screw in the crown.

2. Mounting is carried out in the reverse order – however, before mounting, insert new sealing rings coated with a little lubricating oil.

The locking wire is to be mounted in such a way that the wire is tightened if one of the screws works loose.
See Procedure 913-7.

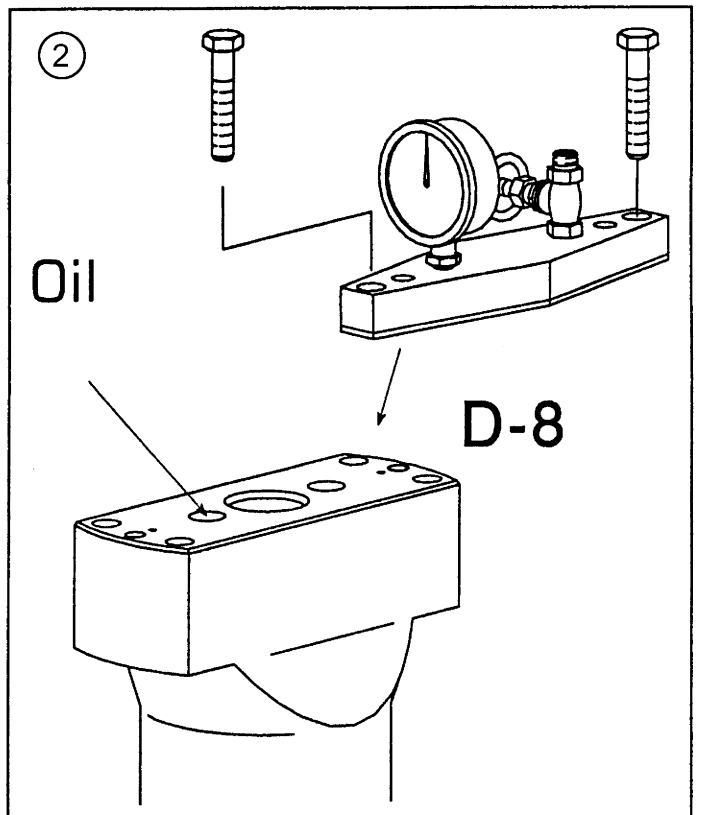
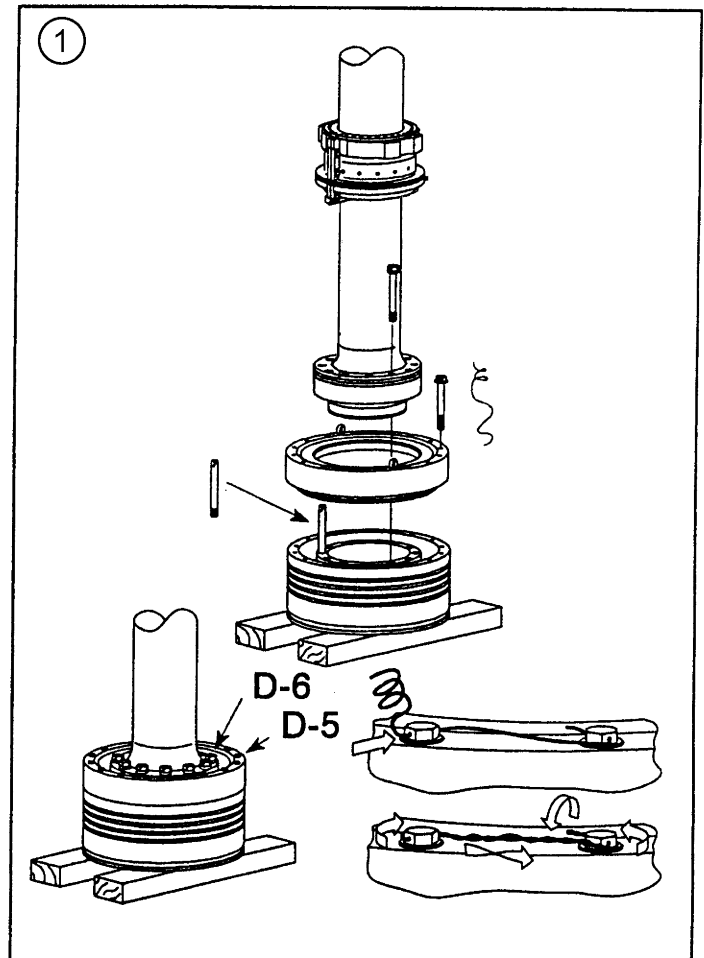
3. Fill the piston and piston rod with lubricating oil.

Mount the pressure-testing tool on the base of the piston rod.

Pressure-test the piston with the pressure stated on the data sheet.

Check the contact surfaces of the piston and the sealing rings for tightness.

Check the piston crown for possible cracks.



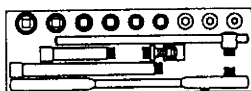
Safety Precautions

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

Standard tools: see Section 913

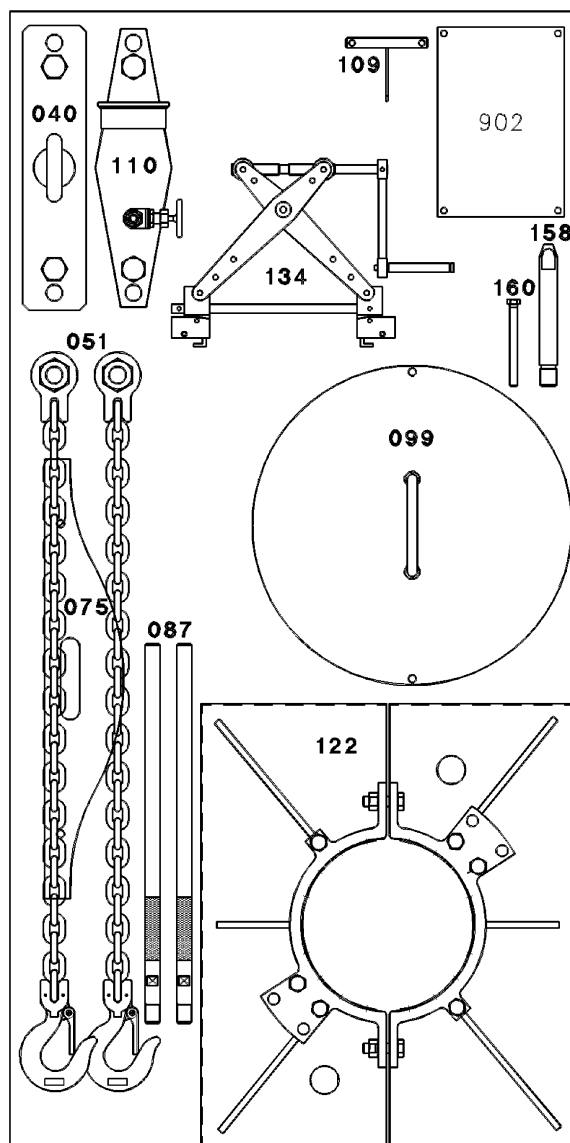


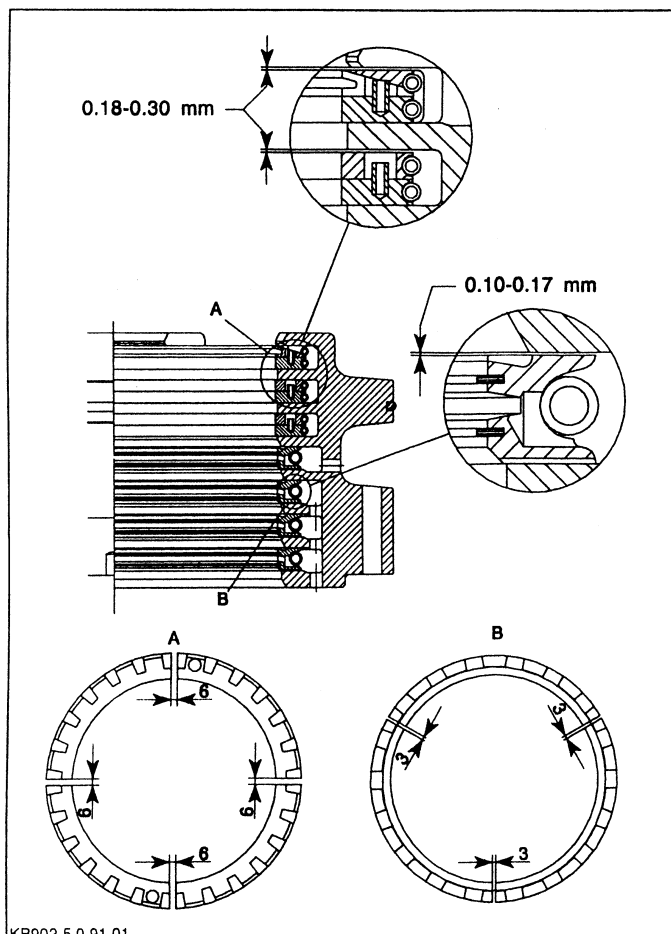
2 x M16



DATA:

D-1	Stuffing box complete.....	160 kg
D-2	Stuffing box half.....	55 kg
D-3	Stuffing box flange.....	30 kg
D-4	Tightening torque – stuffing box halves.....	80 Nm
D-5	Tightening torque – inner and outer screws.....	200 Nm

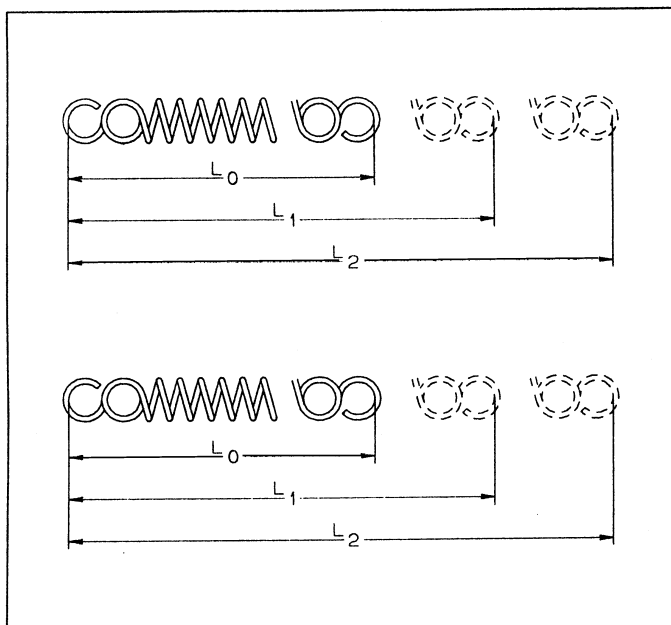




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The ring-end clearances stated apply to new rings.

As a general guide, it is recommended – depending on the overhauling intervals and own experience – to replace sealing rings and scraper rings when the above clearance values have changed by more than 50%.



Spring for uppermost scraper ring/sealing ring and springs for sealing rings (protecting rings/sealing rings)

L_0	0 N..Check length	761 mm
L_1	134 ± 7 N..Check length	1018 mm
L_2	163 ± 10 N..Check length	1075 mm

Springs for scraper rings

L_0	0 N..Check length	719 mm
L_1	160 ± 7 N..Check length	965 mm
L_2	220 ± 10 N..Check length	1058 mm



1. Normally, overhaul of the piston rod stuffing box is carried out by routine methods in connection with the dismantling (pulling) of the pistons.

During such overhauls the piston rests on a support placed over one of the cut-outs in the top platform.

The work on the stuffing box is then carried out from the platform below.

Dismantling

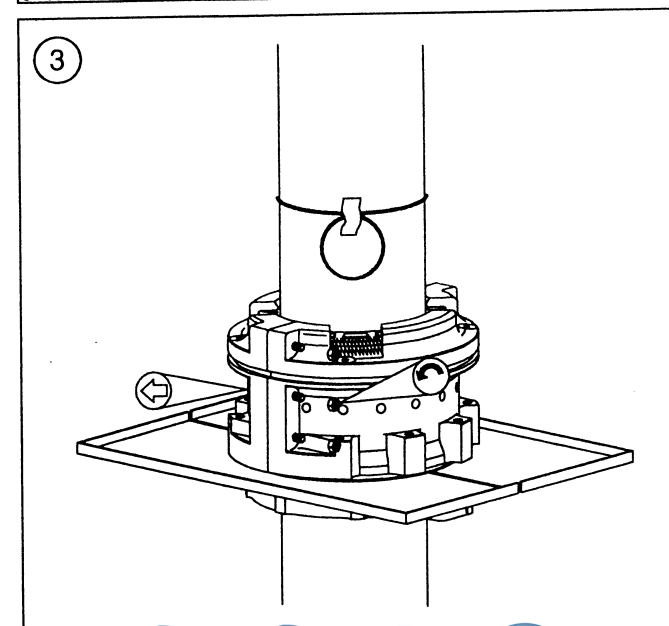
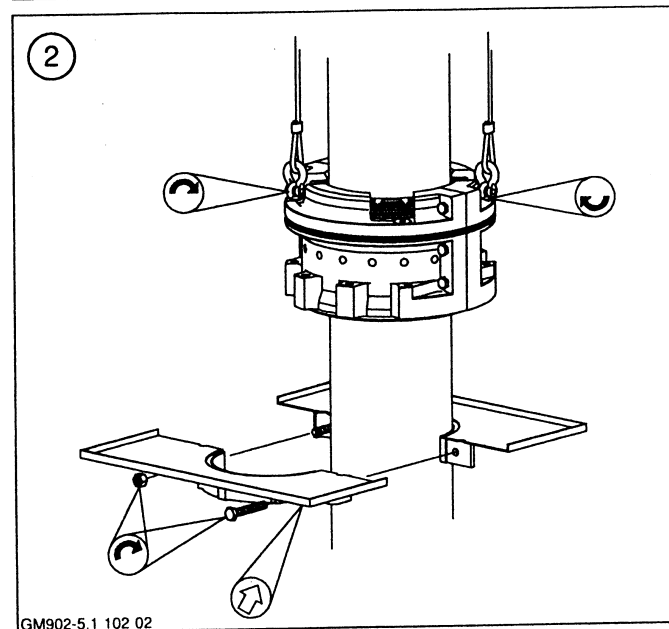
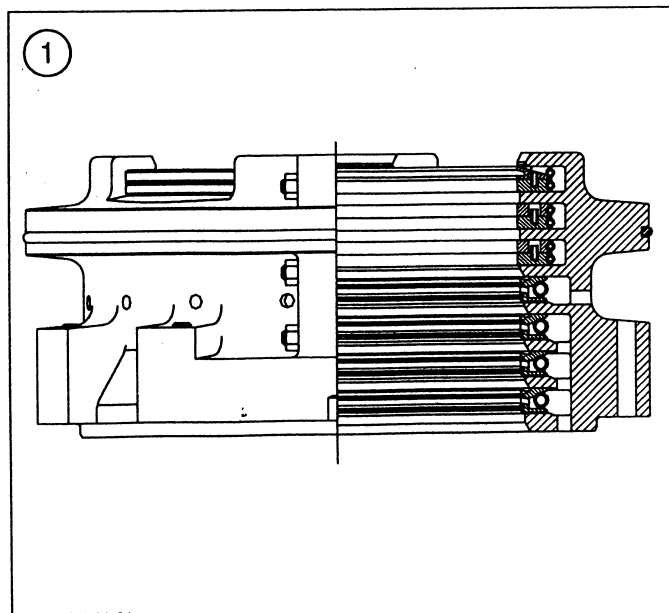
2. Mount two eye bolts in the stuffing box flange for lifting the stuffing box, and hook on two tackles.

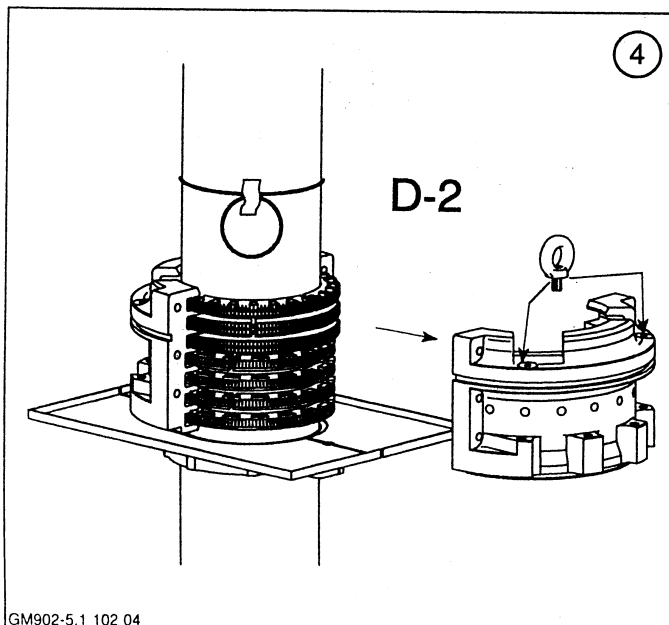
Lift the stuffing box a little up the piston rod, and mount the worktable round the piston rod at a suitable working height. *See Data D-1.*

Land the stuffing box on the worktable, and remove tackles and eye bolts.

3. Remove the O-ring of the stuffing box. If the O-ring is intact and is to be used again, move it up the piston rod and fasten it, for example, with tape.

Remove and discard the self-locking nuts from the fitted bolts of the stuffing box.





4. Take out the bolts, and pull the stuffing box halves apart.

Mount two eye bolts on one of the stuffing box halves and remove it from the worktable. *See Data D-2.*

5. Measure the clearance between the ring segments (*to judge whether replacement is necessary, see Data*).

Press all sealing rings and scraper rings down against the worktable.

Dismantle and stack the rings in the same order as when fitted in the stuffing box.

Clean all the ring segments carefully.

Inspect and judge the surface quality of the sealing rings. If the sliding surfaces have scratches or marks, replace the rings.

6. Carry out check calibration of the springs (*see Data*).
7. Inspect the surface of the piston rod.

If small longitudinal scratches have occurred (caused by poorly adapted stuffing box rings), smooth the piston rod surface carefully with a fine grained carborundum stone. In the case of coarse scratches, it may prove necessary to carry out machine grinding in a workshop.

8. Clean the halves of the stuffing box housing.



Mounting

9. Lubricate the piston rod (the area where all the ring units in the stuffing box will be positioned) with molybdenum disulphide (MoS_2).

Assemble all ring units round the piston rod, on the worktable, in the following way:

Place the lowermost scraper ring segments on the worktable, place the spring round the segments and, by means of the two hooks, assemble the spring ends.

Repeat this procedure for the remaining scraper rings.

On top of the scraper rings, assemble the two sealing ring units (each consisting of a 4-part and an 8-part ring).

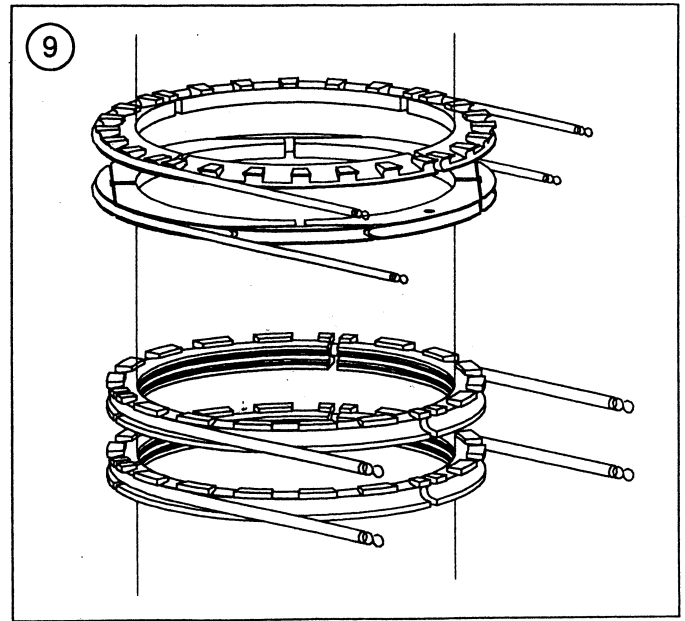
Assemble the 8-part sealing ring so that the two guide pins face upwards.

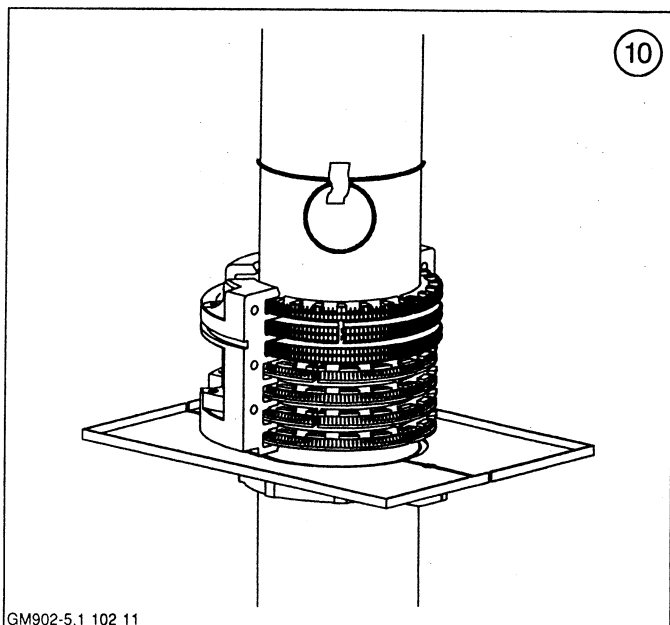
Place the spring round the segments and hook the spring ends together.

Assemble the 4-part sealing ring above the 8-part sealing ring.

Push the two rings together in such a manner that the guide pins in the lower sealing ring engage with the two holes in the upper sealing ring.

Finally, assemble the uppermost ring unit (consisting of a 4-part scraper ring and an 8-part sealing ring).





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10. Use the stuffing box half on the worktable to adjust the height of all the assembled ring units on the piston rod until the ring units are opposite the corresponding grooves of the stuffing box housing. Subsequently, push the stuffing box half into contact with the piston rod, round the ring units.

Measure the clearance between the rings and the corresponding groove of the stuffing box housing, *see Data*.

11. Place the other half of the stuffing box housing on the worktable, pushing it into place round the rings.

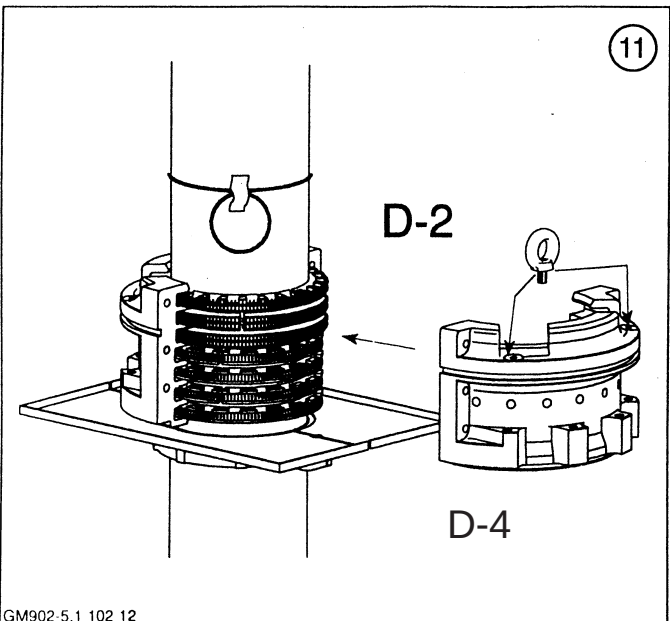
Mount the fitted bolts and new self-locking nuts and tighten up the bolts. *See Data D-4*.

Insert the O-ring in the groove of the stuffing box.

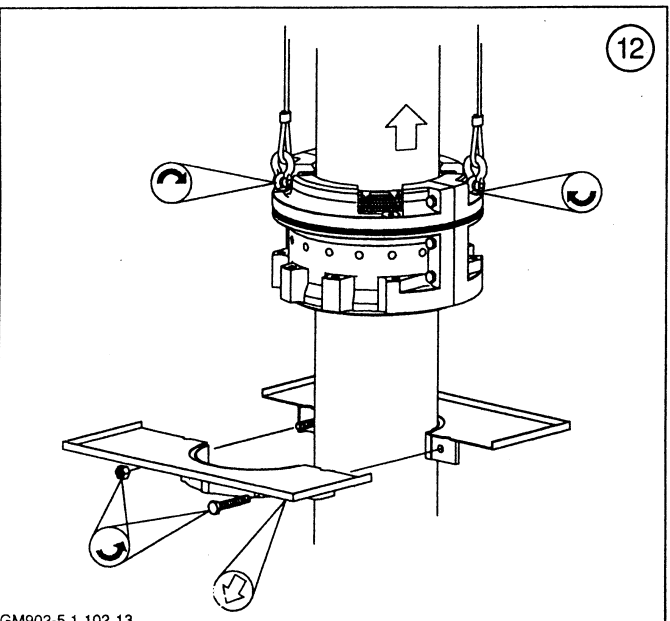
12. Mount eye bolts and tackles and lift the stuffing box a little.

Remove the worktable and lower the stuffing box until it rests against the distance piece on the piston rod foot.

Remove the tackles and eye bolts.



GM902-5.1 102 12



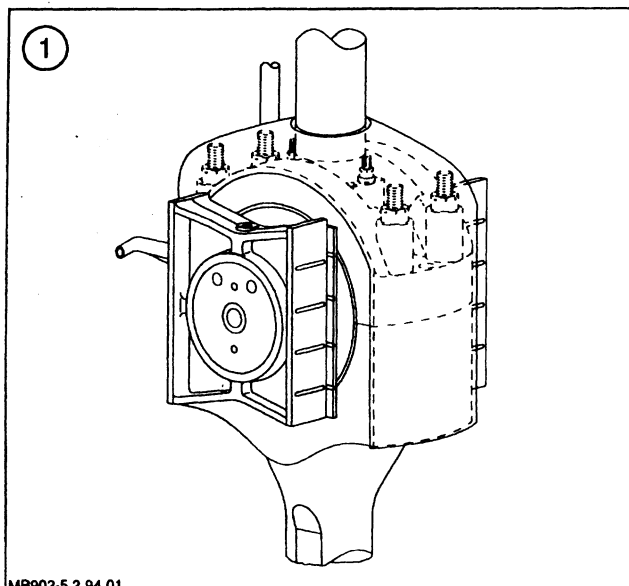
GM902-5.1 102 13

If, in the period between piston overhauls, it becomes necessary to inspect the piston rod stuffing box, this can be done according to the following procedure:

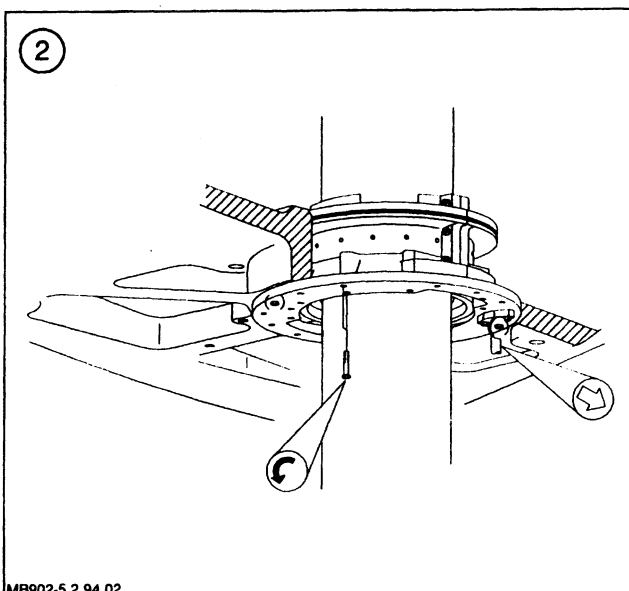
1. Turn the crosshead to about 90° from TDC.

Mount the rubber cover around the piston rod for protecting the crosshead bearing against impurities.

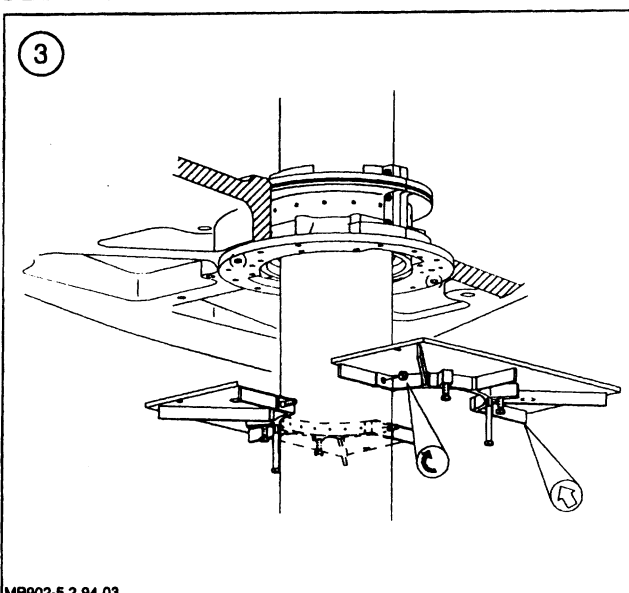
2. Remove the drain oil pipe and all inner-most screws and all outer screws with locking wire except two screws placed diametrically opposite in the flange of the stuffing box, longitudinally to the engine.
3. Mount the worktable round the piston rod so that the two remaining screws in the flange of the stuffing box can be loosened through the holes in the worktable.



MB902-5.2 94 01

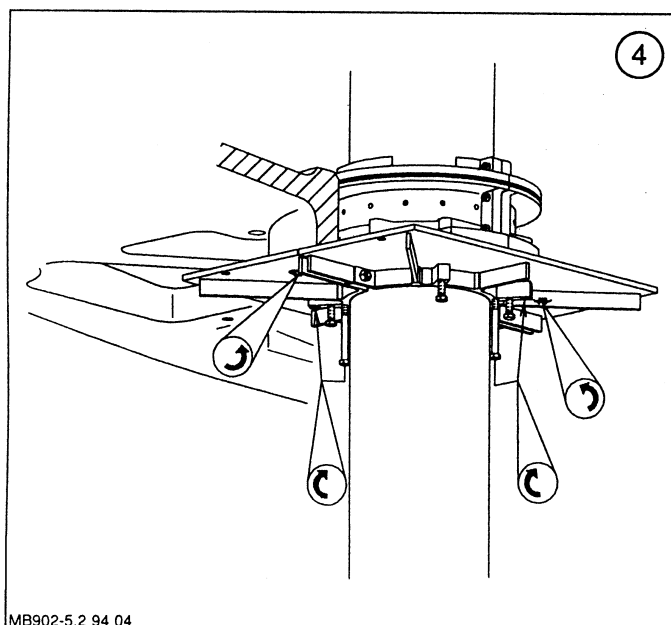


MB902-5.2 94 02



MB902-5.2 94 03





- Remove the two long screws from the worktable.

Mount them in the stuffing box through the holes in the worktable.

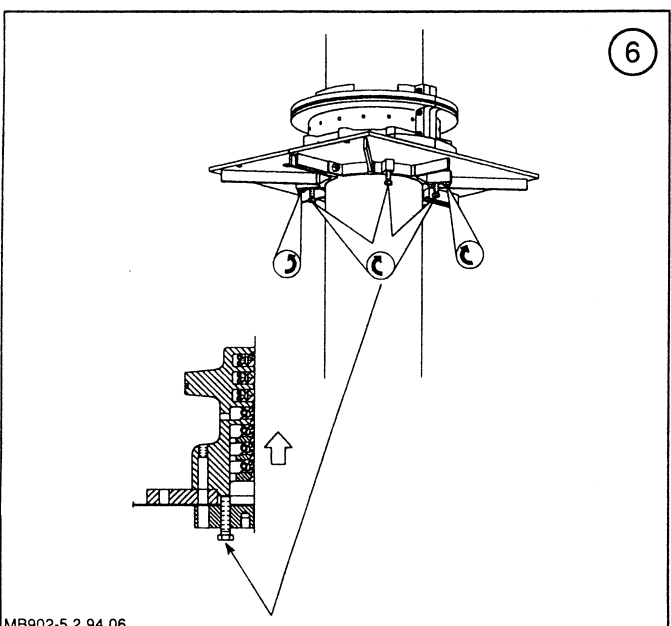
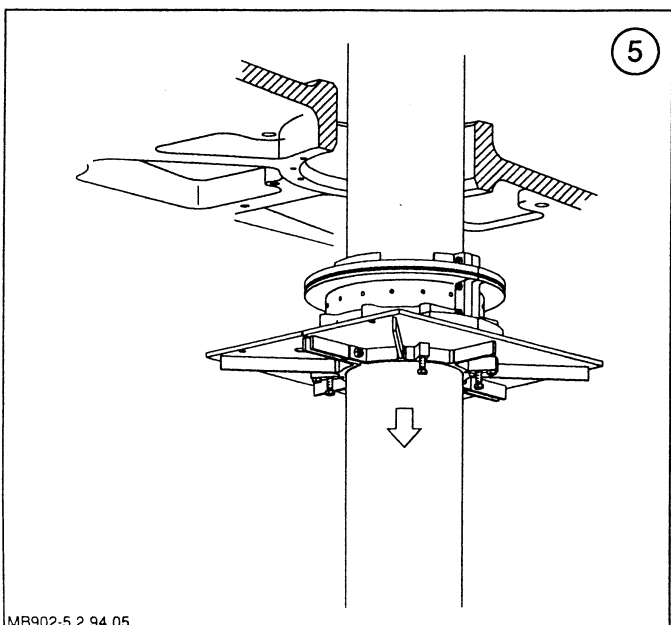
Remove the remaining two screws from the stuffing box.

- Turn the piston to BDC, thereby withdrawing the stuffing box from the cylinder frame bottom.

Remove the two long dismantling screws from the stuffing box and mount them in the worktable.

- By means of the four short screws in the worktable, press the stuffing box out of the flange.

For overhauling the stuffing box, see *Procedure 902-5.1*



7. After overhauling, assemble the stuffing box halves on top of the four screws.

Mount the two long screws from the worktable in the stuffing box.

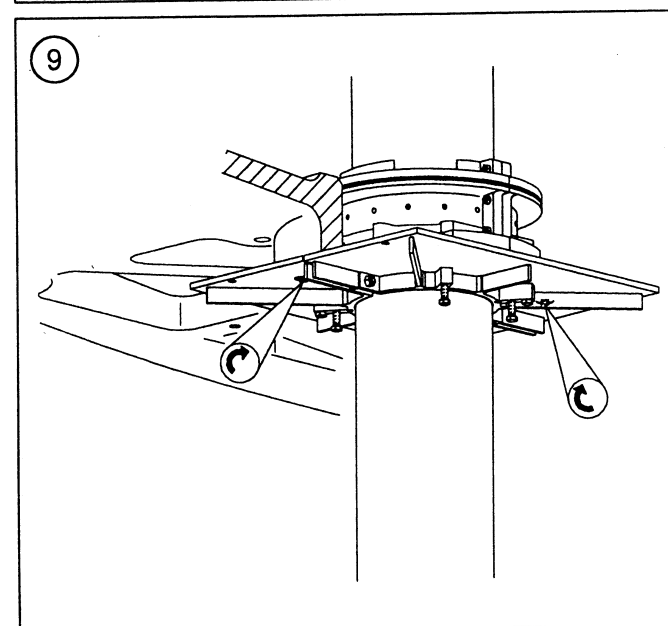
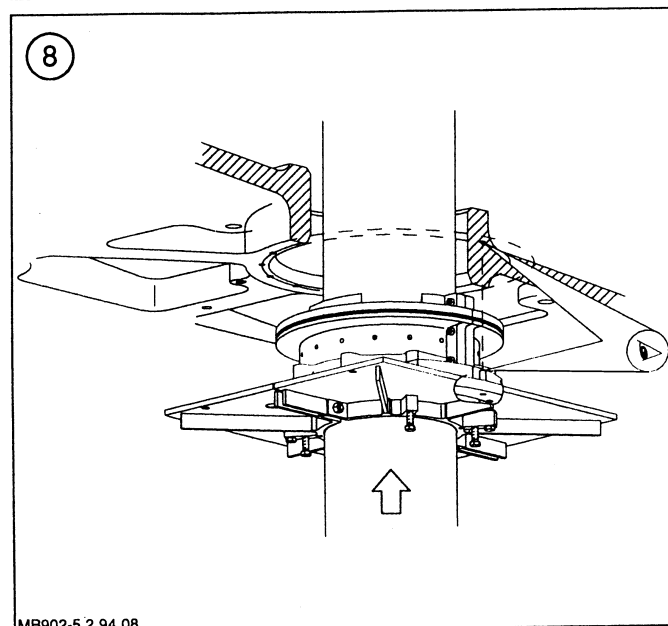
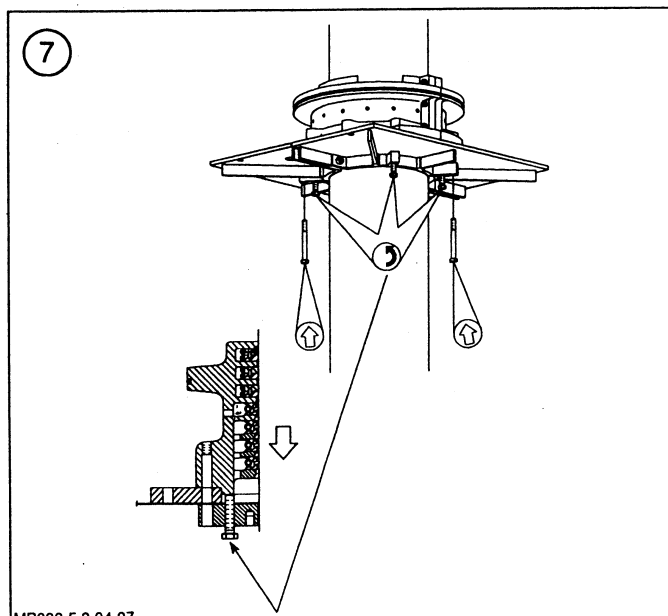
Turn down the short screws so that the stuffing box lands on the flange.

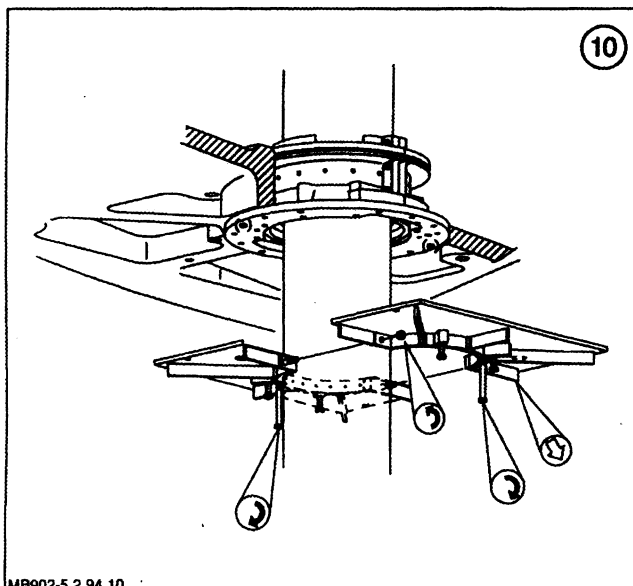
8. Turn the piston upwards until the stuffing box is in place in the cylinder frame.

Note!

Make sure that the two guide pins in the flange enter the guide holes in the bottom of the cylinder frame.

9. Mount two screws in the flange through the holes in the worktable.





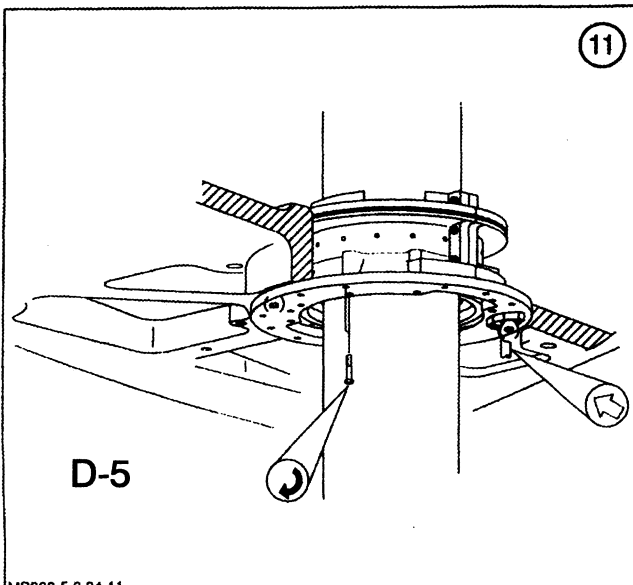
MB902-5.2 94 10

10. Remove the long screws from the stuffing box and mount them in the worktable.

Remove the worktable from the piston rod.

11. Mount and tighten all the inner and outer screws with locking wire for the stuffing box.
The outer screws to be locked with locking wire
See Data D-5

Mount the drain oil pipe.



MB902-5.2 94 11

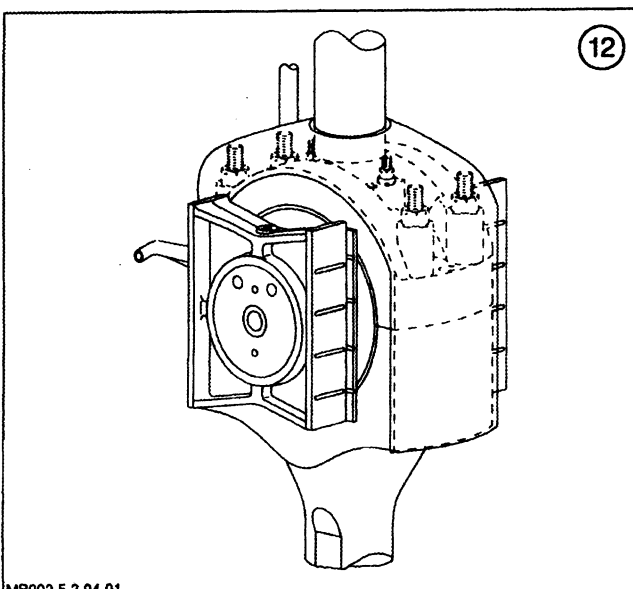
12. Remove the protecting rubber cover from the piston rod/crosshead.

Smear the piston rod with molybdenum disulphide.

Then turn the crankshaft a couple of revolutions.

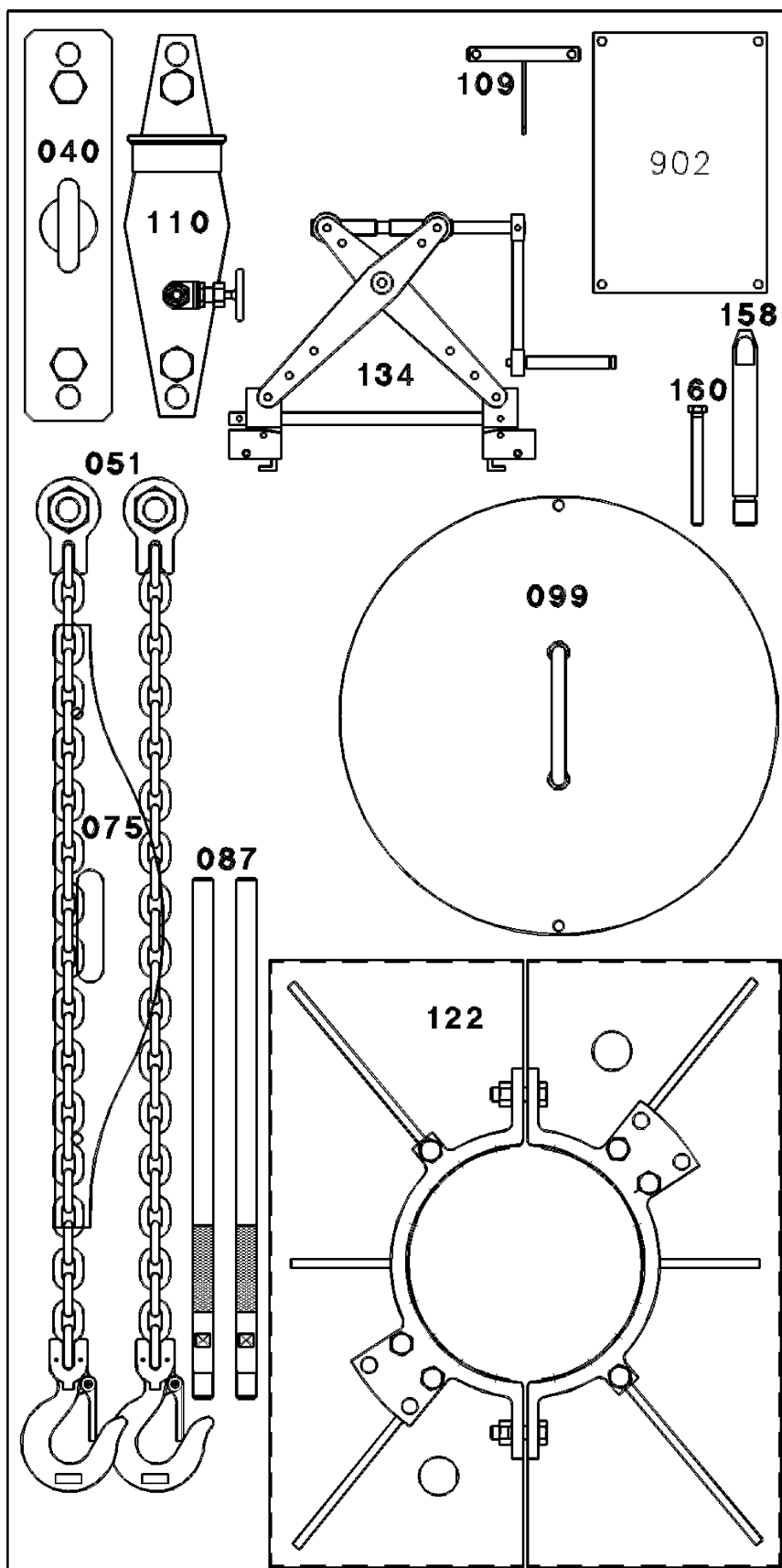
Start up the engine and keep it running for approx. fifteen minutes at a number of revolutions corresponding to very slow or idle speed.

Then stop the engine and inspect the piston rod and stuffing box.



MB902-5.2 94 01

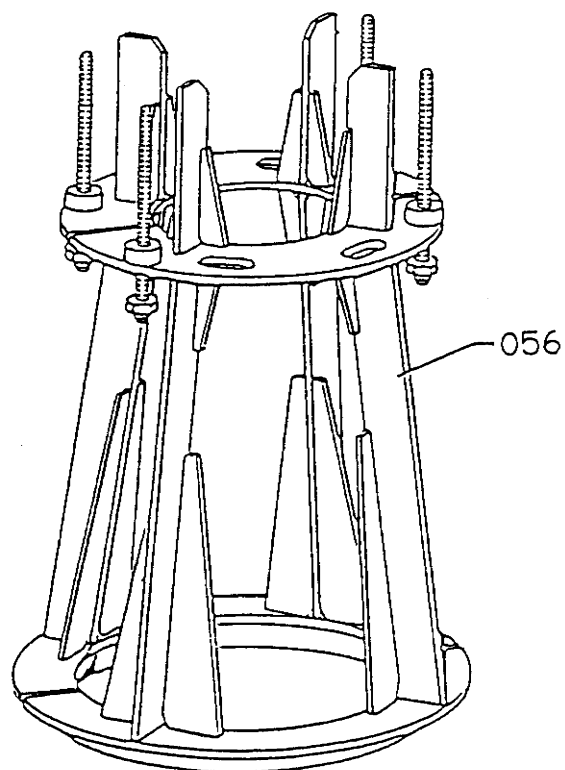
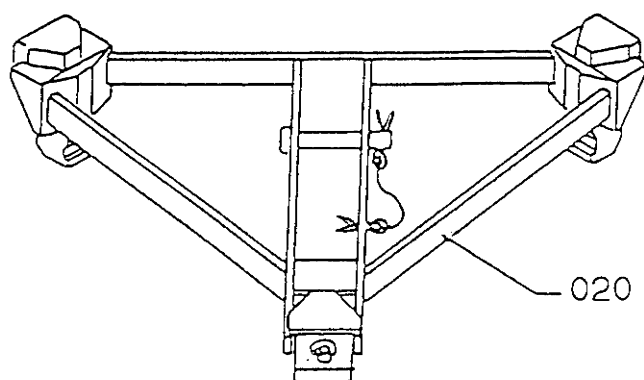
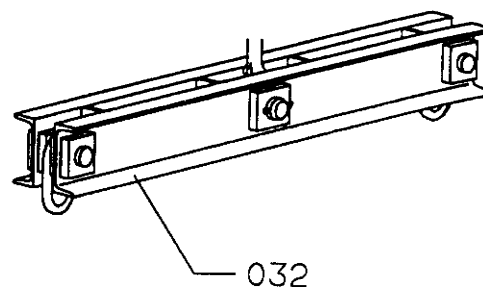
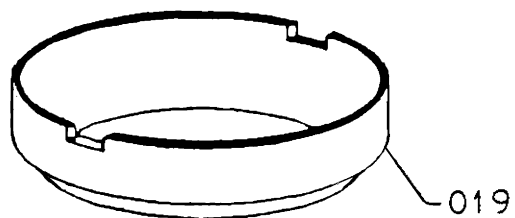




Item No.	Part Description
902	*) Tool panel
040	Lifting for piston rod foot
051	Lifting and tilting screw
075	Template for piston top
087	Distance piece for stuffing box
099	Cover for stuffing box hole
109	Mounting tool for stuffing box spring
110	Pressure test tool for piston
122	Working table for stuffing box
134	Expander for piston ring
158	Guide screw for piston crown
160	Hex. bolt for piston skirt dism.
902	*) Tool Panel, complete
160	with tools
	*) Optional extras

Item No.	Part Description

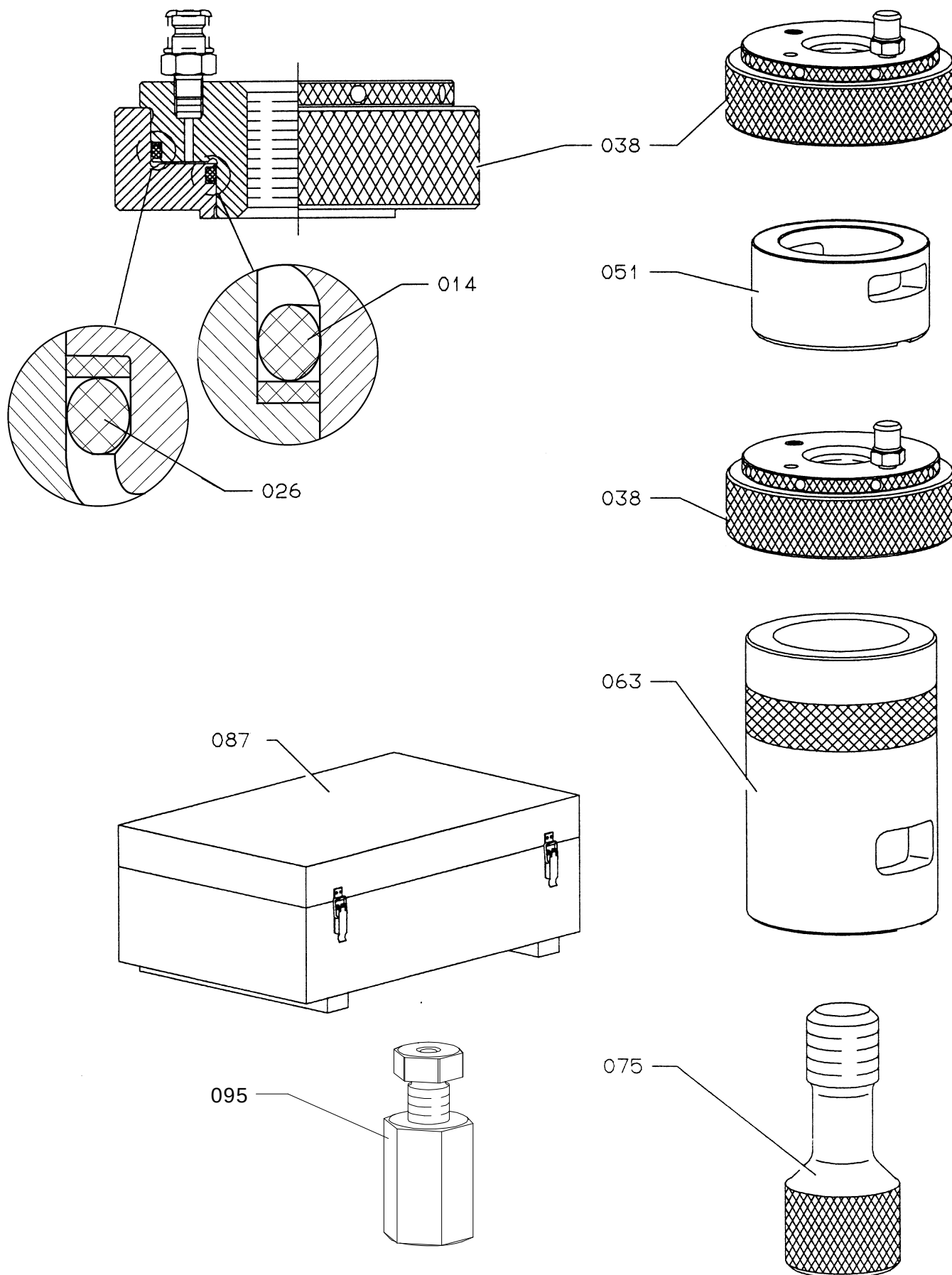




Item No.	Part Description
019	Guide ring for piston
020	Lifting tool for piston
032	Cross bar for Cyl. liner
056	Support iron for piston

Item No.	Part Description





Item No.	Part Description
014	O-ring with back-up ring,50/55 mm
026	O-ring with back-up ring, 70/75 mm
038	Hydraulic jack
051	Spacer ring
063	Spacer ring for damper studs
075	Extension stud
087	Hydraulic tools for piston rod and damper studs, complete
095	Stud setter

Item No.	Part Description



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☒ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

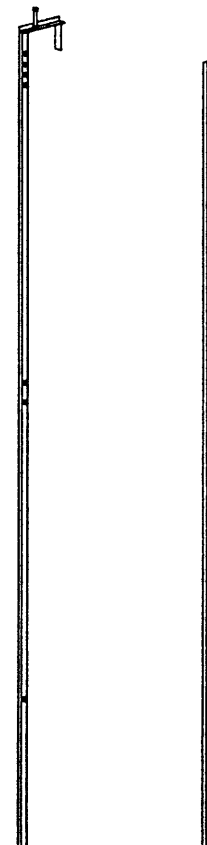
Standard tools: see Section 913

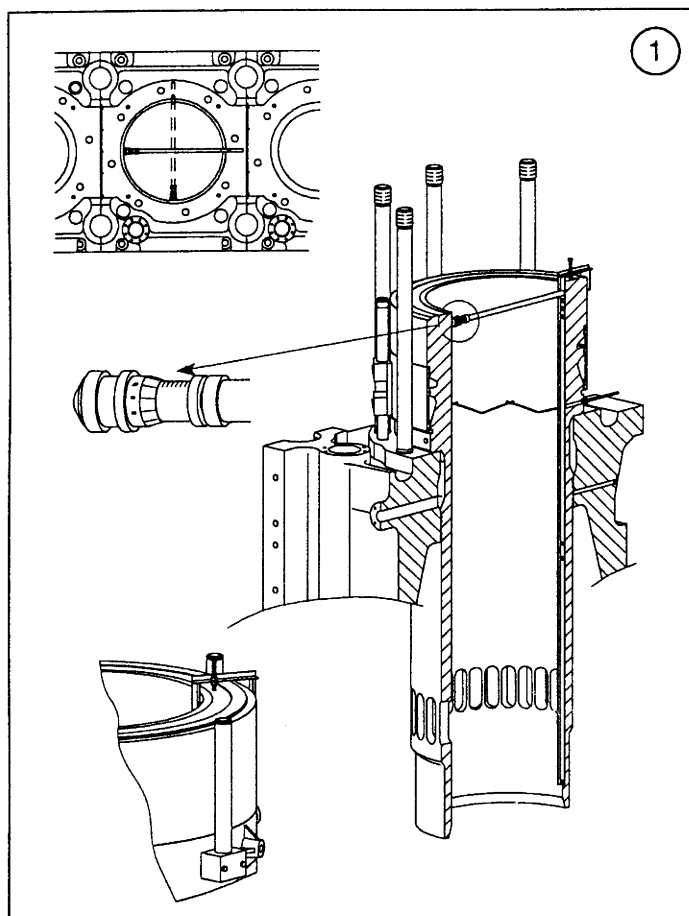
DATA:

Cylinder diameter, new..... 700 mm
+0.125

Piston cleaning ring
diameter. new 698.7 mm

The cylinder liner should be renewed if wear exceeds 0.4-0.8% of the cylinder diameter.





1. Dismount the cylinder cover and piston.
See Procedures 901-1.1 and 902-2.1.

Discard the mild steel ring and piston.
Cleaning ring between the cylinder liner and the cylinder cover.

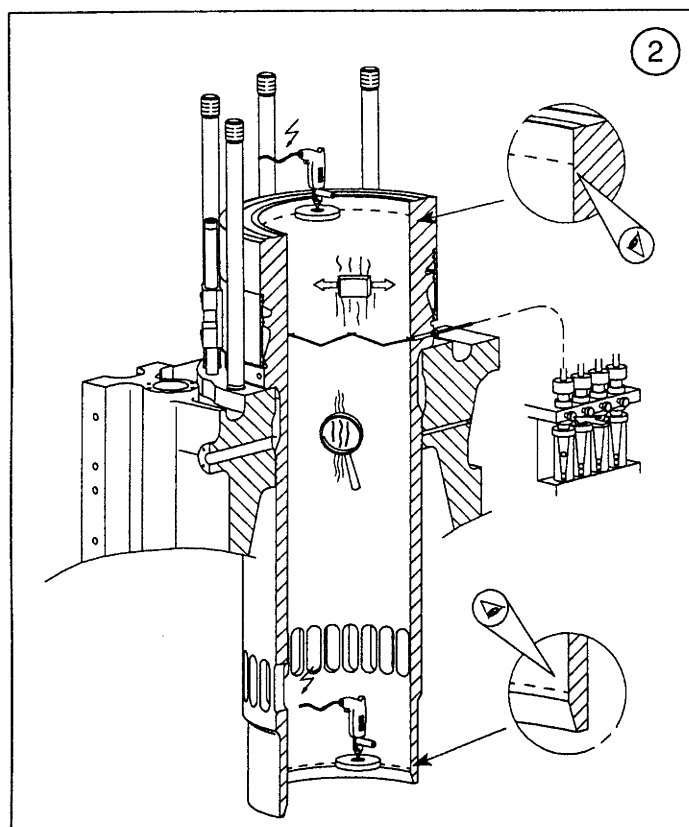
Clean the cylinder liner and scavenge air ports.

Position the cylinder liner measuring rod.
Measure the cylinder liner with an inside micrometer at the positions indicated on the measuring rod.

Take measurements in fore-and-aft and athwartship directions. Note down the measuring results.

2. Check the condition of the cylinder liner and assess according to the description in Volume I, Chapter 707.

Carefully scratch over any scores or marks on the cylinder liner running surface by means of a rough grinding stone held in the hand.



By means of a grinding machine, remove the wear ridges at the top and bottom of the cylinder liner (where the piston rings reverse direction) so that a smooth transition is formed.

Check the lubricating points of the cylinder by manually pumping cylinder oil to each individual lubricating point.

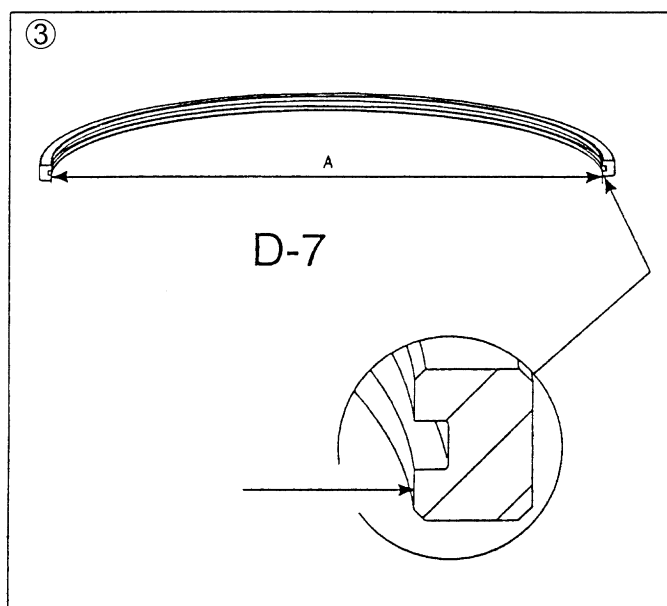
Clean any blocked lubricating duct.

Mount the piston and cylinder cover.
See Procedures 902-2.2 and 901-1.2.

Note !

In cases where shims have been mounted between the piston rod and the crosshead – after delivery of the engine – the length of the measuring rod must be adjusted to allow for the thickness of the shims.





3. Measure the inside diameter **A** of the piston cleaning ring, measured in the athwartship direction.

Compare the measured inside diameter **A** with the diameter of a new piston cleaning ring, *see Data*, to calculate the wear of the piston cleaning ring.

For the cylinder liner, compare the inside diameter at the position marked PC on the measuring tool, measured in the athwartship direction, with the inside diameter of a new cylinder liner, *see Data*, to calculate the wear of the cylinder liner.

The wear of the piston cleaning ring and the wear of the cylinder liner at the positions mentioned above interacts as follows:

- IF the wear of the cylinder liner exceeds 1 mm, THEN the piston cleaning ring must be replaced with a new oversize piston cleaning ring (to be ordered as a spare part).
- IF the wear of the piston cleaning ring exceeds the wear of the cylinder liner by more than 0.5 mm AND the wear of the cylinder liner exceeds 1 mm, THEN the piston cleaning ring must be replaced with a new oversize piston cleaning ring (to be ordered as a spare part).
- IF the wear of the piston cleaning ring exceeds the wear of the cylinder liner by more than 0.5 mm AND the wear of the cylinder liner does NOT exceed 1 mm, THEN the piston cleaning ring must be replaced with a new standard size piston cleaning ring.
- IF the wear of the cylinder liner exceeds 2 mm, THEN NO piston cleaning ring may be mounted in the cylinder liner.



1. Dismount the exhaust valve.
See Procedure 901-2.3.

Turn the engine until the piston concerned is in BDC.

Position the measuring rod on the top of the piston. Access to the cylinder liner is obtained through the exhaust valve bore in the cylinder cover.

Measure the cylinder liner with the inside micrometer at the positions indicated on the measuring rod.

Take measurements in fore-and-aft and athwartship directions, *see Data*.

Note down the measuring results.

Check the condition of the cylinder liner and assess as described in Volume I, Chapter 707.

Note !

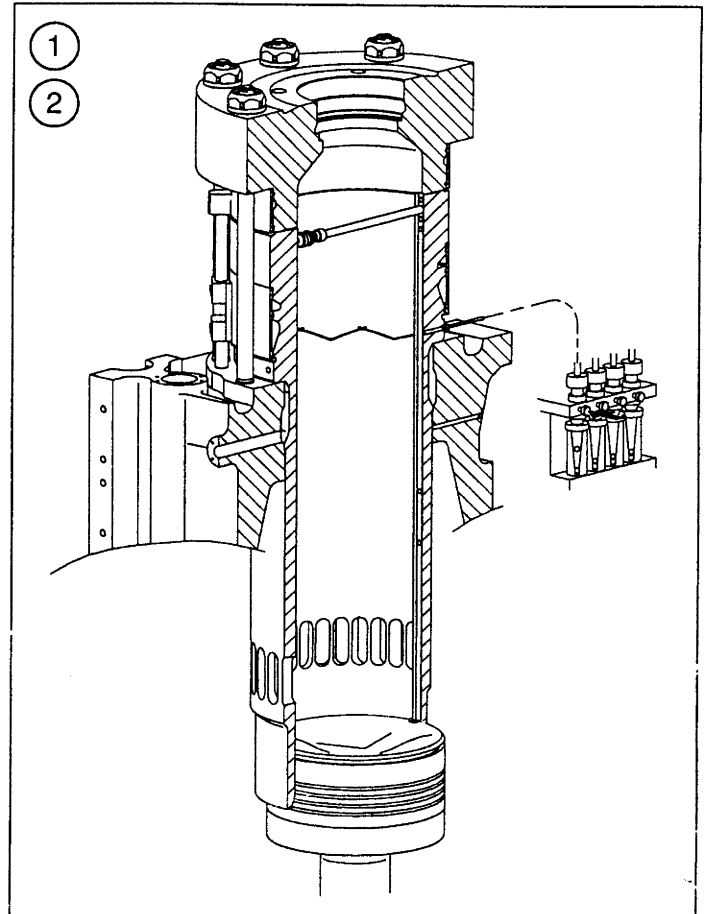
If a new cylinder liner is mounted a new piston cleaning ring must also be mounted after mounting the piston.

2. Check the cylinder lubricating points by manually pumping lubricating oil through each individual lubricating point.

Clean any blocked lubricating duct.

Mount the exhaust valve again.

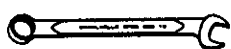
See Procedure 901-2.3.



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☒ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913



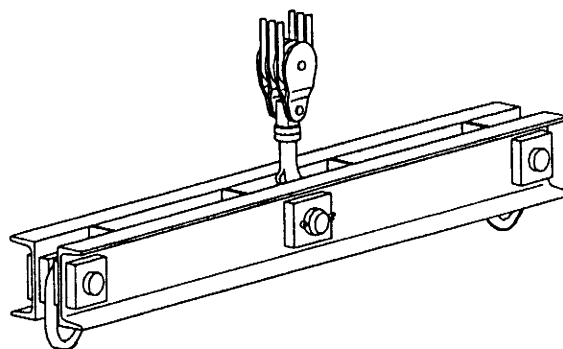
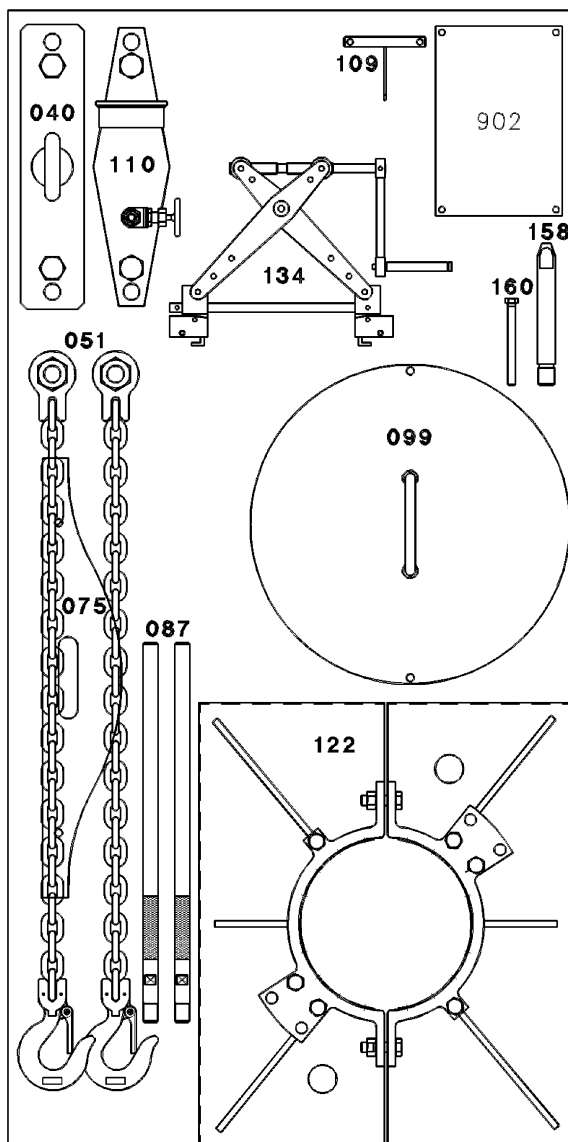
18. 24. 41. 46. 55 mm



750 – 2000 Nm



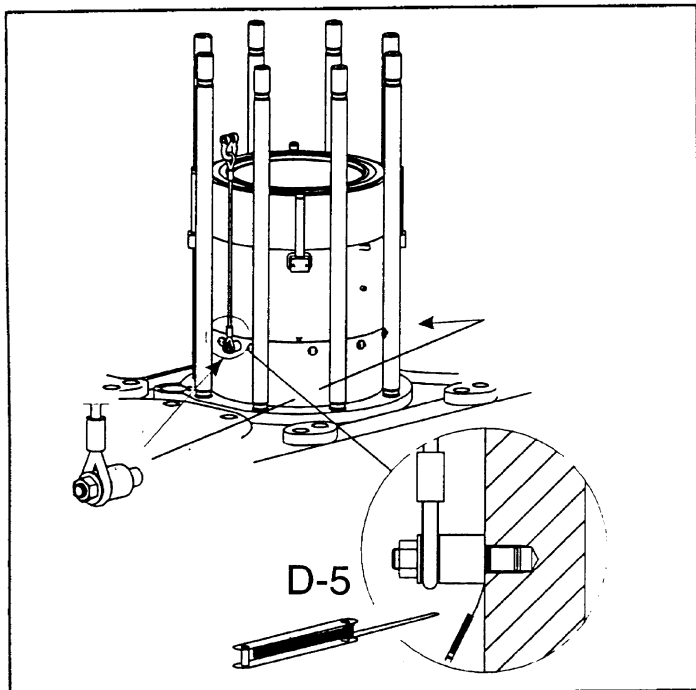
4 x 200 kg



DATA:

- | | | |
|-----|---|---------|
| D-1 | Cylinder liner, complete..... | 4500 Kg |
| D-2 | Cooling jacket..... | 173 Kg |
| D-3 | Distance of
cylinder cover studs | 2~3mm |
| D-4 | Cylinder cover stud..... | 92 Kg |
| D-5 | Gap on lifting screw | 0mm |
| | (Full contact) | |





1. Dismount the cylinder cover
See Procedure 901- 1.1

Discard the mild steel ring and piston cleaning ring from the top of the cylinder liner.

Turn down the piston far enough to make it possible to grind away the wear ridges at the top of the liner by means of a hand-grinder.

See Procedure 903-2.1.

Dismount the piston.

See Procedure 902-2.1.

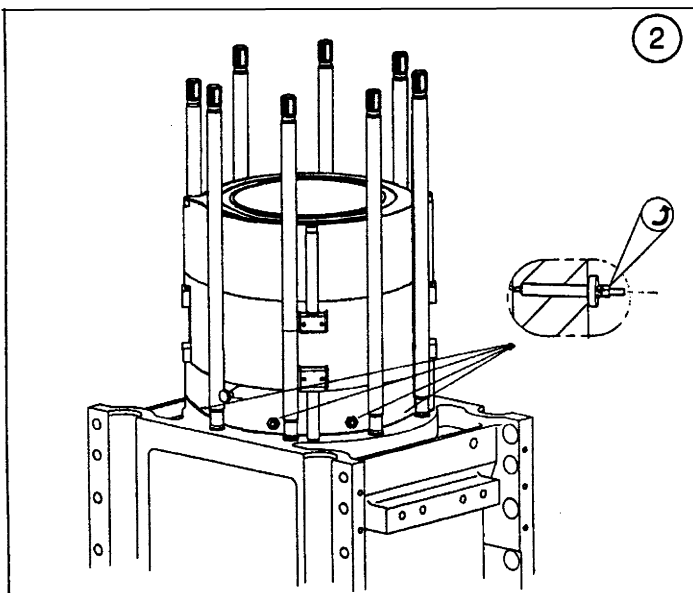
Mount the two lifting screws in the cylinder liner in fore/aft direction.

2. Disconnect – at the non-return valves - the oil pipes leading from the cylinder lubricator to the non-return valves. Screw off the eight non-return valves.

Dismount the four cooling water pipes – between the cooling jacket and cylinder cover – and clean them carefully.

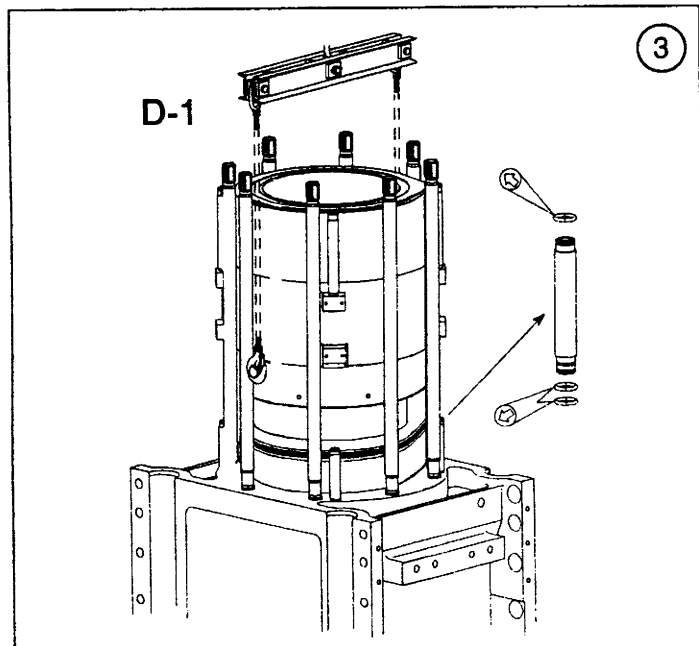
3. Attach the crane to the crossbar. Hook on the lifting tool to the two lifting screws and lift the cylinder liner from the cylinder frame.

Land the cylinder liner vertically on, for instance, a couple of planks.



Warning !

Never lift the cylinder liner with the crossbar attached to lifting screws in the cooling jacket.



Clean the cylinder frame internally, taking special care with the contact surfaces for the cylinder liner at the top of the cylinder frame and at the bottom where the sealing rings are fitted. These two places provide sealing for the cooling water.

Remove the cooling water pipes and discard the O-rings.
Clean the pipes carefully.

Mount new O-rings lubricated with a little grease in the ring grooves and mount the pipe in the cylinder frame.



4. Attach two tackles to the crossbar, as shown.

Mount two lifting screws in the cooling jacket.

Hook on the tackles to the lifting screws on the cooling jacket and haul tight.

Remove the two lifting screws in the cylinder liner.

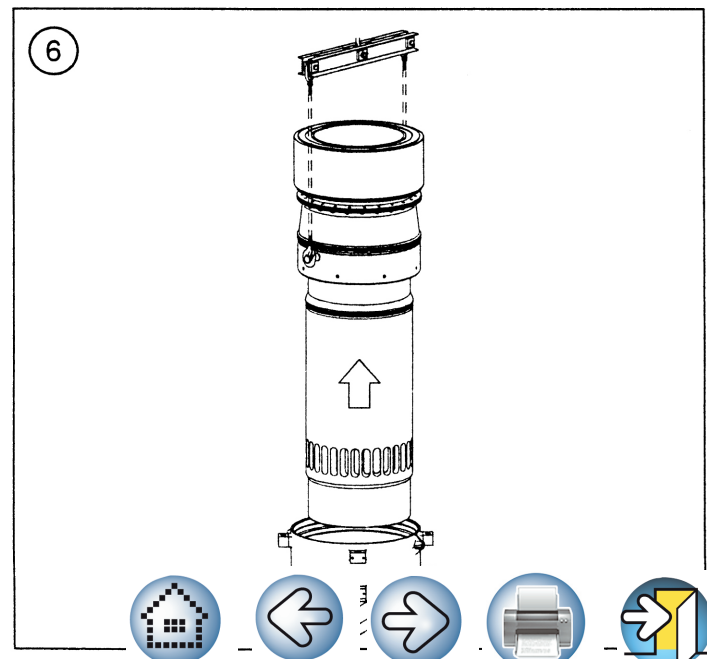
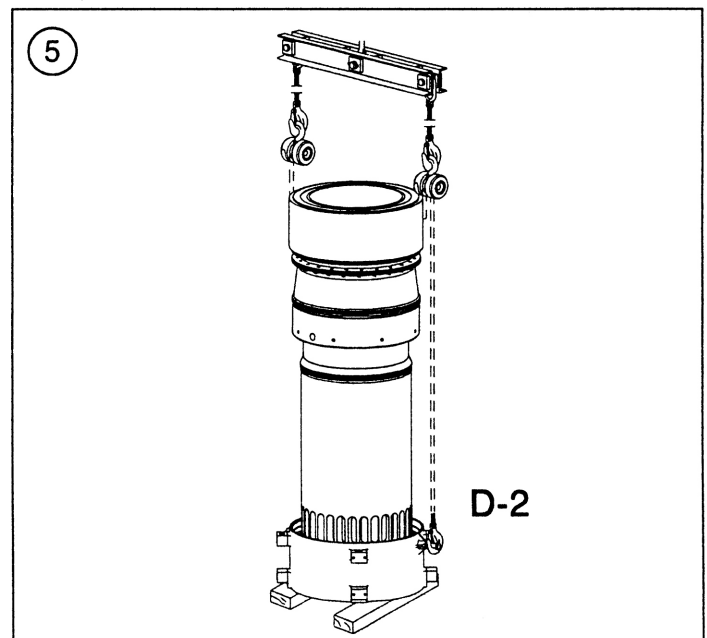
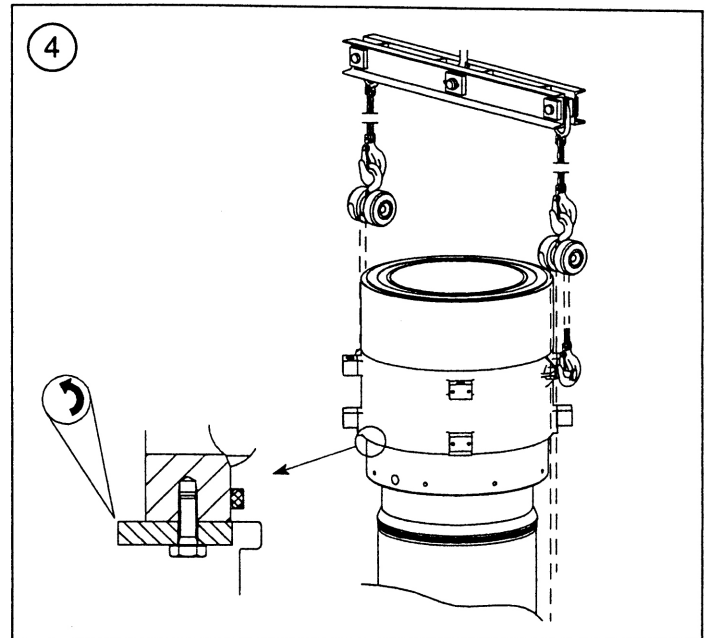
Loosen the four screws on the clamps which fix the cooling jacket to the cylinder liner. Turn the clamps away from the liner.

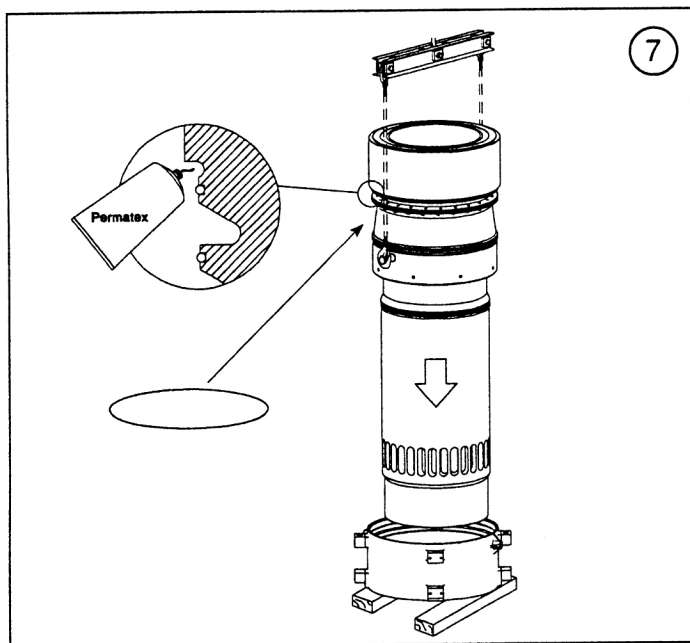
5. Lower the cooling jacket by means of the tackles and land it on the wooden planks.

6. Mount the two lifting screws in the cylinder liner.

Lift the cylinder liner away from the cooling jacket.

Clean the cooling jacket internally.





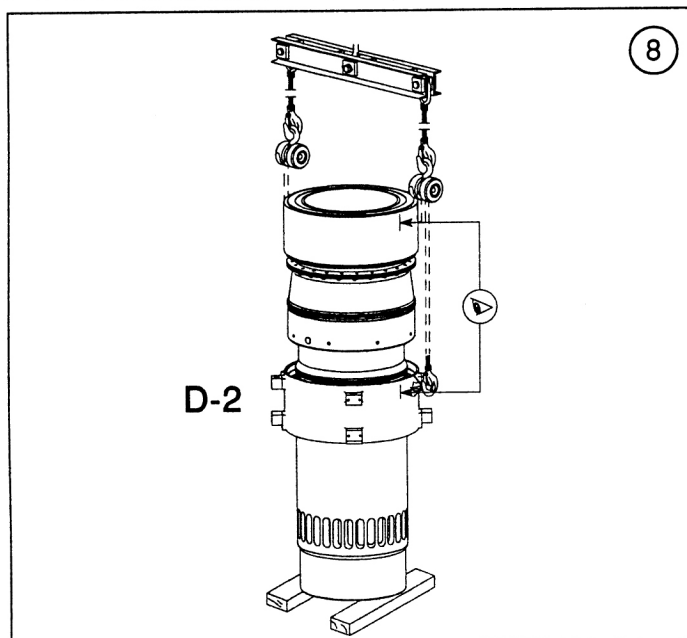
7. Clean the new cylinder liner, removing the protecting layer of grease. Fill up the relief turning in the contact surface of the liner with joint paste (to prevent corrosion).

Mount the two lifting screws on the new liner.

Lift the new liner a little and mount new O-rings for the cooling jacket. Then place the liner in the cooling jacket.

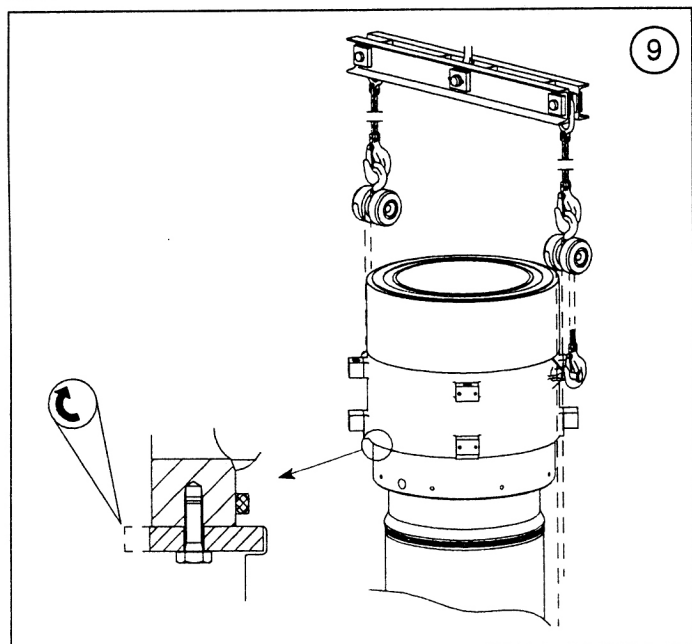
Remove the lifting screws.

8. Lift the cooling jacket into position – marking scratches jacket/cylinder liner must coincide (camshaft side).



9. Turn the four clamps until they fit in the groove of the liner and tighten the screws.

Remove the tackles from the lifting tool and the cooling jacket lifting screws.



10. Loosen the eight water connections on the cooling jacket. The joint surfaces, cylinder frame/cylinder liner, must be completely clean.

Mount the two lifting screws in the cylinder liner.

Hook the lifting tool to the lifting screws and lift the jacket/liner assembly.

Mount the O-rings and apply a little lubricating oil on the rings. Then lift the liner into position in the cylinder frame, with the marking scratch on the camshaft side, and guiding the jacket in accordance with the water connections.

11. Tighten the lower water connections on the cooling jacket as soon as the cylinder liner is correctly positioned.

Mount the non-return valves for cylinder lubrication in the bores of the liner.

Screw the pipes from the lubricator on to the non-return valves, but do not tighten. Vent the cylinder lubricating system by manually pumping each individual pipe through until oil, without air bubbles, comes out from the union pipe/non-return valve. When this is in order, tighten the pipes firmly on the non-return valves and again pump manually until it is certain that each individual lubricating point functions correctly.

12. Place a new sealing ring on top of the cylinder liner.

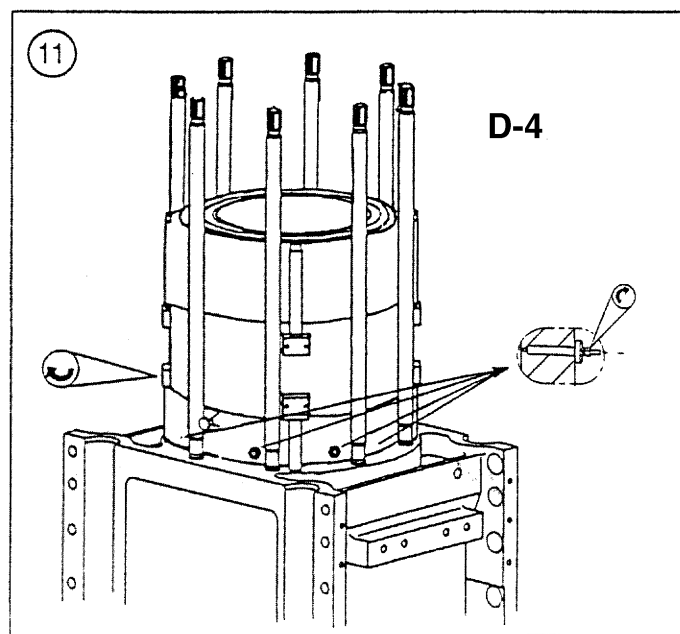
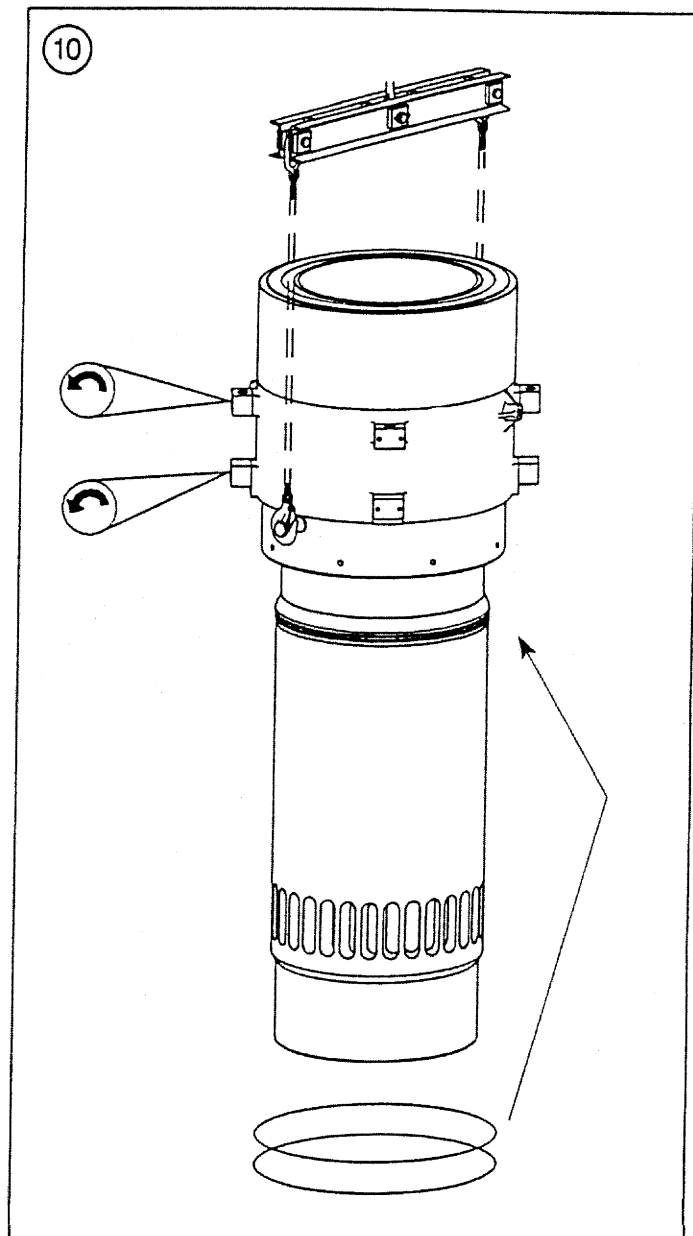
Mount piston cleaning ring and the piston and cylinder cover.

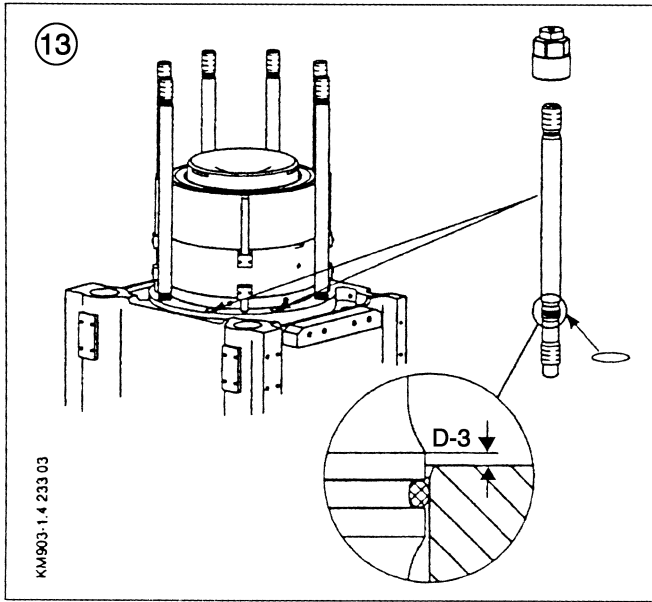
See *Procedures 902-2.2 and 901-1.2.*

Tighten the upper water connections on the cooling jacket as soon as the cylinder cover is correctly positioned.

Note !

According to the lifting height and crane capability in the engine room, it can be necessary to remove a number of cylinder cover studs.





13. If one or more cylinder cover studs have been removed during the dismantling of the cylinder cover, remount the studs using the stud setter, *see Data*.

Note!

The studs should not be fully screwed-in. Instead the stud should only be screwed-in until the edge on the stud is the distance D-4 above the cylinder frame, *see sketch*.

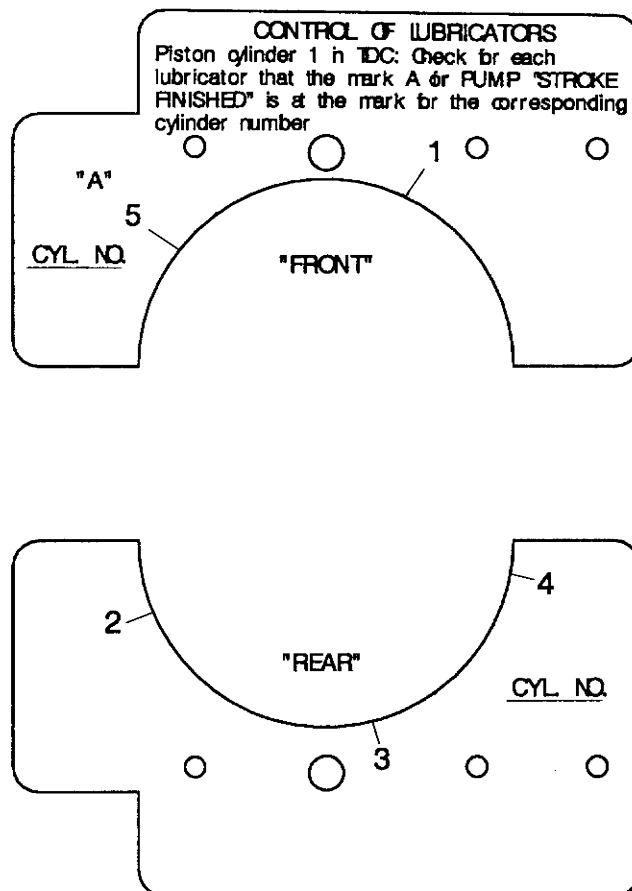
D-3 : 2~3mm



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913



Lubricator: See separate instructions for the make and type fitted.

The specific cylinder oil feed rate is:

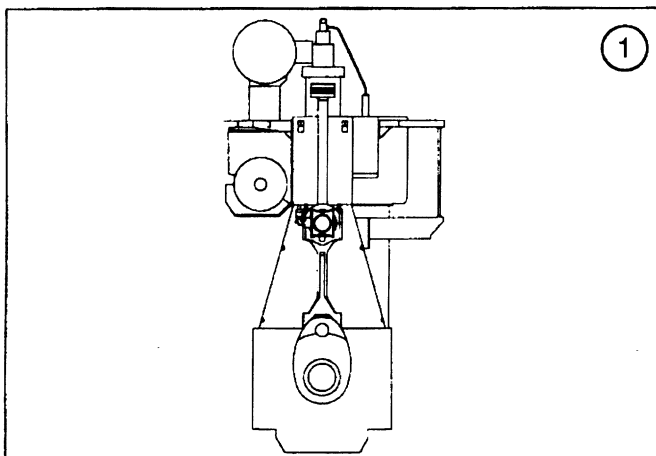
K/L-engines: 0.6 g/BHP_h – 0.9 g/BHP_h
0.8 g/kWh – 1.2 g/kWh

S-engines : 0.7 g/BHP_h – 1.1 g/BHP_h
0.95 g/kWh – 1.5 g/kWh

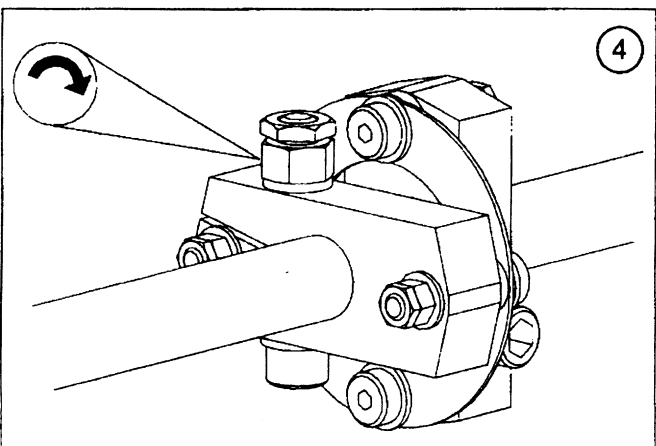
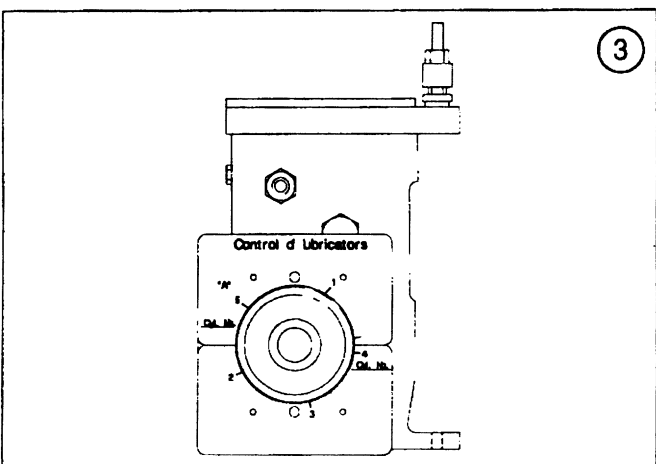
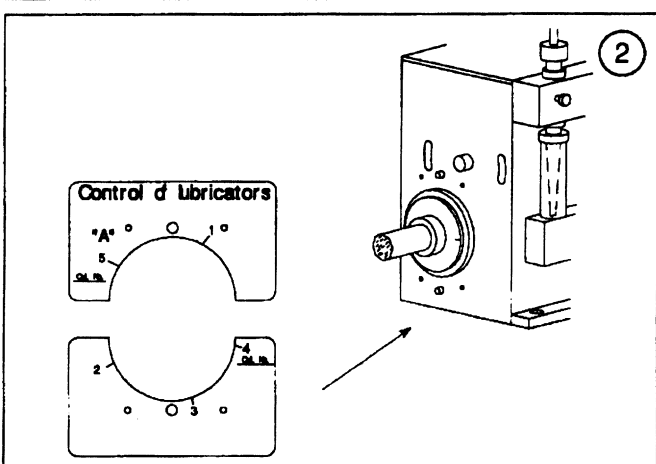
For information on cylinder oil dosage during running-in, running at MCR, running at part load and special conditions, see Volume I, OPERATION, Chapter 707.

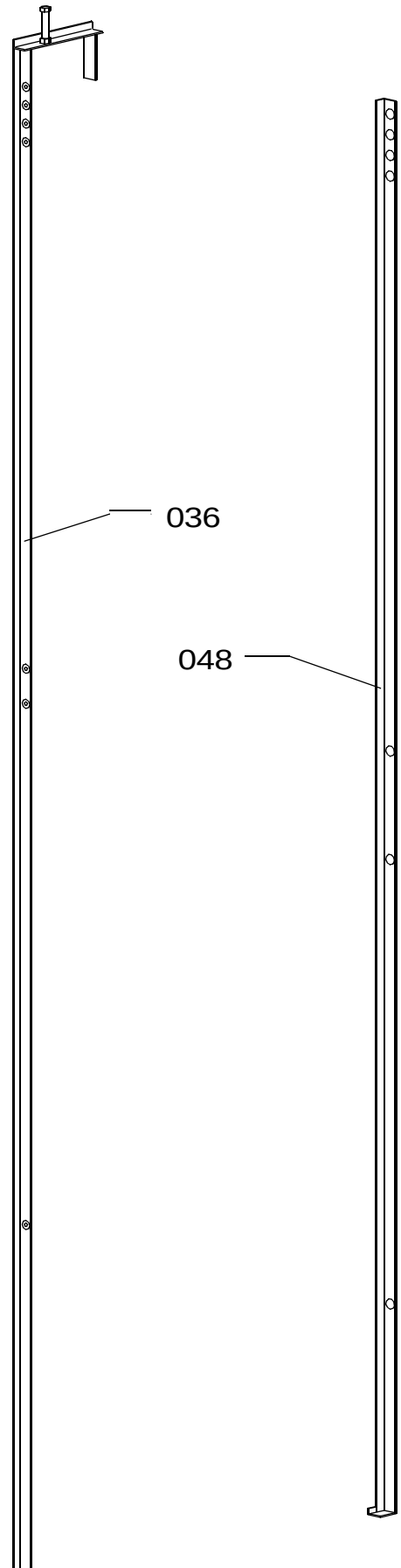
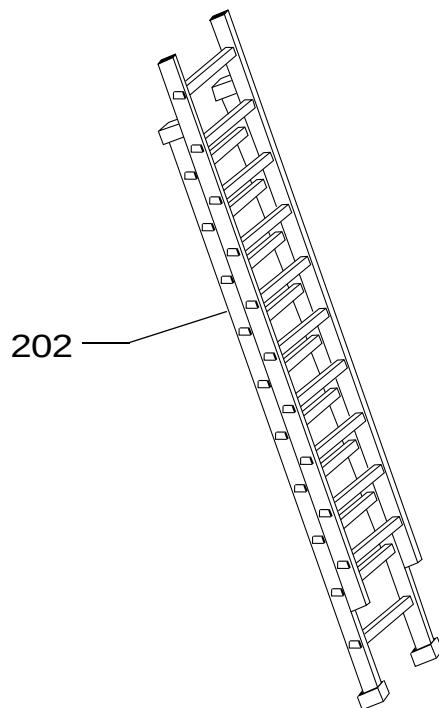
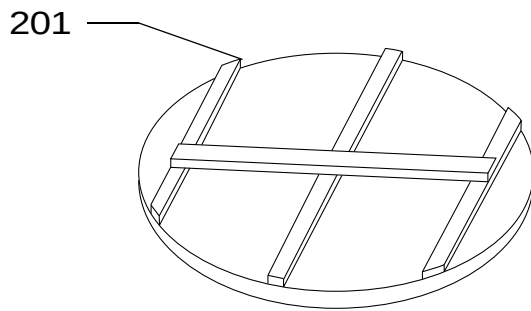
D-1 Tightening torque..... 90 Nm





1. Turn piston of cylinder 1 to TDC.
2. Mount the template on the lubricator.
3. Correct setting of each individual lubricator can be ascertained by comparing the marking **A** on the rotary element against the relevant cylinder number on the template. The marking **A** indicates pump stroke finished for the cylinder lubricator.
4. If the couplings between the cylinder lubricators have been loosened (e.g. for reasons of adjustment), their screws must be retightened with a torque spanner to D-1.





Item No.	Item Description
036	Measuring rod for cylinder liner, long
048	Measuring rod for cylinder liner, short
201	Cover for Cyl, bore
202	Ledder for Cyl, bore checking

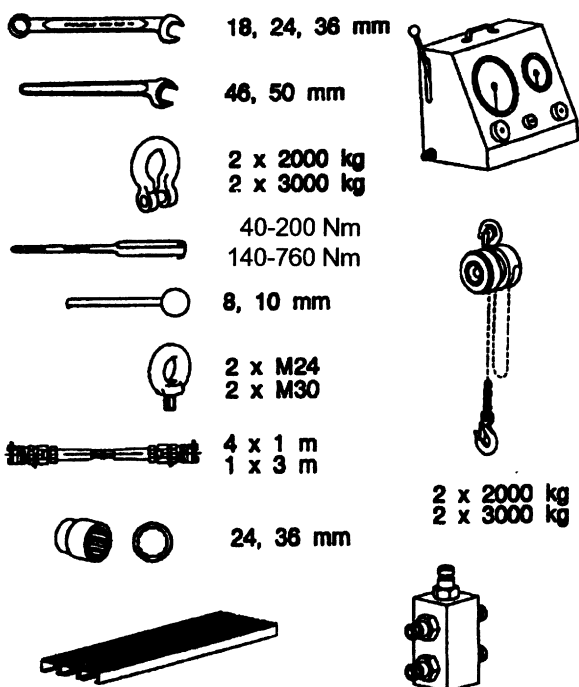
Item No.	Item Description



SAFETY PRECAUTIONS

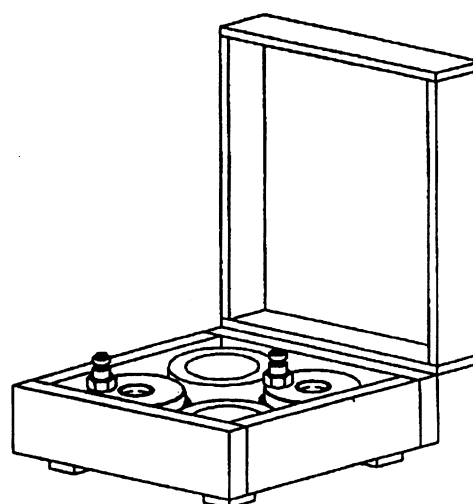
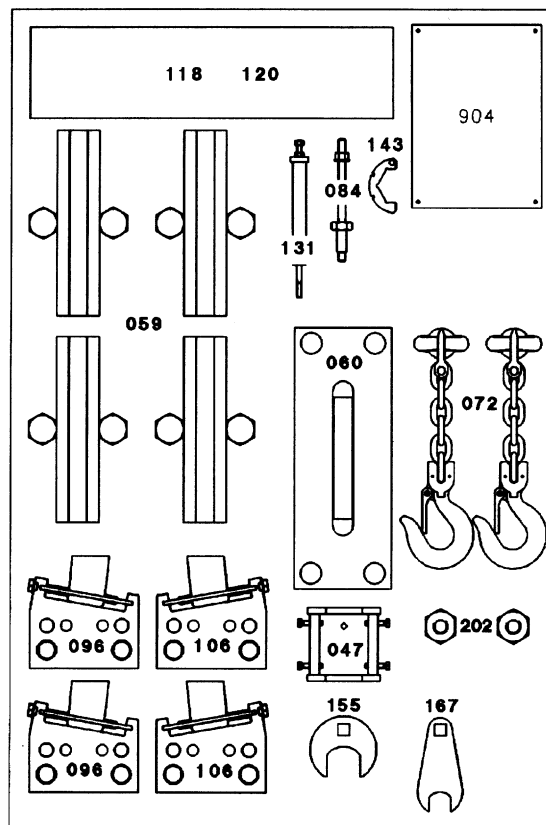
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

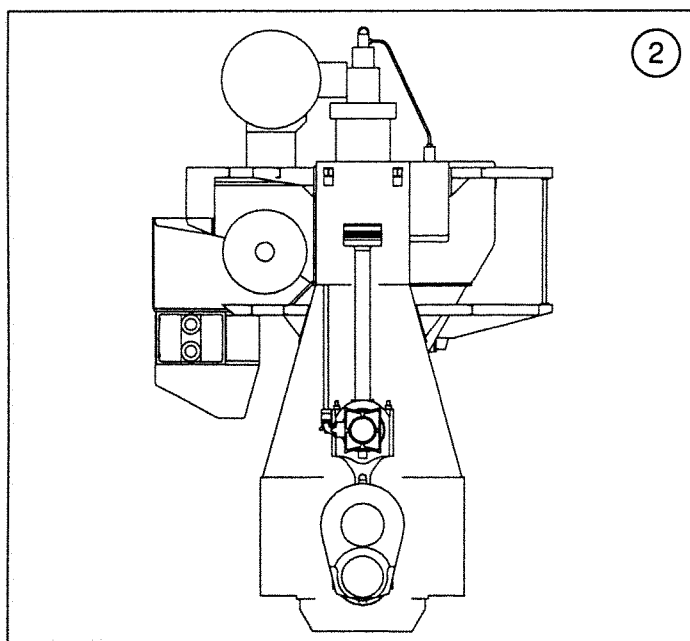
913



DATA:

D-1	Oil wedge length.....	L = 15 mm
D-2	Hydraulic pressure	
	- tightening	900 bar
	- dismantling	900-990 bar
D-3	Crosshead bearing cap.....	815 kg
D-4	Bearing shell, upper.....	72 kg
D-5	Crosshead + piston	
	complete.....	6215 kg
D-6	Crosshead complete.....	3406 kg
D-7	Bearing shell, lower.....	92 kg
D-8	Telescopic pipe.....	48 kg
D-9	Tightening torque -	
	telescopic pipe.....	170 Nm
D-10	Screwing-in torque -	
	crosshead bearing stud.....	380 Nm
D-11	Tightening torque -	
	thrust piece.....	230 Nm



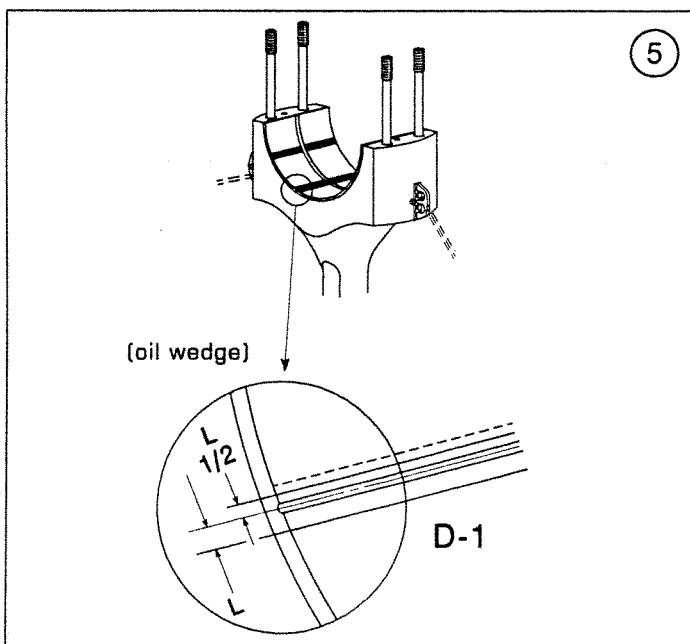
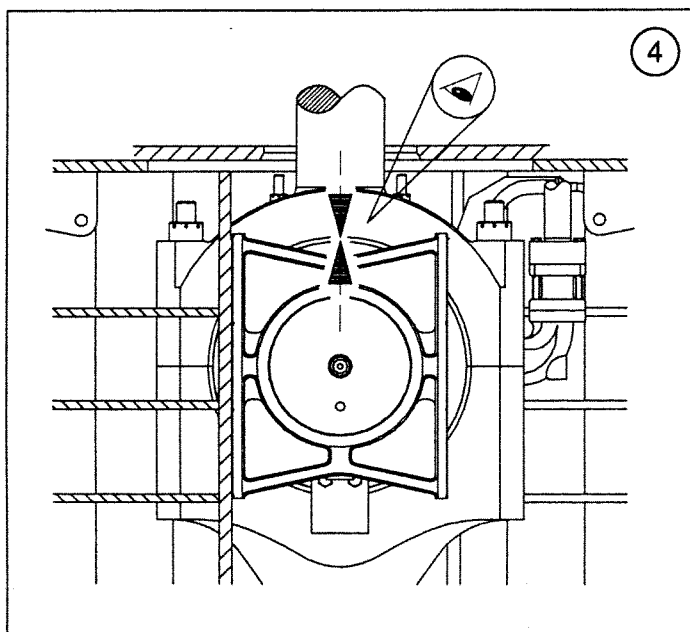


The top clearance between the journal and a new bearing shell is the result of a summation of the production tolerances of the bearing assemblies.

The top clearance will normally be in the range of 0.28 mm to 0.46 mm.

For the top clearance of a specific bearing, see the measurement in the adjustment sheet.

1. Open the crankcase door at the relevant cylinder.
2. Turn the crosshead concerned to BDC.
3. Measure the clearance in the crosshead bearings through the inspection hole of thrust piece by inserting a feeler gauge at the top of the upper bearing shell.
4. When checking the clearances, the discrepancy between the measurements noted in the adjustment sheet (or the clearance noted for a new bearing installed later) **must not** exceed 0.05 mm. If so, the crosshead bearing must be disassembled for inspection. See Procedure 904-2.2.
5. The wear limit for a crosshead bearing shell is confined to 50% reduction of the oil wedge length L .
6. For further external inspection of the crosshead bearing, see Chapter 708, 'Bearings' in the instruction book, Volume I, OPERATION.



1. Turn the crosshead down far enough to give access to the nuts on the piston rod, the crosshead bearing cap, and the screws on the telescopic pipe.

2. Mount the two chains in the inner screw holes in the crankcase topplate, in the athwartship direction, for suspending the piston rod.

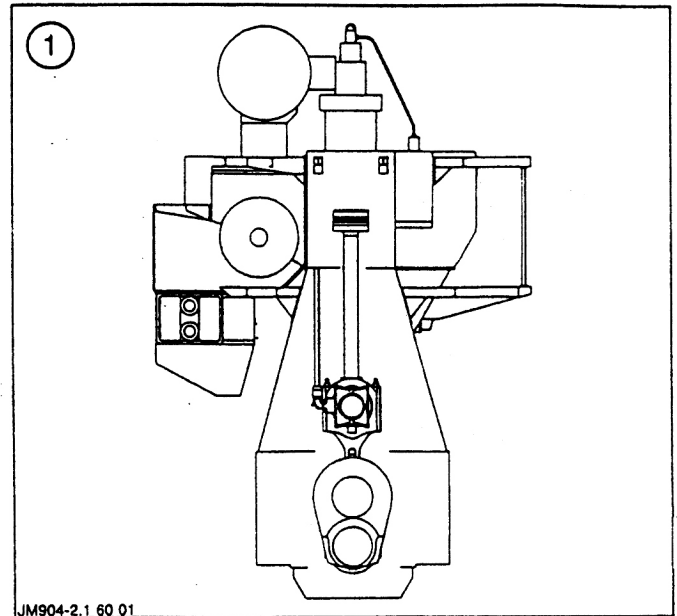
Mount two tackles in the two outer lifting brackets in the top of the frame box in the athwartship direction.

3. Mount the spacer rings and the hydraulic jacks for loosening the crosshead bearing cap nuts and the nuts on the piston rod.

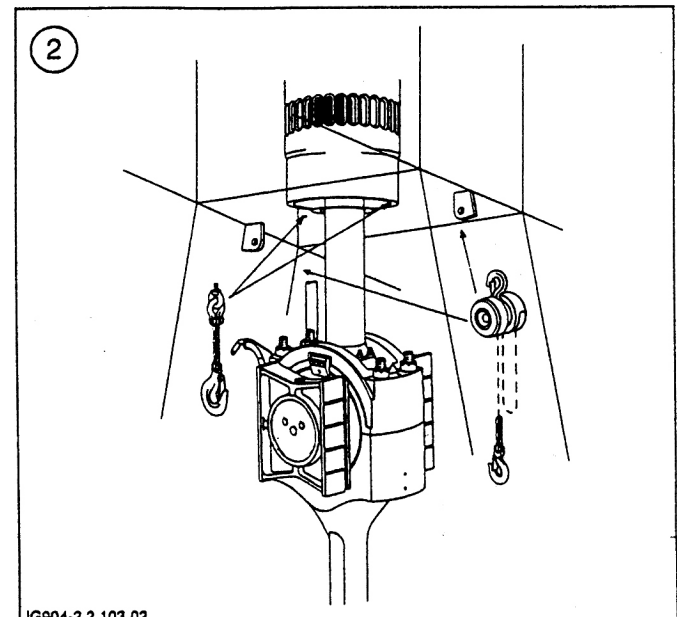
Loosen the nuts.

For operation of the hydraulic tools, see Procedure 913.

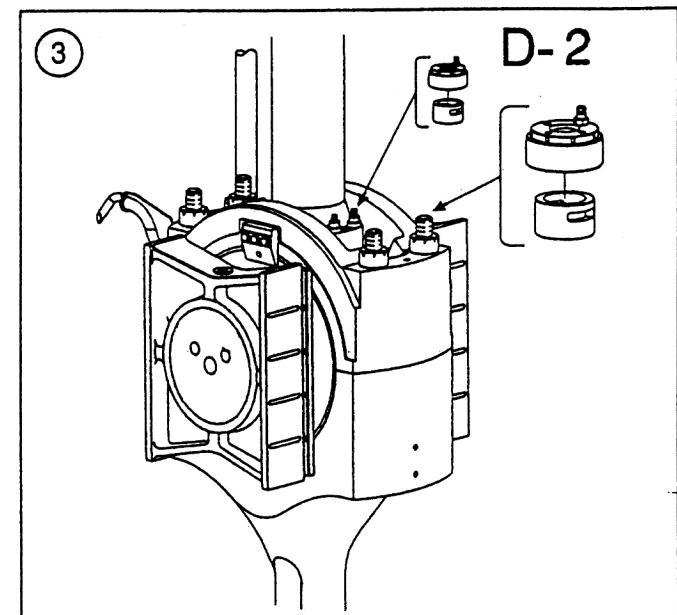
Remove the hydraulic jacks and unscrew the nuts.



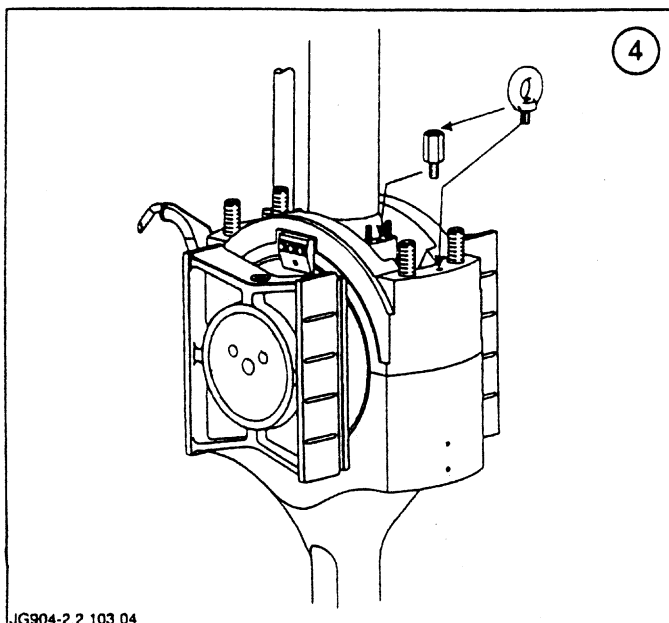
JMS904-2.1 60 01



JG904-2.2 103 02



JG904-2.2 105



JG904-2.2 103 04

4. Mount a lifting eye screw on each side of the bearing cap.

Mount a lifting eye screw with an extension screw on each side of the piston rod foot.

5. Loosen and remove the screws which tighten the telescopic pipe to the bend.

Remove one screw from the telescopic stuffing box housing and mount the special tool for suspending the telescopic pipe.

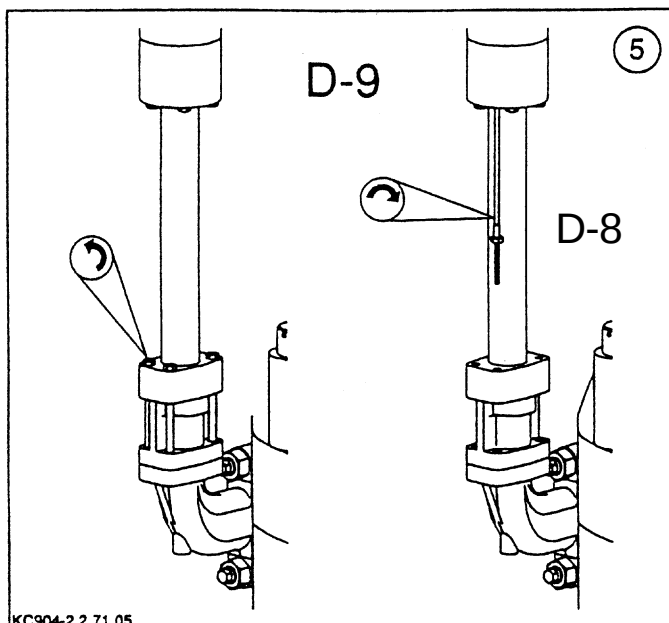
6. Turn the crosshead to TDC.

Hook the ends of the chains to the lifting eye screws in the piston rod.

Suspend the telescopic pipe by means of the tool. *See Procedure 902.2.*

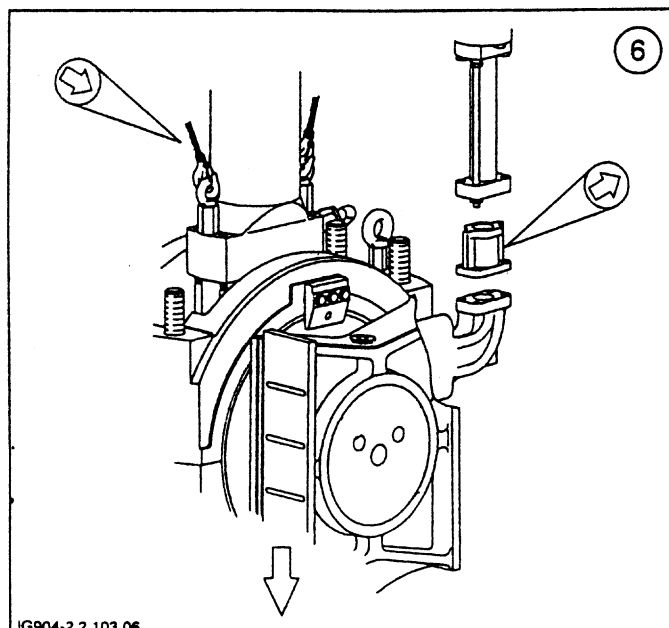
Turn the crosshead downward and the piston rod will remain suspended from the two chains.

When turning downwards, remove the distance tube from the bend.



KC904-2.2 71 05

Warning !
When a piston is dismantled, never turn the engine without first dismantling the telescopic pipe from the crosshead.



JG904-2.2 103 06

7. Turn the crosshead to BDC.

Hook the tackles on to the eye screws in the crosshead bearing cap and raise it to a position in which it is possible to check the upper bearing shell and the upper part of the journal.

If it is necessary to replace the bearing shell, remove the bearing cap from the engine.

Remove the screws and dismount either the foremost and aftmost thrust piece from the crosshead bearing cap.

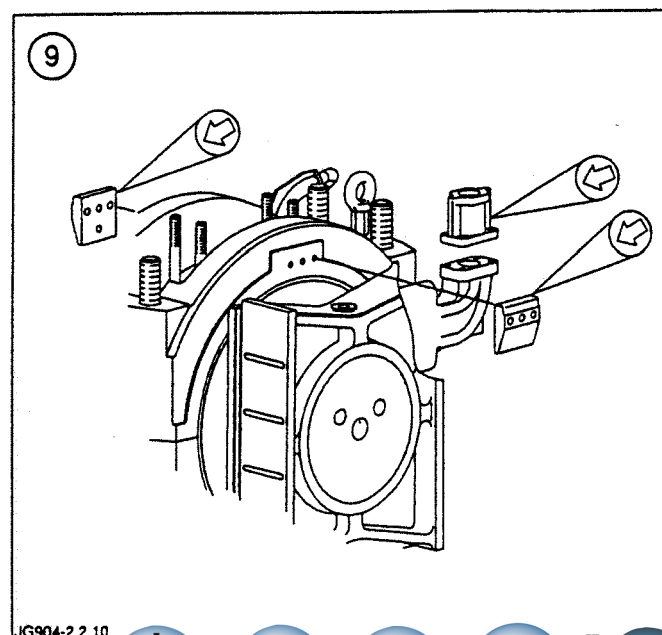
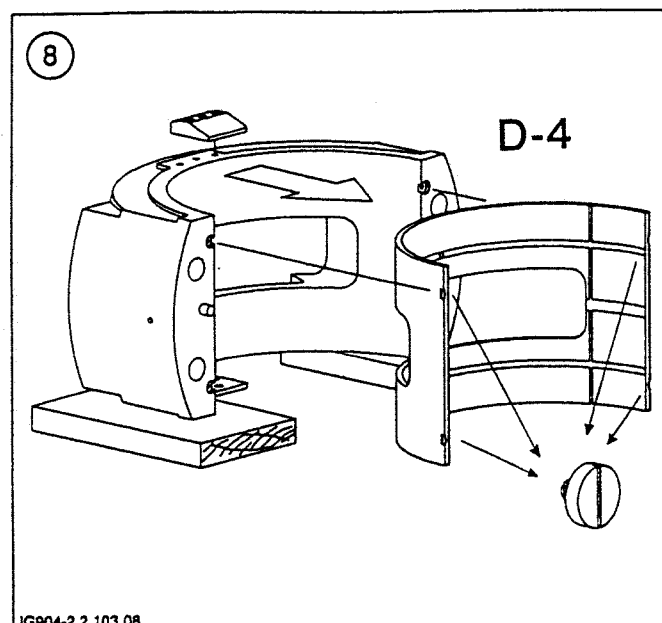
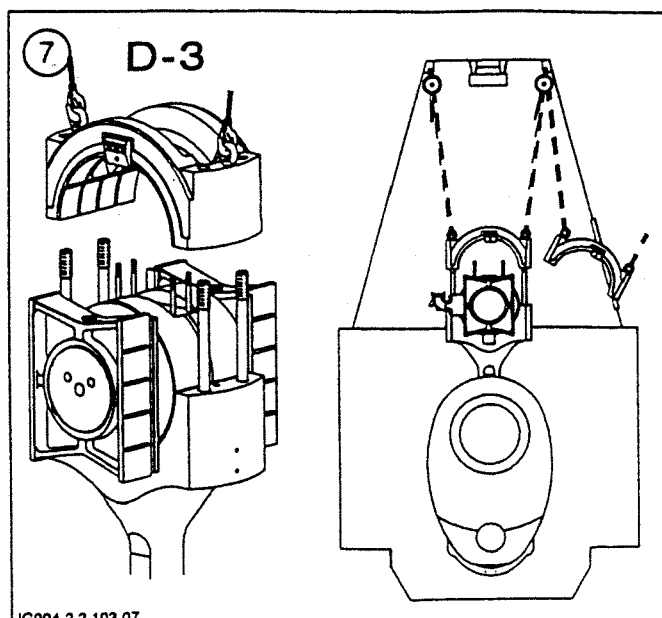
8. Place the bearing cap on one side on a couple of wooden planks.

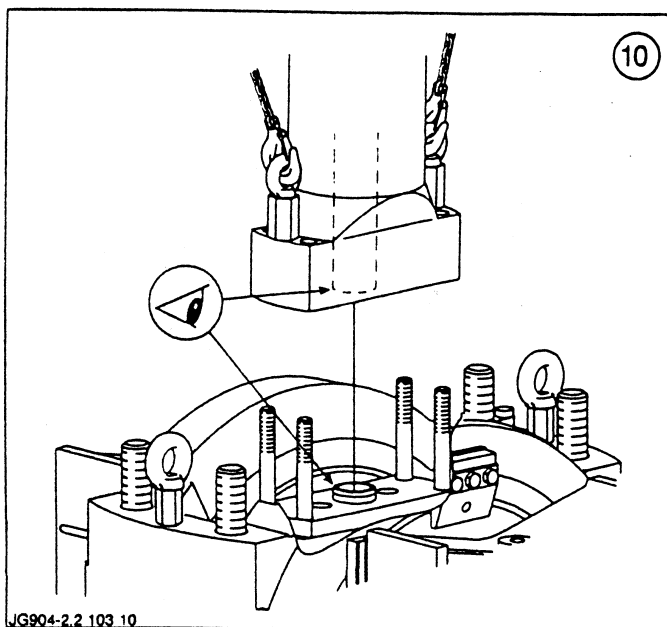
Dismount the locking screws and replace the bearing shell by a new one.

Then lift the bearing cap into the engine again.

Lower the bearing cap onto the crosshead, and remove the tackles.

9. Mount the distance pipe on the telescopic pipe bend.





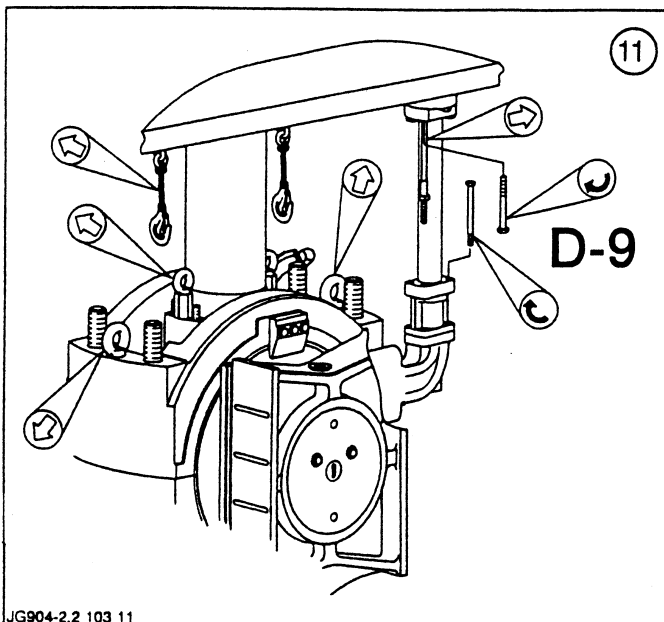
10. Turn the crosshead upwards until the piston rod lands on the crosshead. Ensure that the guide ring in the crosshead fits correctly in the centre hole of the piston rod.

11. Land the telescopic pipe on the bend.

Turn down to BDC and remove the chains and eye screws from the frame box topplate, from the piston rod and from the crosshead bearing cap in the athwartship direction.

Remove the suspending studs and mount the screws in the telescopic stuffing box housing.

Mount the screws and tighten the telescopic pipe, *see Data*.

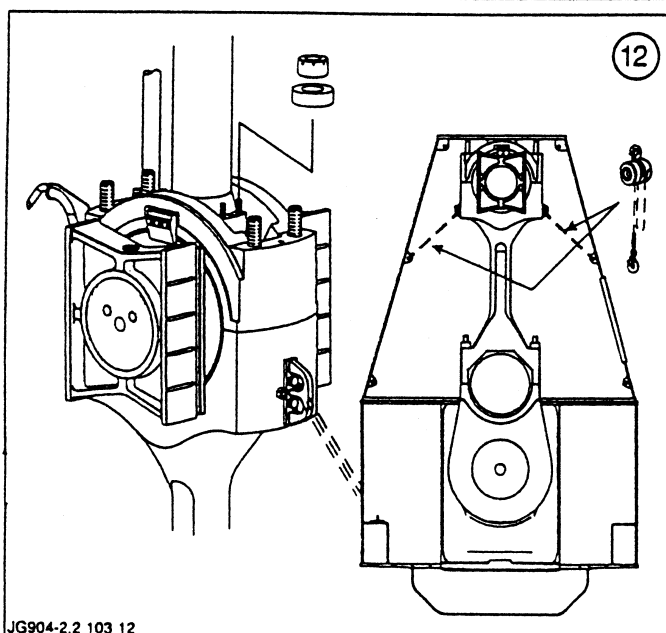


12. Mount the nuts and washers for the piston rod, but do not tighten.

Mount lifting attachments for fixing the connecting rod on the head of the connecting rod.

Fasten tackles to the fixed lifting brackets on the frame box wall.

Turn to TDC and attach the tackle hooks to the mentioned mountings. Haul the tackles tight.



13. Mount the four support for the guide shoes on the crosshead guides.

Carefully turn the crank down towards the exhaust side, until the crosshead shoes rest on the supports.

Adjust the support brackets to the guide shoes so that the weight of the crosshead is distributed evenly on the four supports. Haul the tackles tight.

14. Turn the crankthrow towards BDC while 'following' with the tackles, thus continuously supporting the connecting rod.

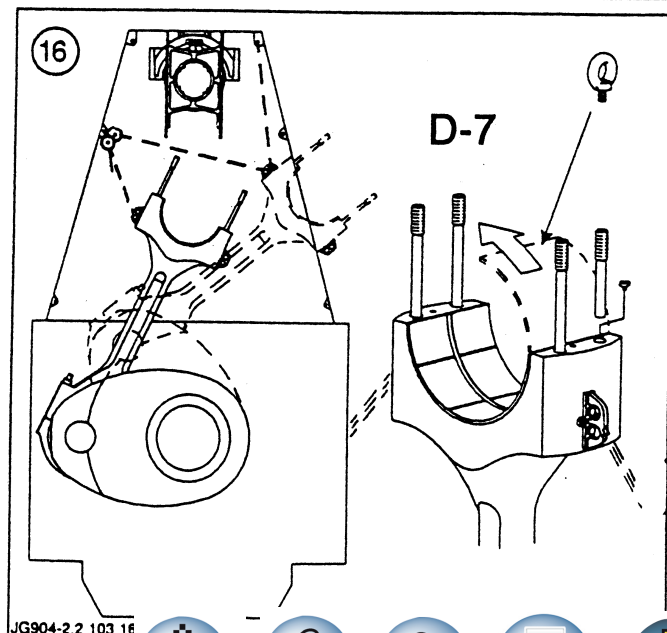
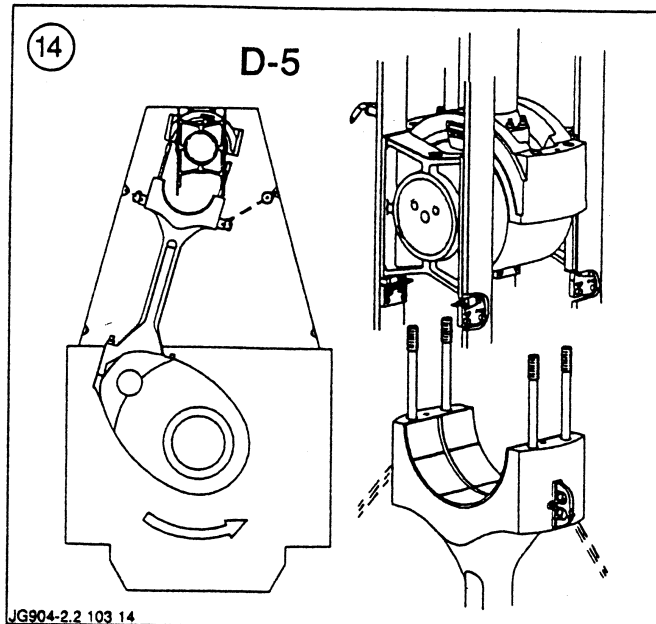
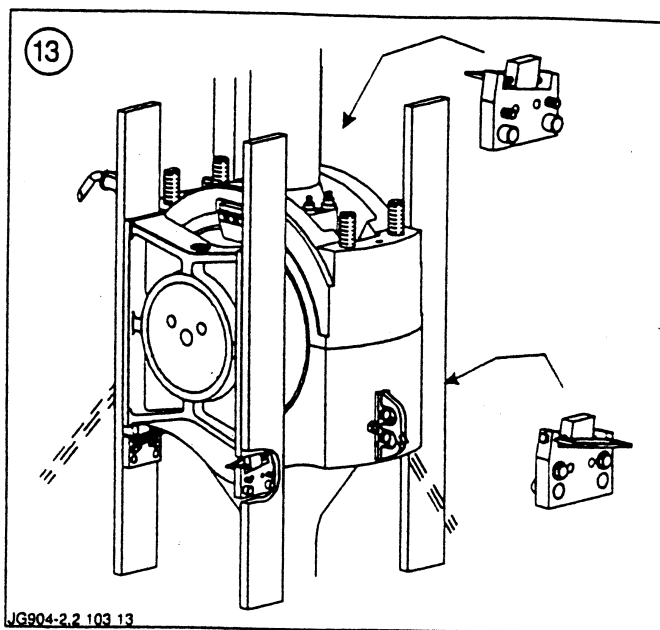
15. With the crosshead resting on the supports, check the lower part of the crosshead journal and the bearing shell.

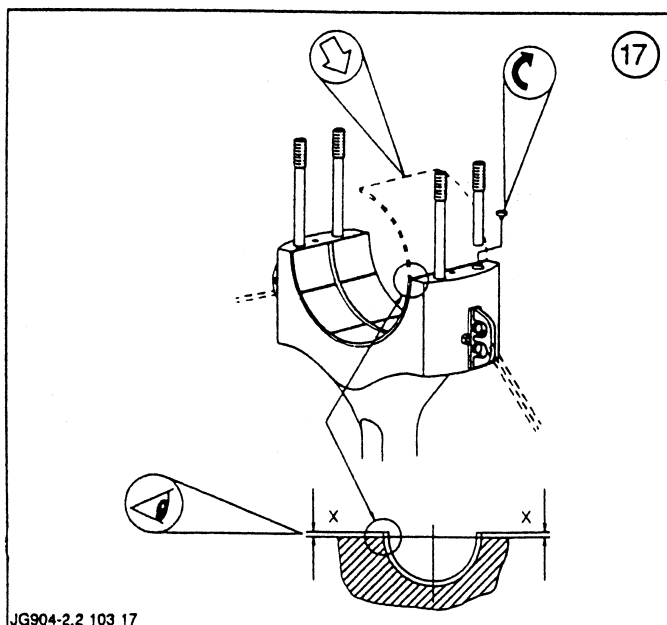
Regarding checking of journal and bearing shells, see Volume I, OPERATION, Chapter 708, 'Bearings'.

16. In cases where it is necessary to remove the lower bearing shell, tilt the connecting rod towards the opening in the camshaft side by means of the tackles.

Dismount the locking screws, and turn the bearing shell so far up that an eye screw can be mounted.

Lift the bearing shell out of the engine.

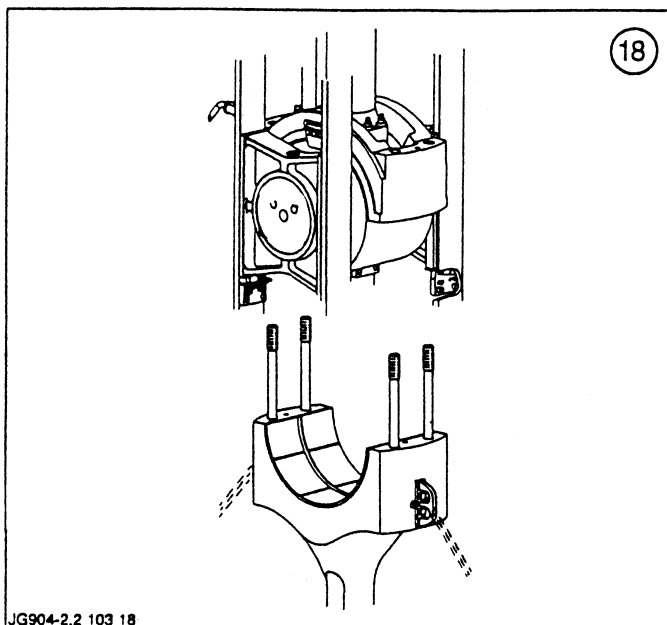




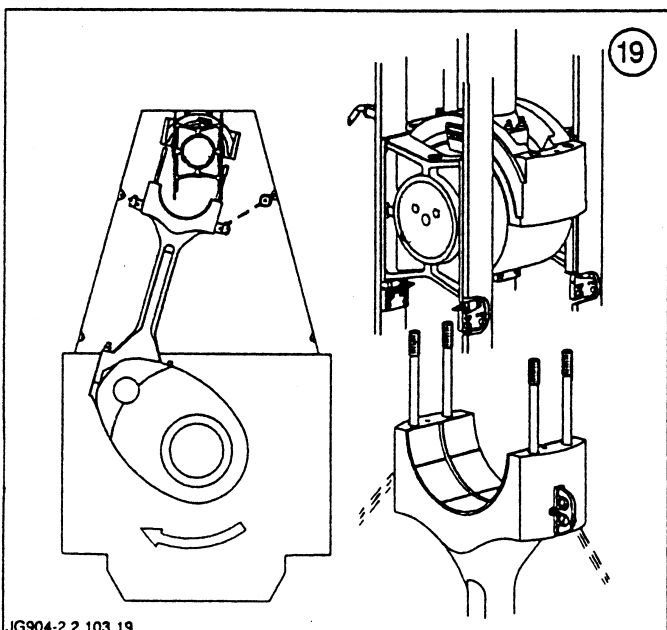
17. Mount and secure the new bearing shell in the bearing housing.

The excess height **X** is to ensure correct tightening-down of the bearing shell and **must not** be eliminated.

18. Raise the connecting rod to an upright position.



19. Turn to TDC while 'following' with the tackles, for assembling the crosshead and the connecting rod.



20. Remove the four supports from the crosshead guides and the lifting attachments from the connecting rod.

Mount the thrust piece for the connecting rod on the side of the crosshead bearing cap.

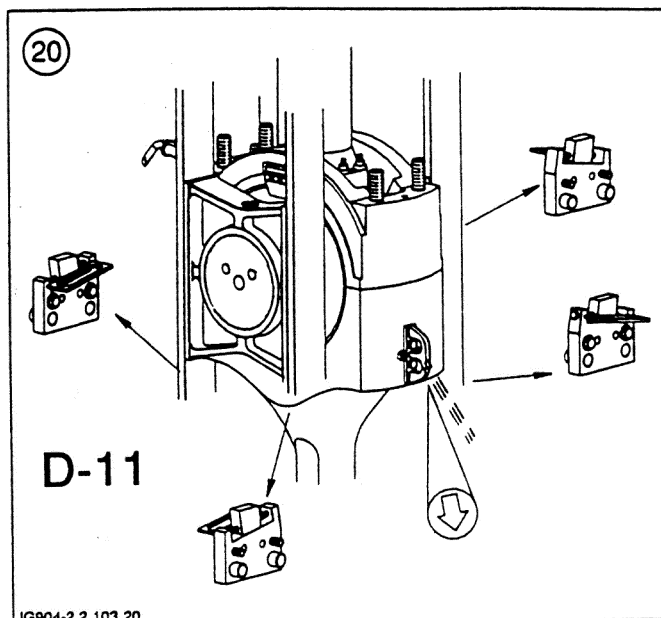
Tighten the screws for the thrust piece and lock by means of locking wire.

Mount the locking wire in such a way that the wire is tightened if one of the screws works loose.

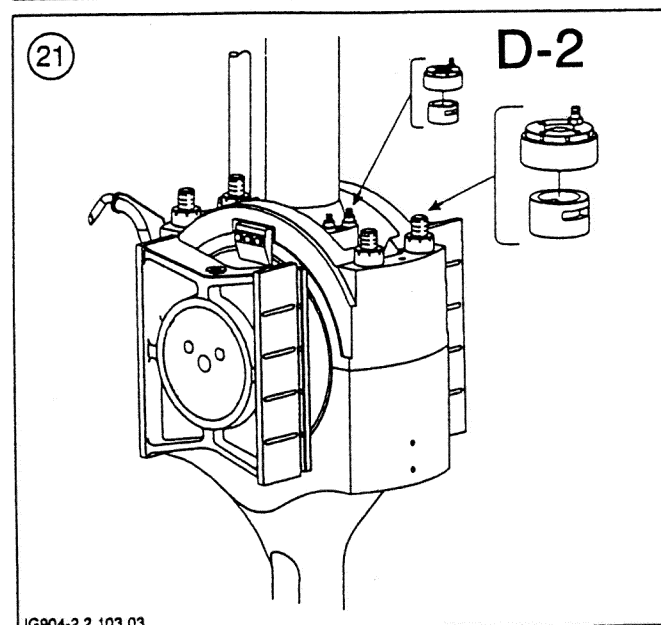
See Procedure 913-7.2.

Turn the crosshead down far enough to facilitate the tightening of the nuts.

21. Then tighten the crosshead bearing cap nuts and the piston rod nuts. The tightening force can be applied either stepwise or fully.

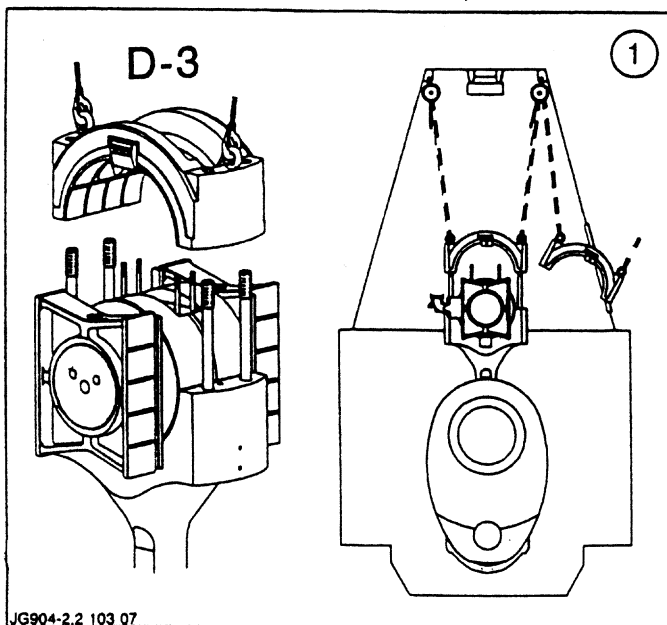


JG904-2.2 103 20



JG904-2.2 103 03





1. If the piston is removed from the cylinder (see Procedure 902-2), the crosshead bearing shells can be inspected in the following way:

Turn to BDC.

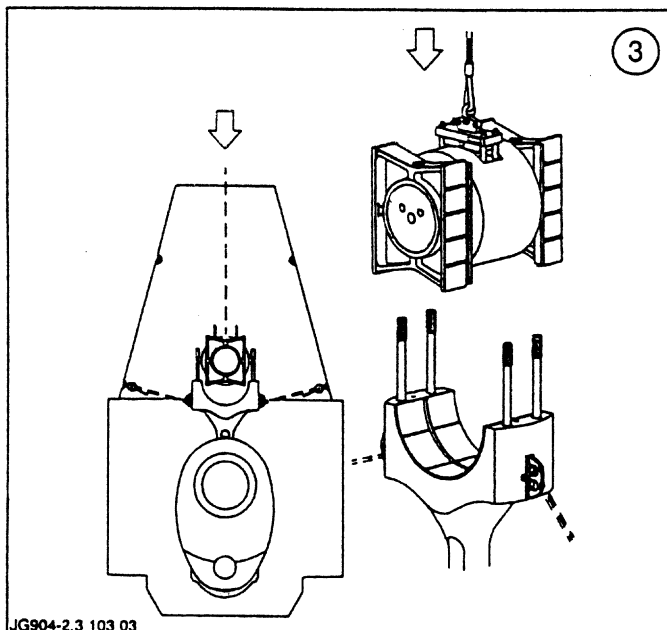
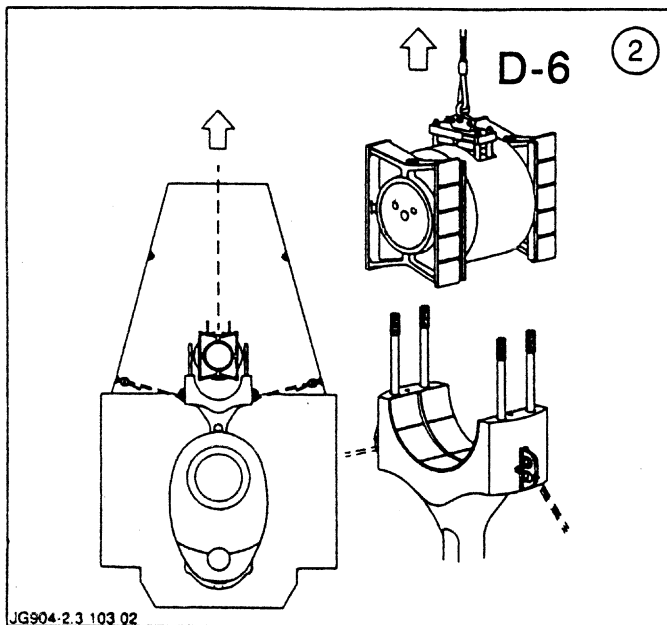
Loosen and remove the nuts from the bearing cap and lift the bearing cap out of the engine and, if necessary, replace the upper bearing shell.

By means of the tools and tackles, fix the connecting rod.

2. Mount the special lifting tool on the crosshead and, by means of the engine room crane, lift the crosshead far enough to permit inspection of the lower shell and lower part of the journal.

If it is necessary to replace the shell, repeat the procedure in point 16.

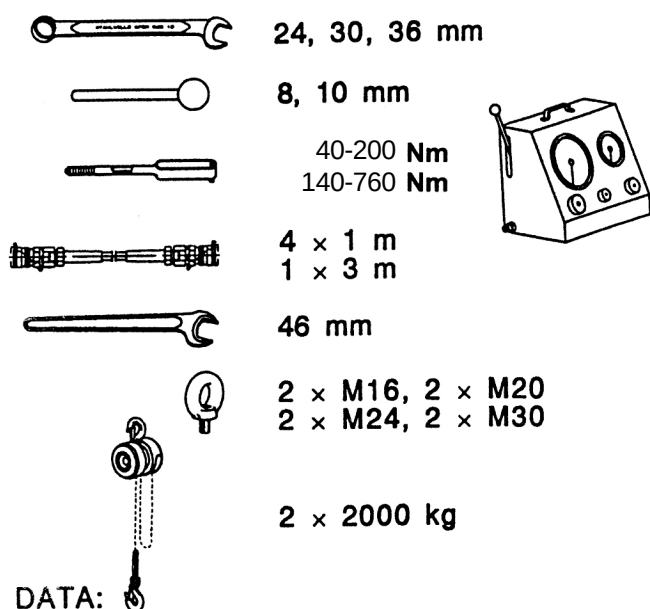
Assemble the parts in the reverse order to disassembling. See Data.



SAFETY PRECAUTIONS

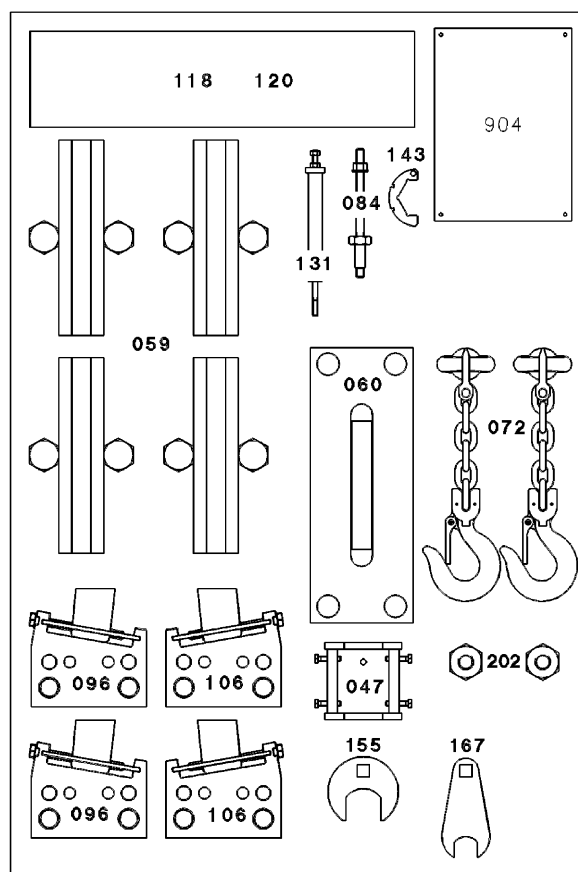
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☒ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

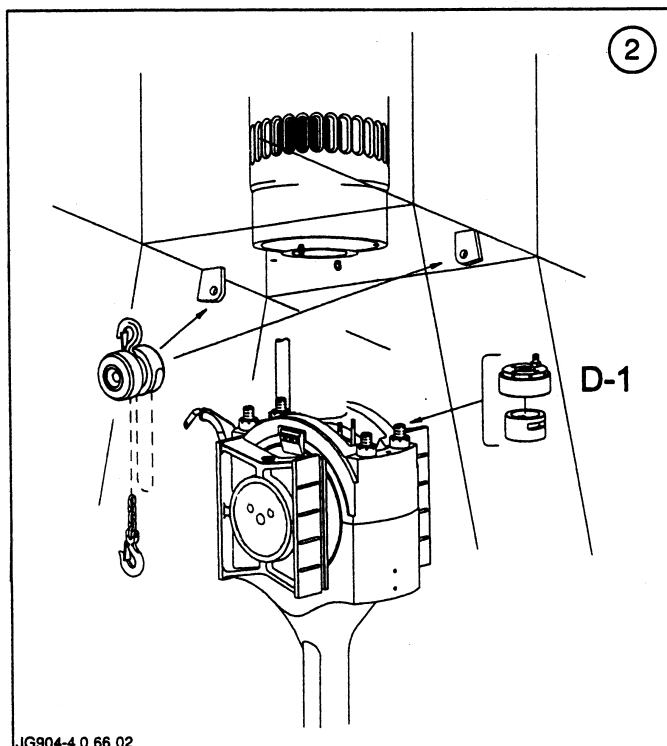
913



DATA:

D-1	Hydraulic pressure	
	- dismantling.....	900-990 bar
	- tightening.....	900 bar
D-2	Crosshead bearing cap.....	815 kg
D-3	Crosshead.....	2813 kg
D-4	Connecting rod.....	3350 kg
D-5	Crankpin bearing cap.....	346 kg
D-6	Guide shoe.....	280 kg
D-7	Cooling oil outlet pipe.....	45 kg
D-8	Cooling oil inlet bend.....	38 kg
D-9	Thrust piece.....	4.8 kg
D-10	Screwing-in torque - piston rod stud.....	100 Nm
D-11	Screwing-in torque - inlet pipe stud.....	325 Nm
D-12	Screwing-in torque - crosshead bearing stud.....	380 Nm
D-13	Tightening torque - thrust piece.....	230 Nm
D-14	Tightening torque - nuts on guide strips.....	380 Nm
D-15	Tightening torque - outlet pipe.....	365 Nm
D-16	Tightening sequence -	
	1. Tightening-up torque.....	100 Nm
	2. Tightening-up angle.....	50°





JG904-4.0 66 02

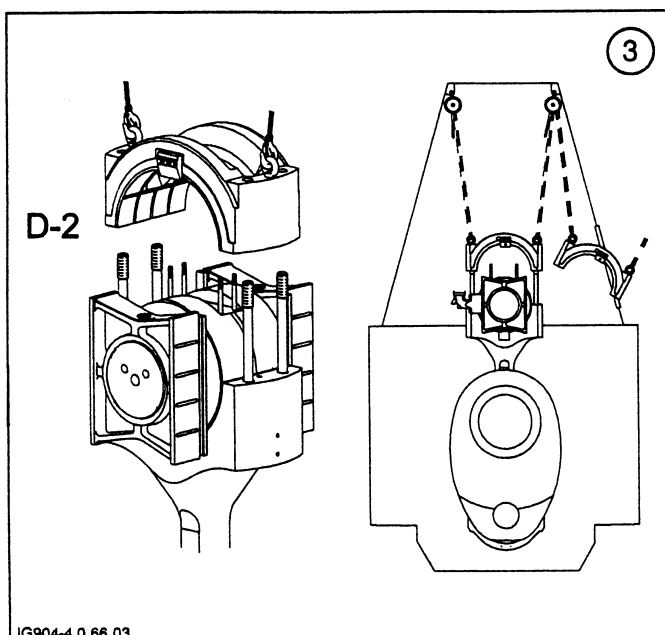
1. Dismount the piston.
See Procedure 902-2.
2. Turn the crosshead down far enough to give access to the nuts on the crosshead bearing cap.

Mount two eye screws in the bottom of the cylinder frame box in the fore-and-aft direction, mount two eye screws in the athwartship direction, and suspend two tackles.

Mount the spacer rings and the hydraulic jacks for loosening the nuts on the crosshead bearing nuts.

For operation of the hydraulic tools, see Chapter 913.

Loosen the nuts, remove the hydraulic jacks and unscrew the nuts.



JG904-4.0 66 03

3. Mount eye screws in the crosshead bearing cap and hook on the tackles.

Dismount the bearing cap and lift it out of the engine.

Remove the screws and dismount either the foremost and aftmost thrust piece from the crosshead bearing .

Remove the guide ring and the shim from the crosshead.



4. Dismount the four studs for the bearing cap by means of the stud setter.

Dismount the cylindrical dowel by means of the special drawing tool.

Mount the eye screw in one of the screw holes in the bend, hook on a tackle and haul taut.

Remove the spring pin and dismount the bend for the telescopic pipe and remove the studs from the crosshead.

Mount the special lifting tool on the crosshead and hook on the engine room crane.

5. Turn the crosshead to TDC and hand taut with the engine room crane.

Mount an eye screw in each side of the crankpin bearing cap and, by means of shackles and wires, hook on the tackles and haul taut.

Mount the spacer rings and hydraulic jacks for loosening the nuts on the crankpin bearing cap studs.

For operation of the hydraulic tools, see Chapter 913.

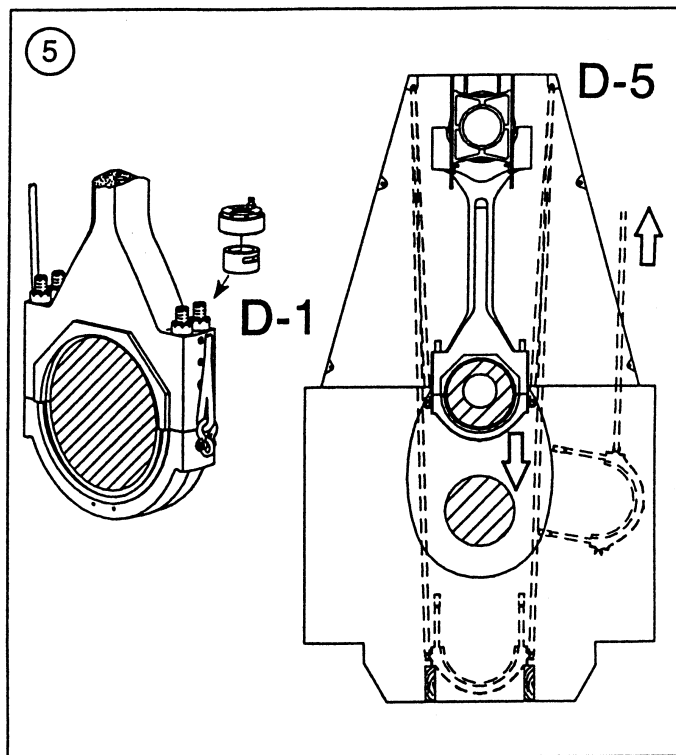
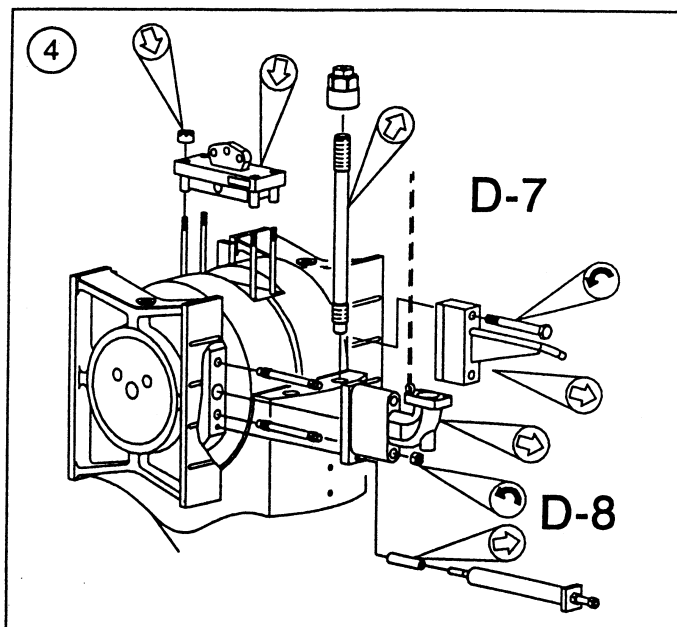
Loosen the nuts, remove the hydraulic jacks and unscrew the nuts.

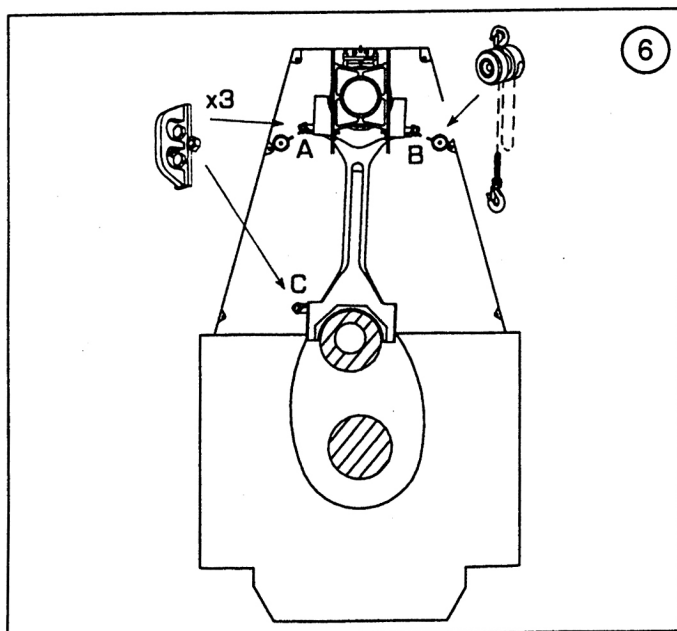
Lower the bearing cap.

Caution !

Be careful that the studs do not damage the crankpin journal.

Remove the bearing cap from the engine. Then remove the tackles from the bottom of the frame box.



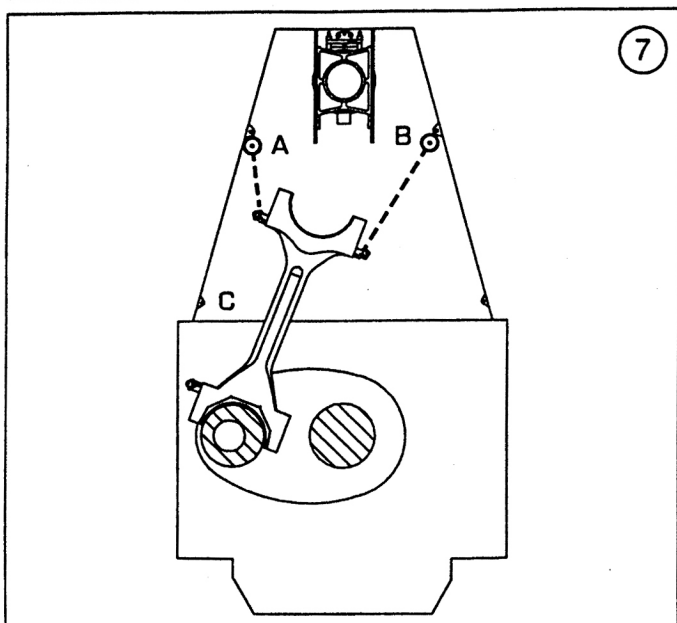


6. Mount the lifting attachments for fixing the connecting rod on the head of the connecting rod. Fasten tackles to the fixed mountings **A** and **B** on the frame box wall and attach the tackle hooks to the mentioned mountings. Haul the tackles taut.

Mount also a lifting attachment in the crankpin end of the connecting rod, on the exhaust side.

7. Turn the crankthrow towards BDC while "following" with the tackles, thus continuously supporting the connecting rod.

The crosshead is now resting on the supports.



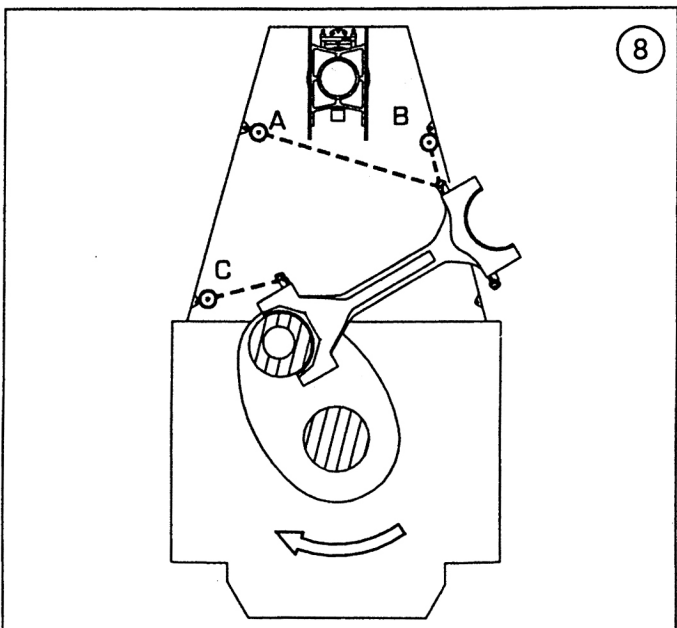
Turn the crankthrow to 45° before BDC. Shift tackle **B** from the lifting attachment on one side of the connecting rod to the other lifting attachment.

8. By means of the tackle from lifting fitting **A**, tilt the connecting rod towards the camshaft side until the connecting rod is leaning out of the doorway.

Attach a tackle to the fixed mounting **C** on the frame box wall and connect the tackle hook to the lifting mounting at the lower end of the connecting rod.

Turn the crank carefully upwards while "following" with the tackles, guiding the head of the connecting rod out of the doorway.

Shift the tackles from one lifting attachment to another when it is necessary.



9. Remove the floor chequer plate for the pertaining cylinder.

Place a wire rope round the connecting rod, hook on the engine room crane and haul taut.

Continue turning upwards till about 30° after TDC while "following" with the tackles and the engine room crane.

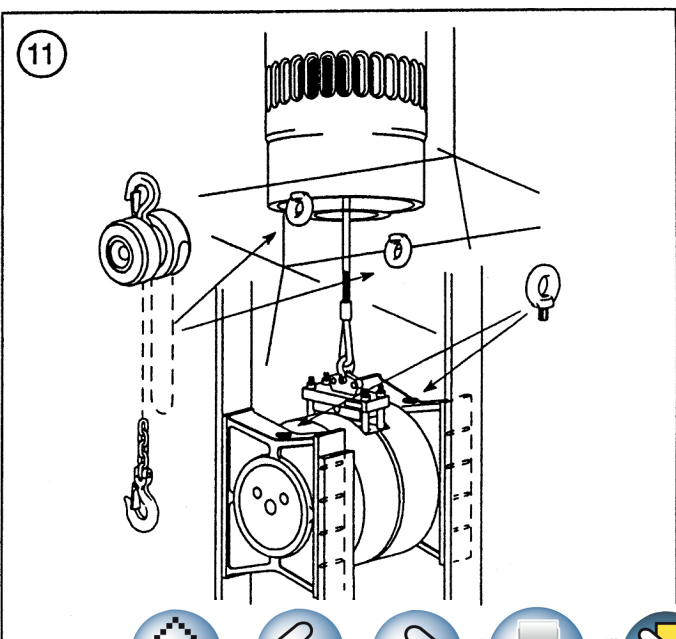
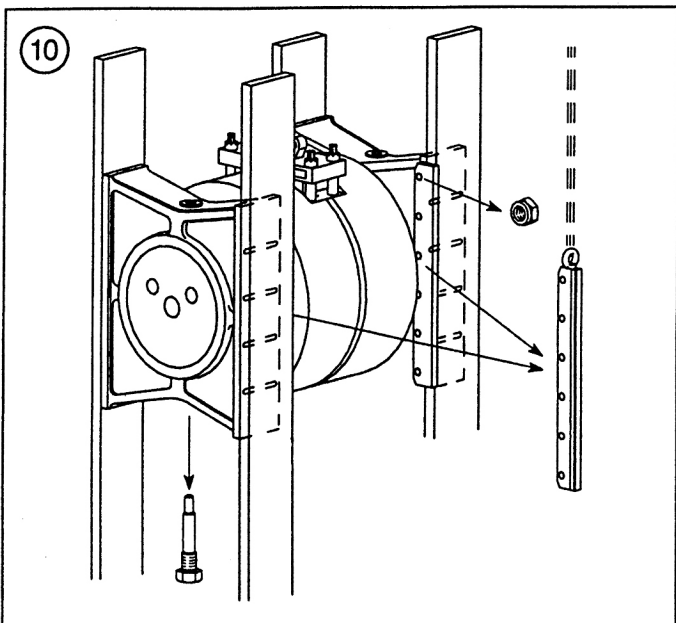
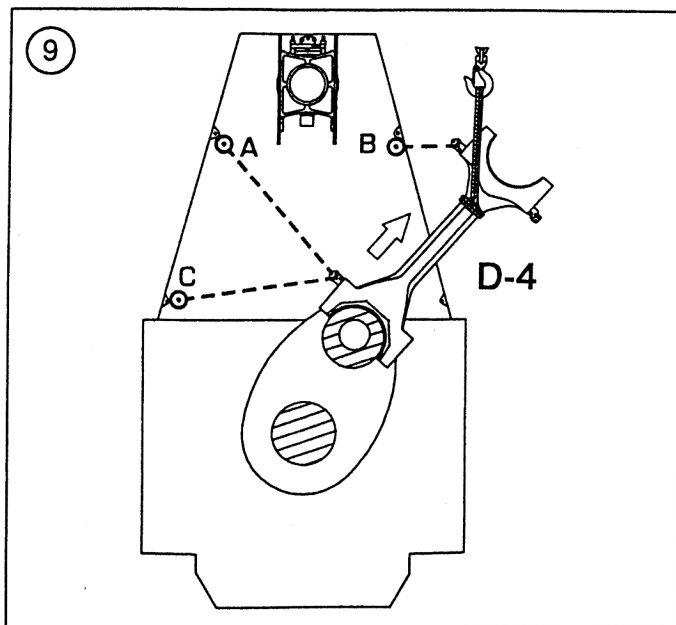
Then lift the connecting rod out of the engine by means of the engine room crane and the tackles.

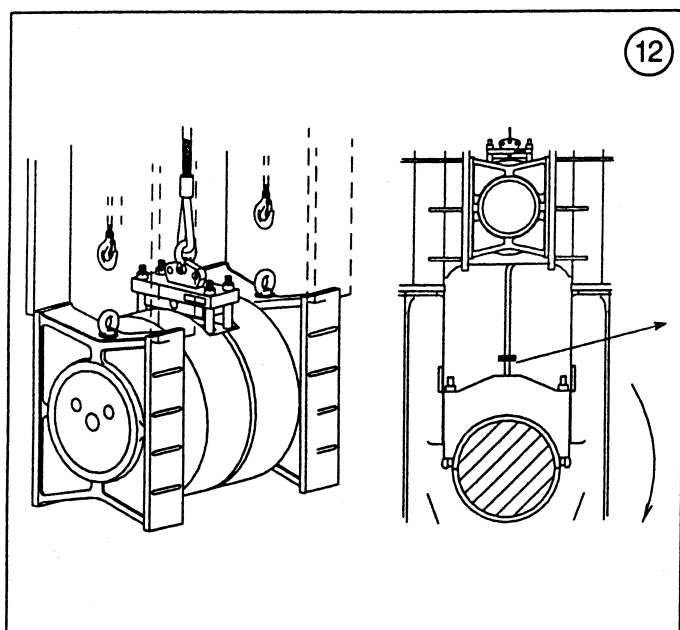
10. Remove the guide strips and the guide screws from the guide shoes.

Dismount the guide screws from the bottom of the guide shoes.

11. Suspend two tackles from the eye screws in the bottom of the cylinder frame in the fore-and-aft direction.

Mount an eye screw in the top of each guide shoe.





12. Turn the crank to BDC.

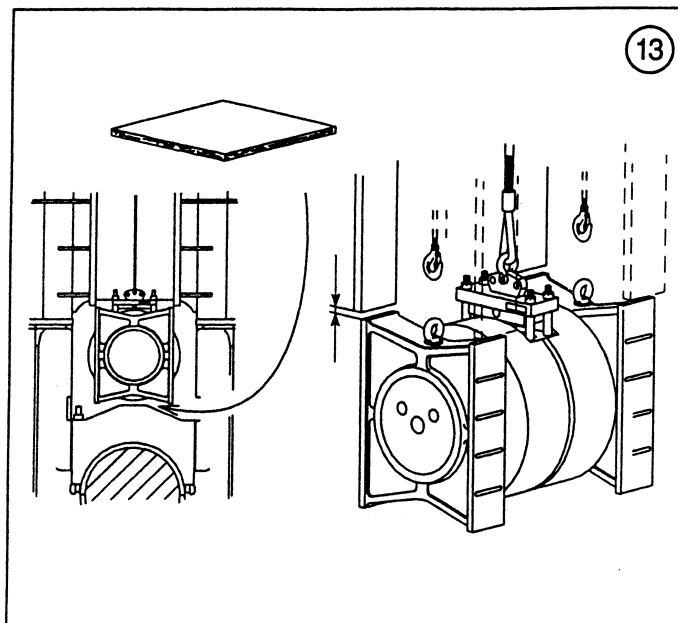
Remove the oil pipes from the two adjacent main bearing caps.

13. Place a thin wooden plank or similar on top of the crank to protect the crosshead.

Lower the crosshead so that the guide shoes are just below the cut-out in the body plate of the framebox.

Note !

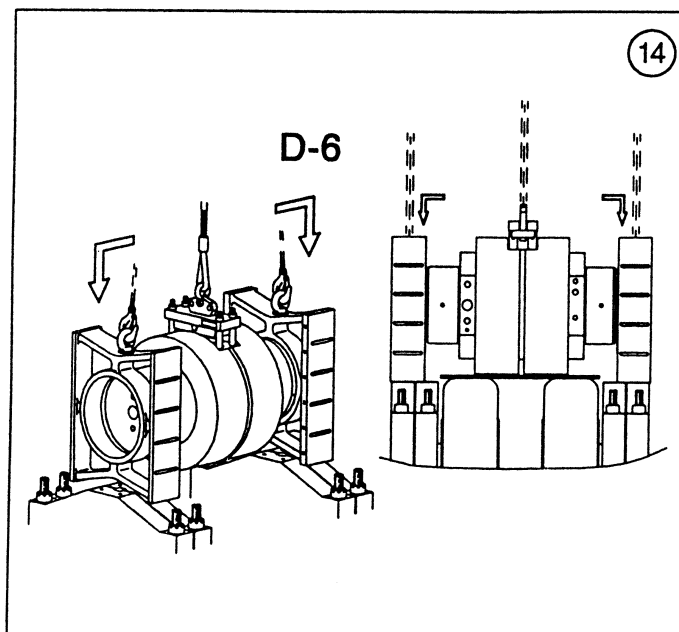
Be aware that the clearance between the crank and the crosshead is very narrow.



14. Hook on the tackles to the eye screws in the guide shoes.

Haul tight and, at the same time, draw the guide shoes sideways until they are free of the crosshead.

Land the guide shoes on top of the main bearings.



15. Turn the crosshead 90°.

Mount an eye screw at the end of the crosshead and, by means of wire rope and tackles, remove the crosshead from the engine.

Land and protect the crosshead outside the engine.

Remove the guide shoes from the engine.

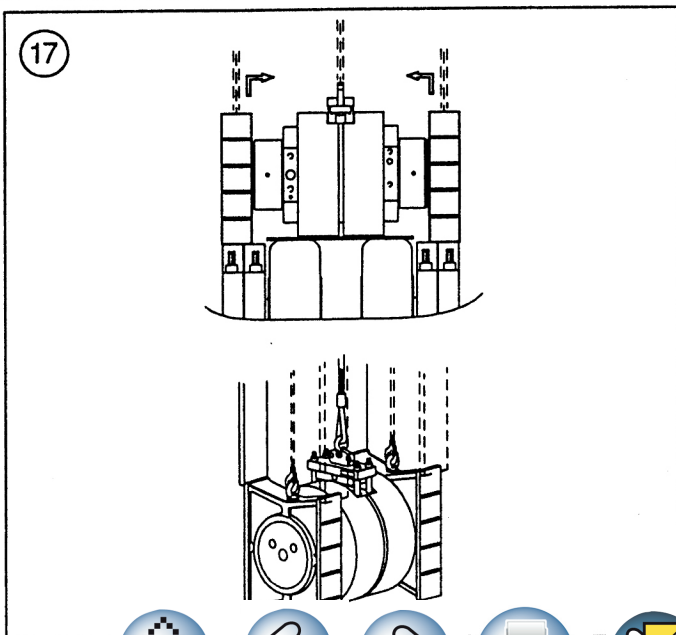
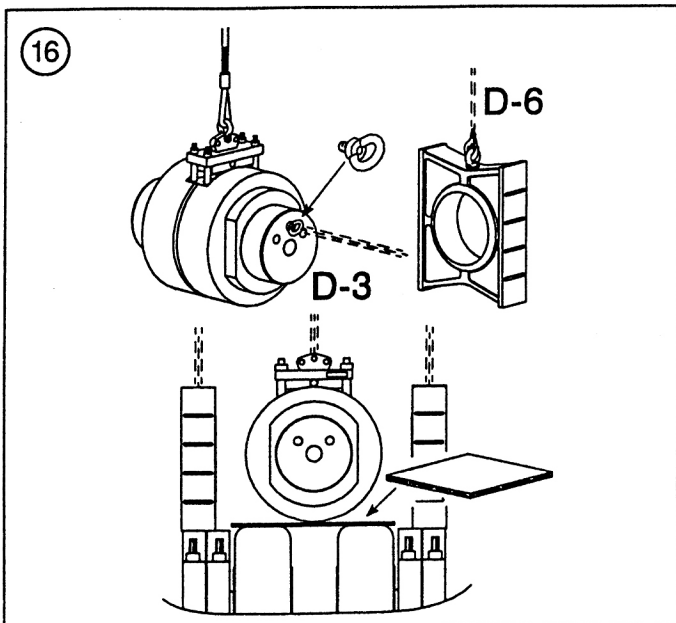
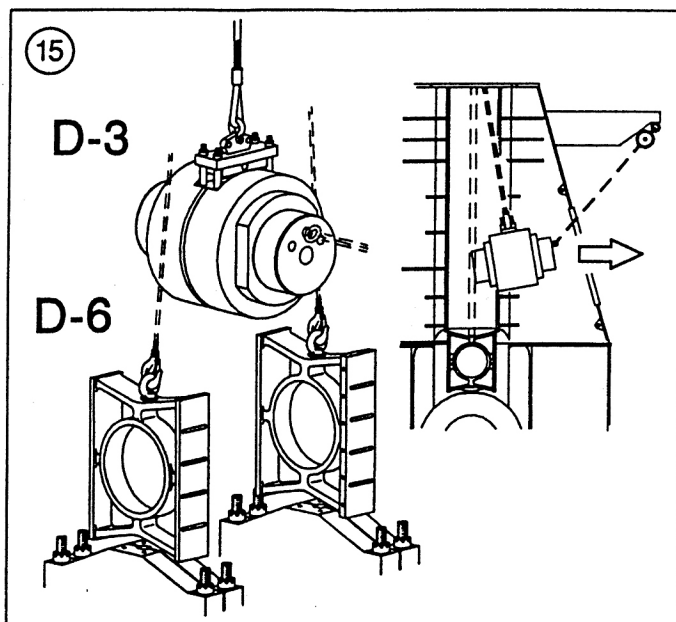
Mounting the new crosshead

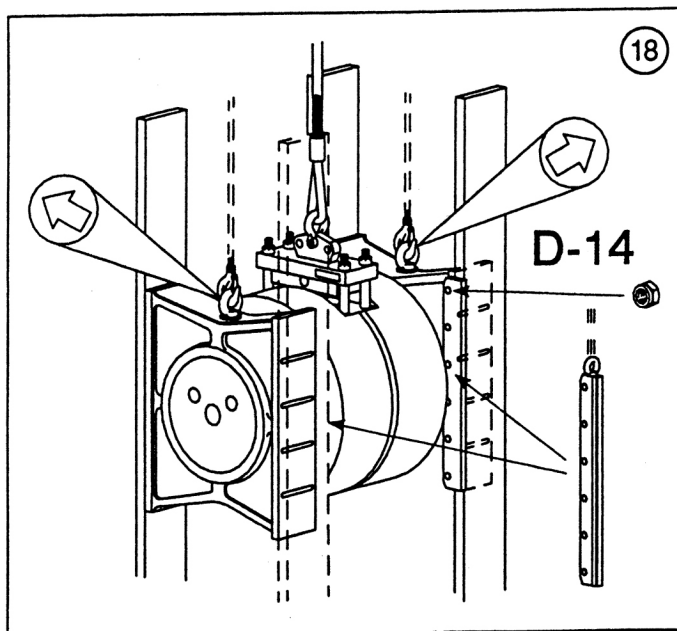
16. Place the guide shoes without the guide strips in the engine upon the main bearing caps.

Clean the new crosshead, removing the protecting layer of grease, insert an eye screw in the end of the crosshead, and mount the special lifting tool.

Lift the crosshead into the engine by means of wire rope, tackles and the engine room crane.

17. Hook on the tackles to the eye screws in the guide shoes and mount the guide shoes on the crosshead and mount the guide screws in the bottom of the guide shoes.



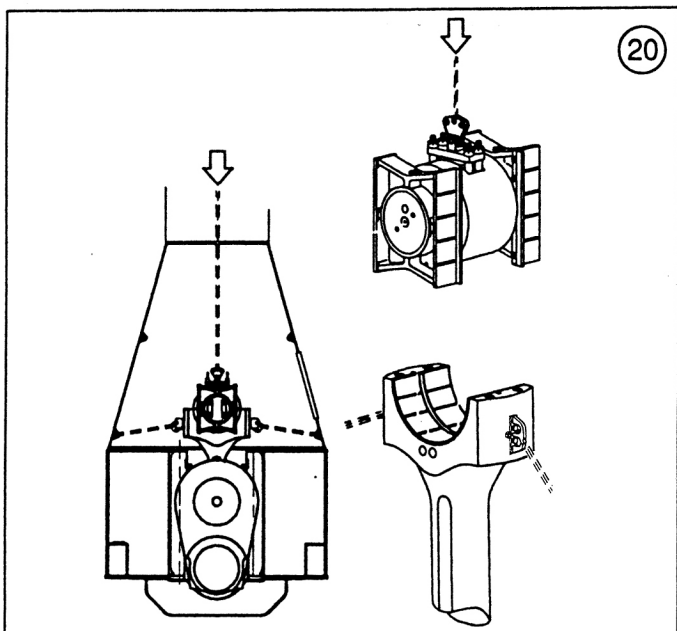
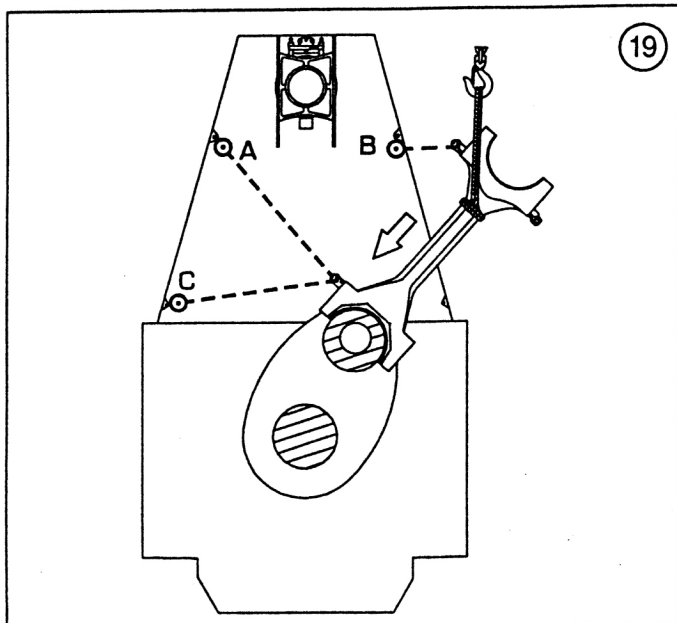


18. By means of the engine room crane, lift the crosshead to a working position and mount the guide strips on the side of the guide shoes.

Remove the tackles and eye screws from the guide shoes.

19. Lift the connecting rod into the engine in the reverse order to dismantling, see points 7, 8, 9 and 10.

20. Turn the connecting rod upwards, guiding with the tackles until the crosshead is landed in the connecting rod.



21. Turn down while following with the engine room crane and tackles.

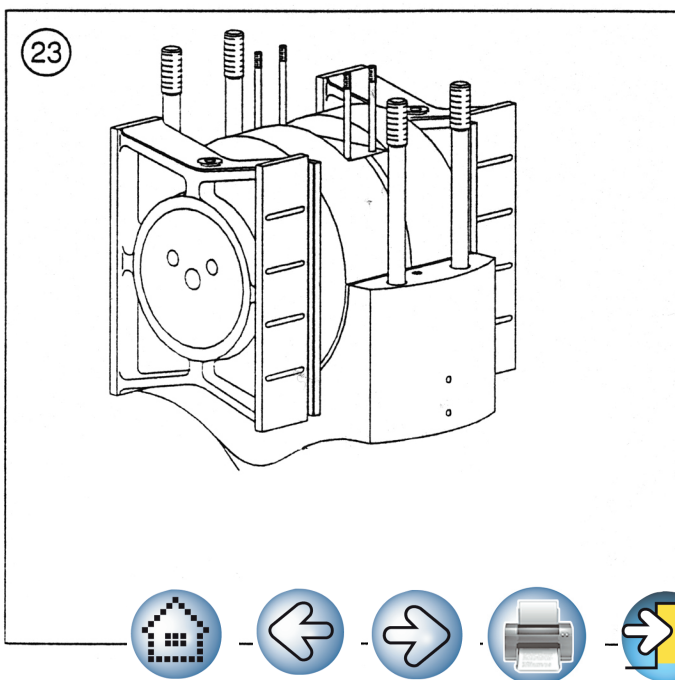
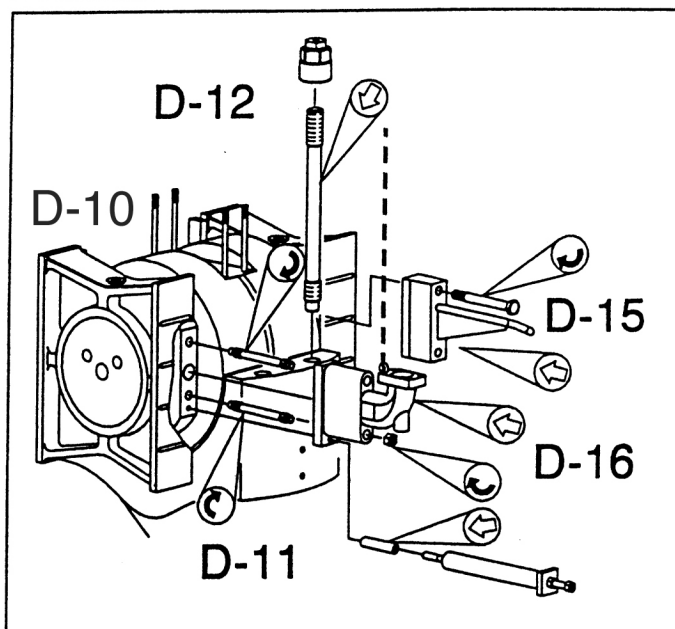
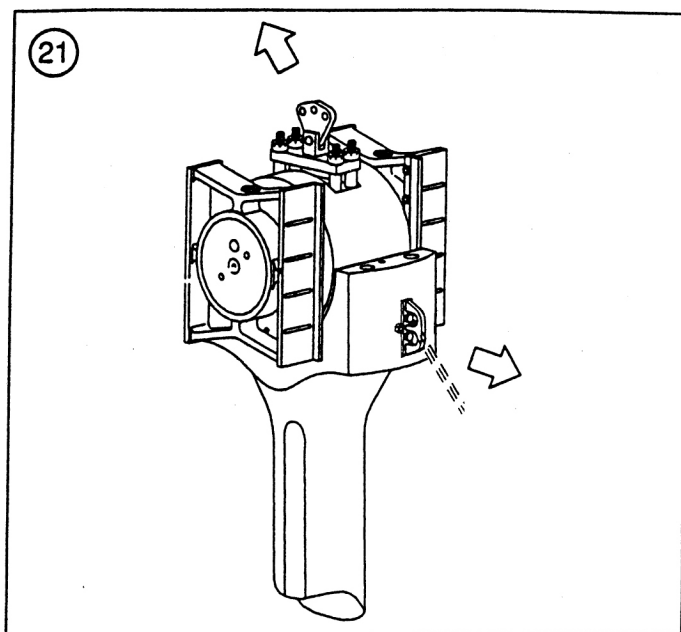
Remove the engine room crane from the lifting tool, and remove the lifting tool.

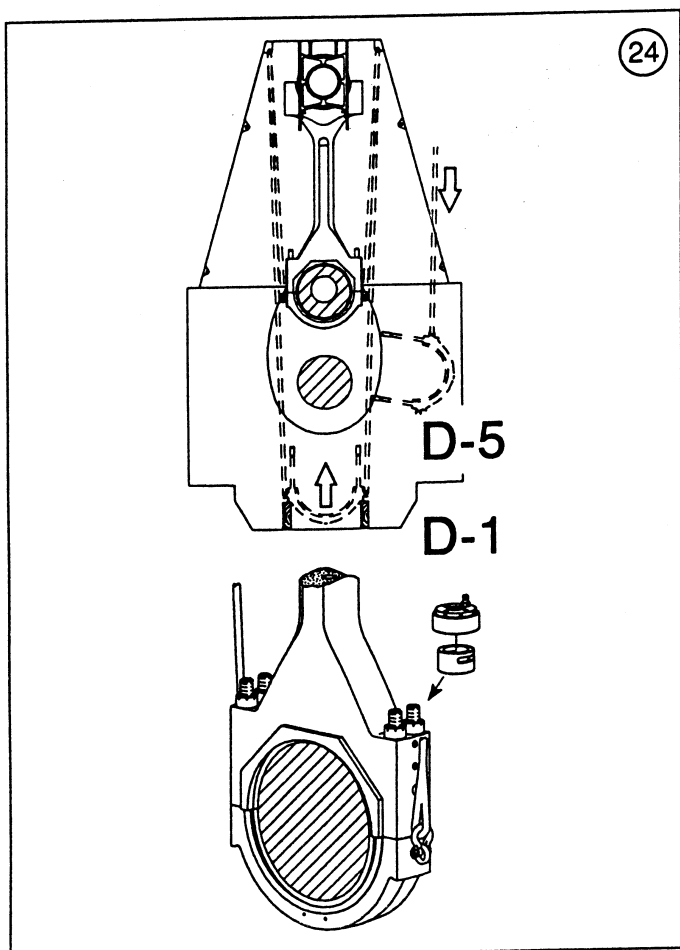
When possible, remove the lifting attachments from the connecting rod and the lifting tool from the crosshead.

22. Mount the studs for the cooling oil inlet bend. Mount the bend and outlet pipe.

Mount the cylindrical dowel with threaded hole in the bend.

23. Mount the shim and the guide ring on the crosshead.





24. Turn to TDC.

Lift the crankpin bearing cap into the engine.

Mount and tighten the crankpin bearing cap and remove the eye screws.

25. Turn to BDC.

Lift the crosshead bearing cap into the engine.

Mount and tighten the crosshead bearing cap. Remove the eye screws.

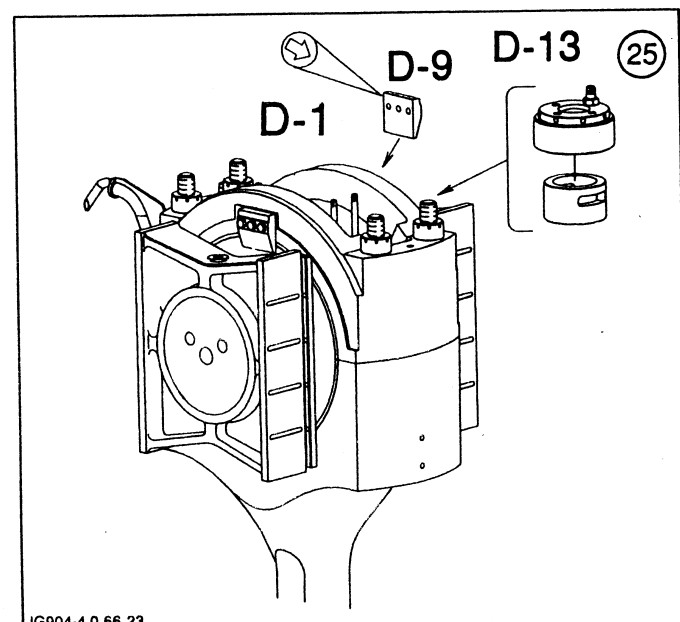
Mount the two thrust pieces on the side of crosshead bearing cap and lock the bolts.

26. Mount the piston.

See Procedure 902-2.

Remove the nut from the telescopic pipe suspending tool. Turn downwards and tighten the telescopic pipe.

27. Finally mount the cylinder cover.
See Procedure 901-1.



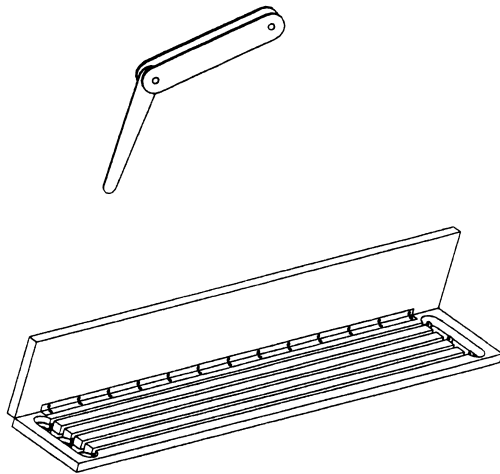
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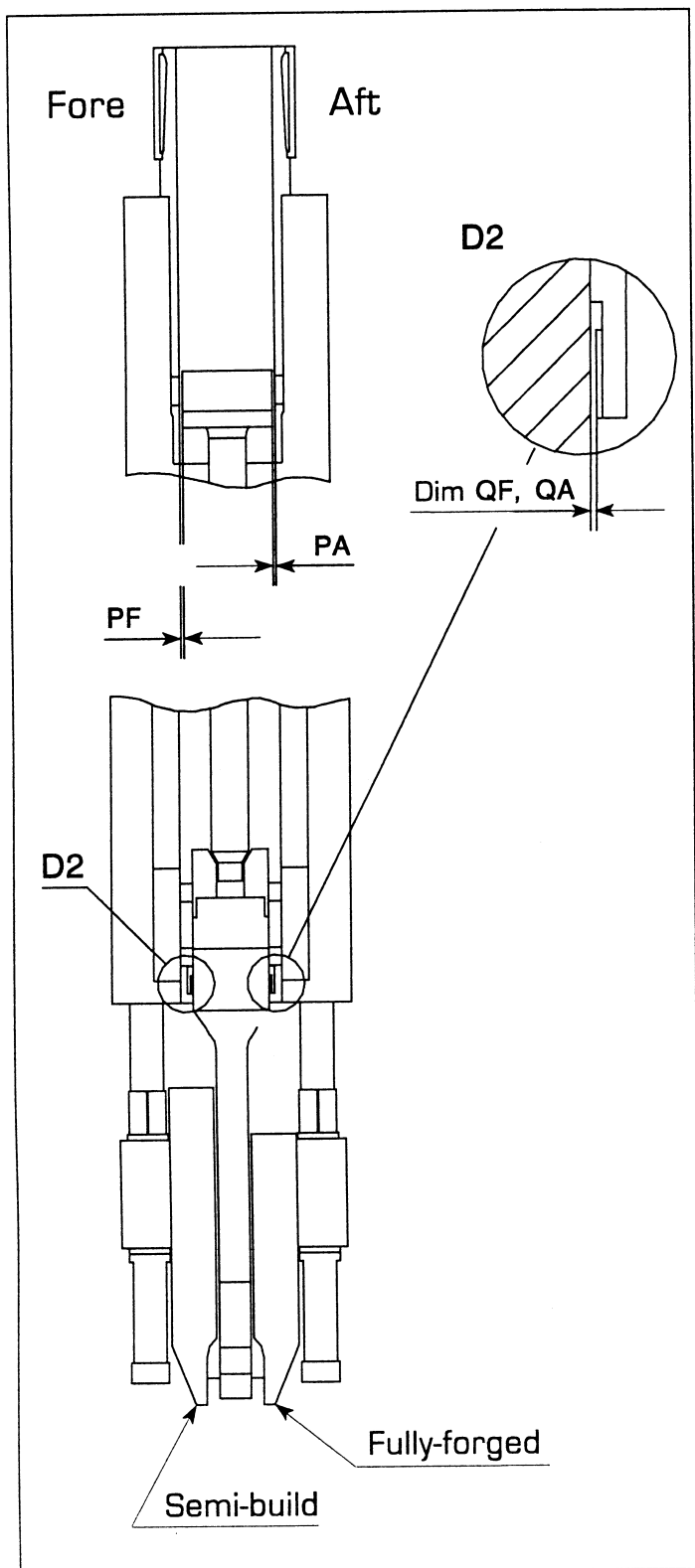


SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

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DATA:

Acceptance criteria with piston in centre (F-A direction).

Measuring points	Value		mm
PF + PA	N _{max}		0.75
E + G	N	max	0.55
		min	0.2
H + F	O _{max}		0.85
J + X	N	max	1.1
L + Y		min	0.6
K + X	O _{max}		1.3
M + Y			
QF + QA	O _{max}		0.8
N: New and cold engine with staybolts tightened (less than 100 running hours).			
O: Engine in service.			

Unit mm	Cyl.	1	2	3
Piston/liner	PF			
	PA			
Framebox	E1			
	E2			
	E3			
	E4			
Crosshead guide	F1			
	F2			
	F3			
	F4			
Bolted type ☐	G1			
	G2			
	G3			
Fixed type ☐	G4			
	H1			
	H2			
	H3			
	H4			
	J+X			
	L+Y			
	K+X			
	M+Y			

In order to achieve uniform measuring conditions on board, the ship's trim must be kept as close as possible to 0°.

1. Mount a transparent plastic tube along the length of the bedplate.

Bend the ends approx. 250 mm up along the framebox side. See T.

Fill the tube with water (possibly coloured) until the water level is approx. 100 mm from the end of the tube.

Trim the ship so that the difference between the water level **S** fore and aft is less than 1.5 mm per 1000 mm.

Measurements are to be taken with a ruler.

2. Turn the crankshaft in ASTERN direction to approx. 45° after BDC (Position 1). The crosshead shoes now rest against the AHEAD guides.
3. The centering of the piston in the cylinder is measured (from the scavenge air space by means of a long feeler gauge) between the piston skirt and the cylinder liner in the Fore and Aft positions (**PF-PA**).

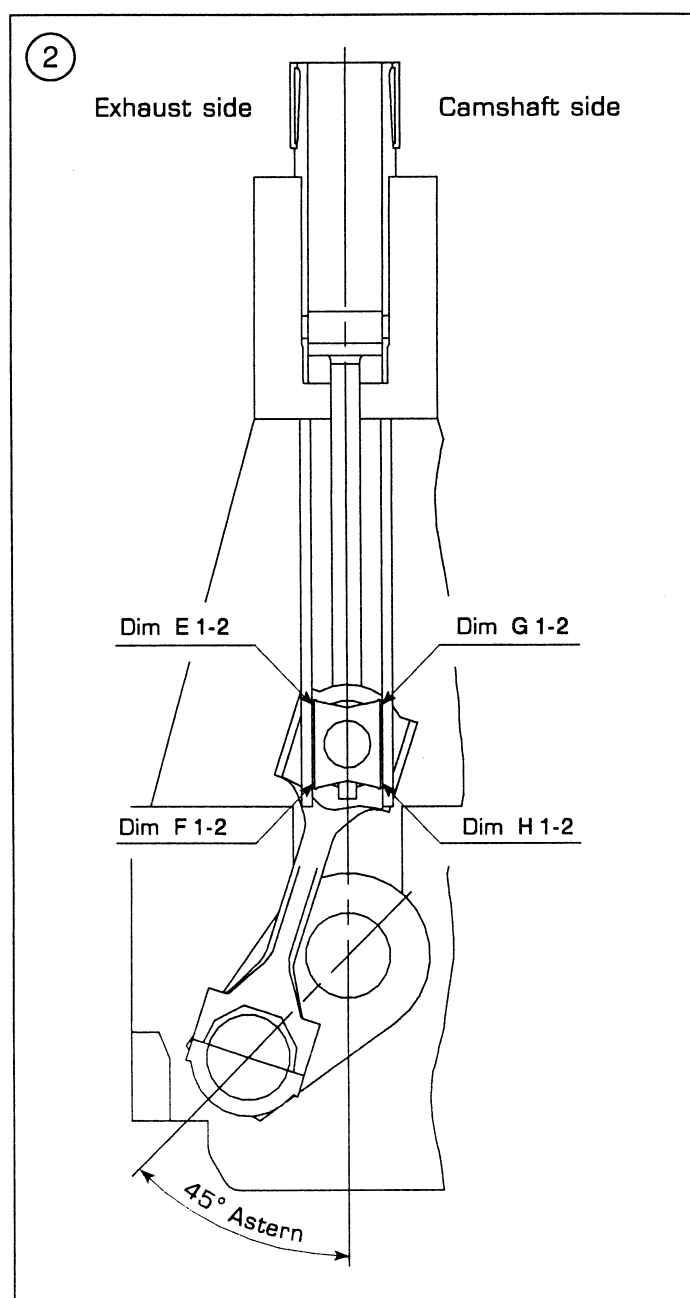
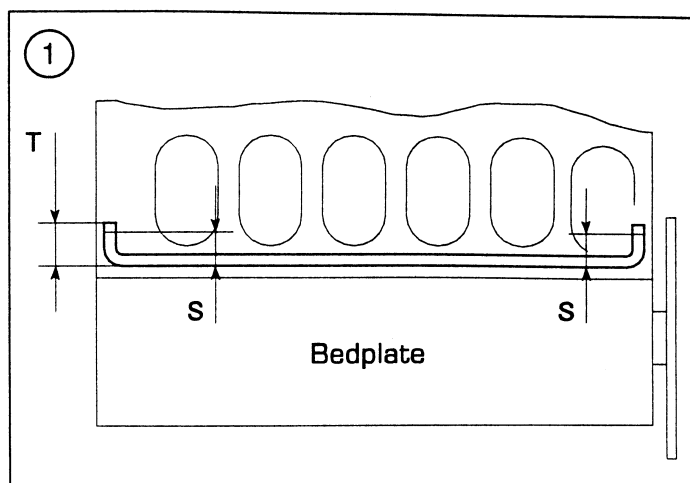
Note !

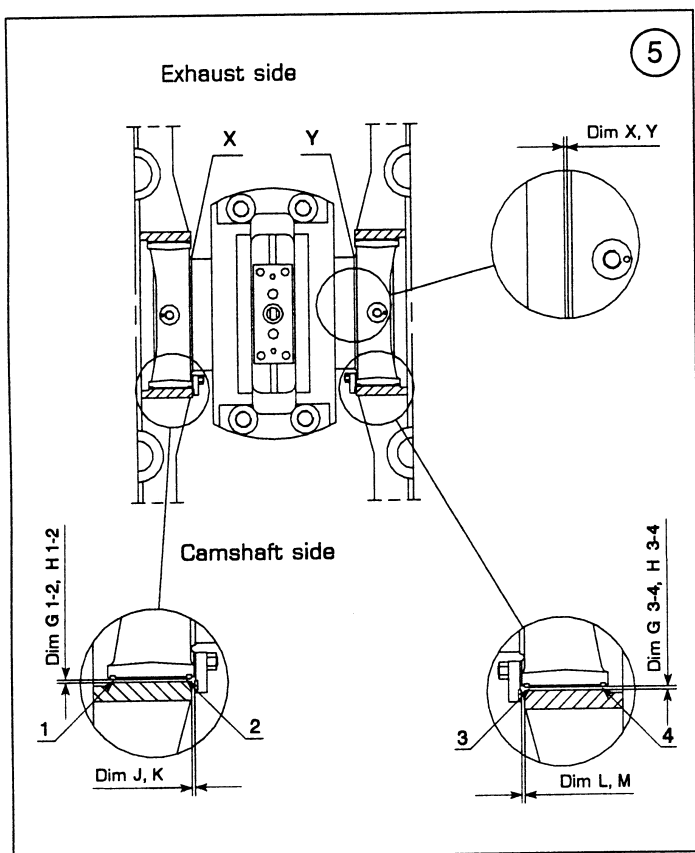
When the skirt is designed with a bronze ring, the clearance is to be checked between the bronze ring and the cylinder liner

Make sure that the piston is clear of the cylinder liner in the fore-and-aft direction.

4. Check that the guide shoes are in contact with the guides both at the top **G** and at the bottom **H**.

Then measure the clearance between the opposite guide shoes and guide at the top **E** and the bottom **F**.





5. Measure the clearance between the guide shoes and the crosshead (**X** and **Y**).

Measure the clearance between the guide strips and guides (**J**, **K**, **L** and **M**).

The clearance, calculated as **J+X**, **K+X**, **L+Y** and **M+Y**, is adjusted by the insertion of shims so that it is symmetrical in relation to the clearance between the piston skirt and the cylinder liner.

Parallelity between the guide strip and guide is to be kept within a tolerance of 0.2 mm per 1000 mm.

6. Check the clearance between the crosshead and the connecting rod (**QF** and **QA**, see *Data*).

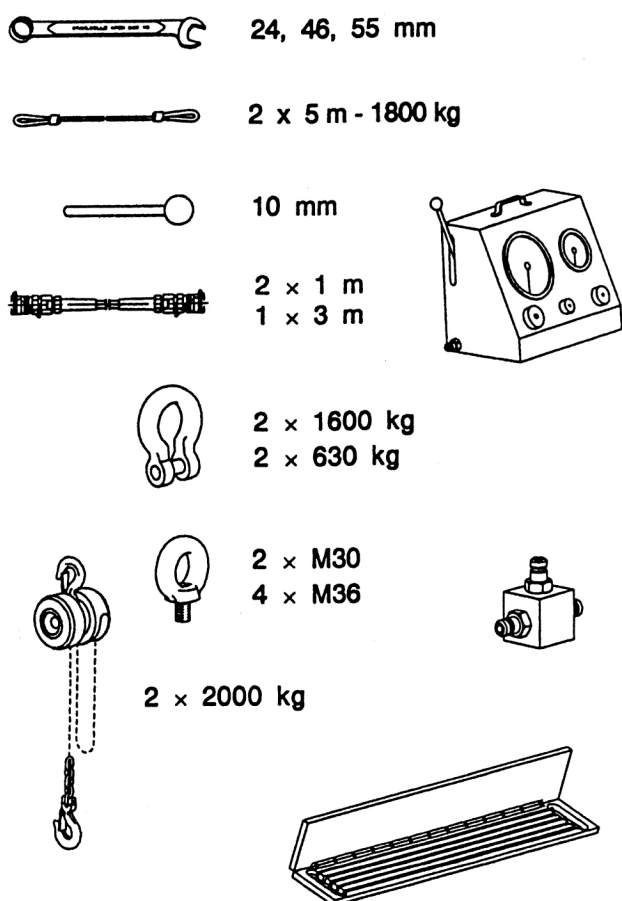
It is recommended to note down the measured results to be able to ascertain possible later changes.



SAFETY PRECAUTIONS

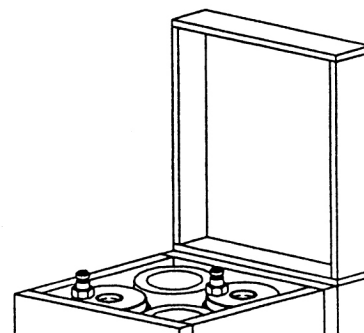
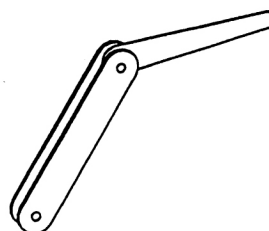
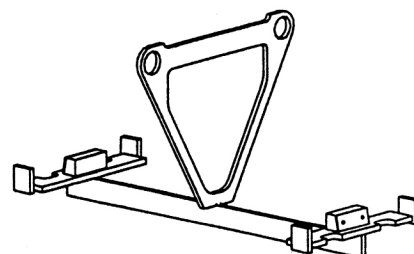
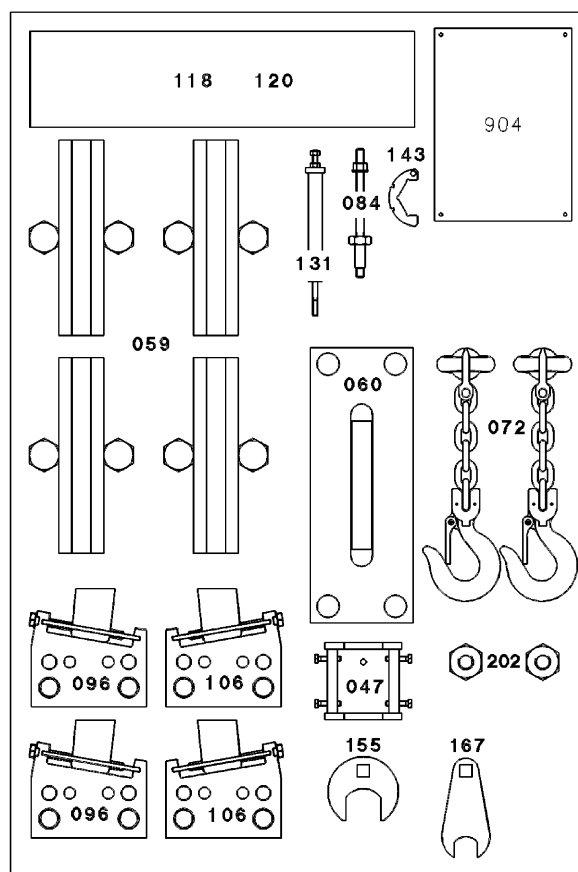
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

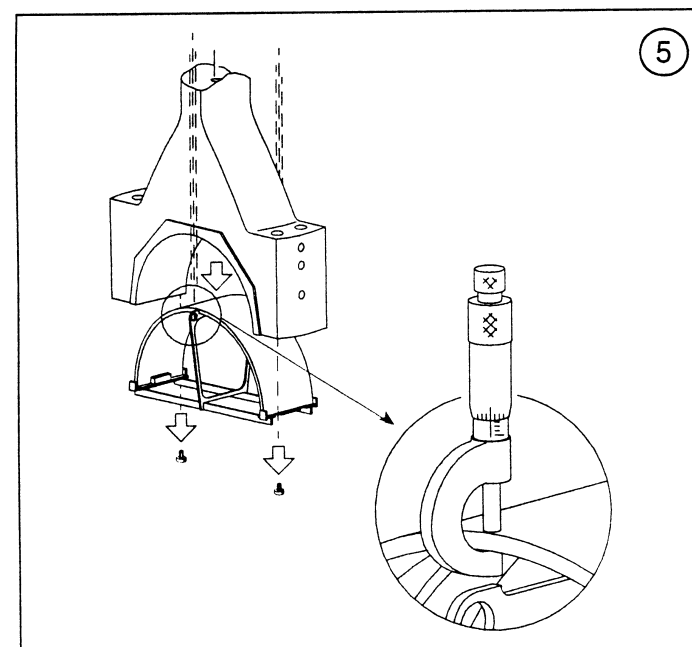
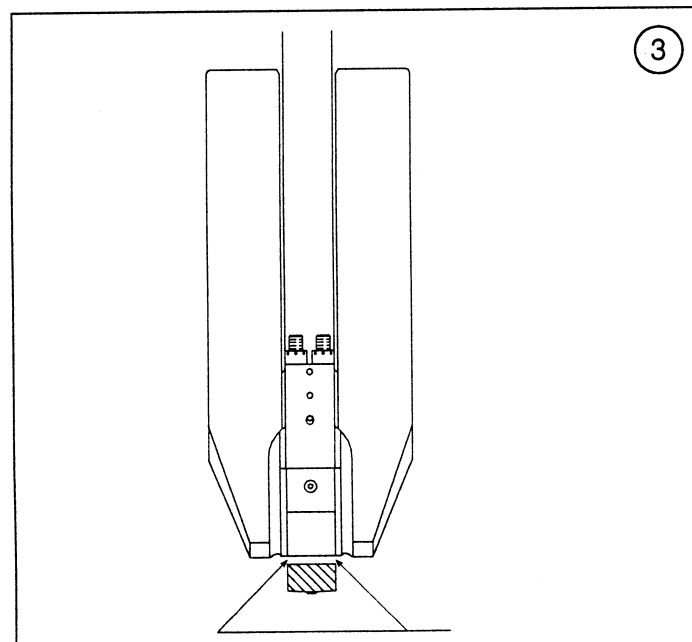
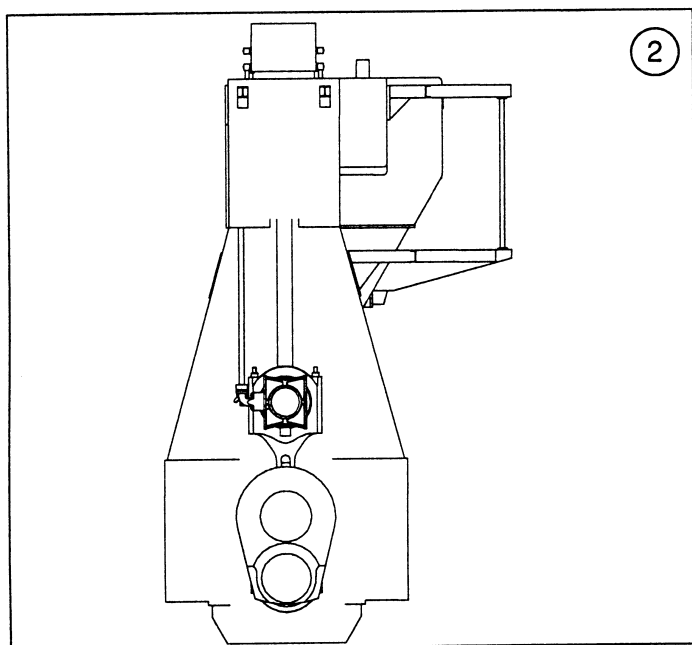
913



DATA:

D-1	Hydraulic pressure:	
	- dismantling.....	900-990 bar
	- full tightening.....	900 bar
	- stepwise tightening.....	400 bar
D-2	Crankpin bearing cap.....	346 kg
D-3	Crankpin bearing - upper shell.....	54 kg
D-4	Crankpin bearing - lower shell.....	41 kg
D-5	Crankpin bearing cap + shell + connecting rod studs	437 kg





The bottom clearance between the journal and a new bearing shell is a result of the summation of the bearing assemblies production tolerances.

The bottom clearance will normally be in the range of 0.36 mm to 0.58 mm.

For the bottom clearance on an actual bearing see the measurement in the adjustment sheet.

1. Open the crankcase door opposite the cylinder concerned.
2. Turn the crank concerned to BDC.
3. Measure the clearance in the crankpin bearing by means of a feeler gauge, which is to be applied at the bottom of the bearing shell in both sides.
4. When checking the clearances, the discrepancy between the noted measurements in the adjustment sheet (or the noted clearance for a later new installed bearing) **must not** exceed 0.05 mm, if so, the crankpin bearing must be disassembled for inspection.
See Procedure 904-6.2.
5. The wear limit for the crankpin bearing shells is based on an evaluation of the bearing condition at the time of inspection.

An average wear rate of 0.01 mm per 10,000 hours is regarded as normal.

For further external inspection of the crankpin bearing, see Chapter 708 'Bearings' in the instruction book, Vol. I, OPERATION.



1. Turn the crank to BDC.

If the clearance is not within the limits stated on the Data Sheet, proceed as follows:

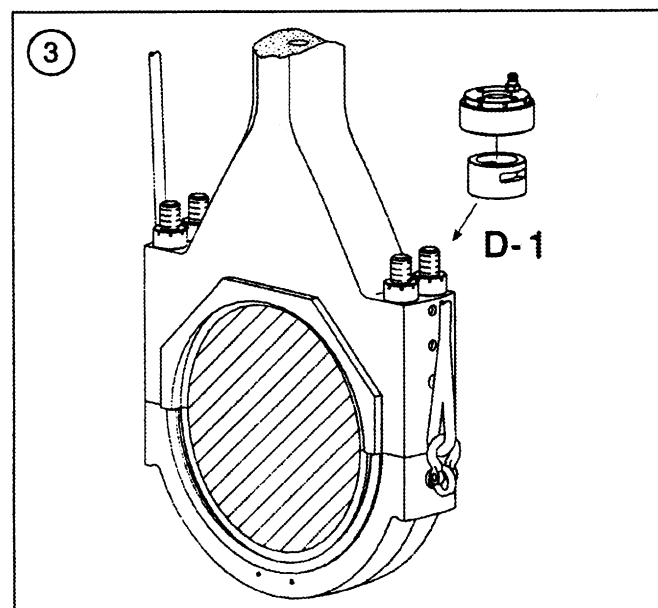
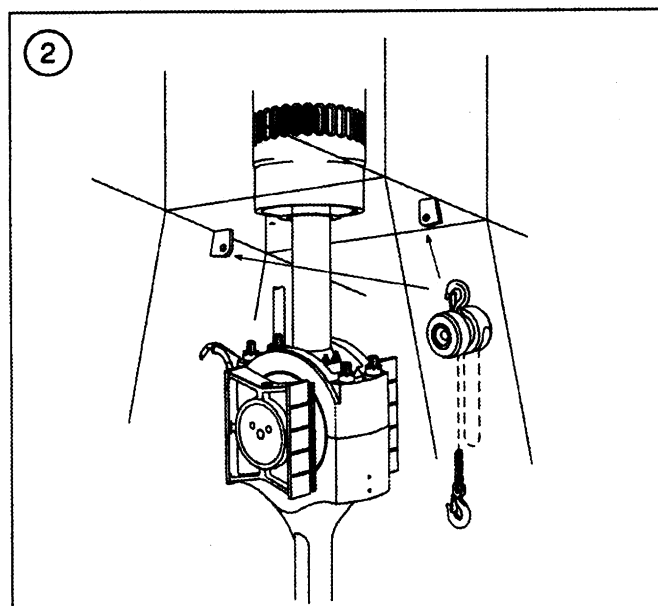
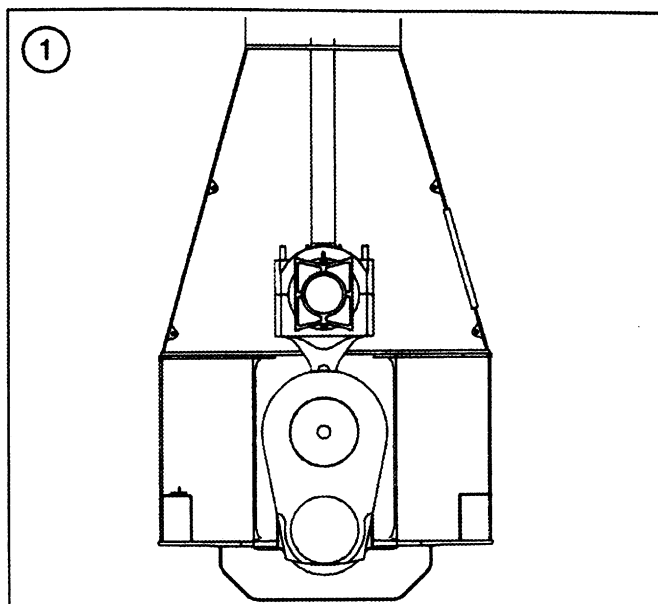
2. Suspend two tackles in the two lifting brackets in top of the frame box in the athwartship direction.
3. Turn the crank to TDC.

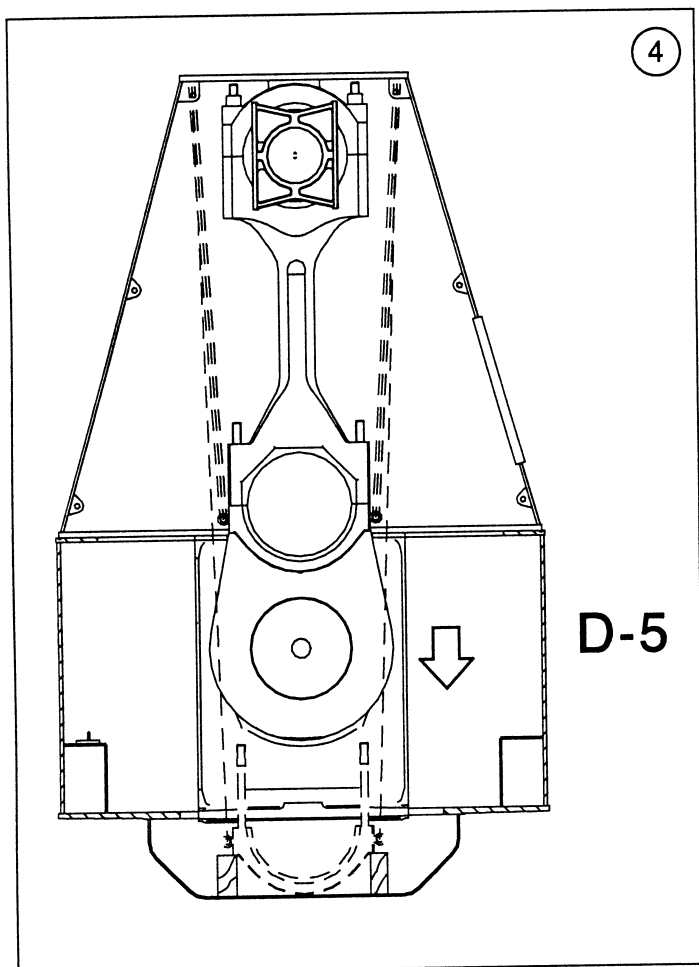
Mount an eye screw in each side of the crankpin bearing cap and, by means of shackles and wires, hook on the tackles and haul tight.

By means of the hydraulic jacks, loosen the nuts of the crankpin bearing studs.

For operation of the hydraulic jacks, see Chapter 913.

Remove the hydraulic jacks and the nuts.





4. Lower the bearing cap while seeing **carefully** that the studs do not damage the crankpin journal.

Land the bearing cap on a couple of planks in the oil pan.

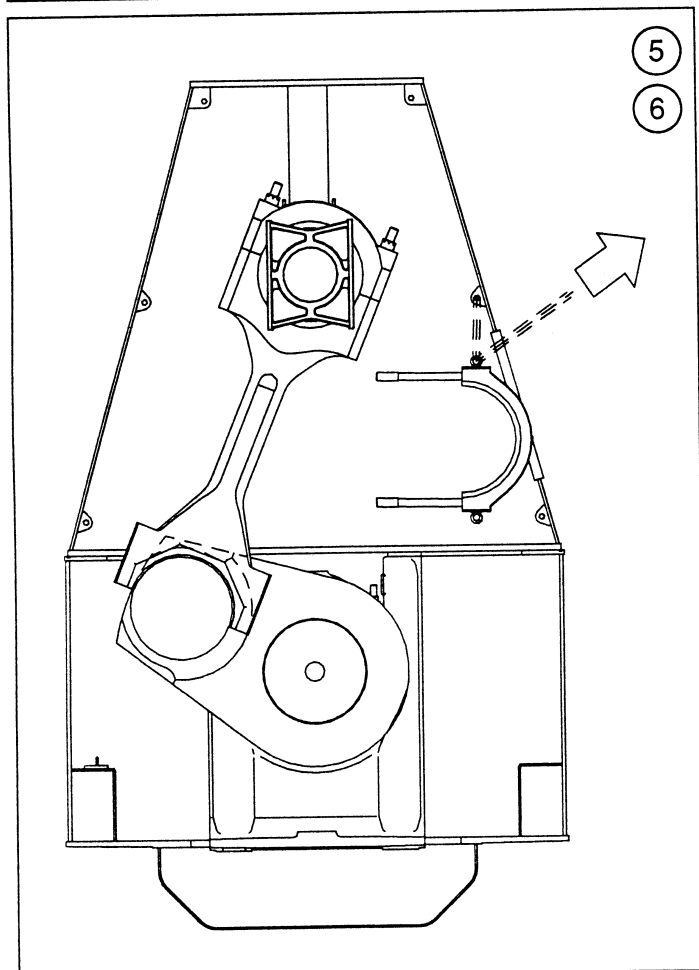
Carry out the inspection of the bearing shell.

5. If the bearing shell needs to be exchanged, the whole bearing cap should be removed from the crankcase.

Suspend a tackle from the lifting brackets on the inside camshaft side of the frame box over the crankcase door opening.

Hook the tackle on to an eye screw on one side of the bearing cap.

6. By means of the tackle from the frame box inside wall, together with a tackle suspended from the platform bracket, lift out the bearing cap from the crankcase.



7. Place the bearing cap on one side on a couple of planks.

Dismount the bearing shell locking screws and replace the bearing shell by a new one.

8. Turn to TDC.

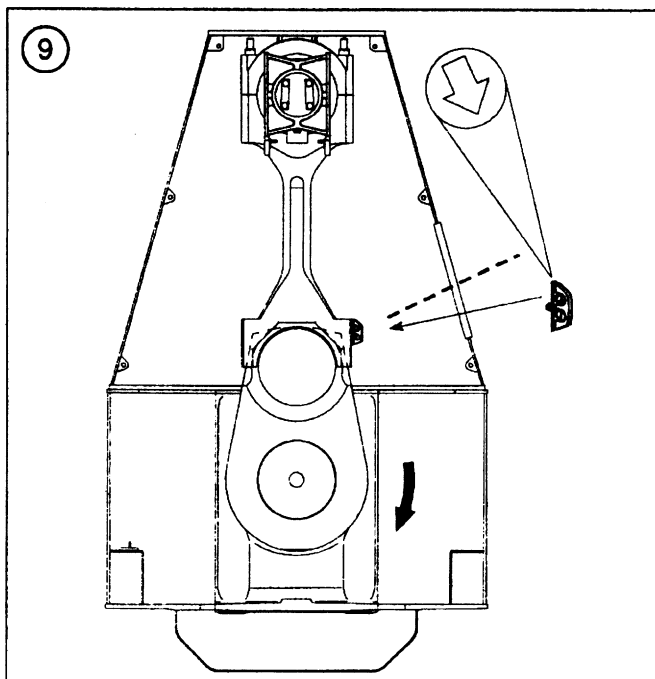
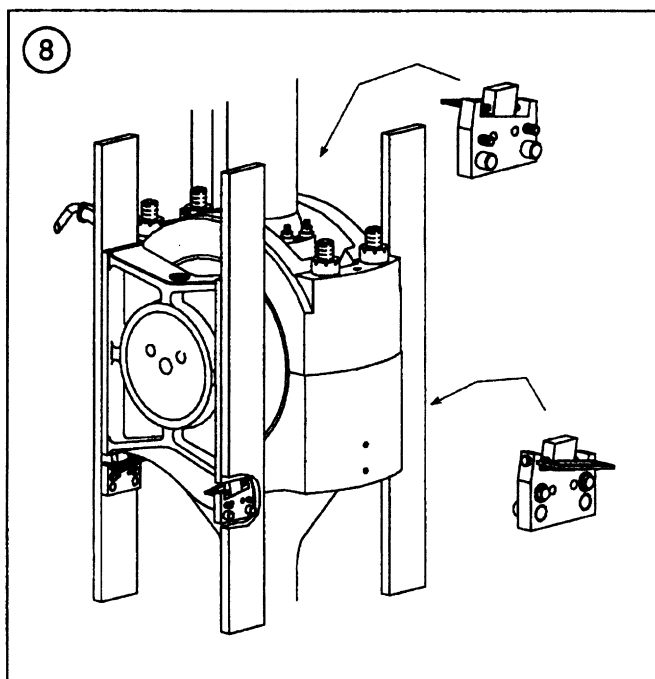
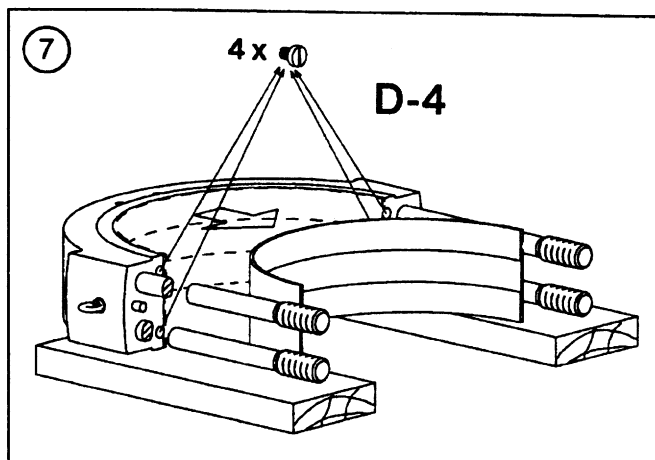
Mount the supports for the guide shoes on the crosshead guides.

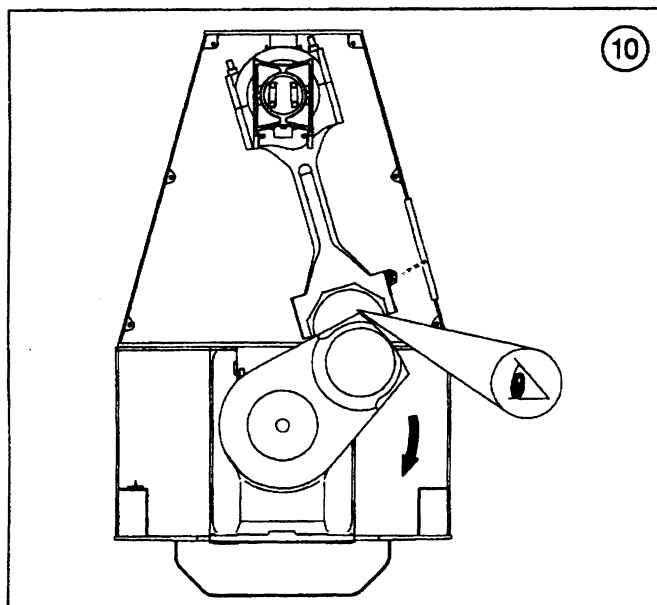
Carefully turn down the crank until the crosshead shoes rest on the supports.

Adjust the support brackets to the guide shoes so that the weight of the crosshead is distributed evenly on the four supports.

9. Mount a lifting attachment for fixing of the connecting rod at the lower end, on one side.

Hook on the tackle and haul tight.





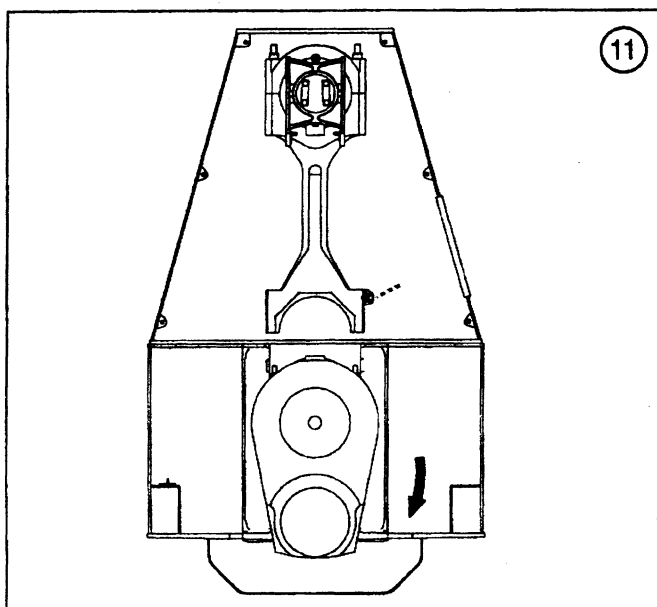
10. **Carefully** turn the crankshaft downwards, while “following” with the tackle, making sure that the upper bearing comes completely clear of the recess in the crankshaft when the parts begin to “separate”.

Continue turning the crankshaft until the bearing surface can be freely inspected.

Inspect the bearing surface and crankpin journal.

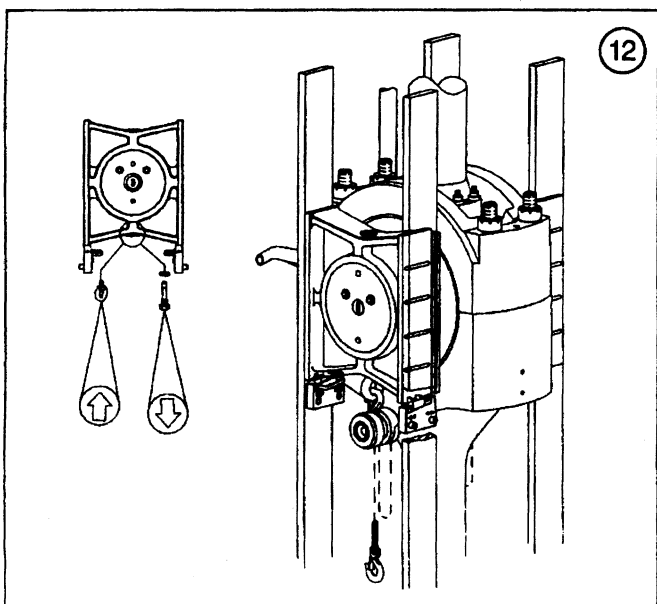
11. If it is necessary to replace the bearing shell, proceed as follows:

- Turn the crankshaft to BDC.
- Release the tackle so that the connecting rod is hanging freely.



12. Remove the stop screws from the lower side of the guide shoes and mount eye screws instead.

Suspend two tackles from the eye screws.



13. Place the lifting tool for the crankpin upper shell on the crank webs and hook the tackles on to the lifting tool.

Mount the tool on the bearing shell in the connecting rod by means of the tackles and haul taut.

14. Dismount the bearing shell locking screws.

Lower the lifting tool with the bearing shell by means of the tackles.

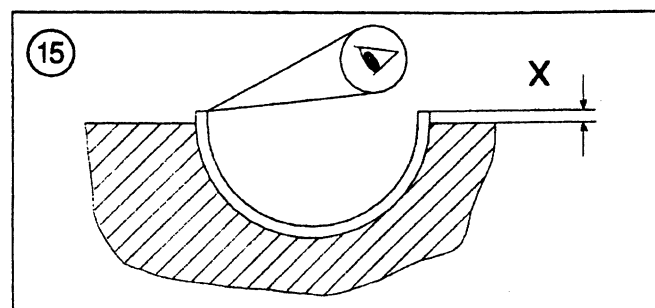
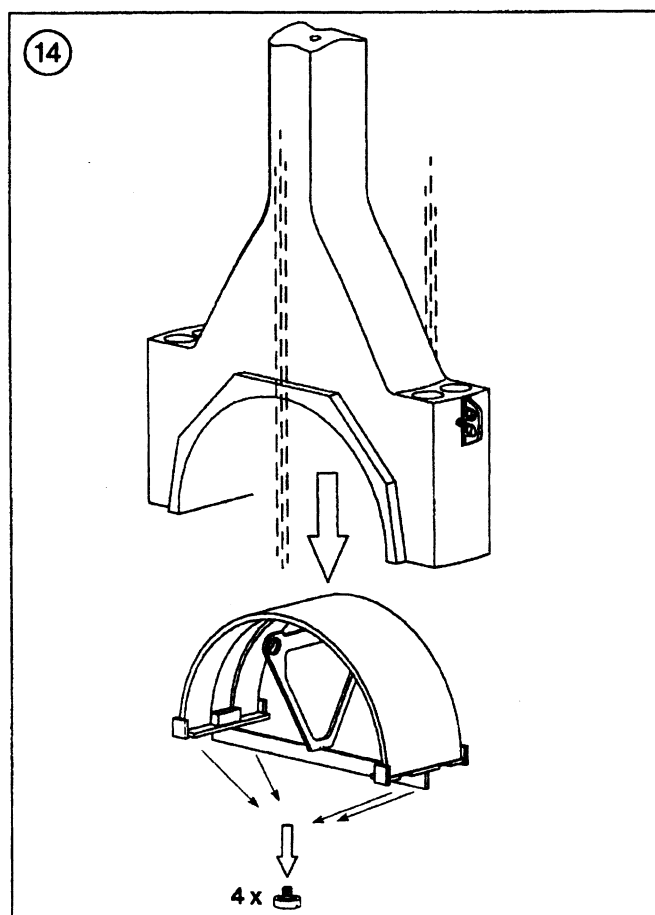
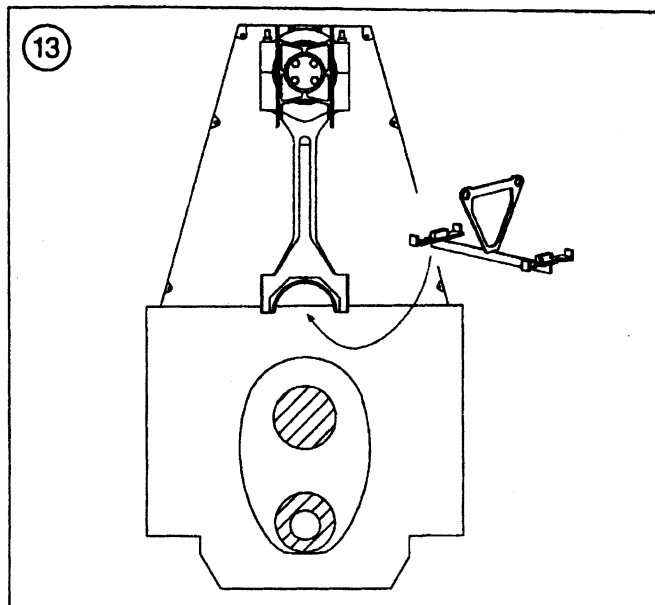
15. Replace the bearing shell with a new one, coat the bearing surface and journal with clean lubricating oil.

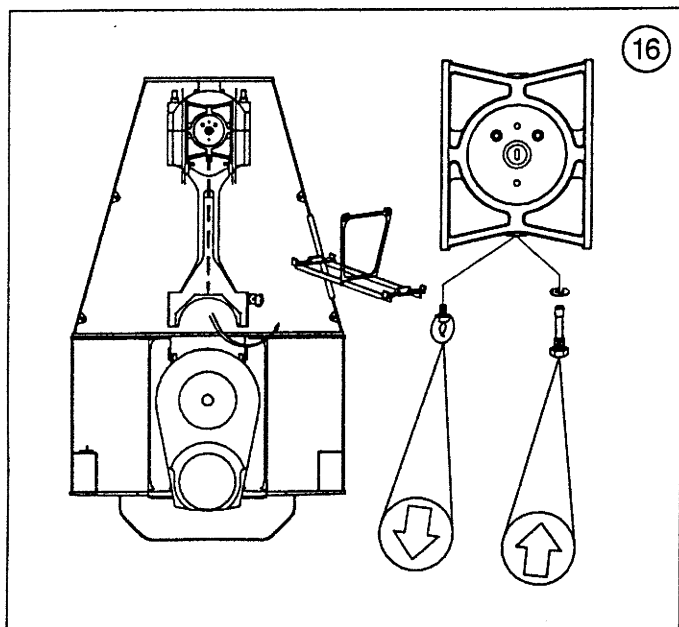
Mount the parts in the reverse order to dismantling.

The excess height **X** is to ensure correct tightening-down of the bearing shell and **must not** be eliminated.

Up to 3 mm undersize bearing shells are available as spares.

See also Volume I, OPERATION, Section 708.





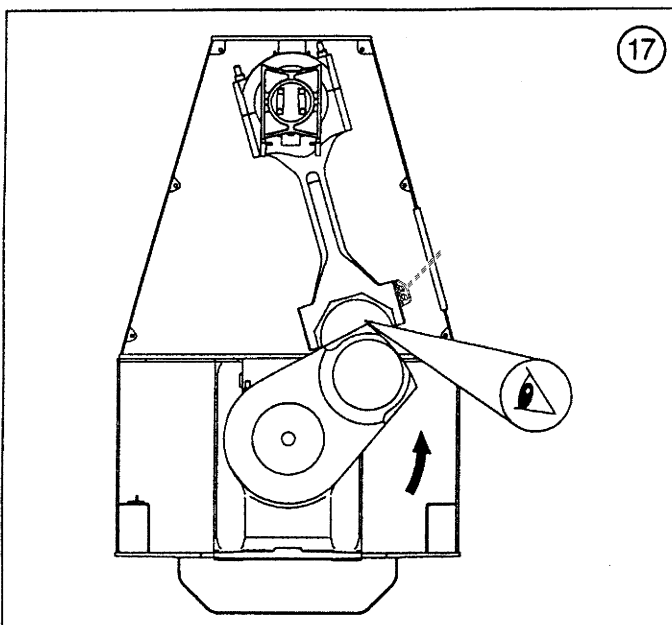
16. Remove the lifting tool, the tackles and the eye screws from the guide shoes.

Mount the stop screws in the guide shoes.

17. Hook on the tackle from the lifting bracket under the opening to the lifting attachment on the connecting rod and haul tight.

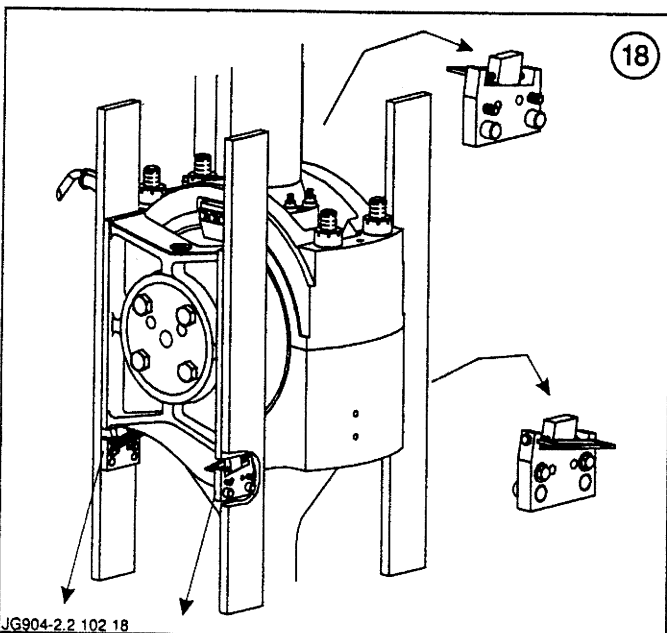
Carefully turn the crankshaft upwards while following up with the tackle, making sure that the upper part of the bearing enters the recess in the crankshaft when the parts turn together.

Remove the tackle and the lifting attachment from the connecting rod.



18. Turn the crosshead to TDC.

Remove the supports for the guide shoes from the crosshead guides.



19. Suspend the tackles from the lifting brackets in the top of the frame box.

Lift the bearing cap into the crankcase and land it on a couple of planks in the oil pan.

20. Hook the tackles on to the wires and lift the bearing cap into position against the connecting rod.

Caution !

During mounting, be careful that the studs do not damage the crankpin journal and check that the locating pins mounted in the bearing cap fit correctly in the opposing grooves.

This is to prevent the bearing shells from twisting during the tightening process.

21. Mount the nuts and, by means of spacer rings and hydraulic jacks, tighten the crankpin bearing cap. *For operation of hydraulic jacks, see Chapter 913.*

If four hydraulic jacks are available, all four nuts should be tightened simultaneously.

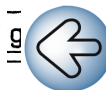
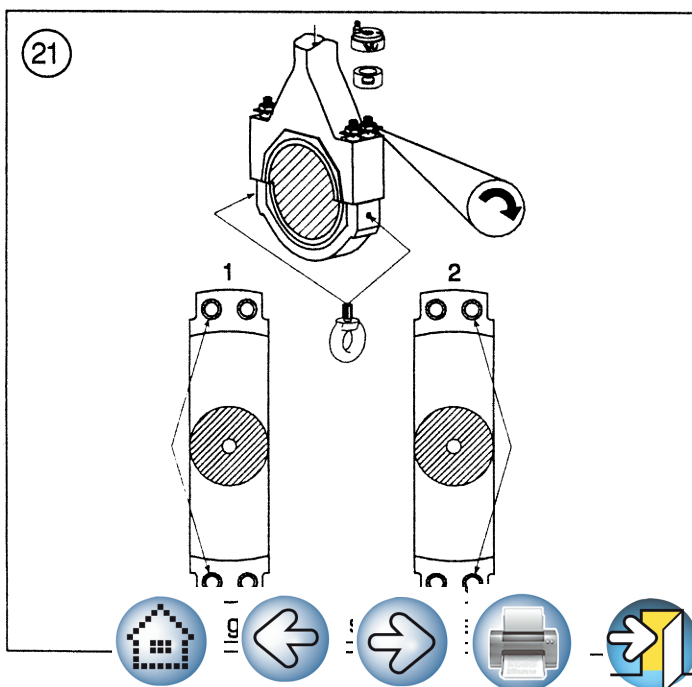
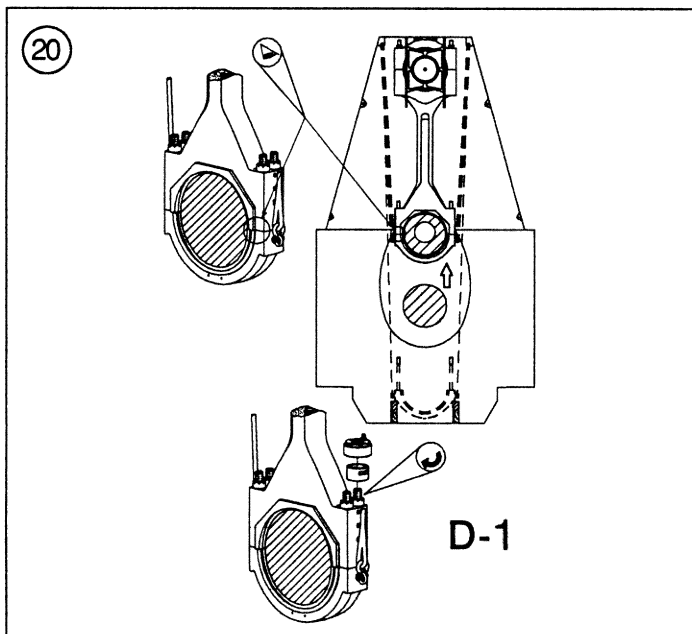
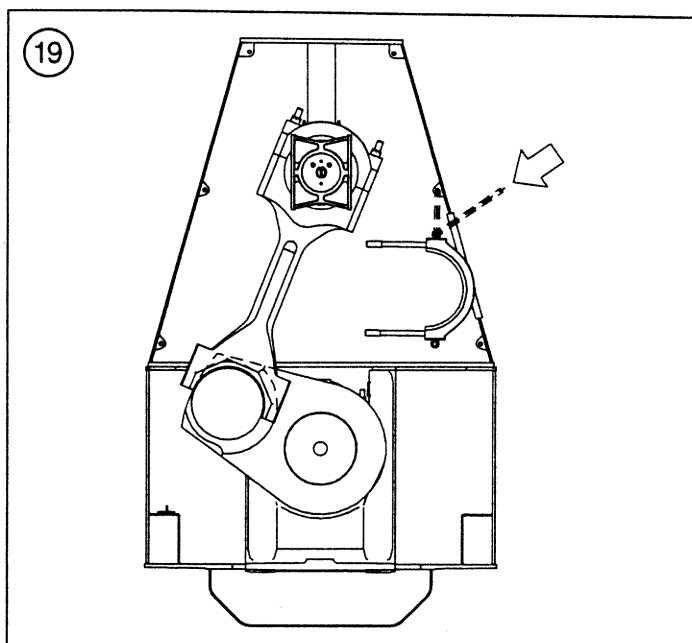
If only two hydraulic jacks are available, the nuts should be tightened in pairs, starting with the two foremost nuts, and then the two aftmost ones.

The tightening force can be applied either stepwise or fully.

Stepwise tightening is carried out as follows:

- tighten the foremost pair of nuts to the stepwise tightening pressure, see *Data*
- tighten the aftmost pair of nuts to the full tightening pressure
- tighten the foremost pair of nuts to the full tightening pressure

Remove the tackles from the top of the framebox.



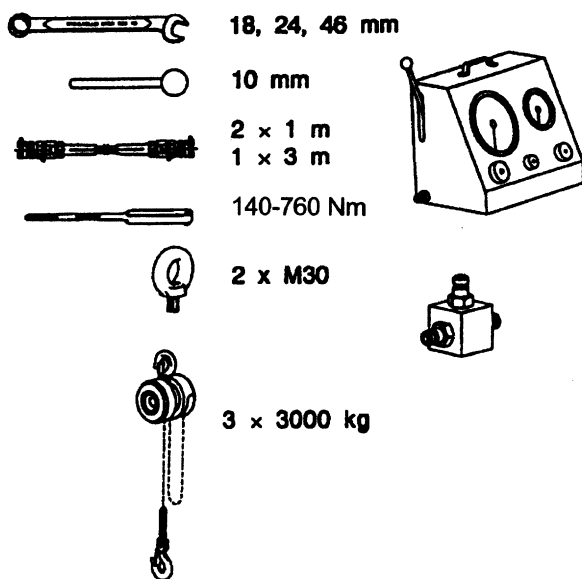
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SAFETY PRECAUTIONS

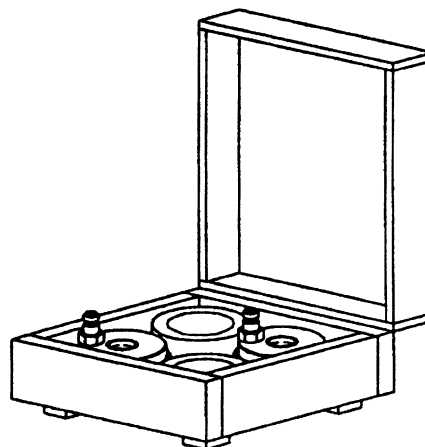
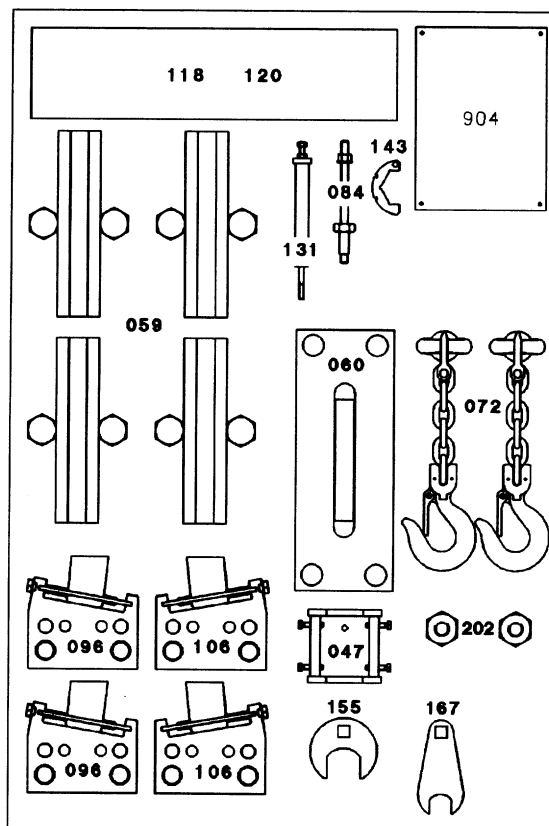
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

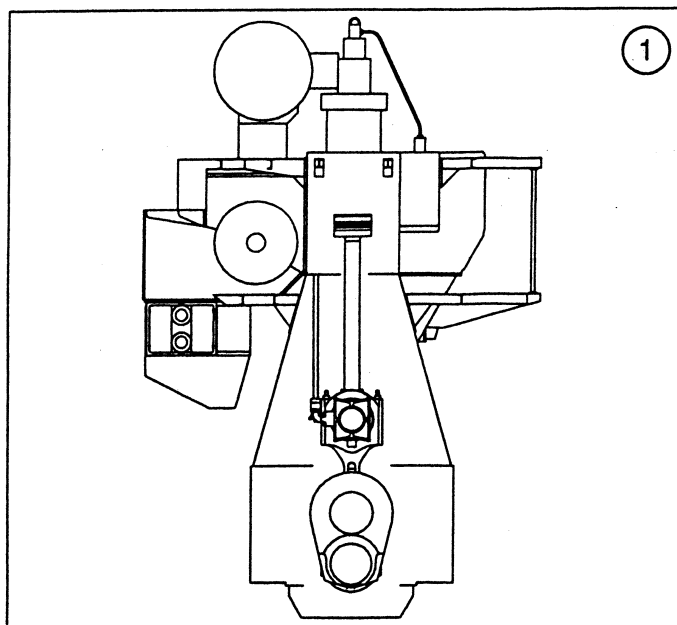
913



DATA:

D-1	Connecting rod	
	L70MC.....	3200 kg
	S70MC.....	3350 kg
D-2	Screwing-in torque – crosshead bearing studs	380 Nm
D-3	Tightening torque – thrust piece.....	230 Nm





Dismantling

1. Turn the crank to BDC.

Dismount the nuts from the crosshead bearing studs.

See Procedure 904-2.2.

2. Suspend two tackles from the two lifting brackets at the top of the frame box.
3. Turn the crank to TDC.

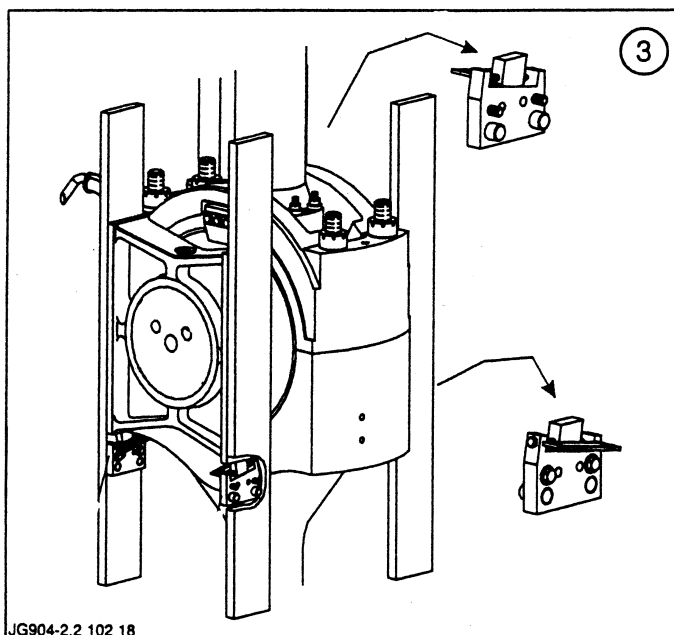
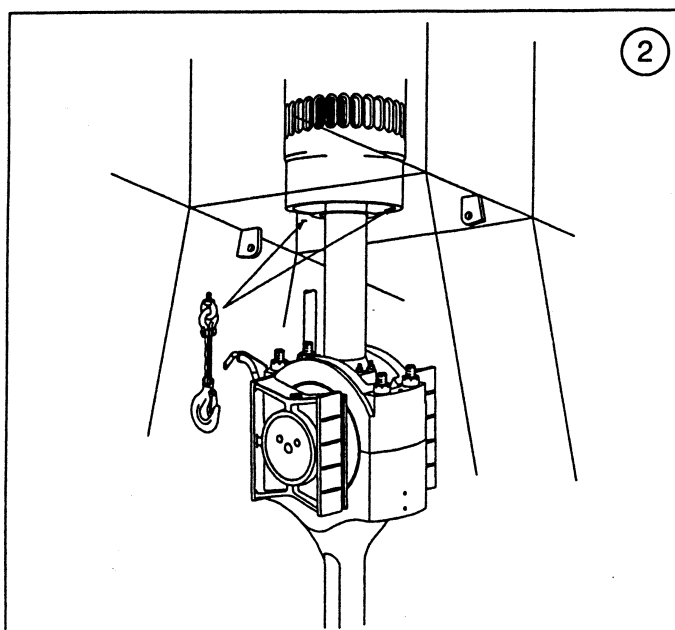
Mount the four supports for the guide shoes on the crosshead guides.

Carefully turn the crank down towards the exhaust side, until the crosshead shoes rest on the supports.

Adjust the support brackets to the guide shoes so that the weight of the crosshead is distributed evenly on the four supports.

4. Dismount the crankshaft bearing cap, and remove the bearing cap from the engine.

See Procedure 904-6.



5. Mount the lifting attachments for fixing of the connecting rod on the head of the connecting rod.

Fasten tackles to the lifting brackets **A** and **B** on the frame box wall and attach the tackle hooks to the mentioned lifting attachments on the connecting rod.

Haul the tackles tight.

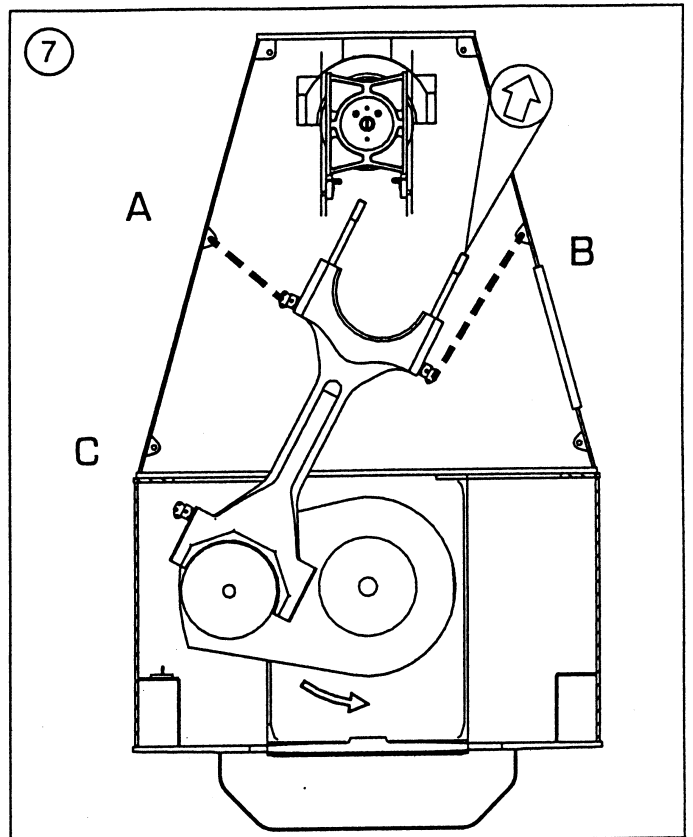
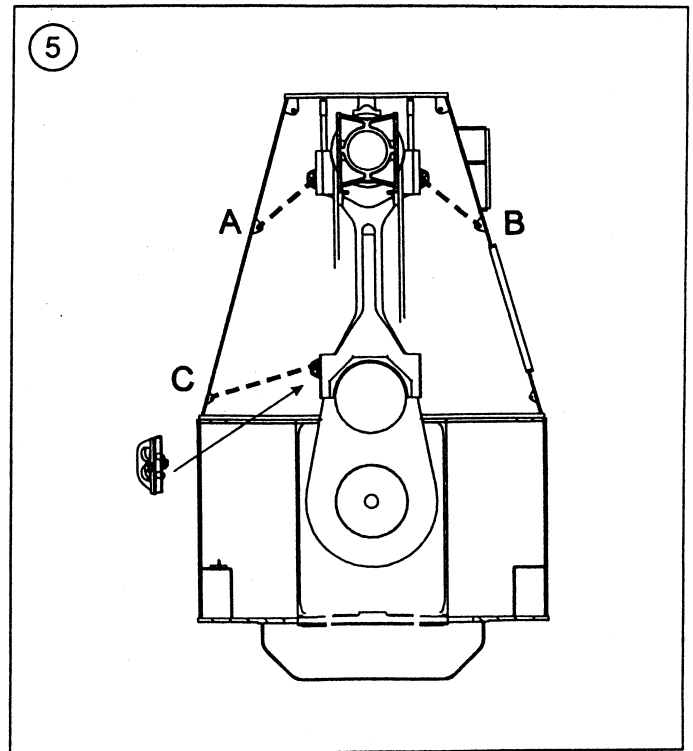
Also mount a lifting attachment in the crankpin end of the connecting rod, on the exhaust side.

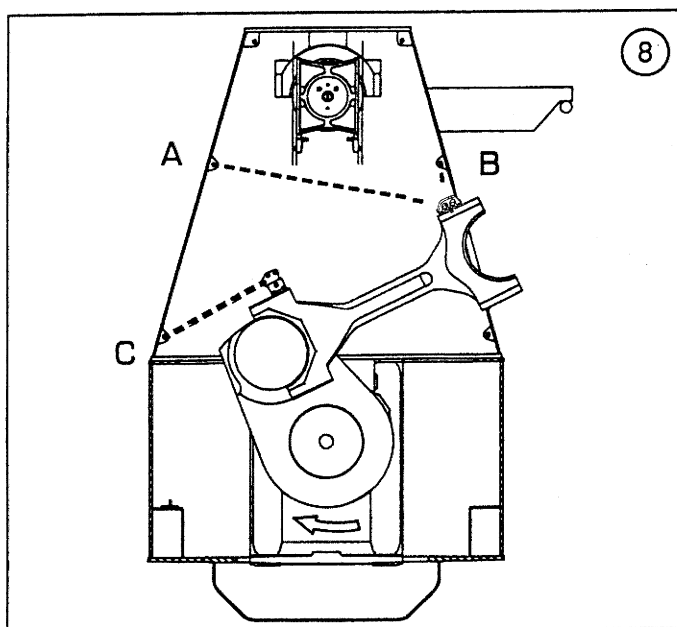
6. Turn the crankthrow towards BDC while "following" with the tackles, thus continuously supporting the connecting rod.

The crosshead now rests on the four supports.

7. Turn the crankthrow to 45° before BDC.

Remove the four studs from the connecting rod.



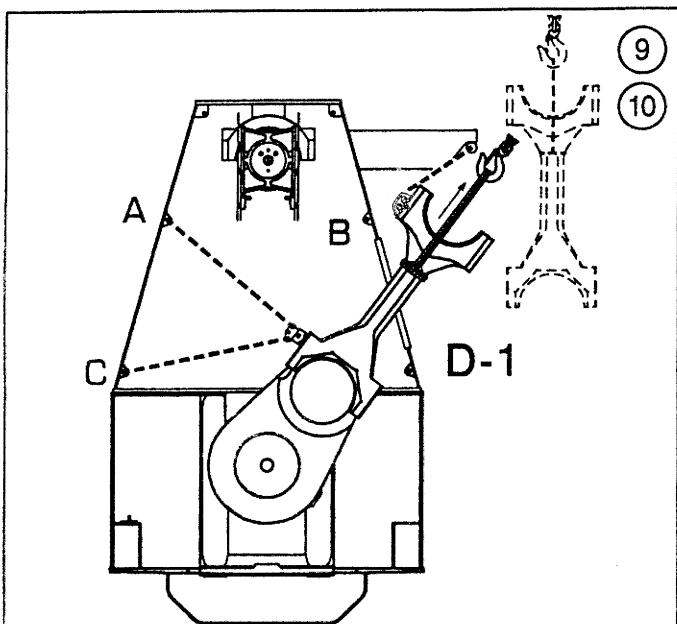


8. By means of the tackle from lifting bracket A, tilt the connecting rod towards the camshaft side until the connecting rod is leaning out of the doorway.

Attach a tackle to lifting bracket C on the frame box wall and connect the tackle hook to the lifting attachment at the lower end of the connecting rod.

Turn the crank carefully upwards while "following" with the tackles, guiding the head of the connecting rod out of the doorway.

Shift the tackles from one lifting bracket/attachment to the other, as necessary.



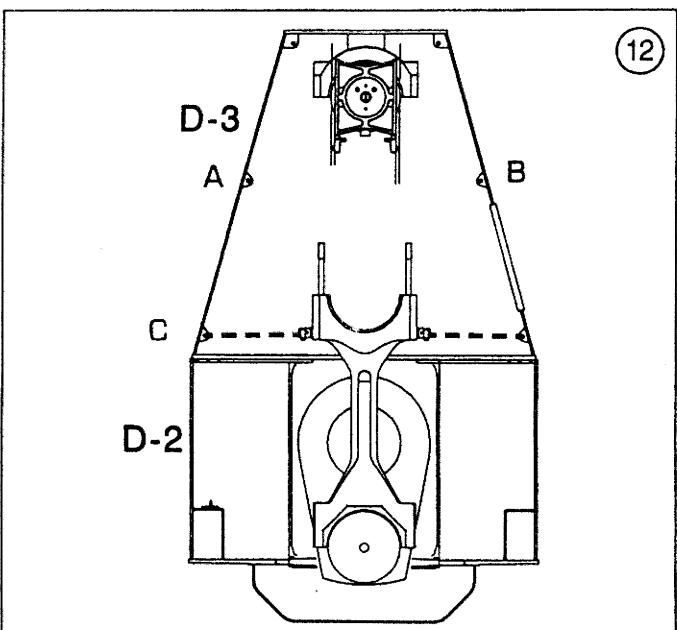
9. Remove the floor chequer plate for the pertaining cylinder.

Place a wire rope round the connecting rod.

Hook on the engine room crane and haul tight.

10. Continue turning upwards till about 30° after TDC while "following" with the tackles and the engine room crane.

Then lift the connecting rod out of the engine by means of the engine room crane and the tackles.



Mounting

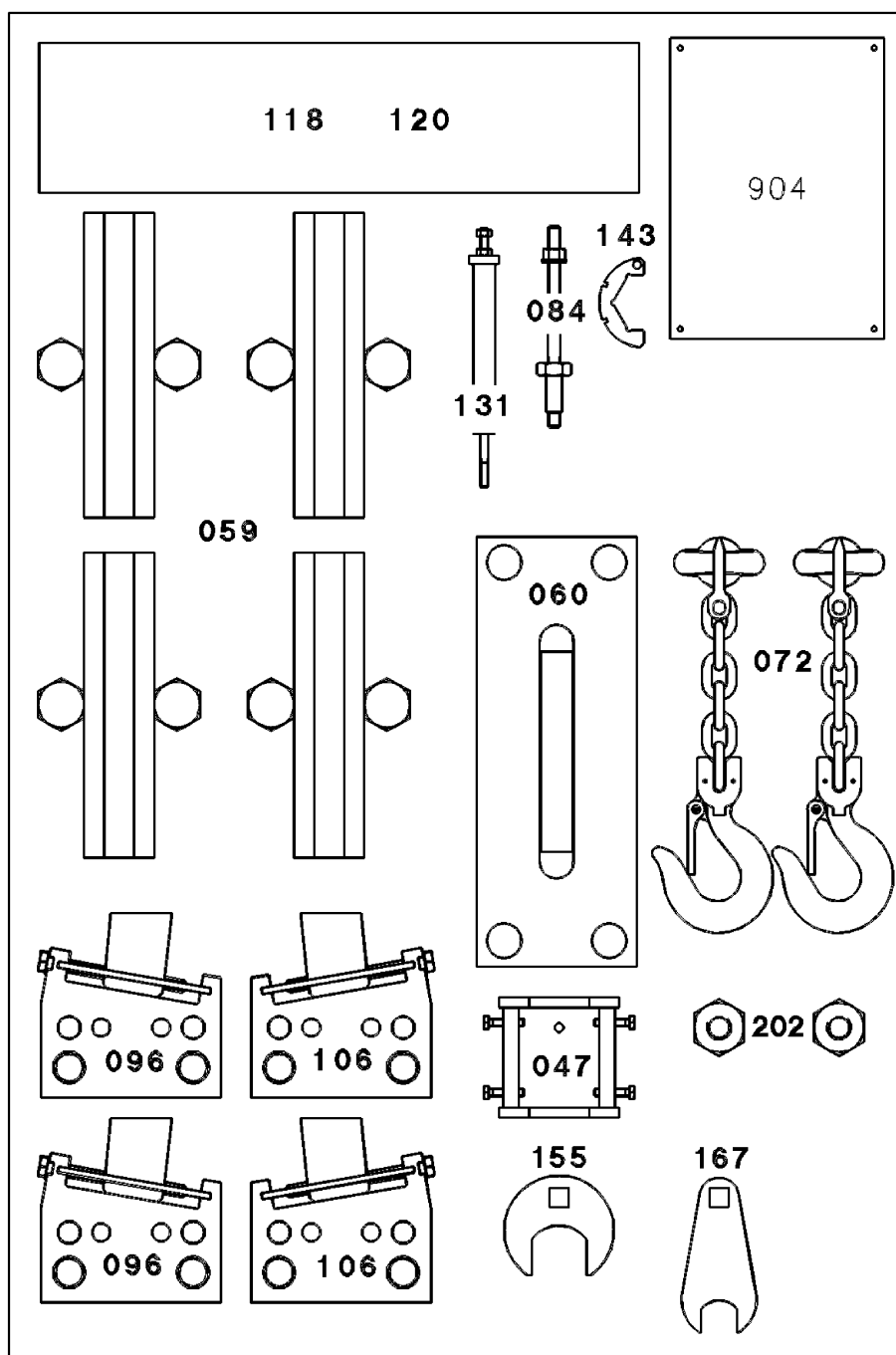
11. Equip the connecting rod with the same lifting attachments as mentioned under dismantling.

Turn the crank to a position about 25° past TDC at the camshaft side.

Apply clean lubricating oil to the crank-pin bearing shell and journal.

Mount the connecting rod and assemble the parts in the reverse order.

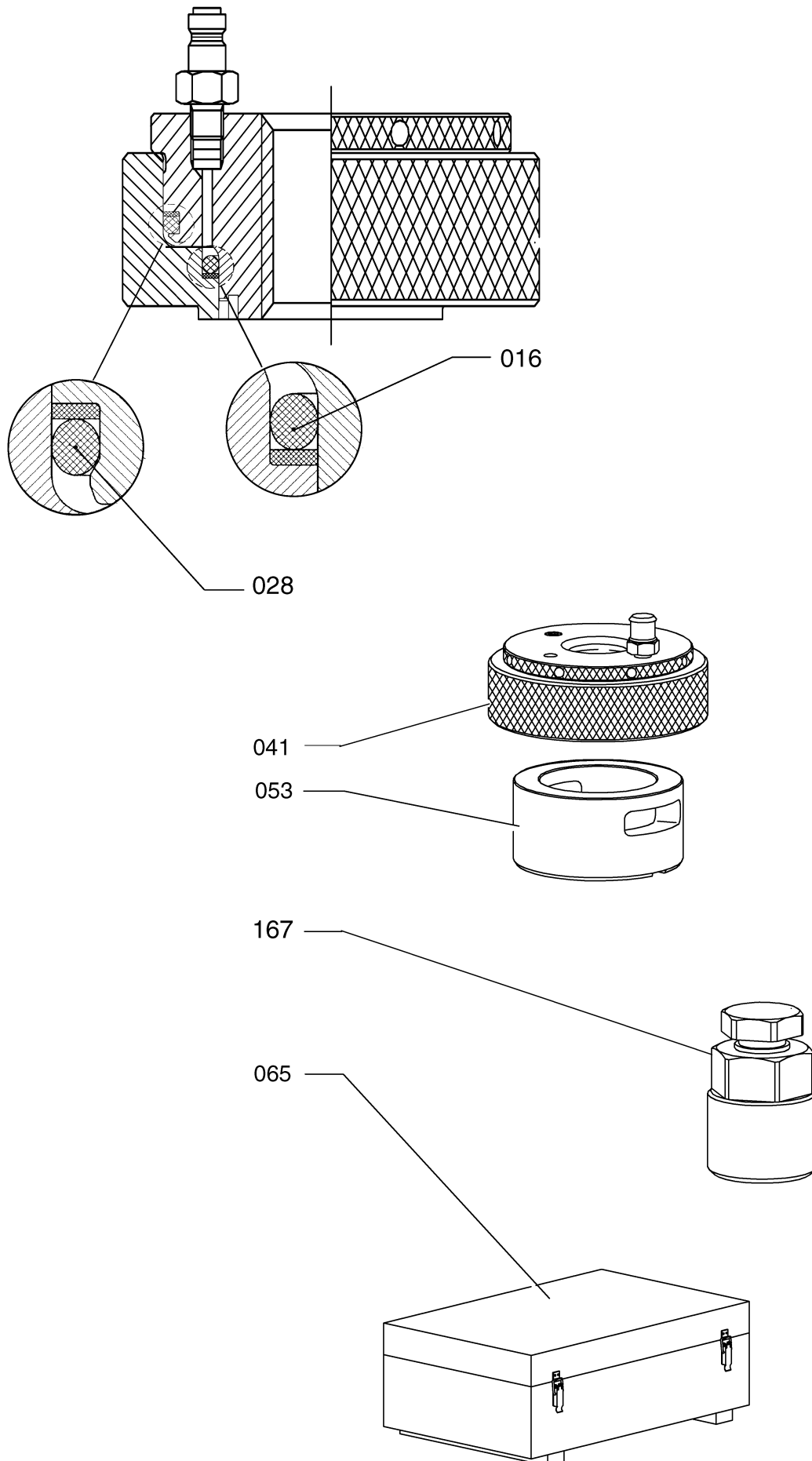




Item No.	Item Description
904	Name plate
047	Wire guide
059	Lifting attachment for conn. rod
060	Lifting tool for crosshead
072	Chain for suspending piston
084	Retaining tool for telescope pipe
096	Bracket for support of crosshead
106	Bracket for support of crosshead
118	Rubber cover for crosshead
120	Rubber cover for crosshead
131	Drawing tool for bell sheaped
143	Tightening template for lub. oil inlet bend
155	Crowfoot spanner
167	Crowfoot wrench head
202	Screw with special head
904	*) Tool panel, complete with tools
202	*) Optional extras

Item No.	Item Description





Item No.	Item Description
016	O-ring with back-up ring, 80/90 mm
028	O-ring with back-up ring, 140/150 mm
041	Hydraulic jack for crosshead stud / conn. rod stud
053	Support for Hydr. jack
065	Steel box for Hydr. jack
167	Stud setter, M 60x5.5

Item No.	Item Description

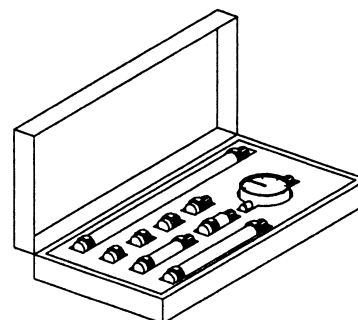
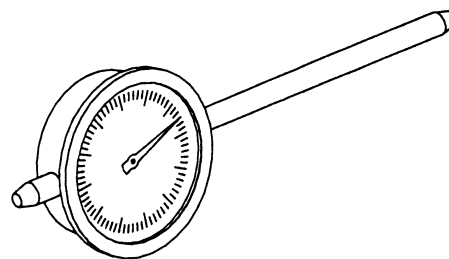


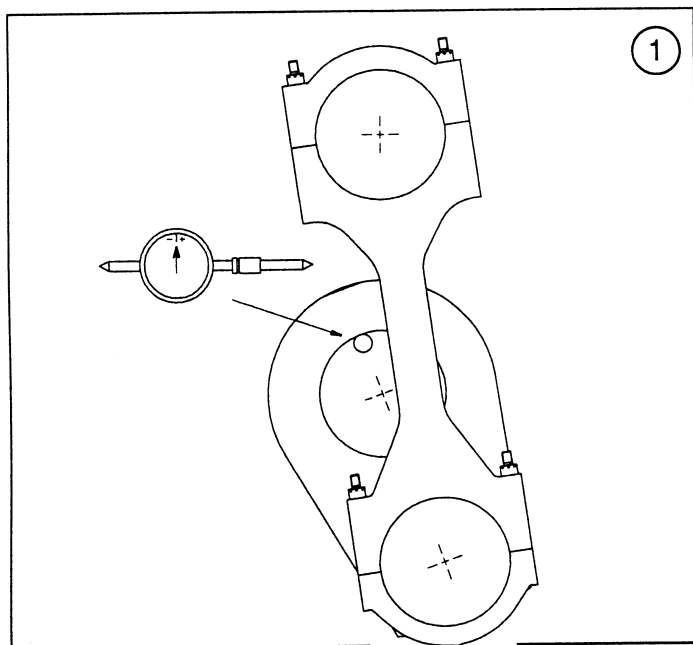
Safety Precautions

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

For measuring and evaluation, see also Chapter 708 in Volume I, OPERATION.



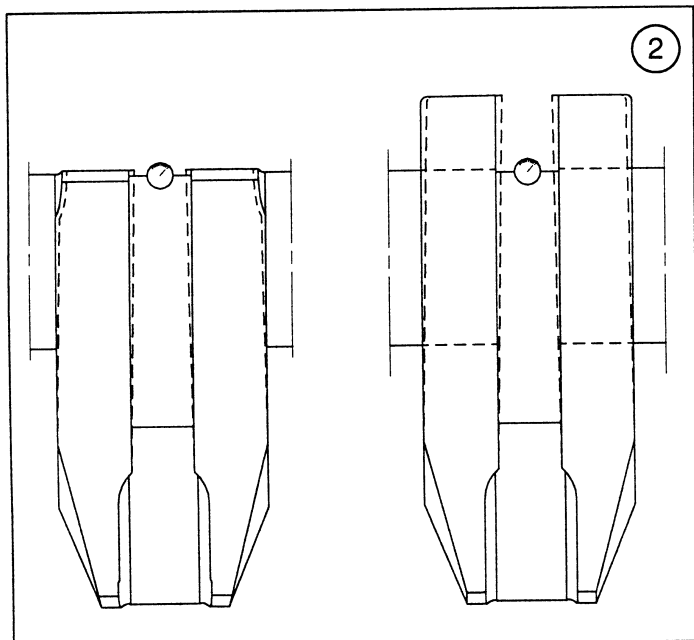


Checking of the crankshaft deflection must be done while the ship is afloat (i.e. not while in dry dock).

As the alignment is influenced by the engine temperature as well as the loading conditions, the deflection measurements should, for comparison, always be made under nearly the same temperature and load conditions.

1. Place a dial gauge axially in the crankthrow opposite the crankpin, as illustrated on the sketch. The correct mounting position is marked with punch marks on the crankthrow.

See also Chapter 708, Volume I.



2. "Closing" of the crankthrow (compression of the gauge) is regarded as negative.

3. Set the dial gauge to zero at the **B1** side near BDC. Whilst turning clockwise, make the readings for instance when the throw passes the positions:

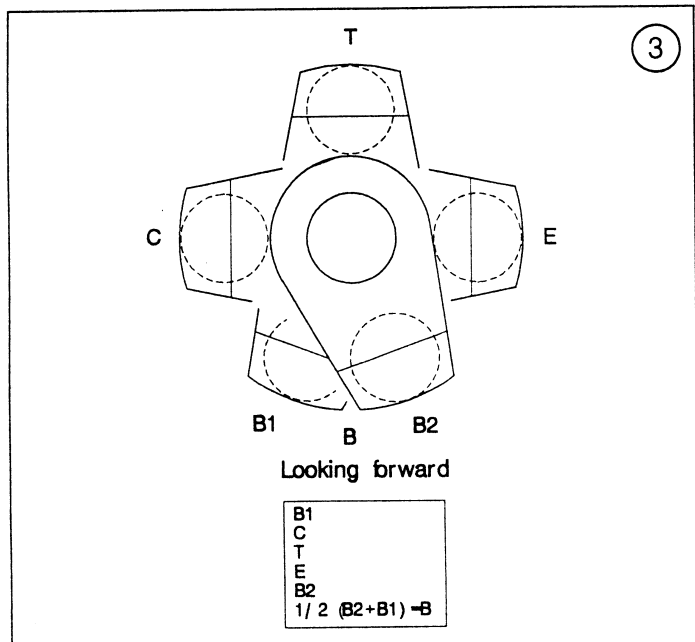
- B1** (near bottom)
- C** (camshaft side)
- T** (top)
- E** (exhaust side)
- B2** (near bottom).

$$1/2 (B2+B1) = B.$$

4. When taking deflection readings for the three aftmost cylinders, the turning gear should, at each stoppage, be turned a little backwards to ease off the tangential pressure on the turning wheel teeth. This pressure may otherwise falsify the readings.

If the crankshaft deflection (alignment indicator) is approaching the tolerance limits (see Vol. I, OPERATION), a new lower shell should be adapted in accordance with the crankshaft alignment indicator.

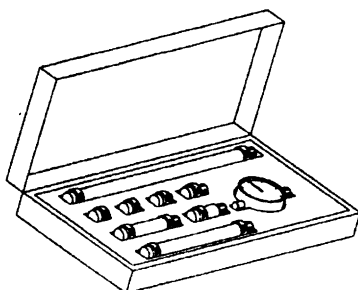
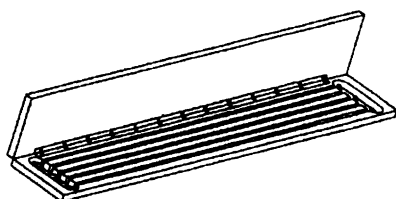
See Procedure 905-2.2 for overhaul of main bearing.



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913



DATA :

Clearance in main bearings
except the two aftmost ones

Max. 0.50 mm
Min. 0.30 mm

Clearance in two aftmost
main bearing

Max. 0.45 mm
Min. 0.25 mm

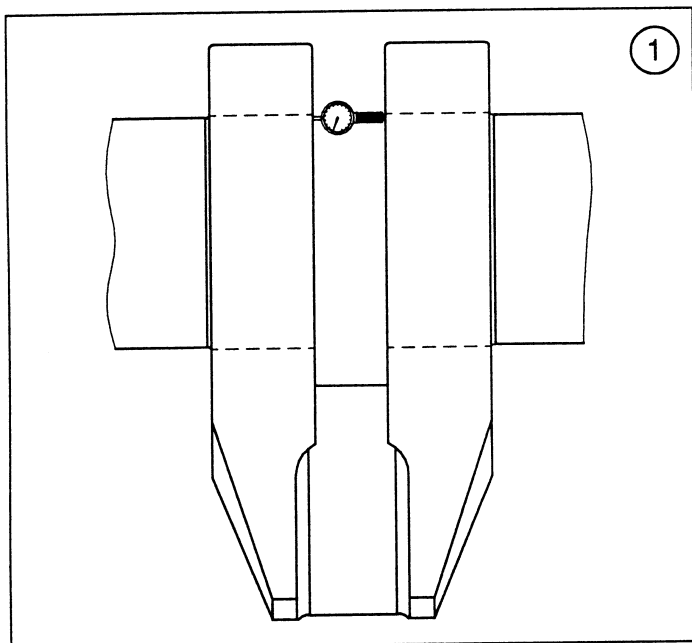
D-1 Main bearing cap 380 Kg

D-2 Main bearing shell 118 Kg

D-3 Hydraulic pressure

- dismantling 900-990 bar
- Tightening 900 bar



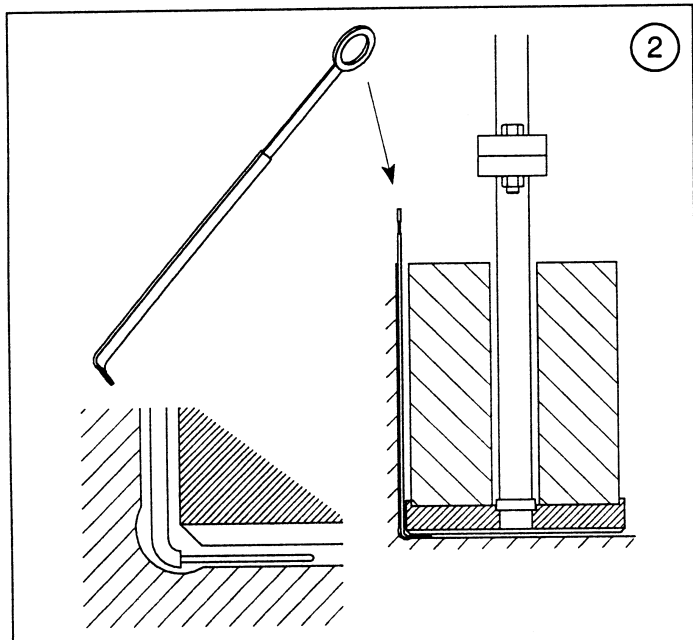


1. When there is too large a difference in the crankshaft deflection measurements (autolog) 905.1, check the individual bearings.

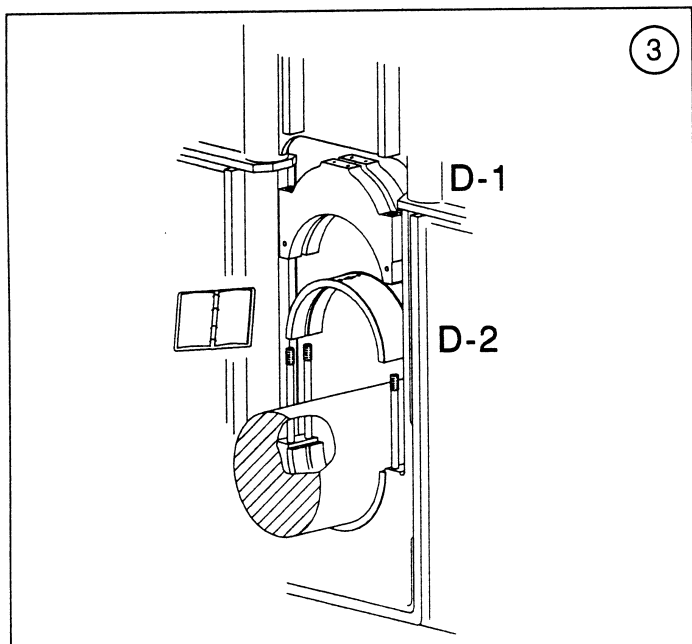
2. Check the clearance with a 'Kjær' feeler blade between the upper shell and the journal. Do not press the feeler blade too far, so as to reduce the risk of scratches.

If the clearance has appreciably increased, this may be an indication of loose staybolts or actual wear of the lower shell.

After measuring, dismount the bearing – see *Procedure 905-3* – for further inspection.



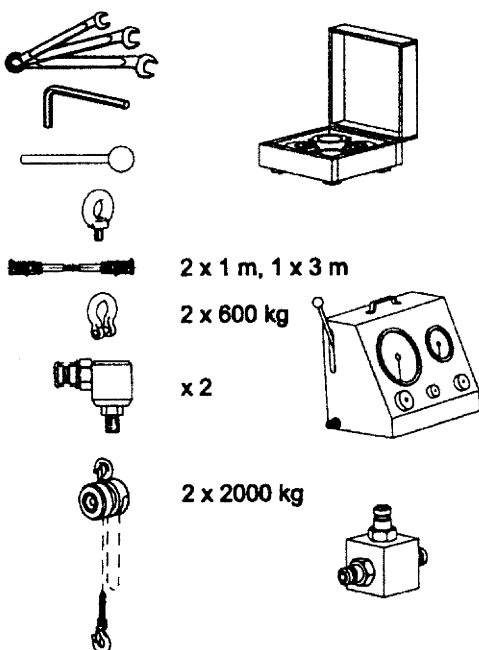
3. After dismounting the bearing cap and upper shell, inspect the bearing and the journal (*please refer to Volume I, OPERATION, Chapter 708, 'Bearings'*).



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

Standard tools: see Section 913



DATA :

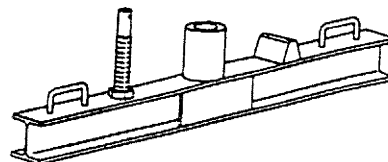
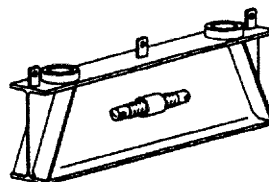
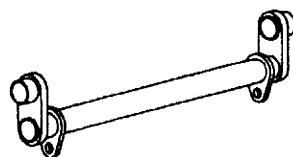
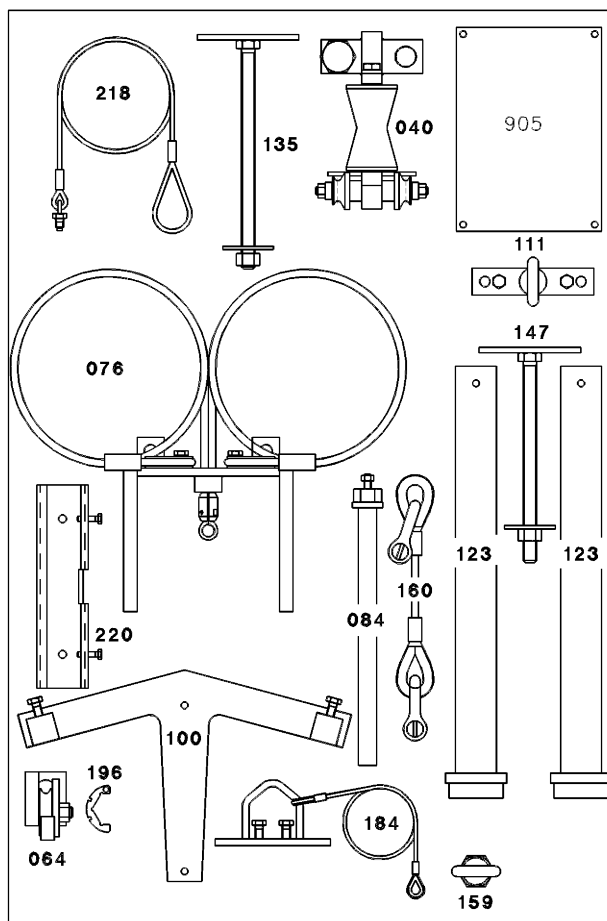
Clearance in main bearings
except the two aftmost ones

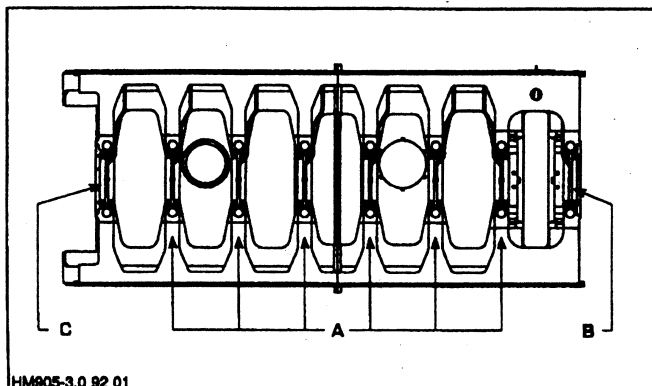
Max. 0.50 mm
Min. 0.30 mm

Clearance in two aftmost
main bearing

Max. 0.45 mm
Min. 0.25 mm

D-1 Main bearing cap 380 Kg
D-2 Main bearing shell 118 Kg
D-3 Hydraulic pressure
- dismantling 900-990 bar
- Tightening 900 bar





For inspection purposes, the main bearings are divided into three categories:

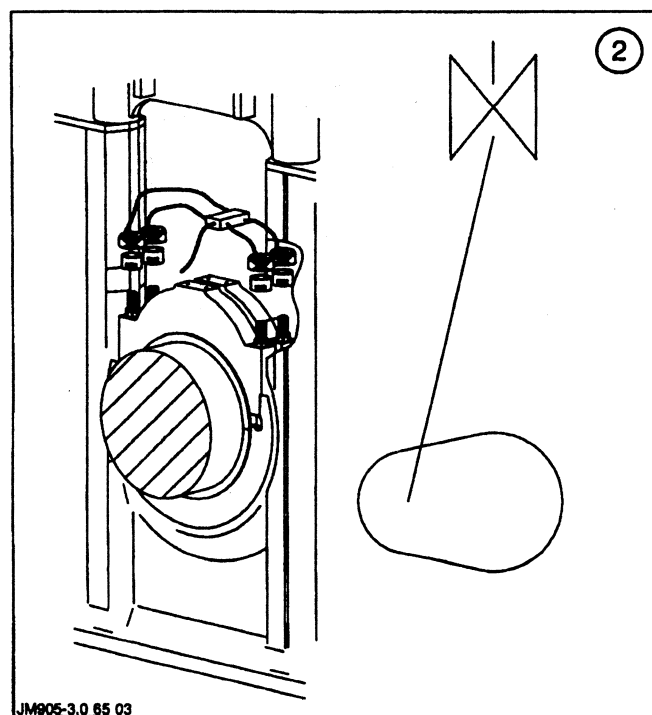
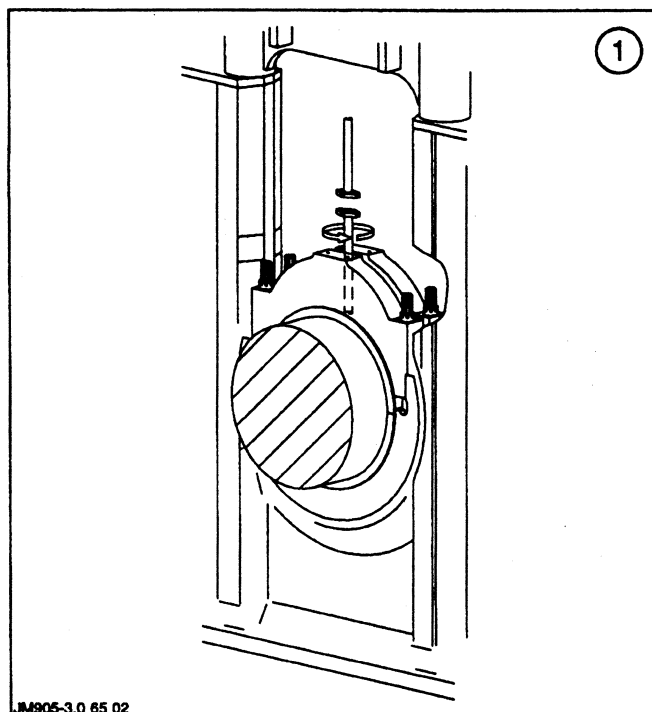
- The middle main bearings (marked A).
- The aftmost main bearing (marked B).
- The foremost main bearing (marked C).

Inspection of the middle main bearings A.

1. Disconnect the lubricating oil pipe from the main pipe.
2. Turn the crankthrow so that it points towards the exhaust side of the engine.

Check the clearance before dismounting, and note down for later reference.

Mount the hydraulic jacks, and loosen and remove the nuts.
See Procedure 913-1.



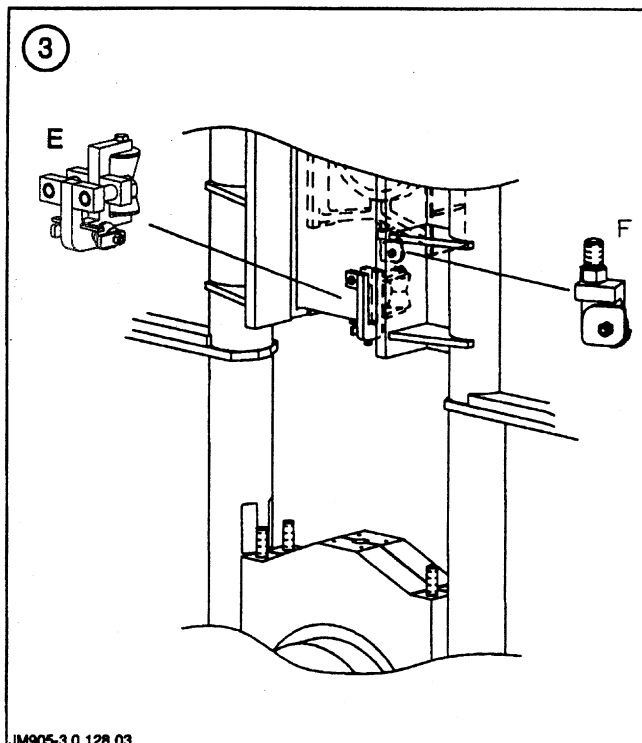
3. Mount the pulley **E** on the web plate above the bearing cap.

Note !

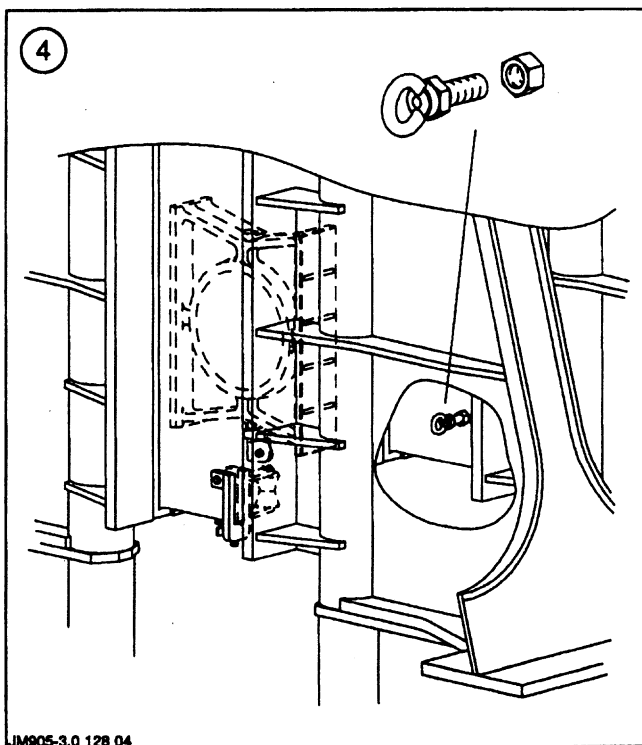
Two versions of this pulley are available, thus enabling the mounting of the pulley on either side of the web plate.

Remove the stop screw from below the guide shoe and mount the other pulley **F** in the bottom of the guide shoe.

4. Mount an eye bolt on the opposite web plate.

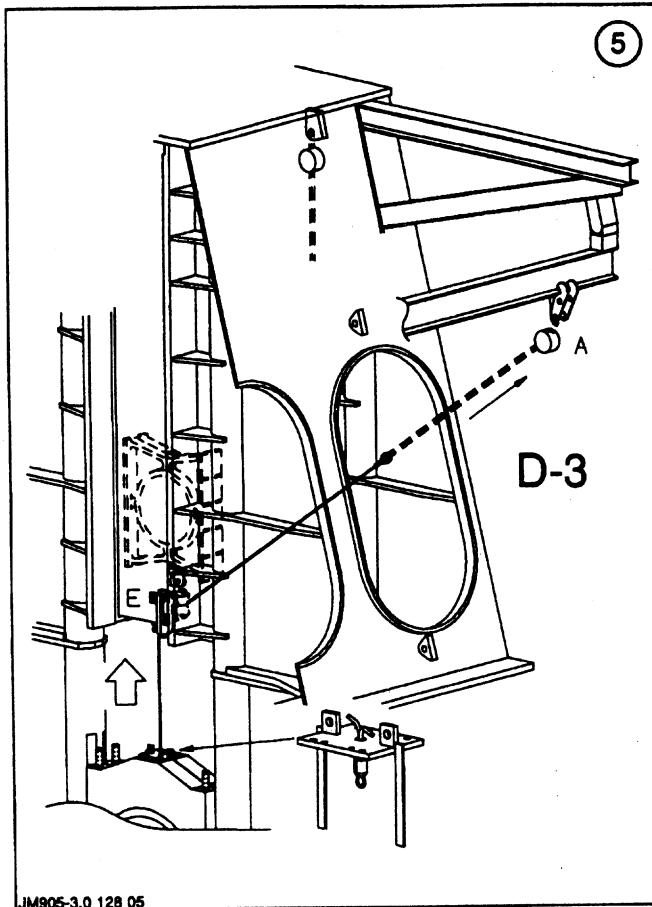


JM905-3.0 128.03



JM905-3.0 128.04





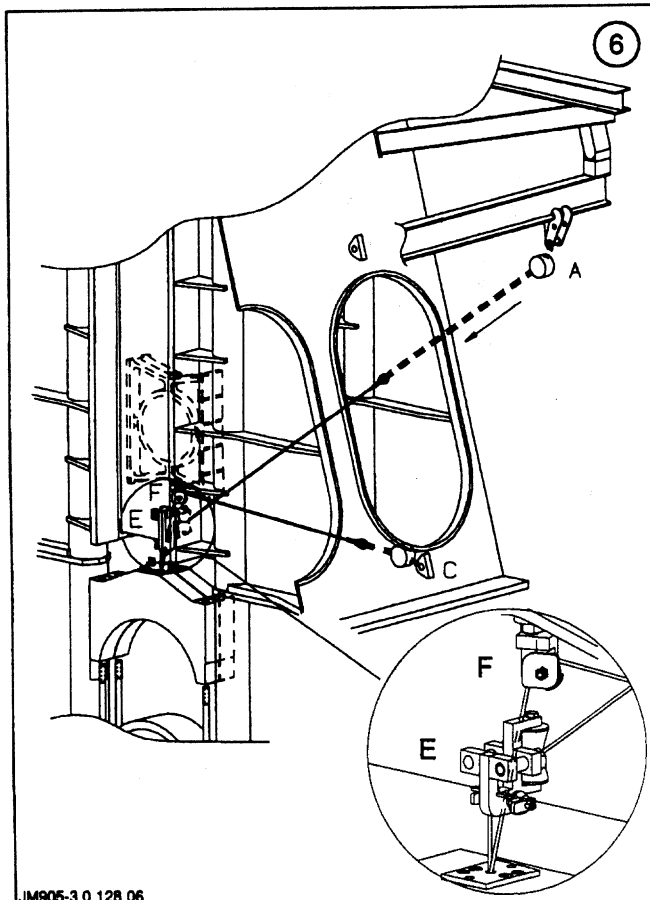
5. Mount the main bearing lifting tool on the main bearing caps, and place the wire rope as shown.

Carefully lift the main bearing cap clear of the studs.

6. The lifting tool has one free wire rope.

Place this wire rope around the wheel of pulley F mounted in the guide shoe. Hook the wire rope on to the chain of tackle C. Tighten tackle C and release tackle A, until the main bearing cap is suspended vertically below pulley F.

7. Remove the wire rope of the lifting tool from the wire rope of tackle A. Remove the wire rope of the lifting tool from the pulley E mounted on the web plate.



8. Hook the chain of tackle **D** on to the wire rope mounted on the side of the main bearing lifting tool.

Tighten tackle **D** and release tackle **C** at the same time.

9. Hook the chain of tackle **B** on to the free wire rope of the main bearing lifting tool.

Attach the chain of tackle **A** around the wire rope of the main bearing lifting tool.

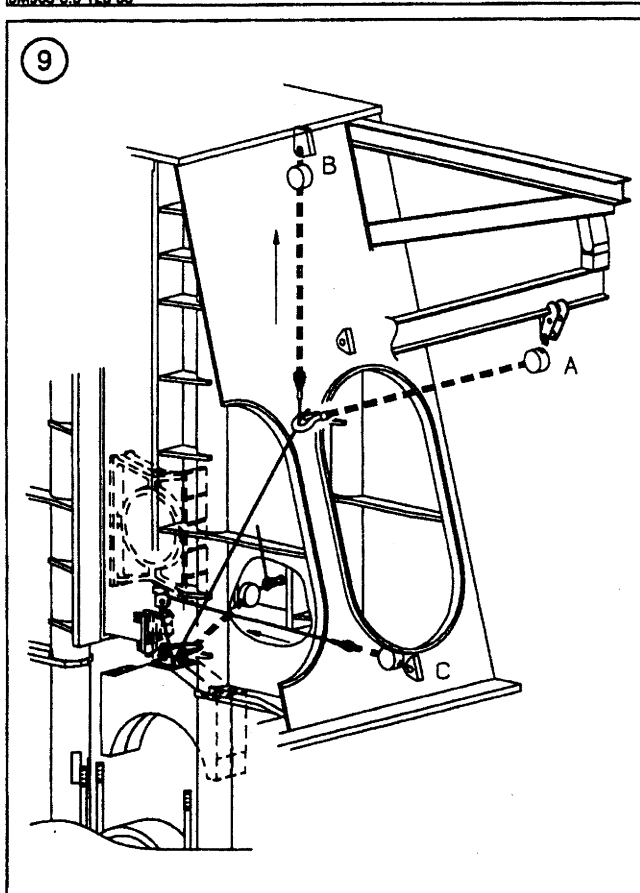
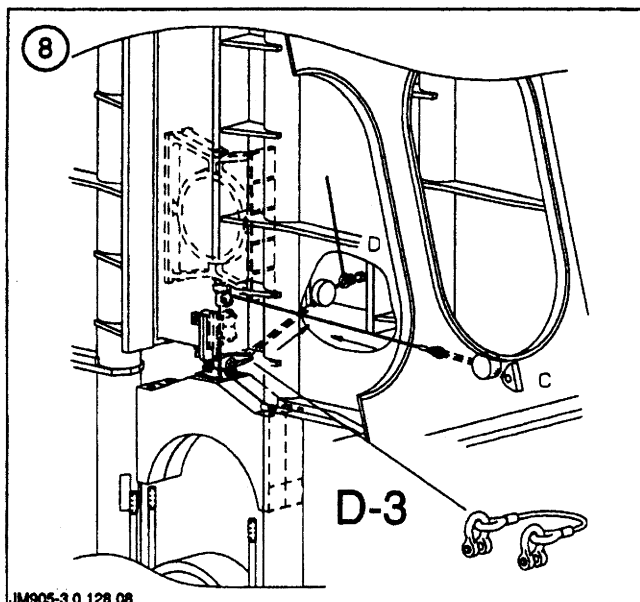
Tighten tackle **A** to pull the wire rope of the main bearing lifting tool clear of the guide shoe.

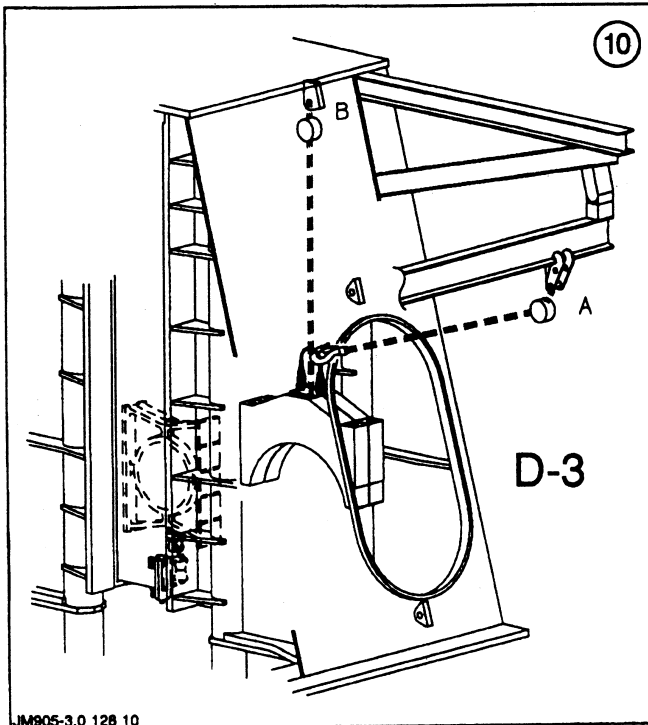
Tighten tackle **B** and release tackle **C** at the same time.

Note !

Make sure that the wire rope of the main bearing lifting tool does not scrape against the edges of the guide shoe.

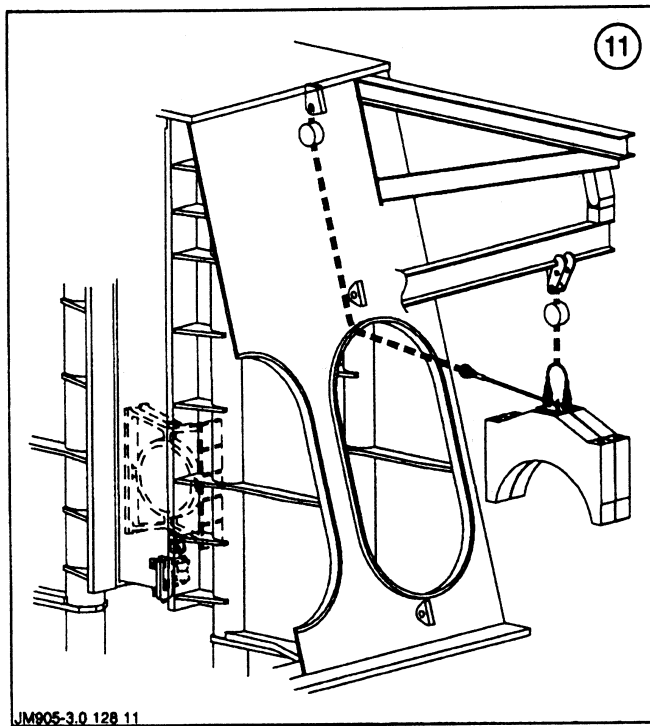
When the main bearing cap is hanging vertically below tackle **B**, remove tackles **A** and **C**.





10. Hook the chain of tackle **A** on to the wire rope mounted on the main bearing lifting tool.

11. Lift the bearing cap out of the engine and land it on the gallery.



12.

Note!

This procedure is to be used after the bearing cap has been dismantled, *see Procedure 905-3*, but **before** lifting the upper bearing shell.

The extractor tool is used to partially extract the vertical guide pins from the bearing shells.

Place the extractor on the upper bearing shell and screw the spindle into the threaded hole of the guide pin. The spindle has been screwed down to the correct position when the outer pipe is flush with the shoulder of the spindle.

Note !

Make sure that the extractor engages securely with the internal thread of the guide pin.

Knock the inner spindle upwards with the hammer head. The guide pins are free of the lower shell when the small pin in the slot of the outer pipe is 1-2 mm below the upper edge of the slot.

The extractor ensures that, when lifted, all the guide pins are completely clear of the holes in the lower bearing shell.

Thus the guide pins remain fitted in the bores of the upper bearing shell and should **not** be removed.

Unscrew the spindle from the guide pin, and remove the extractor tool. Repeat the procedure on all the guide pins.

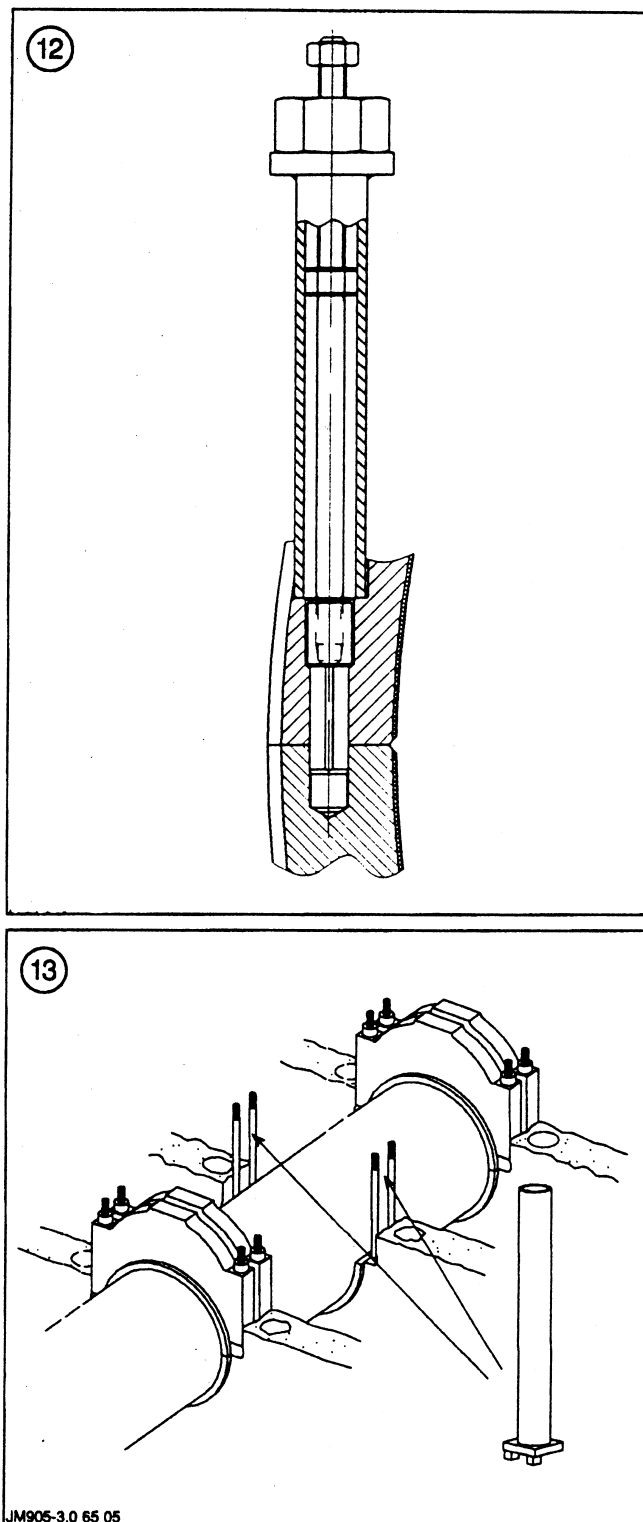
13.

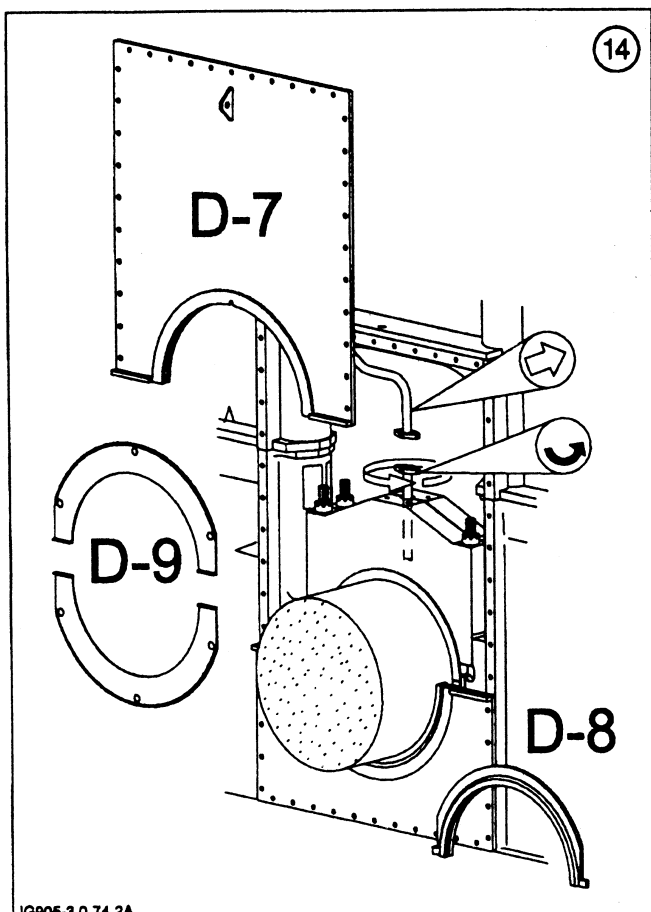
Note !

If the crankshaft is turned with the bearing cap dismantled, use the two stops which prevent the lower shell from being rolled out.

Place the stops on the bearing studs and secure with the nuts.

The engine can also be turned without the lower bearing shell being mounted.





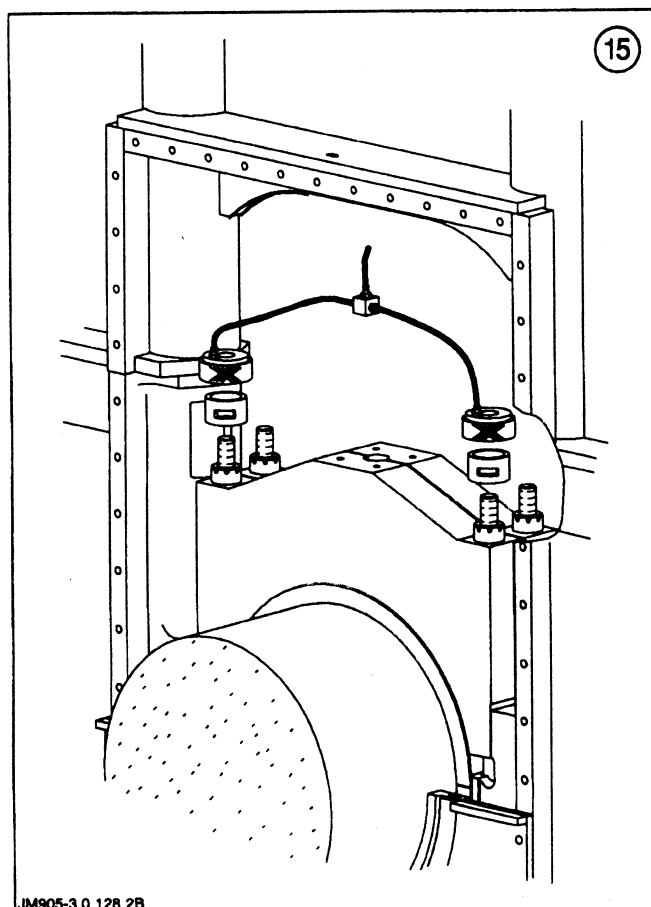
Disassembly of the two aftmost bearing caps marked B:

14. Dismount the large cover from the aft end of the frame box, disconnect the lubricating oil inlet pipe and remove the screwed-in pipe.

Remove the oil throw ring and the scraper ring.

15. Mount the spacer rings and the hydraulic jacks on the studs. By means of the hydraulic jacks, loosen the nuts of the main bearing studs (*for operation of the hydraulic jacks, see Chapter 913*).

By means of the studsetter, loosen and screw up the two studs.



16. Mount the crossbar in the chain drive.

Rig up tackles inside and outside the engine.

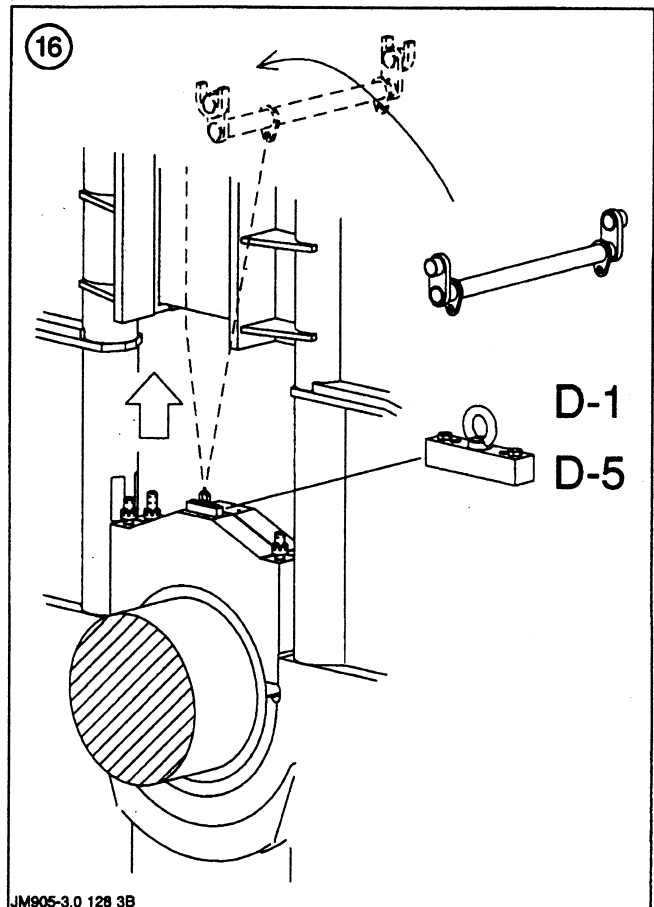
Mount the lifting attachment with the two wire ropes on the aftmost bearing cap and, by alternate use of tackles, lift the cap and studs out of the engine.

Repeat the above procedure for the inner bearing cap.

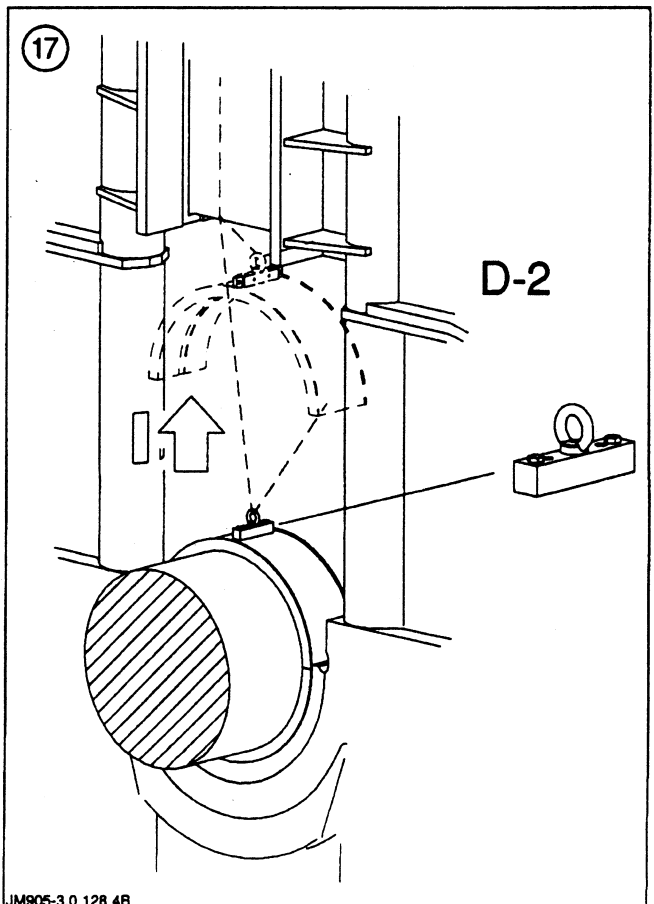
17. Dismount the upper bearing shell using the same lifting tool as above.

18. If the crankshaft is turned with the bearing cap dismounted, mount the studs back again, and use the two stops which prevent the lower shell from being rolled out.

Check that there is a clearance between the journal and the main bearing shell in the two adjacent main bearings. See Procedure 905-3, item 13.

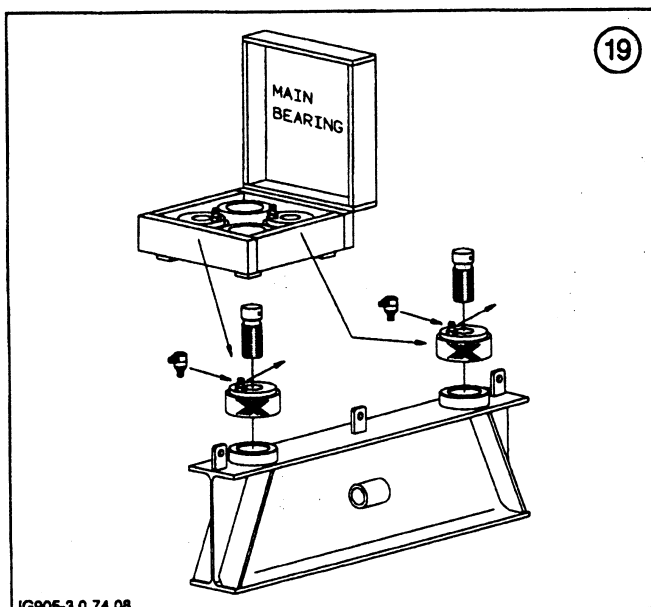


JM905-3.0 128 3B



JM905-3.0 128 4B



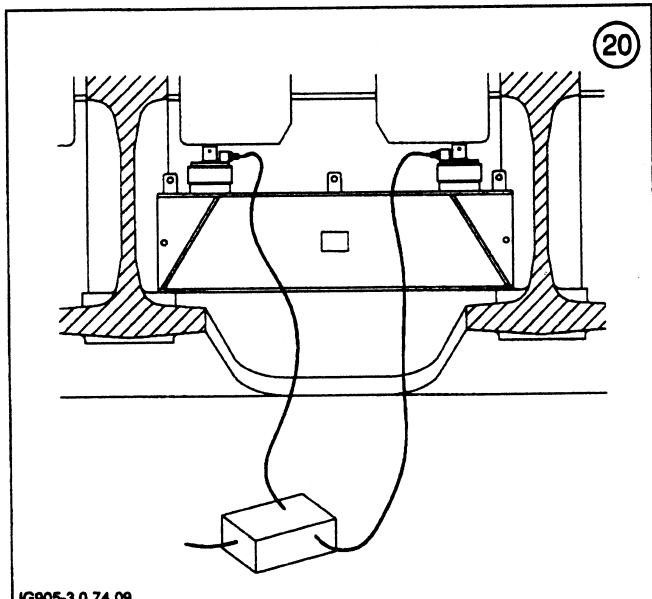


19. Remove the screws from the cross piece (only screwed in for safe keeping) and screw them into the threaded holes of the hydraulic jacks (for tightening the main bearing studs).

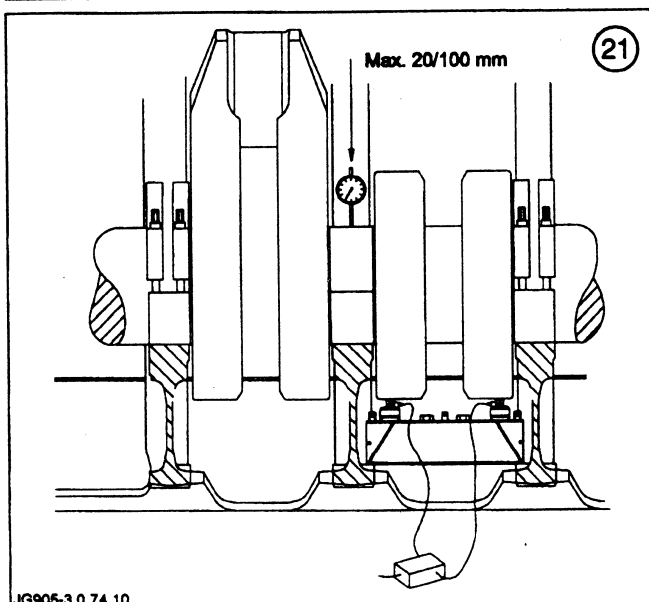
Replace the snap-on connectors of the hydraulic jacks with angular snap-on connectors.

20. Place the cross piece in the bedplate with the ends resting on the cross girders, and place the hydraulic jacks beneath the crank webs as shown.

Tighten the screws against the crank webs.



21. Connect the hydraulic jacks to the high-pressure pump and raise the pressure until the crankshaft has lifted max. 0.2 mm or has not been lifted more than the clearance which was measured in the adjacent bearings.



22. Check after lifting that the clearance between journal and bearing shell, and between bearing shell and main bearing support, is equal on both sides, to be sure that the crankshaft has been lifted straight vertically. If not, adjust the position of the jack until the crankshaft is lifted correctly.

If re-positioning of the jacks does not suffice for ensuring a vertical lift, place a 5-tonne jack between the sidewall and the crankthrow, and correct the lift in this way.

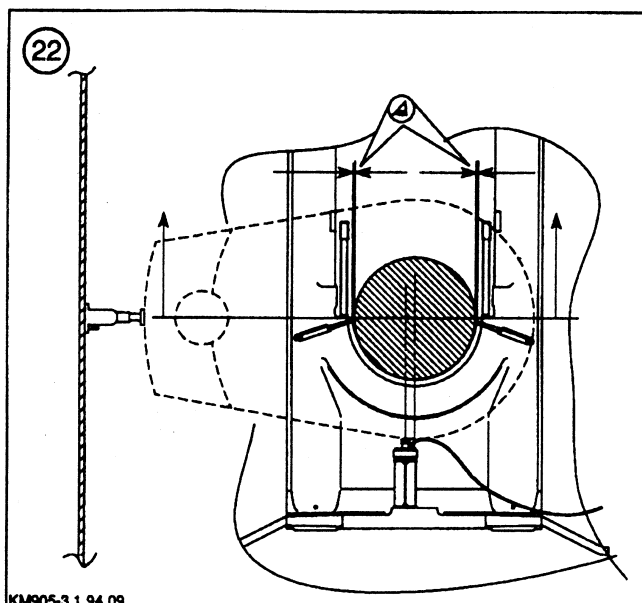
To avoid air suction, be sure the pump cylinder is facing downwards.

23. Fasten the two wire ropes to the top of the shell, one for pulling and one for retracting if the shell is getting caught in the main bearing support.

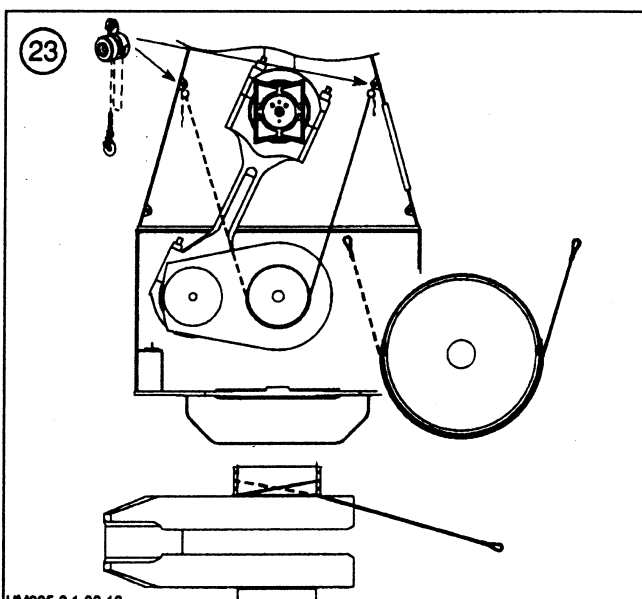
Place the wire ropes as shown.

24. Pull the lower shell round and up until it lies over the main bearing journal.

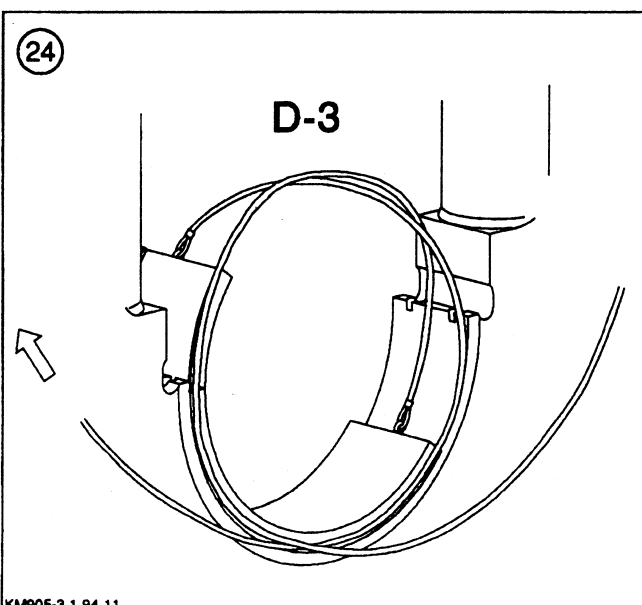
Take out the lower shell from the crankcase in the same way as the upper shell, i.e. using the lifting tool.



KM905-3.1 94 09

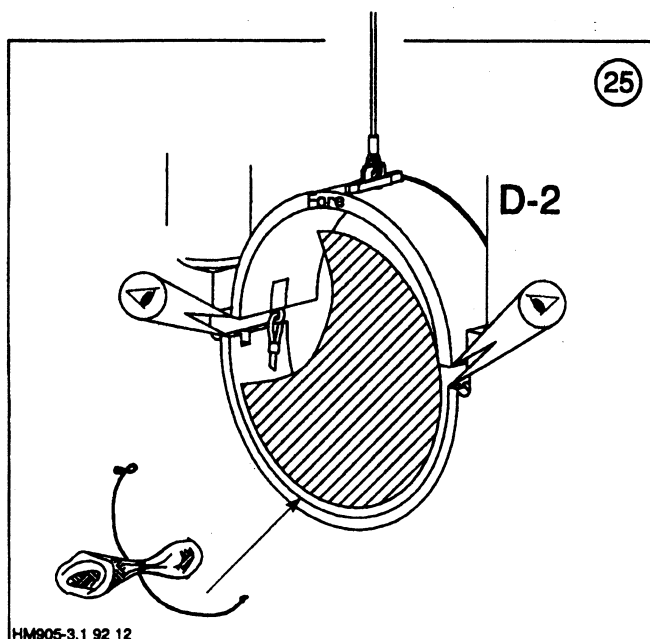


HM905-3.1 92 10



KM905-3.1 94 11



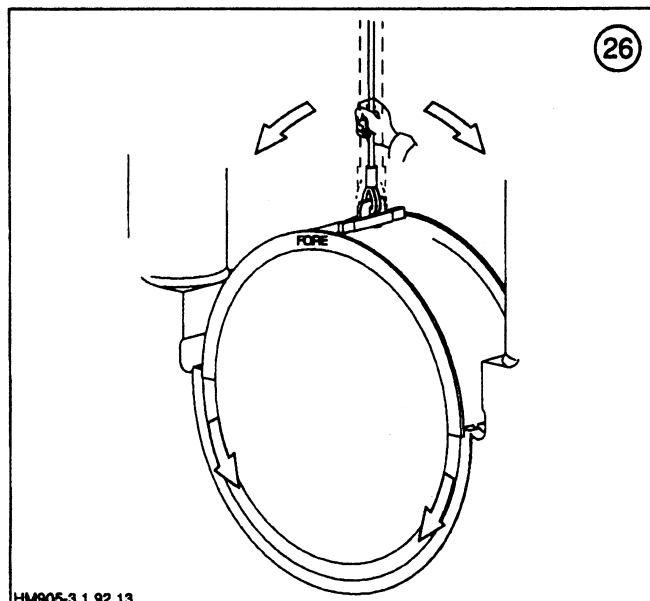


25. Before remounting:

- Check edges for damage and burrs, the shell and bearing support in particular.
If necessary, clean by means of a straight scraper and/or the special polishing tool.
- Be sure all parts are clean, use non-fluffy cloth to clean between journal and main bearing support.
- Mount the two special wire ropes.
- Lubricate the bearing journal, the main bearing support and the back of the shell.
- Check that the shell is **not** caught up in the wires.

Note !

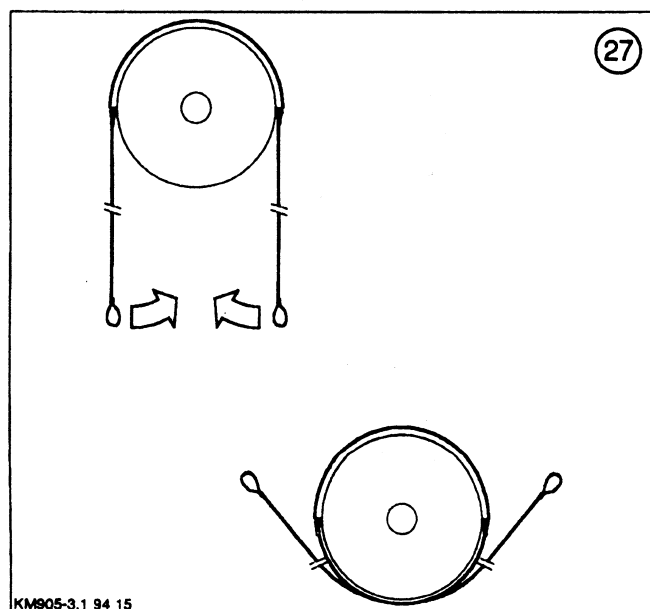
Make sure that the marking on the shell faces forward.



26. Before turning the lower shell down, check that it can move freely between the journal and bedplate in both sides.

- To prevent the shell from turning when the lifting tool is dismounted, use the special wire ropes to hold the shell back.

27. Tighten the wire ropes and use them to hold back and pull the shell into place.



28. Check that the bearing shell is positioned with the same distance on both sides.

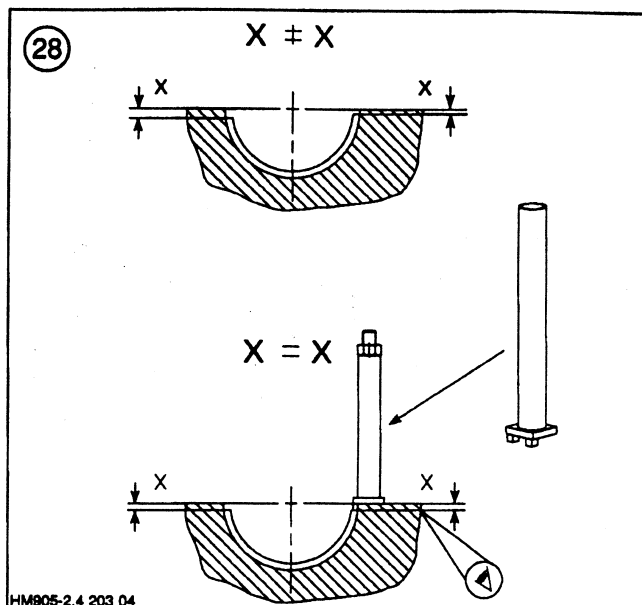
To obtain the same distance on both sides, use the stops for main bearing shell for adjustment.

29. After inspection of a bearing shell or after installation of a new bearing shell, take out or insert the required number of shims to obtain the clearance stated on the data sheet.

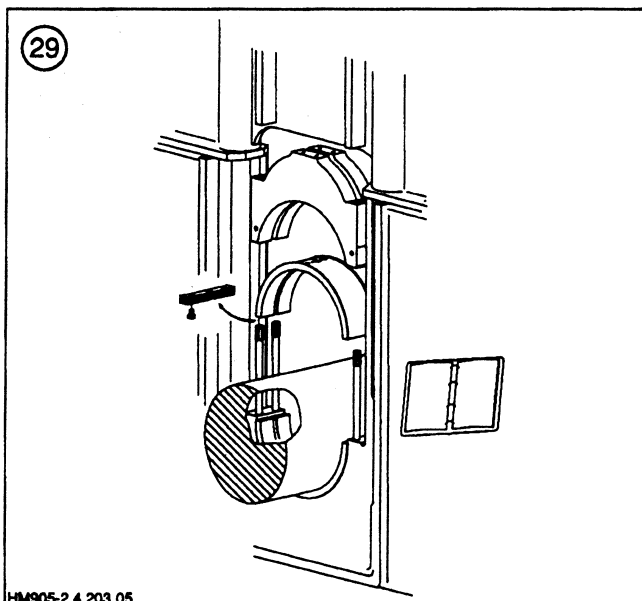
After assembling the bearing, check this clearance with the 'Kjær' feeler.

30. Make sure that the caps are mounted in the correct position.

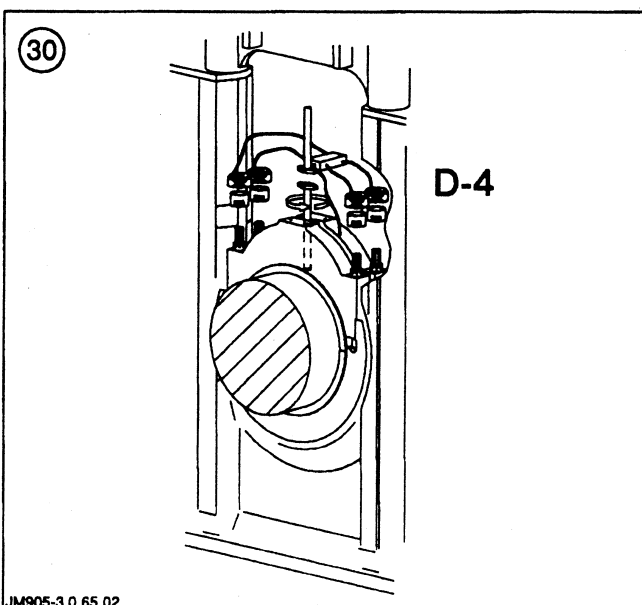
Mount the bearing cap and tighten the nuts by means of the hydraulic jacks.
See Procedure 913-1.



HM905-2.4 203 04

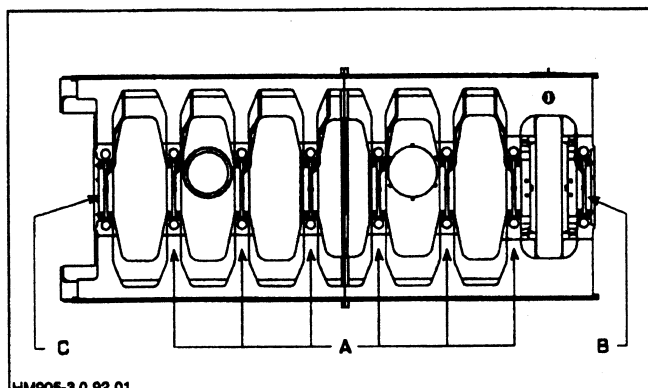


HM905-2.4 203 05



JM905-3.0 65 02





HM905-3.0 92 01

Inspection of the foremost main bearing C (axial vibration damper end)

31. Disconnect the lubricating oil pipe from the main pipe.

Turn the crankthrow so that it points towards the exhaust side of the engine.

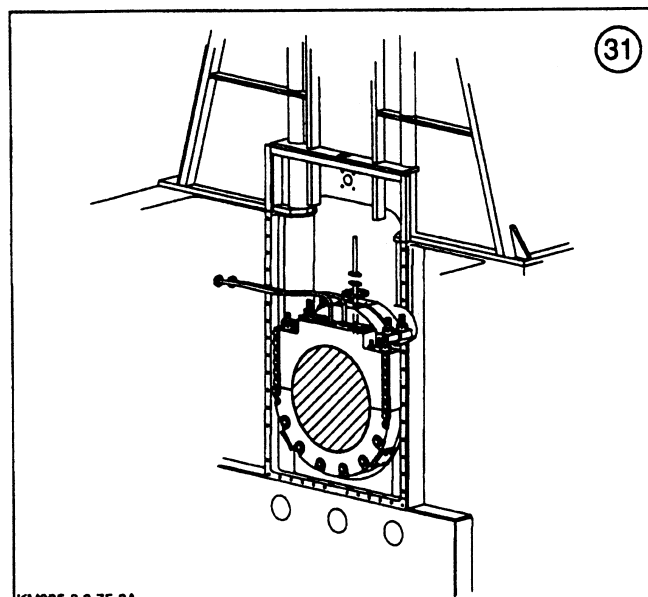
The two foremost bearing caps can be dismantled in the same way as the middle bearings A.

Alternatively proceed as follows:

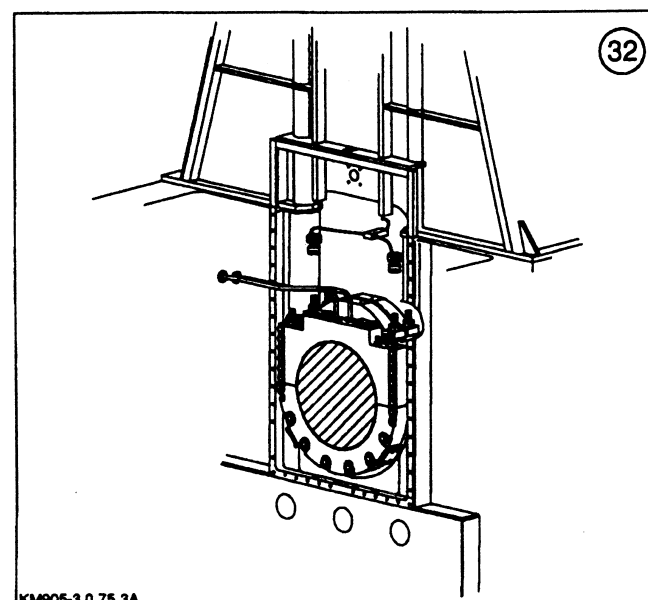
32. Mount the spacer rings and the hydraulic jacks on the foremost pair of studs.

By means of the hydraulic jacks, loosen the nuts of the main bearing studs.

For operation of the hydraulic jacks, see Chapter 913.



KM905-3.0 75 2A



KM905-3.0 75 3A

33. Mount the guide pulley, with the lifting wire and attachment, on the frame wall.

Mount the lifting attachment on the foremost bearing cap.

Hook a tackle on to the wire rope of the lifting tool.

Mount the protective caps on the neighbouring bearing studs.

34. Lift the bearing cap free of the studs and land it on the neighbouring studs.

Note !

Before lifting the caps, make sure that there are scratch marks on the caps, indicating the correct position.

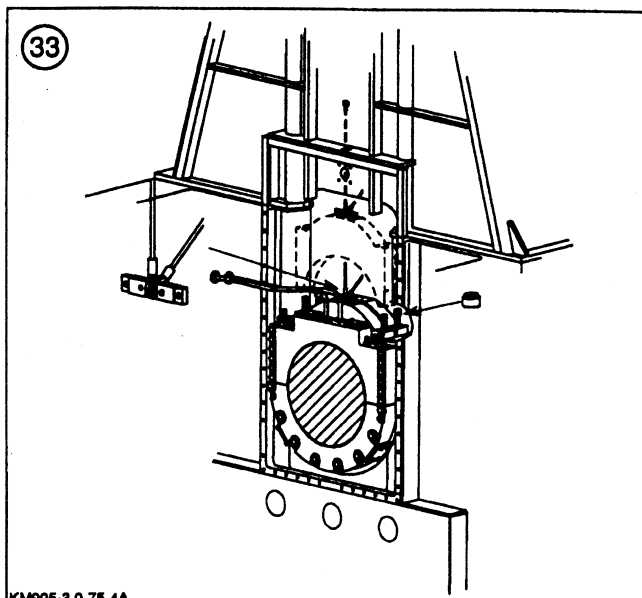
Lift the cap out by alternate use of the tackles.

35. Lift the crankshaft and take out the bearing shells.

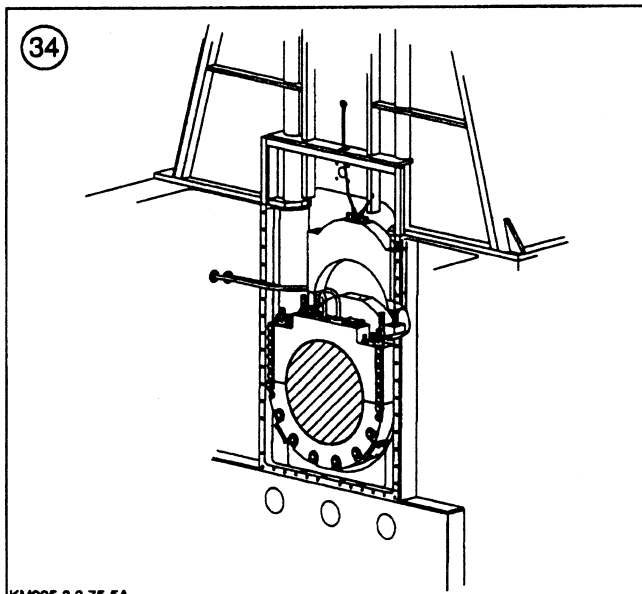
The clearance between the upper part of the axial vibration damper and the journal can be the decisive factor in judging how much the crankshaft can be lifted.

Note !

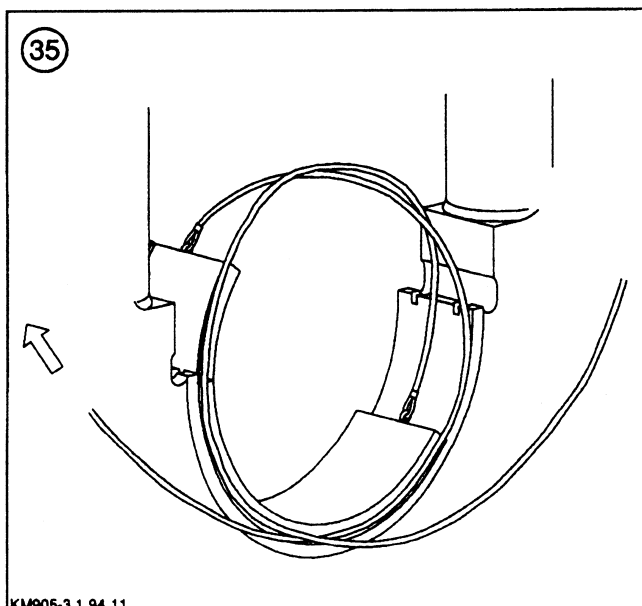
Never remove the tools for lifting the crankshaft before the lower main bearing shell has been remounted (foremost bearing only).



KM905-3.0 75 4A

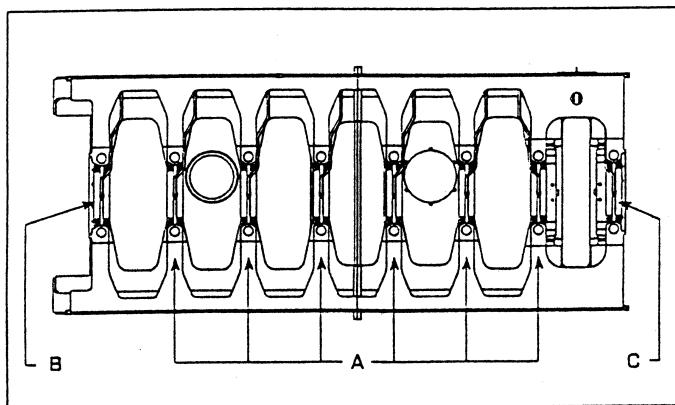


KM905-3.0 75 5A



KM905-3.1 94 11



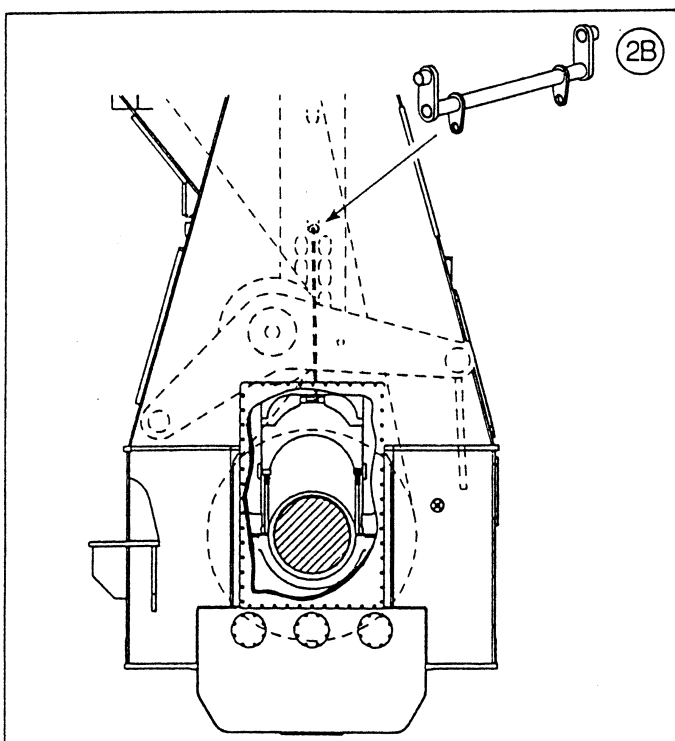
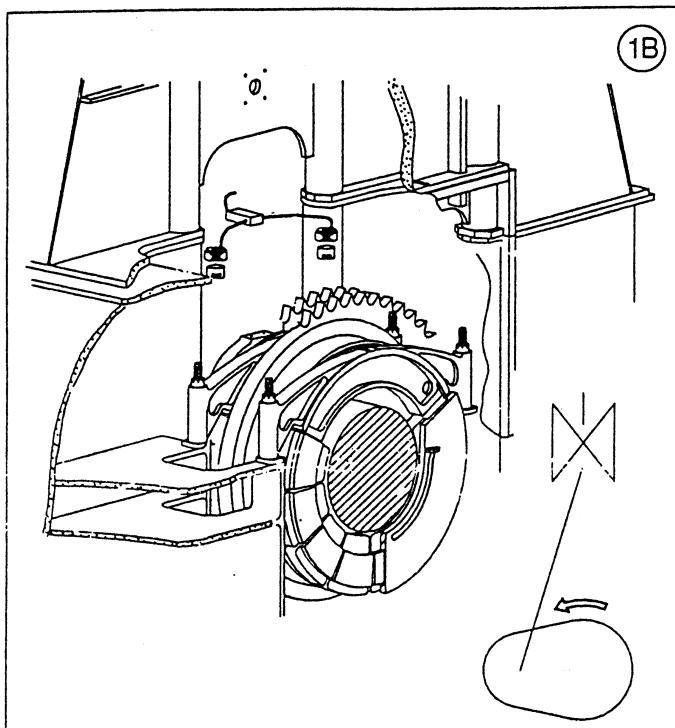


Inspection of the main bearing in the thrust shaft end (C).

1B Dismount the large cover from the aft end of the frame box. Disconnect the lubricating oil pipe from the main pipe.

Mount the spacer rings and the hydraulic jacks on the studs. By means of the hydraulic jacks, loosen the nuts of the main bearing studs (*for operation of the hydraulic jacks, see Chapter 913*). Turn the crankthrow so that it points towards the exhaust side of the engine.

2B Mount the crossbar in the chain drive and the protective caps on the aftmost bearing studs.

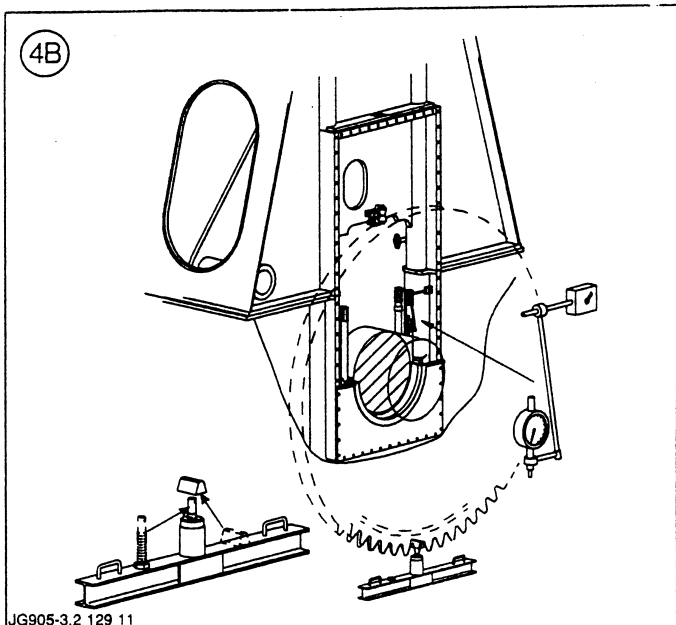
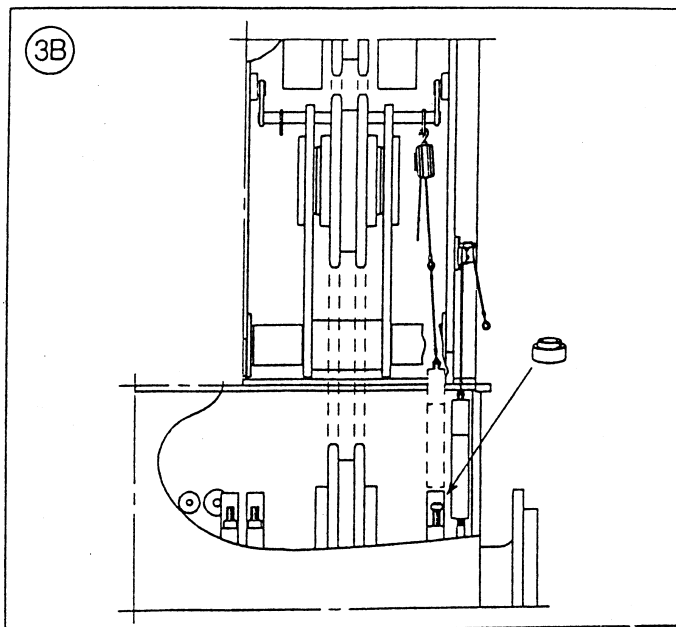


3B Suspend a tackle at the end of the frame box above the rib and remove the cover from the rib.

Mount the lifting attachments with the two wire ropes on the bearing cap and, by alternate use of tackles, lift the cap out of the engine.

Repeat the above procedure for the aftmost bearing cap.

4B Place the crosspiece under the turning wheel as shown. Mount a dial gauge to measure the lift of the crankshaft. Connect the hydraulic jack to the high-pressure pump, and raise the pressure until the crankshaft has been lifted max. 0.2 mm.



JG905-3.2 129 11



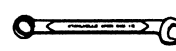
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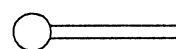


SAFETY PRECAUTIONS

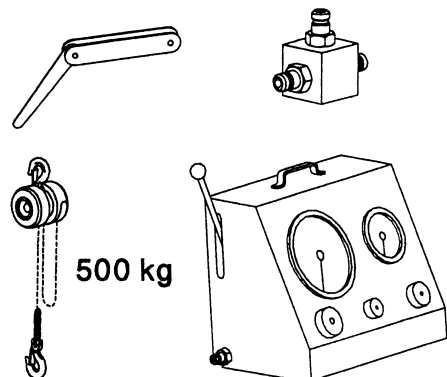
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

 13, 16, 24 mm

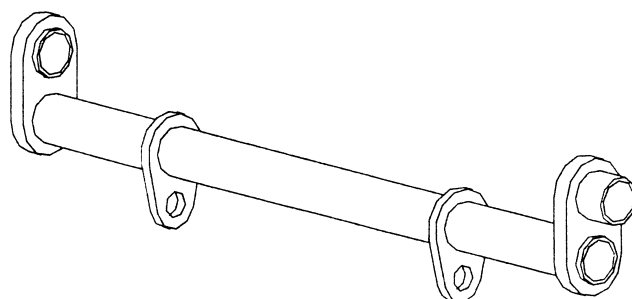
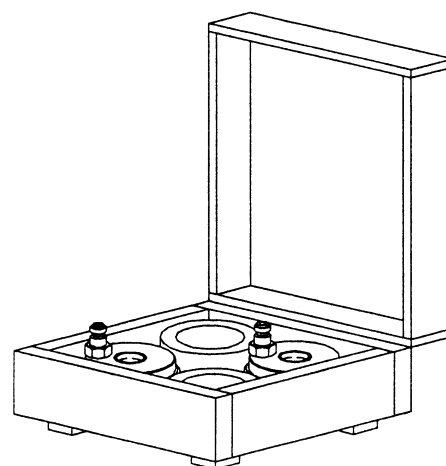
 8 mm

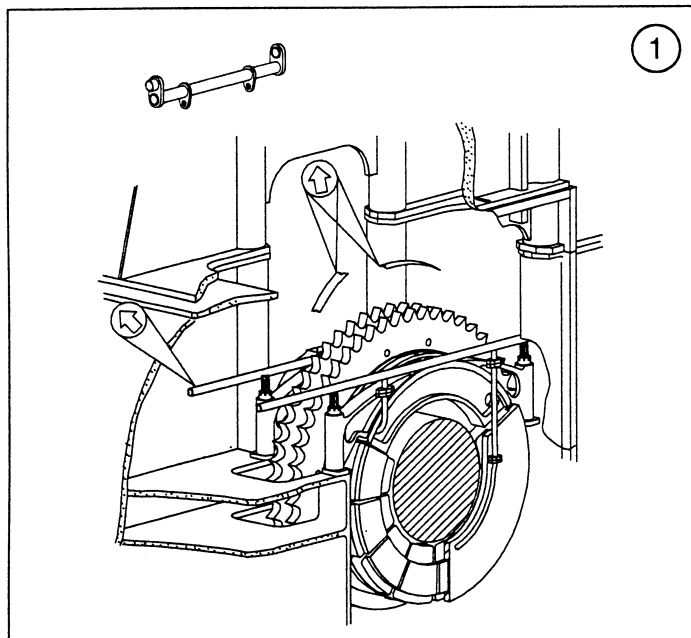
 M16



DATA:

- D-1 Stopper..... 220 kg
- D-2 Hydraulic pressure
- dismantling.....900-990 bar
 - tightening..... 900 bar





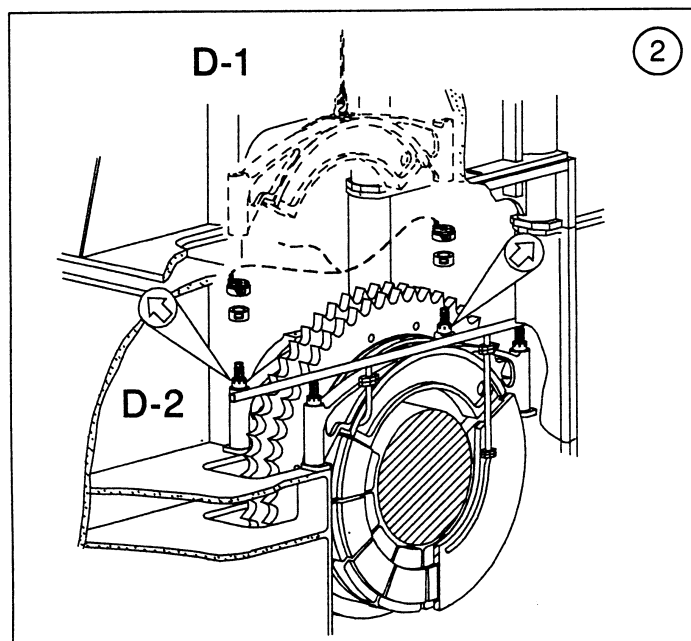
The clearance in the thrust bearing has been measured during testbed trials of the engine and noted down in the 'Adjustment sheet' which is inserted at the front of Volume I, OPERATION.

For a new engine the clearance is 0.5 – 1.0 mm, and for an engine in service it must not exceed 2.0 mm.

The wear of the thrust bearing is checked in the following way:

1. Remove the lubricating oil pipe over the forward segment stopper.

Remove the protecting shield on the foremost side of the thrust collar.



Mount the crossbar in the chain drive and suspend a tackle.

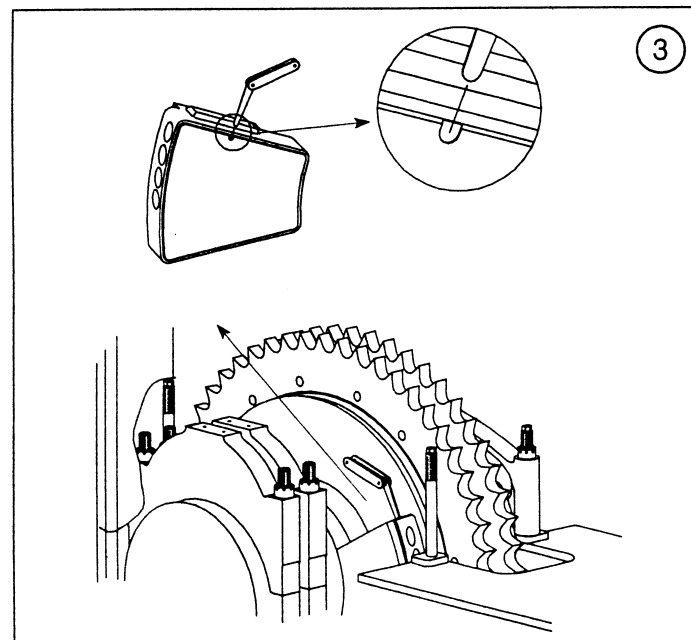
2. Mount the hydraulic jacks and loosen the nuts from the stopper.

Remove the hydraulic jacks and dismount the nuts.

Lift the stopper from the forward thrust segments.

3. There is a wear groove of 1 mm in the uppermost thrust segment.

The feeler gauge is to be applied in this groove on the foremost side of the thrust collar.

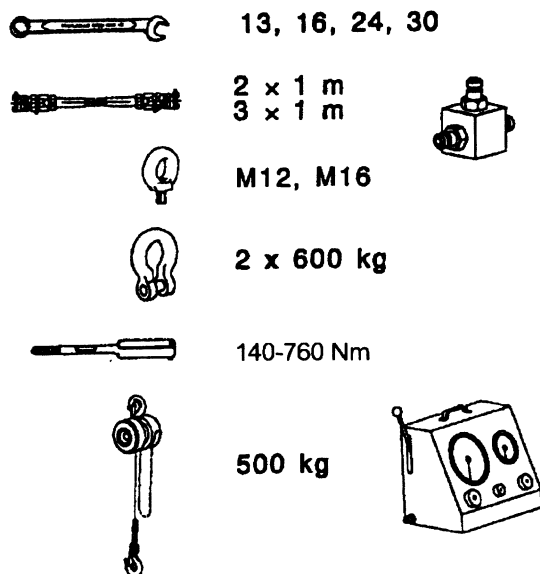


If a feeler gauge of 0.05 mm is **not** able to enter in the wear groove, the thrust bearing must be overhauled.

SAFETY PRECAUTIONS

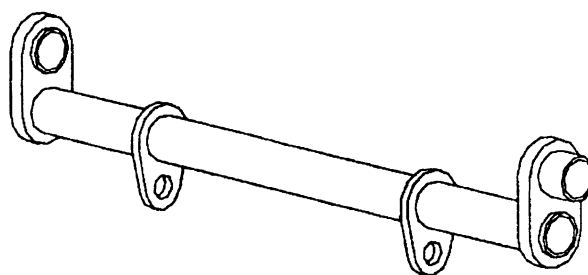
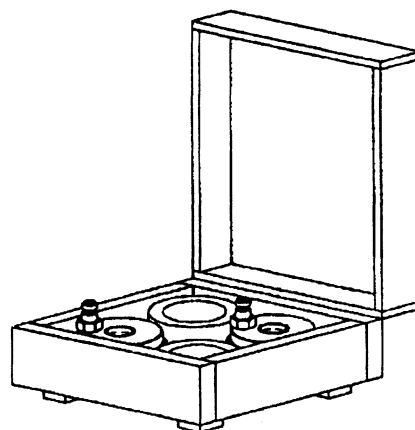
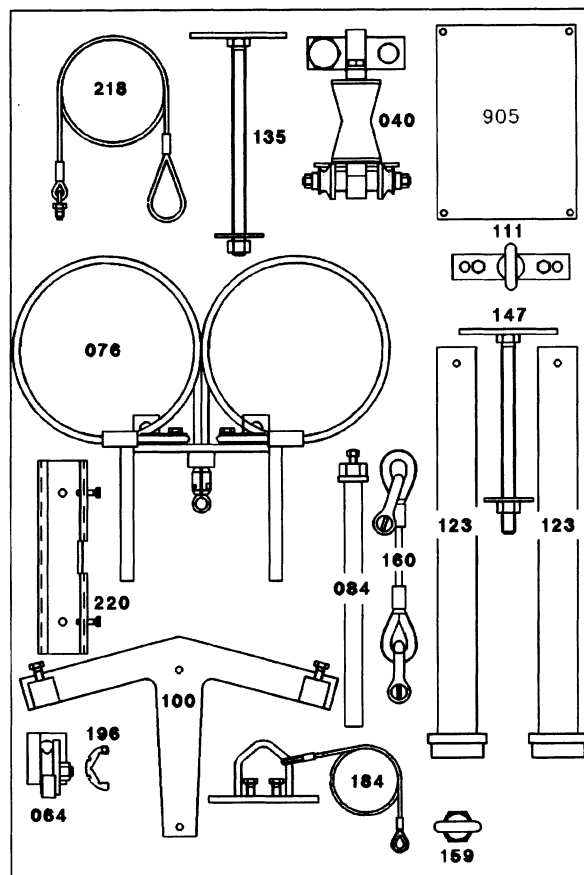
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

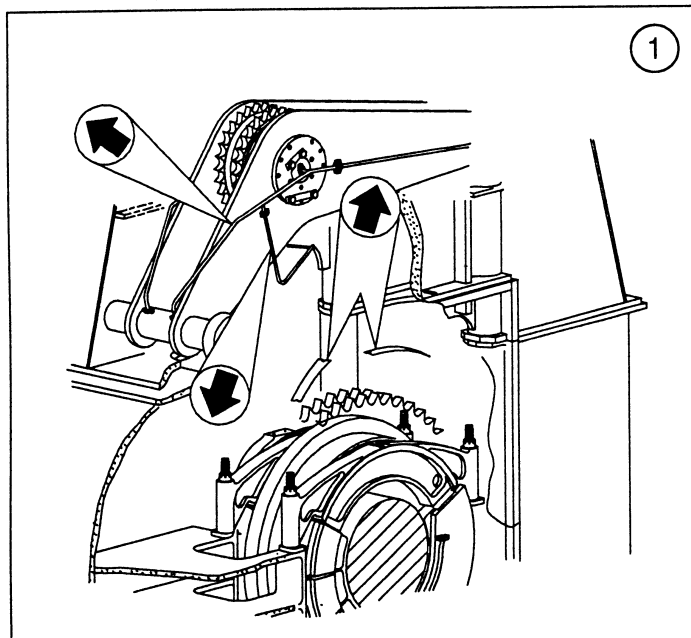
913



DATA:

- D-1 Hydraulic pressure
 - dismantling.....900-990 bar
 - tightening..... 900 bar
- D-2 Stopper..... 240 kg
- D-3 Thrust bearing segment..... 83 kg
- D-4 Screwing-in torque - stud for segment.....600±50 Nm





1. Remove the lub. oil pipes from the side plate of the chain tightener and the lub. oil pipe for the thrust segments.

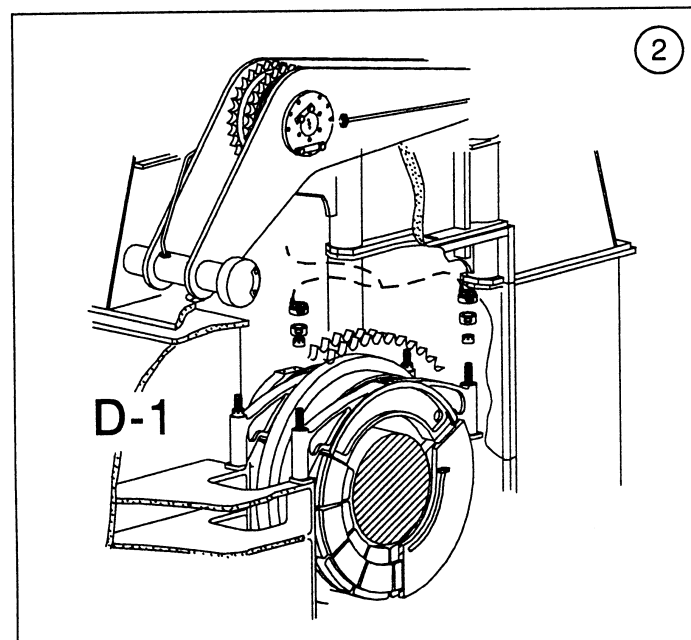
Remove the protecting shields from the thrust collar.

2. Loosen and remove the nuts from the segment stops by using hydraulic tools.

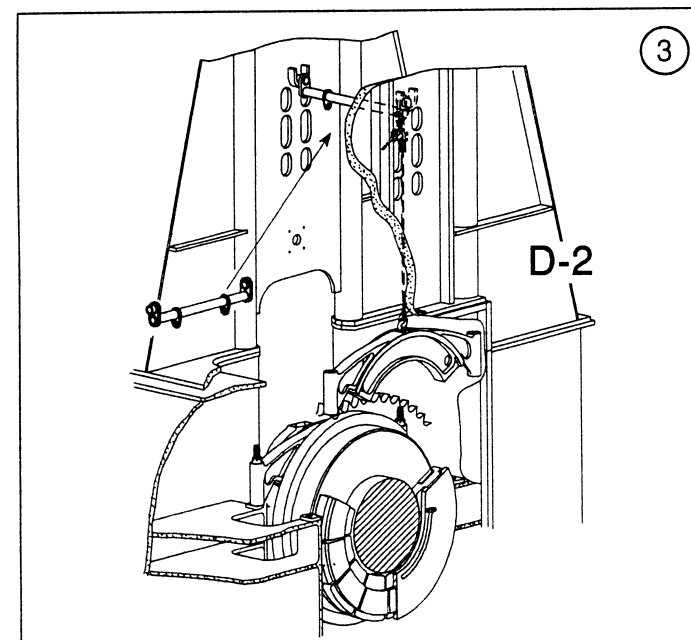
Unscrew the studs.

3. Mount the crossbar in the chain drive and suspend a tackle over the stopper which has to be removed.

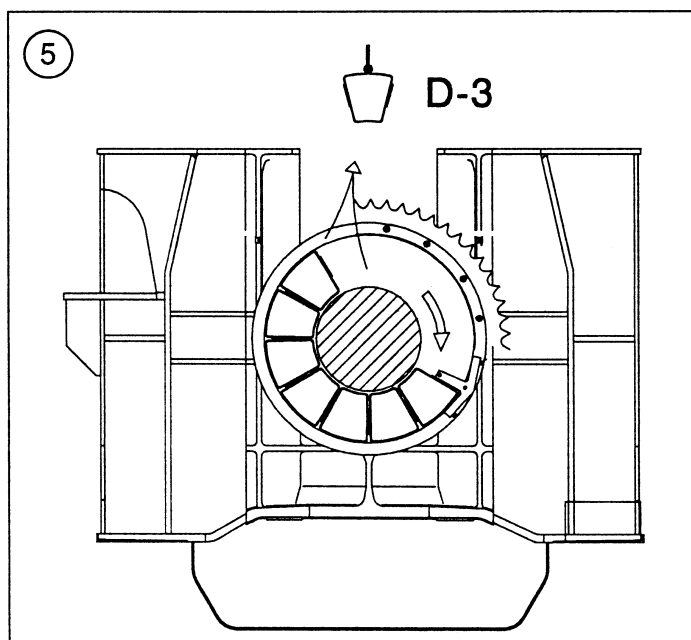
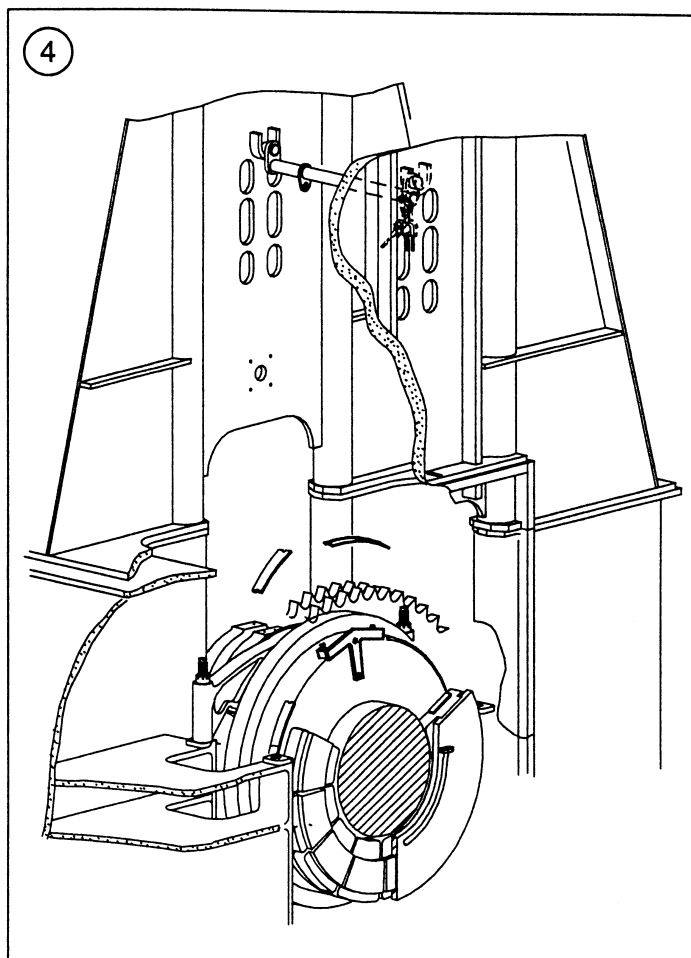
Remove the stopper from the chain drive above the thrust segments (AHEAD or ASTERN) that are to be taken out.



Remove the probes from the thermometer pockets of the uppermost thrust segment.



4. For turning-up the thrust segments, mount the tools on the chain wheel.
5. Turn up the segments by turning the engine, and remove them from the chain drive.
6. Mounting is carried out in the reverse order.



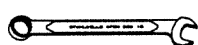
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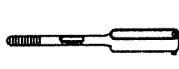


SAFETY PRECAUTIONS

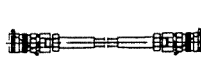
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

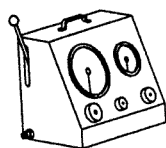
913

 18, 24, 30, 36 mm

 140-760 Nm
750-2000 Nm

 2 x M 16

 2 x 1 m
1 x 3 m



DATA:

- D-1 Damper housing,
upper part..... 622 kg
- D-2 Hydraulic pressure
- dismantling..... 900-990 bar
- tightening..... 900 bar
- D-3 Screwing-in torque –
studs..... 100 Nm
- D-4 Tightening torque –
horizontal screws..... 950 Nm
or tightening angle..... 40°
- D-5 Clearance at joints
- middle oil seal..... 6 mm
- side oil seal..... 8 mm

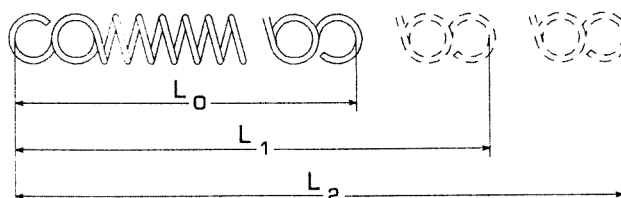
Calibration of springs:

Spring for the middle oil seal:

L_0 0 N..... Check length 2322 mm
 L_1 70 ± 8 N..... Check length 3265 mm
 L_2 105 ± 12 N..... Check length 3750 mm

Spring for the side oil seals:

L_0 0 N..... Check length 1938 mm
 L_1 55 ± 7 N..... Check length 2555 mm
 L_2 83 ± 10 N..... Check length 2880 mm



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Electronic

1. For checking the effectiveness of the axial vibration damper in service, a proximeter probe with bracket is built on the lower part of end shields.

Note!

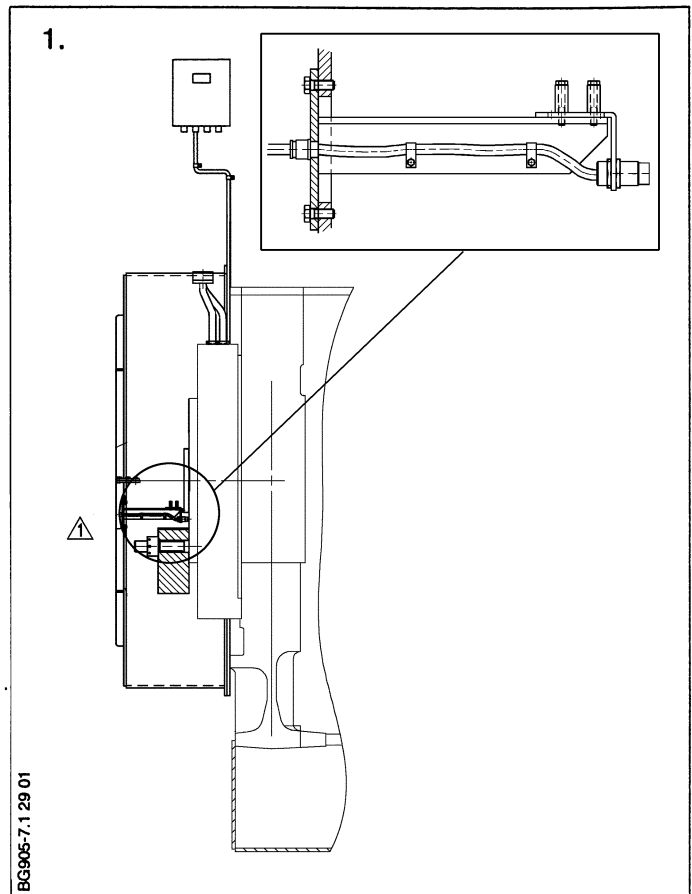
The proximeter probe is not standard for all engines.
For engines without a proximeter probe, see instead Mechanical checking on page 2.

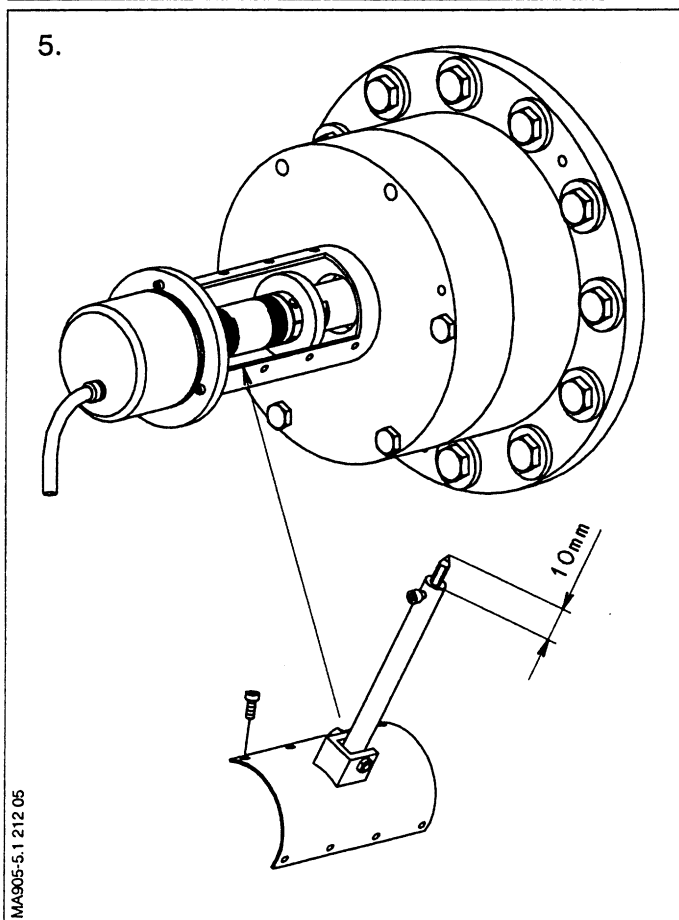
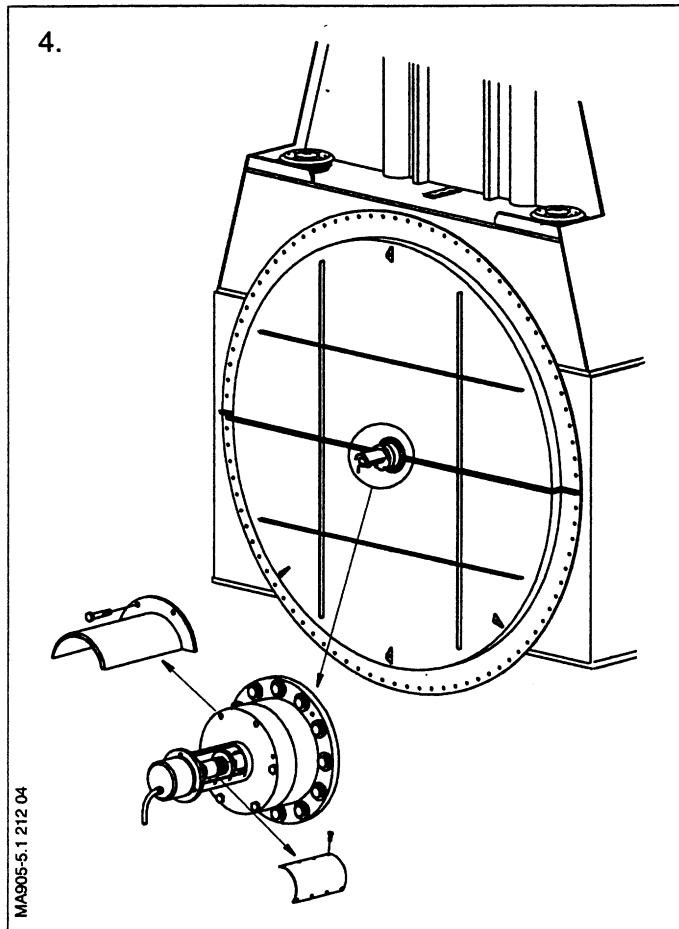
The cable from the probe is connected to a monitoring box which is mounted on the exhaust side of the framebox and towards the forward end of the engine.

2. The peak-to-peak value displayed in mm on the monitoring box should be compared with the original values obtained during the sea trial, and with the limits given below.

If the peak-to-peak value does not exceed the permissible values, **S1**, it is not necessary to overhaul the damper.

For **S1**-Limits for permissible peak-to-peak values, see *Data*.





Mechanical

- When checking the effectiveness of the axial vibration damper in service (which is recommended every 8000 hours), a special measuring tool has to be mounted in the shield on the forward end of the engine, in order to measure the axial movement of the crankshaft fore end.

The actual measurement obtained should be compared with the original values obtained during the sea trial, and with the limits given on the next page.

- The following procedure should be followed:

Stop the engine.

Dismount the cover on top of the angle encoder housing at the front of the engine. Apply Molykote™ on the side of the shaft cam.

- Mount the axial vibration measuring tool with the screws from the cover.

Attach a pencil to the arm.

Note!

The tip of the pencil should protrude **10 mm** from the end of the arm, in order to obtain a correct measurement.

6. The measurement should be taken at the same r/min as used during the sea trials (preferably 90% and 100% of MCR).

Start the engine and pull the measuring arm against the shaft cam with one hand. With the other hand, move a sheet/block of paper, clipped on to a solid backing plate, lightly downwards against the tip of the pencil.

To ensure a certain inertia, the backing plate should have a mass of approx. 1-2 kg.

The axial movement recorded on the paper block must be measured with a calliper as shown in the sketch.

If the peak-to-peak distance **a** in mm does not exceed the values, **S2**, it is not necessary to overhaul the damper.

For S-2-Limits, see Data.

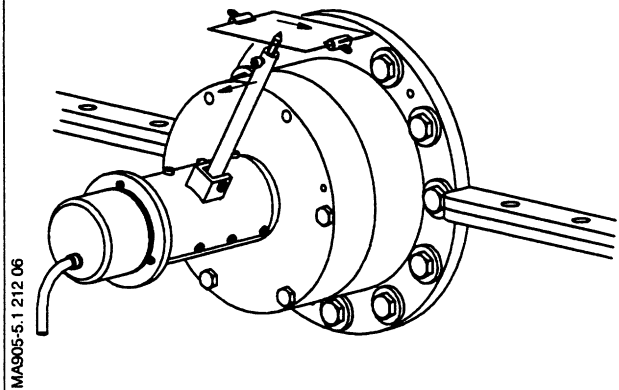
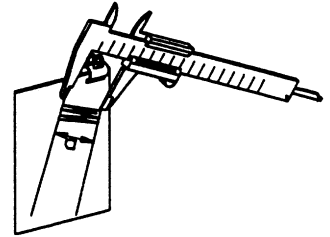
7. Note that the **S2**-limits are only valid for a standard measuring tool with **L1** = 35 mm and **L2** = 178 mm.

If a non-standard measuring tool is used, the **S2**-limits must be adjusted as follows:

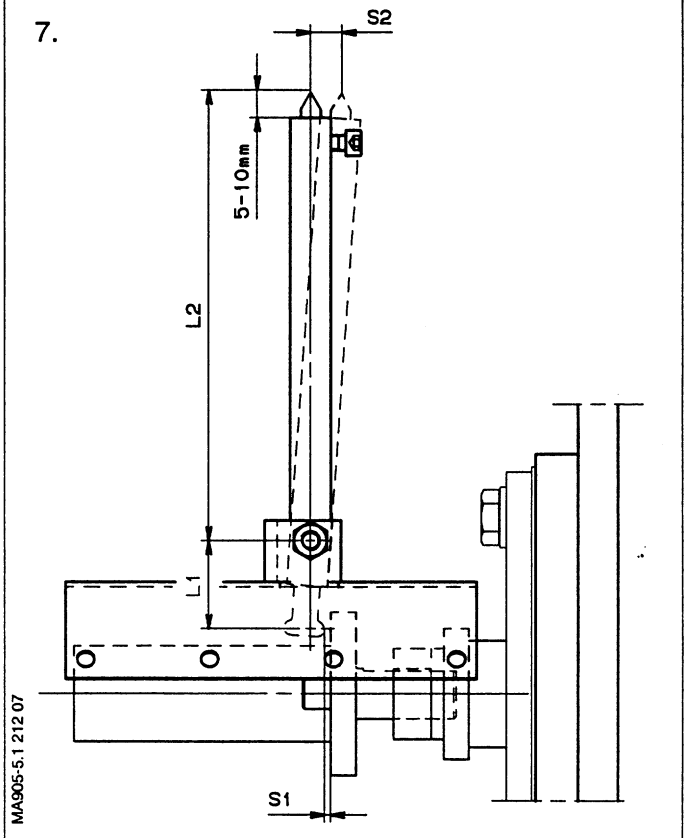
$$S2 = \frac{L2}{L1} \times S1$$

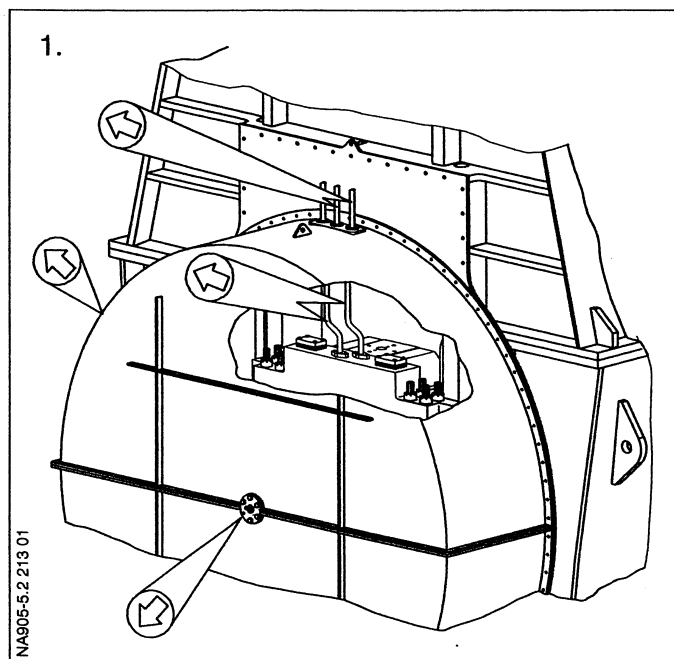
For S1-limits, see Data.

6.



7.





1. Overhaul of the axial vibration damper takes place from the front end of the engine.

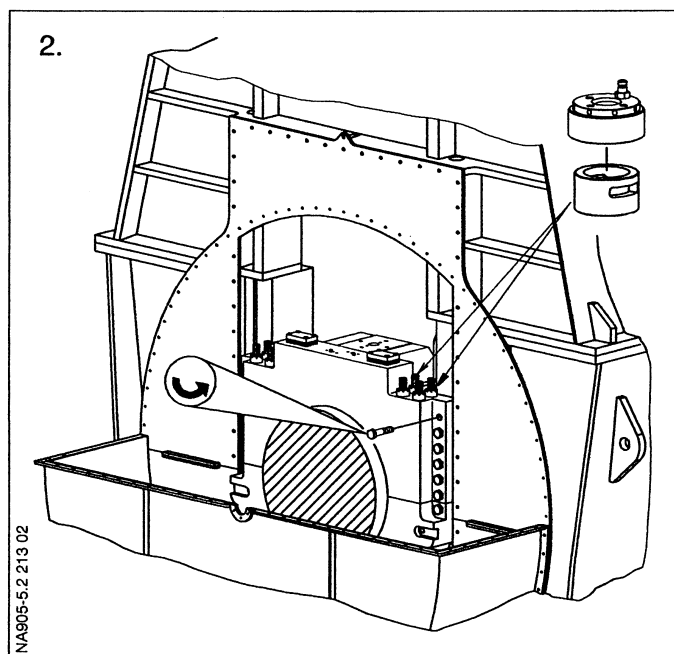
Disconnect and remove the two oil pipes from the axial vibration damper and the oil pipe for the foremost main bearing.

Dismount the small cover on the end shield and the upper part of the end shield.

If the crankshaft is fitted with a counterweight, turn the crankshaft until the counterweight is at its lowest possible position.

2. Loosen and remove the horizontal screws from the damper housing upper part.

Loosen and remove the hydraulic nuts by using the hydraulic jacks for the axial vibration damper.



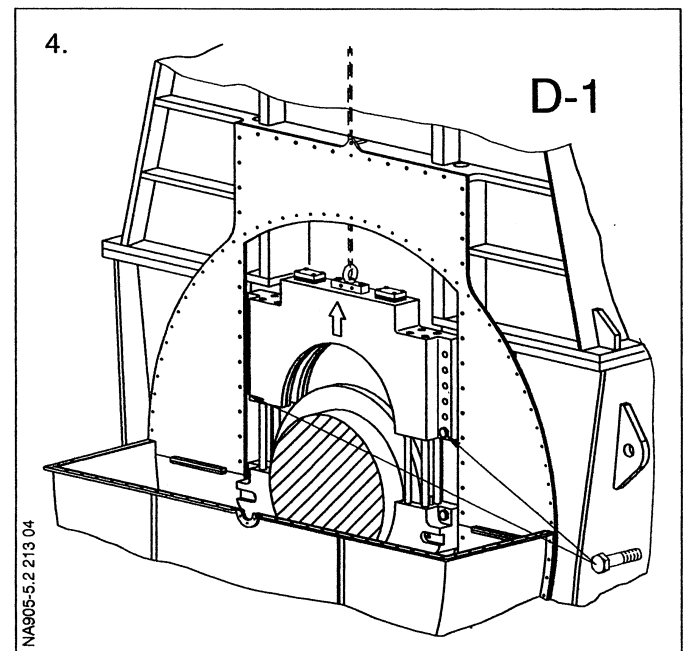
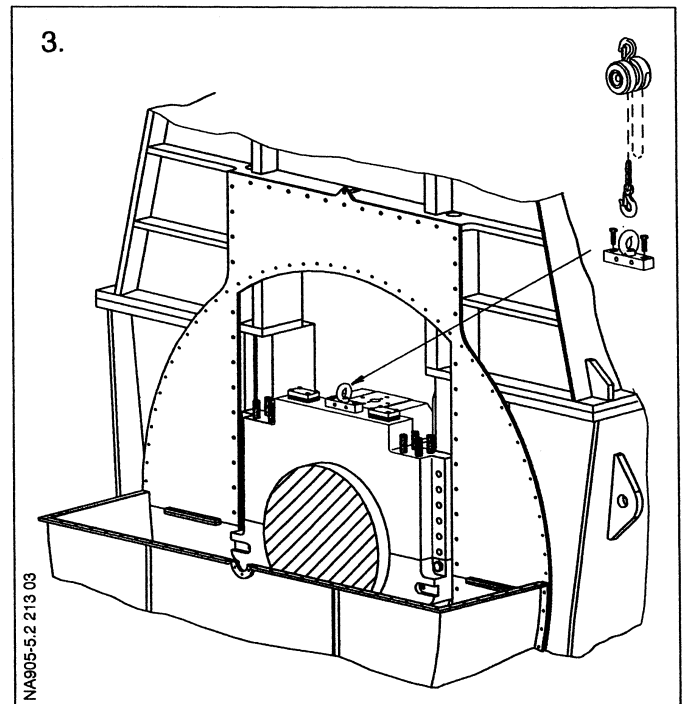
3. Suspend a tackle outside the engine.

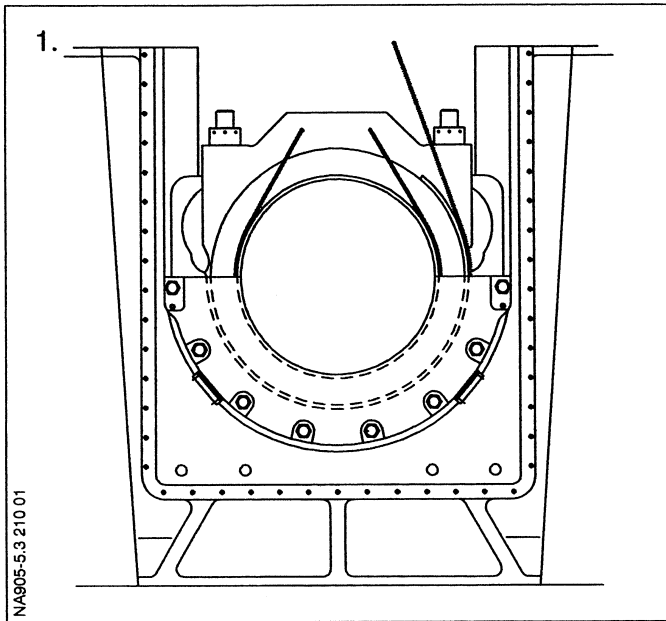
Mount the lifting tool in the top of the damper housing upper part.

4. By means of the tackle, separate and raise the upper part of the damper housing to a position in which it is possible to change the oil seals and springs.

Secure the upper part by inserting two screws in the damper housing.

Only the upper part of the housing needs to be lifted, while the lower half remains mounted on the bedplate.





1. Dismantle and remove the springs from the teflon rings.

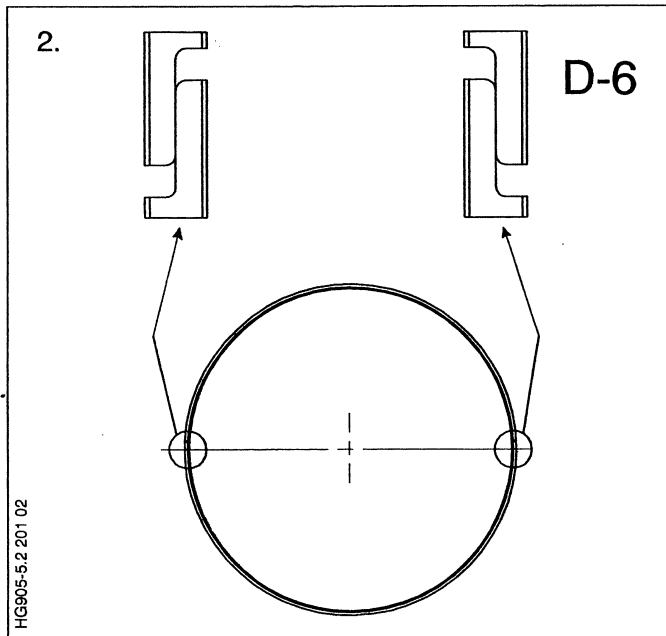
Remove and discard the teflon rings.

When mounting new teflon rings, first insert the lower half of the rings in the lower part of the housing.

Then press the tension springs into the groove between the teflon ring half and the housing.

Note!

The lower half of the teflon rings will protrude above the centreline.



2. Mount all the upper halves of the teflon rings in such a way that there is a clearance at the joints of both the small and the large rings. *See Data.*

Now hook the tension springs into place, ensuring that they are centralised in the grooves of the teflon rings.

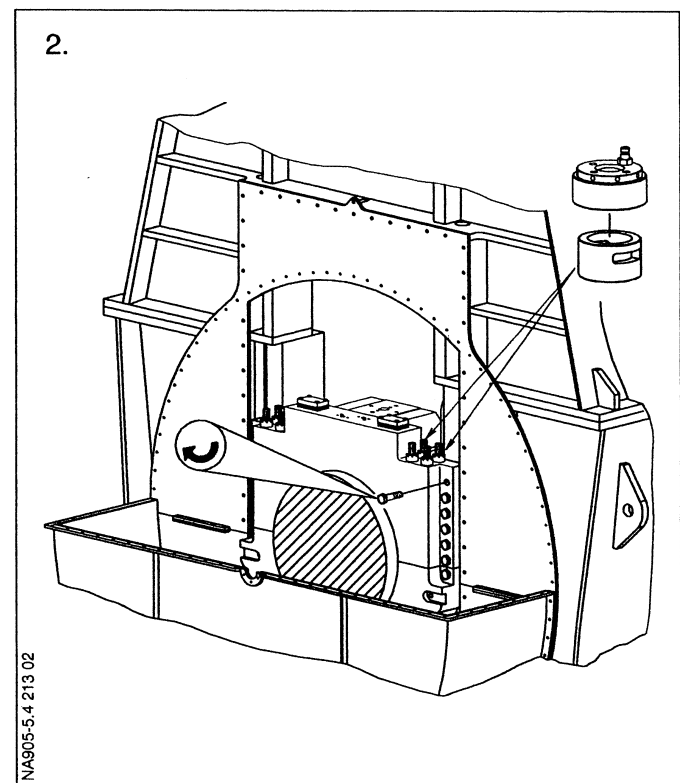
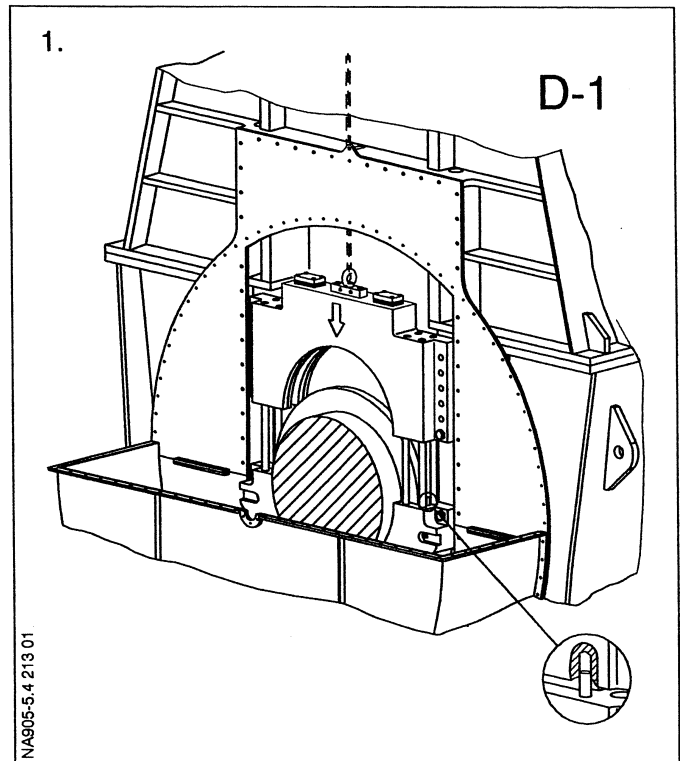
1. Unscrew/release the upper part of the damper housing. Use the two guide pins in the lower part to ensure the correct positioning of the upper part.

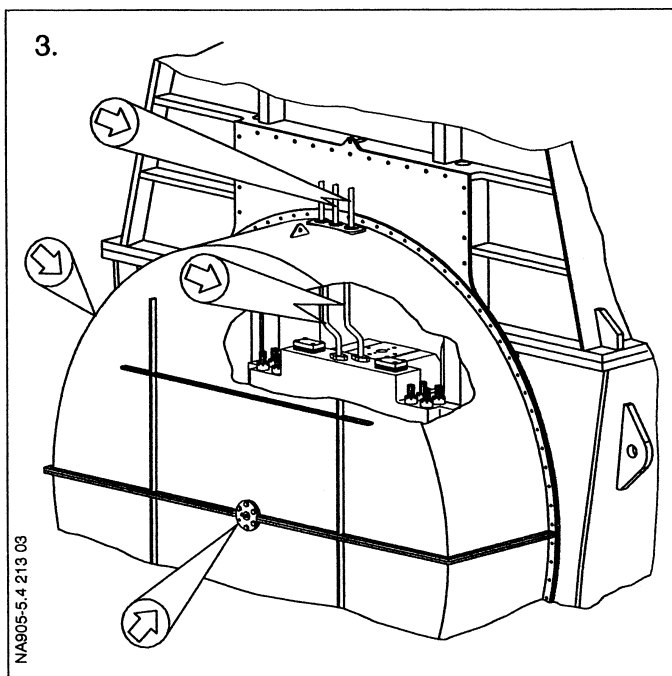
2. Mount the horizontal screws.

Tighten the screws. *See Data.*

Mount and tighten the nuts on the studs. *See Data.*

For operation of hydraulic tools, see Procedure 913-1.





3. Mount the upper part of the end shield and the small cover on the end shield.

Mount the oil pipes for the axial vibration damper and the oil pipe for the foremost main bearing.

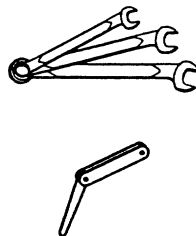
SAFETY PRECAUTIONS

☒	Stopped engine
☒	Block the starting mechanism
☒	Shut off starting air supply
☒	Engage turning gear
☐	Shut off cooling water
☐	Shut off fuel oil
☐	Shut off lubricating oil
☐	Lock turbocharger rotors

Data

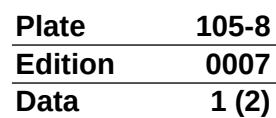
Ref.	Description	Value	Unit
D-1	Tacho pick-ups for governor system		
	– check distance	3 ±0.5	mm
D-2	Tacho pick-ups for Alpha lubricator		
	– check distance	3 +0/-1	mm

Standard Tools: See Section 913



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The task-specific tools used in this procedure are shown on the plates at the end of this chapter or in the chapters indicated by the first three digits in the plate number, e.g. **P90951** refers to chapter 909.

Plate	Item No.	Description

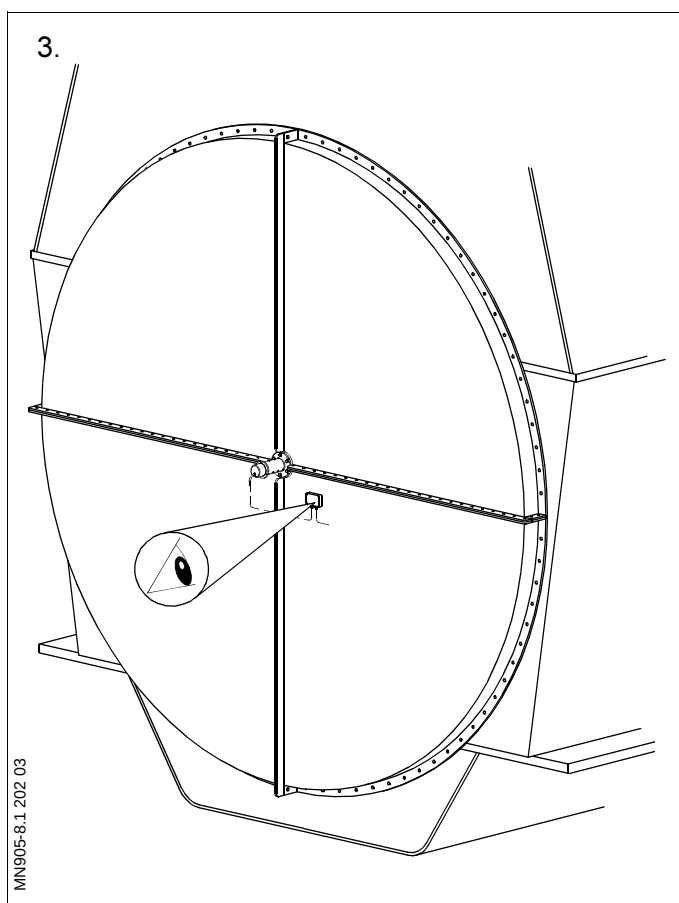
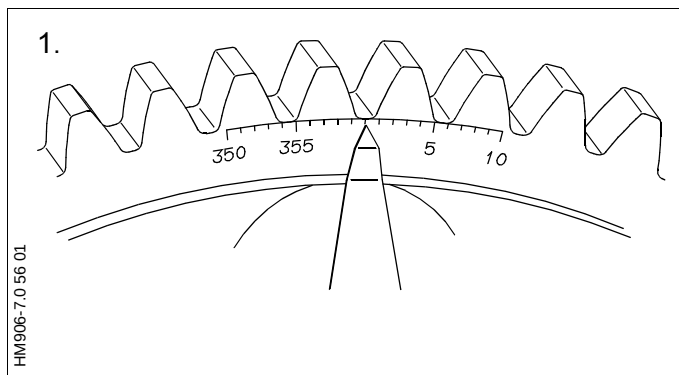
1. Turn the crankthrow for cylinder 1 to TDC.

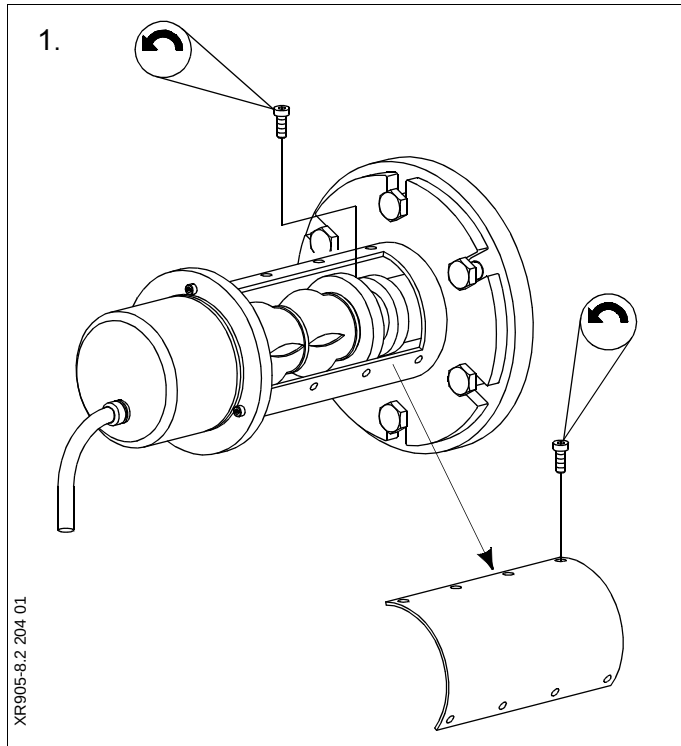
Check the TDC of cylinder 1 against the mark on the turning wheel.

2. Check that power is supplied to the intermediate box.

The green indicator should now light.

For adjustment of the angle encoder, see Procedure 905-8.3.

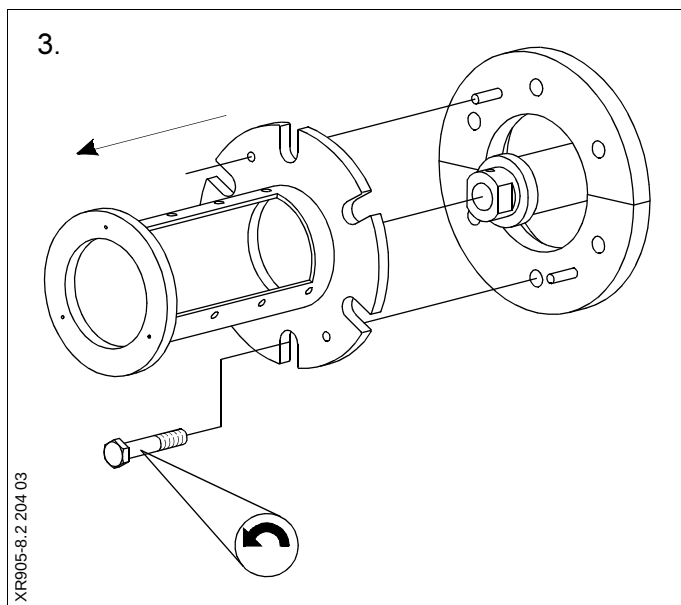
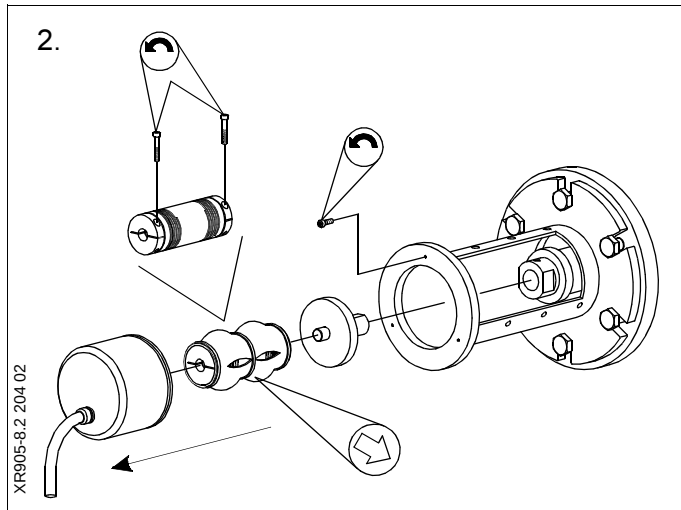




1. Remove the inspection cover.

Cut the cable tie which holds the rubber damper around the coupling, in the end nearest to the engine, and loosen the coupling.

2. Loosen the three adjusting screws on the front flange, and remove the angle encoder and the coupling.
3. Screw out the flange screws and remove the encoder housing. Take care not to damage the guide pins.



1. Turn the crankthrow for cylinder 1 to TDC.

Check the TDC of cylinder 1 against the mark on the turning wheel.

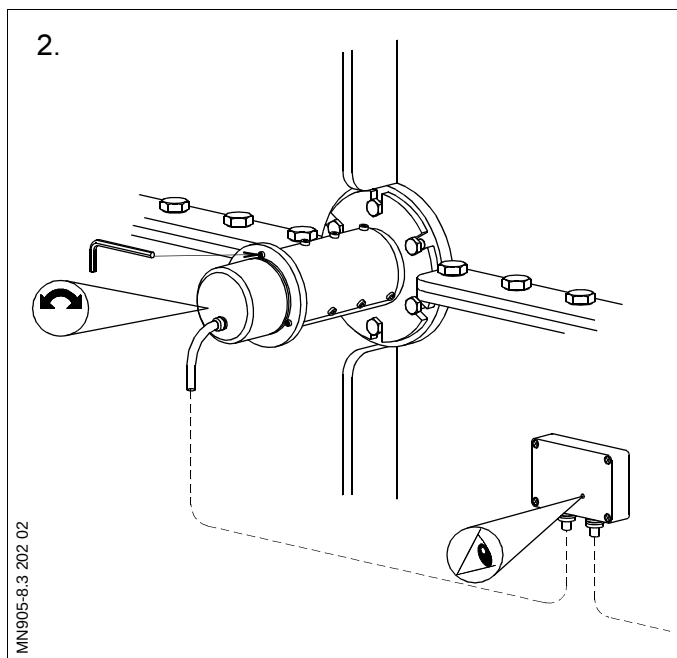
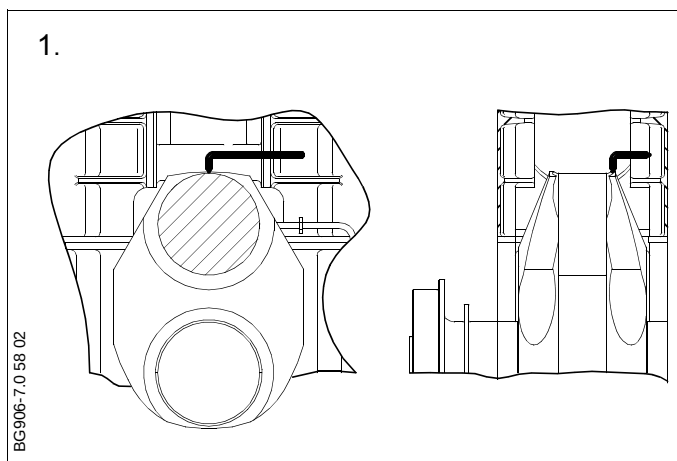
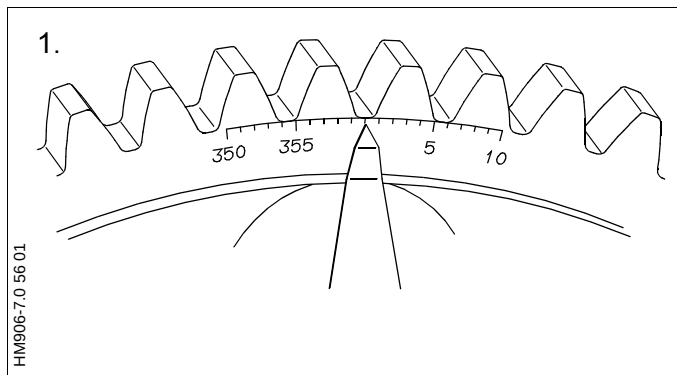
Check the TDC position with the pin gauge on the crankthrow, cylinder 1.

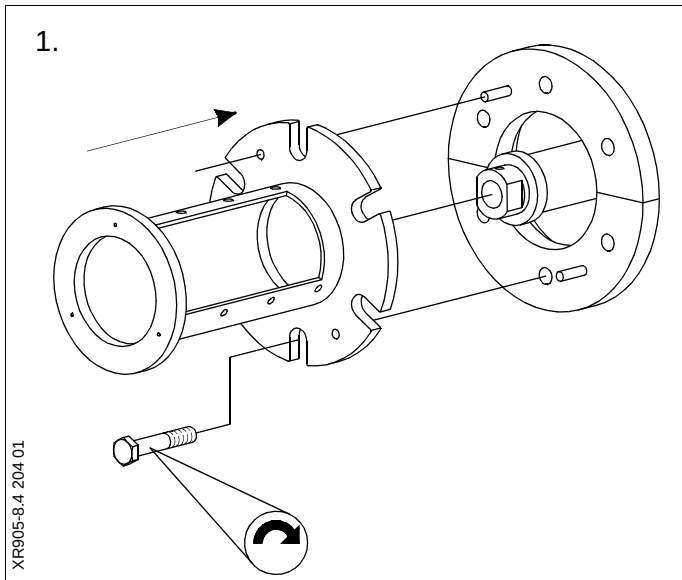
Note!

Before using the pin gauge, check the measurement from tip to tip with the value stamped on the pin gauge, and/or the check-marks stamped on the fore end of the cylinder frame.

2. Loosen the adjusting screws which fasten the encoder to the housing. Slowly turn the encoder until the green indicator lights on the intermediate box.

Tighten the screws to secure the encoder in the correct position.





1. Mount the encoder housing. The two guide pins indicate the correct positioning of the housing. Tighten the screws.

2. Mount the angle encoder and the coupling.

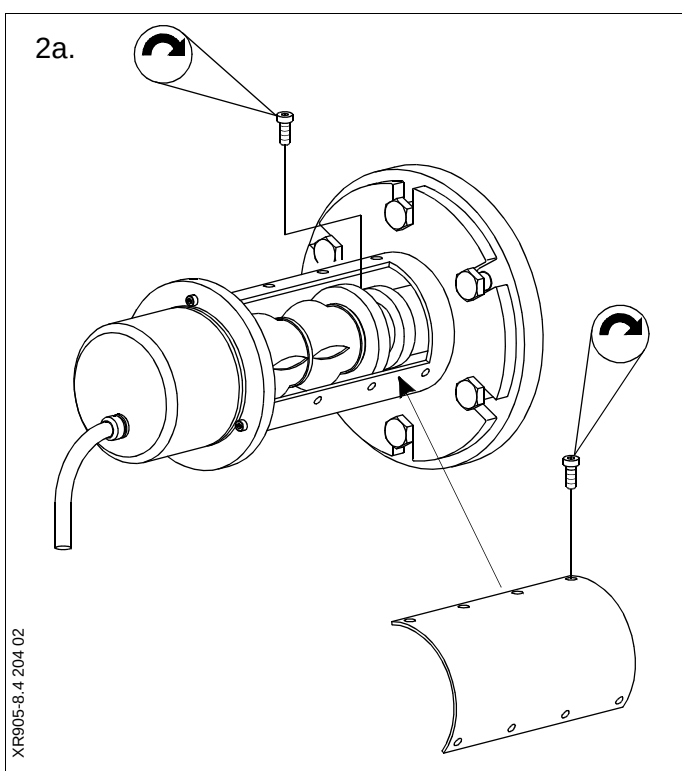
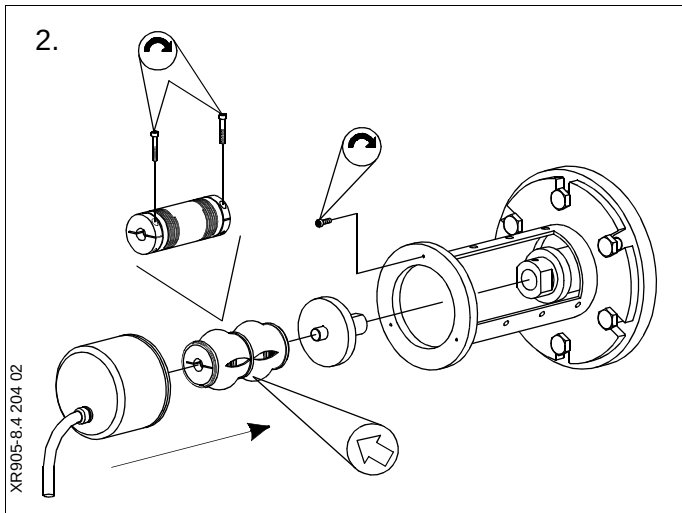
Tighten the coupling, and mount new cable ties around the rubber damper.

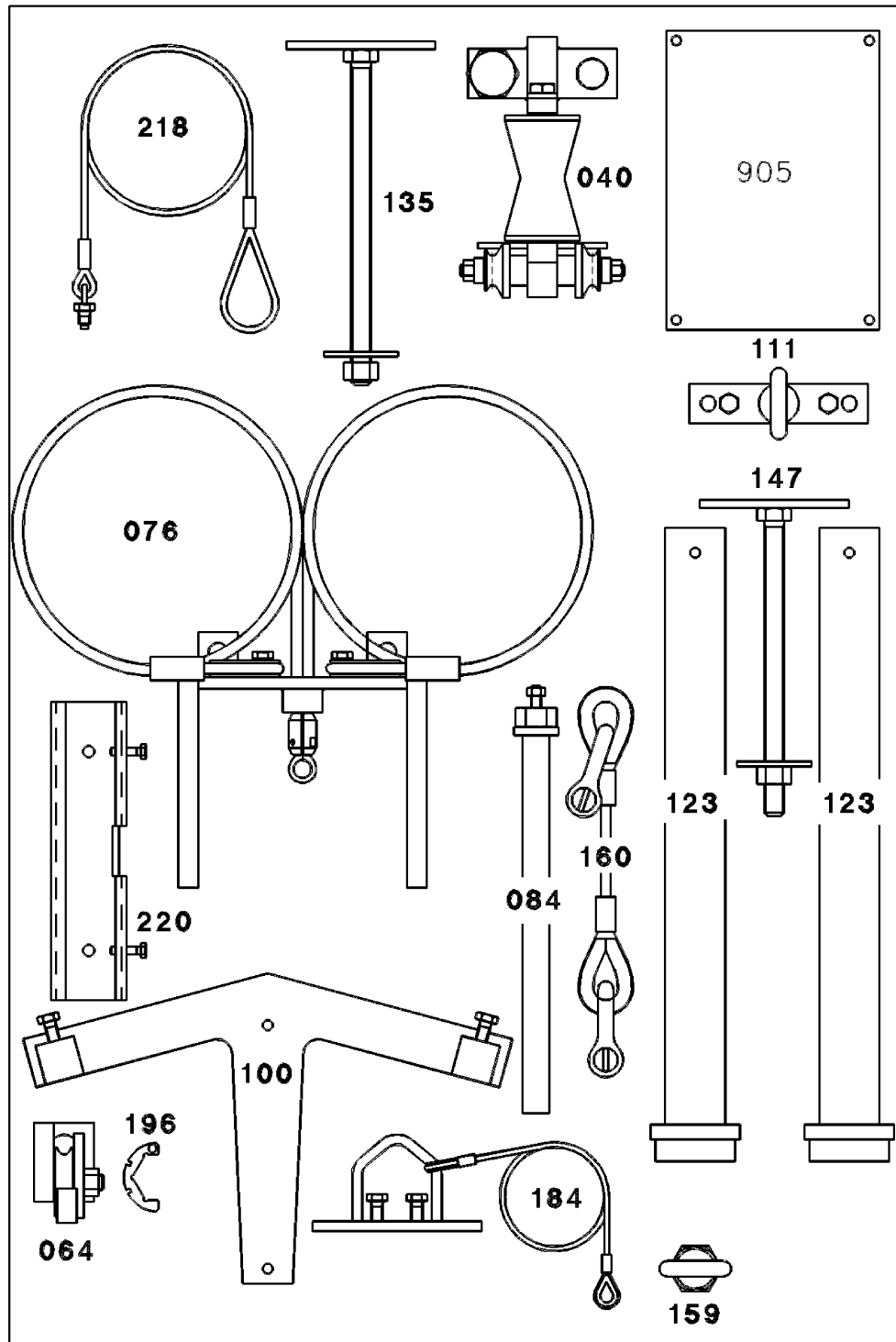
Adjust the angle encoder according to Procedure 905-8.3.

Note!

The adjustment will be easier if mounting is in the same crank position as dismantling.

Mount the cover.

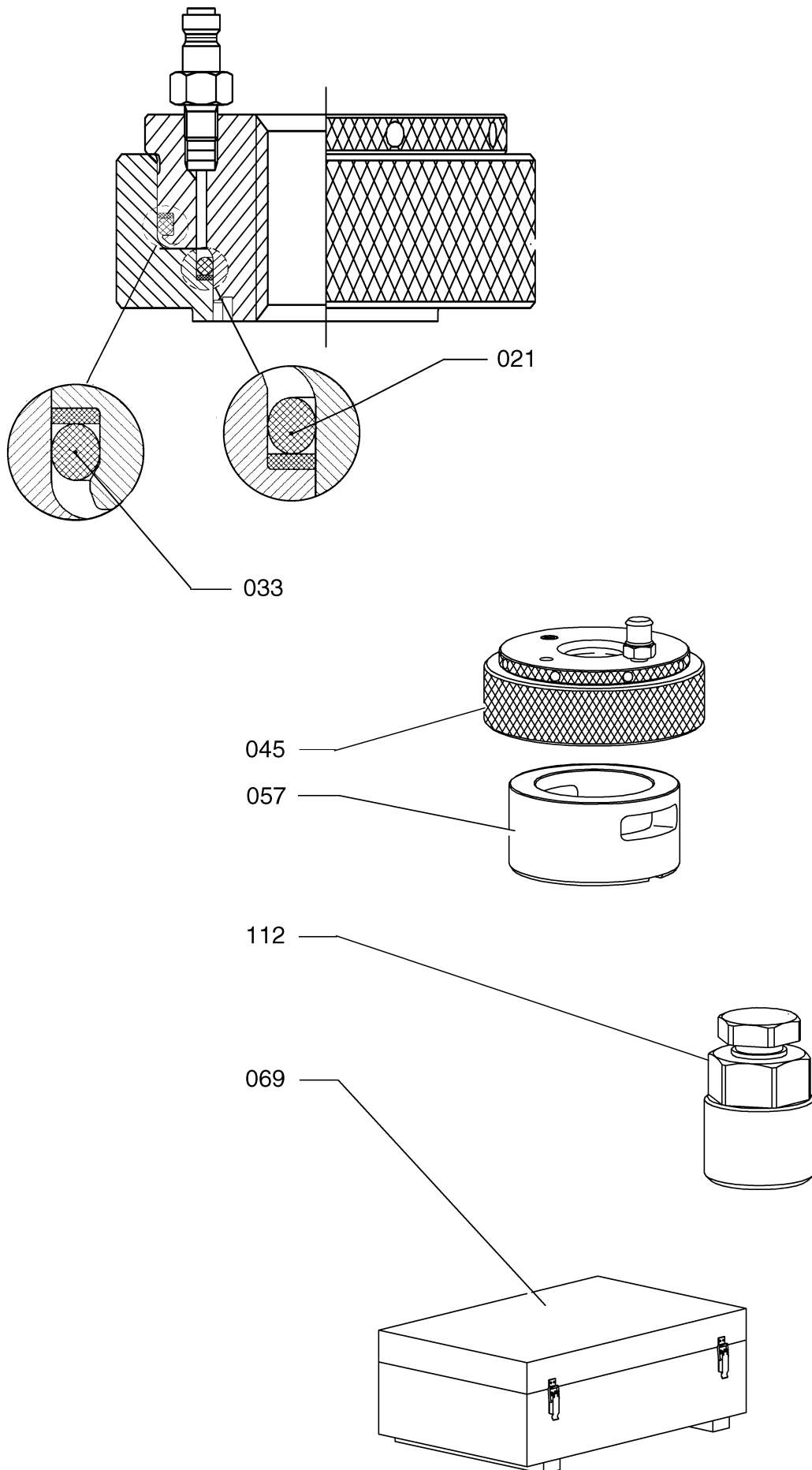




Item No.	Item Description
905	Tool panel *)
040	Pulley for wire of main bearing cap dismantling
064	Pulley for wire of main bearing cap dismantling
076	Lifting tool for main bearing
084	Extrator for main bearing vertical pin
100	Tool for turn out segment
111	Lifting tool for Axi. v. damper
123	Retaining tool for main bearing shells
135	Lifting tool for crankcase relief valve(2)
147	Lifting tool for crankcase relief valve(1)
159	Eye bolt
160	Wire rope for main br'g shell lifting
184	Wire rope for main br'g shell lifting
196	Tightn template for axi.V.demper
218	Wire for dismantling of main bearing shell
220	Wire guide for main bearing
905	*)Tool panel, complete with tools
220	*)Optional extras

Item No.	Item Description

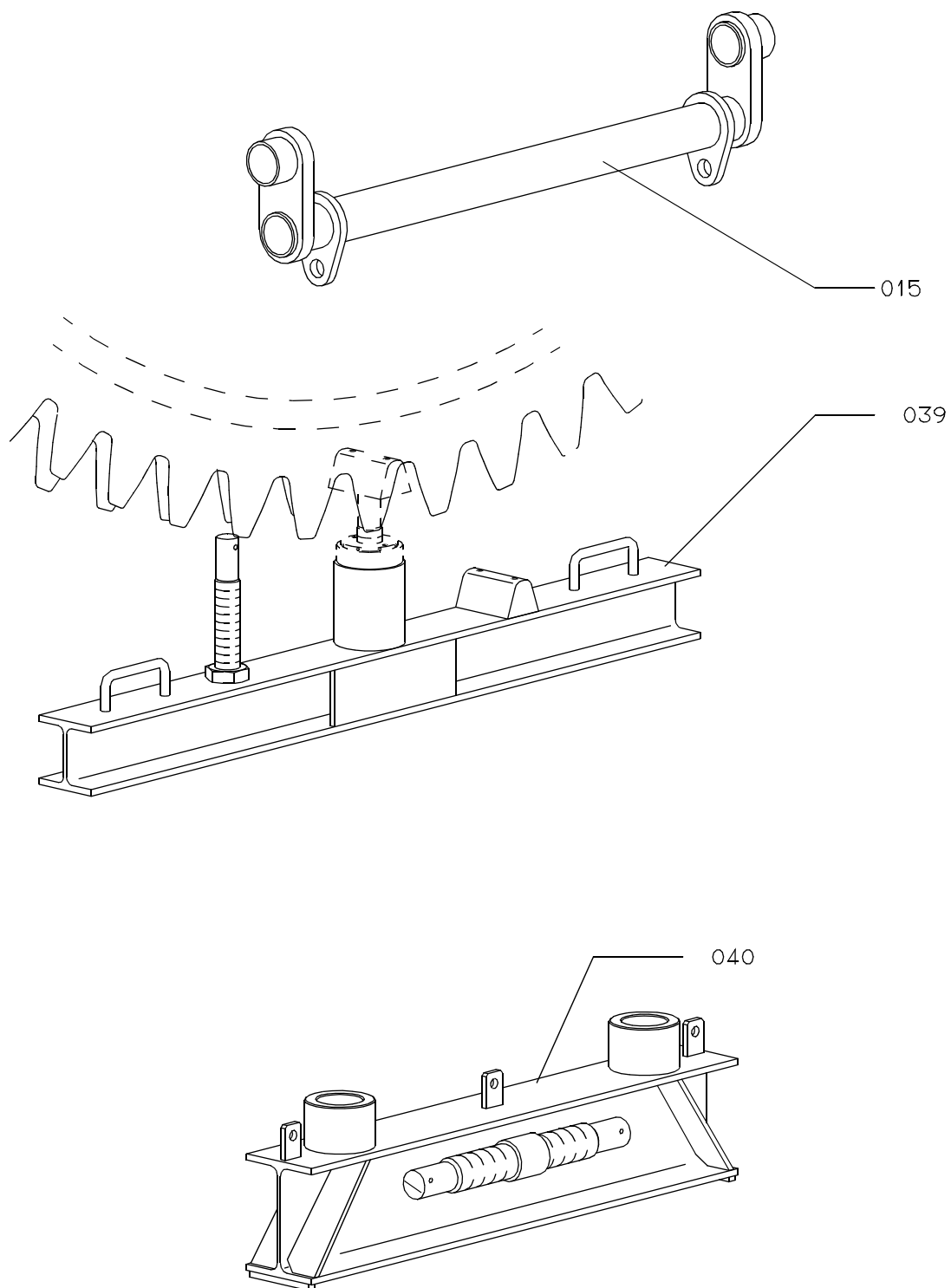




Item No.	Part Description
021	O-ring with back-up ring, 65/75 mm
033	O-ring with back-up ring, 105/115 mm
045	Hydraulic jack for main bearing
057	Support for Hydr. jack
069	Steel box for Hydr. jack
112	Stud setter (M42 x 3)

Item No.	Part Description

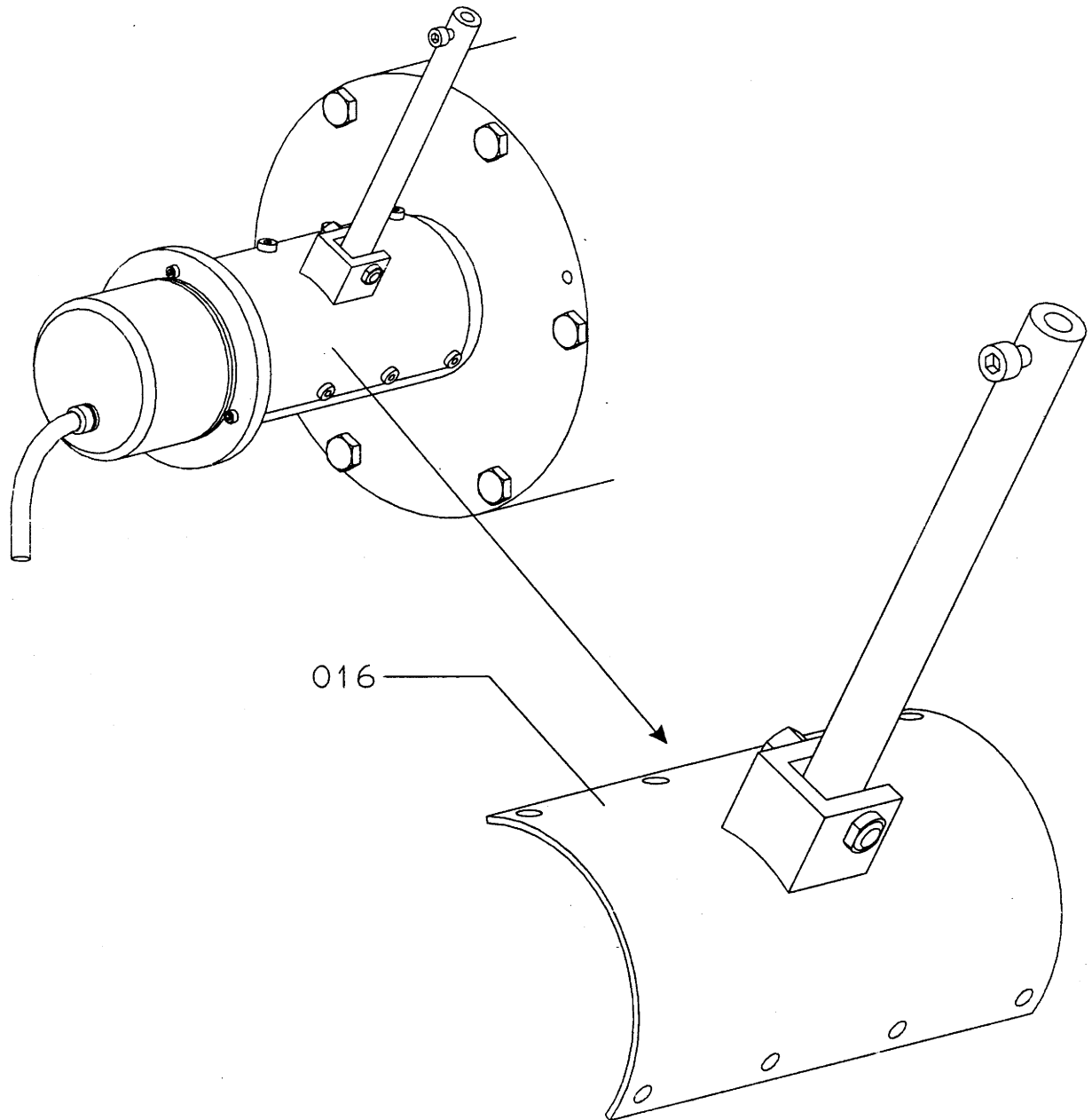




Item No.	Item Description
015	Crossbar for lifting of segment stopper
039	Lifting tool for thrust shaft
040	Lifting tool for crankshaft

Item No.	Item Description





Item No.	Item Description	Item No.	Item Description
016	Measuring tool for axial movement		

SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

DATA:

- D-1 Max. wear of teeth
on chain wheel for:
- | | |
|---|--------|
| 1" Chain..... | 0.9 mm |
| 4 ¹ / ₂ " Chain | 4.0 mm |

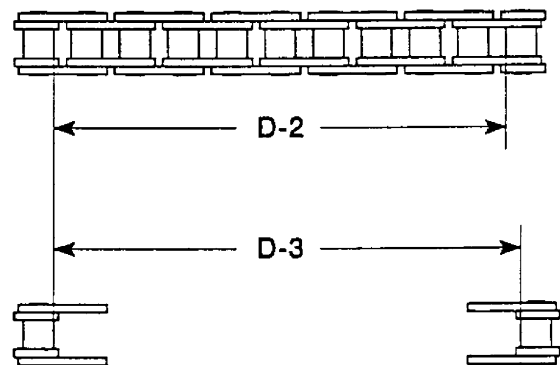
1" Chain

- D-2 Original length
(chain pitch x 10 links)..... 238.2 mm
- D-3 10 links measurements
+ 1% of a tensioned chain
= scrapping of chain..... 240.5 mm

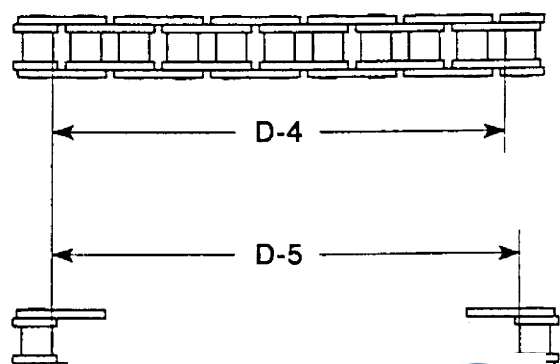
4¹/₂" Chain

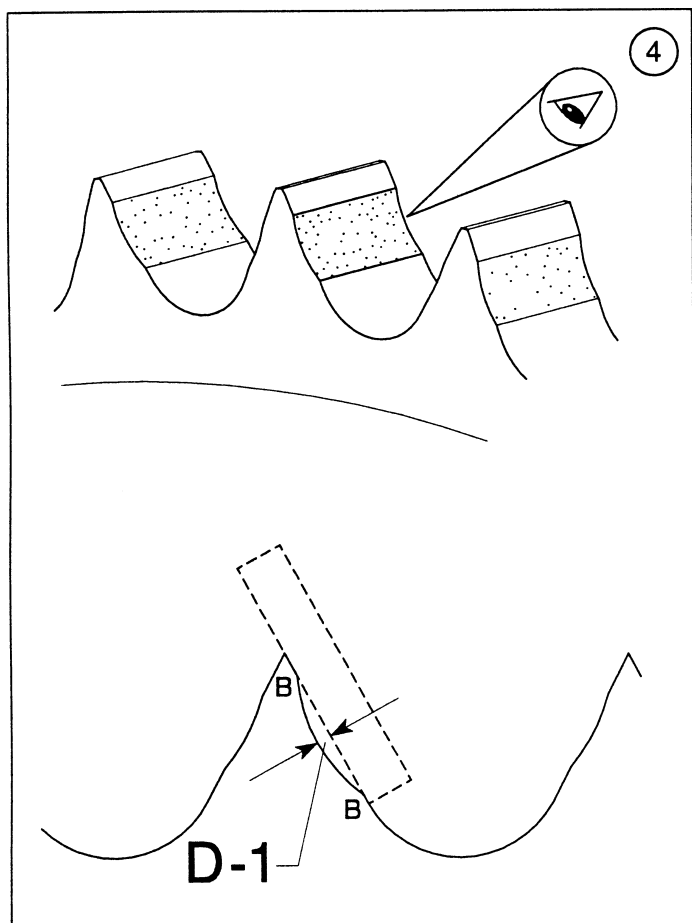
- D-4 Original length
(chain pitch x 10 links) 1070.6 mm
- D-5 10 links measurements
+ 1 % of a tensioned chain
= scrapping of chain 1081.3 mm

1" Chain



4¹/₂" Chain





Carry out the inspection as follows:

1. Make a general inspection for loose bolts and screws.
2. Inspect lube oil pipes for damage, and check jet nozzles for possible stoppages or deformations.
3. Examine the rubber track of the guideways for cracks or other damage.

Make a special check of the guideways at the on and off runs of the chain wheels.

Replace the guideway if bits have started to be "plucked out" of the rubber track.

4. Check the teeth of the chain wheels. If abnormal wear is found, take a measurement (see Data).

Measurements are best made by placing a short straight-edge over the points A and B and then measuring the distance D-1. If abnormal wear is noted at the bottom of the teeth, measure the diameter of the bottom. For assessing the measurement results, contact MAN B&W Diesel.

In most cases, scratches will be found on the sides of the teeth, which are caused by the side plates of the chain. Such scratches can generally be considered normal.

5. The chains for the camshaft drive are matched together to ensure an even load distribution.

To keep such matching chains in their pairs, they have been marked on the side plates of the outer link nearest to the assembled link with year, month, day and chain number.

Example:

No. 1 order,
840520 1A
840520 1B
(840520 1C, possible 3rd chain)

No. 2 order,
840520 2A
840520 2B
(840520 2C, possible 3rd chain)

On the same links there is an arrow (→) which indicates the mounting direction.

Check the chains for cracks on possibly defective rollers and side plates.

Check that the chain rollers can run freely and that the chain links can freely move on the pin and bushing (that they are not “seized” between the pin and the bushing).

It is normal, however, that the rollers get light, circumferential cracks during the running-in period. These fine cracks are of no importance and need not be considered.

It is recommended to turn the chains a complete rotation and check each single link.

Check the chain wear – *see Data* – and adjust the chains (remember to block and lock the nuts of the chain tightener bolt) – *see Data and Procedure 906-2*.



BLANK



SAFETY PRECAUTIONS

☒	Stopped engine
☒	Block the starting mechanism
☒	Shut off starting air supply
☒	Engage turning gear
☐	Shut off cooling water
☐	Shut off fuel oil
☒	Shut off lubricating oil
☐	Lock turbocharger rotors

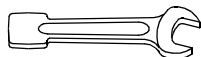
913



17, 19, 24, 30, 36 mm



85 mm



85 mm

Original Spring

DATA:

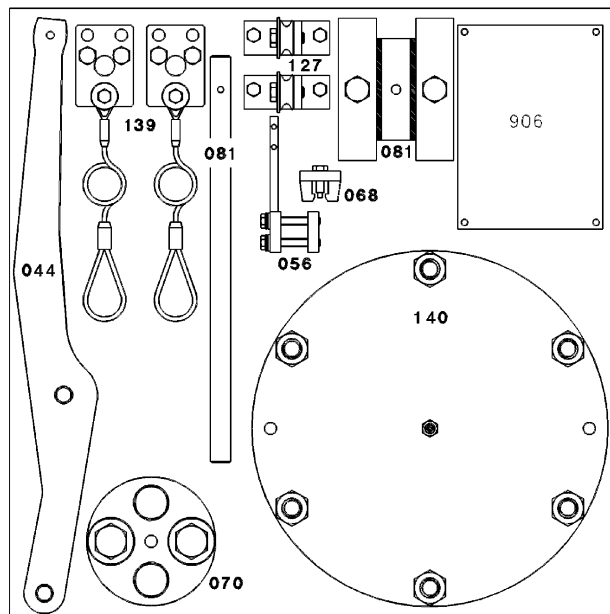
4.1/2" Chain

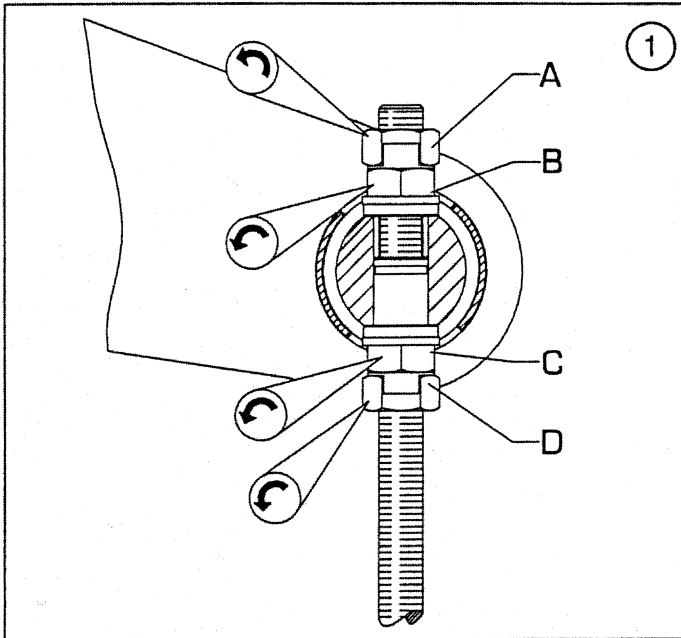
D-1 0.1 mm

D-2 300°

When replacing the chain, the chain tension is to be re-adjusted when the engine has been operating at MCR or after 100 hours' operation.

The chains are to be tightened after sea trial and after 500, 1000 and 1500 service hours, Thereafter, the normal service period is 4000 hours.





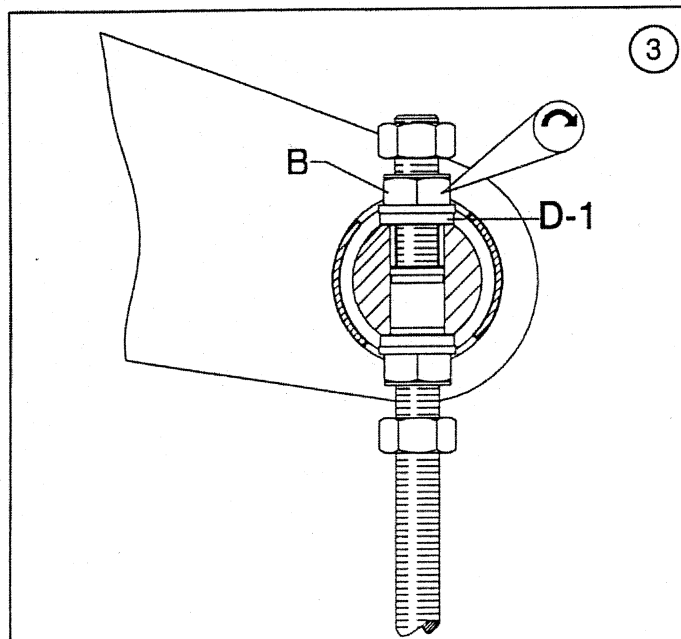
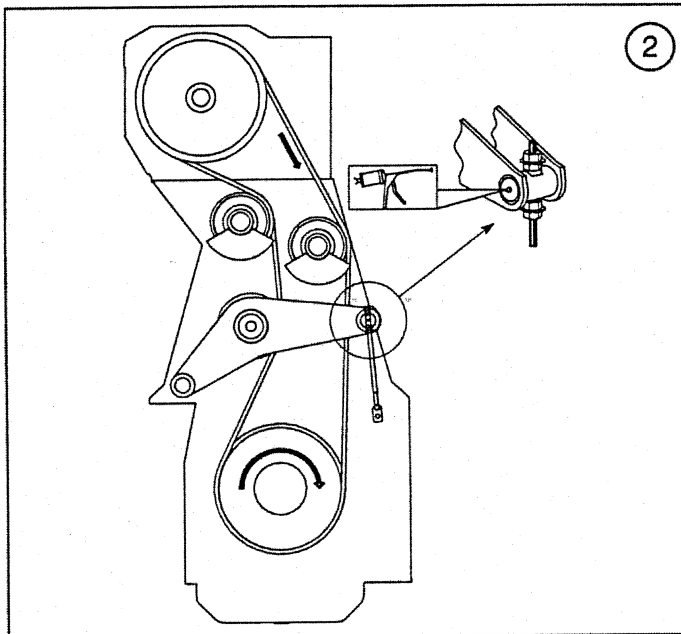
1. When retightening the chains, loosen nuts A, B, C and D to free the chain tightener bolt.

2. Turn the engine so that the slack part of the chains is on the same side as the tightening wheel.

If balanceweights are mounted, continue the turning until they are hanging vertically downwards.

3. With the balanceweights in this position, tighten nut B on the chain tightener bolt until there is a clearance between the shaft and the nut as stated in D-1.

Then tighten nut B a further degrees, see *Data D-2*.



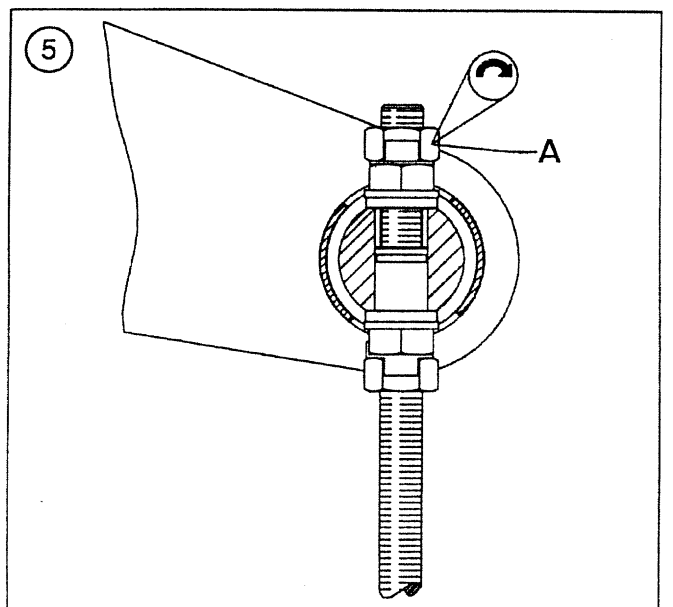
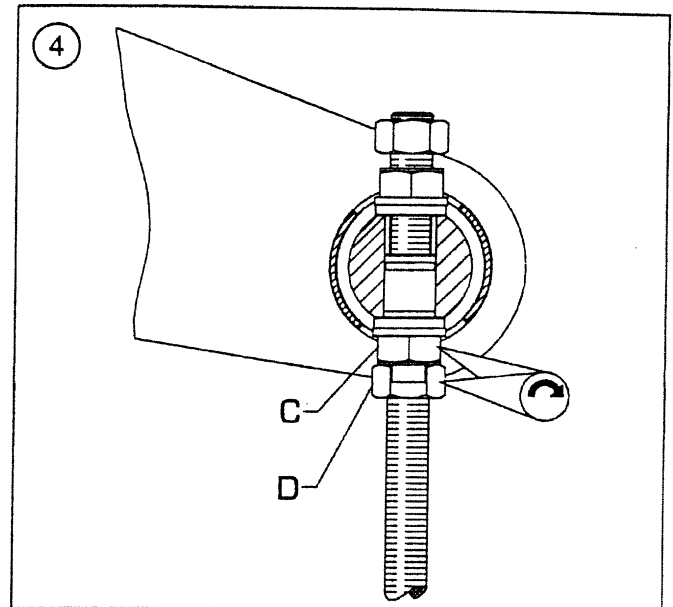
4. Tighten nut **C** hard against the contact face of the shaft.

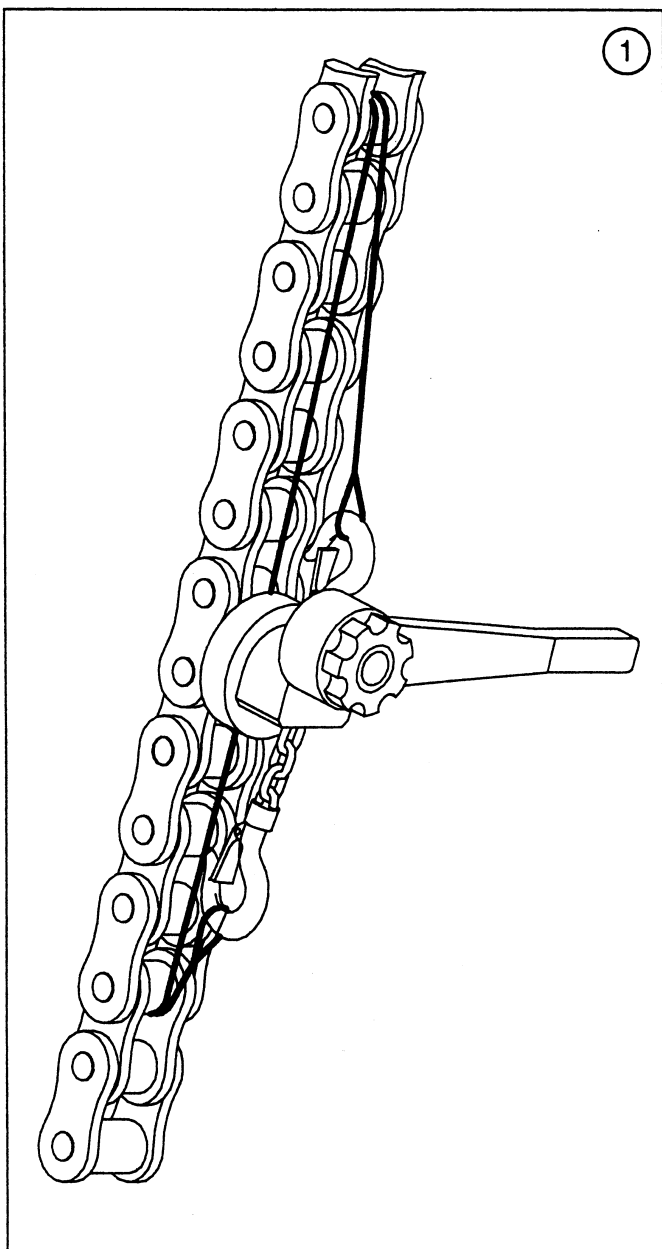
Tighten nut **D**.

Then lock nuts **C** and **D** by means of the tab washer.

5. Tighten nut **A**.

Then lock nuts **A** and **B** by means of the tab washer.





It may become necessary to disassemble a chain if, for instance, cracked rollers or seizures between pin and bushing have been discovered during the inspection (see *Procedure 906-1*), or when replacing worn chains, or when removing the chainwheel or the reversing mechanism.

Caution !

Every time a chain link is disassembled, a new link must **always** be fitted as the link pin press-fit is destroyed when breaking the chain.

When a new link is fitted in one chain, the corresponding link in the other chain must also be renewed.

Disassembling the Chain

1. Turn the chain until the link which is to be disassembled is in a favourable position for the work (normally on the longest free length of the chain on the exhaust side of the chain housing opposite the frame opening). Slacken off the chain so that the entire slackness is on the long free length.

When replacing a chain link, the free ends of the chain are best held by making a lashing with a thin wire rope round the link rollers a short distance from the disassembling point. The wire rope is then lightly pulled tight by means of a tackle. Protect the link rollers over which the wire rope is wrapped against the friction of the wire rope.

If, however, the chain is to be completely removed, the free chain ends must be held by two tackles.

The riveting of the pins that are to be pressed out is to be chiselled or ground away.



- Place the chain bursting device over the smallest part of the chain link and then move it into position so that the dismantling screws are exactly over the ground pin ends.

Lightly tighten the dismantling screws and then start to press out the side plates with pins by alternately tightening the dismantling screws of the bursting tool. Insert the rod in the bursting tool and maintain a firm grip while applying the torque.

Note !

Only one revolution of each screw at a time.

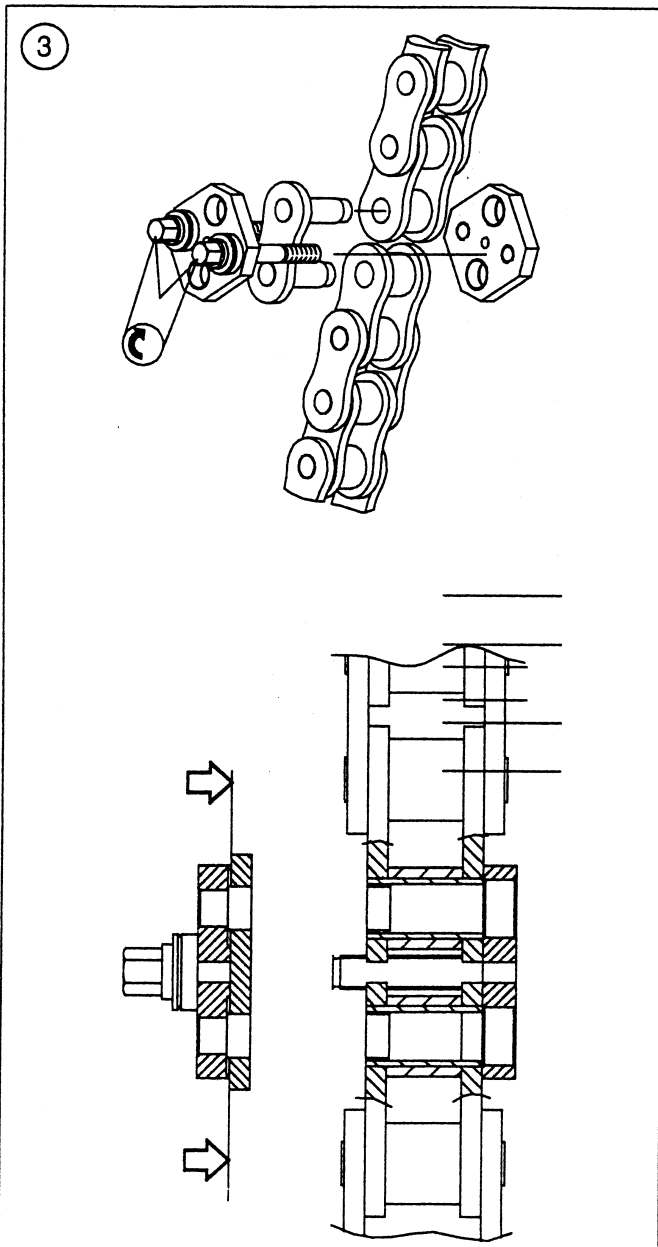
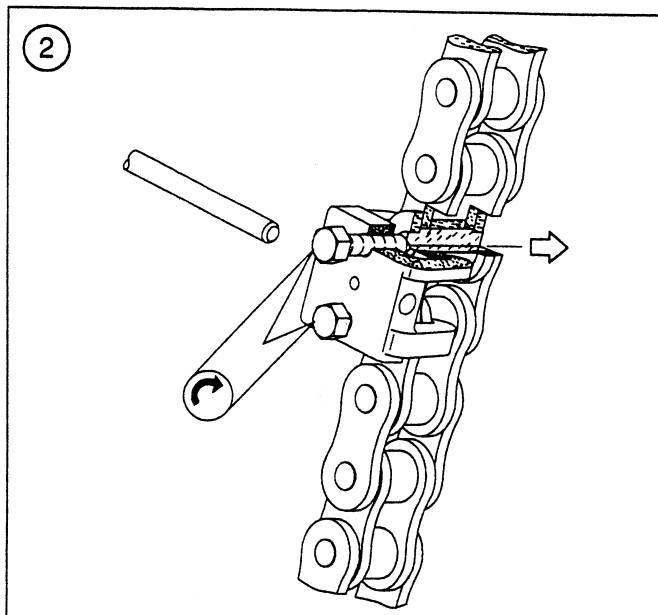
Assembling

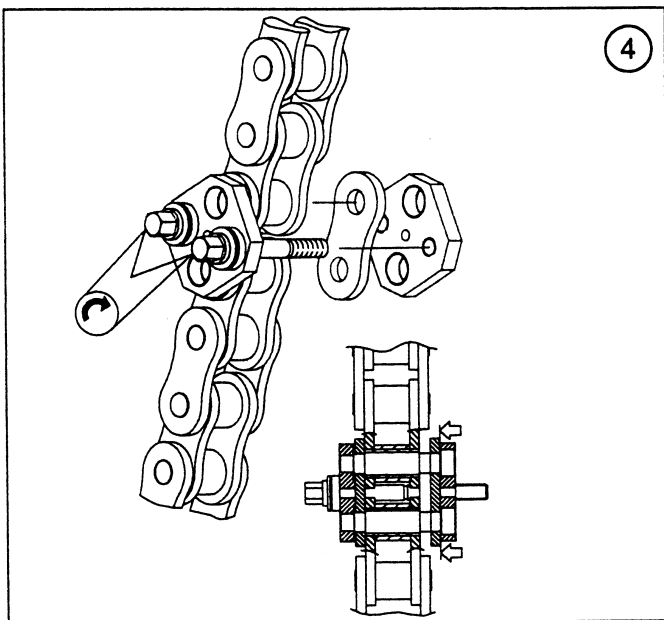
- The assembling tool comprises two traverse pieces and two pulling screws with ball thrust bearings.

The uppermost traverse piece has machine-turned cavities for the pin ends of the side plate.

Press the side plate with pins into the two pertaining holes of the inner links. If it is not possible to press the pins fully home, place the uppermost traverse piece over the side plate so that the ends of the pins guide the traverse piece.

Place the lowermost traverse piece on the other side of the inner links and screw in the pulling screws with ball thrust bearings, and tighten. The side plate with pins is thus pressed home in the inner links by tightening the pulling screws alternately, one hexagon at a time.





- When the pins have been pressed home in the inner links, loosen the pulling screws, thus freeing the lowermost traverse piece. Now position the "loose" side plates between the lowermost traverse piece and the ends of the link pins, and again tighten the pulling screws.

Pull the link plate into position over the pin ends by tightening the pulling screws alternately one hexagon at a time.

When the link has been assembled correctly, remove the tools and lock the pin ends by riveting. Remove the tackle(s) and wire rope.

Repeat the procedure on the other chain, and subsequently adjust the chain tension.

See Data and Procedure 906-2.1.

Disassembling the 1" Chain

- Turn the chain link which is to be taken out into a favourable position and remove the riveting on the pin ends of the link. Lash together the chain links on each side of the link being taken out to hold them together.

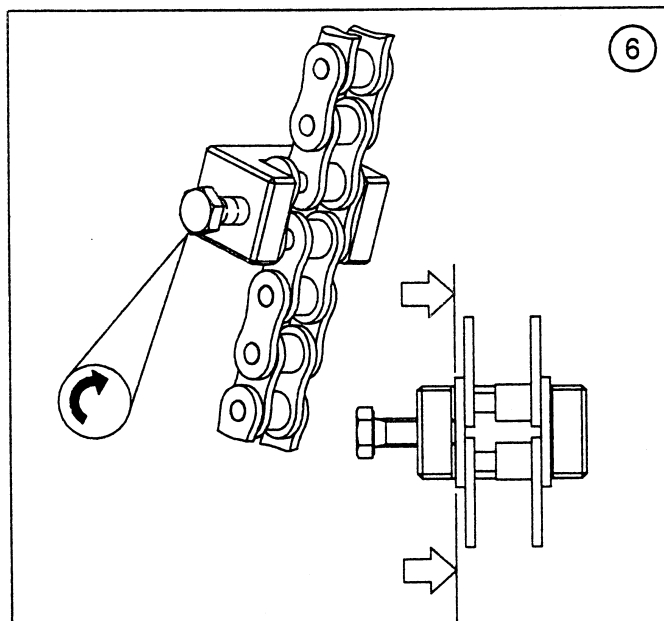
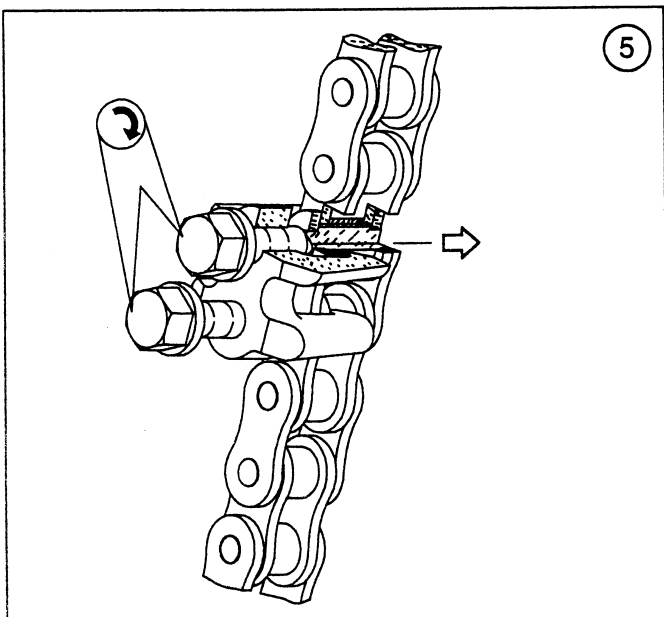
Now slacken off the chain.

Position the chain bursting device and disassemble the chain in the same way as described for the 4 1/2" Chain

Assembling

- Put the side plate with pins in position in the two inner links. Place the assembling tool over the chain link as shown in the illustration, positioning the 'loose' side plate over the pin ends.

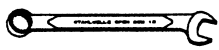
Tighten the screw of the tool and, by this means, the link plate is pressed down over the pin ends. When the parts are in place, remove the tool and lashing, and lock the pin ends by riveting.



SAFETY PRECAUTIONS

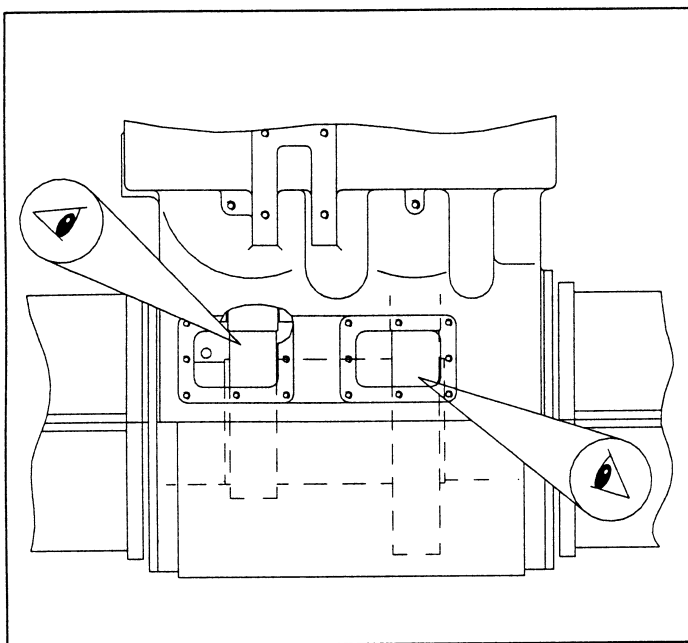
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913



18 mm





When inspecting the roller guides, (*see Procedure 909-5*), also check the running surface of the cams.

The inspection should include the entire surface of the cam, i.e. the cam should be turned the whole way round during the inspection.

The running surface of the cam shall be completely smooth and bright.

If light cracks are ascertained, remove these by the careful use of a fine carborundum stone. These light cracks can appear if the roller guide and the cam do not “run” exactly together.

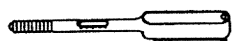
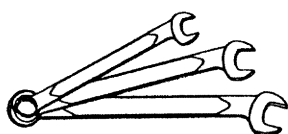
In the case of heavier cracks or direct flaking of the material on the running path (resulting from, for instance, bearing damage), MAN B&W Diesel should be contacted for further instructions.



Safety Precautions

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

Standard tools: see Section 913



140-760 Nm



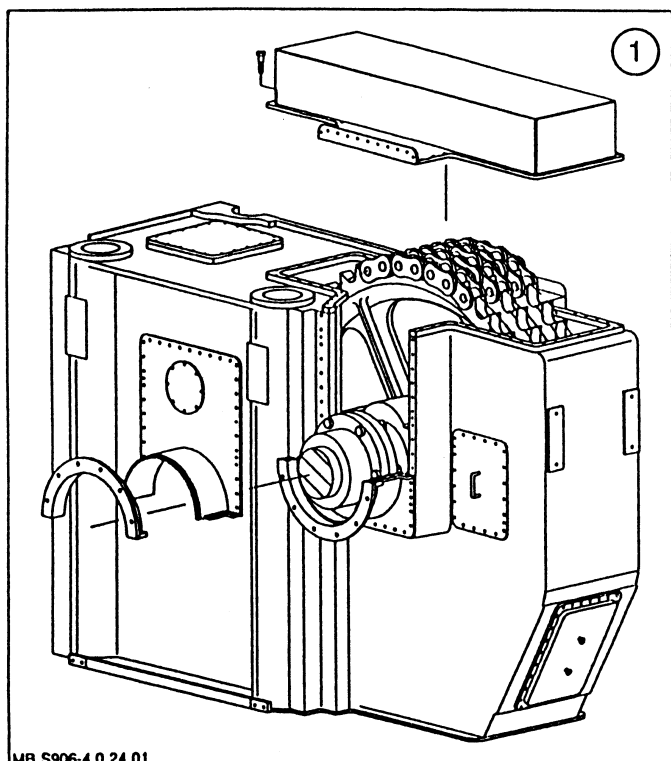
D-4:

Tightening torques

S/L 70 MC

700 Nm





1. In order to gain access to the camshaft coupling bolts, remove one or all of the following:

- the top guard
- the split flange
- the scraper ring

The extent of the disassembling should be evaluated individually in each case.



2. Check the connection between the camshaft coupling flanges with a 0.05 mm feeler gauge.

If any gap can be measured on the entire circumference of the couplings, MAN B&W Diesel or the engine manufacturer should be contacted for further instructions.

3. Remove the locking wire, if provided, from the nuts on the camshaft coupling bolts.

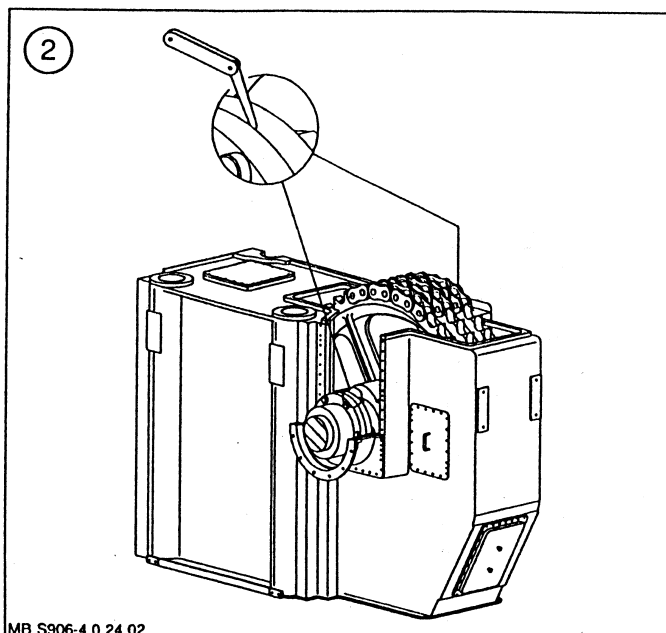
Check the tightening torque of the camshaft coupling bolts.

See Data D-4.

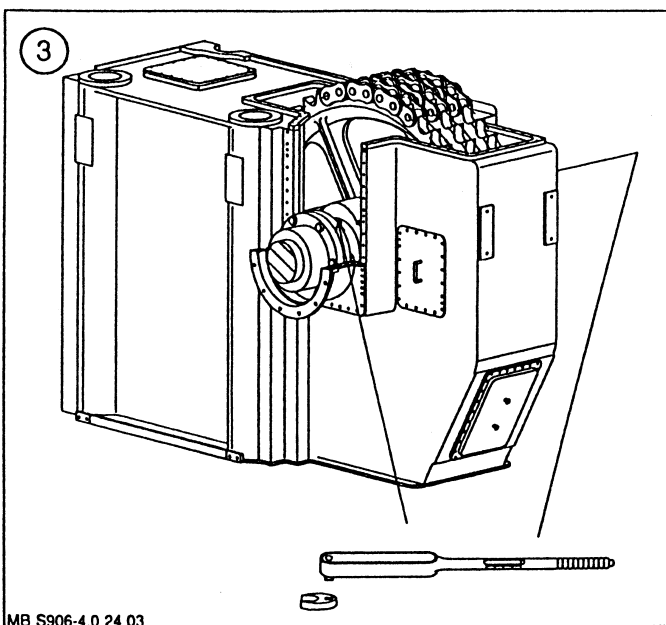
If the torque needed to move the nut deviates LESS than 25% from the value in D-4, the torque is considered to be within limits.

If, however, the torque needed to move the nut deviates MORE than 25% from the value in D-4, retighten the nut as stated in D-4 and recheck the torque after 500-1500 hours of running.

If, during rechecking the torque, it again deviates MORE than 25% from the value in D-4, MAN B&W Diesel should be contacted for further instructions

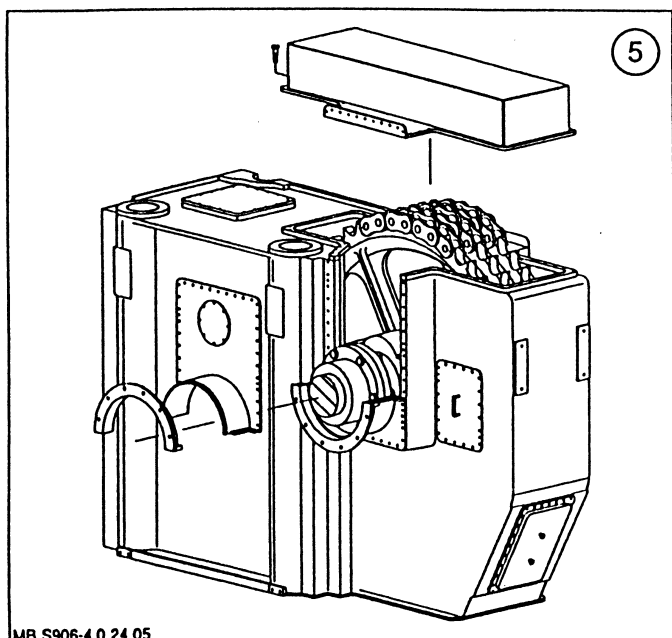


MB S906-4.0 24 02



MB S906-4.0 24 03





4. Mount the locking wire securing the nuts on the camshaft coupling bolts. *See Volume II Maintenance, Chapter 913.*
5. Assemble the top cover, split flange, etc., with liquid gasket/gasket in relevant places.

Tighten all bolts.



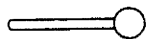
Safety Precautions

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913



18, 24 mm



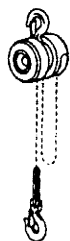
8 mm



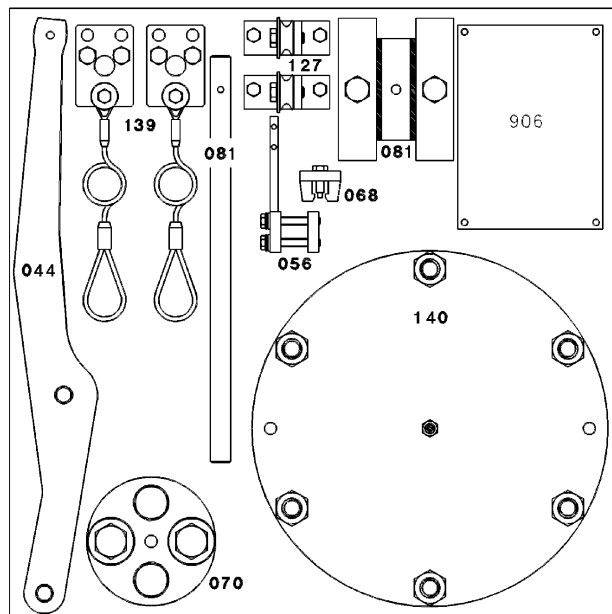
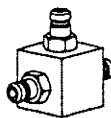
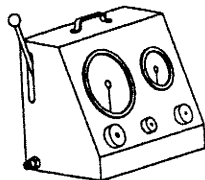
1 × 3 m
2 × 1 m



M16



500 kg



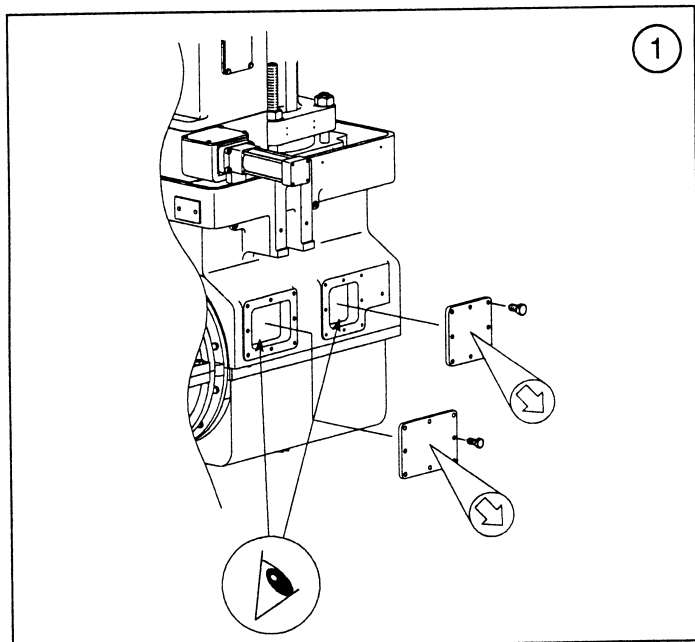
DATA:

D-1 Weight of oil tray..... 100 kg

D-2 Hydraulic pressure
 - dismantling..... 900-990 bar
 - tightening..... 900 bar

D-3 Weight of bearing cap..... 130 kg



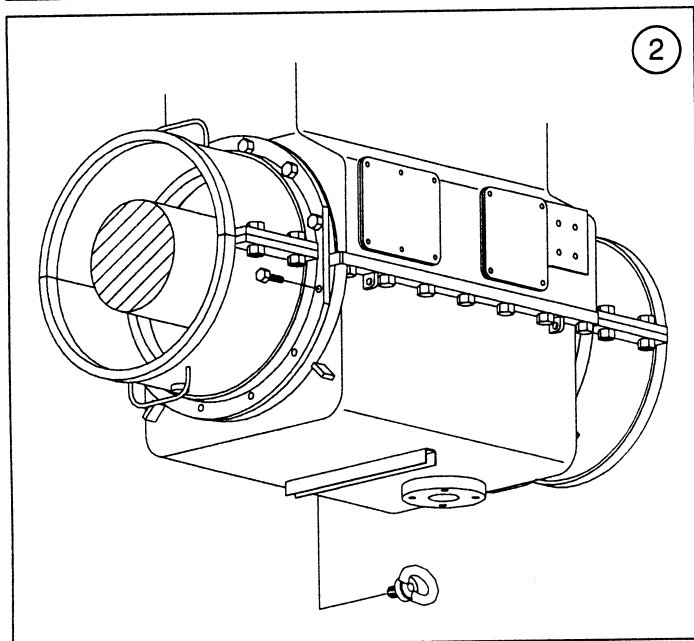


1. As the upper shell of the camshaft bearing assembly has been dispensed with on this engine, it is no longer necessary to measure the top clearance of the camshaft bearing.

However, with normal inspection through the inspection hole in the roller guide housing, we recommend a visual inspection of the condition of the shell in the bearing cap from each side.

If no anomalies are found during the visual inspection, dismantling need only be carried out in connection with Class survey.

In the event of any signs of anomalies, the bearing must be dismantled for closer investigation, and the bearing shell replaced. In such a case, continue as follows:

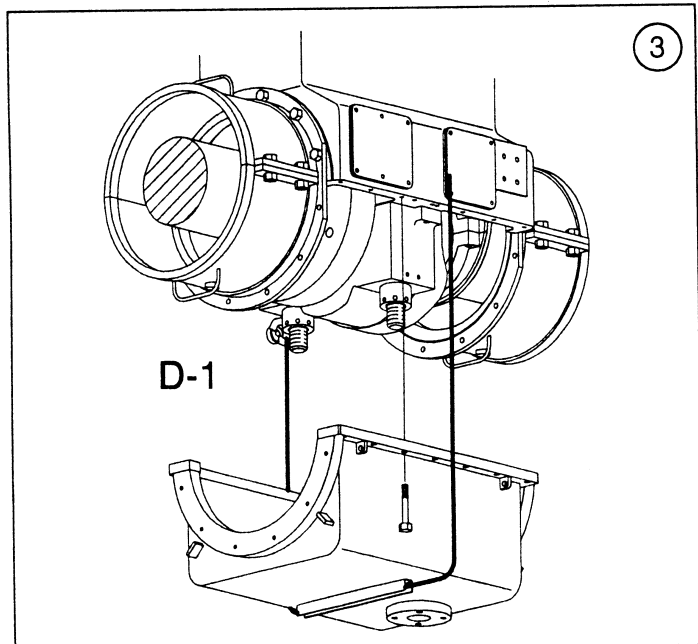


2. Drain off the oil in the oil tray of the roller guide housing and in the shields enclosing the camshaft couplings (on both sides of the roller guide housing).

Dismount the oil outlet pipe from the oil tray. Mount an eye screw in the cylinder frame behind the oil tray.

Release the sealing flanges on the roller guide housing, loosening the screws mounted in the roller guide housing.

Remove only the screws in the lower half of the sealing flange.



3. Attach a wire rope to the eye screw. Place the wire rope in the lifting fitting of the oil tray, hook on a tackle and haul tight.

Remove the screws securing the oil tray to the roller guide housing. Ease off the oil tray, landing it on the platform.

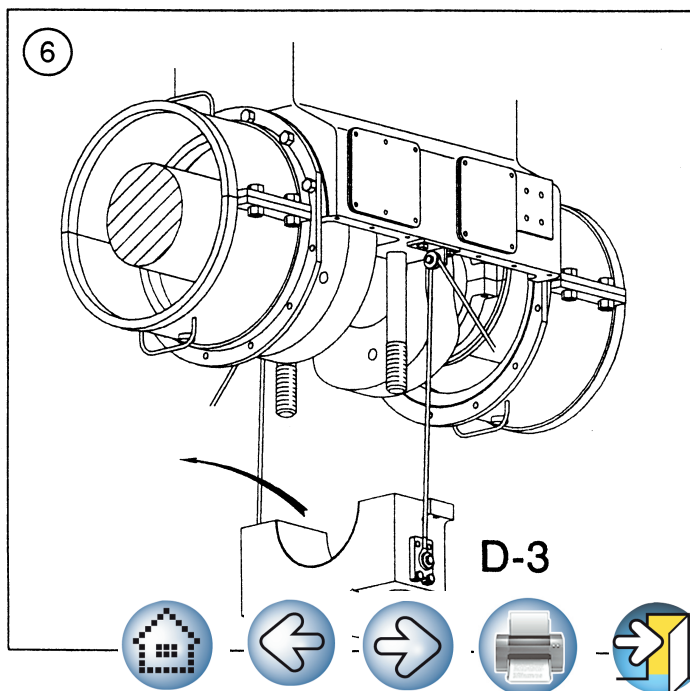
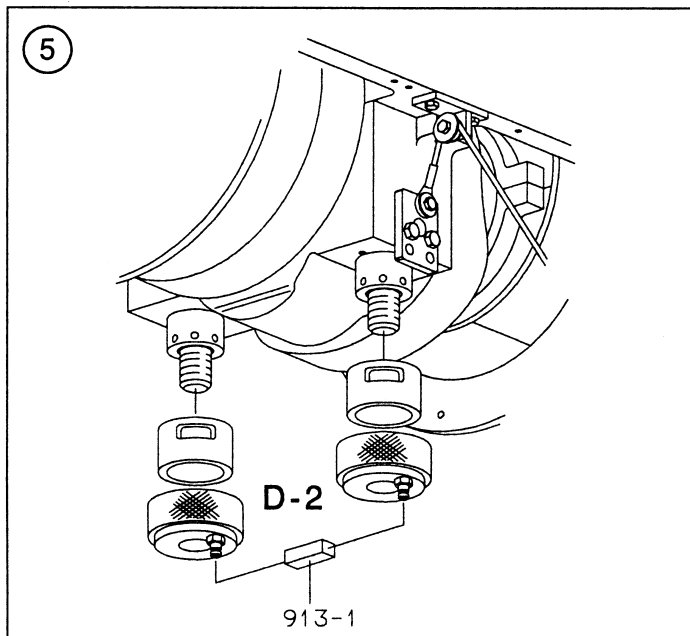
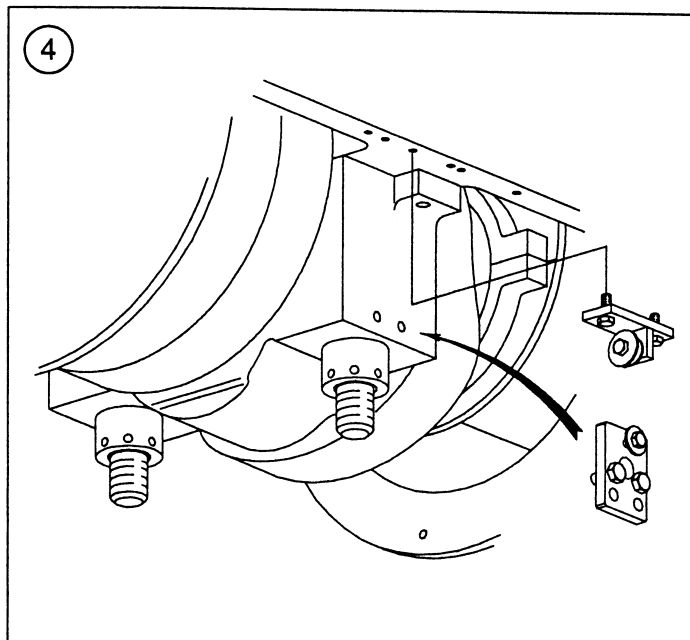


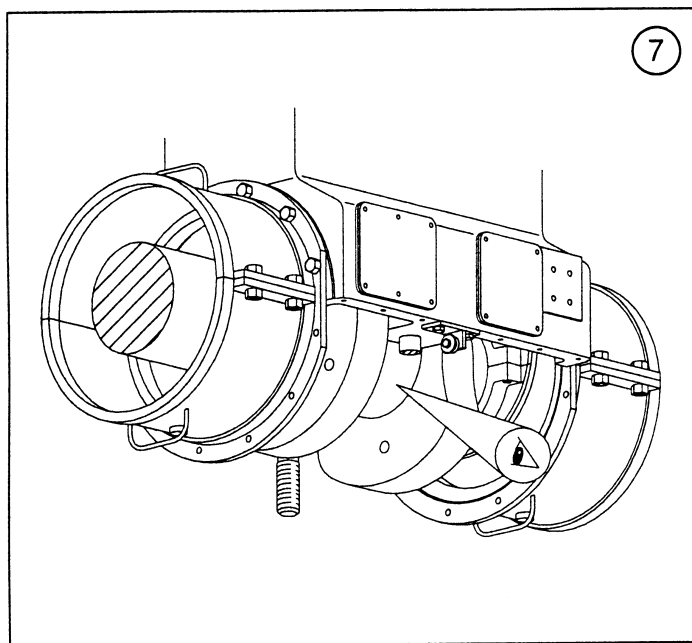
4. Mount lifting fittings on both sides of the bearing half. Mount grooved pulleys on the roller guide housing, and hook wire ropes/tackles on to the lifting fittings/grooved pulleys.

5. Mount the hydraulic jacks and loosen the bearing nuts. *For use of hydraulic jacks, see Procedure 913-1.*

Remove the hydraulic jacks and dismount the nuts.

6. Lower the bearing cap and place it on the platform. Then inspect and, if required, replace the bearing shell.

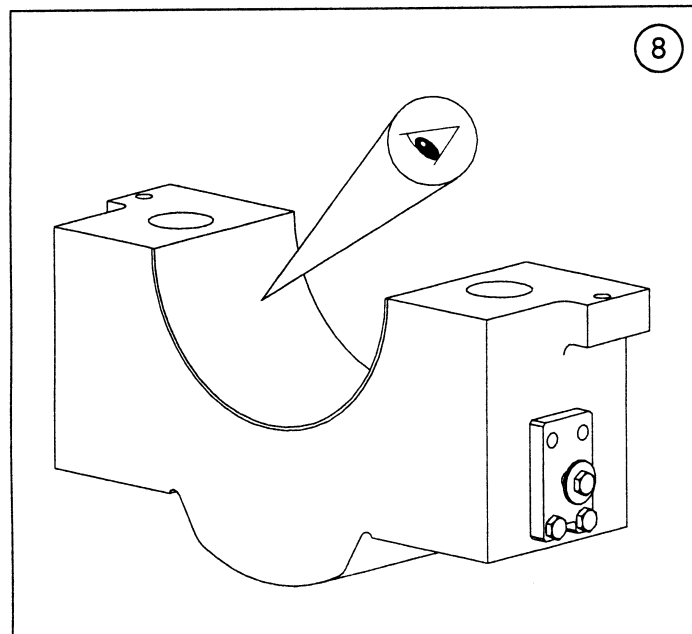




7. For assessment of the bearing condition, see Volume I, OPERATION, Chapter 708 'Bearings'.

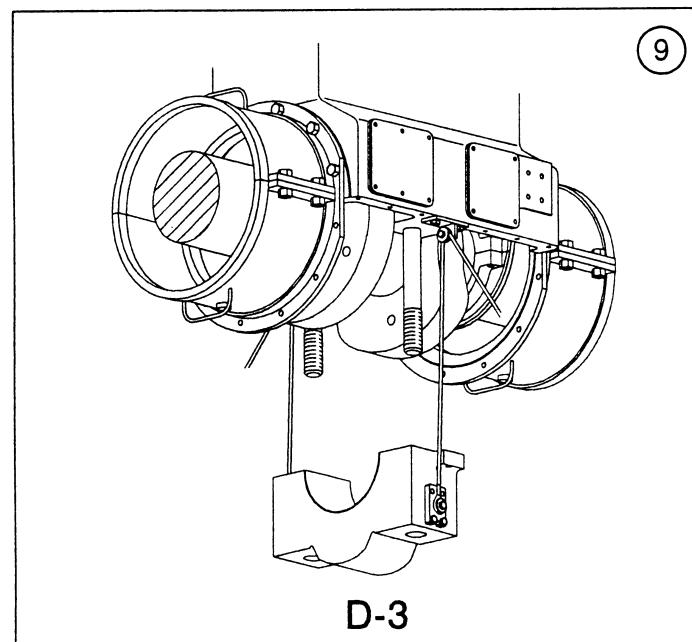
Inspect the bearing journal for seizures. The inspection is to include **the whole** surface of the bearing journal.

If seizures are found (on account of bearing breakdown), polish the surface with a fine carborundum stone to produce a bright and smooth surface again. In the case of serious seizures, contact MAN B&W.



8. By closely examining the sliding surfaces of the bearing shell visually, an impression can be formed of the lubrication of the bearing.

Check the passage through the lubricating oil ducts as well as the lubricating oil inlet pipes, especially if the appearance of the bearing surfaces indicates that the supply of oil has been insufficient or entirely missing. Normally, only failing lubrication can damage the camshaft bearing.



9. Mount the bearing shell in the bearing cap, after coating the shell with oil. Then pull the bearing cap into place by means of tackles/wire rope fitted through the grooved pulleys to the lifting fittings. Check that the guide pins enter correctly.

10. Mount and tighten up the nuts by means of the hydraulic tools.
See Data.

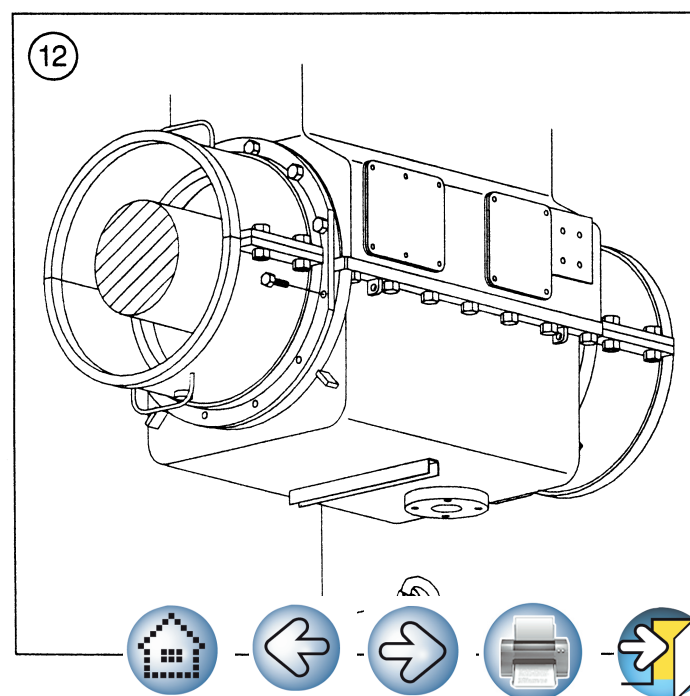
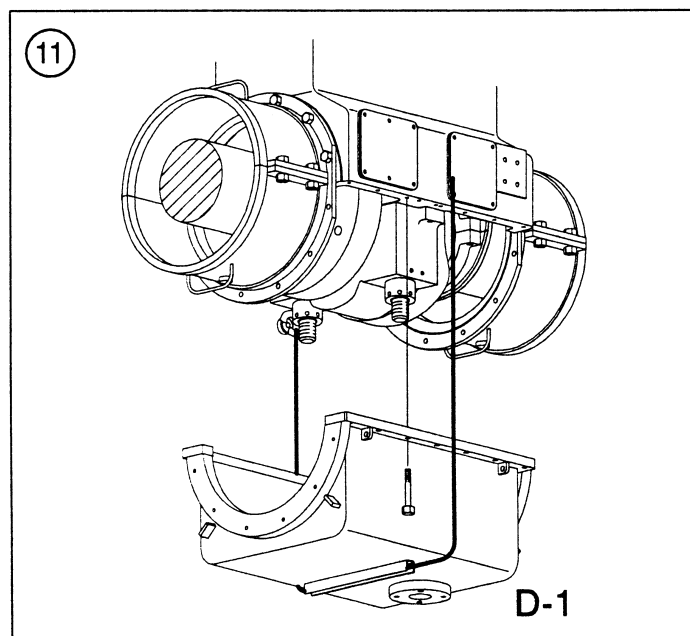
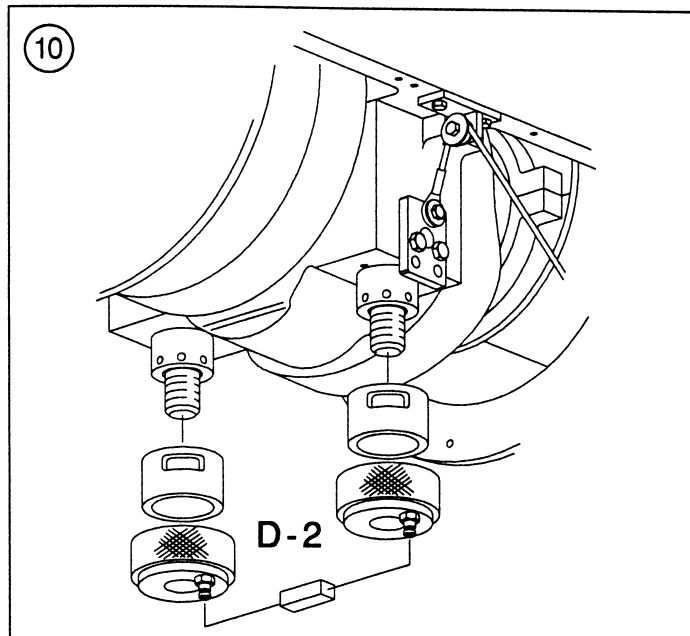
Remove the lifting fittings and grooved pulleys from the roller guide housing.

11. Hoist the oil tray into place, positioning it by means of the guide pins.

Then fasten it to the roller guide housing by tightening up uniformly all round the circumference.

12. Remove the shackle and eye screw.

Mount the screws that fasten the sealing flanges to the roller guide housing. Mount the oil pipe on the oil tray.



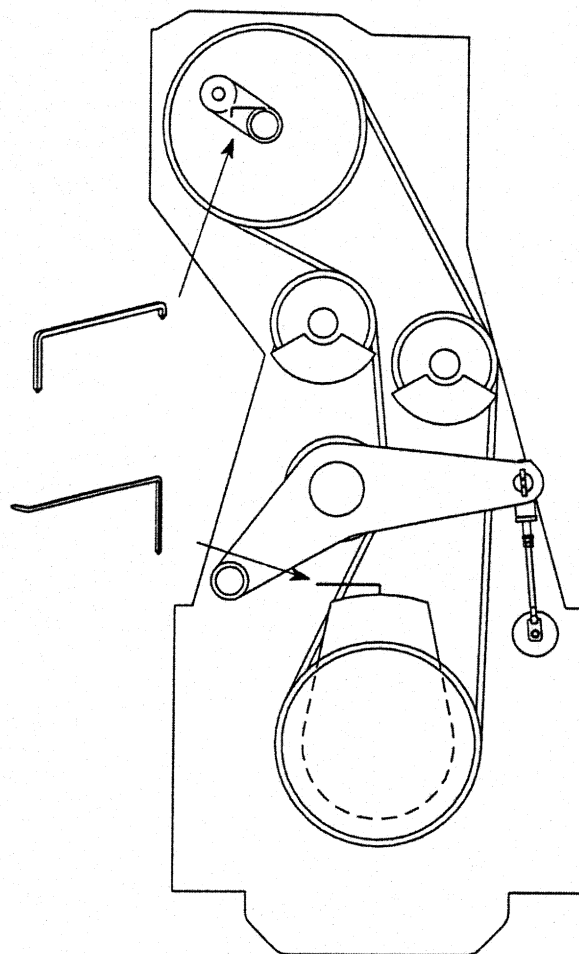
BLANK



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

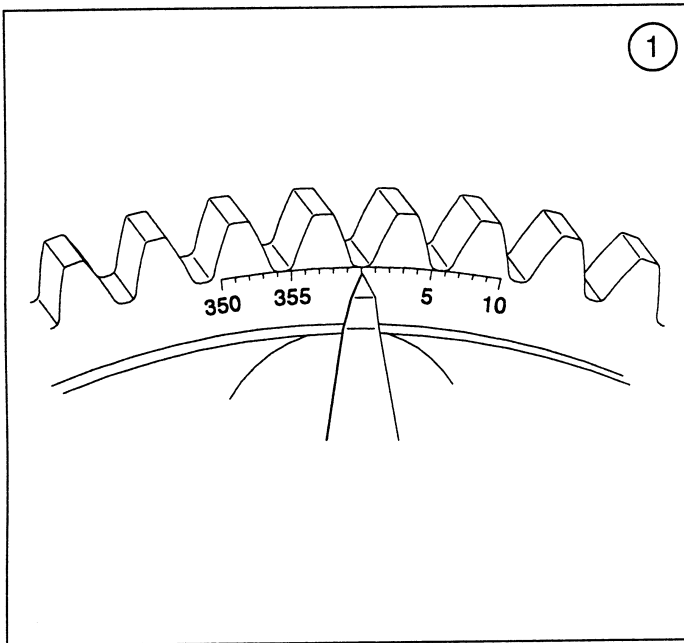
913



DATA:

- D-1 Pin gauge for top dead centre 'crankthrow 1'
Check measurement..... 703 mm
- D-2 Pin gauge for camshaft
Check measurement..... 349 mm
- D-3 Max. permissible change in lead angles = 2°,
corresponding to..... 4.9 mm

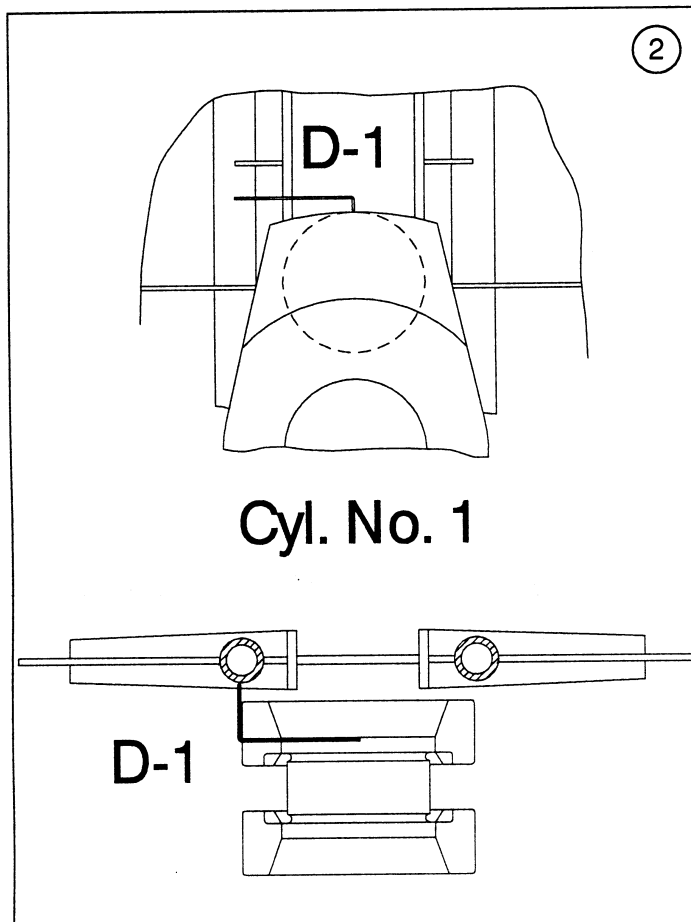




1. Turn the crankthrow for cyl. 1 to TDC - turn in the AHEAD direction to ensure that the tension of the chain on the chain drive is correct. If necessary, adjust the chain tension, see *Procedure 906-2.1*.

Check the TDC of cyl. 1 against the mark on the turning wheel.

2. Check the TDC position by applying the pin gauge on the crankthrow, D-1.

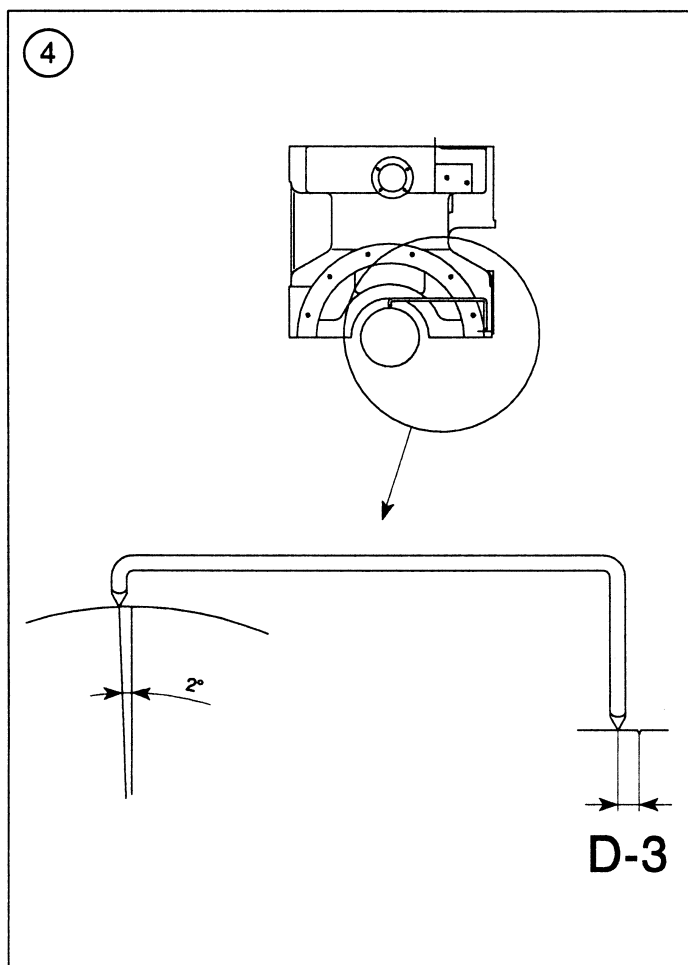
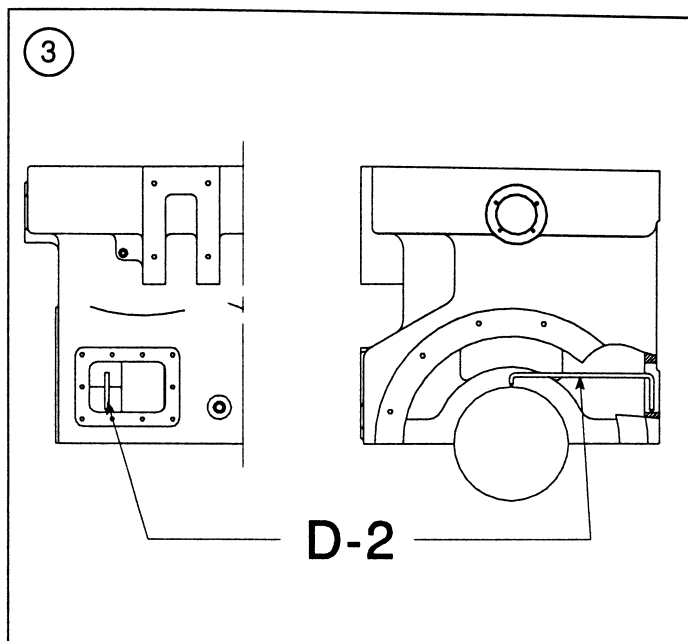


3. Check the correct positioning of each camshaft section (if more than one), by using the pin gauge for the camshaft.
4. Position the camshaft pin gauge in the centre punch mark, and measure the deviation, if any, in lead angle.

For max. permissible change, see D-3.

5. Check and adjust the cyl. lubricator.
See Procedure 903-4.

Check the setting of the starting air distributor.
See Procedure 907-2.



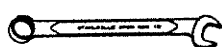
BLANK



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

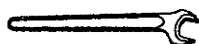
913



18, 24, 36 mm



6 mm

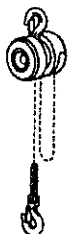
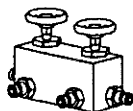


41 mm

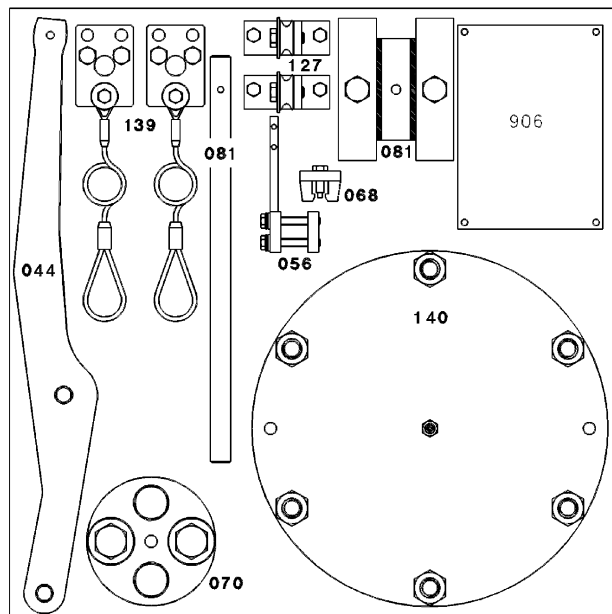
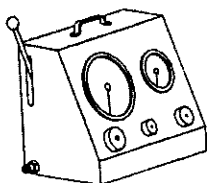


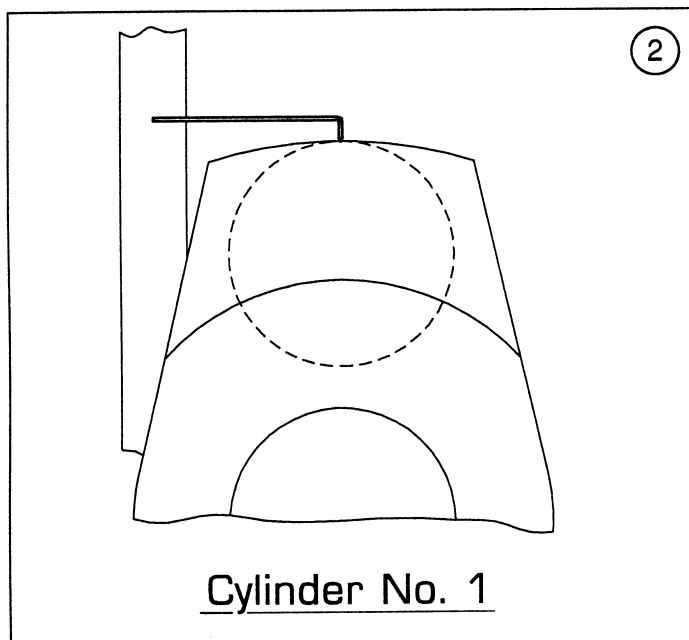
3 × 1 m

1 × 3 m



500 kg





Check the chain tension and the adjustment (timing) of the control gear.
See Procedures 906-2 and 906-7.

If the chains prove to be so heavily worn that the deviation between the measuring points and the pin gauge has reached the maximum value stated in Data 906-7, an adjustment is to be carried out by turning the camshaft to its original position according to the pin gauge.

This is carried out as described in the following (the illustrations show adjustment of the foremost half of the camshaft):

1. It is recommendable to lift all the roller guides from the fuel cams to facilitate the work.
See Procedure 909-5.

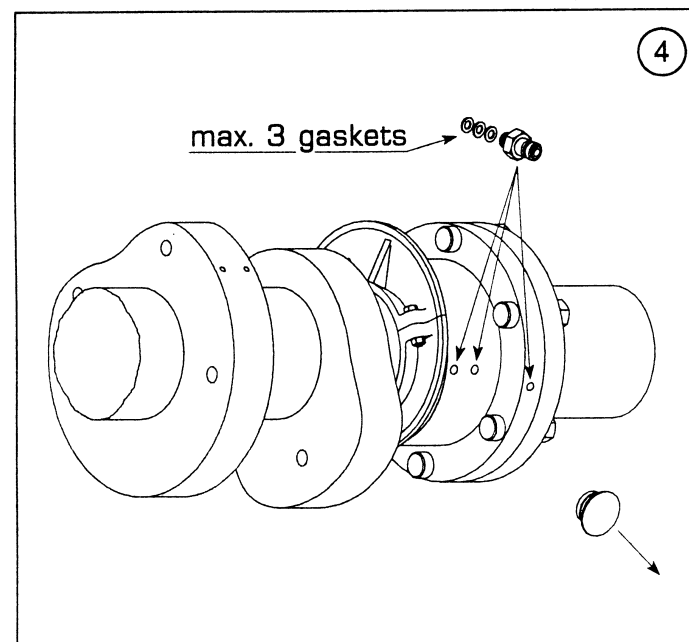
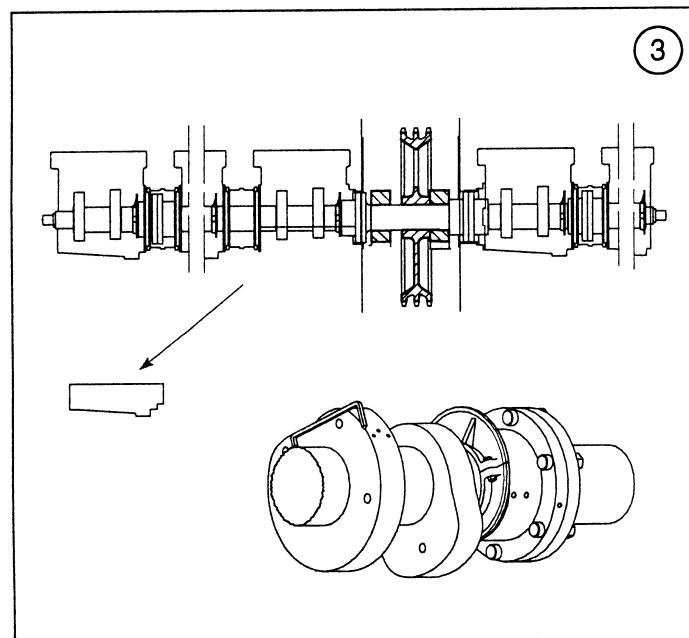
2. Turn the crankthrow of cylinder No. 1 to TDC.

Check the position by means of the pin gauge. *See Procedure 906-7.*

3. Remove the shields, covering the coupling flanges, from the camshaft section nearest to the chain drive.

Remove the oil tray from a roller guide housing in which the exhaust cam is in the working position.
See Procedure 906-5.

4. Dismount the plugs in the coupling flange nearest to the chain drive and mount three snap-on connectors instead.



5. Connect the couplings to the distributor block and the hydraulic high-pressure pump.

Apply a light pressure to the hydraulic system and, after venting the system, tighten-up the couplings.

6. Mount the special spanner on the exhaust cam disc of the camshaft section.
7. Using the high-pressure pump, apply oil pressure to the coupling flange.

When oil seeps out along the shaft below the coupling flange, turn the whole camshaft by means of the mounted special spanner, if necessary using a tackle.

Check the turning by means of the pin gauge for the camshaft/roller guide housing and continue turning until the marks on the camshaft and roller guide housing are in accordance with the pin gauge.

When the camshaft is in the appropriate position, disconnect the oil pressure from the coupling flange.

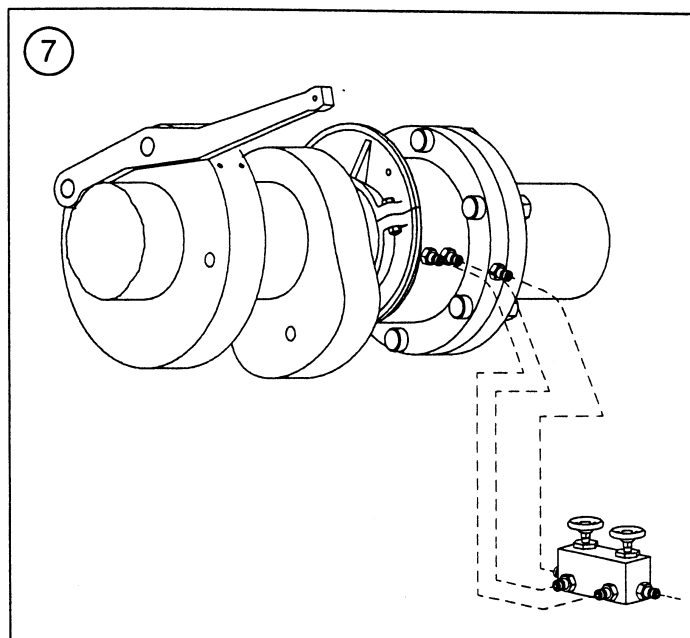
8. Then remove the hydraulic tool and tool for turning the camshaft.

After not less than 15 minutes, again mount the plugs in the oil bores of the coupling flange (this is to allow the coupling flange to set again).

For engine with the camshaft separated at the chain drive, carry out a corresponding adjustment of the aftmost camshaft part, using the same procedure.

Measure and adjust the lead of the fuel pumps and fuel cams.

See Procedures 909-1 and 909-2.



BLANK



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

 11, 18, 24, 30 mm

 8 mm

 65 mm

 65 mm

 M12

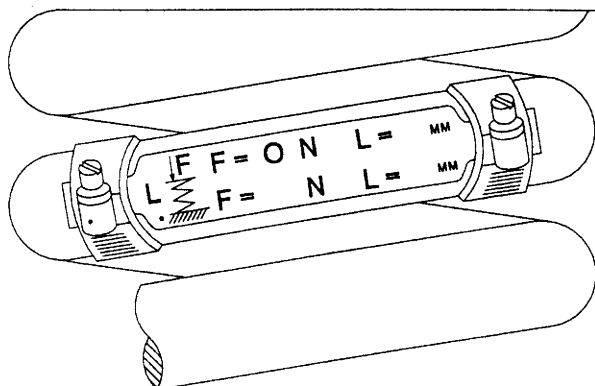
DATA:

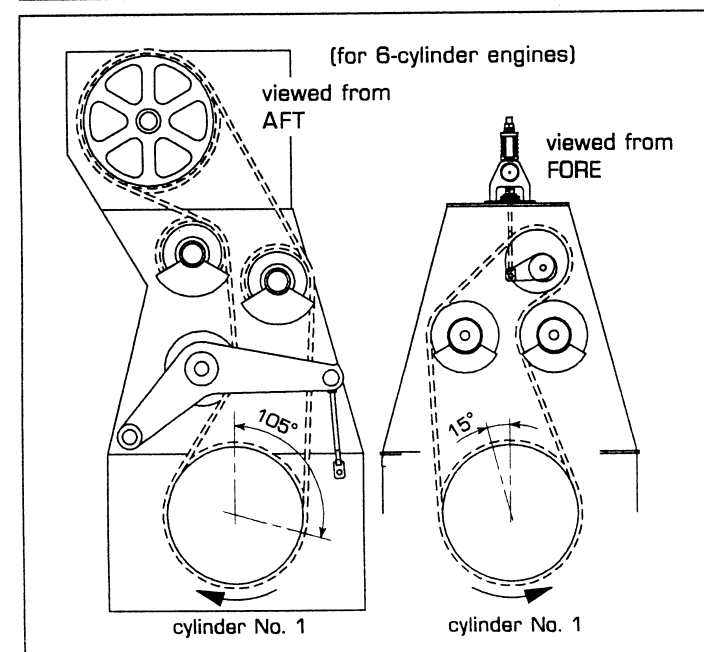
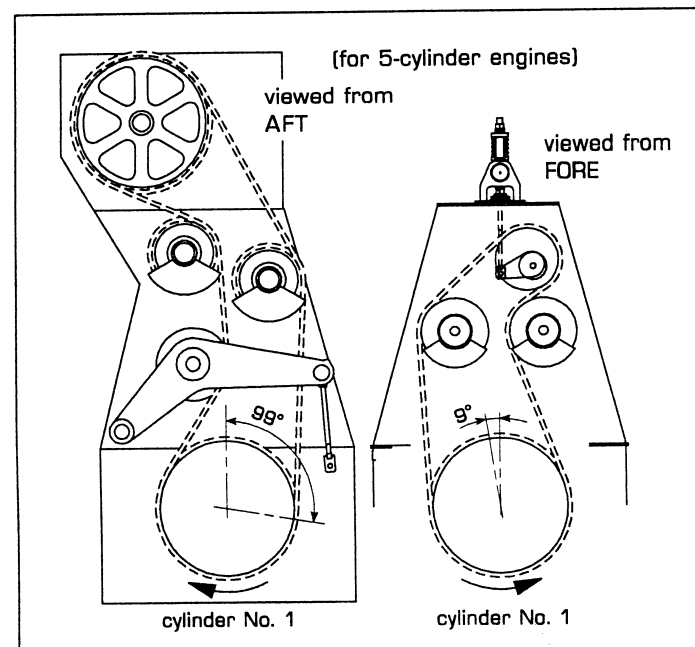
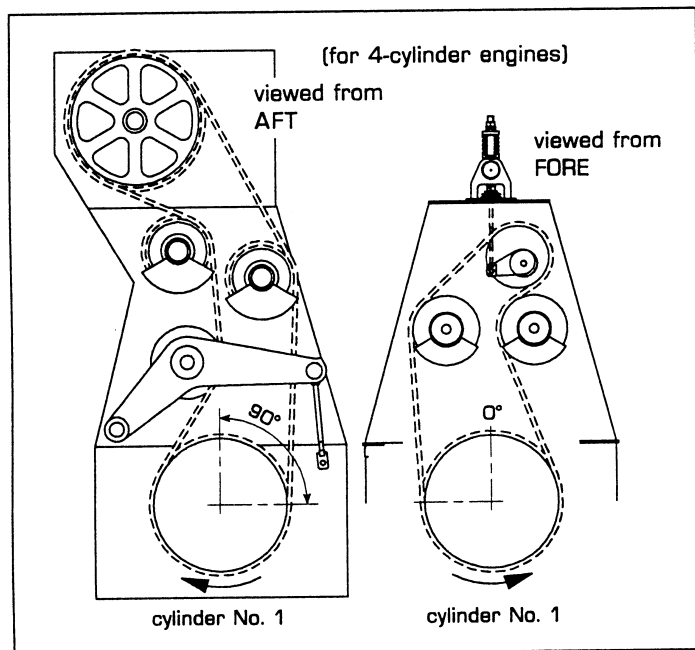
D-1 Reduction of free length of spring by tensioning: See data plate on spring

Note:

A subsequent check measurement will in most cases show that the free length of the spring has been reduced during operation.

Therefore, whenever the chain is to be tightened, the free length is to be measured, and the length of the spring should always be reduced by the number of mm indicated in D-1.





If dismantling has been necessary, the flyweights shall be assembled in the correct position in relation to the engine crankshaft. Wrongly-mounted flyweights can cause (heavy) vibrations of the engine.

OBS !

For a clockwise engine

Aftmost 2nd Order Moment Compensator

Turn the crankthrow, cylinder No. 1, in the AHEAD direction to the position shown in the Figure for, respectively, 4, 5, 6-cylinder engines.

Check that the flyweights point vertically downwards (max. deviation one-half chain-wheel tooth pitch).

Tighten the chain in accordance with the instruction, see *Procedure 906-2.1*.

For mounting the main chain, see *Procedure 906-12.2*.

Foremost 2nd Order Moment Compensator

Turn the crankthrow, cylinder No. 1, in the AHEAD direction to the position shown in the Figure for, respectively, 4, 5, 6-cylinder engines.

Check that the flyweights point vertically downwards (max. deviation one-half chain-wheel tooth pitch) and then mount the chain.

Tighten the chain in accordance with the instruction. See *Procedure 906-12.4*.

Note:

For an **anticlockwise** engine the mentioned degrees have to be **before** TDC, not **after** TDC.



1. The chains are placed on a clean area.

Check the right direction of the chain (hook for the arrows on the assembling links).

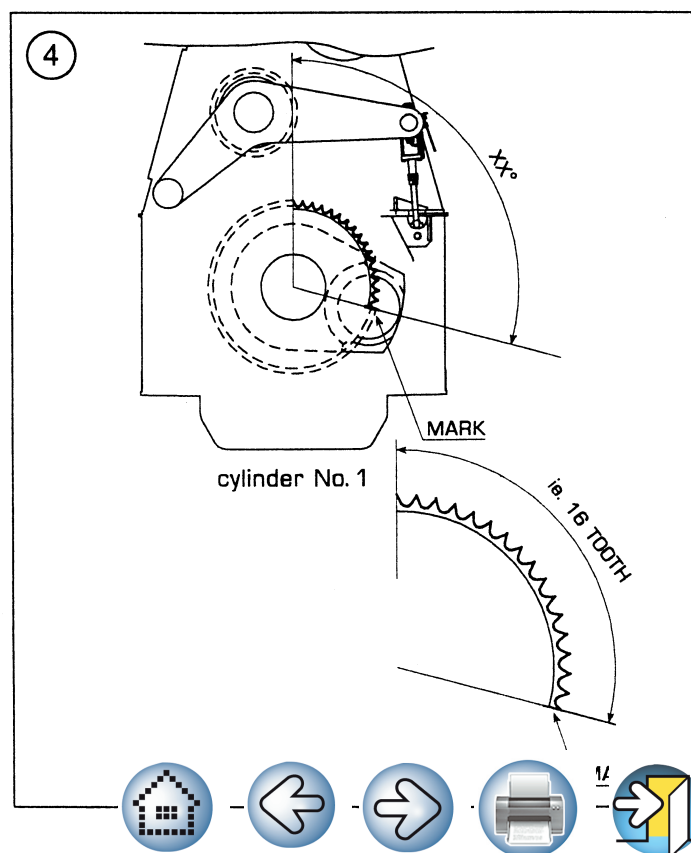
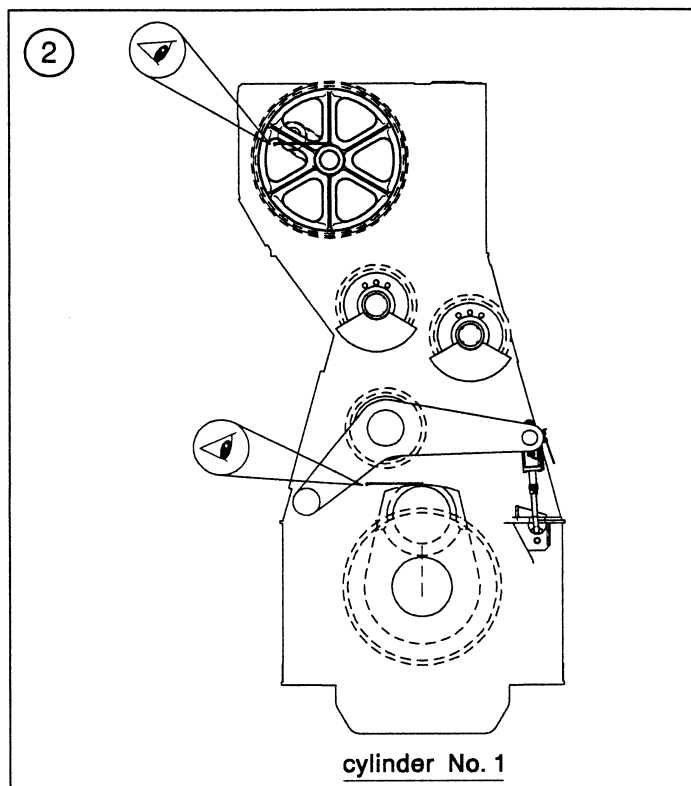
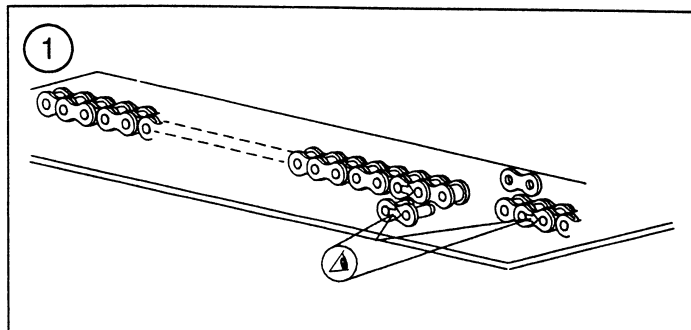
2. Turn the crankthrow for cylinder No. 1 to TDC and check with the pin gauge.
See Procedure 906-7.

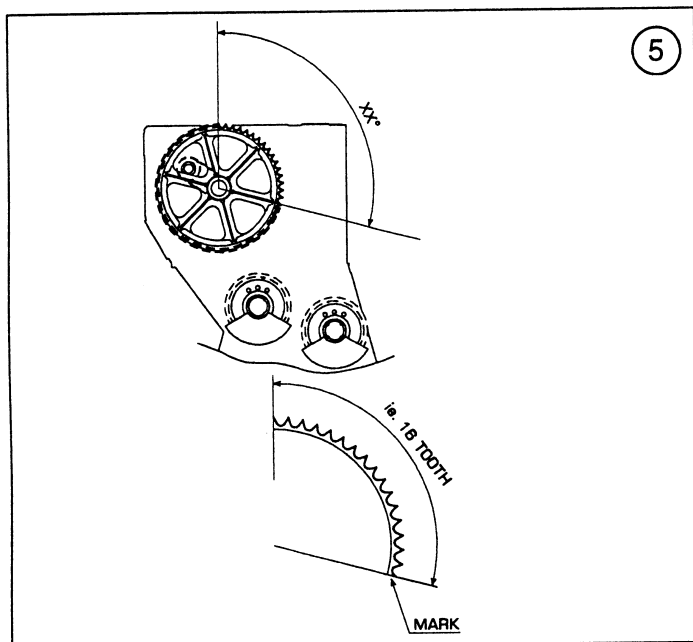
3. Check that the camshaft is in the right position by means of the pin gauge.
See Procedure 906-7.

4. Make a mark on the top tooth in the chain wheel on the crank.

Then turn the crankthrow for cylinder No. 1 in AHEAD direction to the position shown in the figure for respectively 4, 5 and 6 cylinder engines.
See Procedure 906-12.1.

When finished turning the desired degrees, count how many teeth there are from the marked one to the new tooth in top position, by counting backwards.





5. Make a mark on the top tooth in the chain wheel on the camshaft.

Then turn the camshaft relative to the crankshaft.

When finished turning, count how many teeth there are from the marked on to the new tooth in top. It should be the same number as on the crank.

Strap down the camshaft in this position by means of tackles.

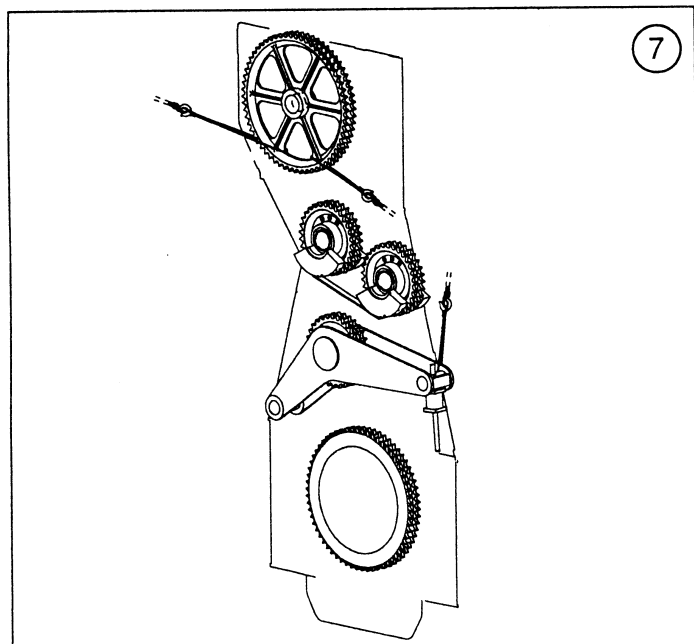
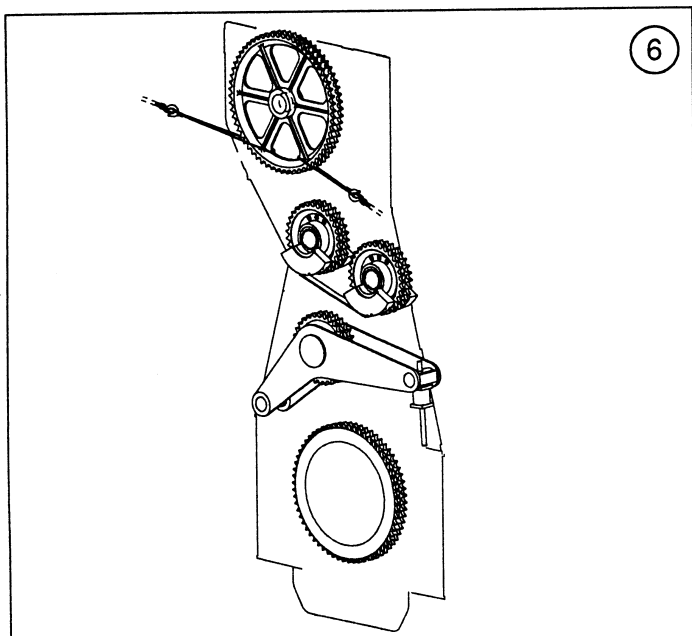
6. Check that the two second order moment compensators are hanging vertical downwards and strap these down in this position.

The maximum deviation is one half chain wheel tooth pitch.

7. The chain tightener has to be loose.

Lift up the chain tightener by means of a tackle.

This has to be done "before" mounting of the chains.



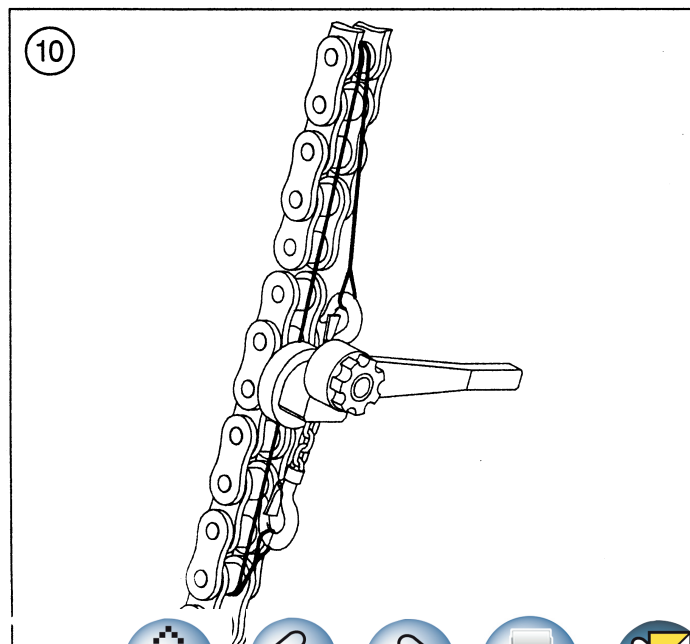
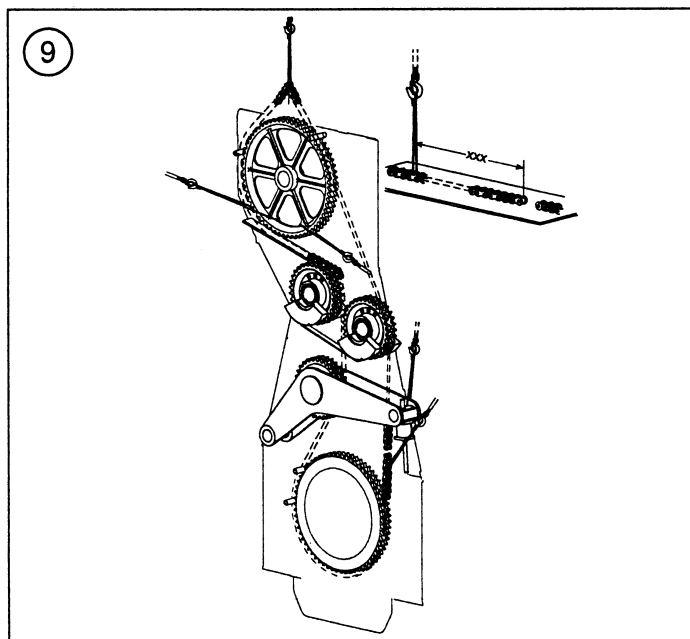
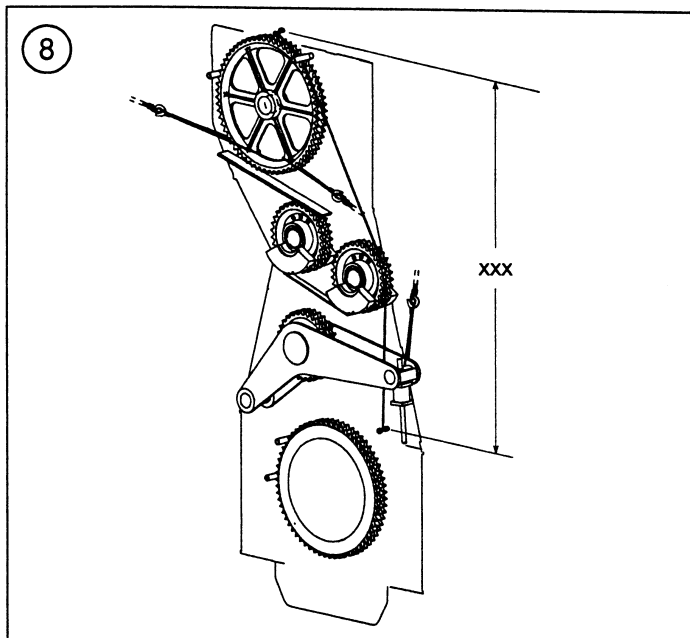
8. Place pipes and sliding ramps inside the engine to guide the chains when mounting.

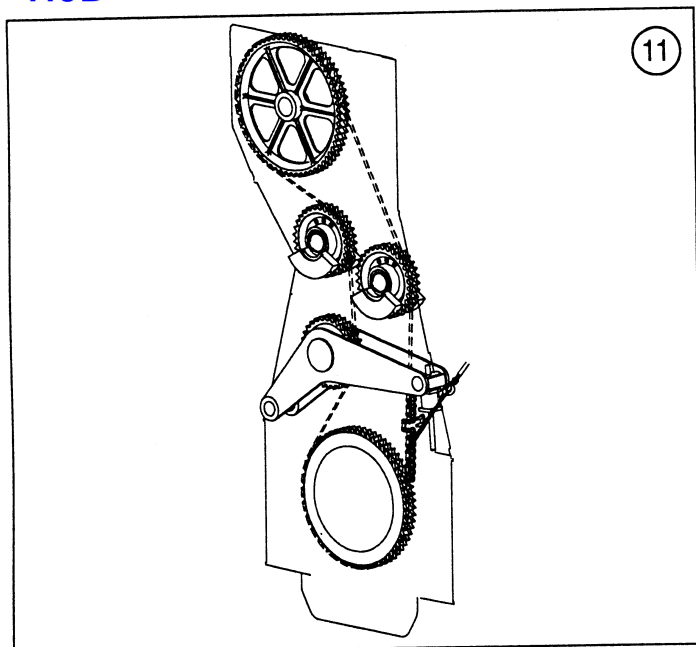
9. By means of a rope measure the length for that of the chain, down to the chain tightener.

Hook on to the chain so the assembling will take place in the exhaust side under the chain tightener.

10. Protect the link rollers over which the wire rope will be wrapped against friction of the wire.

Make a lashing with a thin wire round the link rollers, a short distance from the assembling links.





11. Assemble the chain.
See Procedure 906-2.3

Loosen and remove the tackle from the chain tightener.

Remove all the fixing equipment, pipes, sliding ramp, tackles etc. from the engine.

12. Turn the crankthrow cylinder No. 1 to TDC.

Check with the pin gauges both the crankthrow and the camshaft.
See Procedure 906-7.

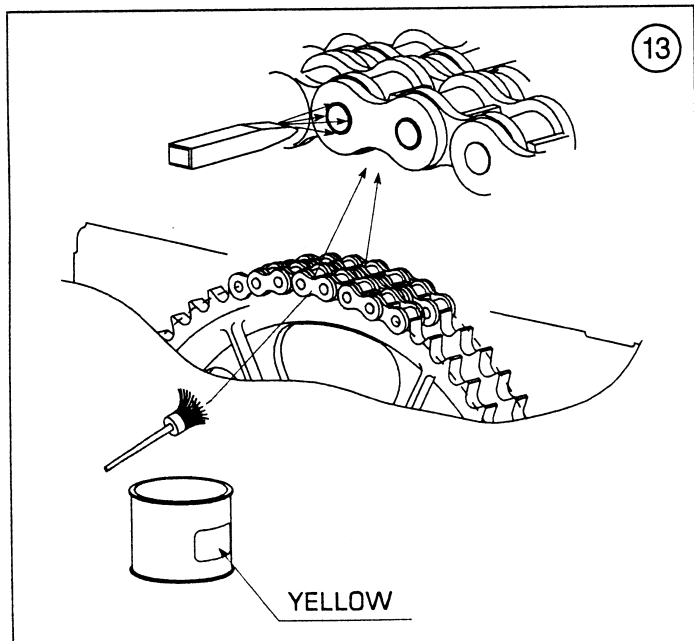
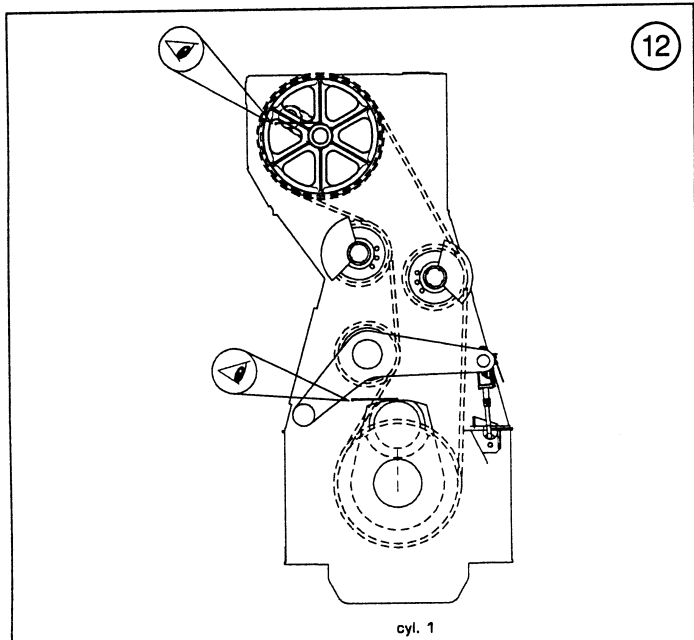
13. Then turn the crankthrow in AHEAD direction to the desired degrees and check that the counterweights for the second order moment compensators are hanging vertical downwards.

14. Tighten the chain tightener.
See Procedure 906-2.

15. Turn the assembly link to the top of the chain wheel on the camshaft.

Secure the assembling link by riveting each chain pin end in four places.

16. Check and make final adjustment of the fuel pump.



1. When tightening the chain, bring the two flyweights to a vertical downward position.

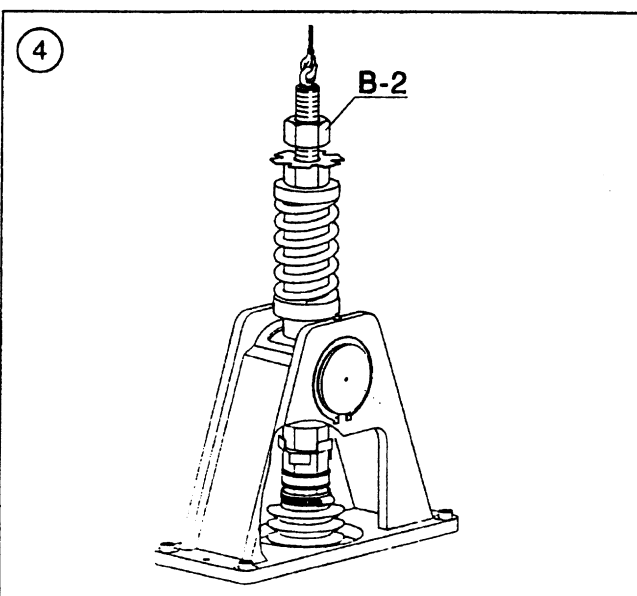
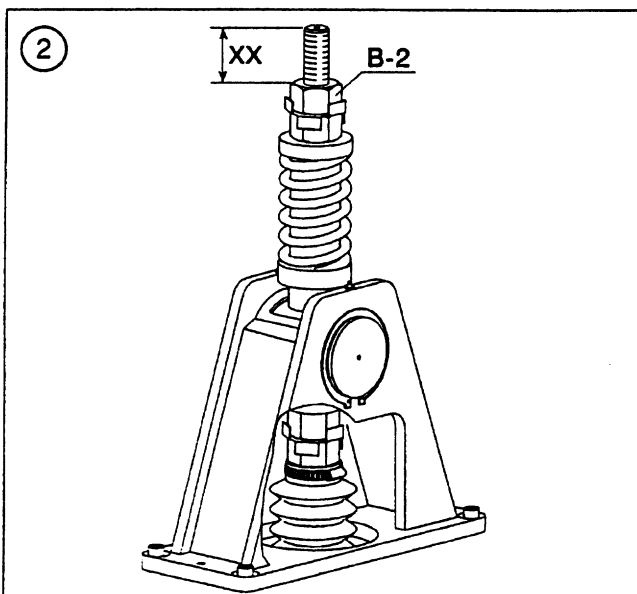
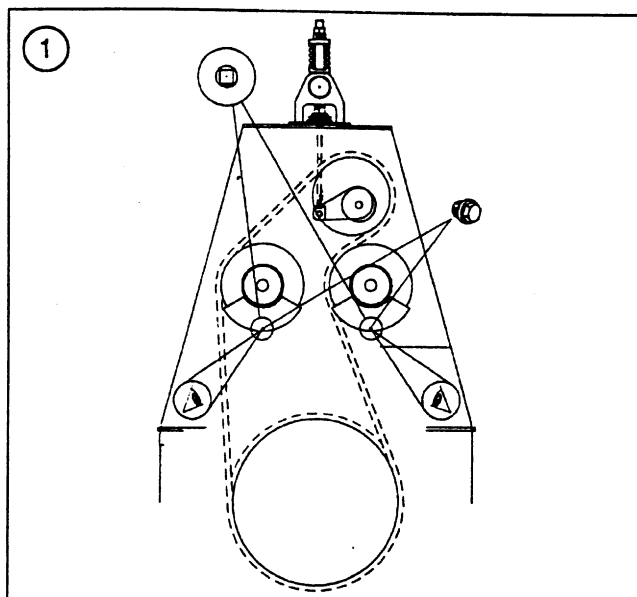
Remove the two check plugs on the chain box.

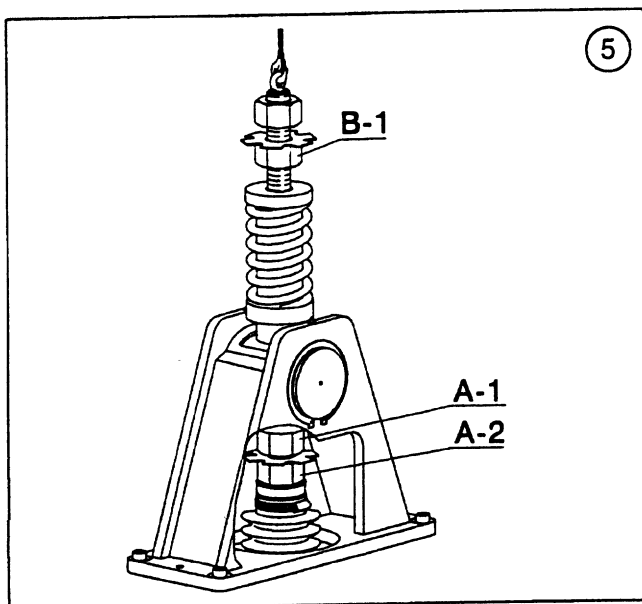
Check through the control holes that the timing marks are visible.

2. Measure the distance from the top of the chain tightener bolt to the top of the upper lock nut **B2**, and note it down for later comparison.
3. Loosen and remove the hose clamp and the rubber gland from the neck nut.

Release the upper lock nut **B2**.

4. Mount an eye screw on top of the chain tightener bolt and, by means of a lifting strap and the engine room crane, suspend the chain tightener bolt while making the tightening adjustment.





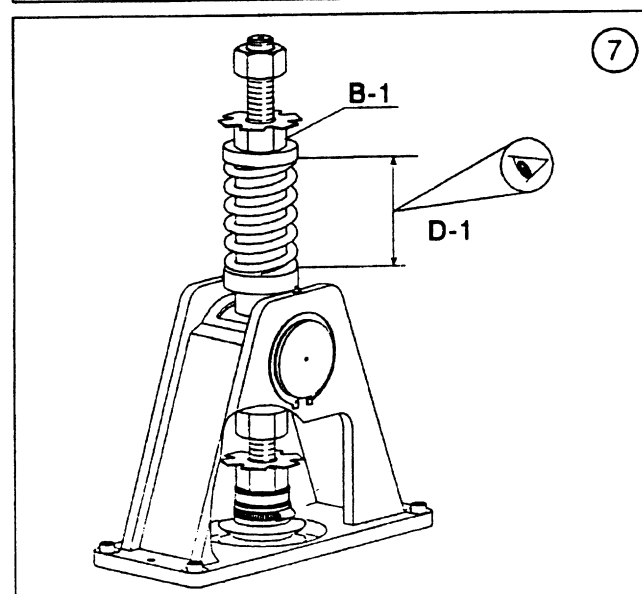
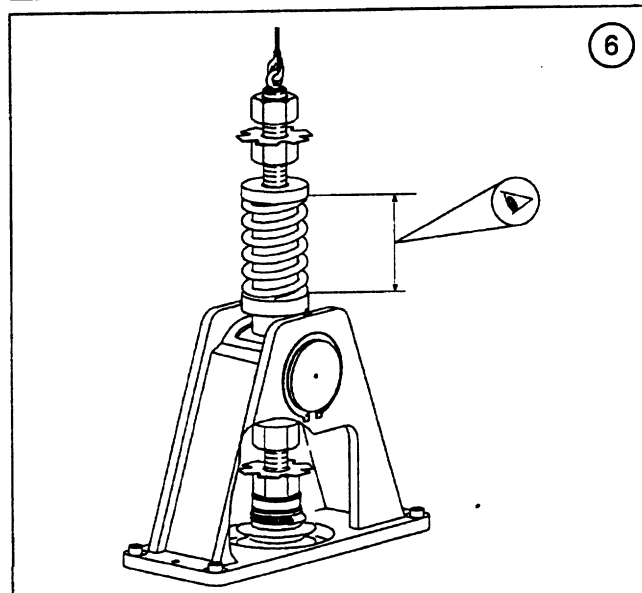
5. Release the locking devices and loosen the nuts A1, A2, B1, and B2.

6. Measure the free length of the spring.

Remove the lifting strap and the eye screw from the tightening bolt.

7. Tighten nut B1 until the length of the spring has been reduced by the number of mm indicated in D-1.

During tightening the nut B1, there must always be a clearance between nut A1 and the shaft.



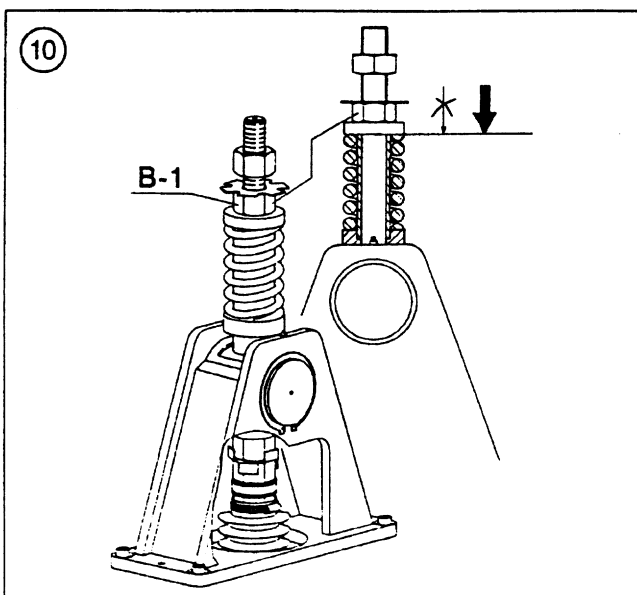
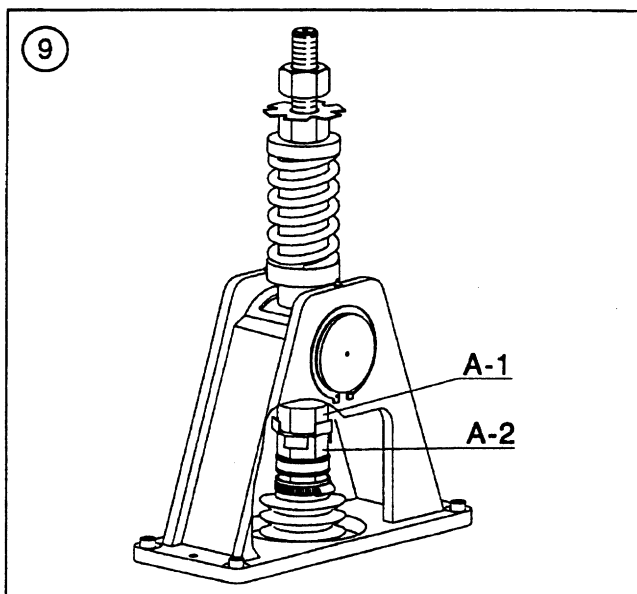
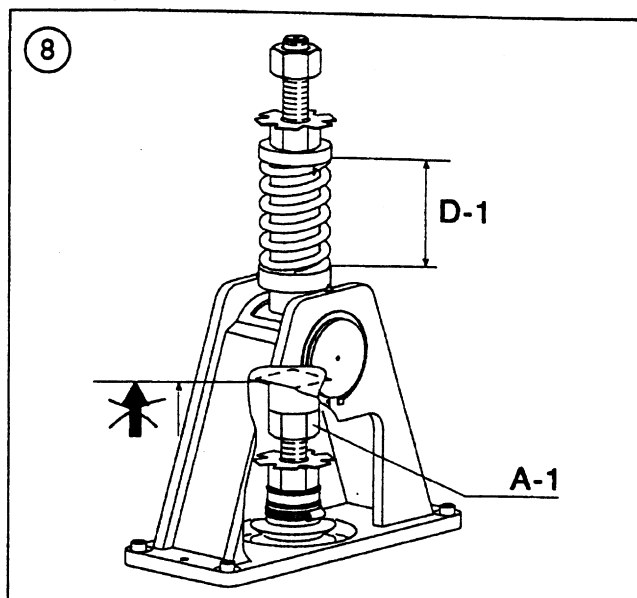
8. Tighten nut A1 lightly.

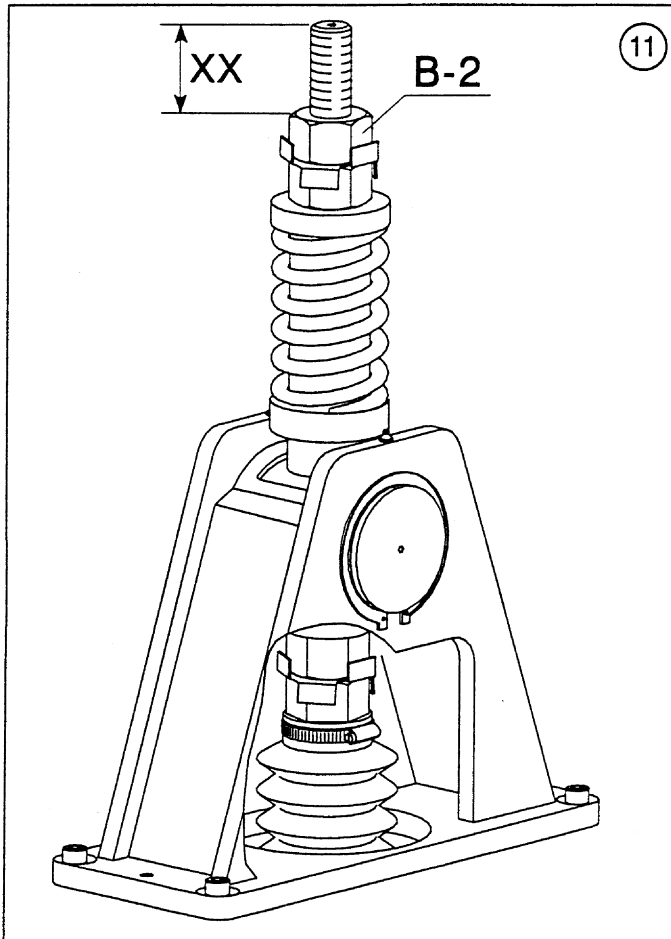
Make sure that this does not further compress the spring.

9. Tighten nut A2 while holding nut A1 with a spanner.

Lock both nuts with the locking device.

10. Tighten nut B1 until thrust flange of the spring presses hard against the distance tube.





11. Tighten nut **B2**, and lock both nuts with the locking device.

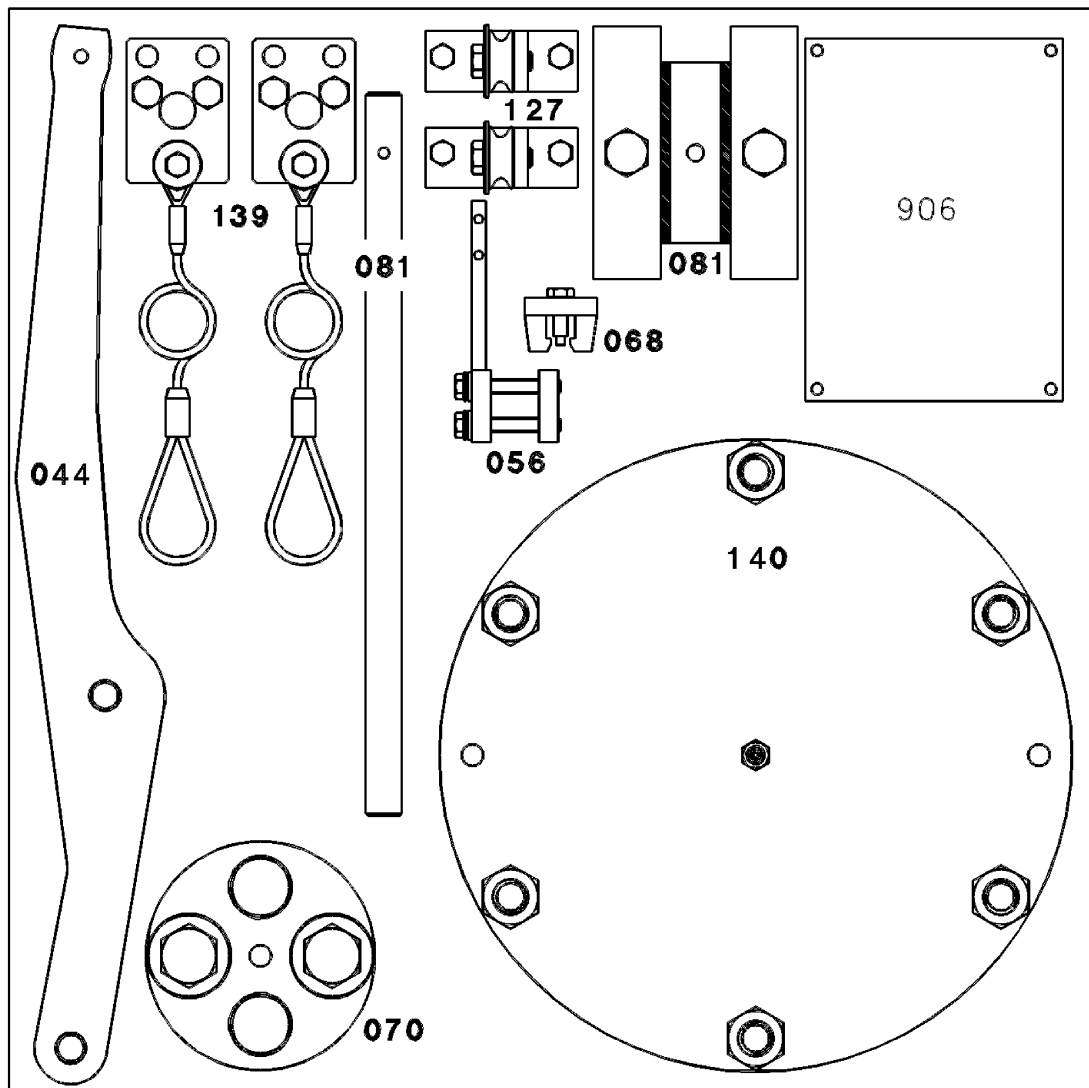
Measure again the distance from the top of the chain tightener bolt to the top of the upper nut **B2**.

Compare this result with the measurement taken before tightening the chain.

In case that the measuring result are the same, most likely the chain tightener is stuck.

12. Mount and tighten the rubber gland and hose clamp on the neck nut.

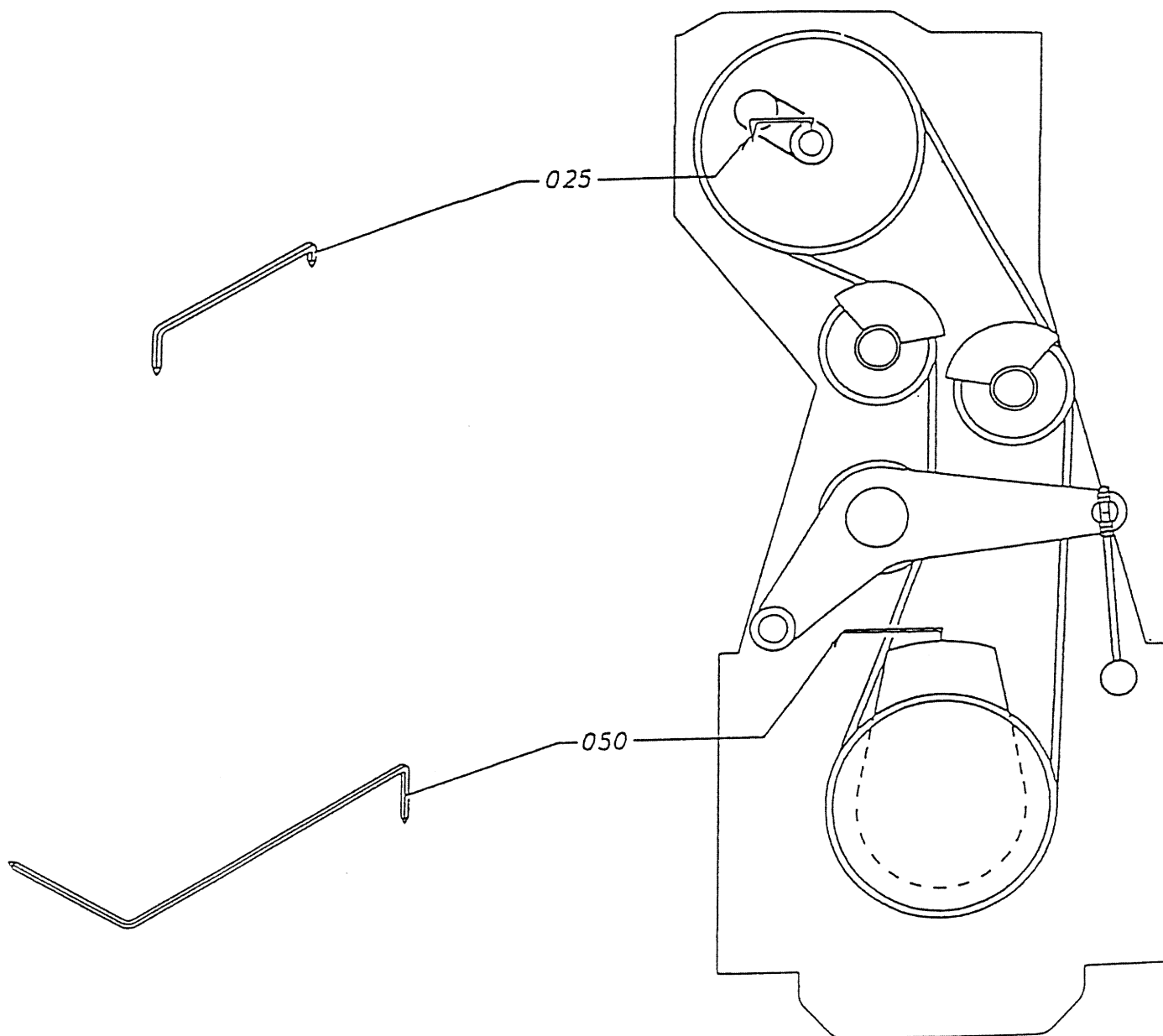




Item No.	Item Description
906	Tool panel *)
044	Face impact wrench for fuel cam adjustment
056	Chain assembling tool (1")
068	Chain disassembling tool (1")
070	Chain assembling tool (4.5")
081	Chain disassembling tool (4.5")
127	Pulley f. wire for camshaft bearing
139	Lifting attachment for camshaft and bearing
140	Hydr. tool for camshaft coupling with o-ring
906	*) Tool panel, complete
140	with tools
	*) Optional extras

Item No.	Item Description

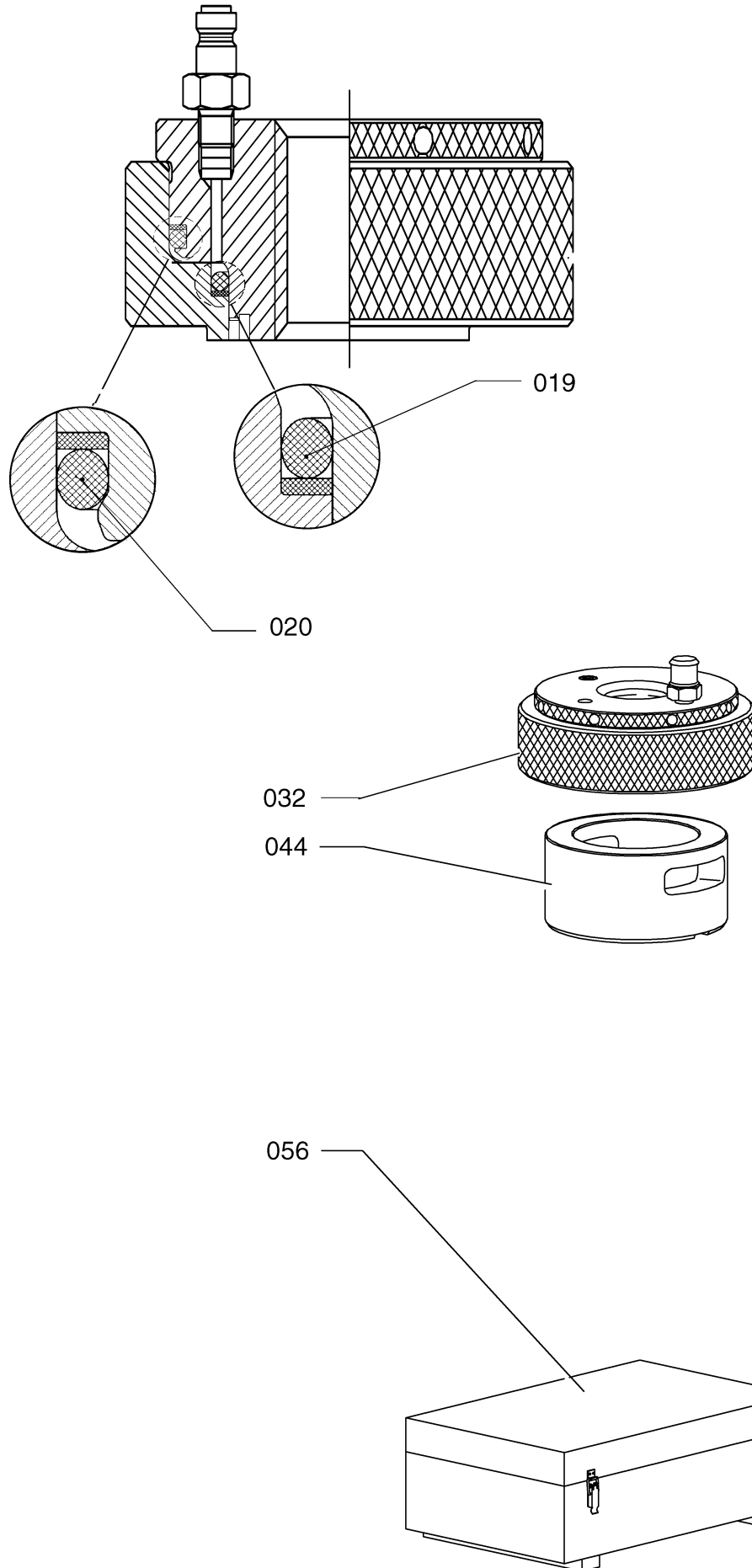




Item No.	Item Description
025	Pin gauge for camshaft
050	Pin gauge for crankshaft

Item No.	Item Description





Item No.	Item Description
019	O-ring with back-up ring, 74/85 mm
020	O-ring with back-up ring, 130/140 mm
032	Hydraulic jack camshaft stud
044	Support for Hydr. jack
056	Steel box for hyd. jack

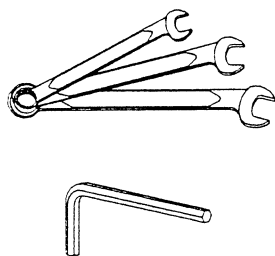
Item No.	Item Description

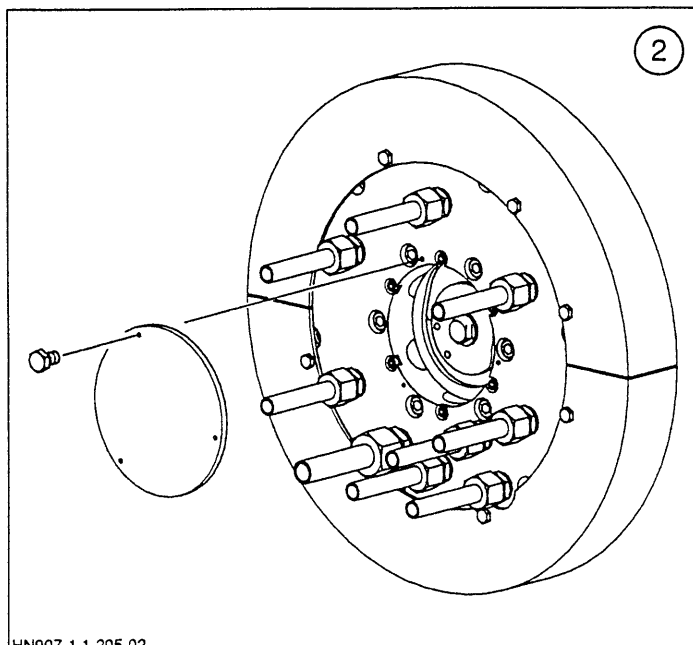


Safety Precautions

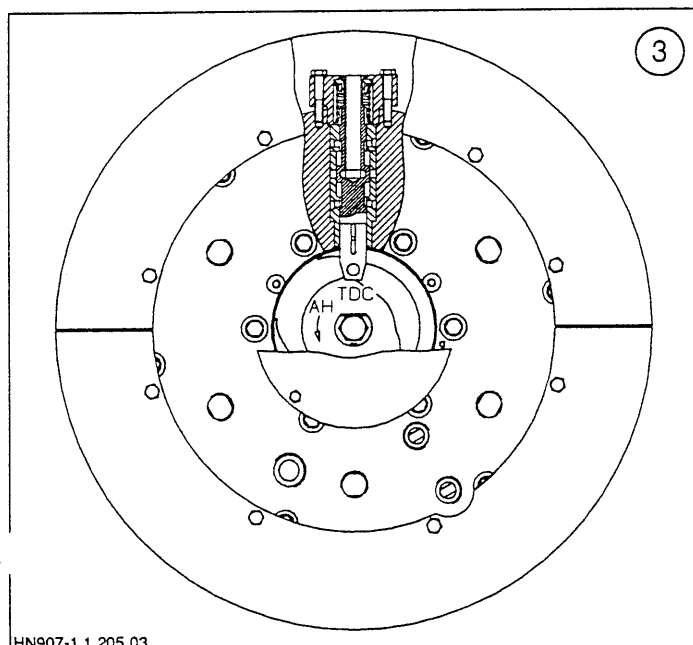
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

Standard tools: see Section 913

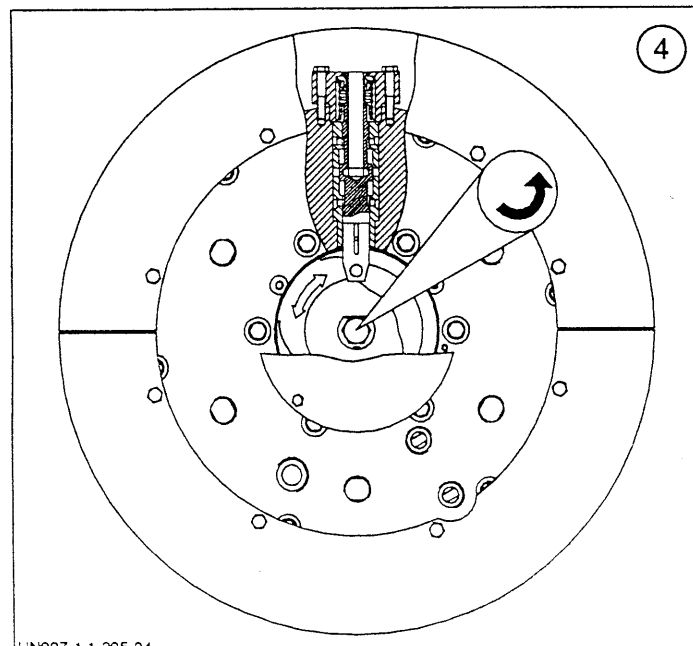




HN907-1.1 205 02



HN907-1.1 205 03



HN907-1.1 205 04

Checking

Turn the engine to bring the piston of cylinder No. 1 to TDC. Check the position with the pin gauge.

See Procedure 906-7.

Remove the small end cover from the distributor housing.

Check that the TDC marking scratch on the starting cam is positioned vertically at the valve slide of cylinder No. 1.

If necessary adjust the position of the starting cam by loosening the centre screw and turning the starting cam until the TDC marking scratch is positioned vertically at the valve slide of cylinder No. 1. Then tighten the centre screw.



Difficulties in starting can be caused by the starting air distributor valve slides "sticking" (see Volume I, Chapter 703), so that these are not activated and pressed against the cam during the starting procedure.

This can be caused by too high humidity in the main starting air system, which can result in the formation of rust, and also by dirt, preventing the slide valves from functioning.

In both cases it is necessary to clean the valve slides and the liners in the distributor housing to remove dirt, rust and foreign particles.

Experience will show how often this is necessary to prevent starting difficulties, as differences will be found from plant to plant.

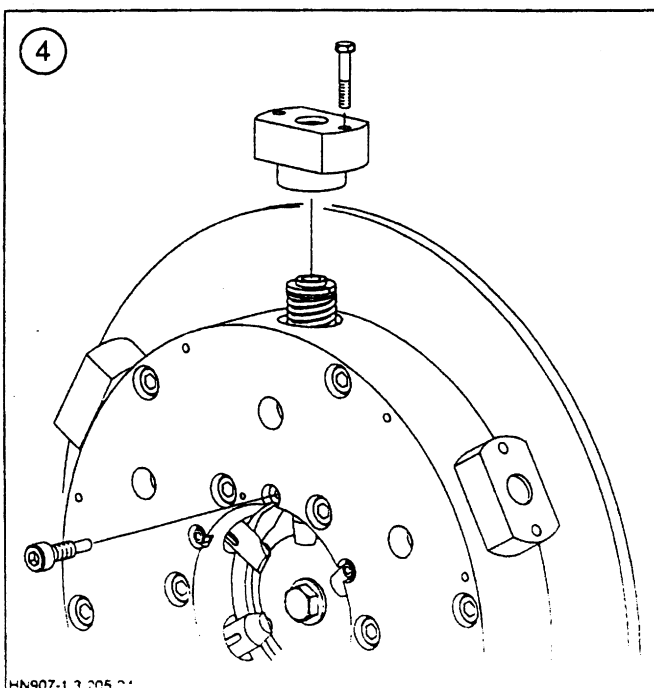
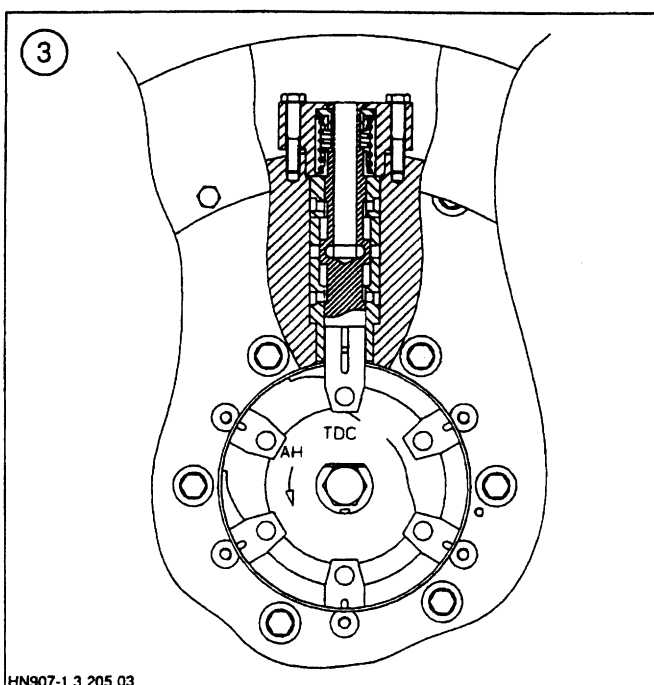
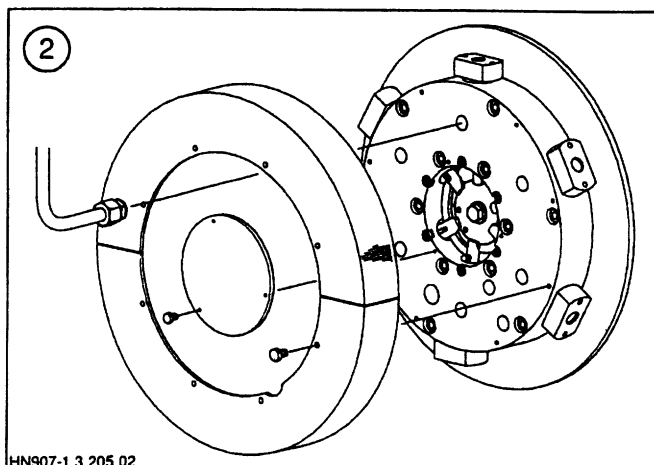
Dismantling

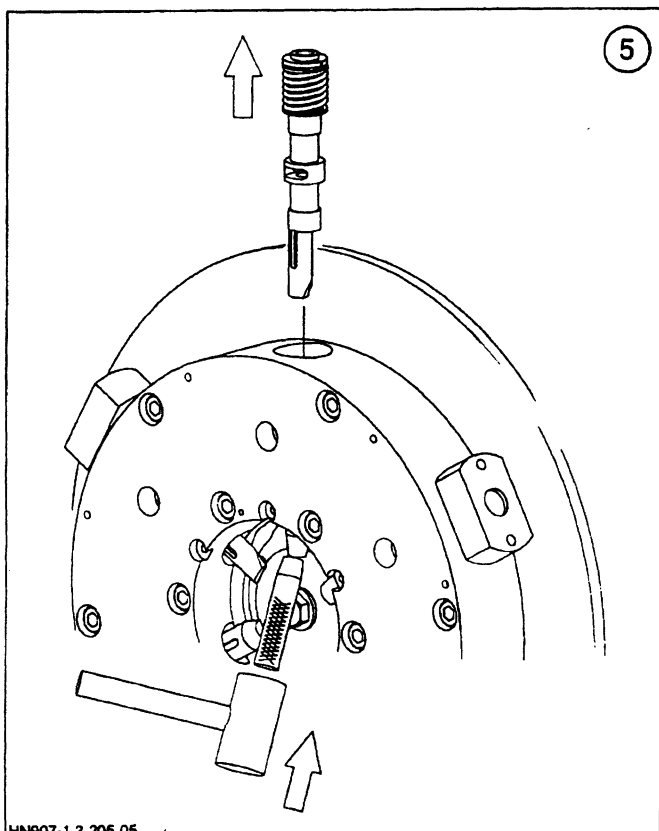
1. Blank off the main starting air and the control air. If this is not possible, lock the main starting valve in the closed position with a padlock.
2. Remove all the pipes from the end of the distributor.

Loosen and remove the screws from the small and large end covers. Dismount the end cover which gives access to the slide valves.

3. Turn the camshaft until the slot in the starting cam is opposite the pin of the valve slide.
4. Remove the screws and the cap from the particular valve slide in question.

Remove the guide screw for the valve slide.



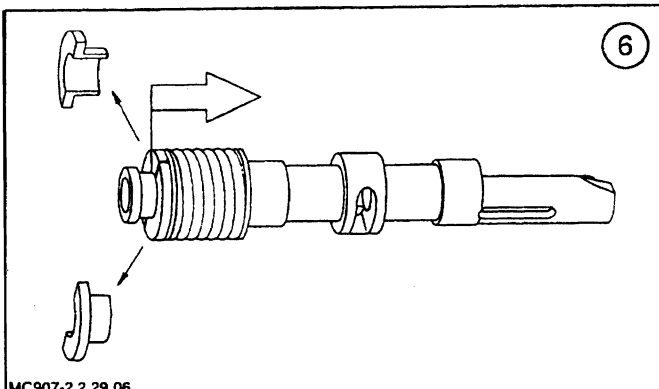


HN907-1.3 205 05

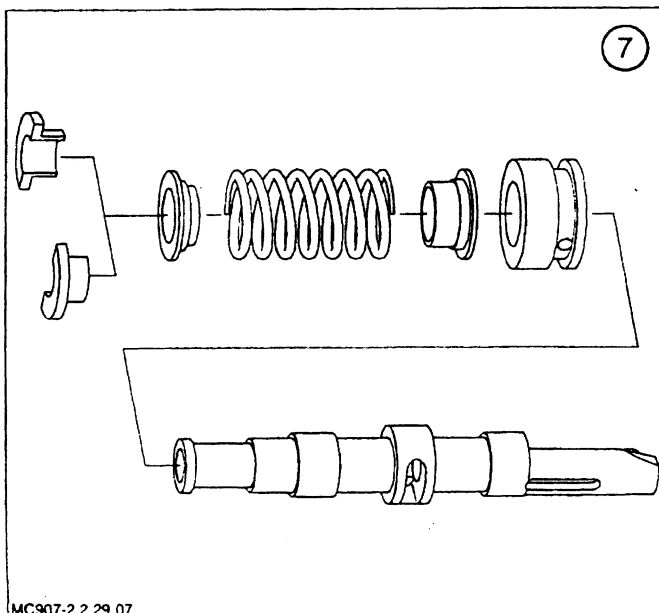
5. Remove the complete slide valve (with spring and the upper liner) from the distributor housing by means of a brass mandrel.

6. Press-in the spring and remove the two-part locking ring.

7. Remove the upper spring guide, the spring, the lower spring guide and the upper liner from the valve slide.



MC907-2.2 29 06



MC907-2.2 29 07



Overhauling

- Clean all the sliding surfaces on the valve slide. Lubricate all parts with Molybdenum Disulphide (MoS_2).

Clean the liners and the distributor housing. Test that the valve slide moves easily in the liners.

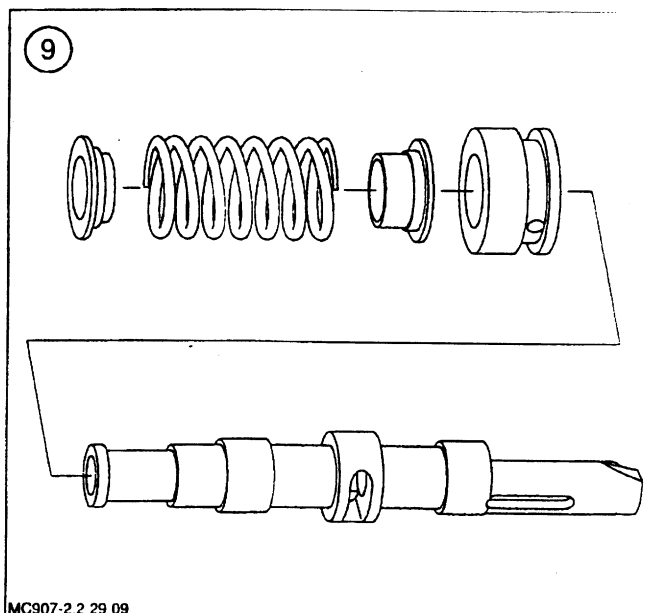
Note !

Polishing with emery cloth or steel wool **must not** take place as this will cause scratching marks on the sliding surfaces of the piston valve slide or distributor housing.

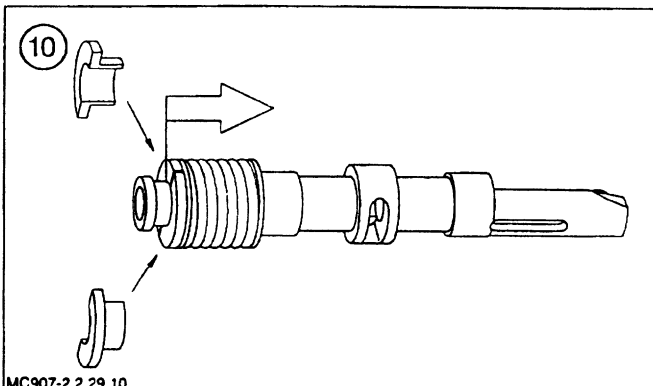
Mounting

- Place the upper liner, the lower spring guide, the spring and the upper spring guide over the valve slide.
- Press-in the spring and mount the two-part locking ring.
- Mount the complete slide valve in the distributor housing by means of a brass mandrel. (Check that the slot of the starting cam is opposite the pin of the valve slide, when mounting).

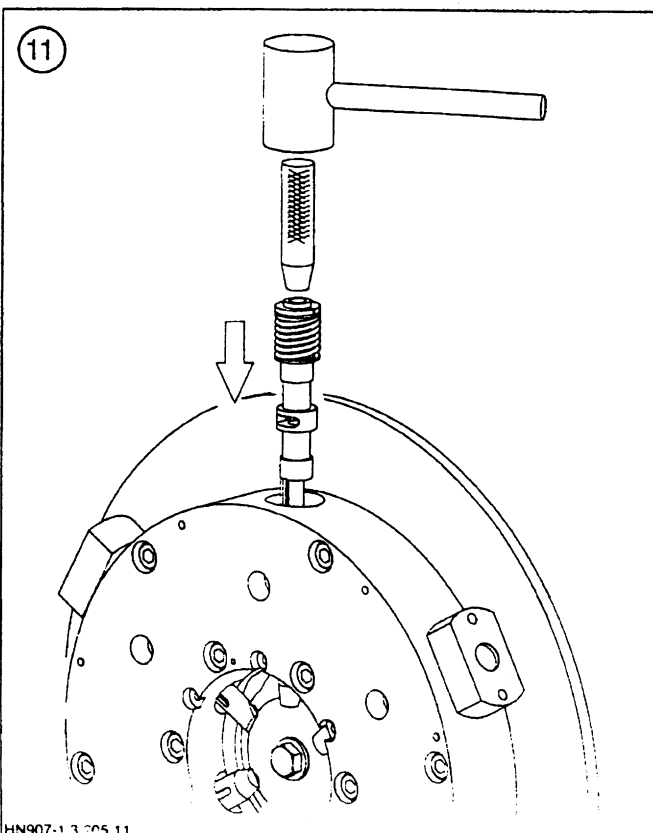
Lubricate the groove of the starting cam with Molybdenum Disulphide (MoS_2).



MC907-2.2 29 09

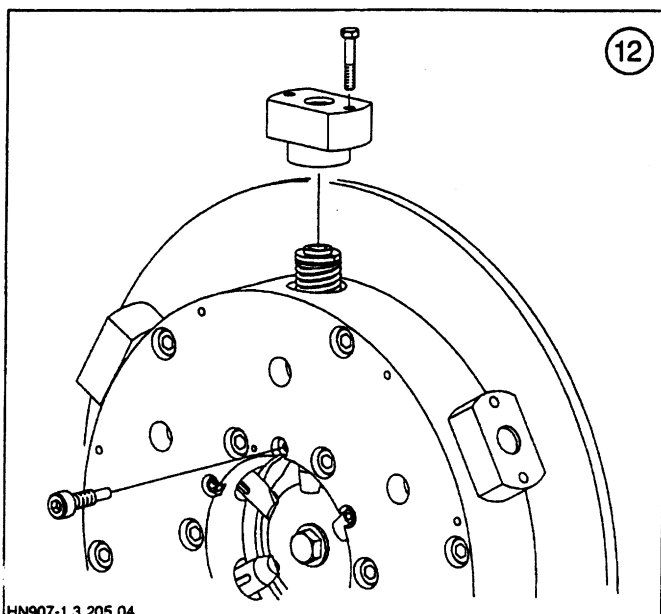


MC907-2.2 29 10



HN907-1.3 205 11

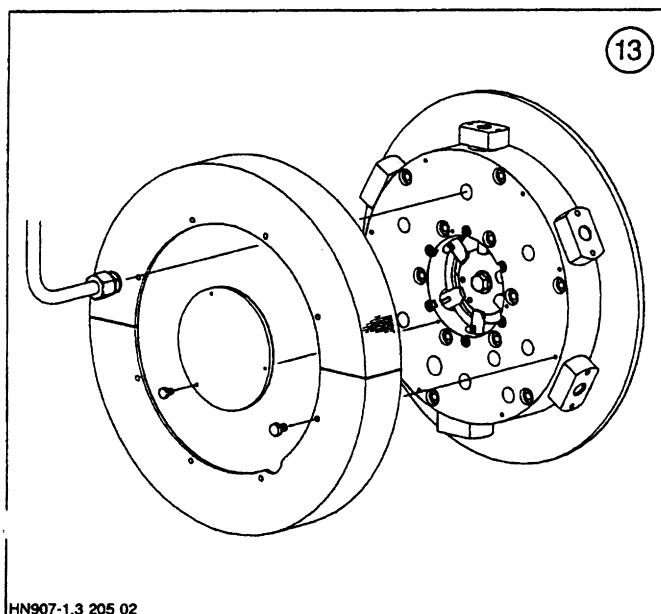




12. Mount the guide screw for the valve slide.

Mount the cap and the screws on the top of the slide valve.

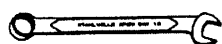
13. Finally, mount the two end covers and connect the main starting air and the control air.



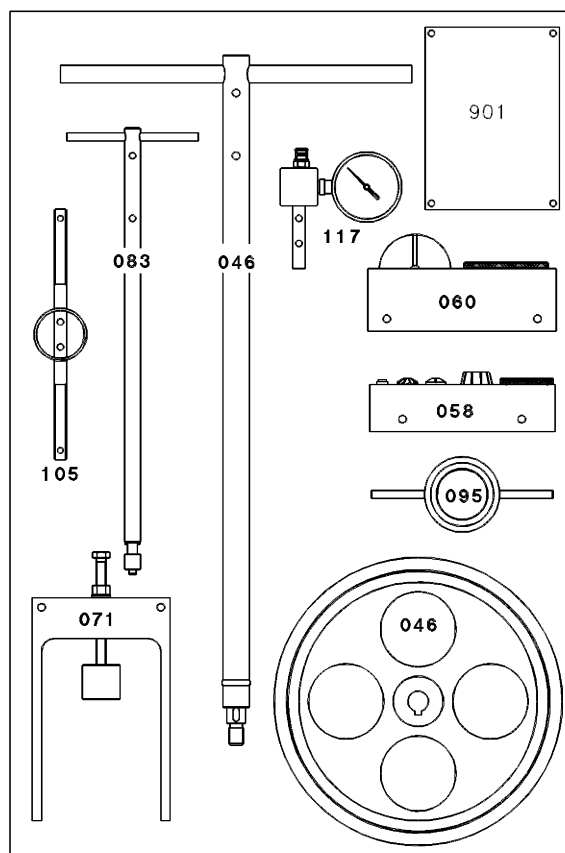
SAFETY PRECAUTIONS

- ☐ Stopped engine
- ☐ Block the starting mechanism
- ☐ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

 18, 36 mm

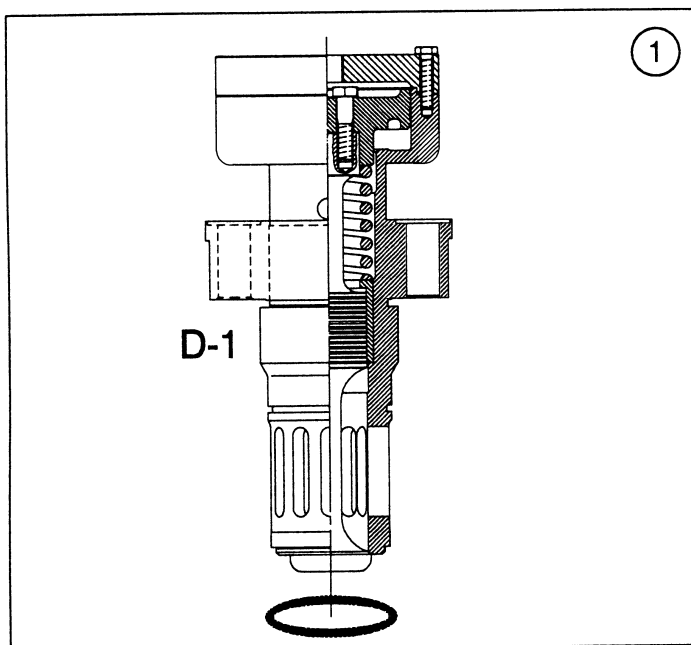
 10 mm



DATA:

D-1 Weight of starting air valve 58 kg





1. Place the starting air valve horizontally in a bench vice provided with "soft" jaws.

Remove and discard the O-ring from the valve housing.

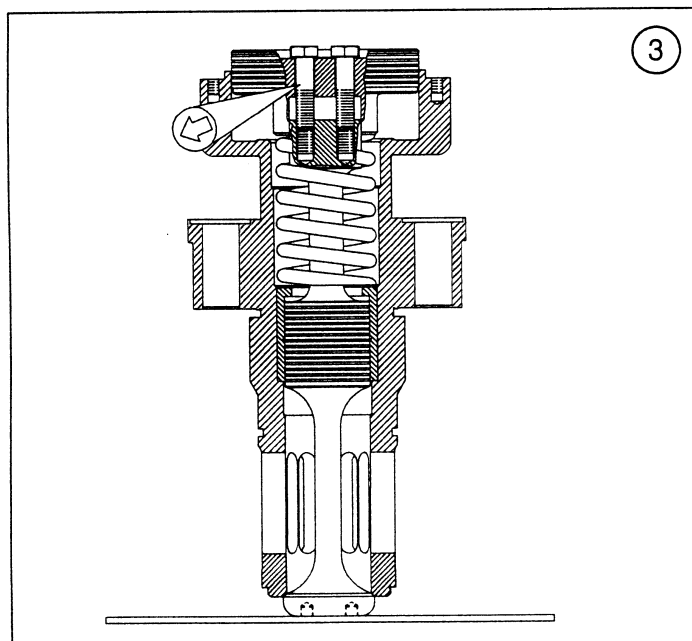
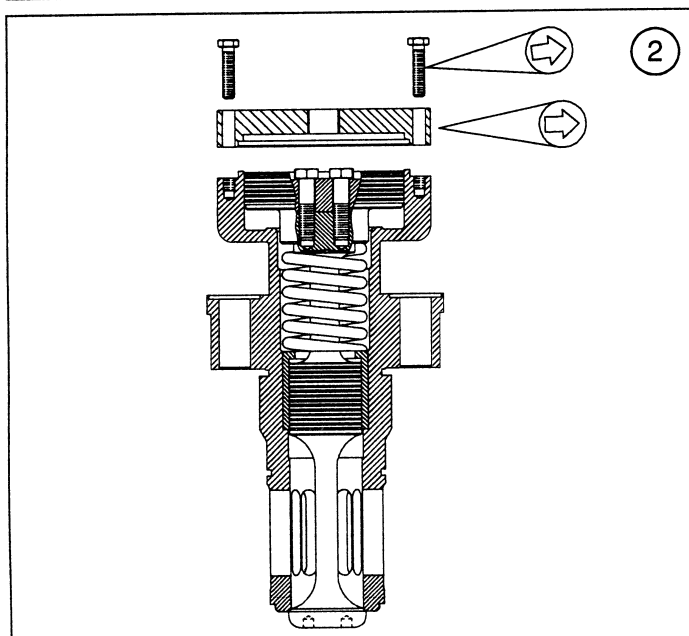
2. Loosen and remove the screws from the top cover.

Dismount the top cover.

3. Use the face wrench for the spindle as a back-stop when loosening the two screws which tighten the piston to the spindle.

Remove the screws.

When unscrewing, the piston will partially be pressed out of the valve housing due to the spring force.



- Remove the piston from the top end of the valve housing.

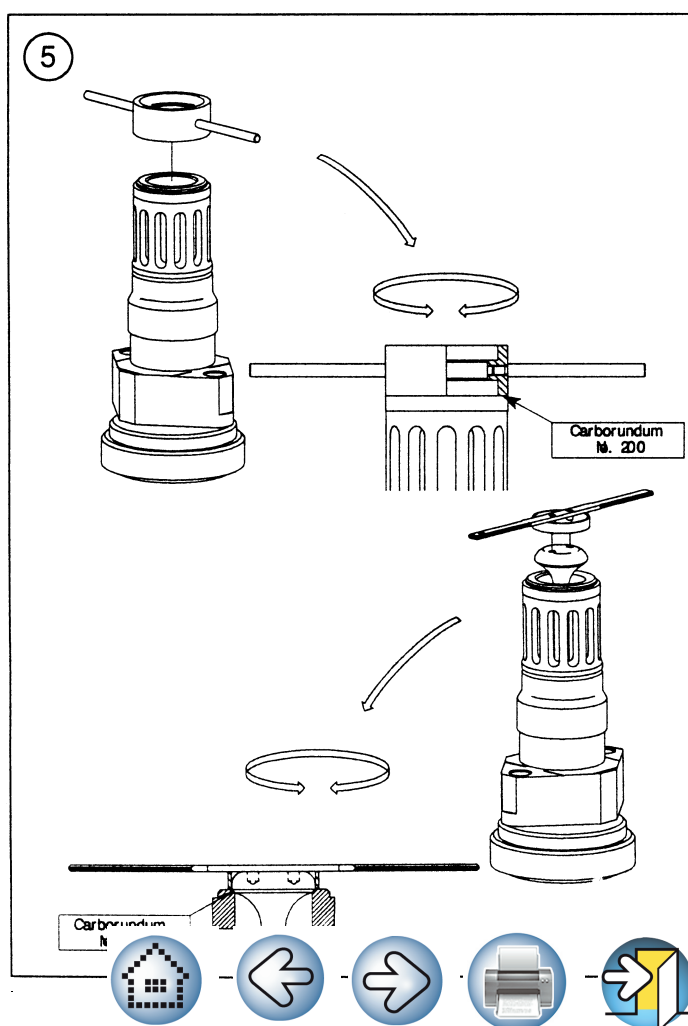
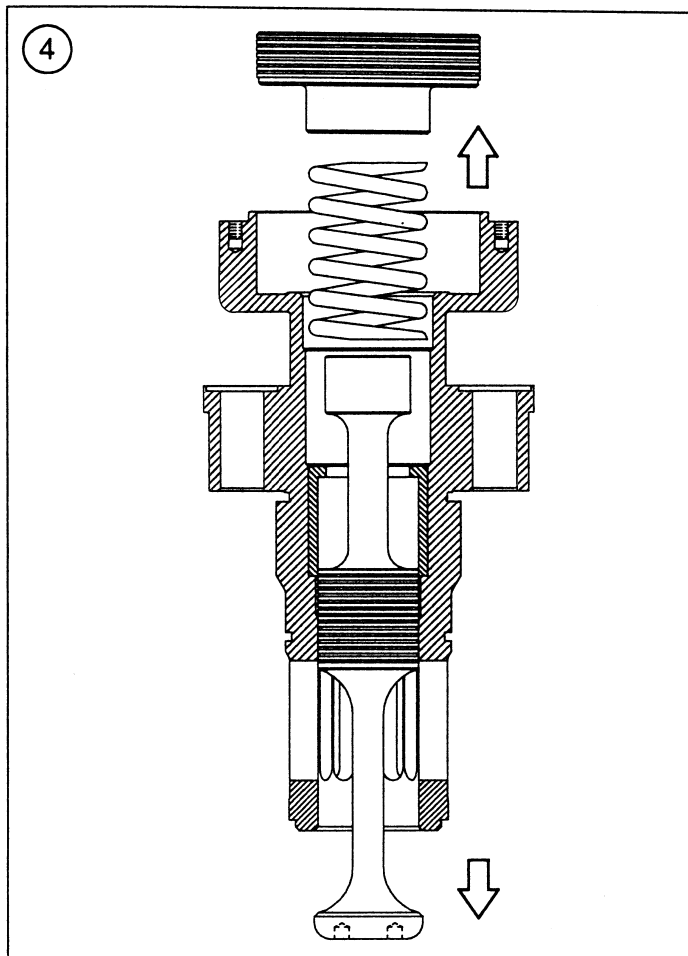
Take out the spindle from the bottom end of the valve housing.

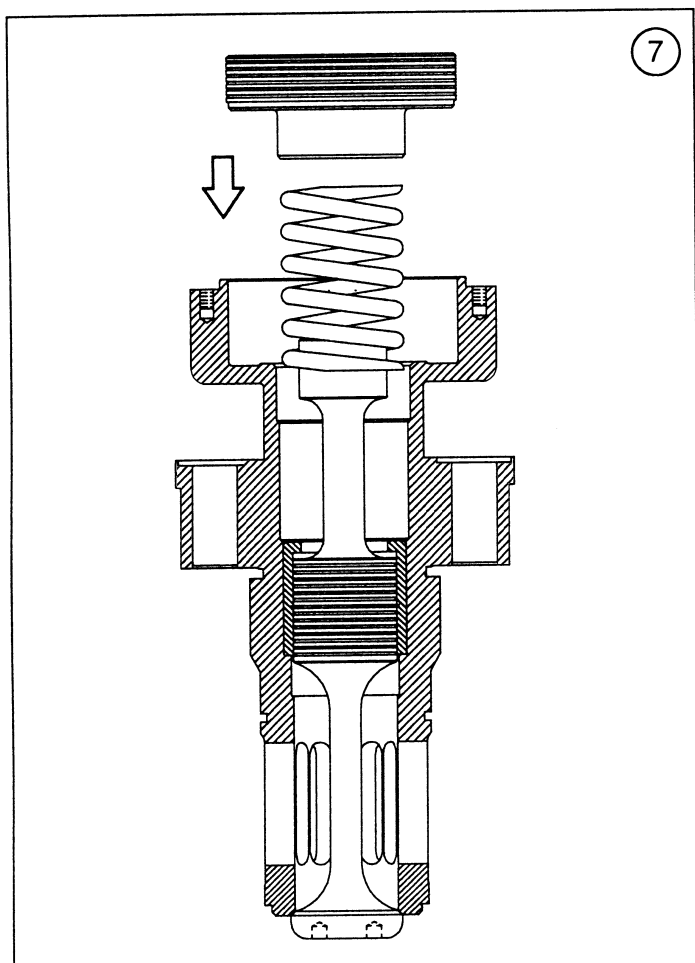
Remove the spring from the top end of the housing.

- Apply grinding paste, e.g. carborundum No. 200. Grind the valve housing seating with the grinding ring.

When lapping the seatings of the spindle and valve housing to match, use the face wrench to rotate the spindle.

As grinding paste, use e.g. carborundum No. 500.





6. Thoroughly clean the valve housing and all the parts in diesel oil or kerosene.

Lubricate all internal parts and sliding surfaces with, e.g., Molybdenum Disulphide, MoS_2 .

7. Insert the spindle in the valve housing. Then mount the spring in the housing around the spindle and, finally, place the piston on top of the spindle.

8. Fit the washer and the two screws.

When tightening the screws, the piston will compress the spring.

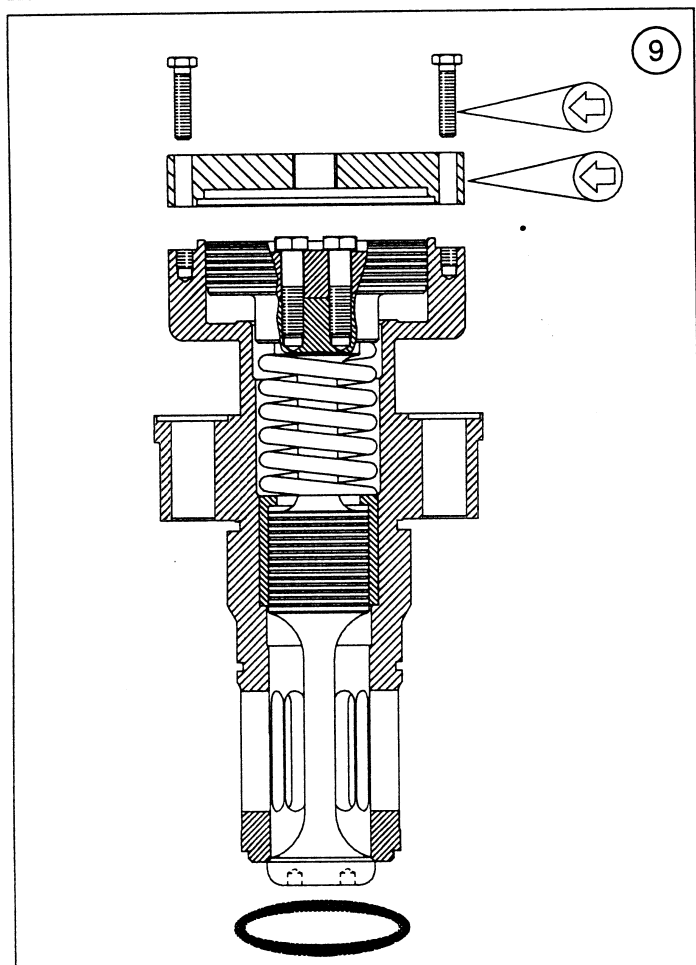
Tighten the screws continuously until the piston faces tightly against the spindle. Use the face wrench as a back-stop.

Lock the screws.

9. Mount and tighten the top cover.

Fit a new O-ring on the valve housing.

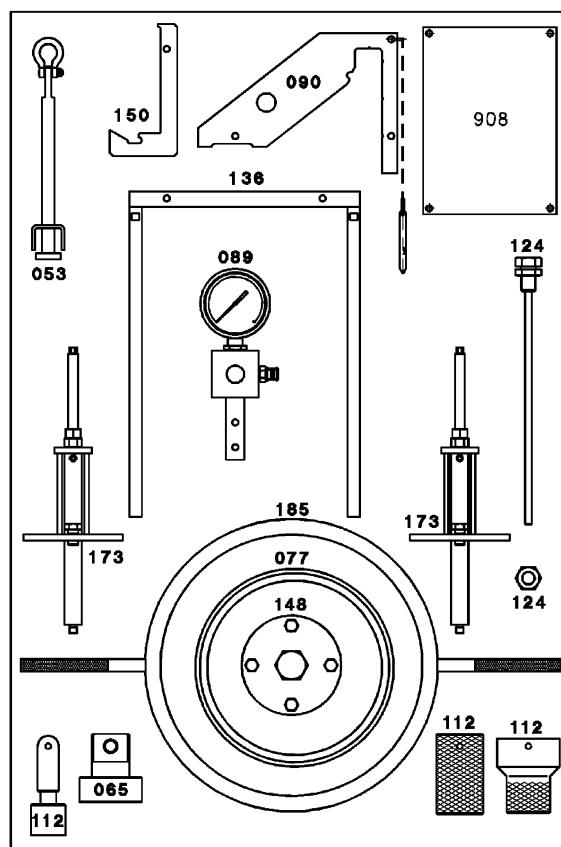
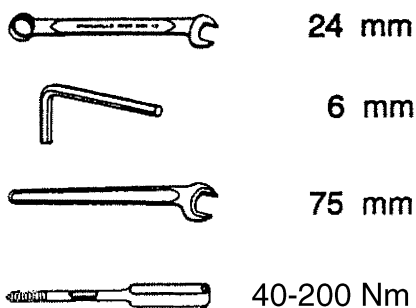
If the valve is not to be mounted in the engine immediately, cover all openings with plastic to prevent dirt from entering the valve during storage.



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

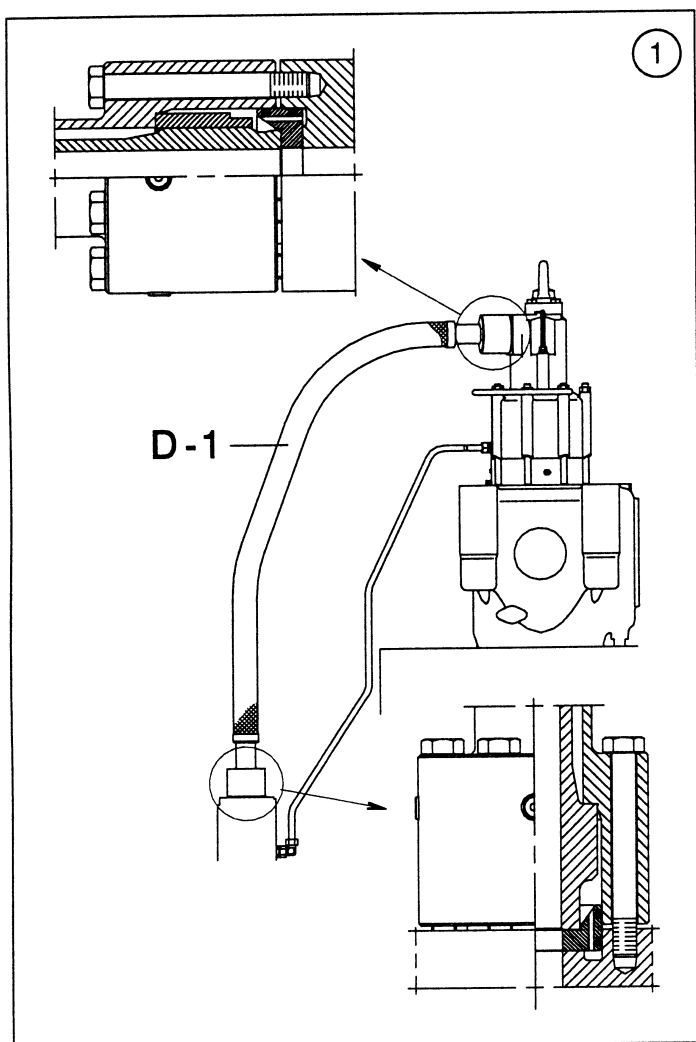
913



DATA:

- D-1 Weight of high-pressure pipe 57 kg
- D-2 Distance from end of high-pressure pipe to lower edge of pressure flange 19 mm
- D-3 Tightening torque – high-pressure pipe..... 80 Nm



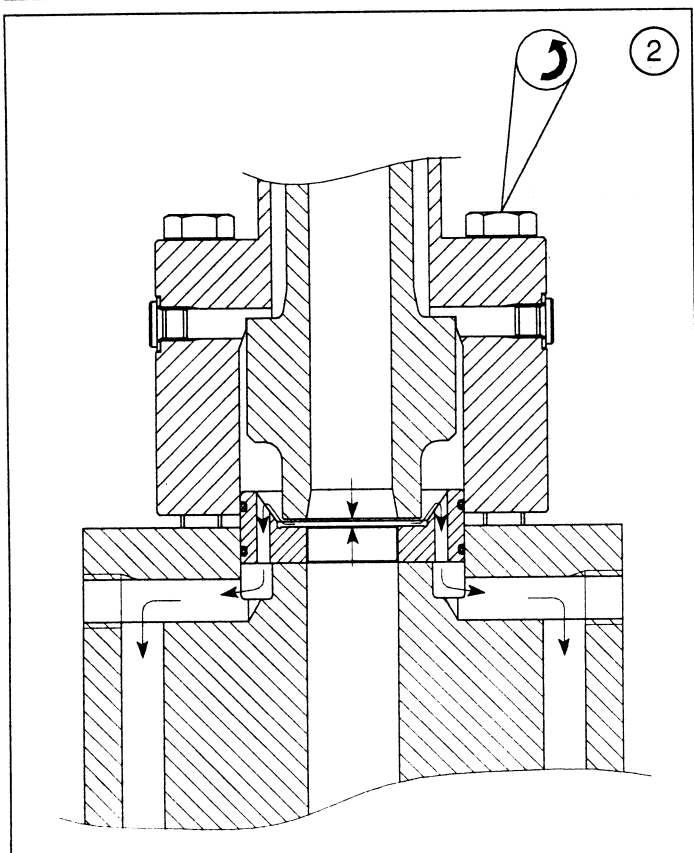


1. In connection with replacement of hydraulic high-pressure pipe, exhaust valve or hydraulic actuator, the high-pressure pipe sealing surfaces are to be checked and reconditioned, if required.

Note !

Before dismantling the high-pressure pipe, stop the camshaft oil pump.

2. Loosen the screws for the high-pressure pipe and lift the pipe a little from the actuator to let the oil in the pipe drain through the drain holes in the actuator.



3. Check the contact surfaces of the pressure pipe for marks and, if necessary, grind the pipe ends by means of the grinding mandrel.

Start grinding with a coarse grinding paste, for example Carborundum No. 200, and finish with a fine grinding paste, for example Carborundum No. 500.

4. After reconditioning the contact surfaces of the pipe, measure the distance from the edge of the thrust bushing to the contact surface at the top end of the pipe. This measurement is to correspond with the value stated in Data.

Check the thrust pads in the exhaust valve and the actuator for marks on the sealing surface.

Replace the O-rings on the thrust pads.

If considered necessary, replace the thrust pads.

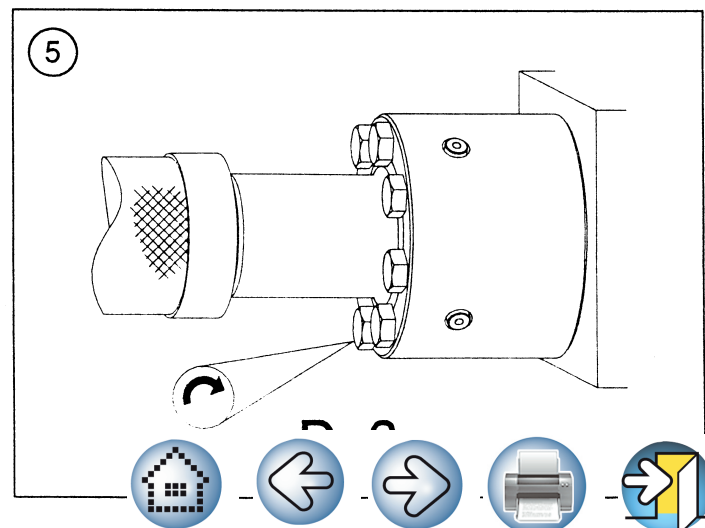
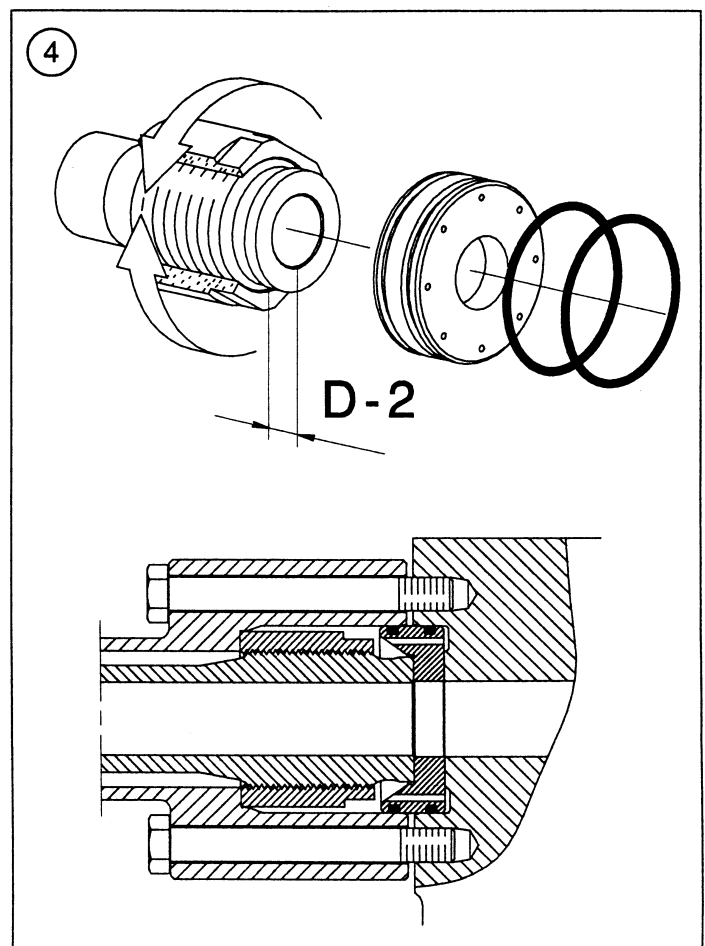
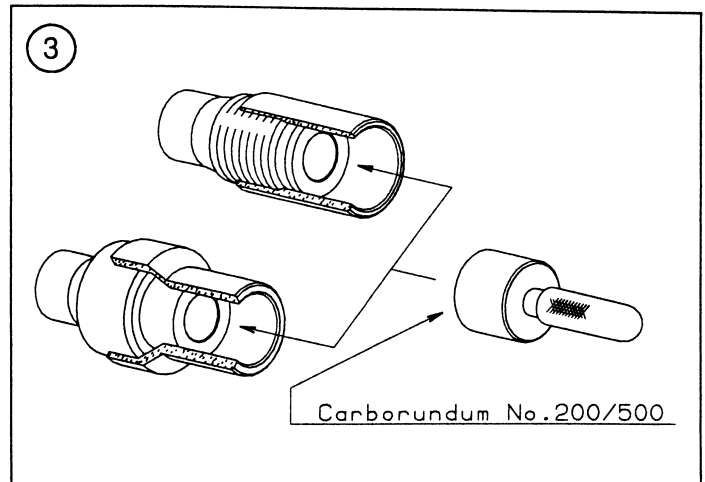
Lift the thrust pad free by, for example, using a screwdriver in the groove of the thrust pad.

5. Mount the hydraulic high-pressure pipe as follows:

Place the high-pressure pipe with the sealing surfaces of the pipe resting on the thrust pads of the exhaust valve/actuator. Take care not to damage the O-rings on the thrust pads.

After fitting the pipe correctly relative to the exhaust valve and actuator, tighten up the screws of the pressure flanges in crosswise order, *see data*.

6. Check the system for tightness.
See Procedure 908-3.



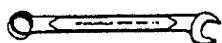
BLANK



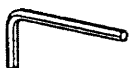
SAFETY PRECAUTIONS

- ☐ Stopped engine
- ☐ Block the starting mechanism
- ☐ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

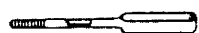
913



13. 16. 17. 22. 50. 55
19, 24, 30, 32 mm



2, 3, 5, 14, 24 mm



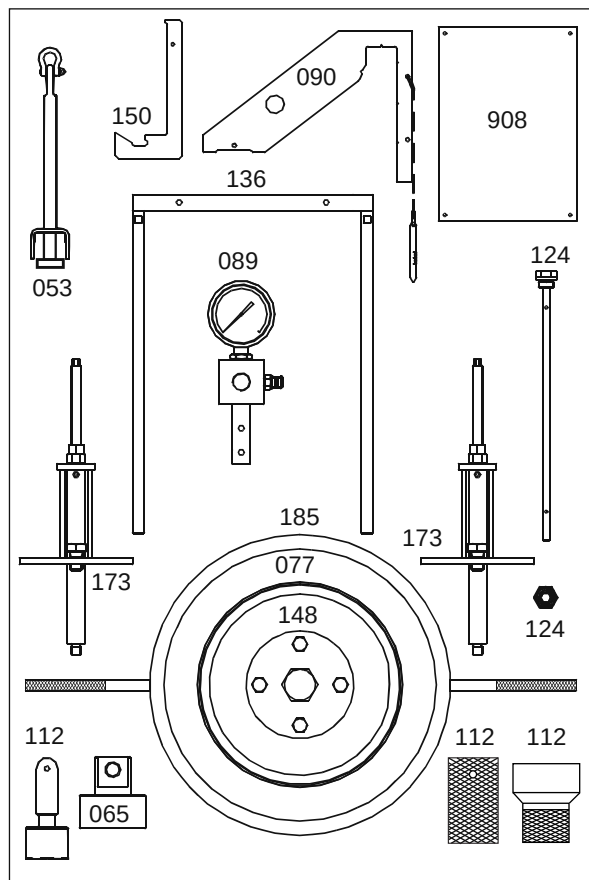
40-200 Nm

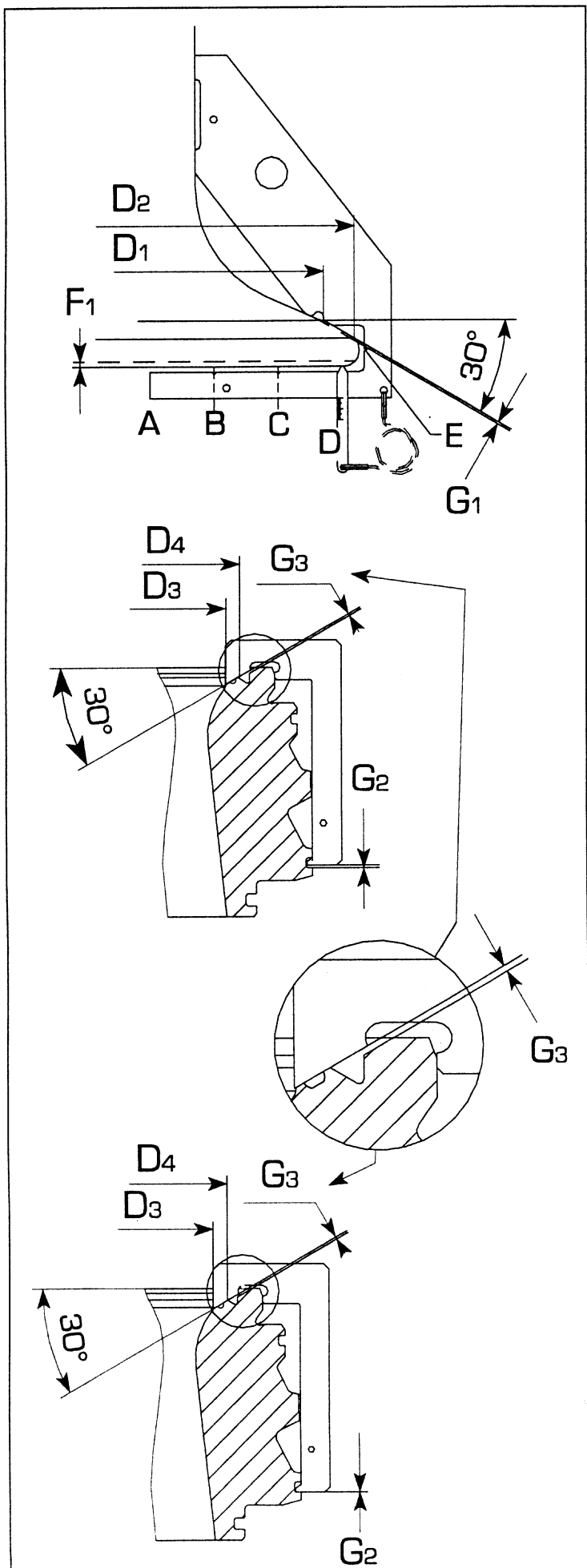


2 x M10, 2 x M16

DATA:

D-1	Exhaust valve, complete....	1110 kg
D-2	Exhaust valve housing.....	612 kg
D-3	Oil cylinder.....	150 kg
D-4	Air cylinder.....	48 kg
D-5	Spindle.....	117 kg
D-6	Bottom piece.....	146 kg
D-7	Piston in air cylinder.....	15 kg
D-8	Oil cylinder, inside diameter max.	100.2 mm
D-9	Piston rings, min. thickness.....	3.8 mm
D-10	Distance to damper piston: between.....	47.0 mm 51.2 mm
D-11	Max. diameter..... top bottom	84.7 mm 87.0 mm
D-12	Min. diameter of spindle stem.....	83.8 mm
D-13	Tightening torque - oil cylinder.....	100 Nm
D-14	Tightening torque - screws for lifting bolt.....	50 Nm
D-15	Tightening torque - safety valve.....	0 50+30 Nm
D-16	Opening pressure, safety valve.....	21 bar
D-17	Offset angle, spindle.....	6.0°





Checking of valve spindle and valve housing seat:

Spindle:

Spindle			
Grinding, max. G_1	D_1	D_2	F_1
2.0	325	382	12

The wear limit of the spindle is checked by measuring at each of the points **A**, **B**, **C**, **D** and **E**, indicated by means of notches in the template.

These measurements should be taken at four diametrically opposite points on the circumference of the spindle.

The measurements taken by means of the template are the differential values between the normal and the defective profile of the valve spindle, and the burn-away must in no place exceed the value indicated on the template.

The spindle can be used again if the measurement G_1 does not exceed that indicated in the table.

Valve housing W-seat:

Valve housing seat			
G_2	D_3	D_4	G_3
2.3	329	351	1

The seat on the recessed chamber valve is checked in a similar way as the spindle.

The measurement G_2 is for a new valve seat.

When the template rests on the lower surface in the groove, i.e. $G_2 = 0$ see the Figure, grinding must not be continued.

The measurement G_3 is always to be kept.

1. Place the exhaust valve on the platform on a couple of planks.

Remove the eight nuts and the safety strap from the oil cylinder.

2. Lift away and place the oil cylinder on a couple of wooden planks.

Dismount and inspect the O-rings and the thrust piece of the hydraulic high-pressure pipe for marks.

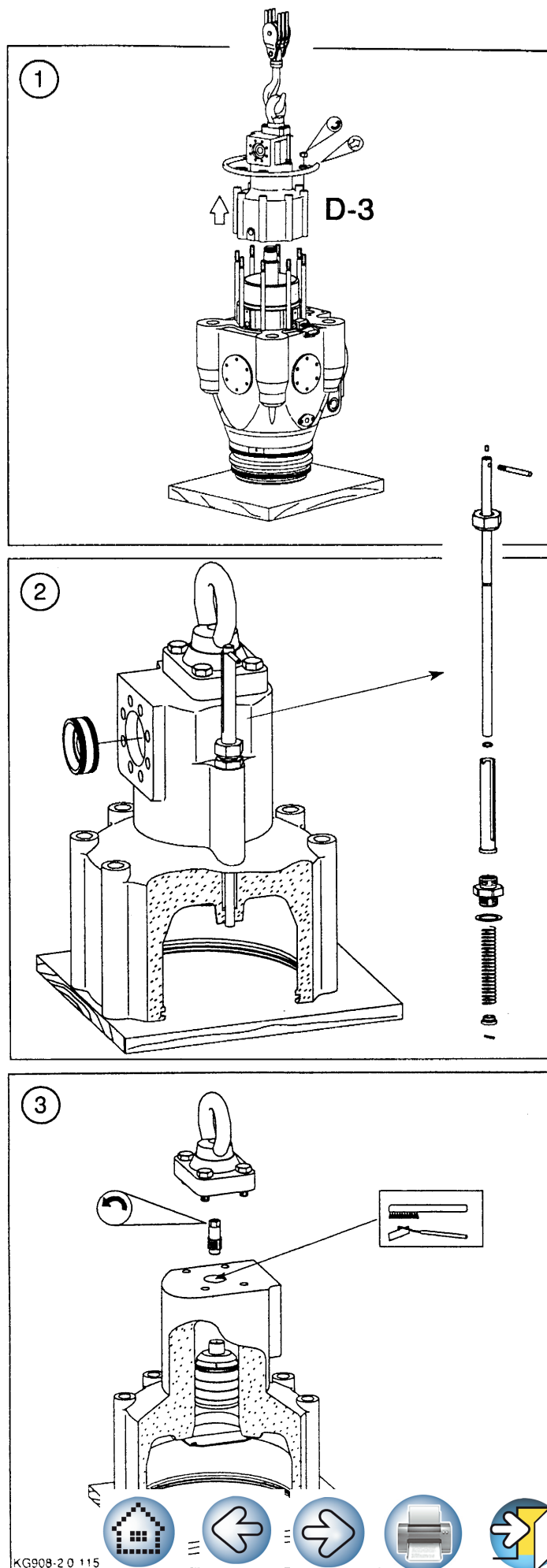
Replace the O-rings and thrust piece, if necessary.

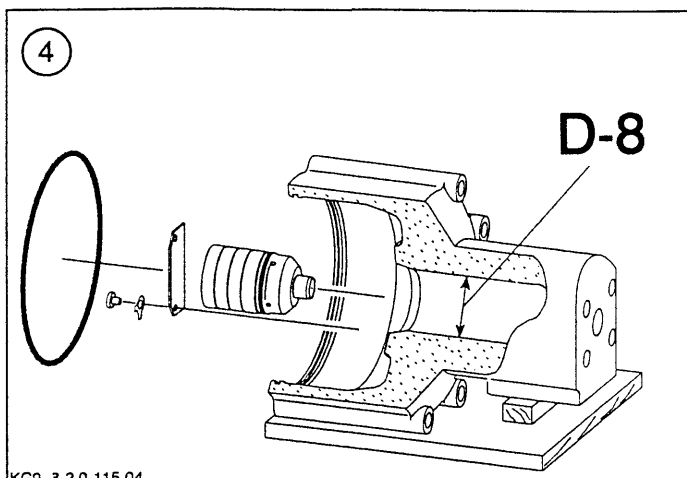
Check the functioning of the exhaust valve rotation indicator.

3. Loosen the screws and remove the lifting eye bolt over the orifice in the oil cylinder.

Unscrew and clean the orifice.

Check and clean the bore for the orifice in top of the oil cylinder.





KG9. 3-2.0 115 04

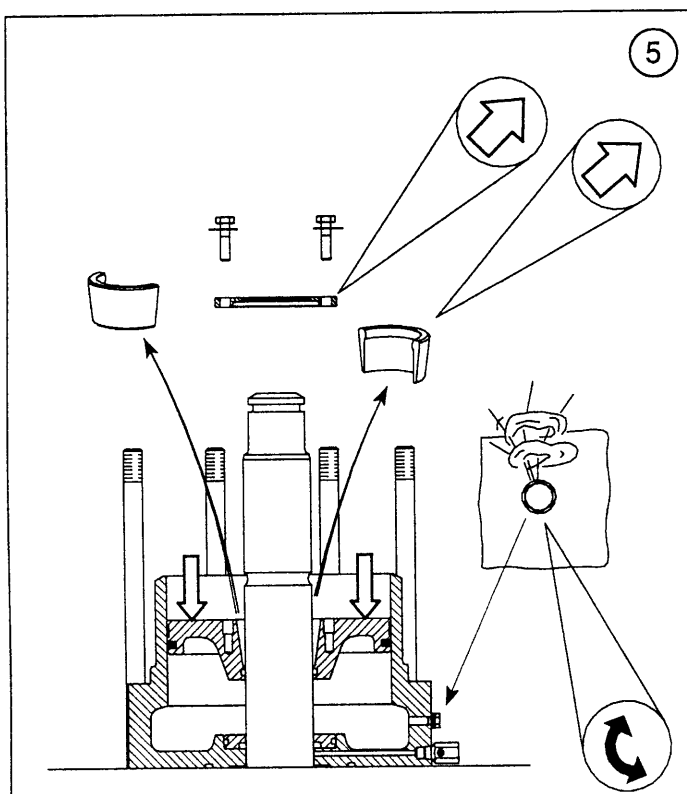
4. Place the oil cylinder in a horizontal position.

Remove the flange and take out the piston.

Inspect the bore of the oil cylinder for scoring and check the measurements.

If the diameter of the bore exceeds the measurements stated in Data, send the oil cylinder to an MAN B&W authorized workshop for repair.

Discard the internal sealing ring for the air cylinder and mount a new one.



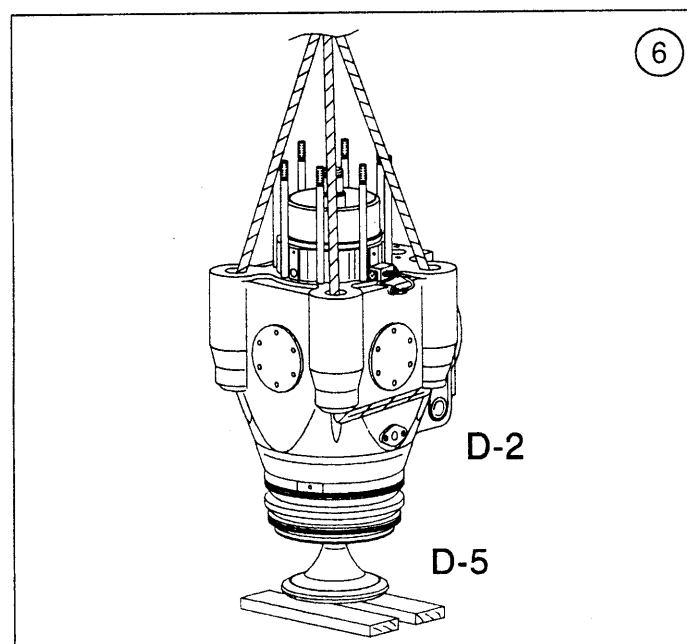
5. Release the vent plug screw placed just above the ball cock on the air cylinder.

Remove the four screws from the flange on top of the air piston and dismount the flange.

Loosen the air piston from the conical locking ring by means of a tin hammer, and remove the conical locking ring.

6. Pass lifting straps through the four bores of the valve housing and lift the valve housing clear of the valve spindle.

Take care – when the internal O-ring in the air piston and the internal rings for the sealing arrangement at the bottom of the air cylinder – pass the groove for the conical ring at the top of the spindle.



7. Poise the valve housing above a couple of planks, leaving a distance of approx. 10 mm between the bottom piece and the planks.

Remove the lock screws which retain the bottom piece and allow the bottom piece to fall the 10 mm on to the planks. If the bottom piece has become stuck, use a tin hammer.

Remove the O-rings from the bottom piece and clean all the cooling bores.

8. Inspect the seating of the bottom piece **carefully** for damage and check with the template, *see Data*.

If it is necessary to grind the seating, this must be done in the following way:

Before placing the bottom piece on the grinding machine, turn the grinding head away from the grinding table.

Mount two eye screws in the bottom piece and place the bottom piece on the circular table of the grinding apparatus, and make sure, by means of a dial indicator, that it is correctly centered.

Note !

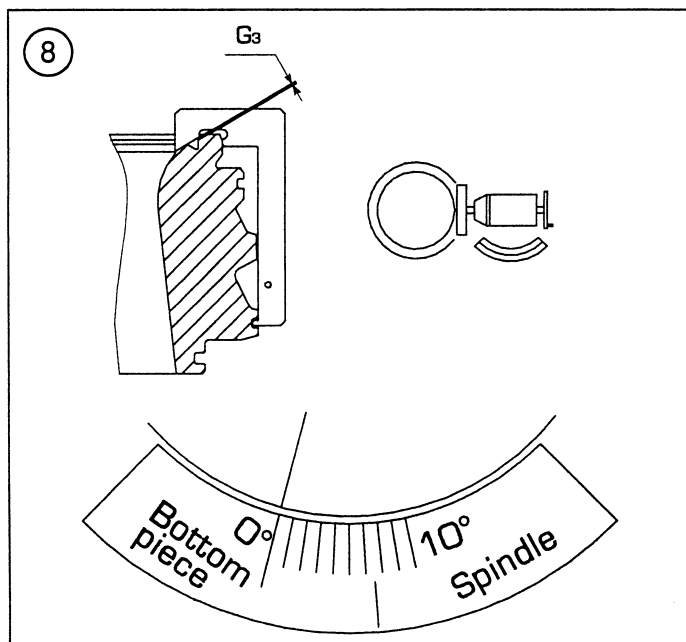
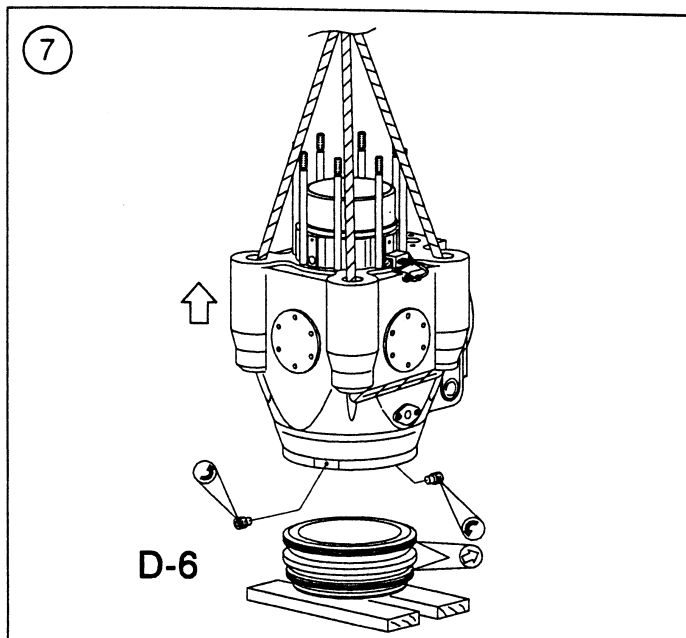
The vertical setting of the grinding head, *see Data*. The 'offset angle' on the horizontal scale is 0°.

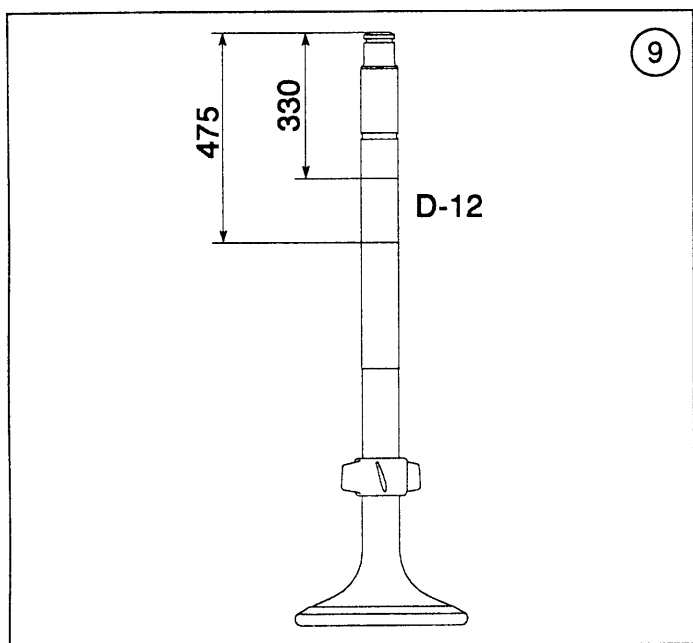
Regarding the use of the grinding apparatus, see separate instructions.

After grinding, inspect the seating of the bottom piece again with the template.

Measure by means of a feeler gauge and the template how much has been ground away from the seat.

Then grind the recess so that the gap G_3 remains as stated on the Data sheet.





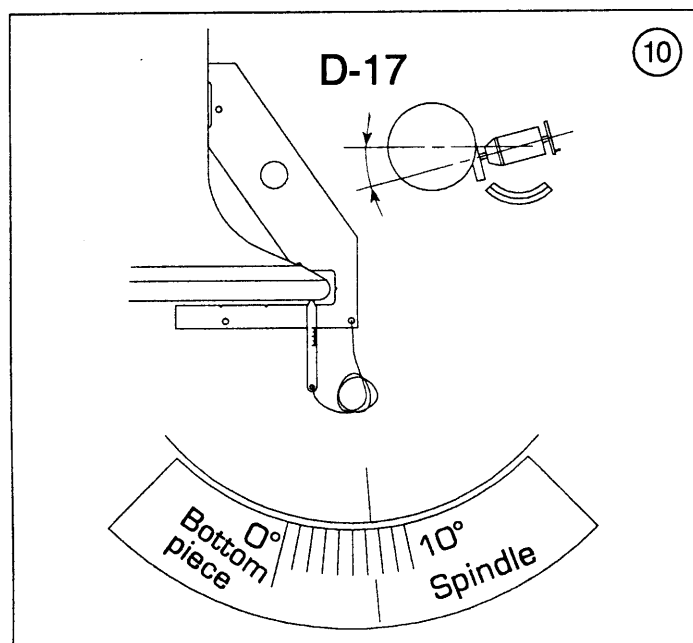
9. Check the spindle stem for wear in the area between 330 mm and 475 mm measured from the top of the spindle.

If the stem diameter is less than stated in Data or the hard facing layer is worn away, contact MAN B&W for further information.

10. Clean the valve spindle and inspect the valve cone and seating surface by means of the template, *see Data*.

Place the spindle in the grinding apparatus and tighten it whereby it will automatically be centered.

Check the alignment by means of a dial gauge.



Note !

Regarding the vertical setting of the grinding head, and the offset angle on the horizontal scale, *see Data*.

Using this offset angle results in sufficient inner contact.

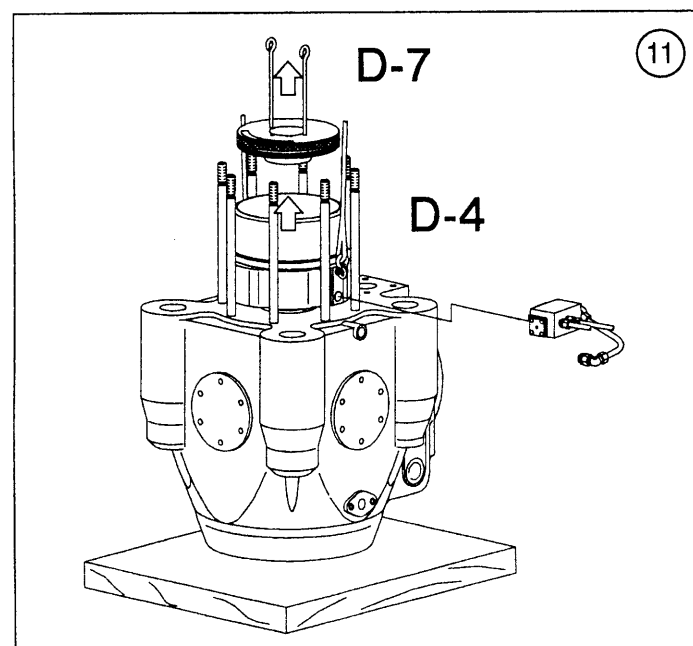
Regarding the use of the grinding apparatus, see separate instructions.

After grinding, inspect the valve spindle seating again with the template, *see Data*.

11. Dismount the air piston from the air cylinder, and check the teflon guide ring and teflon sealing ring for wear.

Dismount the sealing air controlbox from the air cylinder/valve housing.

Mount two eye screws in the air cylinder and dismount the air cylinder.



12. If it is necessary to change the teflon rings, cut them and remove them.

Be careful not to damage the edge of the ring grooves in the piston !

Mount the new O-ring in the groove of the air piston.

Caution !

Before mounting, the new teflon rings must be heated in 100°C hot water for at least five minutes.

When mounting the teflon rings, **be careful** not to damage the running surfaces.

After mounting the teflon rings, compress these by means of the conical ring. This is done by pressing the air piston through the conical ring.

13. Clean the air cylinder and check the running surface for wear or possible scores.

Remove the four screws in the bottom of the air cylinder.

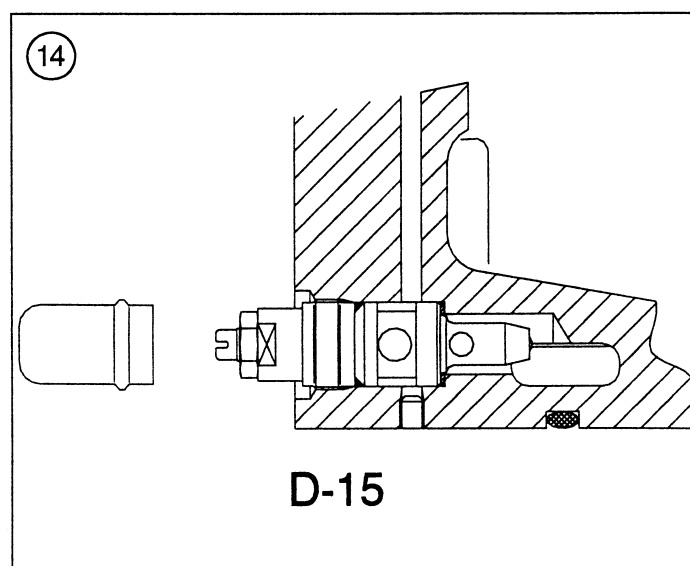
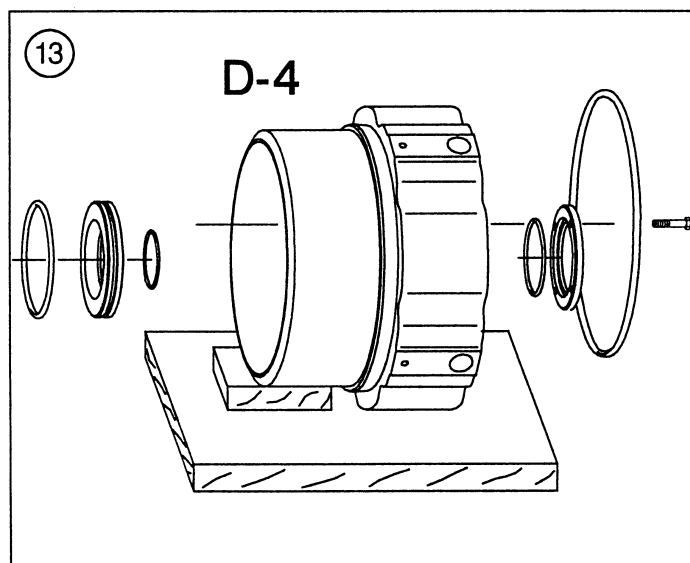
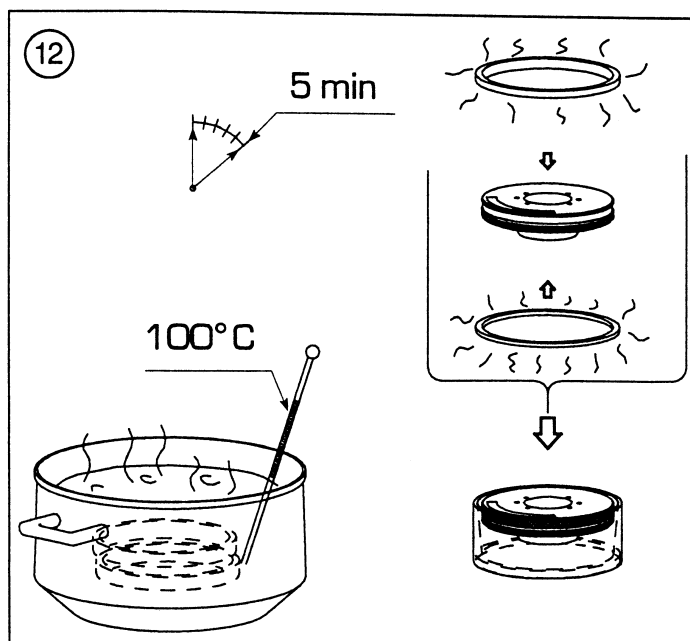
Dismount and check the flanges and the sealing rings of the sealing air arrangement.

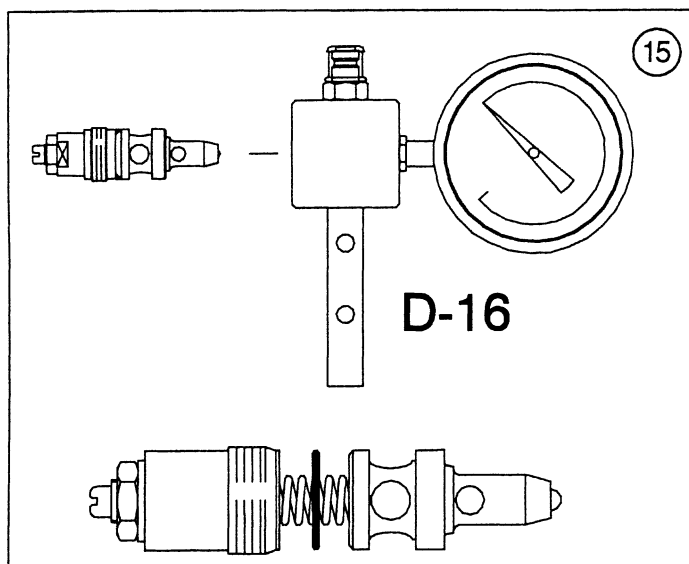
Fit new sealing rings when mounting the flanges in the bottom of the air cylinder.

Tighten the four screws.

Change the sealing ring in the groove from the very bottom of the air cylinder.

14. Remove the protective cap from the safety valve and dismount the valve from the air cylinder and change the gasket and sealing ring.





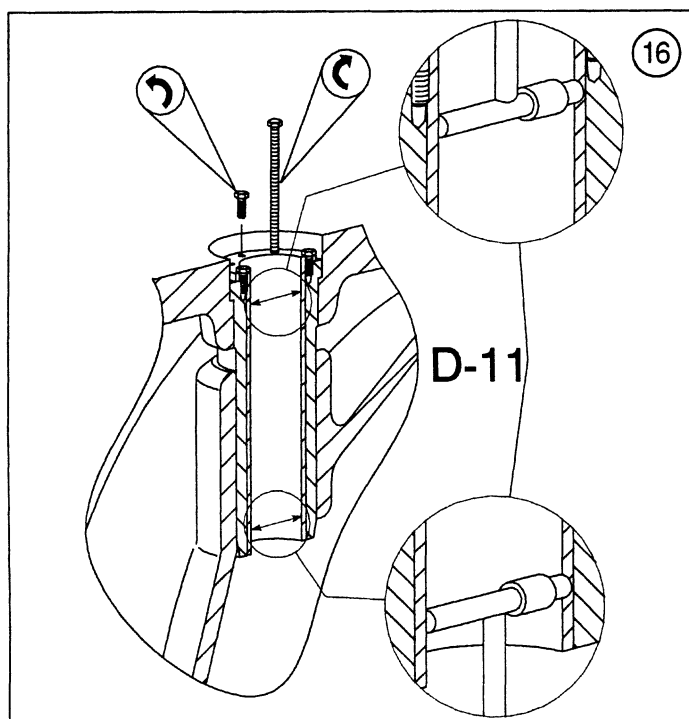
15. Place the valve in the pressure testing device.

Connect the testing device with the high-pressure pump by means of a hose.

Check the opening pressure, *see Data*.

If the opening pressure is not correct, loosen the lock nut and, by means of a screwdriver, adjust the safety valve until the correct pressure is indicated.

Tighten the lock nut and test the opening pressure once more.



When mounting the safety valve in the air cylinder, use only the machined faces on the valve housing and tighten, *see Data*.

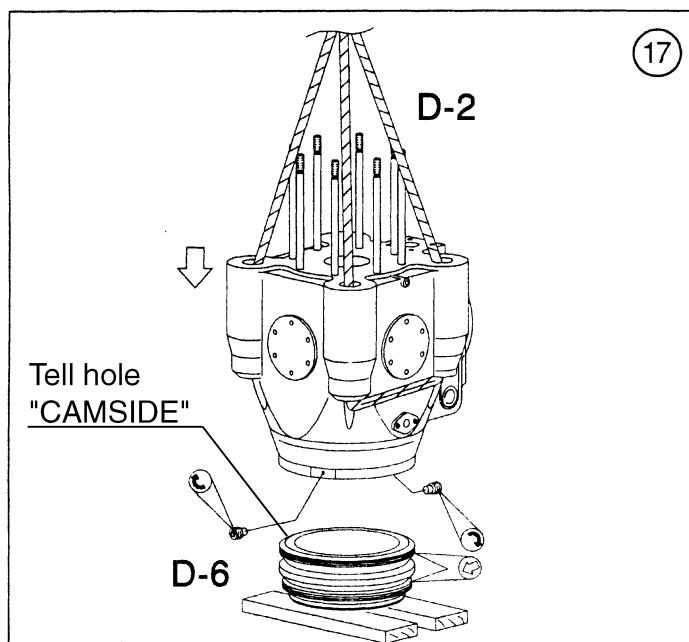
Finally, mount the protective cap.

16. Inspect the bushing in the spindle guide for wear. *See Data*.

If it proves necessary to replace the bushing, pull it clear by means of four dismantling screws.

17. Mount the bottom piece (with new O-rings) on the valve housing and secure with the screws.

Mount the valve spindle in the valve housing.



Caution!

Tell hole provided on bottom piece must be located in camshaft side



18. After overhauling and remounting the valve spindle and valve seat in/on the valve housing, guide the air cylinder with the sealing air arrangement down over the valve spindle.

Caution !

Take great care when the internal rings (well-coated with ordinary lube oil) pass the groove for the conical locking ring.

19. Fit the conical guide ring for the air piston on the air cylinder.

Lower the air piston over the valve spindle down into the air cylinder.

Caution !

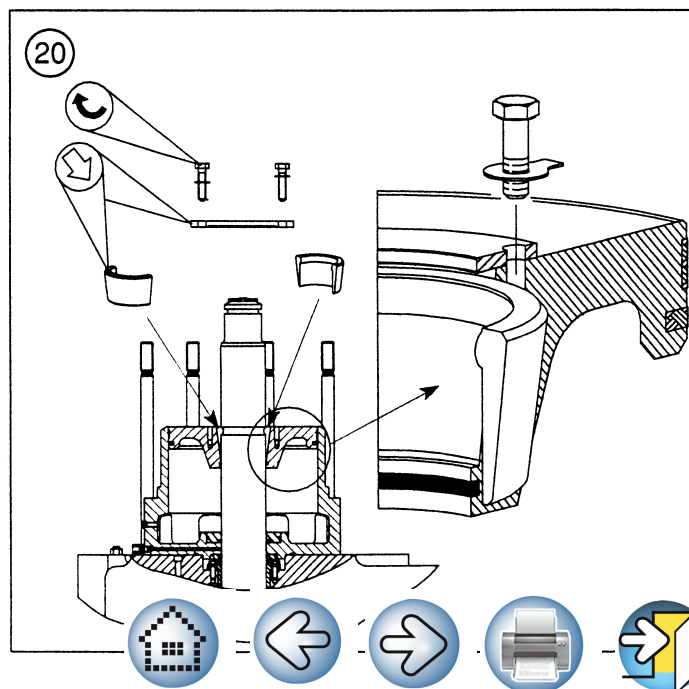
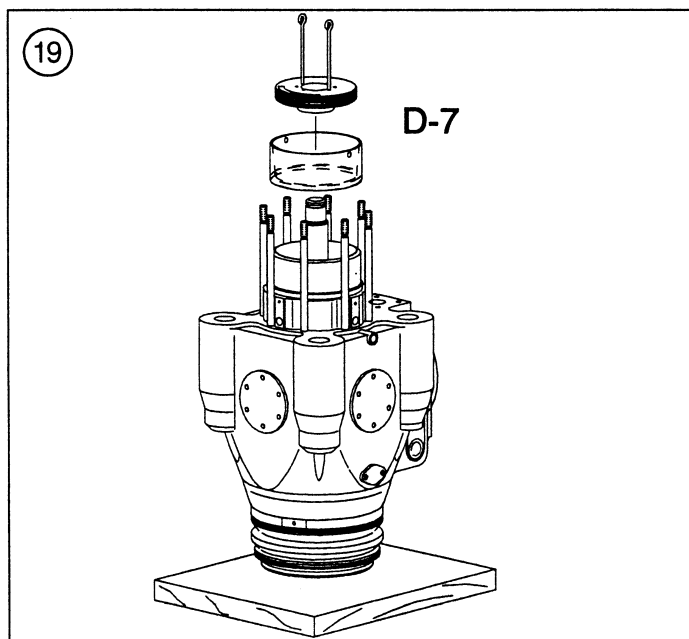
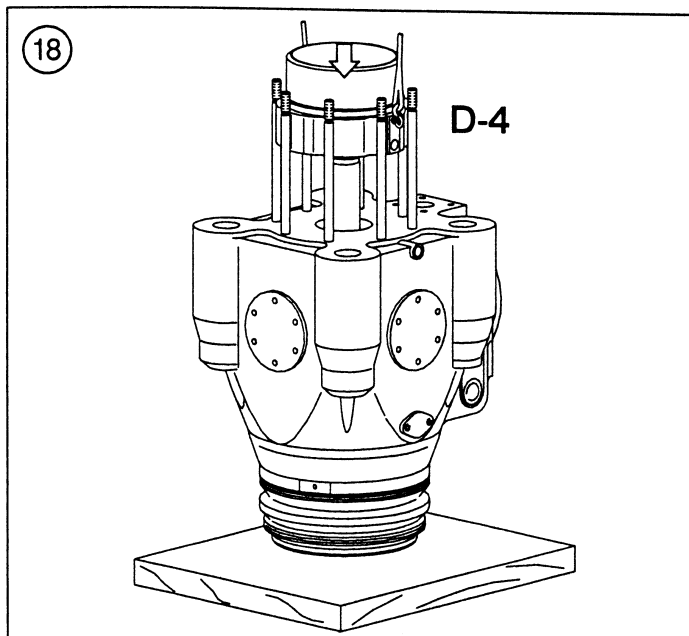
Take great care when the internal sealing ring in the air piston passes the groove for the conical locking ring.

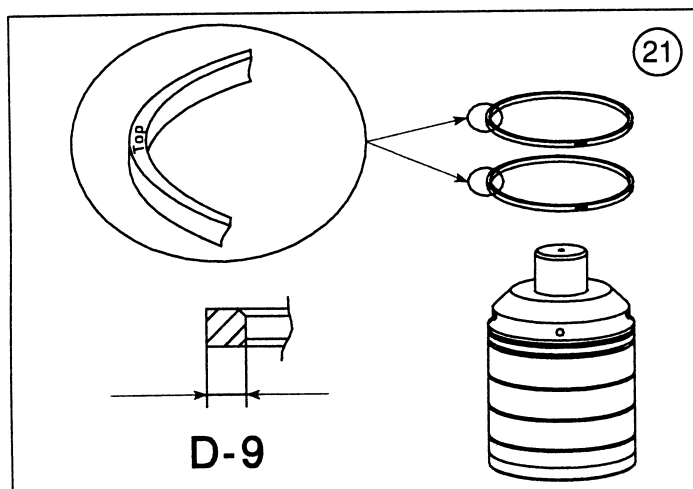
Remove the conical guide ring from the air cylinder, and the eye screws from the air cylinder.

20. Mount the conical locking ring and lift the air piston up around the locking ring.

Mount the flange on top of the air piston and, by means of the four screws, tighten the air piston and the flange together.

Remove the eye screws from the air piston.





21. Take off the piston rings from the oil piston and check the rings for wear.

If the thickness of the rings has reached the minimum, *see Data*, discard the rings and mount new ones.

Check that the **TOP** mark on the piston rings faces upwards, when mounting.

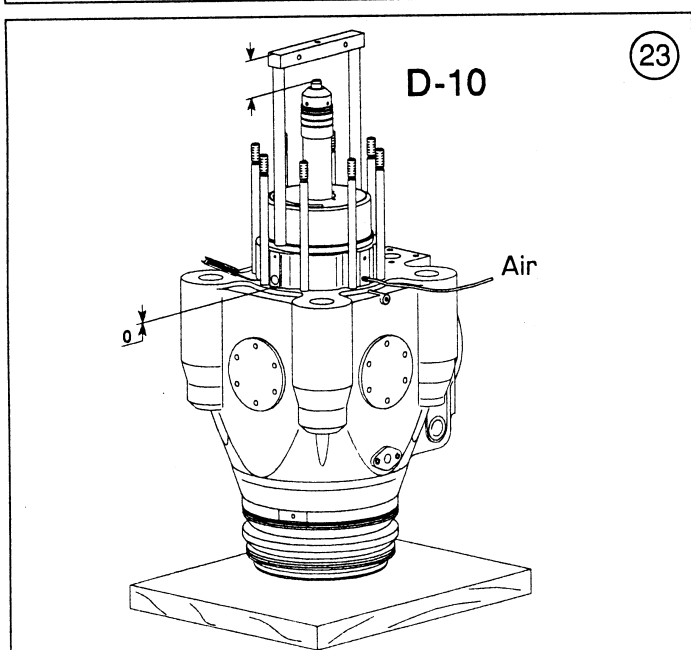
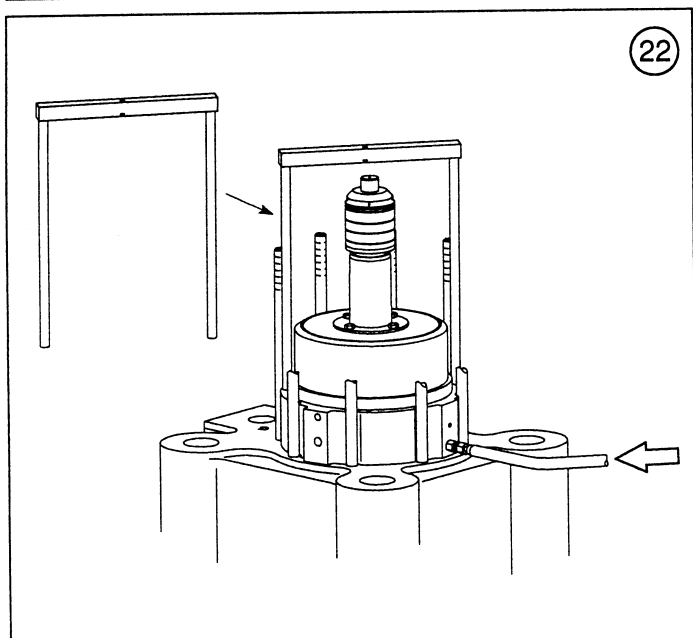
22. Mount the piston on top of the spindle and check the functioning of the damper piston.

Connect the air pressure to the space below the air piston, to keep the valve closed, and to keep the air cylinder in close contact with the valve housing.

Place the measuring tool on the air cylinder, across the piston.

23. Checking the mesh of the damper piston is done by checking the distance from the upper edge of the crossbar to the top of the damper piston. *See Data*.

If the measurement lies outside the values in *Data*, adjustment must take place by changing the disc in the damper piston.



24. Place the piston in the special tool.

Press out the disc with the center screw.

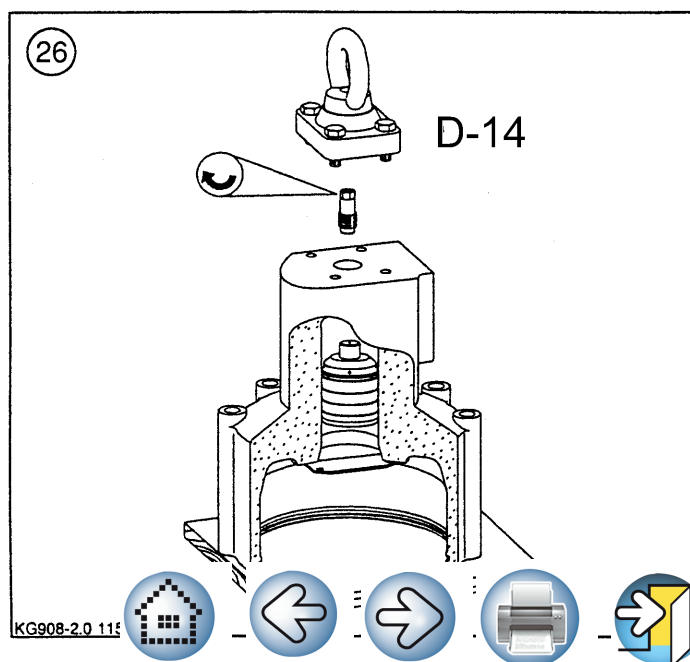
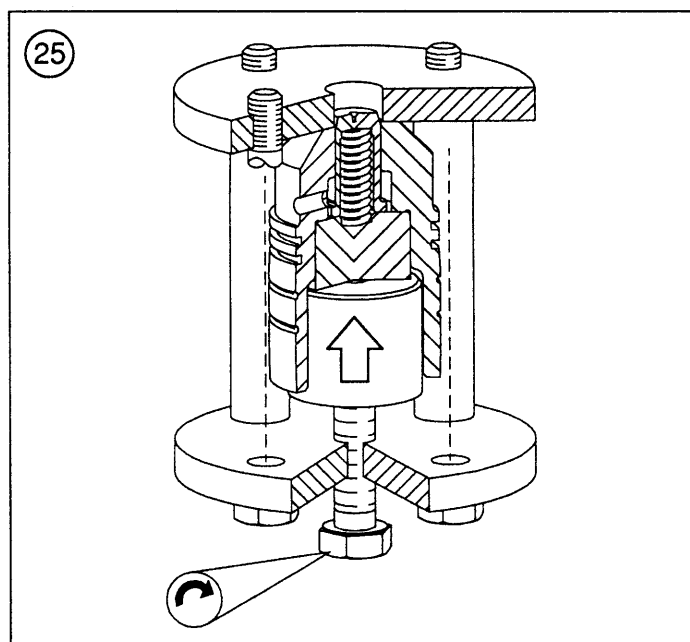
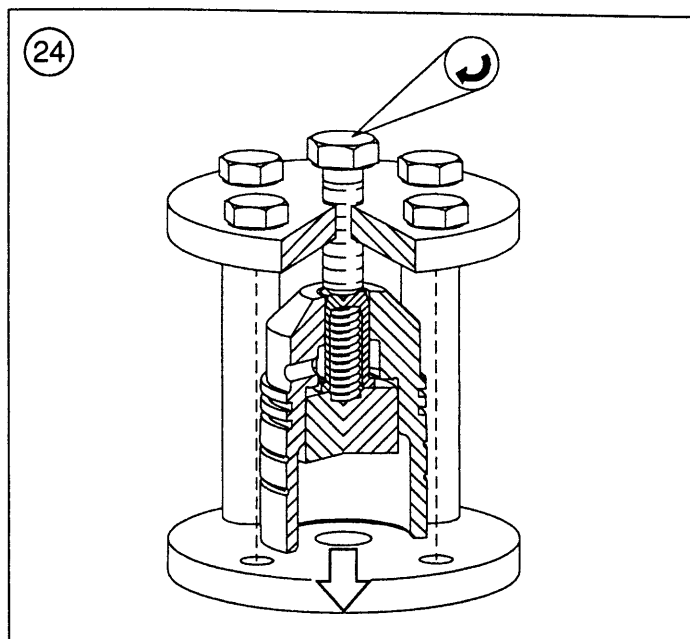
If necessary, change also the spring and the piston.

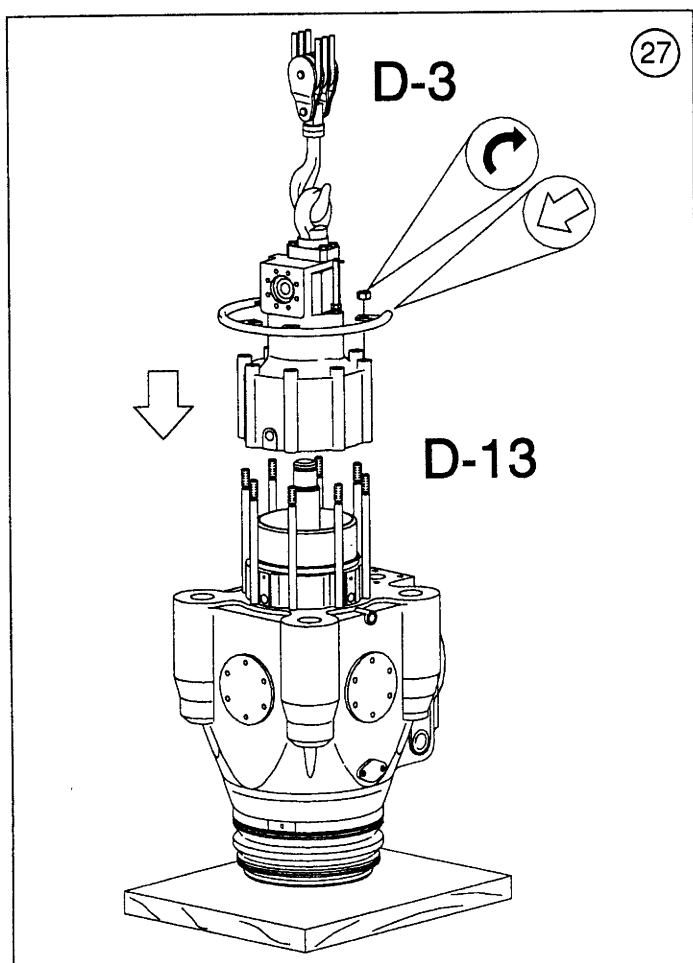
25. Assemble the damper piston with the new disc in the special tool.

Place the piston upside down in the tool and press the disc into place in the piston.

Check the mesh once more, repeating points 22 and 23.

26. After carefully cleaning and checking all the parts visually, assemble the parts and mount the piston, orifice and lifting bolt in the oil cylinder. *See Data.*





27. Mount a new sealing ring in the inner groove of the oil cylinder.

Mount the overhauled oil cylinder on top of the air cylinder.

Mount the safety strap and tighten the nuts. *See Data.*

28. Check the functioning of the sealing air control unit:

Step 1:

Pressurise the STOP line with working air.

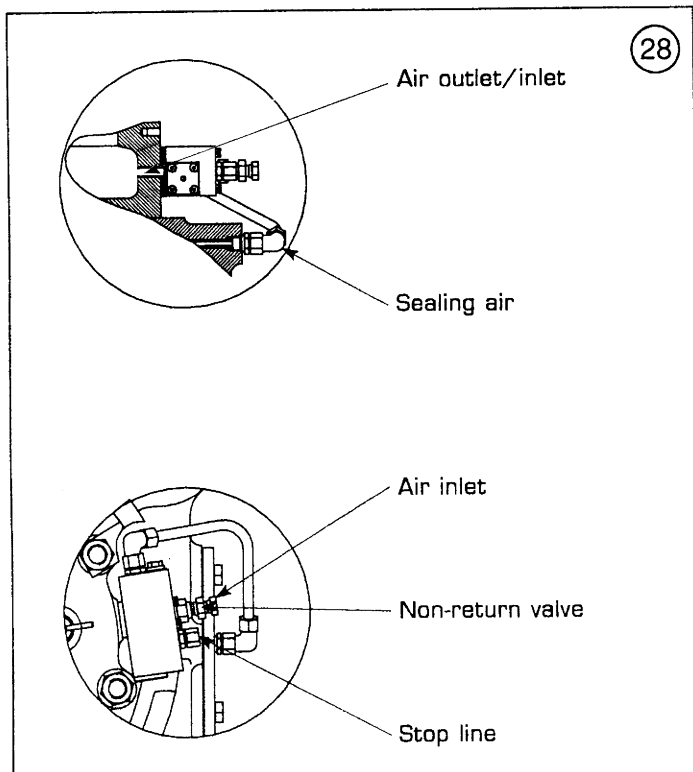
Check that the slide valve spindle protrudes through the cover of the control unit.

Afterwards:

Step 2:

Vent the STOP line.

Check that the action of the spring causes the slide valve spindle to move inwards.



29. If the slide valve does not work correctly, dismantle and check the sealing air control unit.

Remove the plug screw from the oil filter in the air cylinder.

Remove and check the oil filter. After checking, mount the filter and plug screw.

Loosen and remove the screws and cover the sealing air valve spindle in the air cylinder.

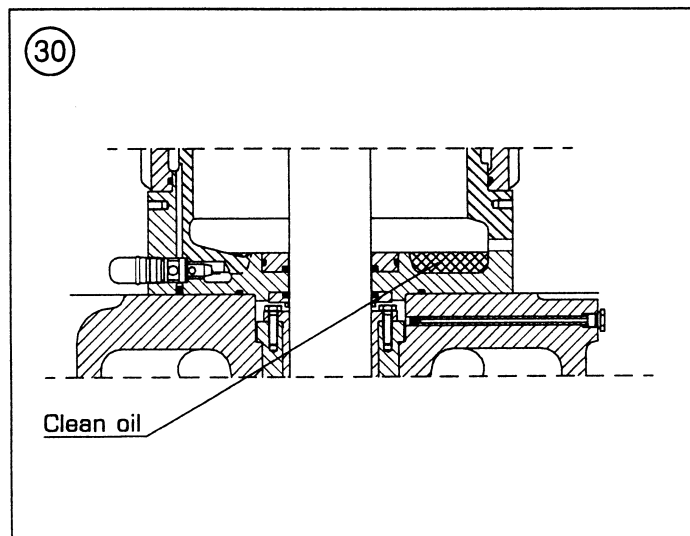
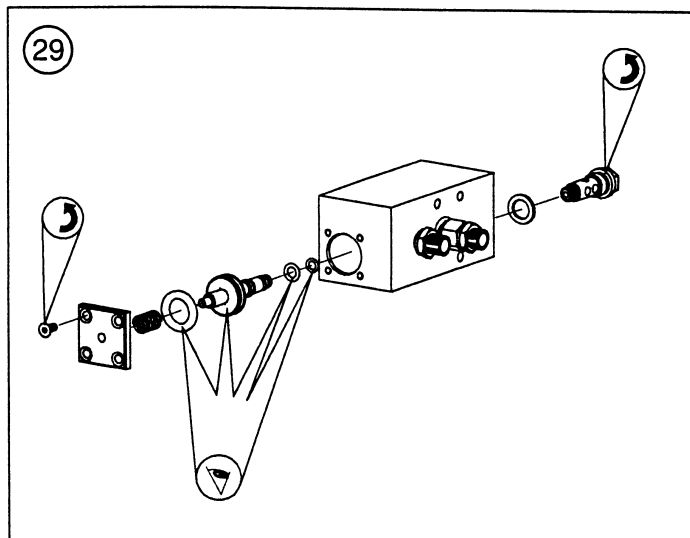
Remove the valve spindle and check the sealing rings and the spring. If necessary, replace them.

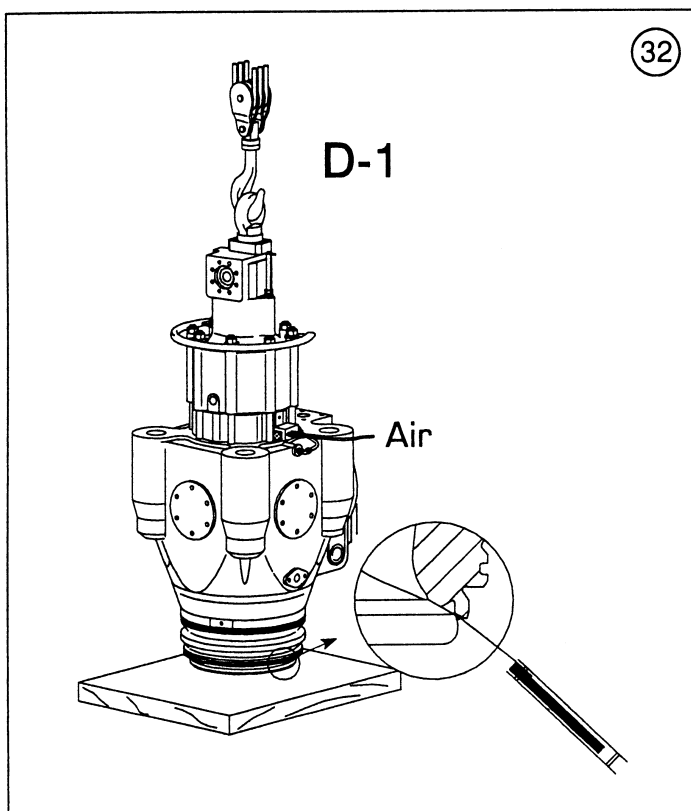
After checking, mount the valve spindle and spring, and tighten the cover.

30. Before mounting the control unit:

- Blow the orifice and pipe through with compressed air, to remove any obstructions.
- Blow the other pipes and fittings through with compressed air.
- Fill the sealing air chamber and the lower part of the air cylinder with clean oil.
- Check the non-return valve.

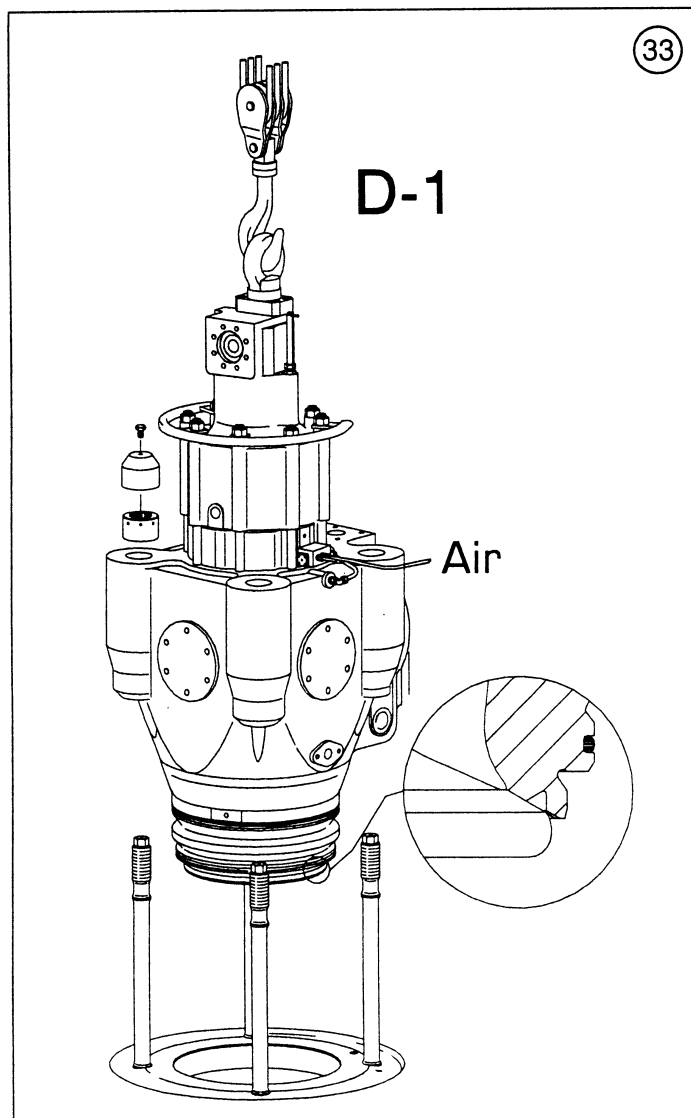
31. Mount the sealing air control unit on the air cylinder.





32. After assembling the valve, it is recommended to test the valve in the following way:

- Lift up the valve with the engine room crane (which makes the valve open).
- Connect compressed air to the pneumatic piston. The valve should now close.
- Check that a 1.0 mm feeler gauge can be pressed about 15 mm into the gap G_3 , to ensure a clearance between the outer parts of the seating faces of valve housing and spindle.
- By disconnecting the compressed air supply and releasing the vent plug screw placed just above the ball cock on the air cylinder, the exhaust valve should open.
- After doing this a couple of times, leave the valve closed and shut-off the compressed air. The valve should remain closed for at least one hour.



33. Before mounting the exhaust valve on the cylinder cover lubricate the new O-rings on the bottom piece with ordinary lube oil.

Connect compressed air to the pneumatic piston to keep the exhaust valve closed during the mounting.

Tighten the valve in the cylinder cover.
See Procedure 901-2.3.

Disconnect the compressed air and connect the normal air supply to the sealing air control unit.

Warning !

The air supply to the valve shall always be connected **before** starting the camshaft oil pumps.

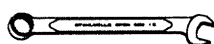
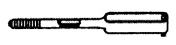
This is **very** important, because otherwise the valve will open more than normal.



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

-  13, 24 mm
-  6, 8 mm
-  55 mm
-  2 × M16
-  40-200 Nm
140-760 Nm
-  41/46 mm

DATA:

- D-1 Weight of high-pressure pipe 57 kg
- D-2 Weight of hydraulic actuator 155 kg
- D-3 Oil cylinder,
inside diameter max. 100.2 mm
- D-4 Piston rings, min. thickness 3.8 mm
- D-5 Hydraulic actuator,
tightening torque..... 900 Nm
or tightening angle..... 27°
- D-6 Max. drain oil quantity
from exhaust valve..... 40 l/h
- D-7 Locking plate,
tightening torque..... 26 Nm
- D-8 High-pressure pipe,
tightening torque..... 80 Nm



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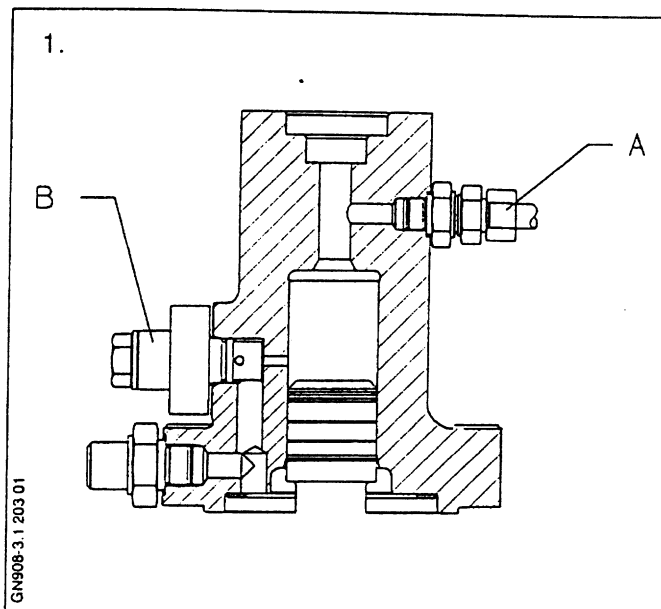


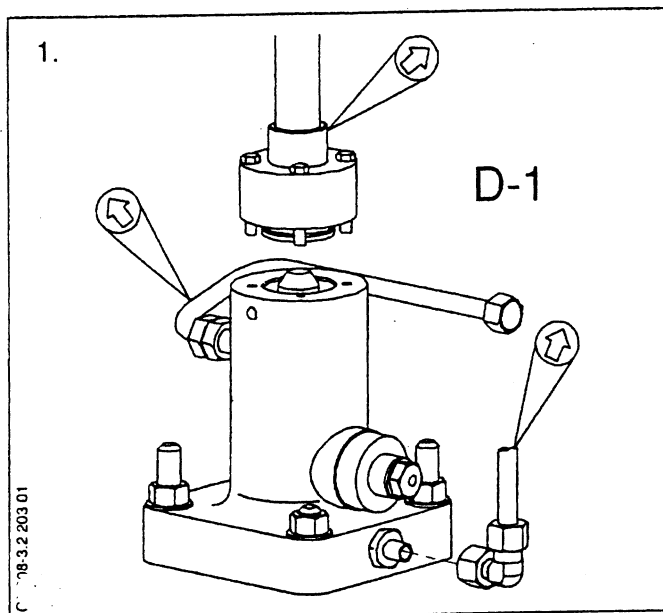
1. The non-return valve **A** is built into the oil inlet pipe to the actuator.

To check the valve, disconnect and clean it and connect a supply of working air (7 bar) to the outlet side of the valve (the side facing the actuator). If an air flow is felt at the inlet side of the valve, it must be overhauled.

During the starting sequence in ASTERN direction, the exhaust valve will start to open while the cylinder is still being supplied with starting air.

The puncture valve **B** will delay opening of the exhaust valve until the starting air sequence has finished.





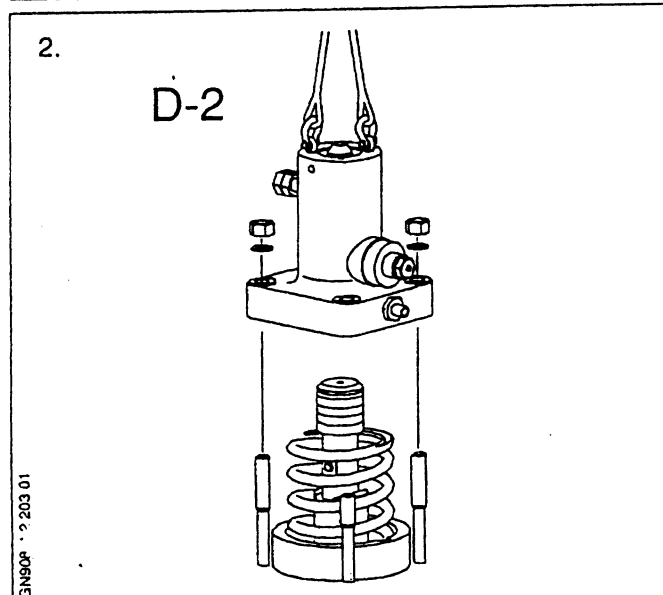
1. Stop the engine and shut off the oil supply.

Turn the camshaft so that the roller rests on the circular part of the cam.

Remove the inspection cover of the camshaft housing to inspect the position of the exhaust cam.

Dismount the inlet pipe and the drain pipe from the exhaust valve.

Dismount the screws of the high-pressure pipe flange, and lift away the high-pressure pipe. *See Data D-1.*
See Procedure 908-1.



2. Fit eye screws in the lifting holes of the actuator housing and hook on a tackle.

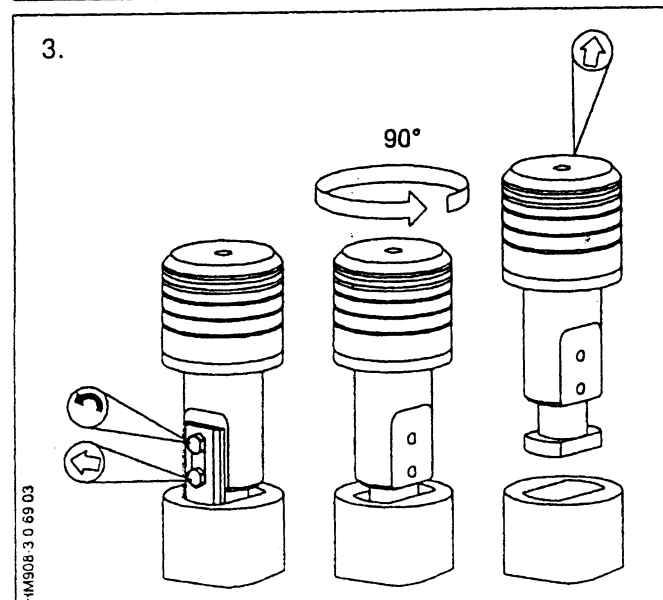
Unscrew the nuts on the two short studs, then loosen the nuts on the long studs successively until the tension of the roller guide spring is relieved.

Dismount the nuts and lift the housing carefully up, leaving the piston on the top of the roller guide.

Remove the spring.

3. Remove the locking plate for the piston. Turn the piston 90° to free it from the bayonet joint.

Remove the piston from the roller guide.



1. Clean the piston in kerosene and blow dry with compressed air.

Take off the piston rings and check them for wear. If the ring thickness has worn down to the minimum (*see Data D-4*), discard the rings and mount new ones.

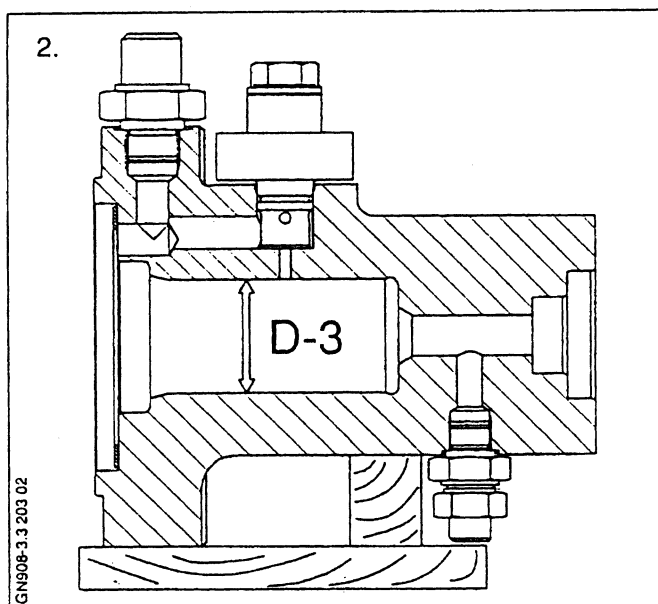
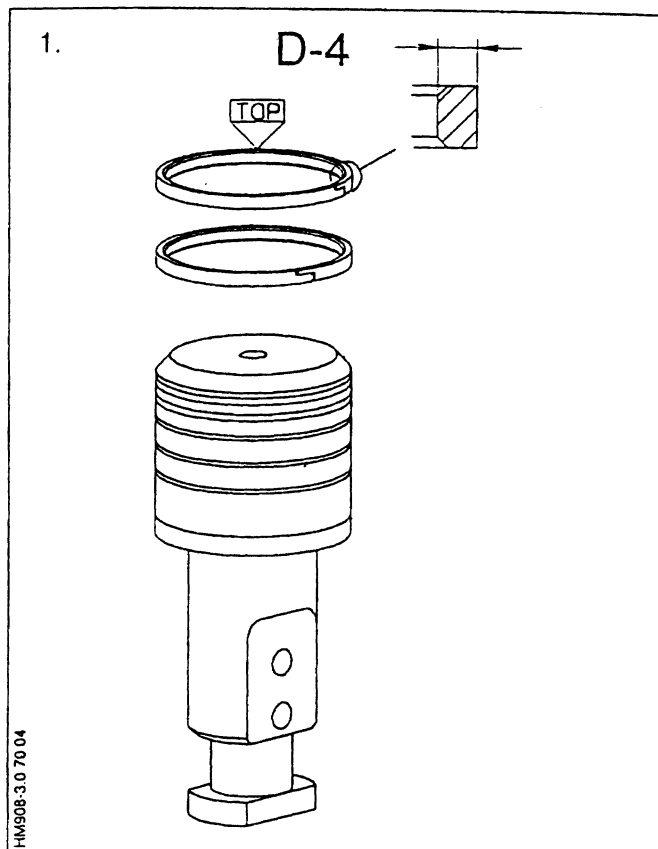
Check that the TOP mark on the piston rings faces upwards when mounting.

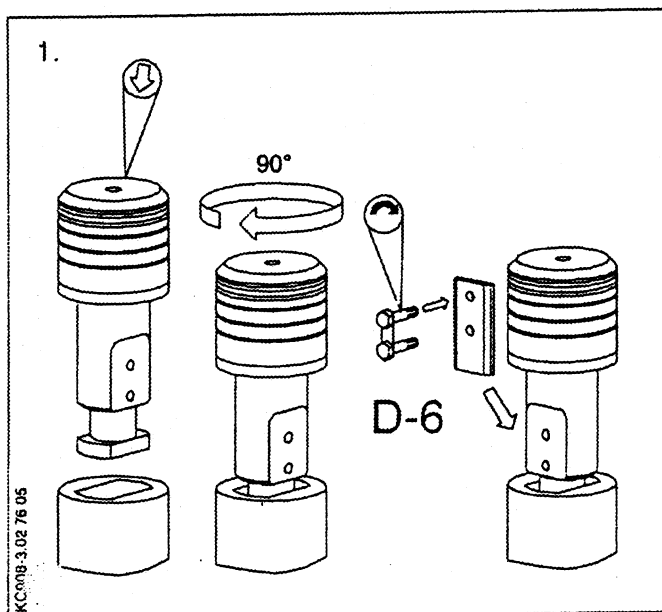
Inspect the sliding surfaces of the piston for scratching or seizure marks.

2. Clean the oil cylinder and inspect the bores for deposits.

Check the bore of the oil cylinder for possible scores and measure it for wear.

If the bore is seized or has worn down to the measurement stated in *Data D-3*, send the oil cylinder to an MAN B&W authorised workshop for reconditioning.





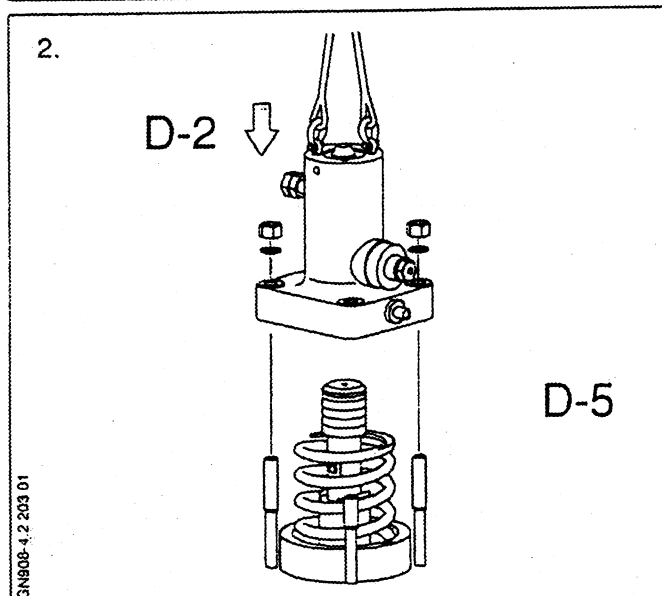
1. Mount the actuator piston in the roller guide and turn 90° to lock it in the bayonet joint.

Mount the locking plate and tighten as stated in Data D-6. Lubricate the piston with plenty of camshaft lubricating oil.

2. Mount the spring on the roller guide. Carefully lower the actuator housing on to the piston, taking care not to damage the piston rings.

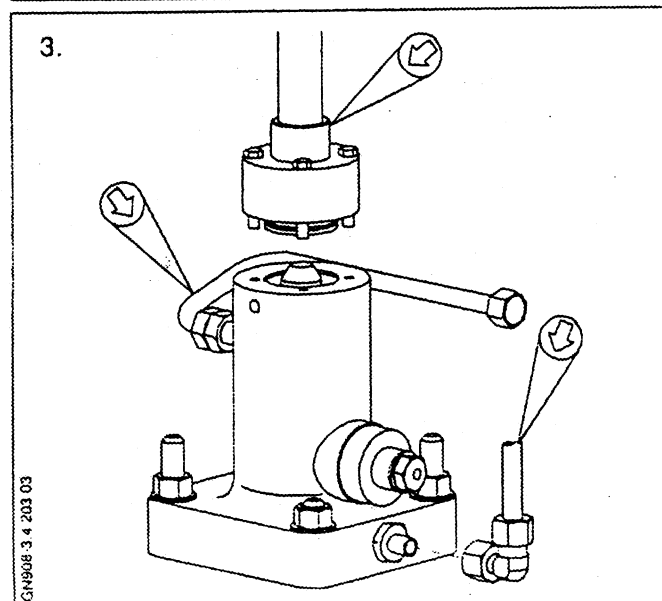
Mount the washers and the nuts on the two long studs and tighten alternately until the actuator housing rests firmly against the roller guide housing.

Mount the washers and nuts on the two short studs. Tighten all four nuts as stated in Data D-5.



3. Mount the oil inlet pipe and the drain pipe from the exhaust valve.

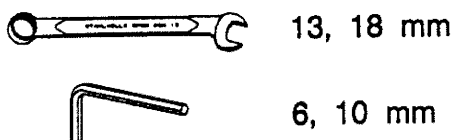
Mount the hydraulic high pressure pipe. See Procedure 908-1.



SAFETY PRECAUTIONS

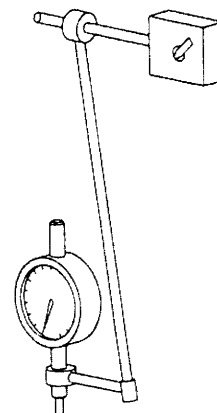
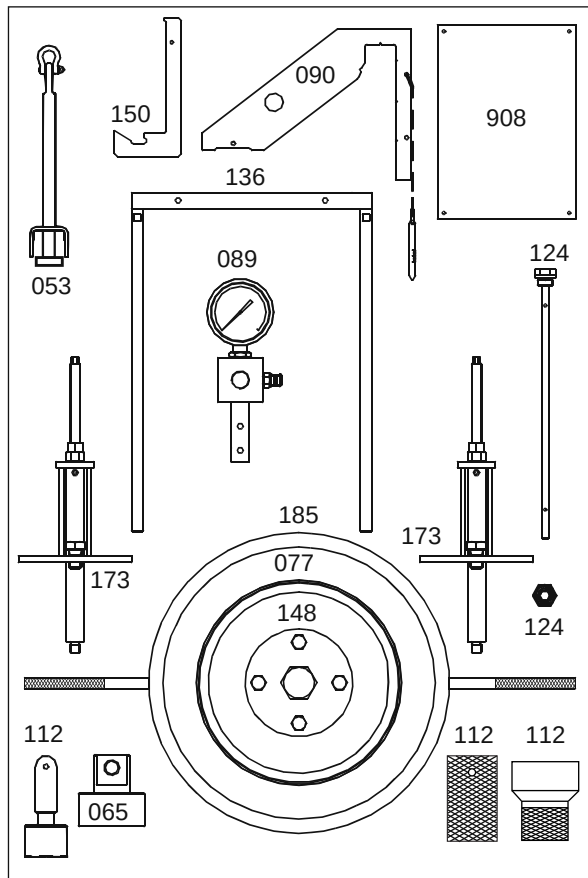
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

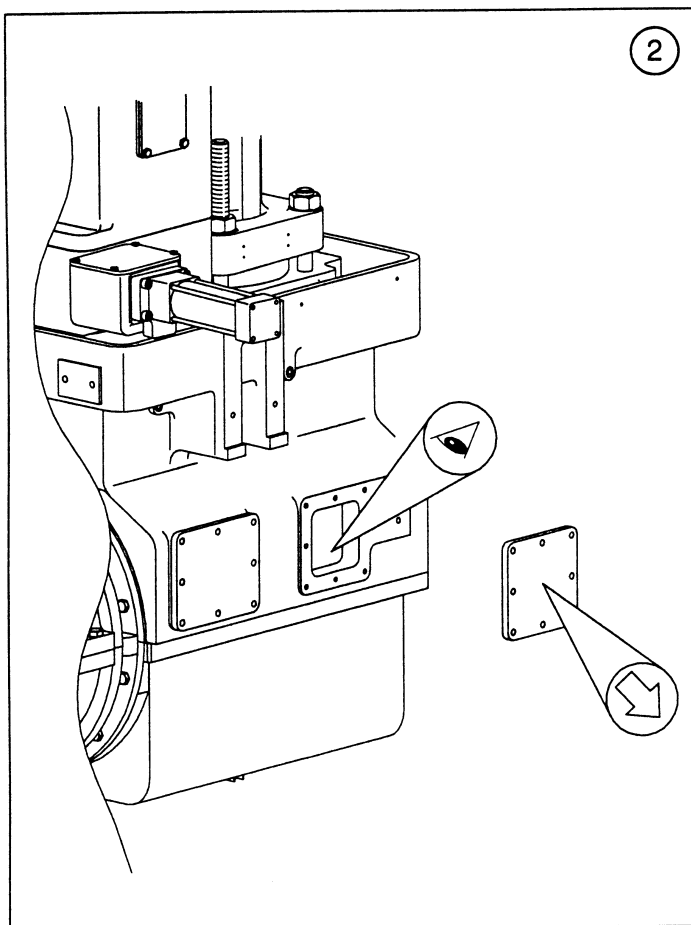
913



DATA:

- | | | |
|-----|---|--------|
| D-1 | Weight of roller guide, complete..... | 72 kg |
| D-2 | Weight of roller..... | 15 kg |
| D-3 | Max. clearance roller/bushing/shaft pin | 0.5 mm |
| D-4 | Discard spacer rings when wedge-shaped oil grooves are worn away. | |





Inspection

The exhaust valve roller guide can be partially checked while mounted on the engine, using the following procedure:

1. Lift the roller guide.
See Procedure 908-5.
2. Remove the cover on the roller guide housing.

Turn the engine to provide the maximum space between the roller guide and the cam disc.

Check the movability of the roller by turning this by hand to ascertain if the roller moves freely and without unnecessary resistance or "hard" points.

Also inspect the surface of the roller for possible damage marks, seizures or scratches. Make sure that no traces of bearing metal exist in the roller guide housing.

Check the clearance in the slide bearing by lifting the roller relative to the roller guide and measuring the difference in distance between the cam disc and the roller in the upper and lower position of the roller.

A more suitable and reliable method is to check the roller guide and the bearing clearance when the roller guide is dismounted.



This procedure applies only to the exhaust valve roller guide.

For the fuel pump roller guide, see Procedure 909-8.

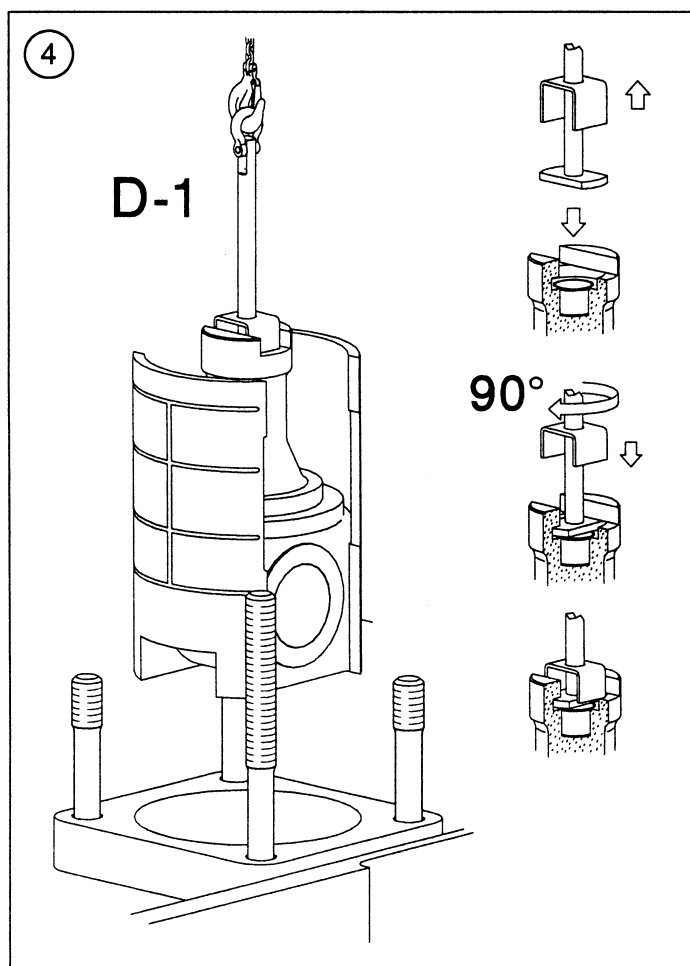
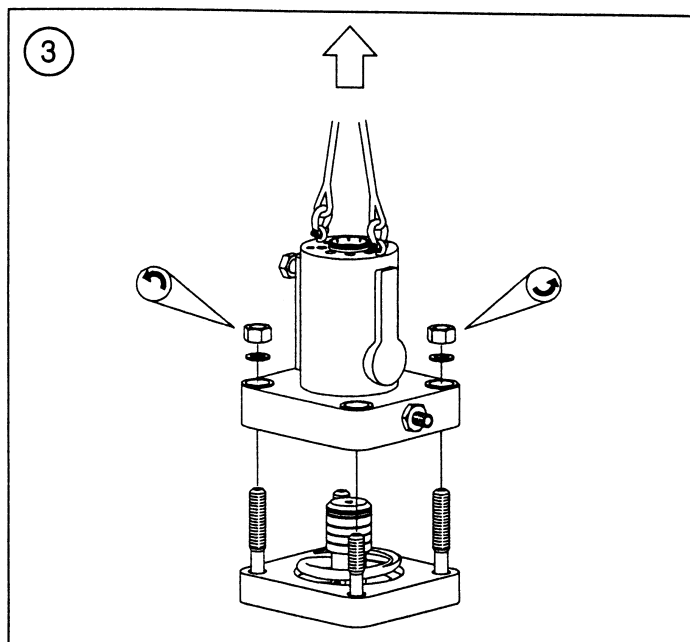
Dismantling

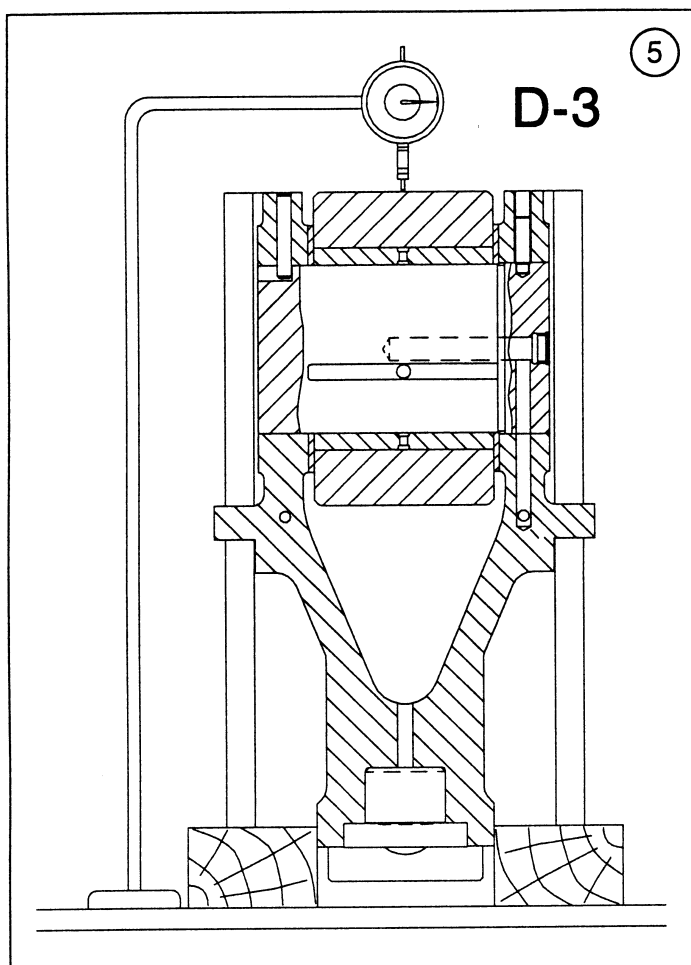
3. Dismantle the hydraulic actuator above the exhaust valve roller guide.
See Procedure 908-3.

4. Mount the lifting tool for the roller guide as follows:

- Lift the lock ring of the tool up on the shaft of the tool.
- Place the tool in such a manner that its foot rests on the thrust piece in the bayonet joint of the roller guide.
- Turn the tool **90°** so as to allow the foot to engage properly in the bayonet joint.
- Lower the lock ring, thereby securing the foot in the locked position.

Lift the roller guide out of the roller guide housing, using the crane. Take care not to damage the sliding surfaces of the roller guide when lifting.





5. Inspect the surfaces of the roller guide and the roller for damage marks, seizures or scratches.

Measure the clearance in the slide bearing of the roller guide by placing the roller guide vertically upside down on a couple of planks with the roller hanging freely.

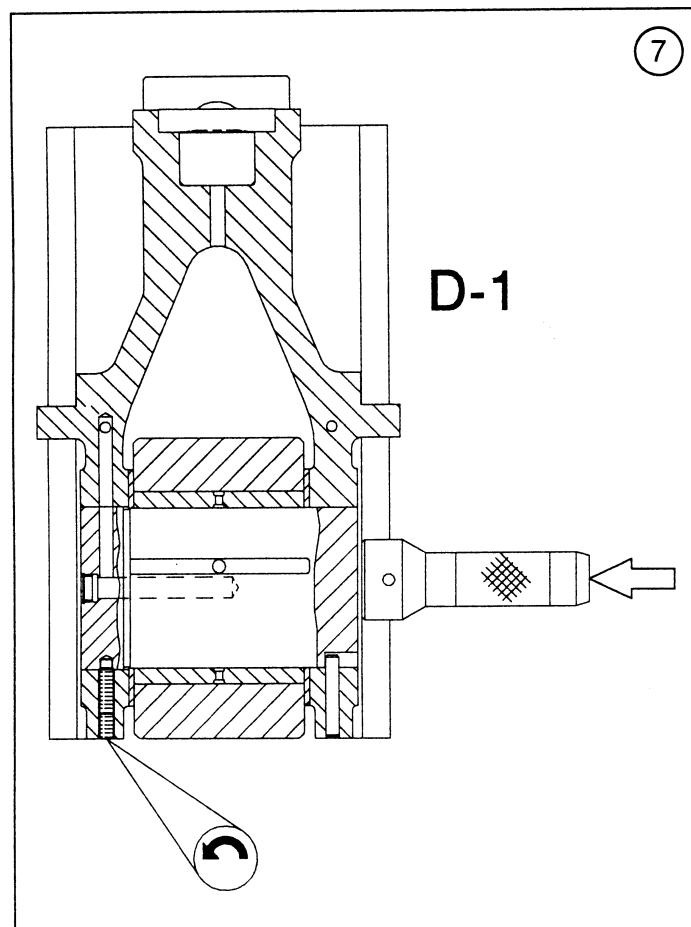
Place a dial gauge against the roller, then lift the roller as much as the clearance permits. This makes it possible to read the clearance directly.

6. It is recommended only to dismantle the roller guide if, during the checking, irregularities when turning the roller, damage on the roller, or larger clearance than indicated on the data sheet, have been observed.

Before dismantling, measure any ovalness of the roller guide. In such cases, continue the procedure as follows:

7. Dismount the lock screws for the shaft pin. By means of the driving-out mandrel, remove the shaft pin from the roller guide. This must be done with the roller guide in a horizontal position on the planks. Take care to use the mandrel on the right side of the roller guide.

Take out the roller with bearing bush and spacer rings from the roller guide. Clean the parts in diesel oil or kerosene.



8. Inspect the surfaces of the roller facing the spacer rings and the sliding surface of the shaft pin for marks and seizures.

Inspect the spacer rings and replace these if the wedge-shaped oil grooves have been worn away.

Replace the slide bearing bushing and any defective parts.

9. Blow the lubricating ducts and bores of the roller guide clean with compressed air.

Inspect the sliding surfaces of the roller guide for marks and seizures. Remedy any damage found.

Inspect the thrust piece of the roller guide for deformations (replace, if necessary).

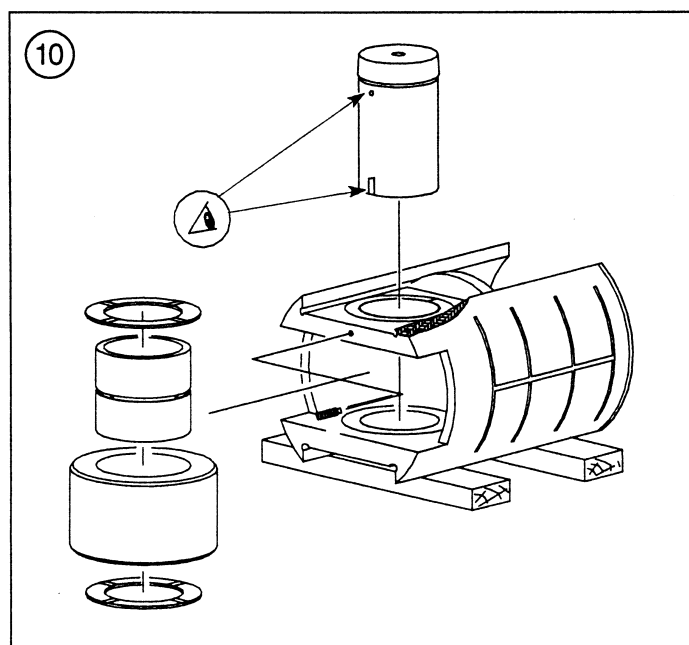
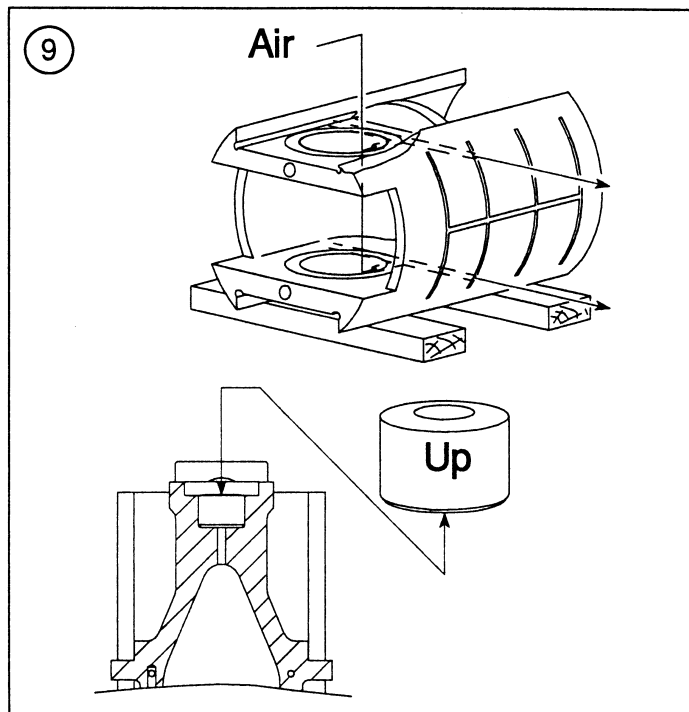
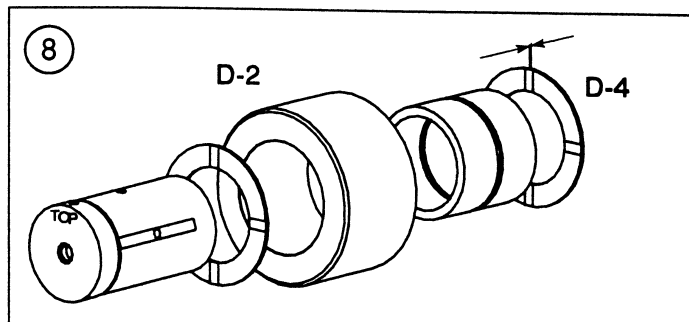
When mounting the thrust piece in the roller guide, check that the chamfered surface marked **Up** turns upwards. See the sketch.

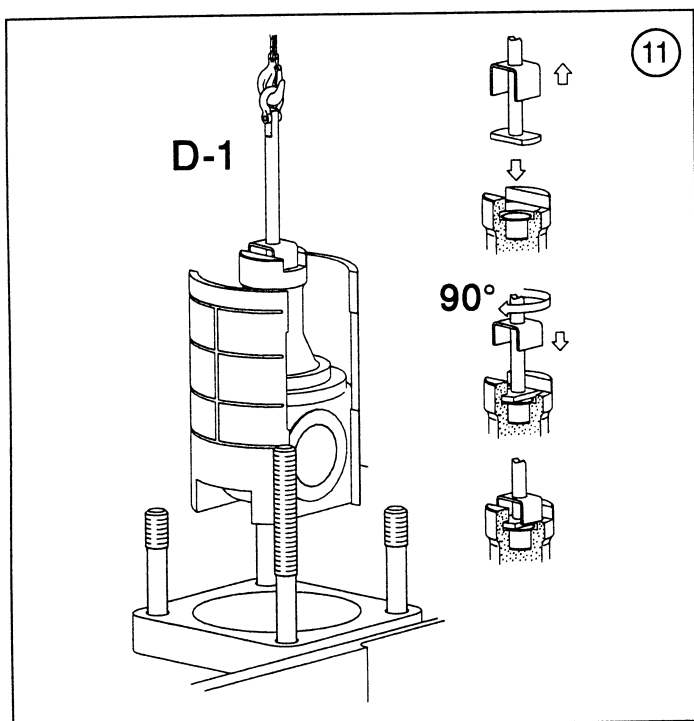
10. Turn over the roller guide. The side with the lock screw must face upwards, the side with the guide pin downwards.

Lubricate the roller, bearing bush, and spacer rings with camshaft lubricating oil and mount the parts in the roller guide so that all the bores coincide.

By means of the mandrel, press the shaft pin in place in the roller guide, taking care that the machined groove in the shaft pin coincides with the guide pin in the roller guide.

When the shaft pin is correctly positioned in the roller guide, mount the lock screw. Make sure that the lock screw enters the locking hole in the shaft pin. Now secure the lock screws with Loctite type: EN243S.





Mounting

11. Mount the lifting tool for the roller guide as follows:

- Lift the lock ring of the tool up on the shaft of the tool.
- Place the tool in such a manner that its foot rests on the thrust piece in the bayonet joint of the roller guide.
- Turn the tool **90°** so as to allow the foot to engage properly in the bayonet joint.
- Lower the lock ring, thereby securing the foot in the locked position.

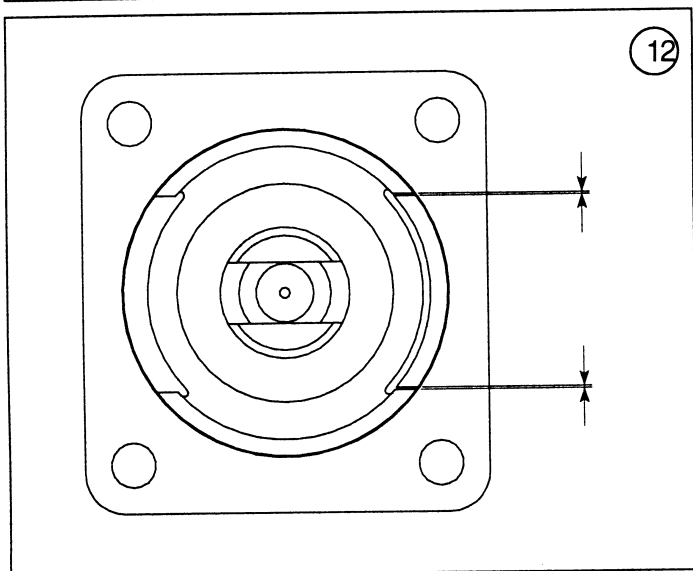
Lubricate the sliding surfaces of the roller and the roller guide and lower it carefully into the roller guide bushing.

Remove the lifting tool.

12. When mounting the roller guide, check the clearance between the roller guide and the guide plate mounted in the roller guide liner.

Turn the camshaft so that the roller guide is lifted approx. 20 mm. The clearance between the roller guide and the guide plate should be the same at both ends ± 0.1 mm.

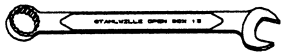
13. Mount the actuator.
See Procedure 908-3.



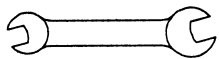
SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913



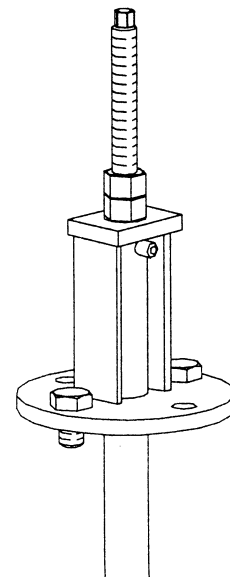
24 mm

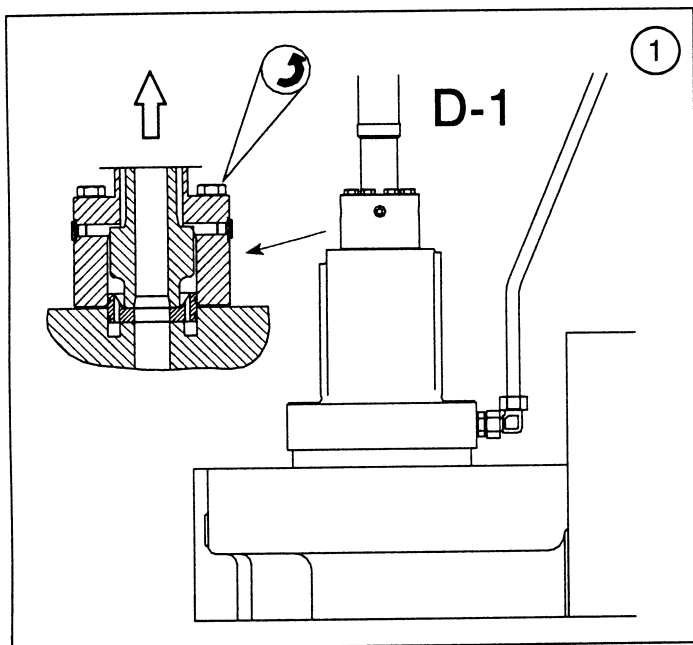


24/30 mm

DATA:

D-1 Weight of high-pressure pipe 57 kg





Warning:

Do **not** use the lifting tool for the roller guide of the exhaust valve actuator while the engine is running !

If an exhaust valve or valve actuator is to be brought out of action, disconnect it in the following manner:

1. Stop the engine.

Lift the fuel pump roller guide.
See Procedure 909-5.

Stop the camshaft oil pump.

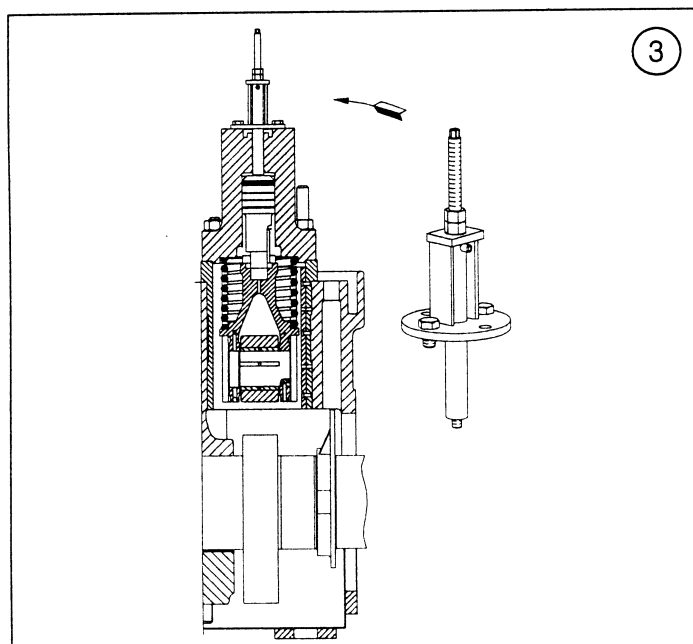
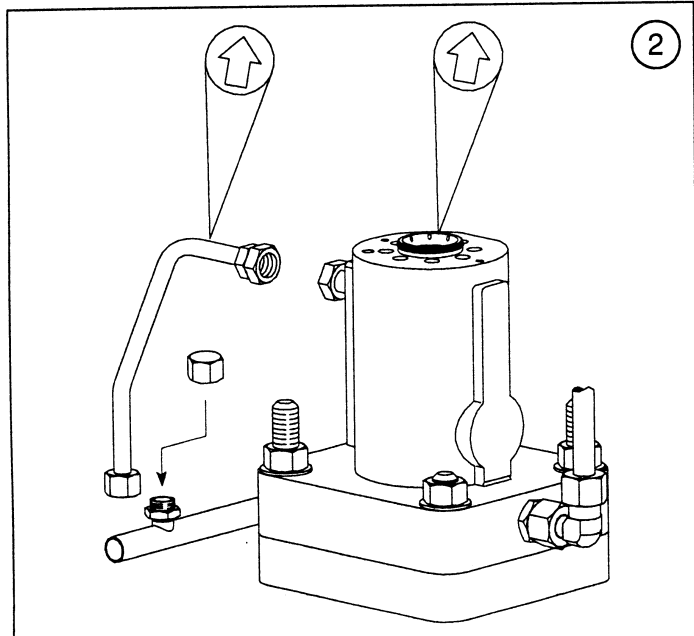
Drain off the oil in the high-pressure pipe by loosening the screws for the high-pressure and lift the pipe a little from the actuator to let the oil drain through the drain holes in the actuator.

2. Disconnect the oil inlet pipe, and blank off the pipe with the screw cap (taken from the tool used in 908-6). Remove the high-pressure pipe.
See Procedure 908-1.

3. Turn the exhaust cam for the pertaining cylinder to TDC.

Position the lifting tool on the actuator and screw the spindle into the top of the hydraulic piston. Using the lowermost nut, pull up the roller guide so far that the hydraulic piston is tight against the top of the cylinder.

Secure the roller guide in this position by tightening the upper nut of the tool against the lower nut.



4. If the engine shall operate with closed exhaust valve, the air supply shall be connected the air cylinder.

If operating with open exhaust valve, see Procedure 908-6.

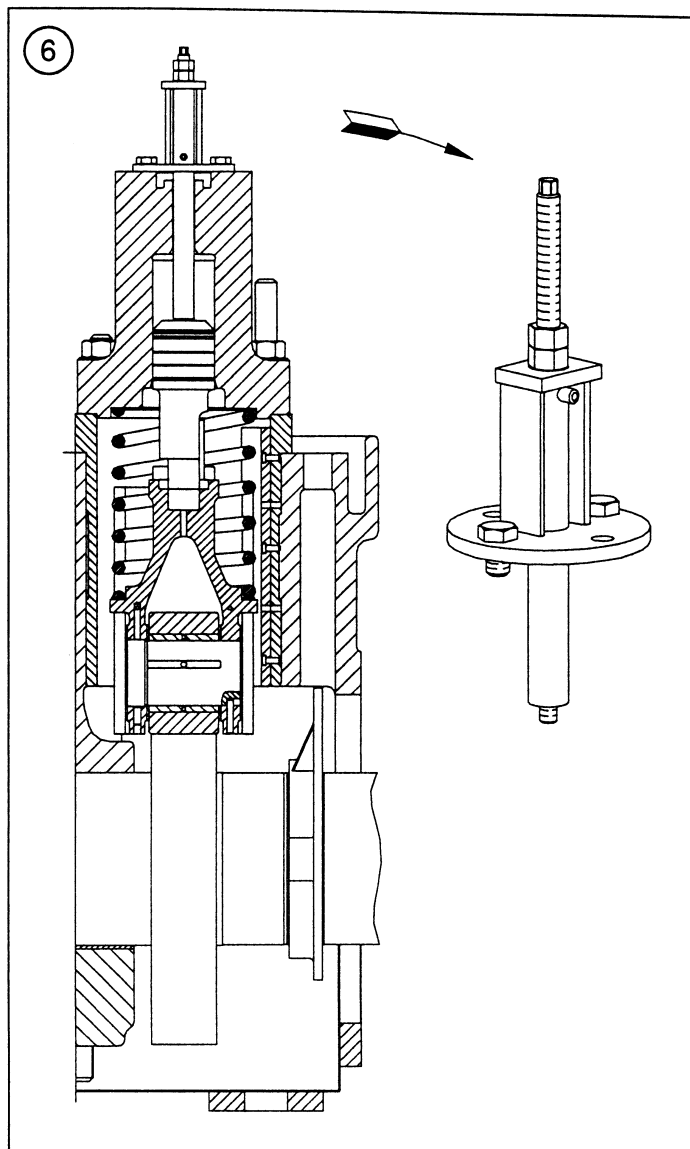
5. The engine can now be operated on the remaining cylinders.
See Volume I, Section 704.

When the engine is running with one exhaust valve out of action, the fuel pump of the pertaining cylinder must also be disengaged.

The engagement of the exhaust valve roller guide **must only** take place at engine standstill.

6. When the roller guide has been lowered into position, remove the lifting tool from the hydraulic cylinder.
7. Mount the high-pressure pipe.
Connect the oil inlet pipe.

For engaging of the fuel pump roller guide, see Procedure 909-5.



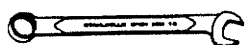
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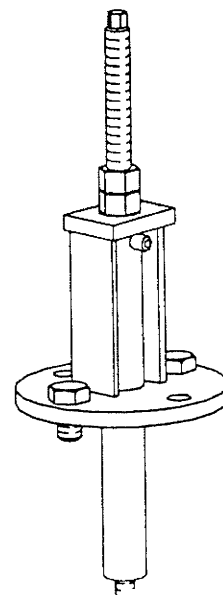
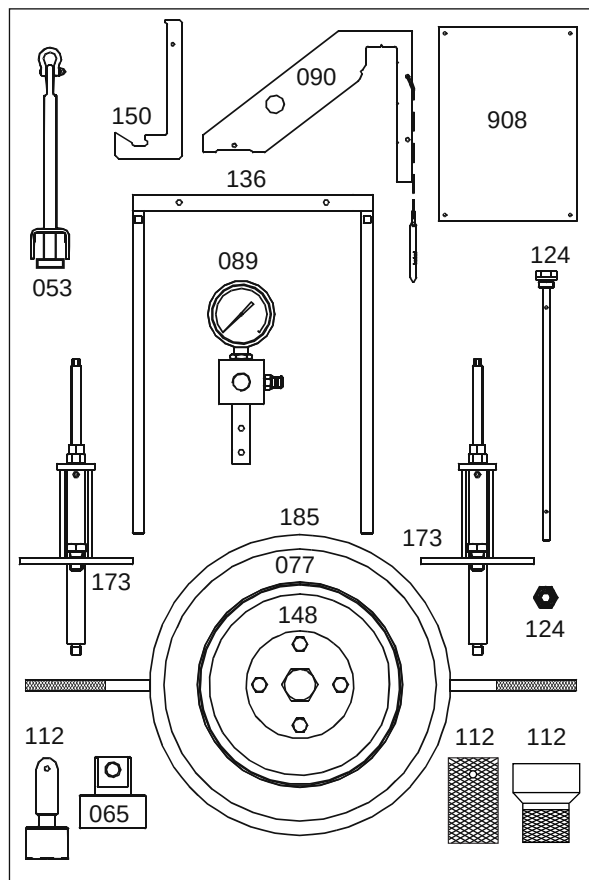
SAFETY PRECAUTIONS

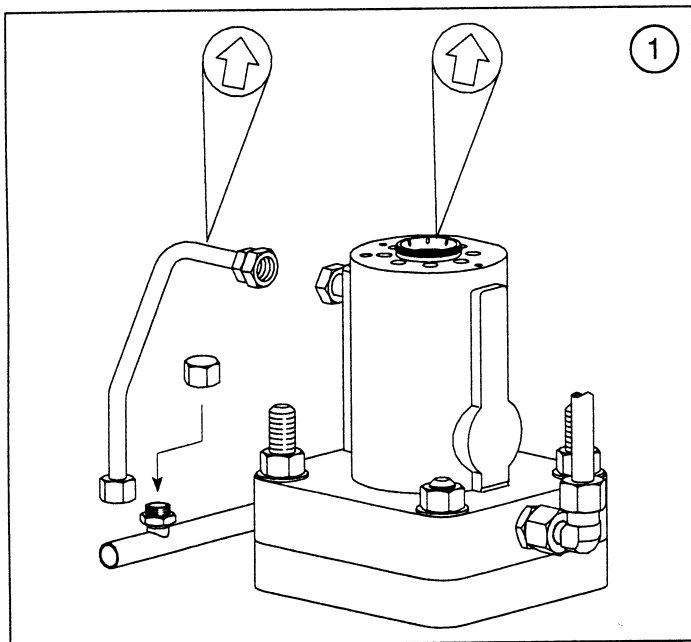
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913



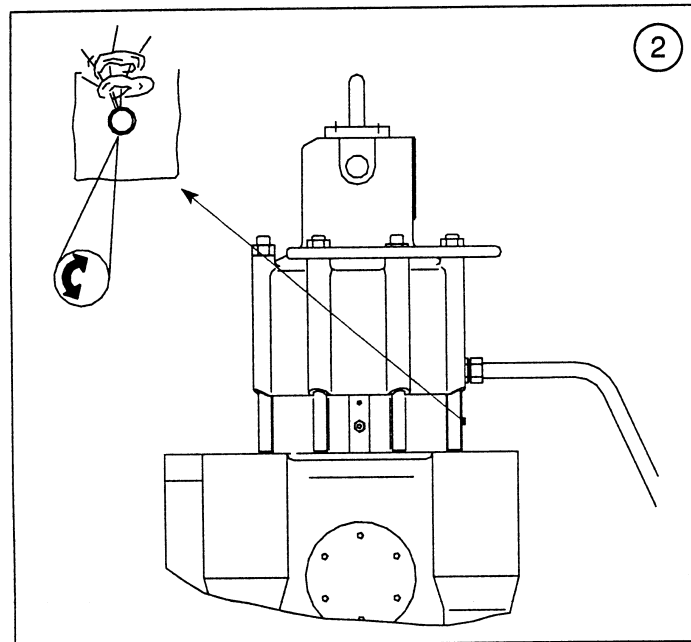
24, 36 mm



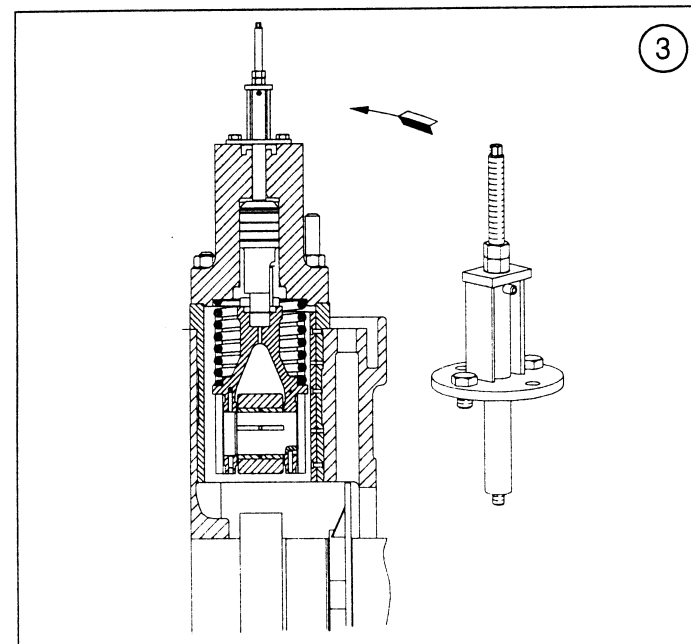


1. Stop the oil pump for camshaft lubrication.

Disconnect the oil inlet pipe and blank-off the connection from the main pipe with the plug screw.



2. Turn off the air to the exhaust valve, and drain off the air inside the air cylinder through the venting plug screw placed just above the ball cock on the air cylinder.



3. Lift the fuel pump and exhaust valve roller guide (see *Procedures 908-5 and 909-5*).

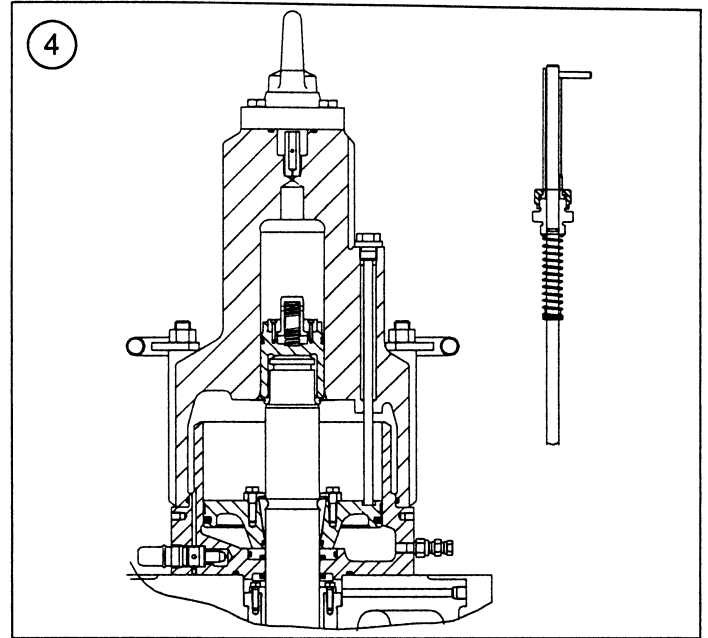


4. Dismount the rotation indicator and mount the tool.

The tool will keep the air piston in the lower position and therefore keep the valve open.

Regarding running the engine, see Volume I, Chapter 704.

5. After overhauling the cylinder unit, engage the roller guides.
(See Procedures 908-5 and 909-5).



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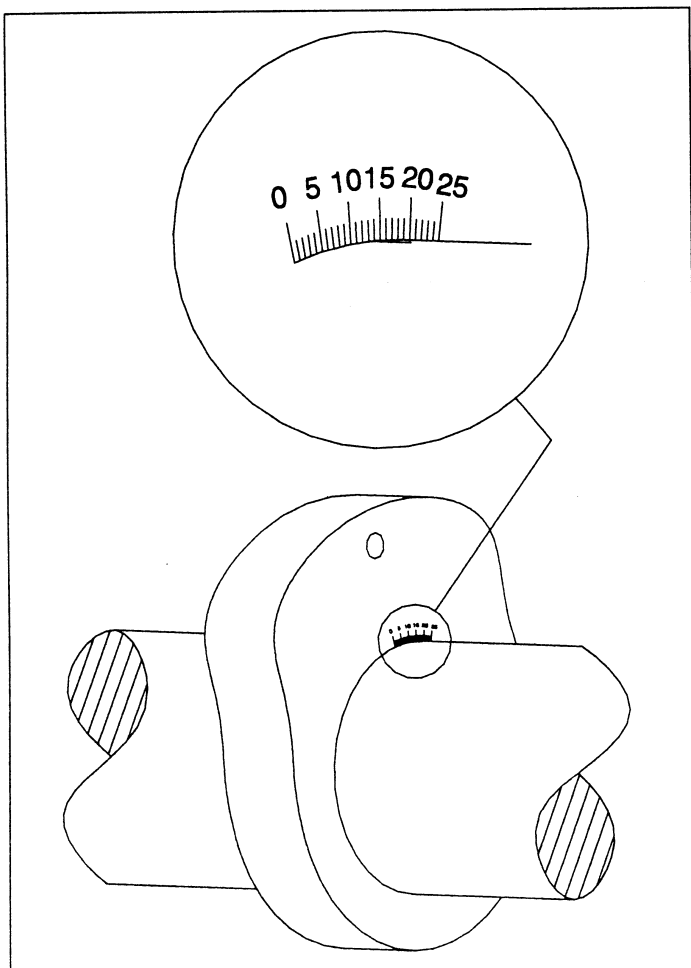
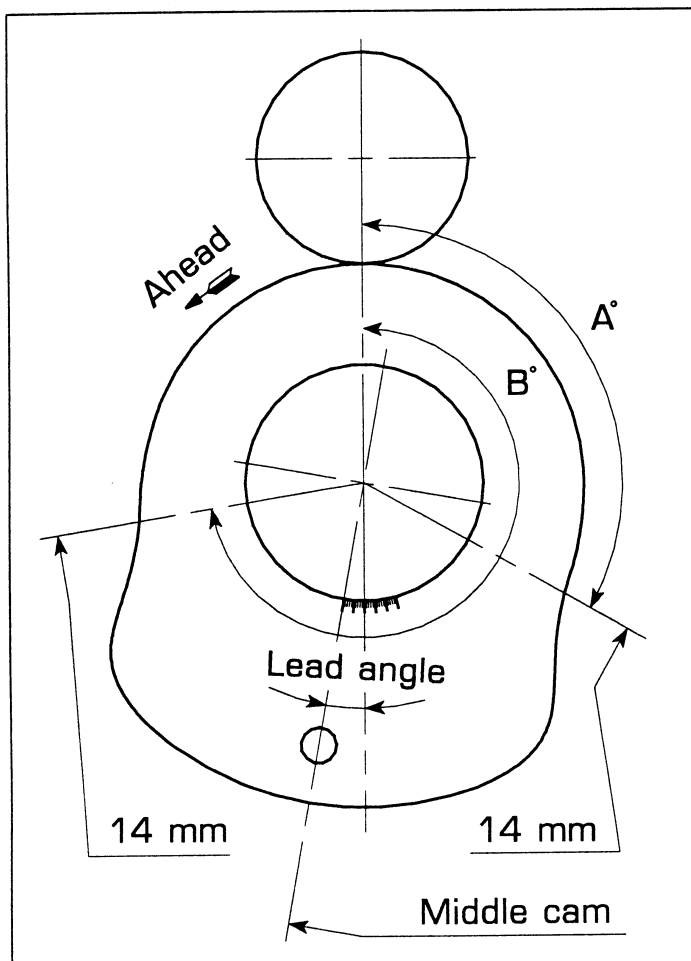


SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☒ Lock turbocharger rotors

913





For checking the position of the exhaust cam, the engine is turned in AHEAD direction until the roller guide (measured on activator plunger) has been lifted 14 mm.

If the cam has been correctly adjusted, the crankthrow for the cylinder concerned must then be in a position of **A°** past its TDC.

For checking the lead angle, the turning is continued in AHEAD direction until the roller guide has been lifted 14 mm corresponding to a turn of **B°** of the crankshaft.

The lead angle is then

$$180^\circ - \frac{A + B}{2}$$

The correct position of the cam shall be within $\pm 0.5^\circ$.

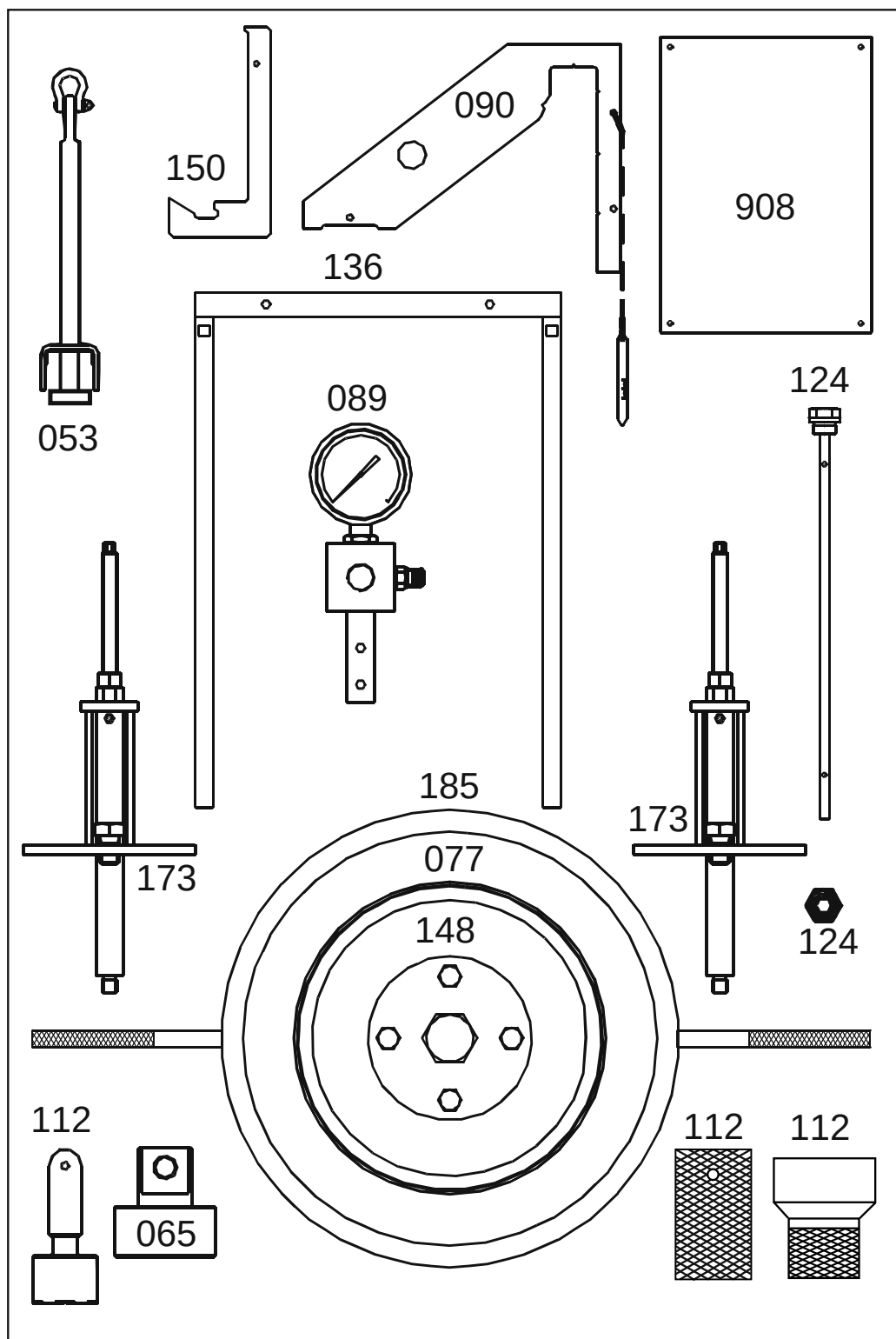
The illustration shows the position of the exhaust cam for a 6-cyl. standard engine, when the piston of the cylinder concerned is in TDC.

See the adjustment sheet in Volume I, OPERATION, Chapter 701, for the "lead angle" of the plant in question.

The cam lead can be checked visually by reading directly the scale position of the exhaust cam over the marking scratch on the camshaft and compare this angle with the angle stated in the adjustment sheet.

At the same time, it is recommendable to check the camshaft with the pin gauge.
See Procedure 906-7.





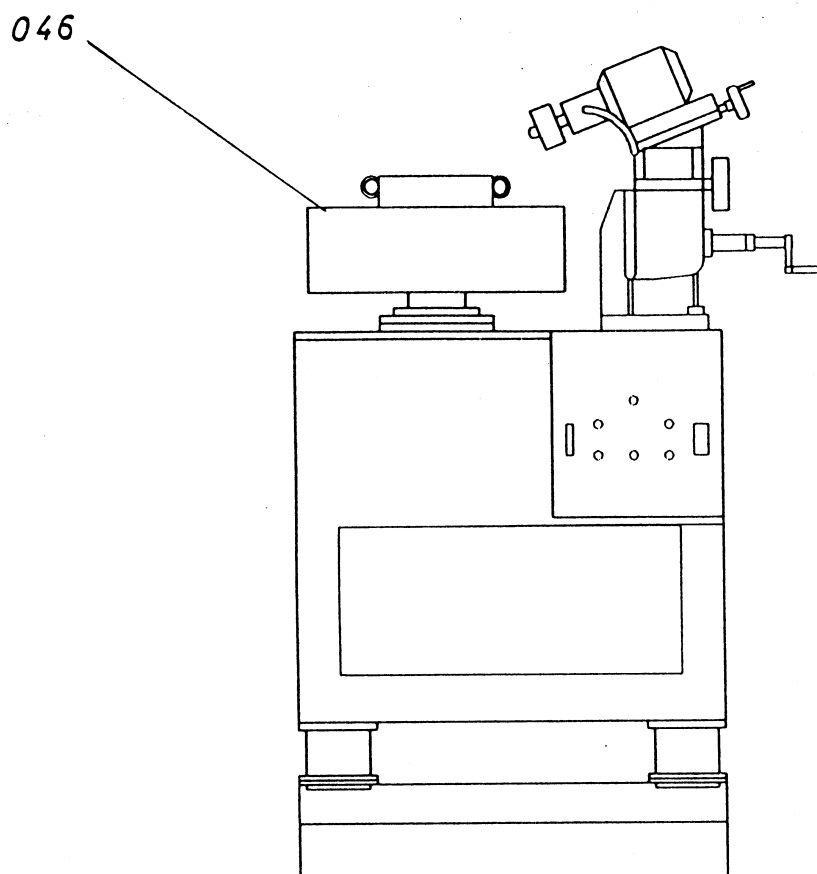
Item No.	Item Description
908	Name plete
053	Lifting tool, for roller guide
065	Liftiang tool for exhaust valve
077	Cone ring, pneumatic piston
089	Test equipment for Exh. valve
090	Cauge for exhaust valve spindle
112	Grinding tool for high pressure pipe
124	Tool for emerg. open Exh. valve open
136	Bridge gauge for Exh. valve
148	Tool for hydraulic piston
150	Gauge for Exh. v/v bottom piece.
173	Liftiang tool for roller guide of Exh. valve
185	Grinading ring for exhaust valve bottom
908	*)Taool panel, complete
185	with tools

Item No.	Item Description





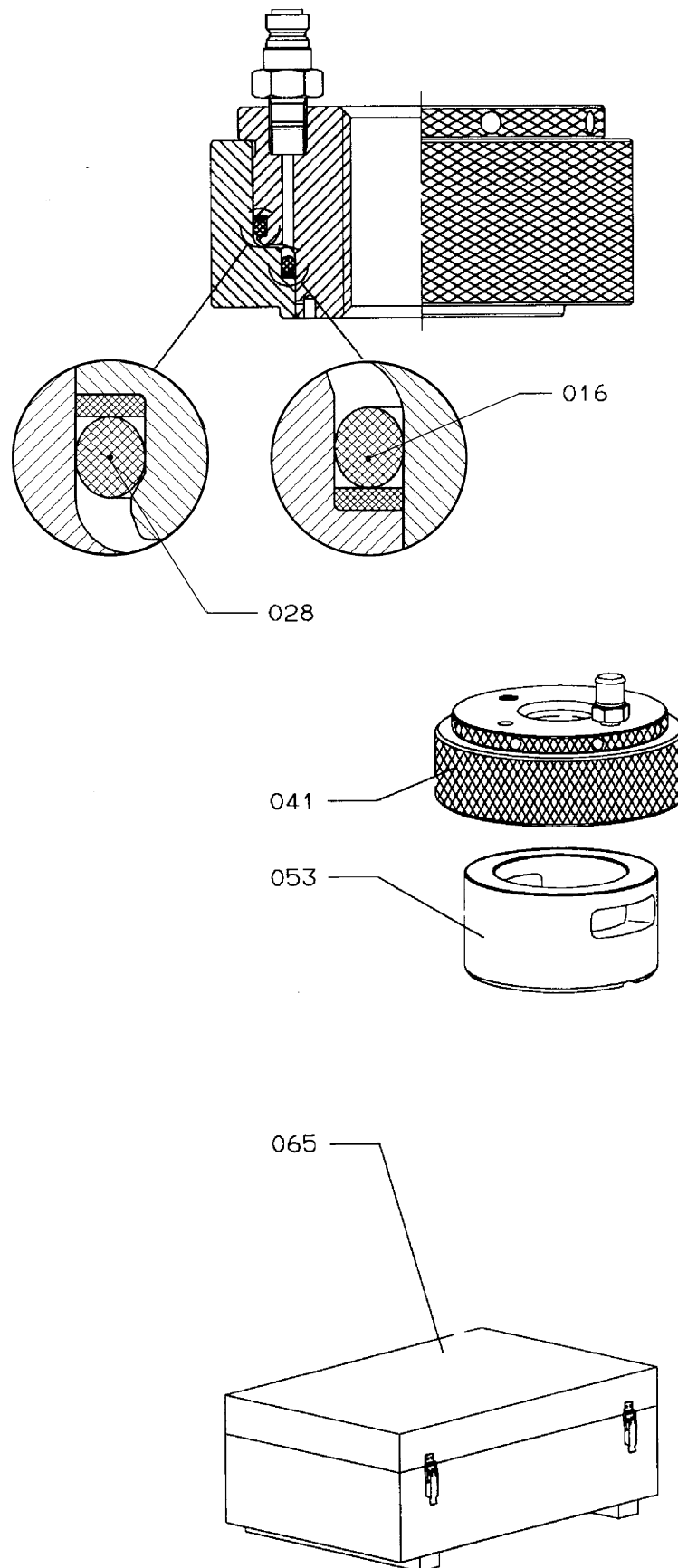




Item No.	Item Description
046	Grinding machine, complete When ordering spare parts, please refer to the KOKACO

Item No.	Item Description

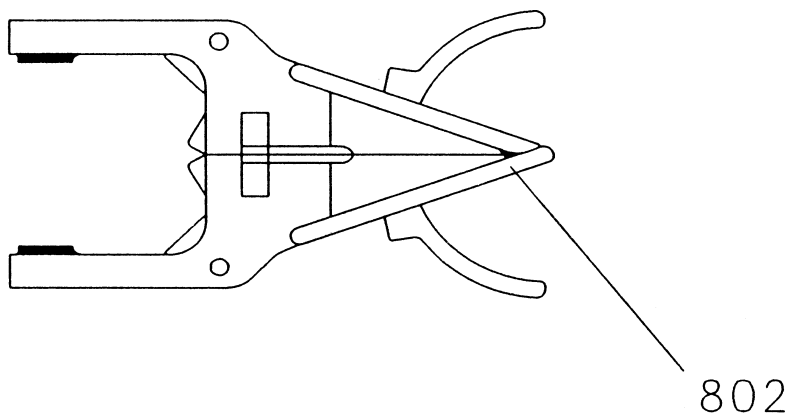
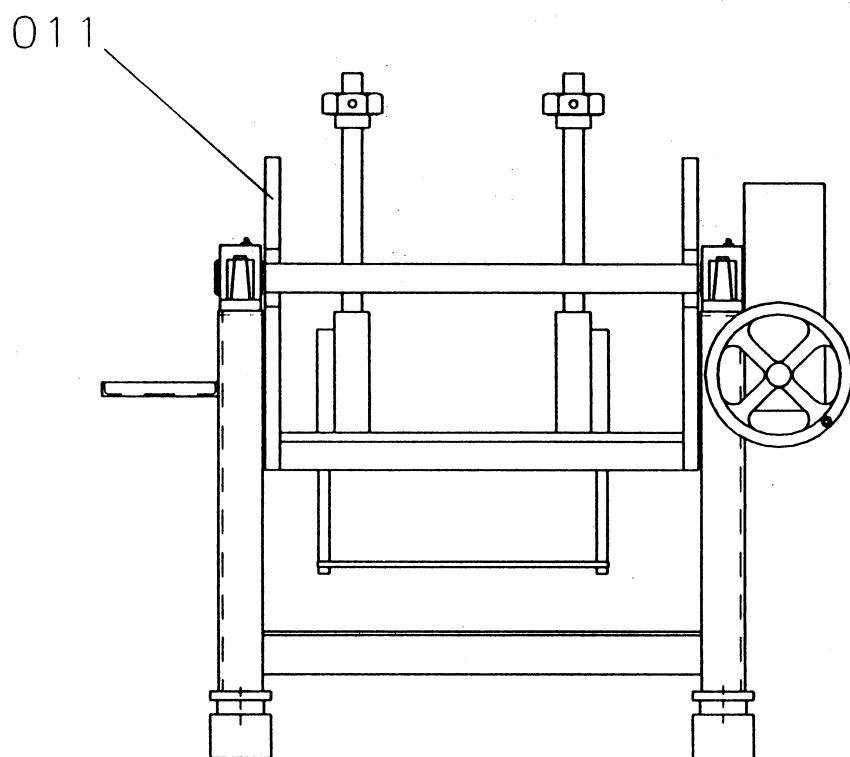




Item No.	Item Description
016	O-ring with back-up ring, 90/100 mm
028	O-ring with back-up ring, 140/150 mm
041	Hydraulic jack for Exhaust valve stud
053	Support for Hydr. jack
065	Steel box for Hyd. jack

Item No.	Item Description





Item No.	Part Description
011 802	Dismantling stand for Exhaust valve Piston ring opener for exhaust valve

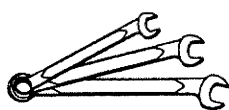
Item No.	Part Description



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

Standard tools: see Section 913



40-200 Nm
750-2000 Nm

DATA:

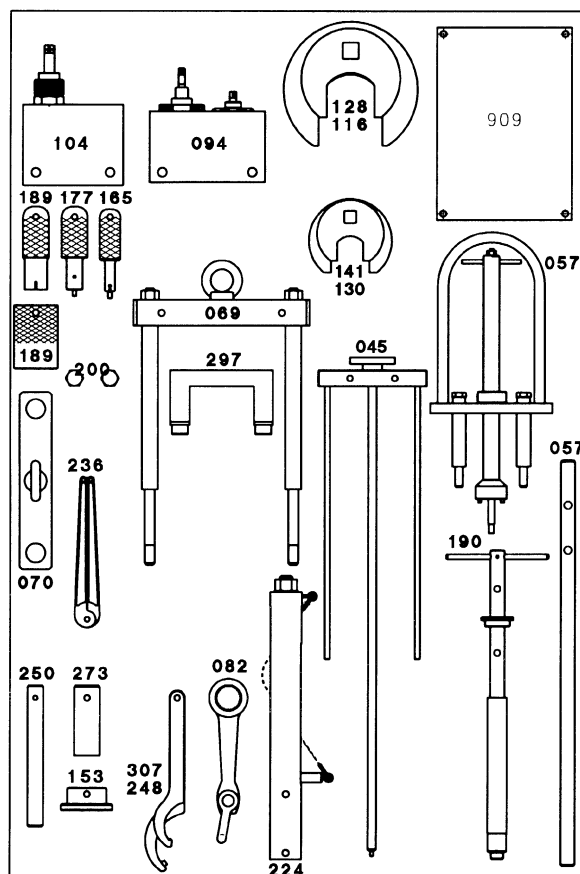
1 VIT-index mark on p_{max} -rack
corresponds to 1 mm change
of the lead.

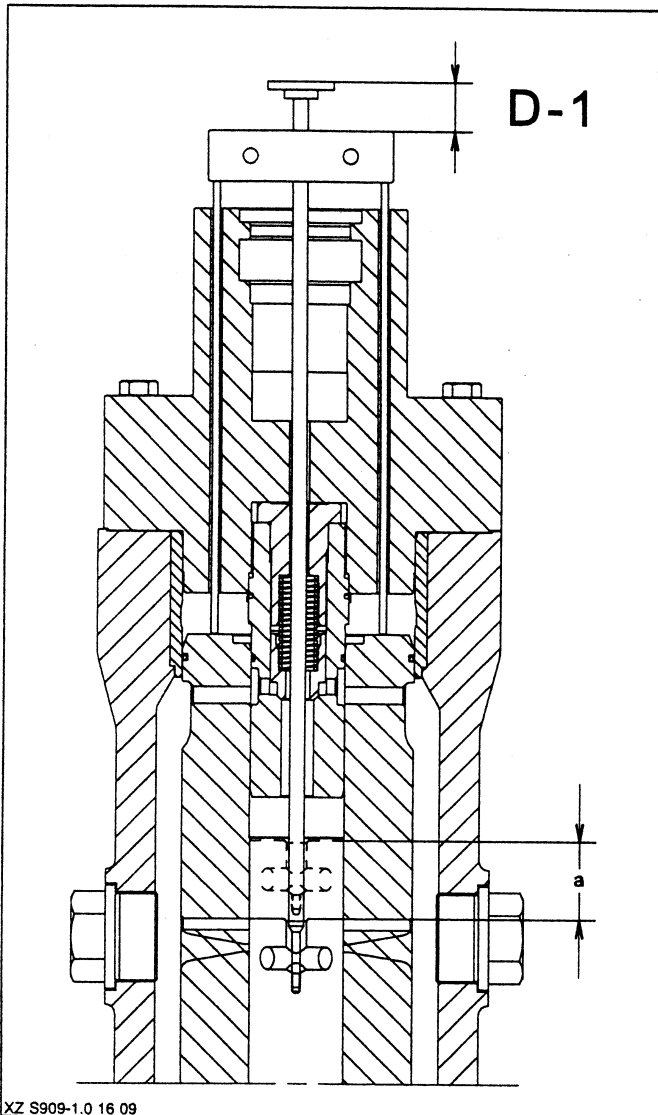
1 mm change of the lead
corresponds to p_{max} being
altered approx. 3-4 bar

Index range of p_{max} -rack..... 0-10

D-1 Measuring tool constant..... 80 mm

D-2 Tightening torque
puncture valve..... 1400 Nm





The fuel pump lead **a** (= the effective lead) is defined as the distance the top of the fuel pump plunger is lifted above the upper edge of the upper cut-off holes in the fuel pump barrel, when the piston of the cylinder concerned is in TDC.

The measuring tool constant **D-1** is calculated at the point where the fuel pump plunger passes the upper edge of the upper cut-off holes at VIT-index 0 (zero).

XZ S909-1.0 16 09



To be able to measure the fuel pump lead, it is necessary to dismantle the puncture valve from the top cover.

Note !

Before dismantling any part of the fuel pump, make sure the pump has been relieved of pressure and that all oil has been drained off.

1. Shut off the fuel oil inlet.

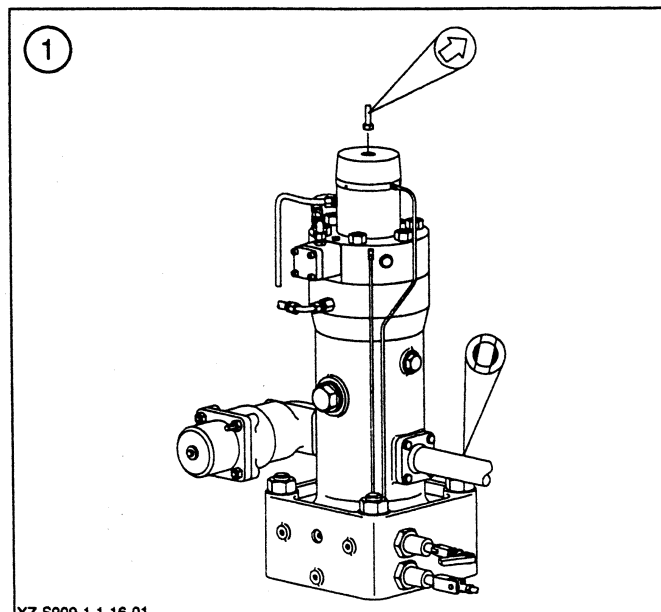
Open the fuel pump drain cock, enabling the oil to escape.

Dismount the air pipe on the puncture valve.

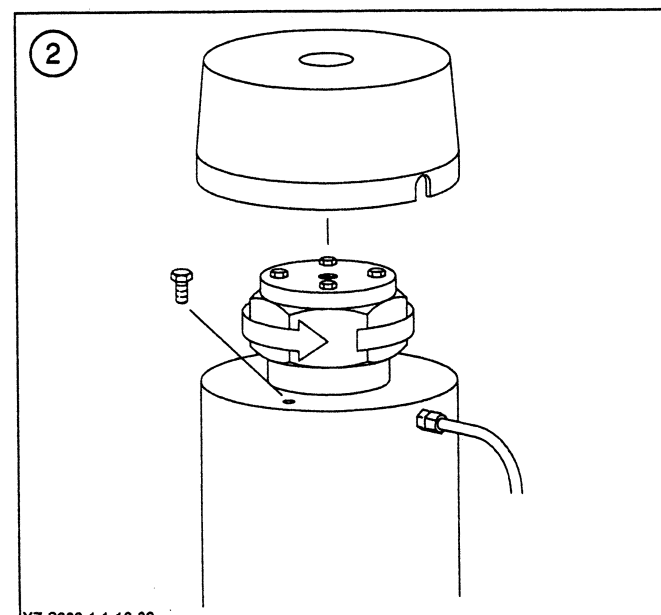
2. Dismount the protective cap and the puncture valve from the top cover.

Dismount the plugs from the measuring holes in the top cover.

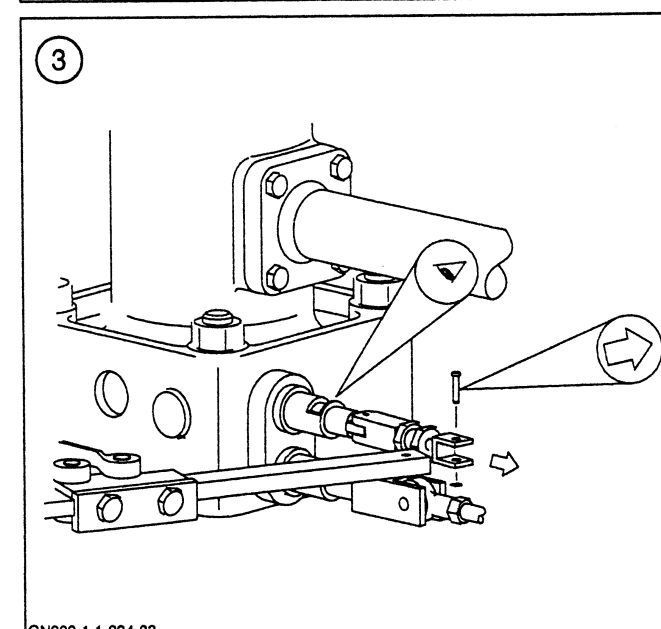
3. Remove the pin in the forked lever which connects the actuator and the VIT-index arm. Pull out the VIT-index arm to index 0 (zero).



XZ S909-1.1 16 01

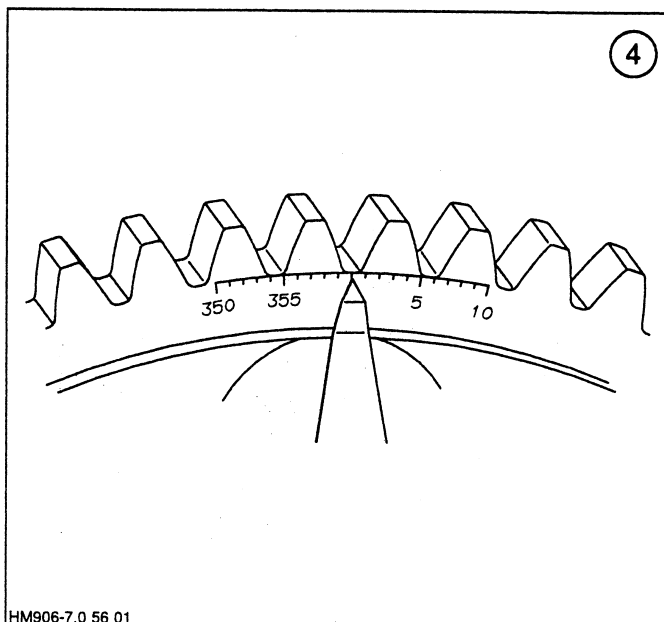


XZ S909-1.1 16 02

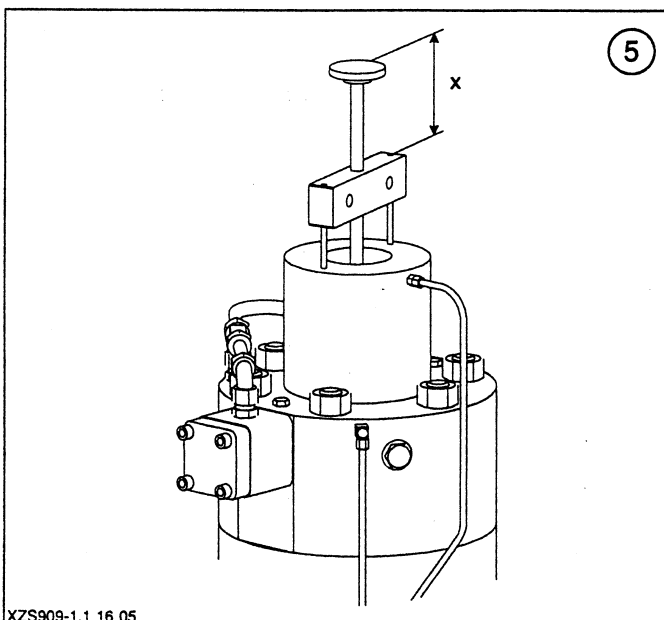


GN909-1.1 204 03





HM906-7.0 56 01



XZS909-1.1 16 05

4. Turn the engine in AHEAD direction until the main piston of the cylinder concerned is exactly at TDC.
See Procedure 906-7

Note !

The correct distance **x** can only be measured when the fuel pump plunger is in its delivery stroke.

5. Mount the measuring tool on top of the fuel pump cover.

Push the measuring pin down until it rests against the plunger.

Measure the distance **x** from the top of the measuring pin to the top of the cross bar.

The fuel pump lead is then calculated as:

$$a = x - "D-1"$$

If the VIT-index is not "0" when measurements take place, the VIT-index must be incorporated into the calculations of the fuel pump lead:

$$a = x - "D-1" - "VIT-index" \text{ See Data.}$$

Note down the result for future reference.

For adjustment of fuel pump lead, see Procedure 909-1.2.

6. Remove the measuring tool from the fuel pump.

Replace the O-rings on the puncture valve and remount the puncture valve in the top cover. *See Data.*



1. If a defective servo air-cylinder has to be replaced, the pump barrel in the pump housing must be disconnected from the threaded guide before mounting the spare servo air-cylinder.
2. The spare servo air-cylinder is to be adjusted by displacing lever **F** so that the camber height **X** is evenly distributed.

The basic adjustment of the servo air-cylinder is to be carried out in accordance with the diagram by displacing the connecting link **E**.

In order to distribute any possible deviation, the control air pressure of 2.75 bar should correspond to index 5.0 on the p_{max} -rack.

3. After this adjustment, assemble the fuel pump, see *Procedure 909-3.1*.

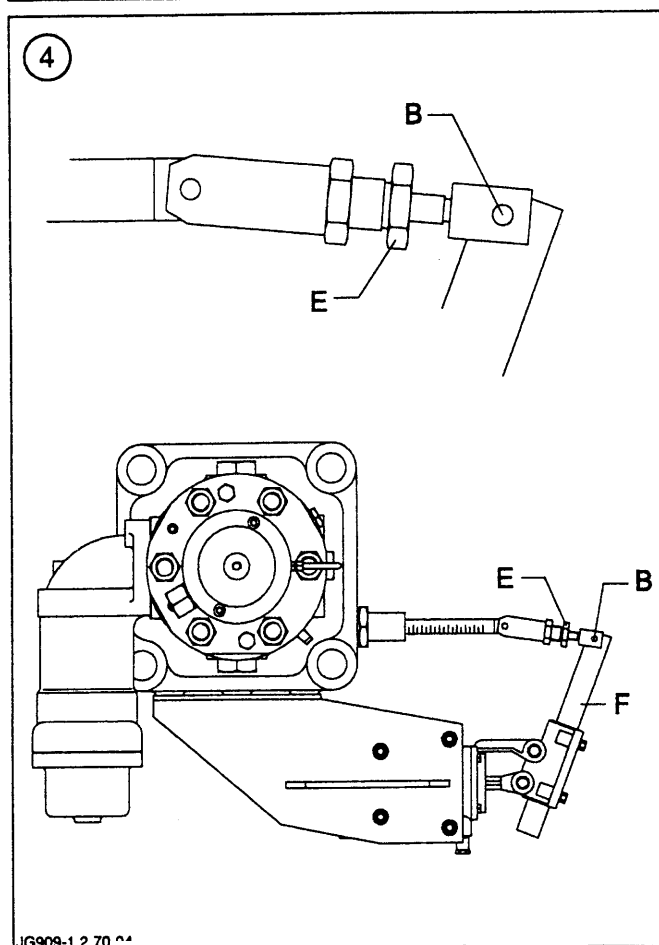
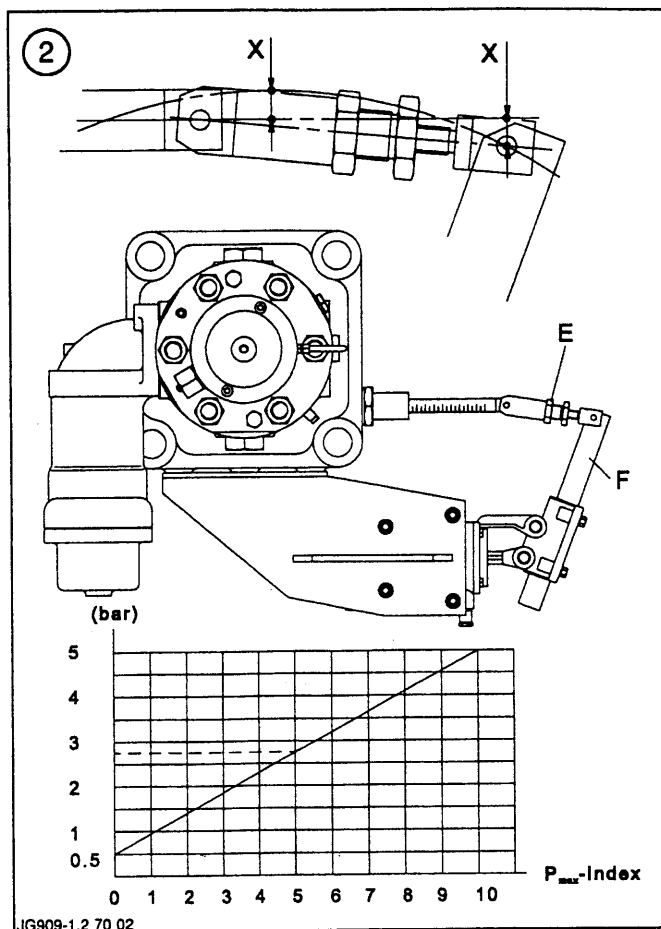
After a few readings in service, it may be necessary to make a final adjustment of the p_{max} pressure of the relevant cylinder.

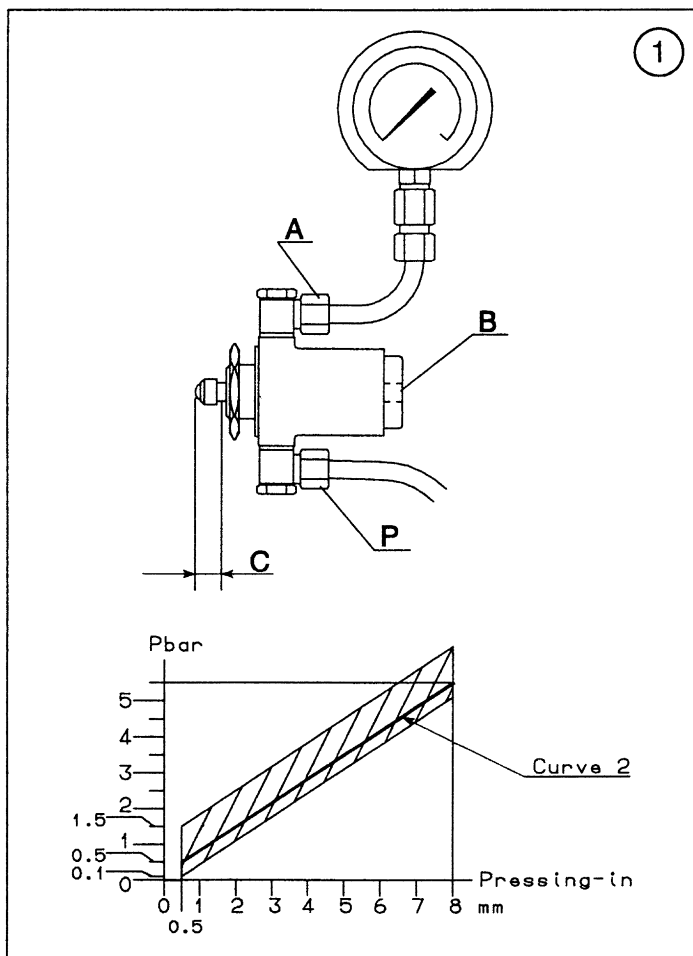
4. Adjustment of the p_{max} can be carried out on the individual fuel injection pumps by first removing pin **B** and then adjusting link **E**.

The link can be adjusted by approx. 3 index marks. See *Data*.

Note !

If the required adjustment of the fuel pump lead cannot be accomplished within the adjustment range of link **E** the adjustment is done by adjusting the fuel cam lead.
See *Procedure 909-2.2*.





1. Spare pilot valves have been pre-adjusted to 0.5-5.5 bar control air pressure, corresponding to 0.5-8.0 mm pressing-in of pin C.

Connect a pressure gauge and a pipe with working air (pressure 7 bar) to connections A and P, respectively, on the pilot valve.

Check that the pressure in the pressure gauge and the pressing-in of pin C is in accordance with the curve.

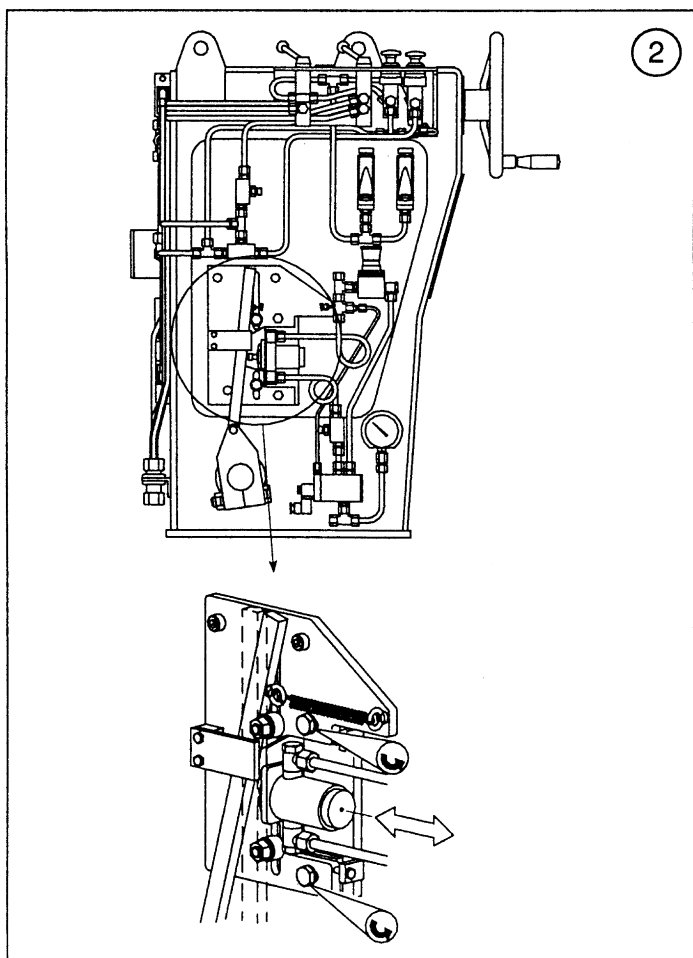
Any necessary adjustment is done on the adjusting screw B.

2. Fine adjustment of the p_{max} pressure in the break point (for all the cylinders) is to be adjusted by axial displacement of the bracket with the pilot valve.

Release the screw and nut which tighten the bracket with the pilot valve to the larger bracket through the slotted holes.

Increasing the p_{max} pressure is done by moving the pilot valve toward the lever.

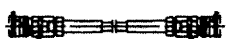
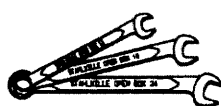
Decreasing the p_{max} pressure is done by moving the pilot valve away from the lever.



Safety Precautions

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

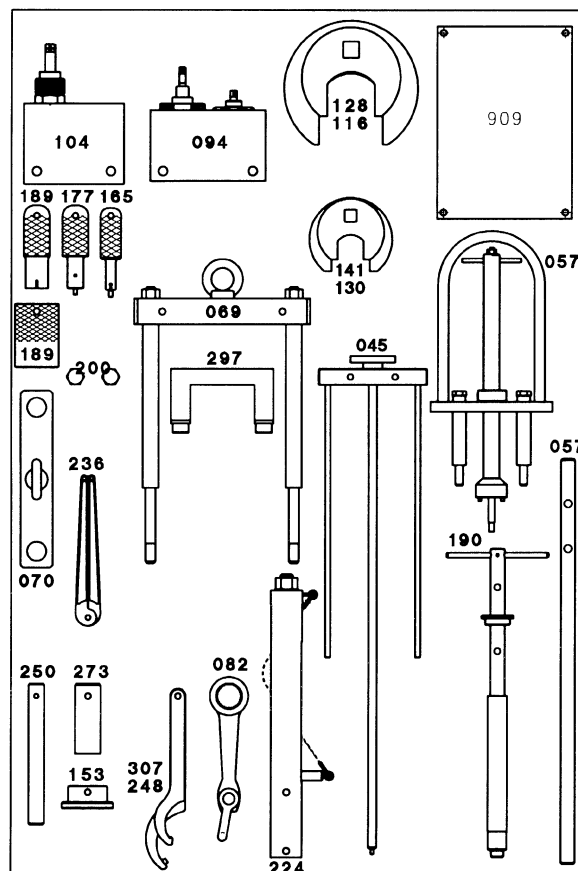
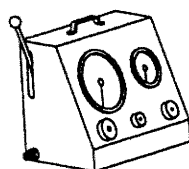
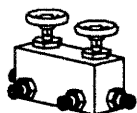
Standard tools: see Section 913



1 x 3 m
3 x 1 m



750-2000 Nm

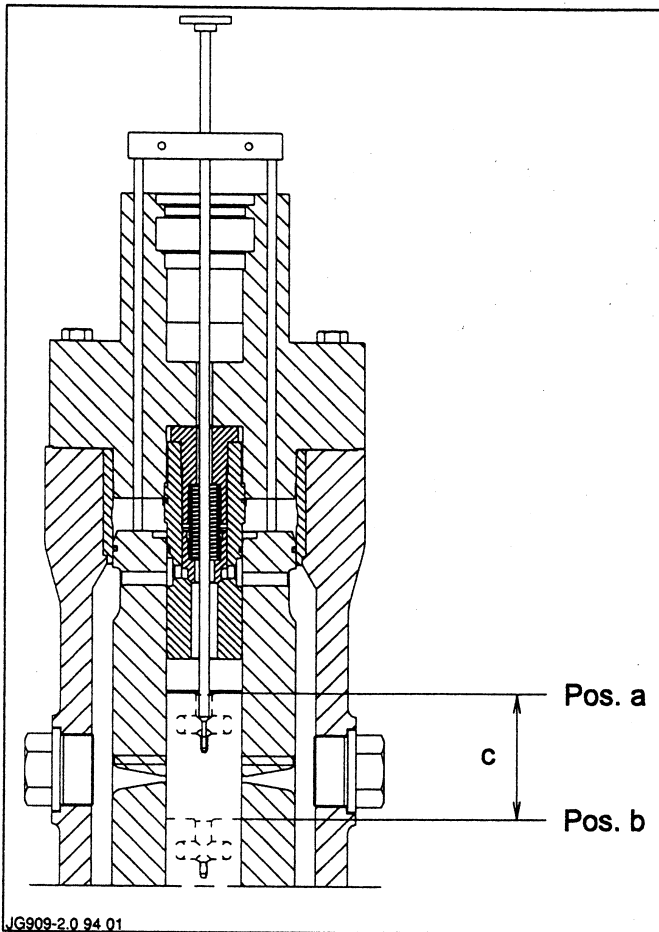


DATA:

D-1 Tightening torque –
puncture valve..... 1400 Nm

Data for adjustment of fuel pump cam.
See Procedure 909-1.





JG909-2.0 94 01

The lead **c** of the fuel cam is defined as the number of mm the plunger is lifted from its bottom position when the main piston is in TDC.

The lead **c** of the fuel cam disc is a combination of two readings, namely **a** and **b**.
See sketches



1. To measure the fuel cam lead, it is necessary to dismantle the puncture valve from the top cover to gain access for the measuring tool.

Note !

Before dismantling any part of the fuel pump, make sure that the pump has been relieved of pressure and that all oil has been drained off.

Shut off the fuel oil inlet. Open the drain cock (at the bottom of the pump housing), enabling the oil to escape from the housing. Unscrew the drain oil pipe from the fuel pump.

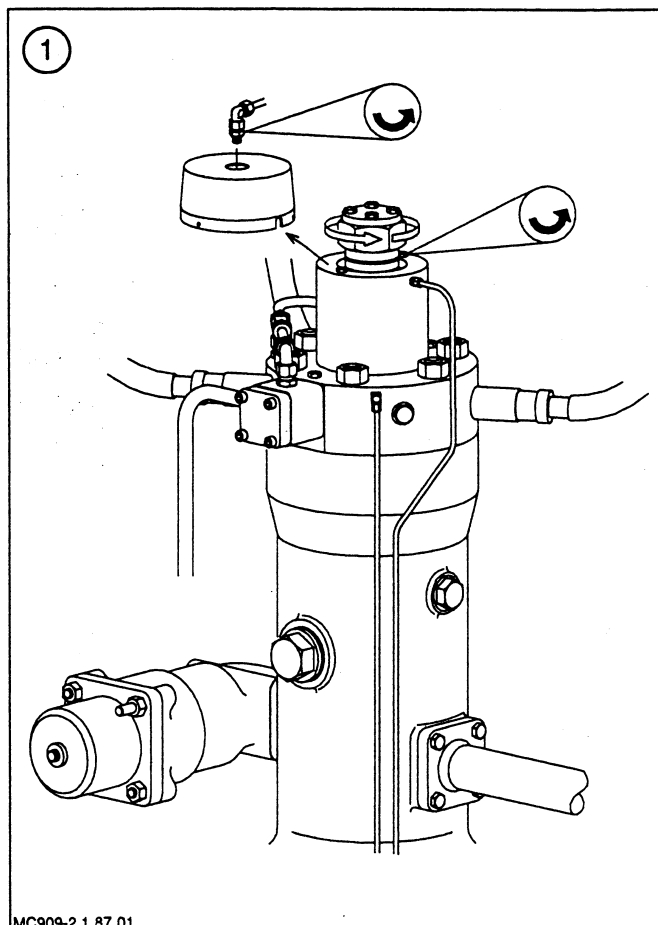
Disconnect the air pipe on the puncture valve.

Dismount the protective cap and the puncture valve from the top cover.

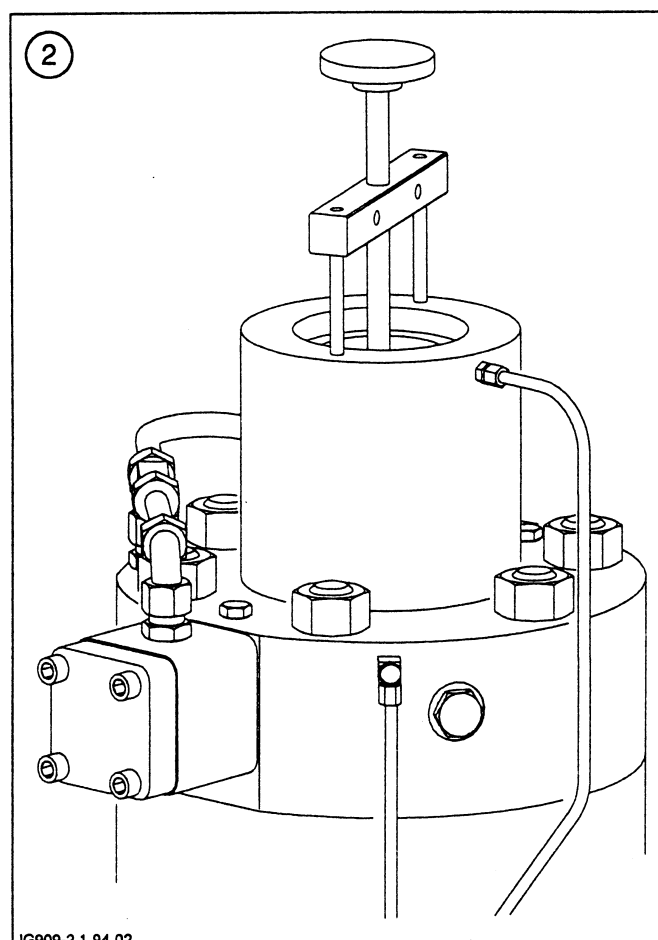
Dismount the two plugs where the measuring tool is to be mounted.

2. Place the measuring tool on top of the top cover.

Push down the measuring pin until it rests against the pump plunger, while the legs of the tool rest against the pump barrel.

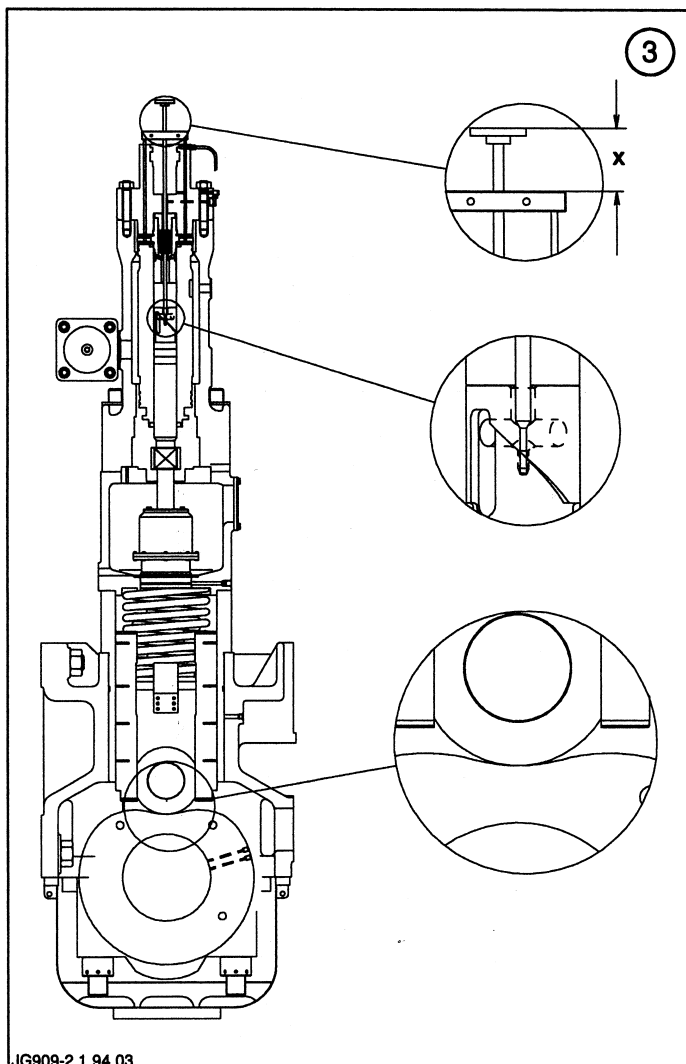


MC909-2.1 87 01



JG909-2.1 94 02





JG909-2.1 94 03

3. Dismount the cover of the fuel cam inspection hole in the roller guide housing.

Turn the engine, while noting the position of the cam through the inspection hole.

Stop turning when the roller is on the lowest part of the cam, i.e. where the roller guide, and thus the pump plunger, is in the lowest position.

Measure the distance x from the top of the measuring pin to the top of the cross bar.

Note down the measurement as b .

This position can also be found by pressing the measuring pin of the measuring tool lightly down against the top of the pump plunger while turning the engine.

On reaching the lowest position of the measuring pin, i.e. when the measuring pin moves no further downwards, stop turning the engine. The pump plunger and the roller guide are then in their lowest position.



- Turn AHEAD until the main piston of the cylinder concerned is in TDC.

Make sure that the measuring pin is pushed right down against the pump plunger.

Again measure the distance x from the top of the measuring tool to the top of the crossbar.

Note down the measurement as a .

The lead c of the fuel cam is thus = $a - b$.

Example:

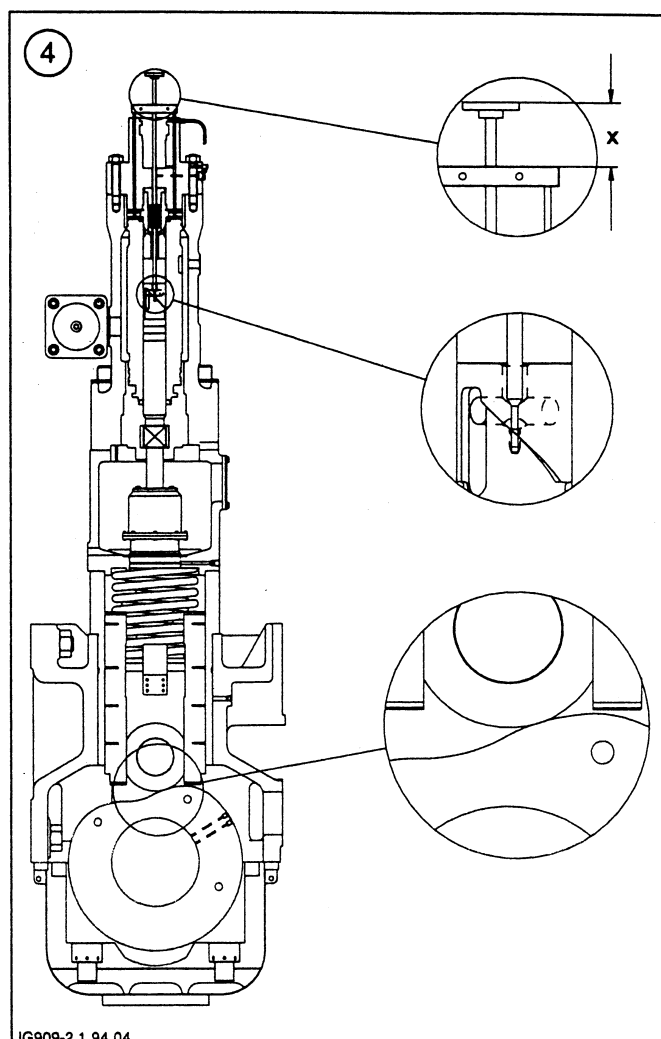
Reading $a = 87$ mm
with main piston in TDC.

Reading $b = -70$ mm
with plunger in lowest position.

$$c = a - b = 87 - 70 = 17 \text{ mm}$$

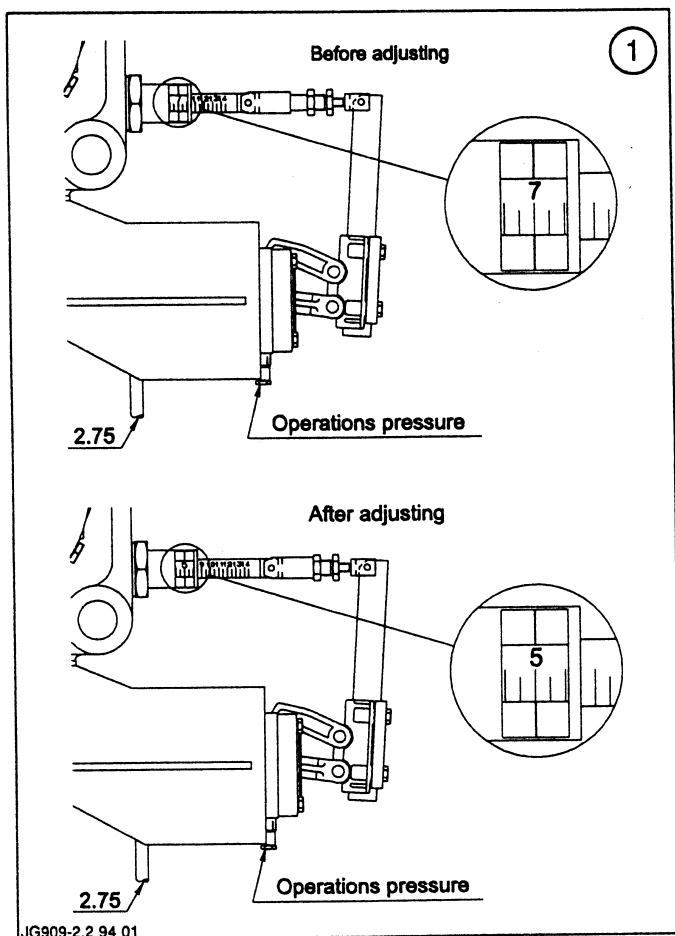
Note down the result for comparison with the test bed results and for future reference

For adjustment of fuel cam lead, see Procedure 909-2.2



JG909-2.1 94 04





If $p_{\max}$ is to be adjusted by adjusting the fuel cam lead instead of adjusting the $p_{\max}$ rack, it is recommended to set the $p_{\max}$ rack to its middle position (index 5 at a control air pressure of 2.75 bar) before adjusting the fuel cam lead. (See Procedure 909-1.2).

1. Supply a control air pressure of 2.75 bar.

Note down the deviation x between the present position of the $p_{\max}$ rack and its middle position.

Maintain the pressure of 2.75 bar, and adjust the $p_{\max}$ rack to its middle position

The deviation x must be incorporated into the calculated change of fuel cam lead:

Example:

Present position (before adjusting link E): index mark 7 (at 2.75 bar)

Middle position (after adjusting link E): index mark 5 (at 2.75 bar)

Deviation x :
 $7 - 5 = +2$ index marks

Purpose:

To increase $p_{\max}$ 9 bar.

Data:

As 1 mm change of fuel cam lead corresponds to $p_{\max}$ being altered approx. 3-4 bar, the cam lead is to be altered approx. 3 mm

Calculated change of fuel cam lead:

Change of fuel cam lead + deviation x :
 $3 + 2 = 5$ mm change of fuel cam lead.

The new fuel cam lead is then calculated as:

The present fuel cam lead + the calculated change of fuel cam lead.
 See Procedure 909-2.1

Note down the new fuel cam lead.



Readjustment of the fuel cam disc is carried out as follows:

2. Dismount the pipe connections and the puncture valve from the fuel pump top cover, and mount the measuring tool.

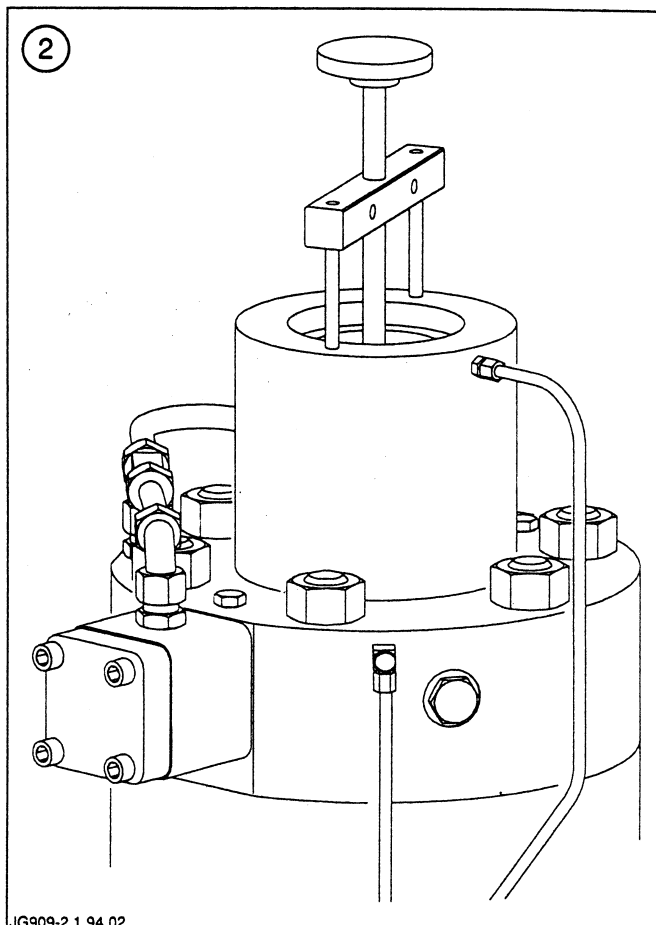
Remove the cover on the upper part of the camshaft housing in front of the fuel cam disc.

3. Turn the engine until the fuel cam disc concerned is positioned with the oil ducts in front of the opening in the housing.

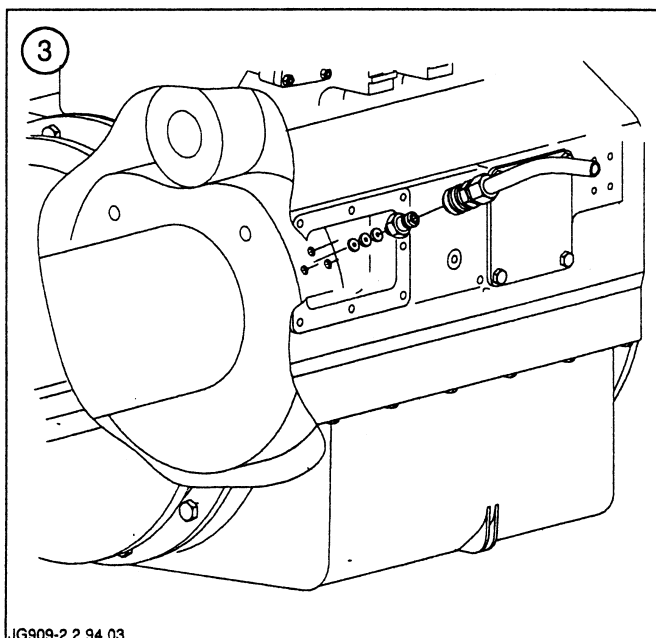
Insert three copper gaskets in each oil duct.

Mount the snap-on couplings in the oil ducts, but do not tighten them up.

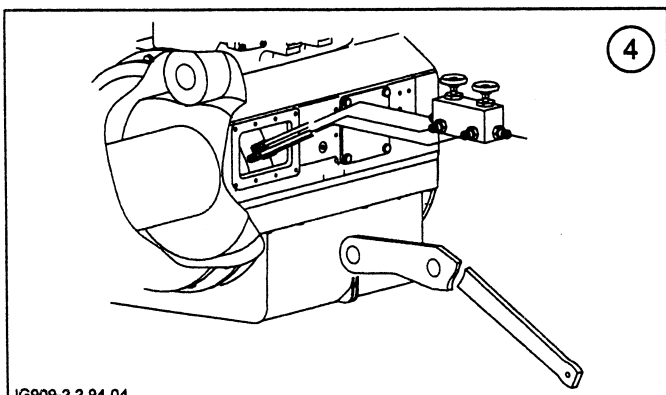
Connect the snap-on couplings to the distributor block and the hydraulic high-pressure pump by means of hoses.



JG909-2.1 94 02



JG909-2.2 94 03

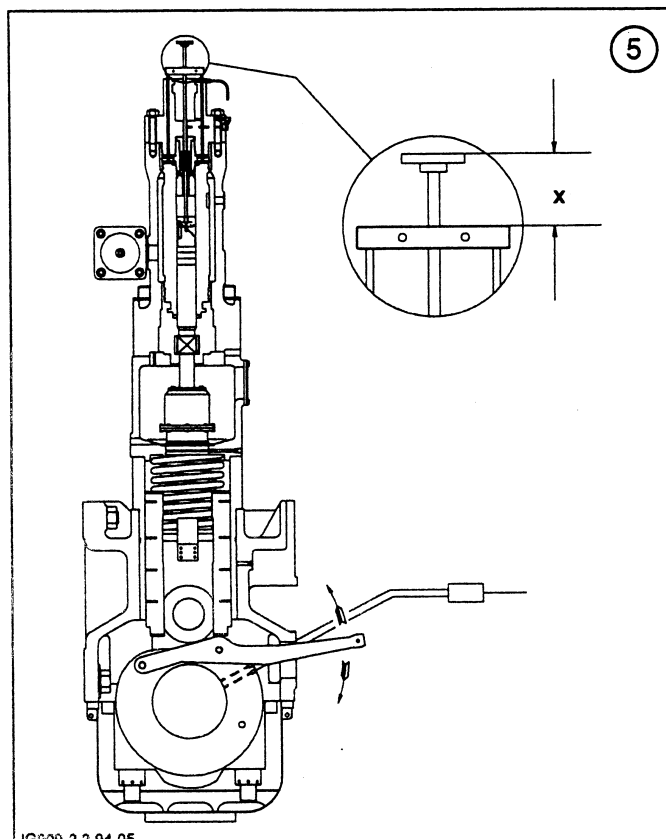


JG909-2.2 94 04

4. Apply a light pressure to the hydraulic system and, after venting the system, tighten up the snap-on couplings.

Note the position on the scale of the measuring tool.

Mount the special spanner on the fuel cam disc so that the two pins enter the holes in the cam.



JG909-2.2 94 05

5. Raise the hydraulic pressure so that oil seeps out along the camshaft on both sides of the cam disc.

Let the cam "float" for 10 min. before moving it.

Turn the cam disc, using the fitted spanner, until the distance x measured from the top of the measuring tool to the top of the crossbar equals measurement a + the calculated change of fuel cam lead.

Example:

$a = 87 \text{ mm}$

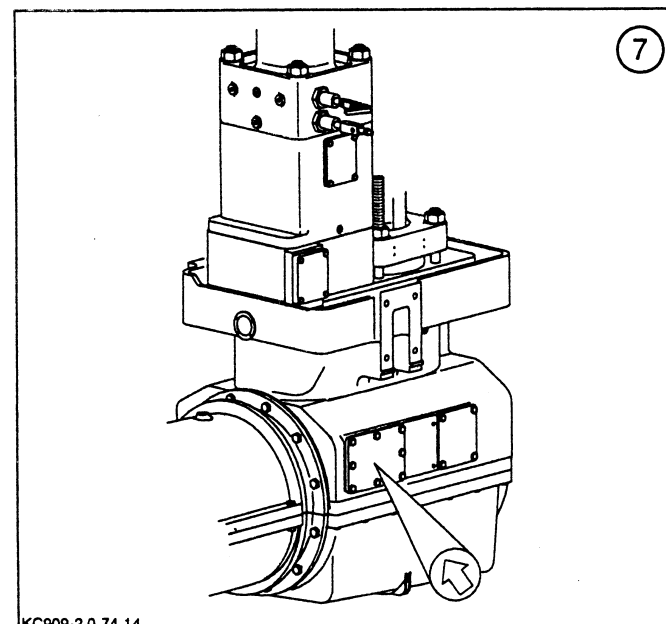
Calculated change of fuel cam lead = 5 mm

$x = 87 + 5 = 92 \text{ mm}$

6. After completing the desired turning of the cam disc, relieve the hydraulic system of pressure and dismount the spanner and the hydraulic equipment.

The cam has to settle for at least 15 minutes before the engine may be operated in any way.

After adjustment, measure $p_{\max}$ and re-adjust the fuel cam lead, if necessary. Note down the fuel cam lead for future reference.



KC909-2.0 74 14

7. Mount the cover on the camshaft housing upper part.

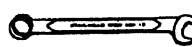
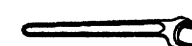
Finally, mount the puncture valve (see Data D-1), the protective cap and the pipes.

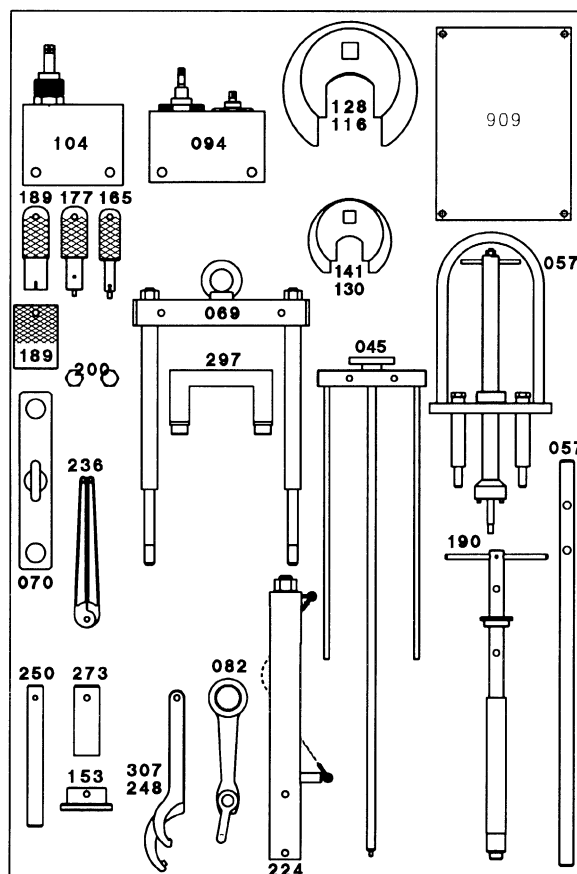


SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

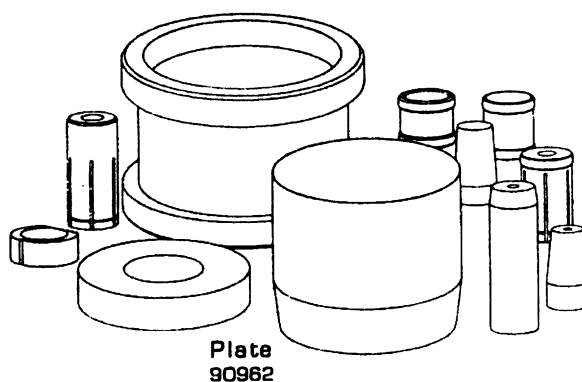
913

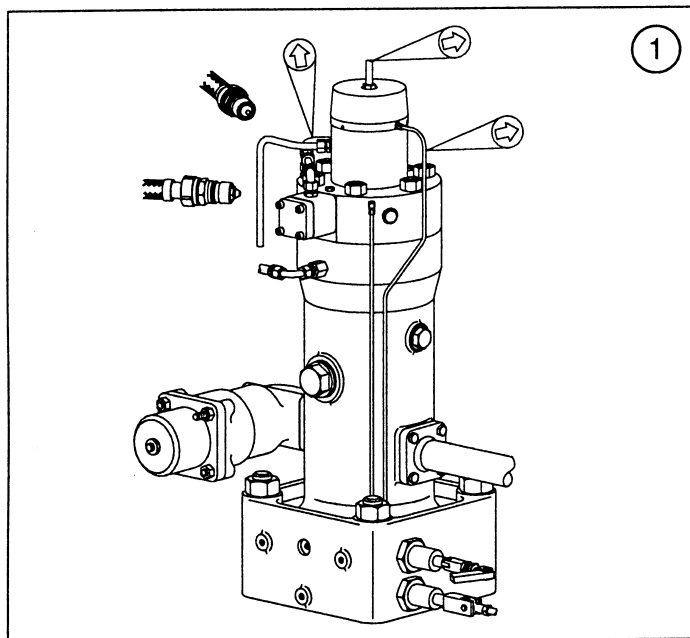
-  14, 19, 24, 30 mm
-  41, 46, 75, 100 mm
-  140-760 Nm
750-2000 Nm



DATA:

- D-1 Weight of top cover..... 54 kg
- D-2 Weight of barrel assembly 77 kg
- D-3 Tightening torque –
top cover nuts..... 410 Nm
- D-4 Tightening torque –
suction valve..... 1400 Nm
- D-5 Tightening torque –
puncture valve..... 1400 Nm
- D-6 Max. milling/grinding
diameter of seat..... 25 mm





Dismantling

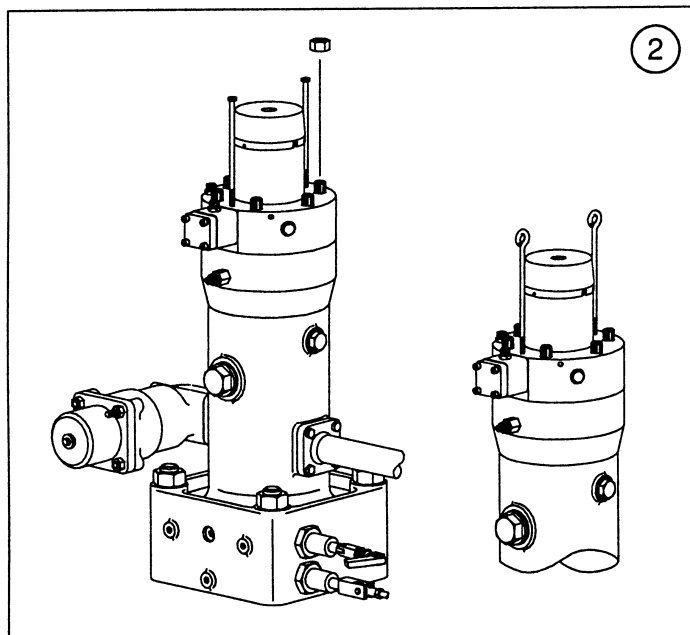
1. Shut off the fuel oil inlet.

Open the drain cock (at the bottom of the pump housing), enabling the oil which is left in the high-pressure pipe and the fuel pump to escape.

Note !

Before dismantling any part of the fuel pump, make sure that all oil has been drained off and the pump relieved of any pressure.

Dismount the pipe connections to the puncture valve.



Dismount the high-pressure pipe (top cover/fuel valves).

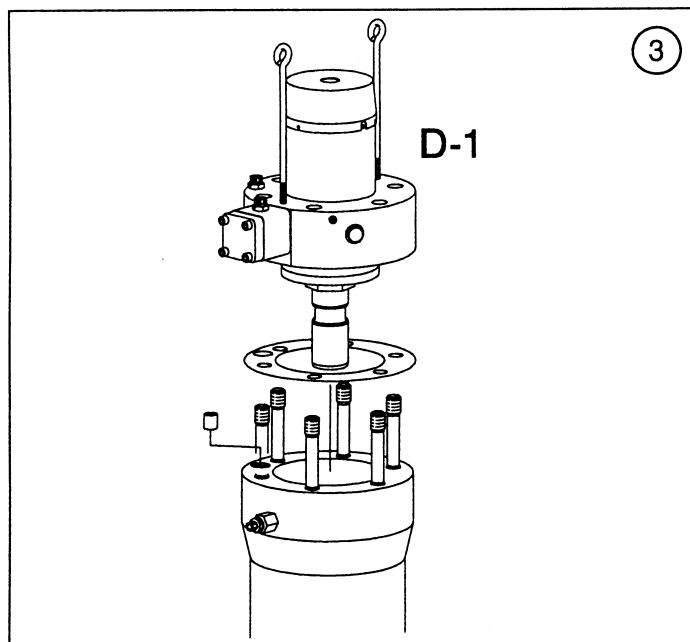
See Procedure 901-2.1.

(At this stage, it is practical to measure the fuel pump lead, see Procedure 909-1).

2. If the top cover is to be overhauled, dismount the puncture valve.

Remove the top cover fixing nuts and mount the dismantling screws for top cover in the two threaded holes.

Pull the top cover with suction valve and puncture valve free by tightening the dismantling screws.



When the top cover is "loose", remove the dismantling screws and mount two eye screws in the threaded holes instead.

3. Lift the top cover with puncture valve and suction valve carefully off.

For overhaul of top cover, puncture valve and suction valve, see Procedure 909-3.3.

Remove the guide bushing and sealing ring from the top of the pump housing.



- Place the lifting tool for the barrel/plunger assembly (without measuring pin) in such a manner that the two distance tubes of the tool rest on the pump barrel.

Be sure that the guide pin of the lifting tool enters the hole in the pump barrel.

Tighten the tool by screwing the two screws into the pump barrel.

Loosen the stop ring on the spindle of the tool and press the spindle down against the pump plunger. Turn the spindle in this position until the two guide pins engage with the two holes in the plunger top.

Tighten the centre screw of the spindle against the plunger.

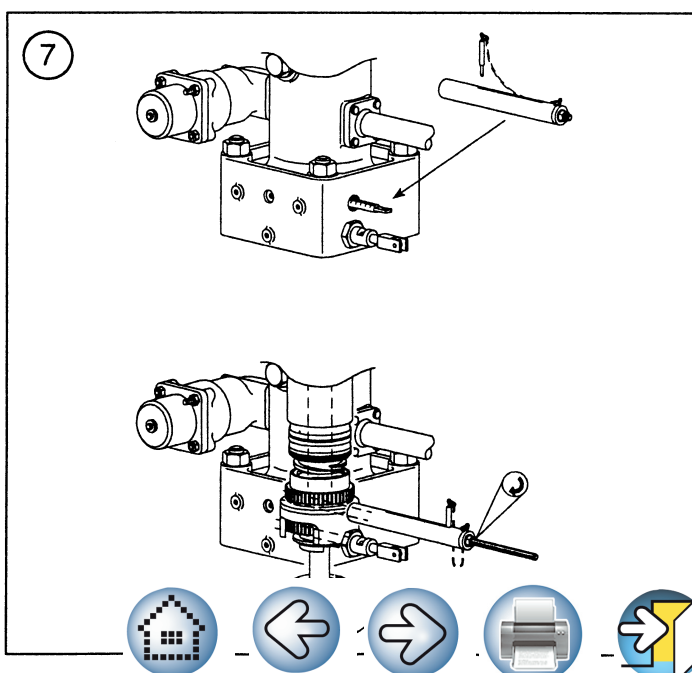
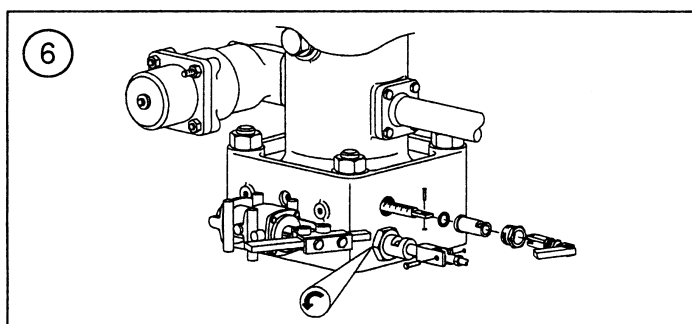
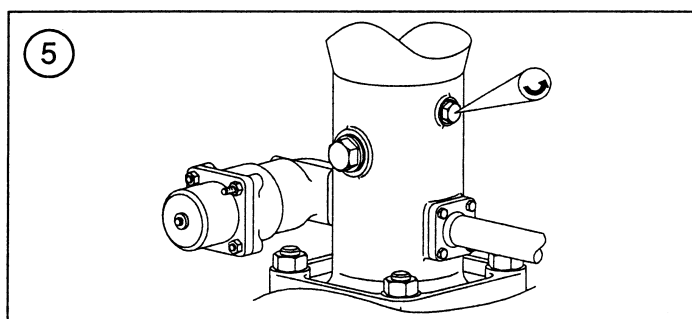
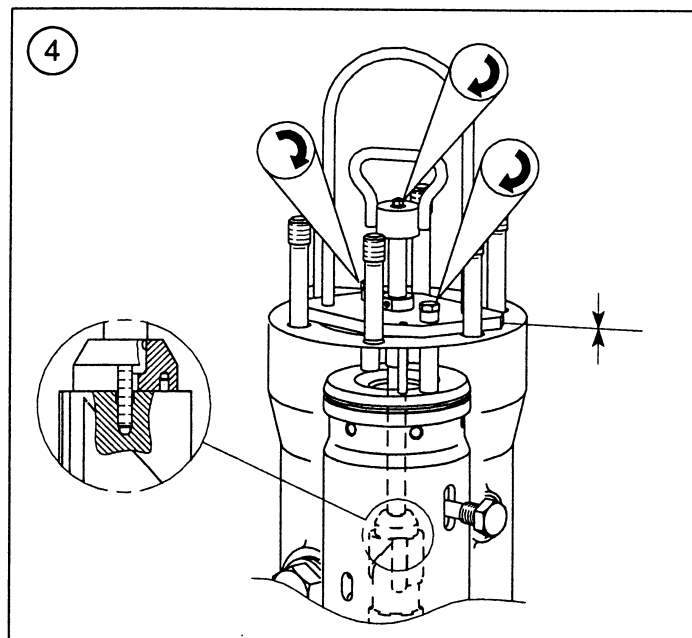
- Dismount the guide screw for the pump barrel from the pump housing.
- Release the connecting links for the timing drive and the regulating drive, and dismount the union and pointer for the timing drive.

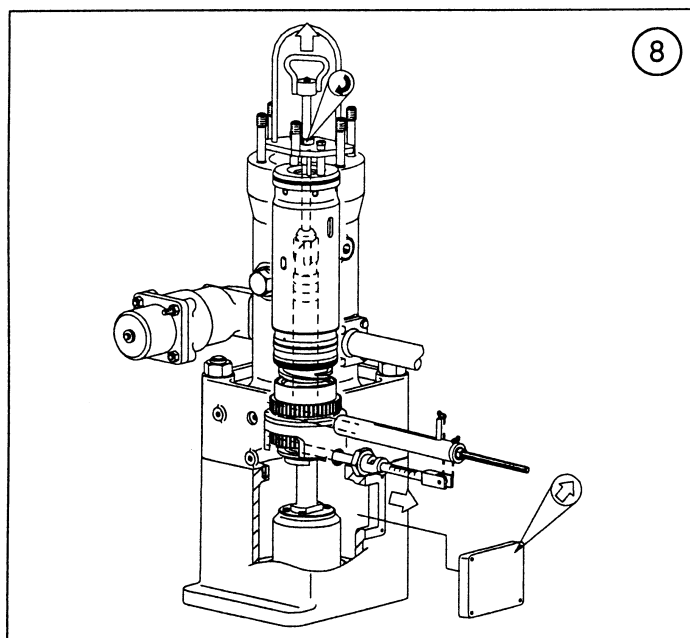
Loosen the union for the regulating drive.

- Mount the extractor tool and connect the timing toothed rack to the pulling rod by means of the pin.

Turn the nut at the end of the pulling rod, and the timing rack will move outwards. Continue turning the nut until the pin is in the outer position of the slot in the tool, whereby the thread of the fuel pump barrel goes clear of the timing guide. Keep the toothed rack in this position during the overhaul or replacement of the pump barrel.

There is now a distance between the lifting tool and the pump housing.



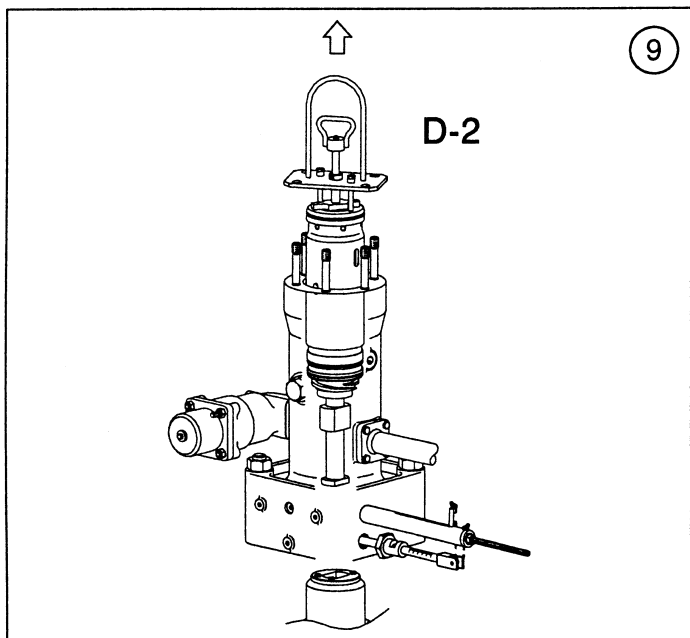


8. Pull the regulating toothed rack as far out as possible, thus turning the plunger foot clear of the bayonet joint in the roller guide. Remove the cover to inspect the position of the plunger foot.

Lift the spindle so that the plunger foot goes clear of the bayonet joint. Move the stop ring of the spindle into contact with the upper flange of the tool, and lock the stop ring in position by means of the stop screw.

9. Carefully lift the barrel/plunger assembly out of the pump housing. Dismount the tool.

Press the plunger to the bottom of the barrel. Send the barrel/plunger assembly to an MAN B&W authorized workshop for repair, or overhaul it on board as described in 909-3.2.



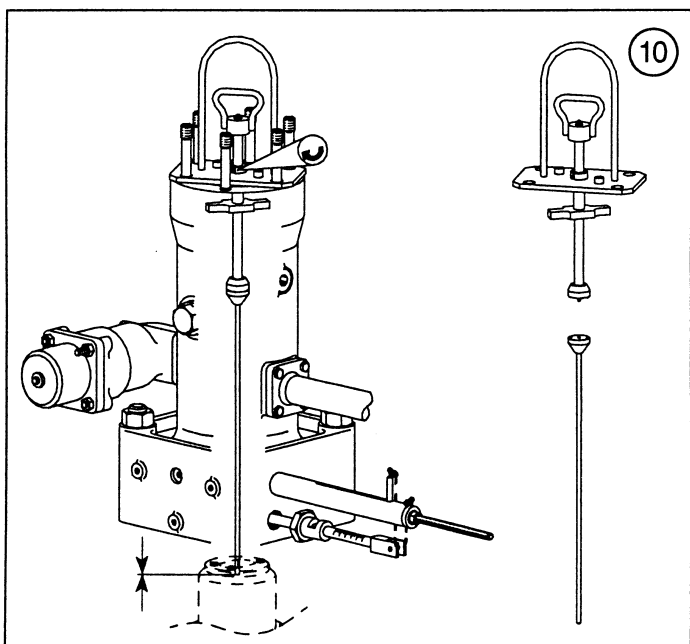
Mounting

10. Place the supplied measuring pin – which is of the same length as the plunger – on the spindle of the lifting tool, fastening it by means of the centre screw of the spindle. Loosen the stop ring on the spindle.

Place the tool on the pump housing, and press the spindle down until the pointed end of the measuring pin reaches the thrust piece of the roller guide.

Then press the stop ring down until it reaches the flange of the tool and lock it there by tightening the screw of the stop ring against the spindle.

Now the stop ring is to remain tightened in this position until the plunger has been correctly mounted.



Note !

The engine **must not** be turned until the mounting of the barrel/plunger assembly has been completed.



11. Dismount the tool from the pump housing and remove the measuring pin from the spindle. Then mount the tool on the barrel/plunger assembly prepared for mounting.

Tighten the tool to the barrel by means of the two screws, and attach the plunger to the spindle of the tool by means of the centre screw of the spindle. The tool is fixed on the barrel, enabling the correct position to be obtained during mounting.

Before mounting the barrel/plunger in the pump housing, lubricate the thread for the timing guide and all sealing rings with molybdenum disulphide.

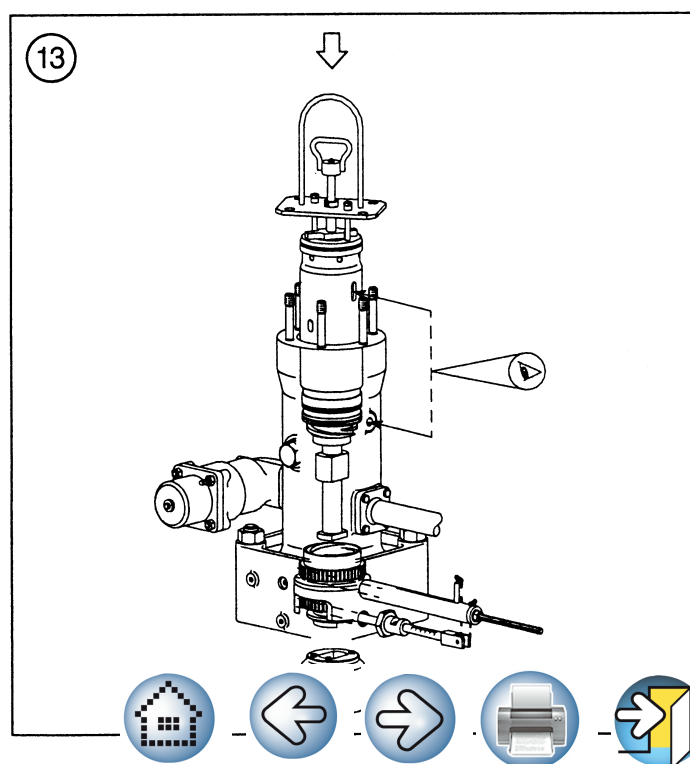
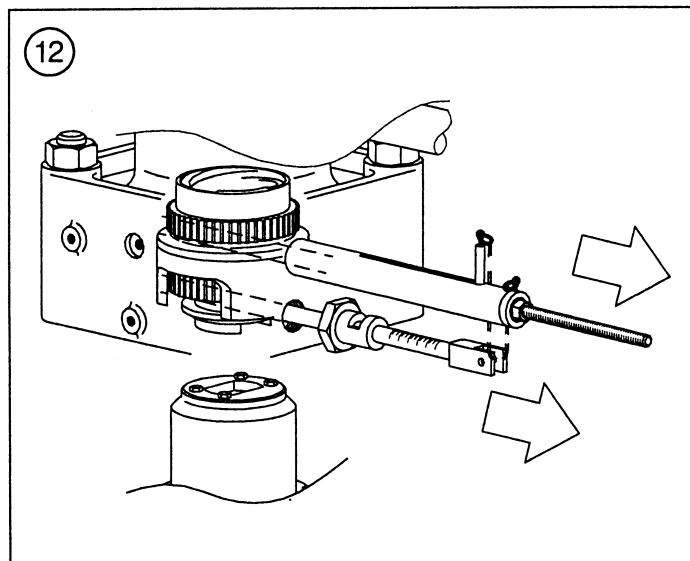
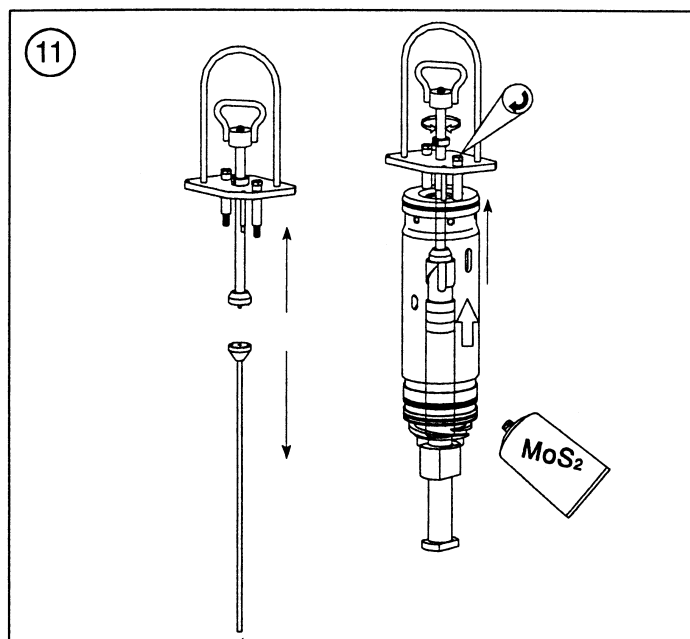
Using the spindle of the tool, pull the plunger as high up in the barrel as possible, at the same time turning the spindle so as to positioning the plunger foot in proportion to the cutout of the regulating guide.

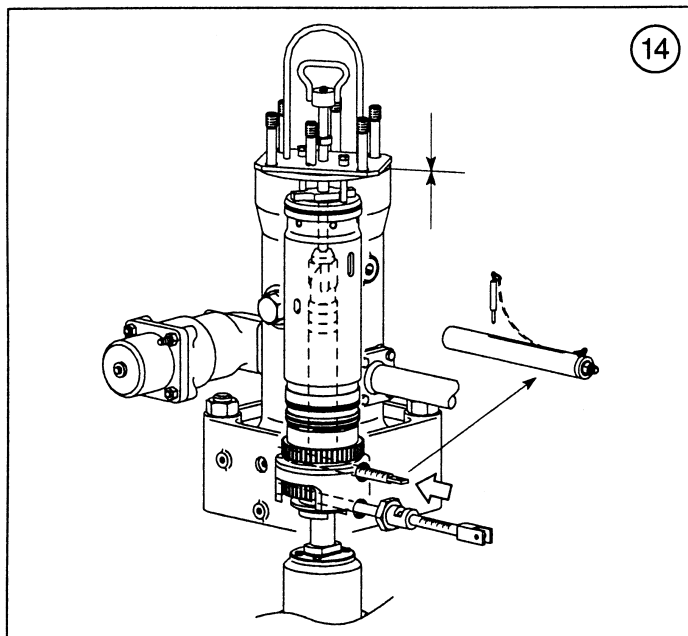
12. Pull the regulating toothed rack as far out as possible and check that the extractor tool is mounted correctly on the timing toothed rack in its outer position.
13. Check that the slot in the barrel coincides with the hole for the guide screw.

Lower the barrel assembly carefully into the pump housing.

If necessary, turn the regulating guide a little (using the toothed rack) to make the foot and the regulating block of the plunger fit properly in the cutout of the regulating guide.

After lowering the barrel assembly so far down into the pump housing that the sealing rings of the barrel are about to enter the bore in the pump housing, continue pressing down the barrel/plunger assembly until the barrel assembly rests on top of the timing guide. There will be a gap between the tool and the pump housing.



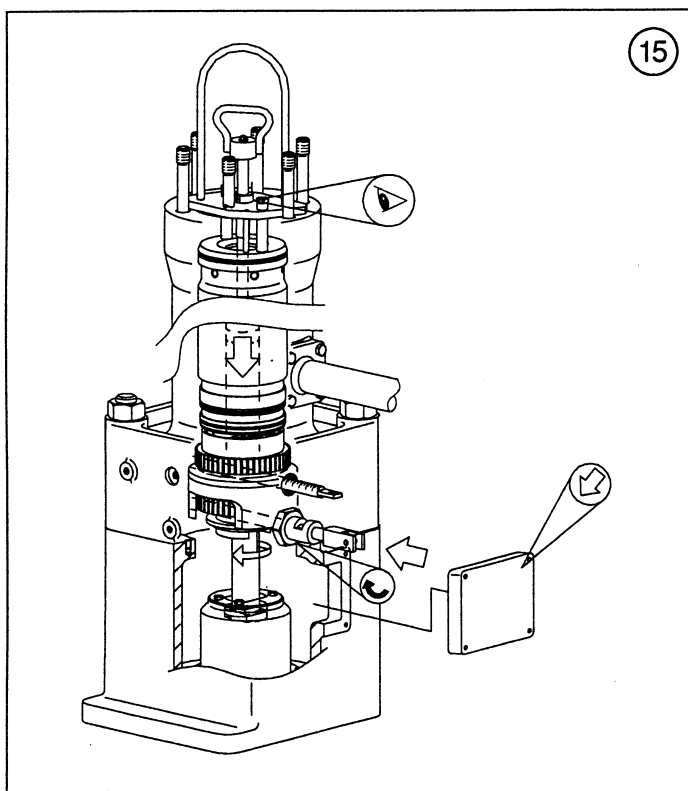


14. Loosen the nut on the extractor, disconnect the pulling rod from the timing toothed rack, and remove the extractor tool.

Engaging the thread of the fuel pump barrel with the timing guide is done by pressing-in the toothed rack. (A pressure of about 30 kp may be required).

Check that the toothed rack is correctly engaged by pressing-in the rack. When doing this the pump barrel shall move downwards.

The top flange of the tool is now resting on the top of the pump housing.



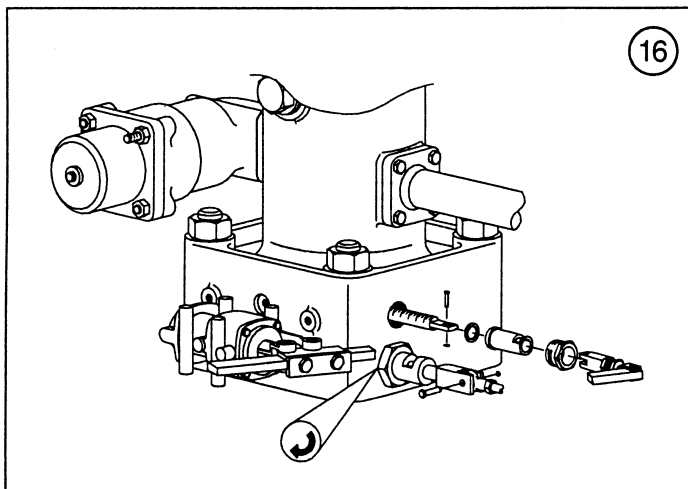
15. After 'landing' the barrel assembly, press the plunger down **into contact** with the thrust piece of the roller guide.

Check that the stop disc of the spindle is in full contact with the flange of the tool, as when measuring.

If necessary, turn the regulating guide a little (using the toothed rack) to make the plunger foot fit properly in the cutout of the roller guide. Inspect the position of the plunger foot through the inspection hole.

When the plunger is in place, press the regulating rod in, thereby turning the plunger by means of the regulating guide and causing the plunger foot to "interlock" with the bayonet joint of the roller guide.

Check that the plunger is correctly engaged by pulling at the spindle of the tool. When doing this, it **must not** be possible to lift the spindle. Mount the cover of the inspection hole.



16. Mount the pointer and union for the timing rack.

Mount the links for the timing drive and the regulating drive in place in accordance with the marks.



17. Mount the guide screw for the pump barrel in the pump housing.

Remove the centre screw from the plunger, and remove the tool.

18. Mount the guide bushing and a new sealing ring on top of the pump housing.

Mount the overhauled top cover (with an overhauled suction valve and reconditioned seatings for the high-pressure pipes) on the pump housing. Lubricate all sliding faces and sealing rings with molybdenum disulphide.

Warning !

As a safety precaution and **before** mounting the top cover nuts, turn the engine one revolution. When doing this, the top cover **must not** move upwards !

Mount the nuts for fastening the top cover, tightening up these diagonally with the torques indicated in Data.

Measure the lead of the fuel pump, see *Procedure 909-1*, and adjust, if necessary.

At the same time, it may prove necessary to adjust the lead of the cam disc, see *Procedure 909-2*.

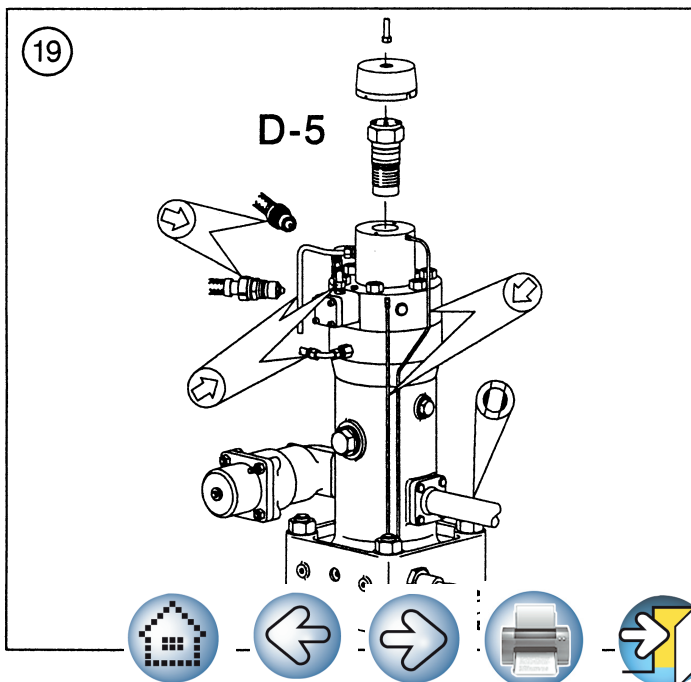
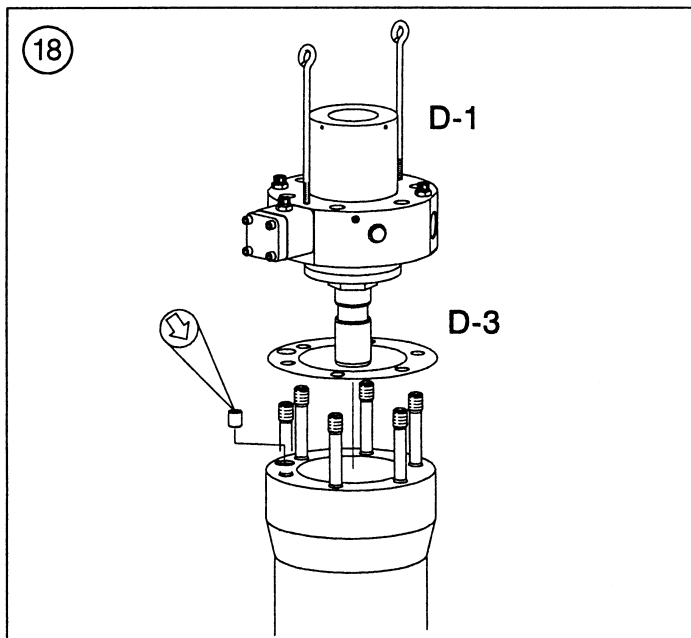
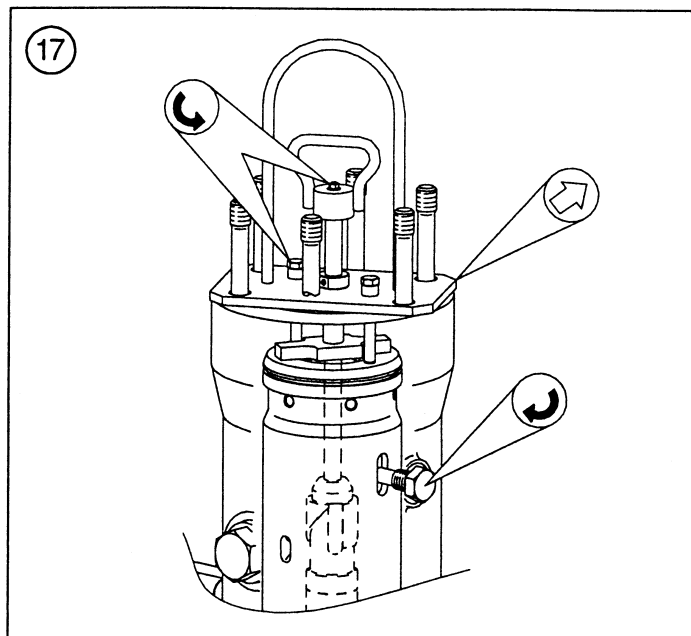
19. Finally, mount a new or overhauled puncture valve on the top cover.

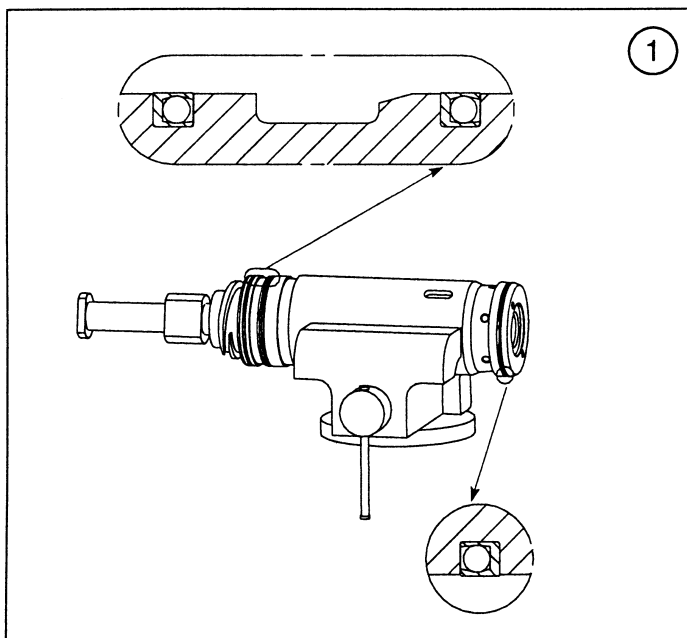
Mount the protective cap over the puncture valve and the two screws in the top cover.

Mount the high-pressure pipes and close the drain cock in the pump housing.

Mount the drain pipes on the top cover, the pump housing and the connecting pipe to the puncture valve.

Open the fuel oil inlet.





1. Set up the pump barrel/plunger in a bench vice which is provided with "soft" jaws.

Remove and discard the sealing rings from the barrel.

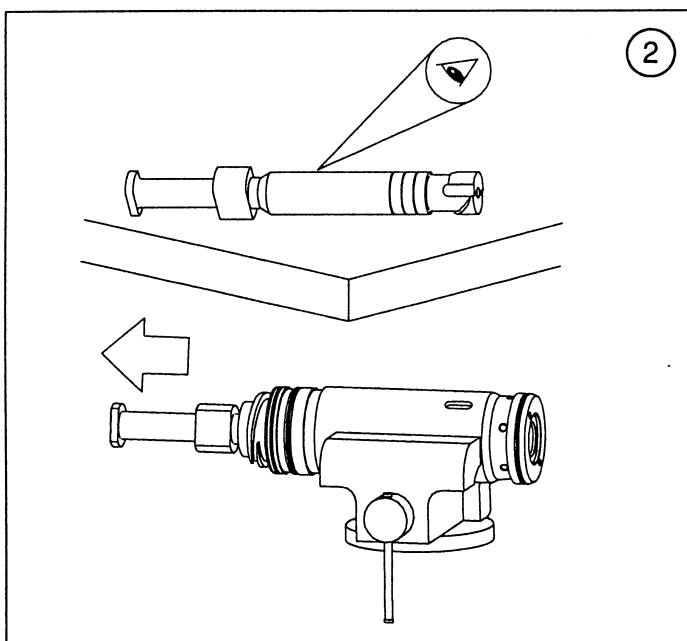
2. Pull the plunger carefully out of the barrel.

Carefully clean the plunger (for example in clean kerosene) and blow it dry with compressed air.

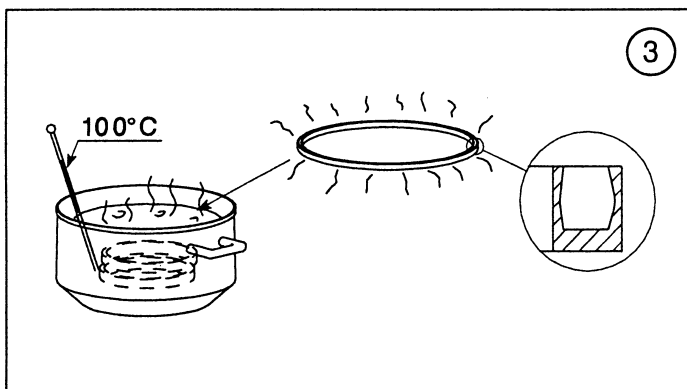
Check the plunger for wear or seizure marks.

Clean the barrel and blow it dry with compressed air.

Check the barrel for wear or seizure marks.



3. Before mounting sealing rings on the barrel, all the new rings **must be heated in 100°C hot water** for at least five minutes.



- When mounting the new sealing rings on the pump barrel at the lower end, the inner sealing ring must be mounted first.

Mount the guide stick in the barrel and position the big cone on the barrel.

Place the spring-loaded sealing ring on the cone with the spring facing upwards, *see the sketch*.

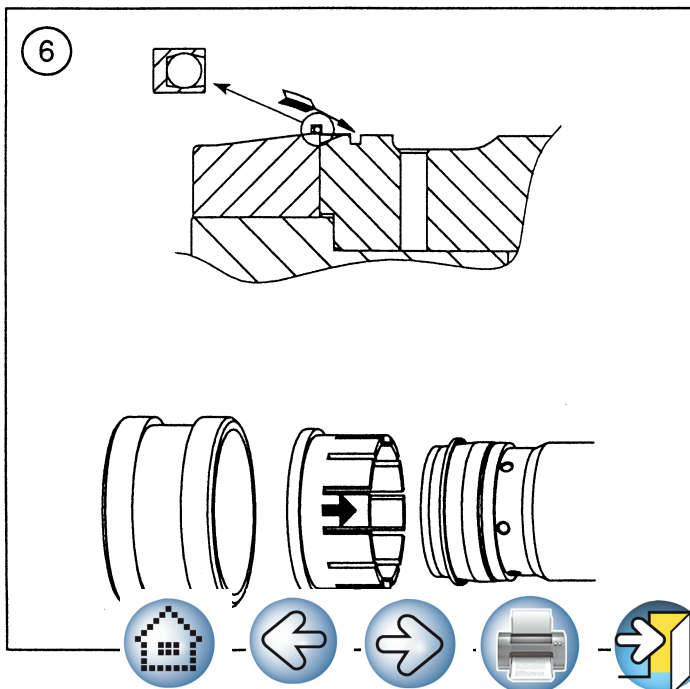
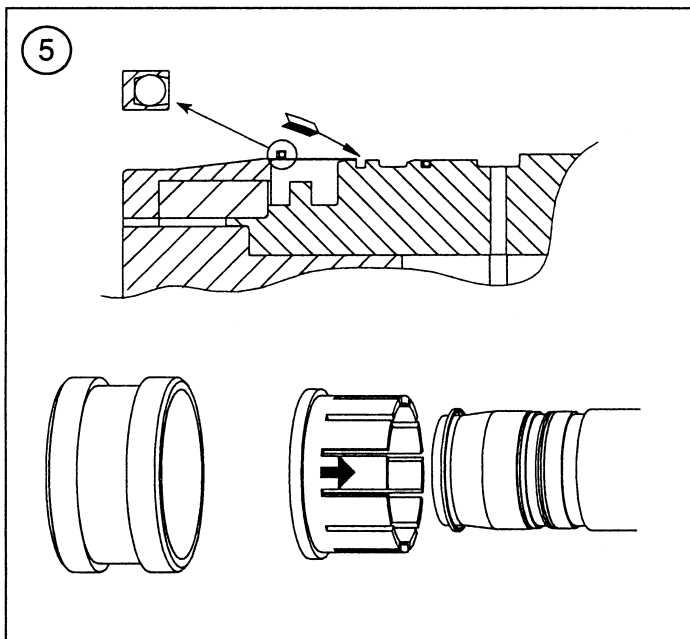
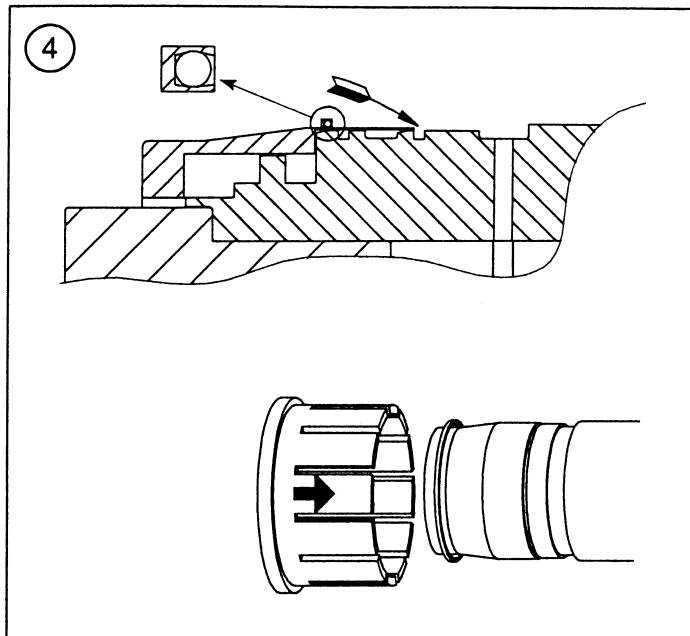
Use the pusher to push the sealing ring into the groove.

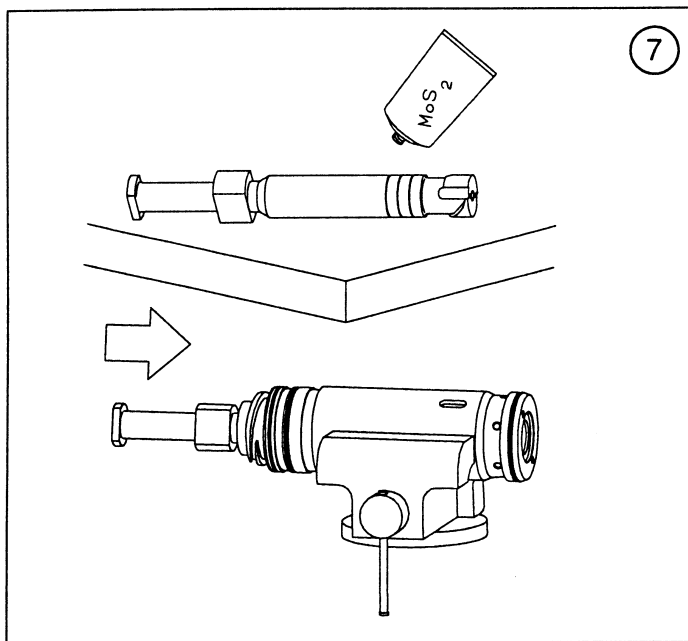
- When mounting the sealing ring in the outer groove, place the spacer inside the cone to obtain the correct distance to the groove, and repeat the above procedure.

After mounting the sealing rings, compress them by means of the "seizer", which is pressed over the sealing rings.

- Mount the guide stick and cone on top of the barrel and mount the sealing ring in the same way as above.

Make sure that the spring faces downwards, *see the sketch*.





7. Lubricate the plunger with molybdenum disulphide (MoS_2).

Slide the plunger into the barrel and press it to the bottom.

1. Dismount the protective cap and the puncture valve from the top cover.
2. Mount two eye screws in the bottom of the top cover.

Mount the top cover upside down in the fuel pump housing.

Note !

The barrel/plunger must be removed.

3. Release the lock washer for the suction valve.

Dismount the suction valve from the top cover.

Remove and discard the lock washer.

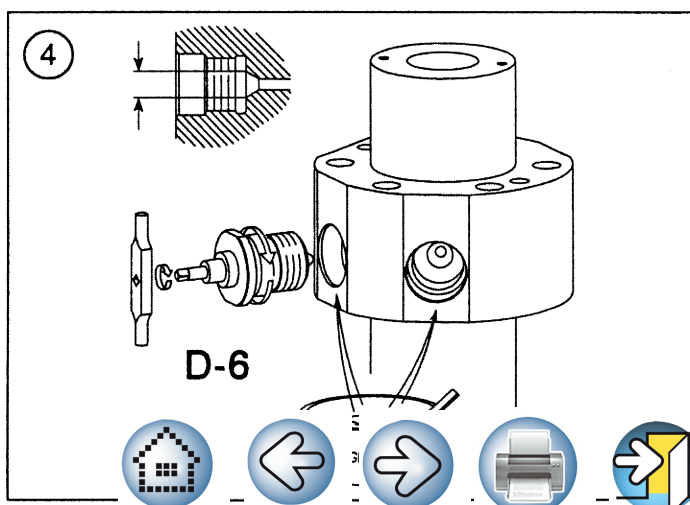
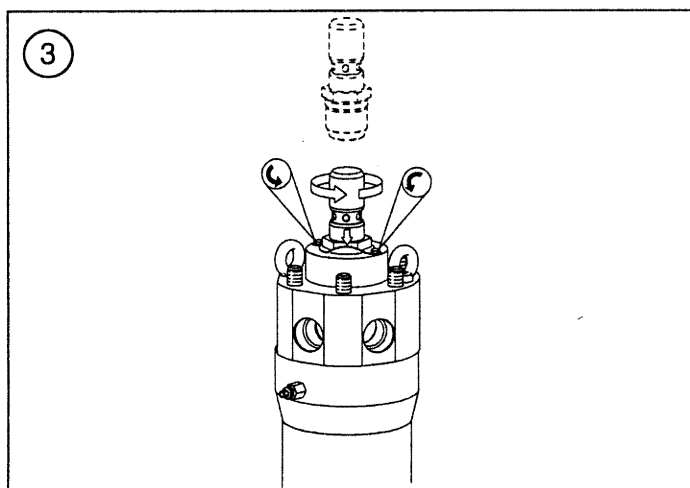
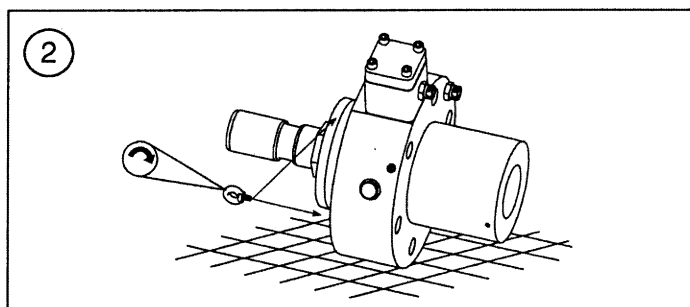
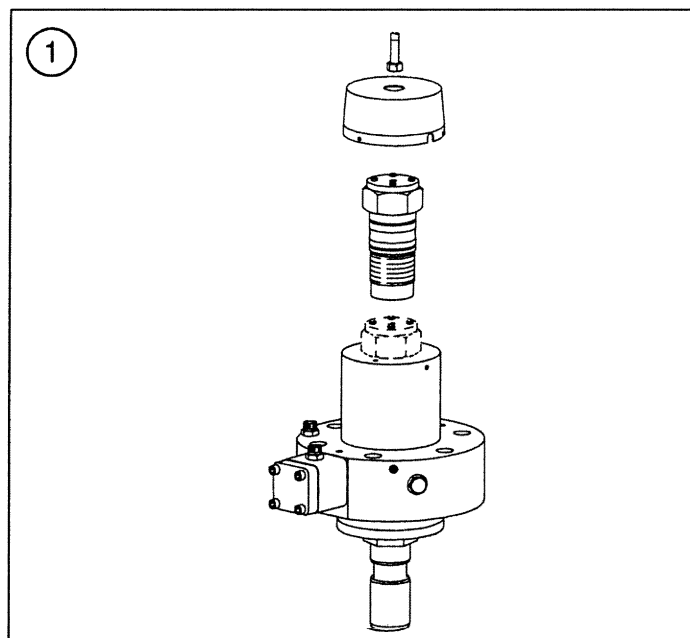
Lift away the top cover from the fuel pump housing.

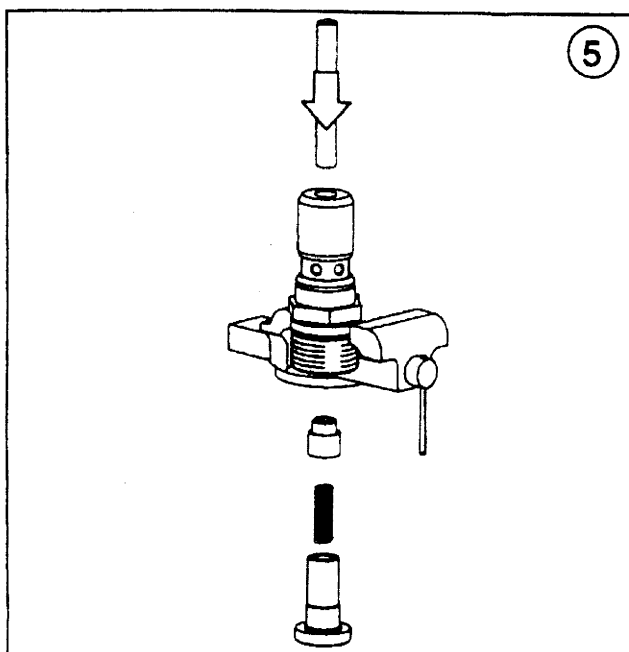
4. Fill the oil ducts in the top cover with vaseline or heavy grease.

During the work the miller is guided by the guide screwed into the high-pressure pipe thread.

After completing the milling, blow out the vaseline/grease from the oil ducts by means of compressed air. Clean the top cover with diesel oil/gas oil, and blow dry with compressed air.

See also Procedure 909-7.





Overhaul of the suction valve

- Set up the suction valve in a bench vice with "soft" jaws and, by means of a brass mandrel and a hammer, release the spring guide from the valve thrust piece.

Disassemble the other parts of the suction valve and clean the parts thoroughly in clean diesel oil.

Remove and discard the sealing ring from the valve thrust piece.

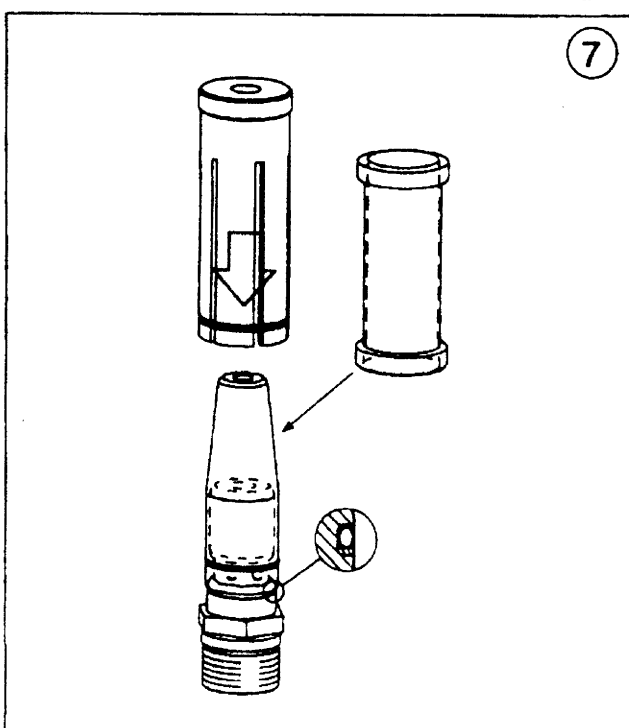
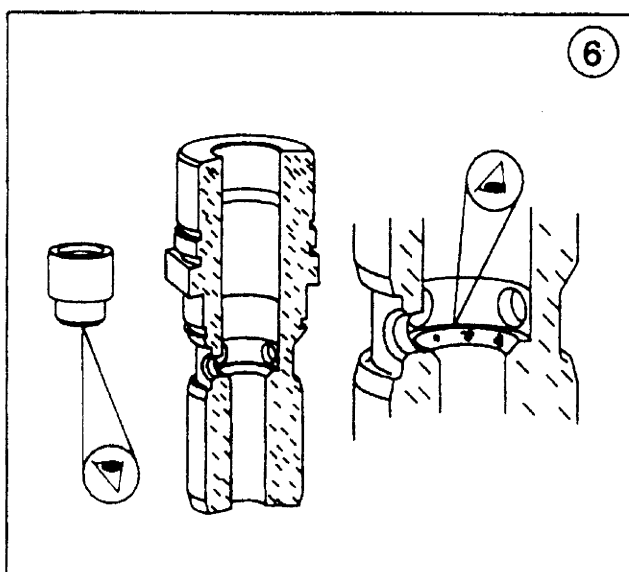
- Inspect the seat of the valve slide and the seat on the thrust piece for damage. If the seats are damaged, both the suction valve and the valve slide must be discarded. Lapping of the seats must not be attempted.

- Mount the O-ring in the ring groove of the thrust piece and position the cone on the thrust piece.

Place the sealing ring on the cone and, by means of the pusher, push the sealing ring on the O-ring into the groove.

Check that the sealing ring is mounted correctly. See the sketch.

After mounting the sealing ring, compress it by means of the "seizer", which is pressed over the sealing ring.



8. After cleaning and overhauling of all internal parts, lubricate these with molybdenum disulphide (MoS_2) and assemble the suction valve.

Check the seats for tightness by filling the discharge hole with diesel oil and wait five minutes. No oil may pass through the seats of the slide/housing.

Overhaul of puncture valve

9. Dismount the puncture valve from the top cover. Remove and discard the O-rings from the puncture valve.

Set up the puncture valve in a bench vice with "soft" jaws.

Loosen and remove the four screws and dismount the plug. By means of a screw, remove the air piston from the housing. Remove and discard the sealing rings from the air piston.

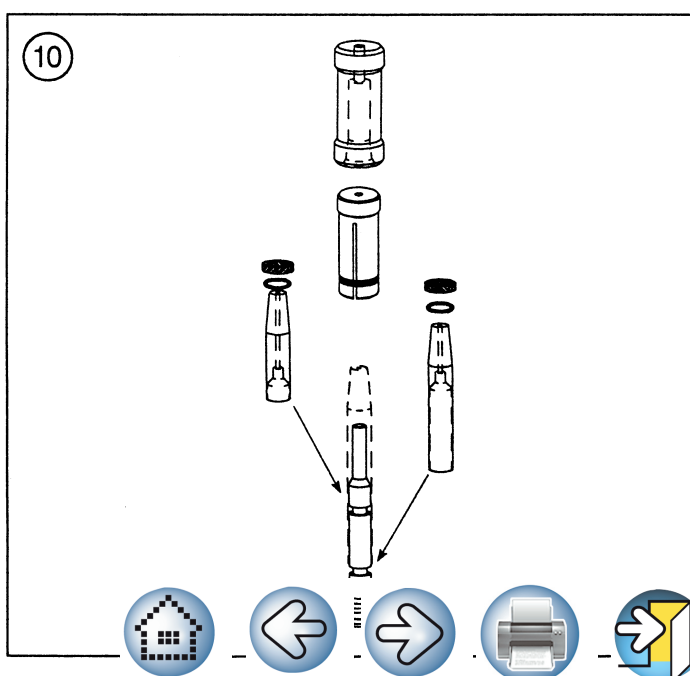
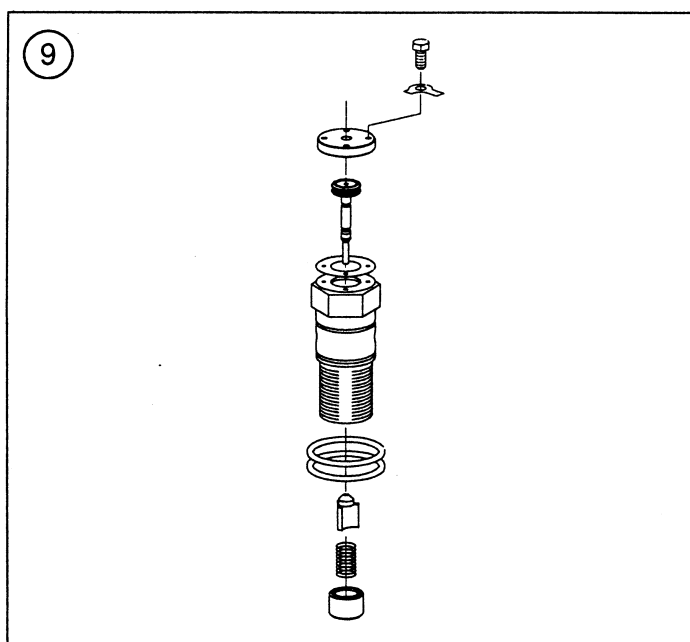
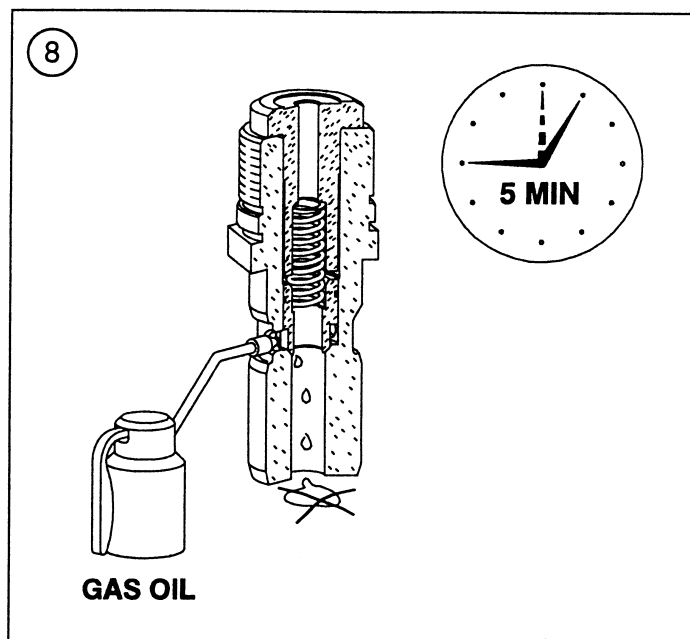
Disassemble the other parts of the puncture valve by means of a brass mandrel and a hammer, and clean all the parts thoroughly in clean diesel oil.

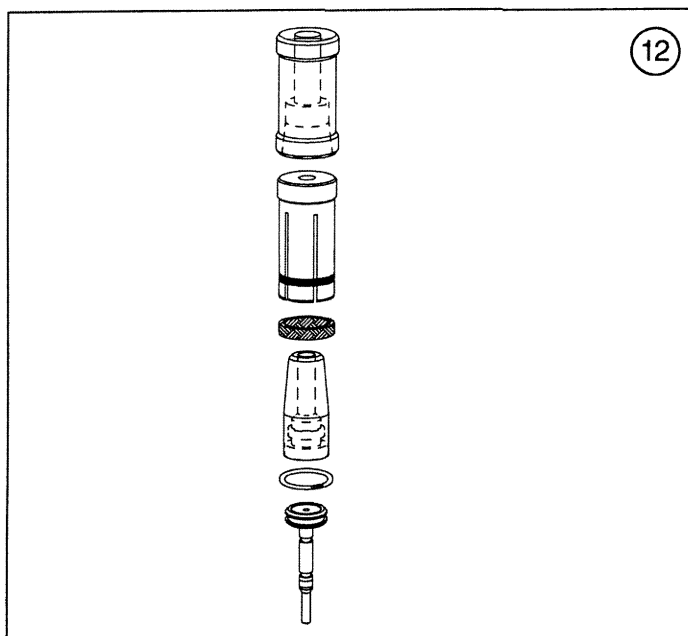
Check all conical seats in the valve housing and on the valve slide, and recondition, if necessary.

10. When mounting the new sealing rings on the rod of the air piston, the inner sealing ring has to be mounted first.

Mount the O-ring in the ring groove and position the large cone on the rod. Place the sealing ring on the cone and, by means of the pusher, push the sealing ring on to the O-ring in the groove.

After mounting the sealing ring, compress it by means of the "seizer", which is pressed over the sealing ring.





11. The sealing ring is mounted in the outer groove, using the short cone, and repeating the above procedure.
12. The new sealing ring is mounted on the head of the air piston in accordance with the same procedure as above.

Before assembling the puncture valve, lubricate all parts with molybdenum disulphide (MoS_2).

Mount new O-rings on the housing.

Mounting of valves on top cover

13. Mount the top cover upside down in the fuel pump housing.

Note !

The barrel/plunger must be removed.

Fit a new lock washer and mount a new or overhauled suction valve on the top cover.

Tighten the suction valve with a torque spanner. *See Data.*

Fit the two screws which secure the lock washer, and lock the suction valve in position by bending up an edge of the lock washer over one of the flats of the valve.

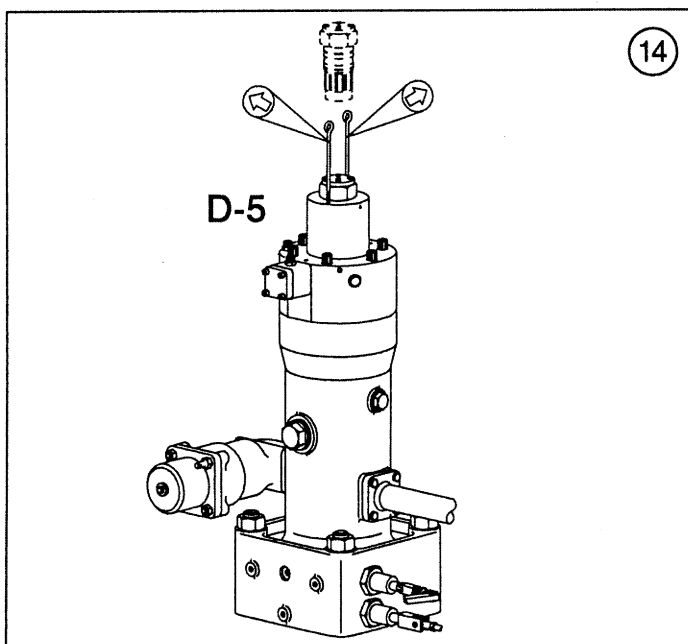
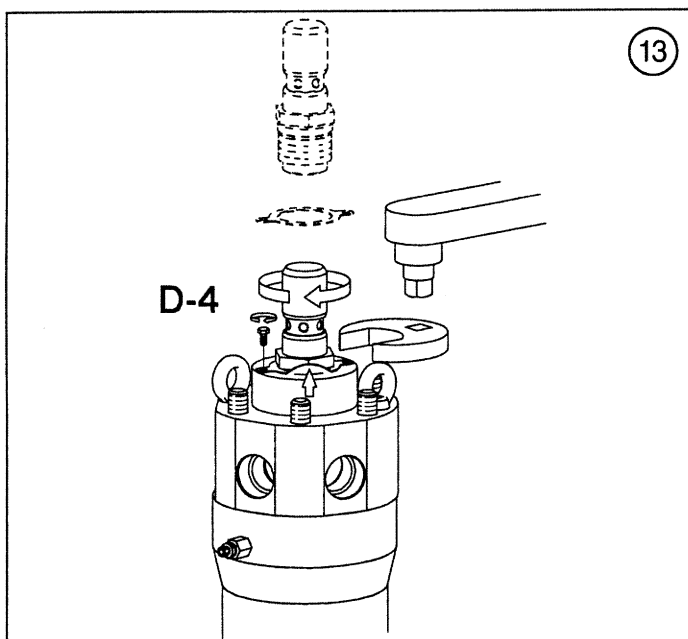
Lift away the top cover from the fuel pump housing.

Mount the barrel/plunger - see 909-3.1.

14. Mount the top cover on the fuel pump housing and tighten the nut. *See Data.*

Mount the puncture valve on top of the top cover and tighten it. *See Data.*

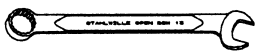
Mount the protective cap over the puncture valve, the three drain oil pipes, the return oil pipe, the air pipe and the



SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

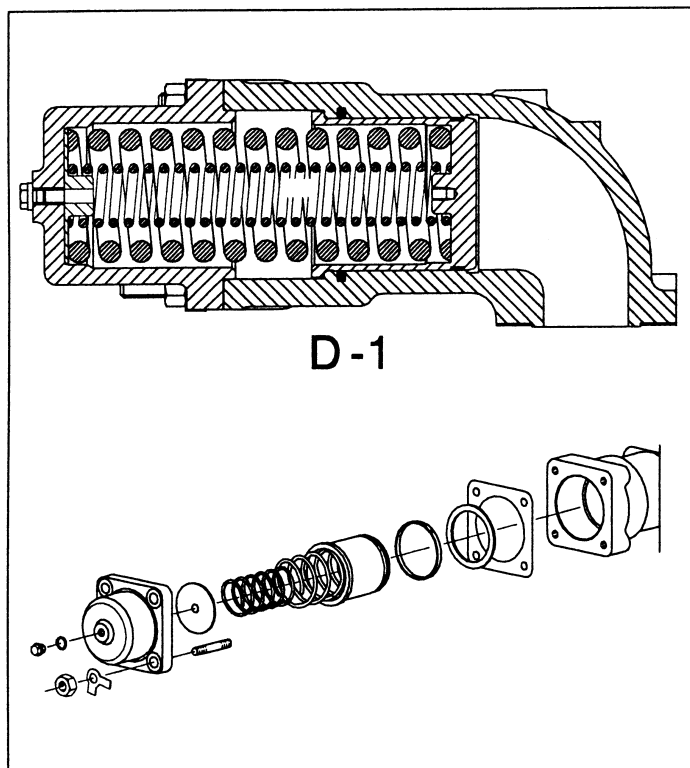


16, 24 mm



14 mm





Checking

The functioning of the shock absorber should be checked at regular intervals. This is done by simply removing the plug in the end cover of the shock absorber and checking, during operation, that air is “pulsated” through the threaded hole (these air pulses occur when the piston in the shock absorber is working and the air above the piston is compressed and forced out through the threaded hole).

At the same time, check the “tightness” of the piston, which can be judged by the amount of oil coming out of the drain pipe of the shock absorber housing. The amount of leakage oil must be checked from time to time to ascertain deteriorations in the piston sealing. If the shock absorber is found to be working unsatisfactorily, it should be disassembled for inspection. Under normal circumstances, inspection is only necessary at the intervals stated in the maintenance programme.

Disassembling

Remove the nuts and lock washers from the end cover (**Note:** the end cover is spring-loaded), and take off the cover together with the spring guide and gasket. Now take out the springs.

Take out the piston. If the piston does not come out easily, screw a long screw into the bottom of the piston and, by this means, pull the piston out.

Overhauling

Take out the sealing ring which is mounted in the piston bore in the shock absorber housing, and then take the wear ring off the piston. Clean and polish the piston and piston bore in the housing so that the parts can operate freely. Mount a new wear ring on the piston and a new sealing ring in the housing.

If, after overhauling there is still a too large drain oil amount, the entire shock absorber must be replaced and the removed shock absorber sent for repair.



Assembling

Carefully place the piston in the bore of the shock absorber housing without deforming the sealing ring or the wear ring (check that the piston/bore fit is in order), position the springs and then mount the cover together with the spring guide and a new gasket.

Now mount the lock washers and nuts. Tighten the nuts and lock them.



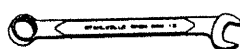
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SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☒ Shut off lubrication oil
- ☐ Lock turbocharger rotors

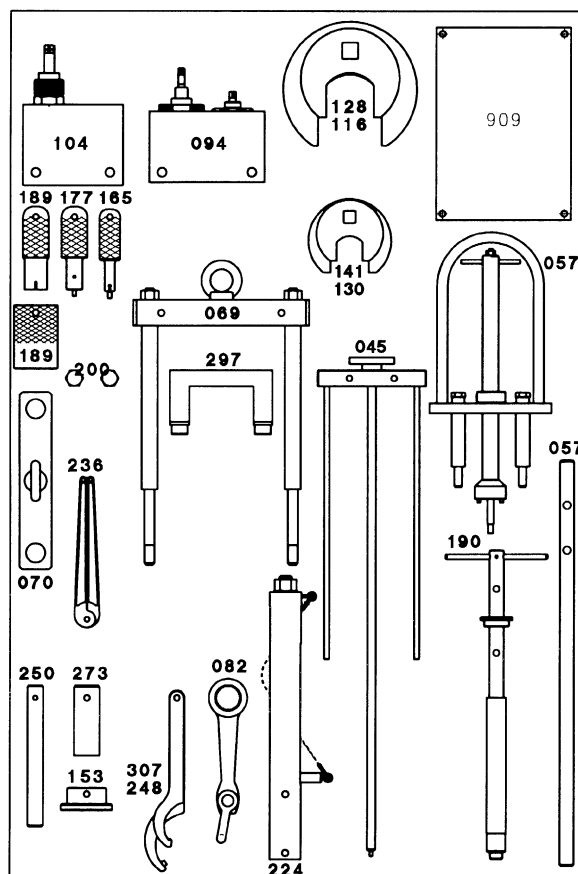
913

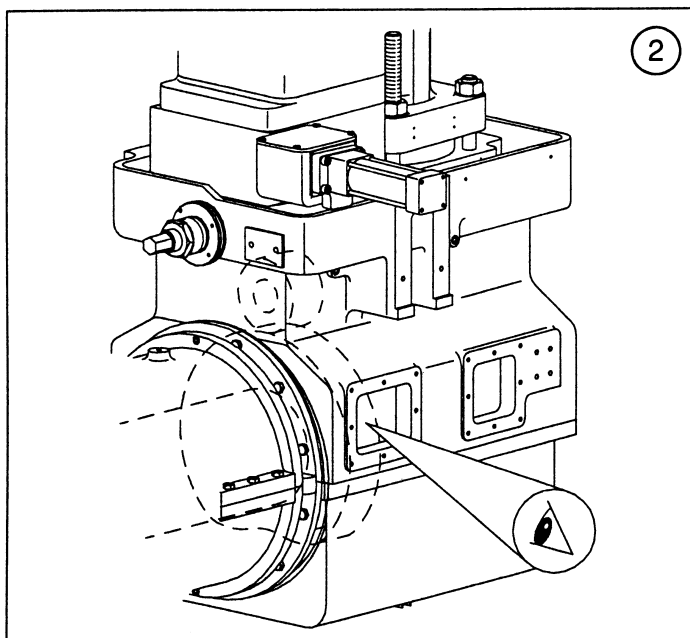
 10, 36 mm

 8 mm

 75 mm

 500 kg





Warning !

Do **not** use the lifting tool for the fuel pump roller guide while the engine is running.

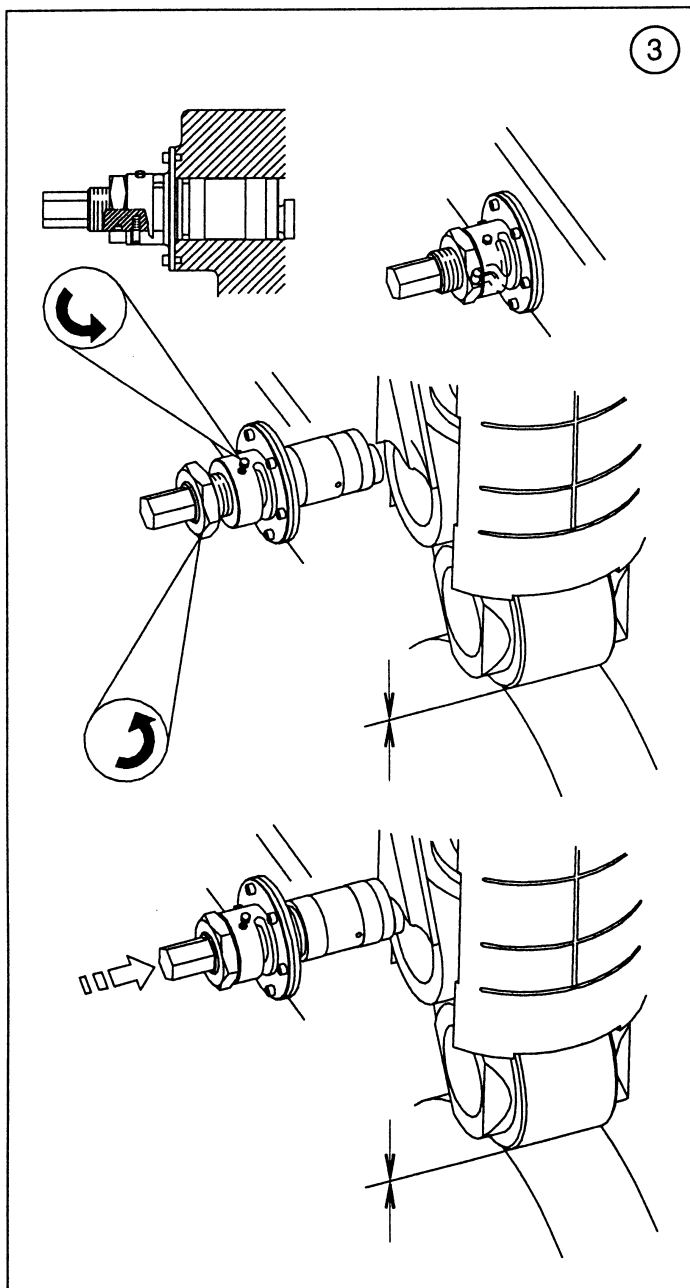
1. If a fuel pump is to be put out of action, disconnect it in the following manner:
2. Stop the engine and engage the turning gear.

Remove the inspection cover on the upper part of the camshaft housing in front of the fuel cam for the pertaining roller guide.

Turn the engine until the roller is in the highest position on the cam (on the circular section of the cam).

3. Loosen the stop screw on top of the flange and the nut on the lifting tool.

Press the shaft against the roller guide. When the shaft is pressed in, the guide screw is positioned in line with the vertical groove of the flange.



4. Mount the chain wheel on the shaft, with the chain in such a position that when pulling at the chain, the chain wheel and shaft will turn anti-clockwise until the guide screw is in top of the groove, which indicates that the roller guide is in the lifted position.

Lock the shaft in this position by means of the lock screw and the nut on the lifting tool.

The roller guide is now clear of the fuel cam, and the engine can operate on the remaining cylinders, *see Volume I, Section 704*.

Engagement of the fuel pump roller guide

Warning !

Engagement of the fuel pump roller guide must **only** take place when the engine is at a standstill.

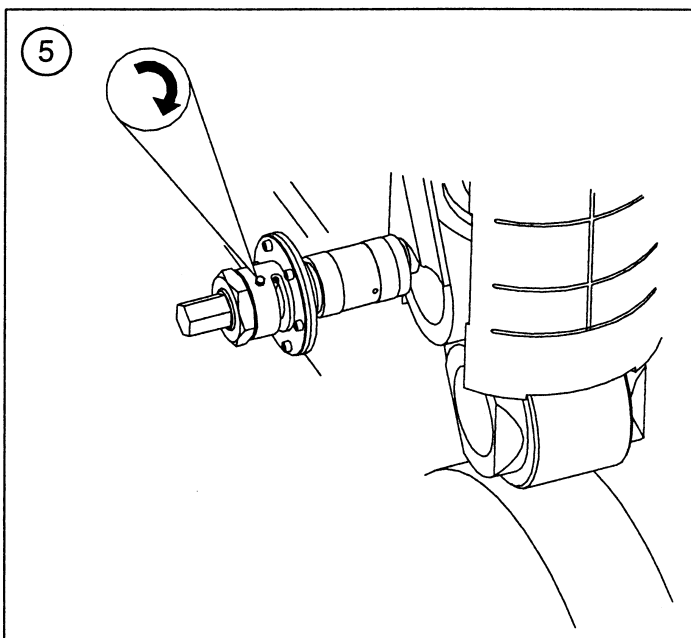
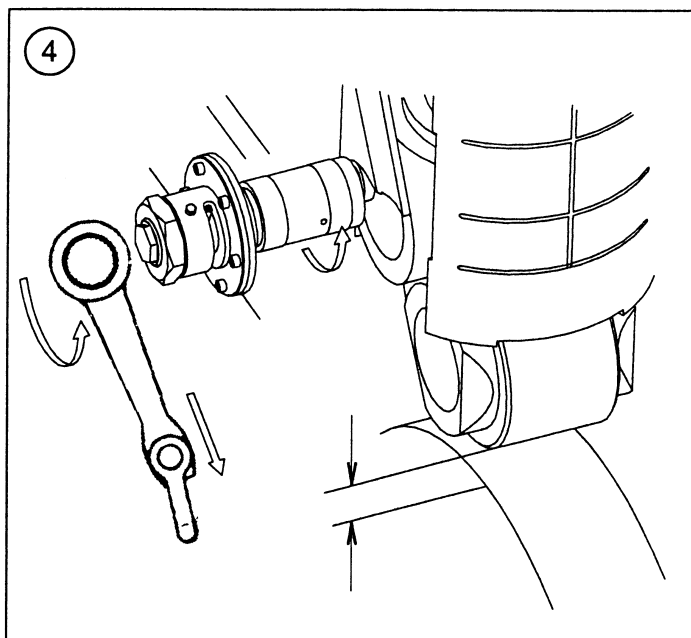
5. Turn the engine until the pertaining fuel cam's circular section is positioned upwards, and lower the roller guide in the reverse order to lifting.

NB! Remember to loosen the lock screw.

Remove the tackle and the chain wheel from the lifting tool.

When the roller guide has been lowered into the position where the guide screw is in the lowermost position, tighten the lifting tool nut against the flange whereby the lifting tool will be drawn away from the roller guide. The guide screw will now be positioned at the end of the horizontal groove of the flange.

Tighten the lock screw.



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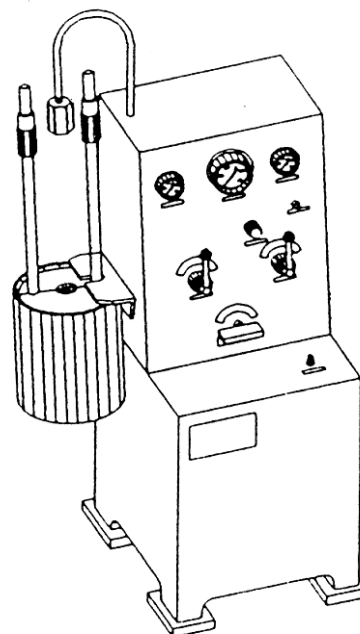
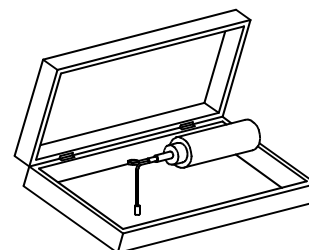
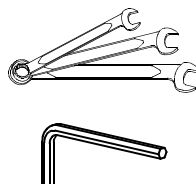
SAFETY PRECAUTIONS

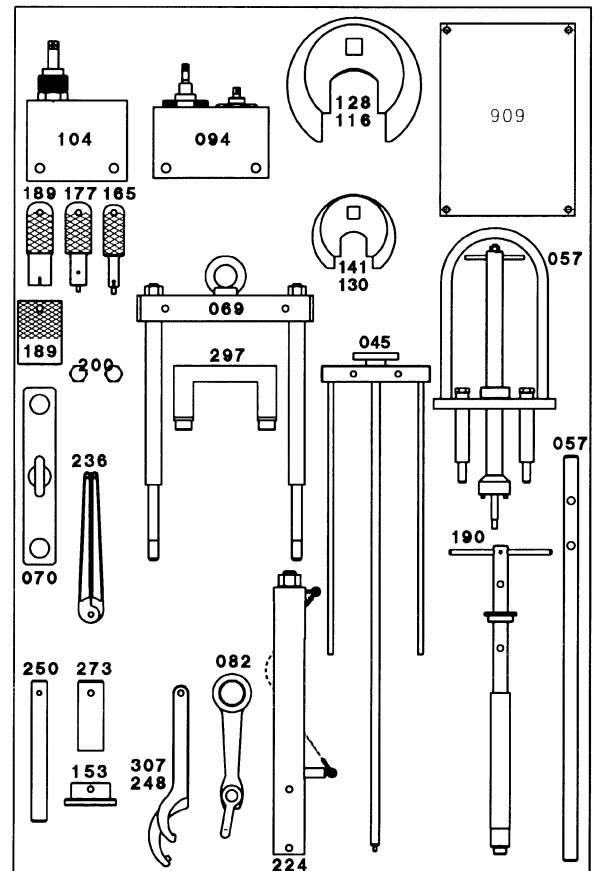
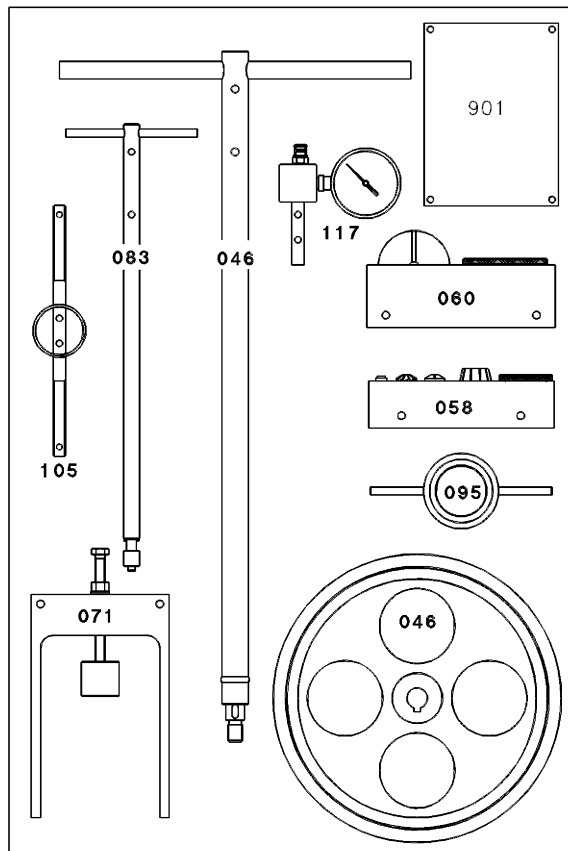
☒	Stopped engine
☒	Block the starting mechanism
☒	Shut off starting air supply
☐	Engage turning gear
☐	Shut off cooling water
☒	Shut off fuel oil
☐	Shut off lubricating oil
☐	Lock turbocharger rotors

Data

Ref.	Description	Value	Unit
D-1	Max. diameter	30	mm
D-2	Weight of fuel valve	15	kg
D-3	Opening pressure	300-380	bar

Standard Tools: See Section 913





The fuel valves must be given the utmost attention and care, as the greater part of irregularities that may occur during the running of the engine can be attributed to defects in these valves.

If the engine gives normal performance in accordance with diagrams and exhaust temperatures, it is only necessary to inspect the fuel valves after the service period stated in the Checking and Maintenance Programme. See *Chapter 900-1*.

In order to obtain reliable results during testing of the fuel valves, all fuel valves that are dismantled from the engine must be disassembled, cleaned, inspected and re-assembled before testing. See *Procedure 909-11.3* and *909-12.3*.

Note!

In the event that the slide-type fuel valve is pressure tested without being cleaned between the fuel nozzle and the cut-off slide, the opening pressure value measured might be considerably lower than specified.

All fuel valves **must** be function-tested before being mounted in the cylinder cover.

1. Pressure testing pump

If an air supply of 10 bar is not available, working air of seven bar can be used. Use only hydraulic oil (rust-preventing) with a viscosity of between 7 and 10 cSt at 50°C.

For operation of the pressure testing pump, see the supplier's instructions.

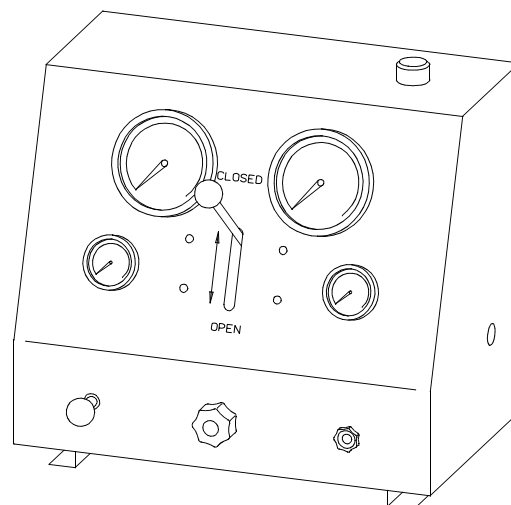
Note that the high-pressure pump should be periodically checked in accordance with the supplier's instructions.

2. Spring housing

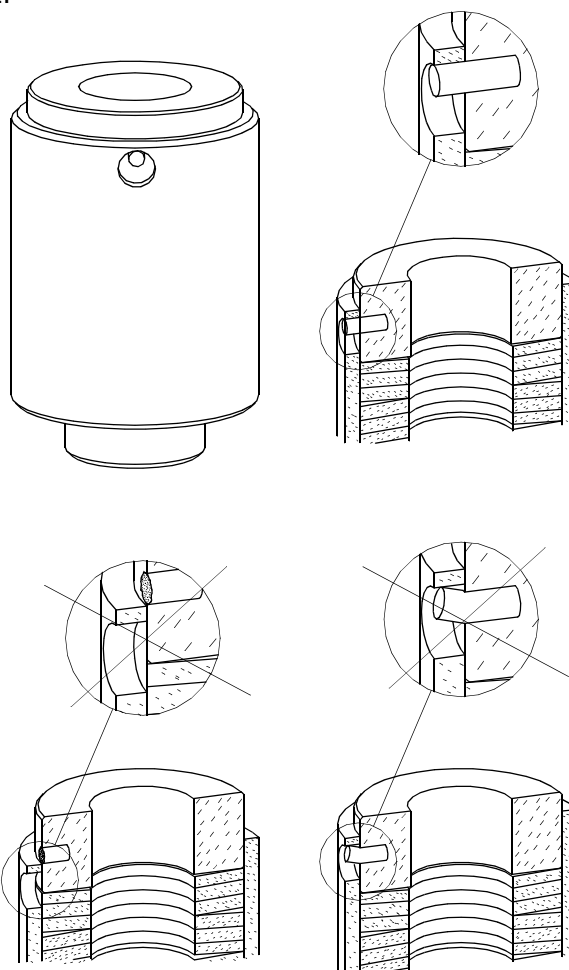
To ensure that overtightening has not taken place, check that the locking/indicating pin has not been bent or broken off.

In the event of overtightening, replace the spring housing by a new one.

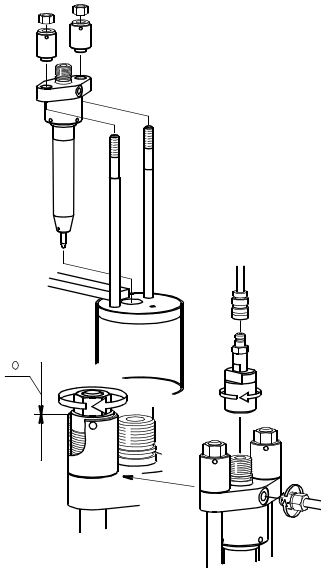
1.



2.



3.



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3. Setting-up the fuel valve

Place the fuel valve in the test rig and secure it with the spring housings and nuts. Tighten the nuts until the top face of the pressure disc is flush with the top face of the spring housings. Mount the oil pipe between the pressure testing pump and the fuel valve.

4. Pressure testing procedure

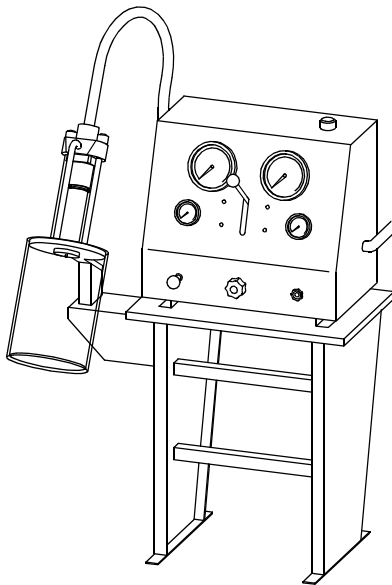
The subsequent items must be followed in the sequence stated. Items 5, 7, 8 and 9 are each divided into the following four sub-items:

- A. Objective
- B. Procedure
- C. Acceptance criteria
- D. Cause of fault.

Note!

If working air of 10 bar is not available, pressures down to 7 bar are acceptable for all the tests.

4.



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5. Flushing and jet control

A. Objective:
To remove air in the system and check the fuel jet.

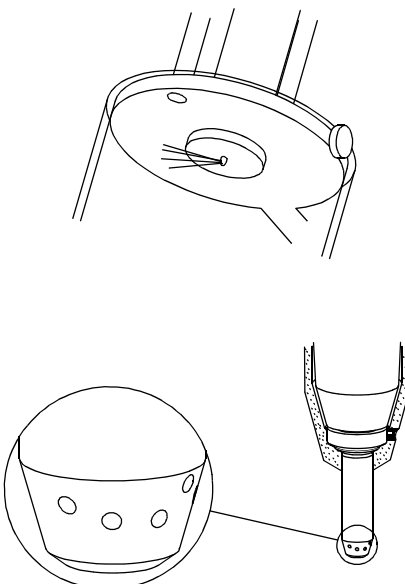
B. Procedure:
The control handle must be in the OPEN position.
Slowly increase the working pressure until straight jets of oil are ejected from the nozzle holes (no atomization).

C. Acceptance criteria:
There is to be a continuous jet of oil through all of the nozzle holes.

D. Cause of fault:
If the jets do not fulfil the above point C, the cause may be:

- Dirt in the nozzle holes.
- The nozzle is not mounted correctly.

5.



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6. Atomization test

Note!

Do **NOT** attempt to carry out an atomization test on slide type fuel valves, as this may damage the cut-off slide and nozzle.

The reason is that the atomization test may damage the valve because it makes the needle oscillate, with a small lift at a very high frequency. The high pressure drop across the cut-off edge and the high contact pressure between slide and fuel nozzle, in combination with the poor lubricity of the test oil, increase the risk of seizures between cut-off slide and nozzle.

All of these conditions involve the risk of seizure between the cut-off slide and the nozzle.

7. Opening pressure

A. Objective:

To check the opening pressure.

B. Procedure:

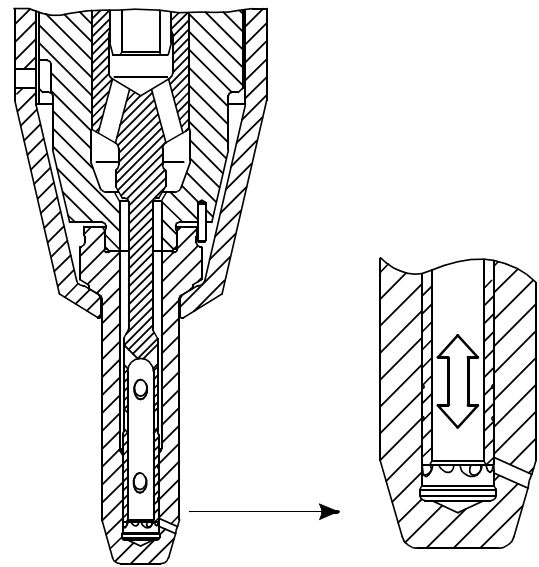
The control handle is to be in the OPEN position.

Increase the oil pressure until oil is admitted through the nozzle holes.

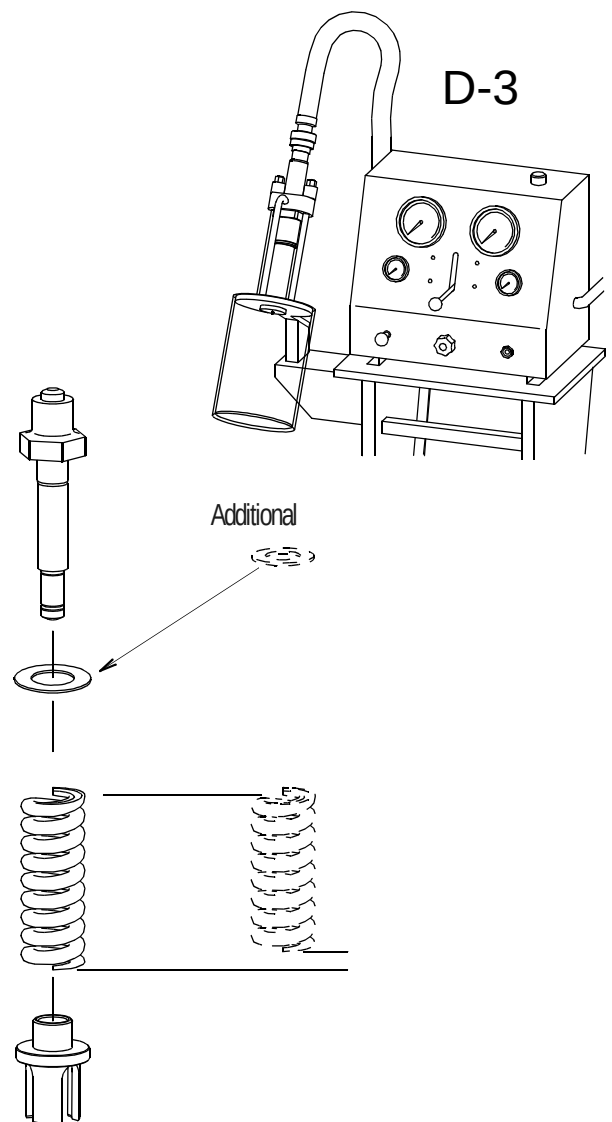
C. Acceptance criteria:

Check the opening pressure on the pressure gauge.

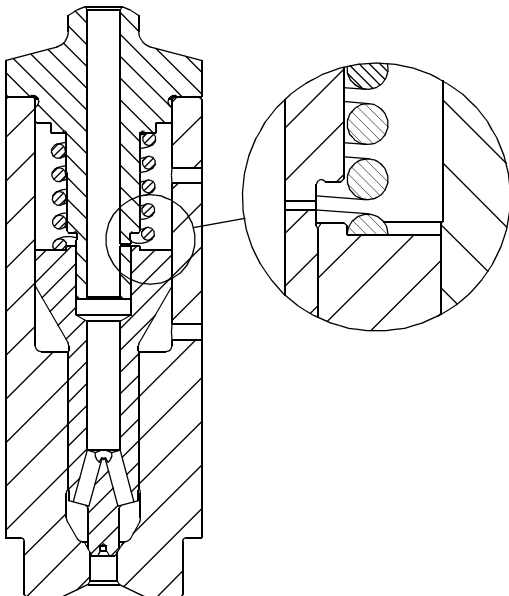
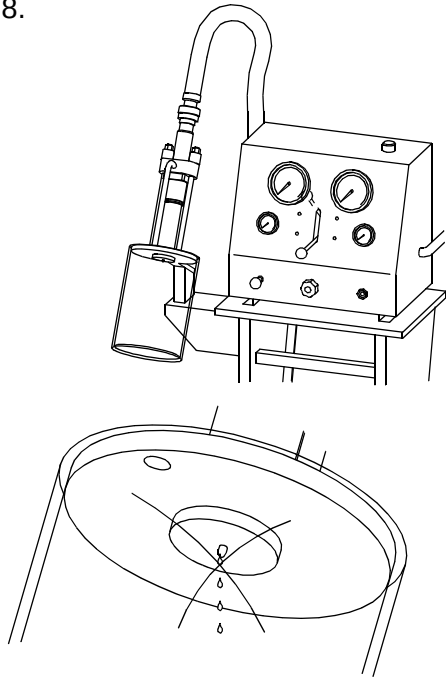
6.



7.



8.



NA909-11.1 211 08

D. Cause of fault:

If the opening pressure is higher than specified in D-3, the cause may be that a wrong type of spring is used – replace the spring on the thrust spindle, if necessary, replace the complete thrust spindle.

If the opening pressure is lower than specified in D-3, the cause may be that the spring has sagged – replace the spring, or add a special thin disc.

Note!

Special thin discs are available as spares.

If a spring or a disc has been changed, the pressure testing procedure of the fuel valve must be repeated from step 4.

8. Sealing test and sliding function

A. Objective:

To check the needle valve seat for tightness and the slide for correct closing.

B. Procedure:

The control handle must be in the OPEN position.

Slowly increase the oil pressure to about 50 bar below the opening pressure. Maintain the built-up pressure by moving the control handle into the CLOSED position. Repeat the procedure two or three times.

C. Acceptance criteria:

Oil must not flow from the nozzle holes.

The pressure drops relatively slowly to about 15 bar, after which it drops quickly to 0 (the slide is pressed against the conical seat and opens for circulation oil).

Note!

Oil flows out of the leak oil outlet when the fuel valve is full of oil.

D. Cause of fault:

D.1 Sealing test

If oil flows out of the nozzle holes, the cause is either:

- Defective spindle guide at needle seat, or a sticking spindle. Examine and/or replace the spindle guide.
See Procedure 909-12.3.
- Too quick pressure drop:
 - the clearances of the movable parts, both of the spindle guide and of the non-return valve, are too large, or
 - the seats between the thrust piece/spindle in the spindle guide or thrust piece/valve slide in the non-return valve are damaged.

Examine and/or replace both the spindle guide and non-return valve.

See Procedure 909-12.3.

See Procedure 909-13.3.

D.2 Sliding function

The pressure drops relatively slowly to about 15 bar, after which it drops quickly to 0 (the slide is pressed against the conical seat and opens for circulation oil).

Note!

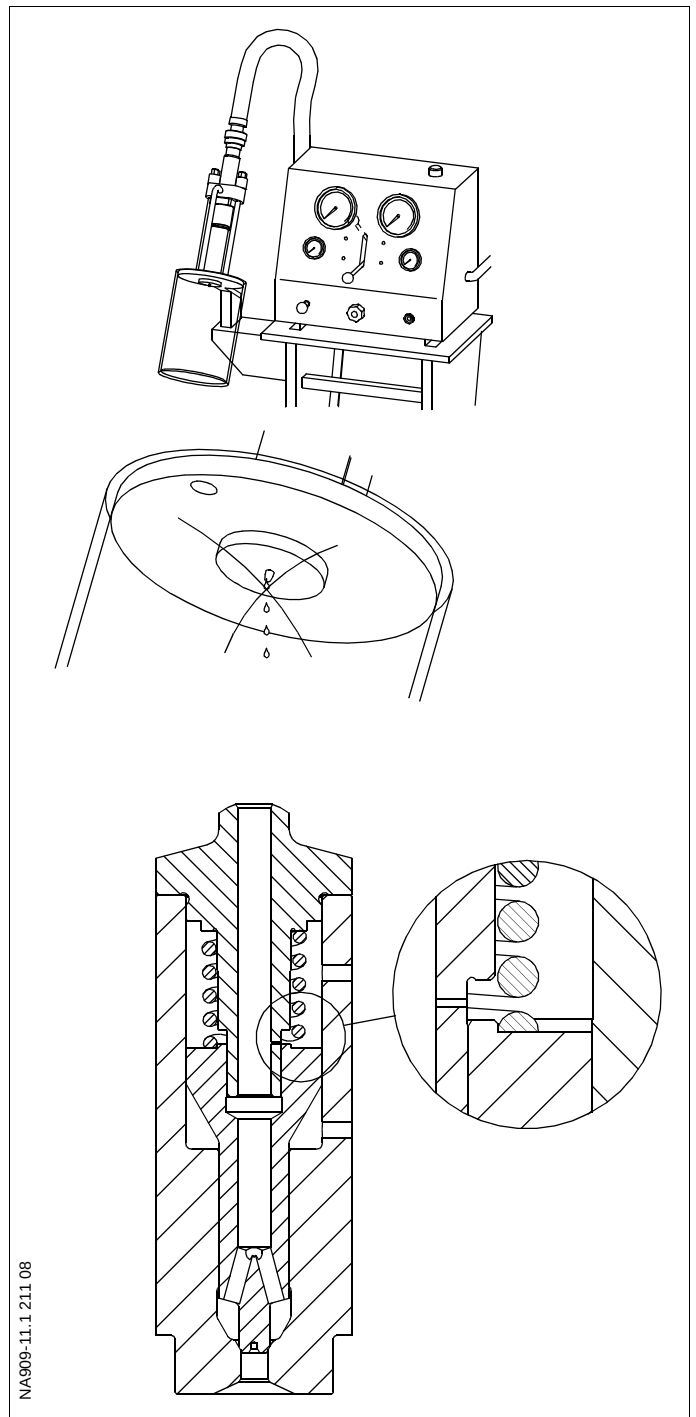
There will always be an oil flow from the leak oil outlet when the fuel valve is full of oil.

If a quick pressure drop from 15 to 0 bar cannot be registered:

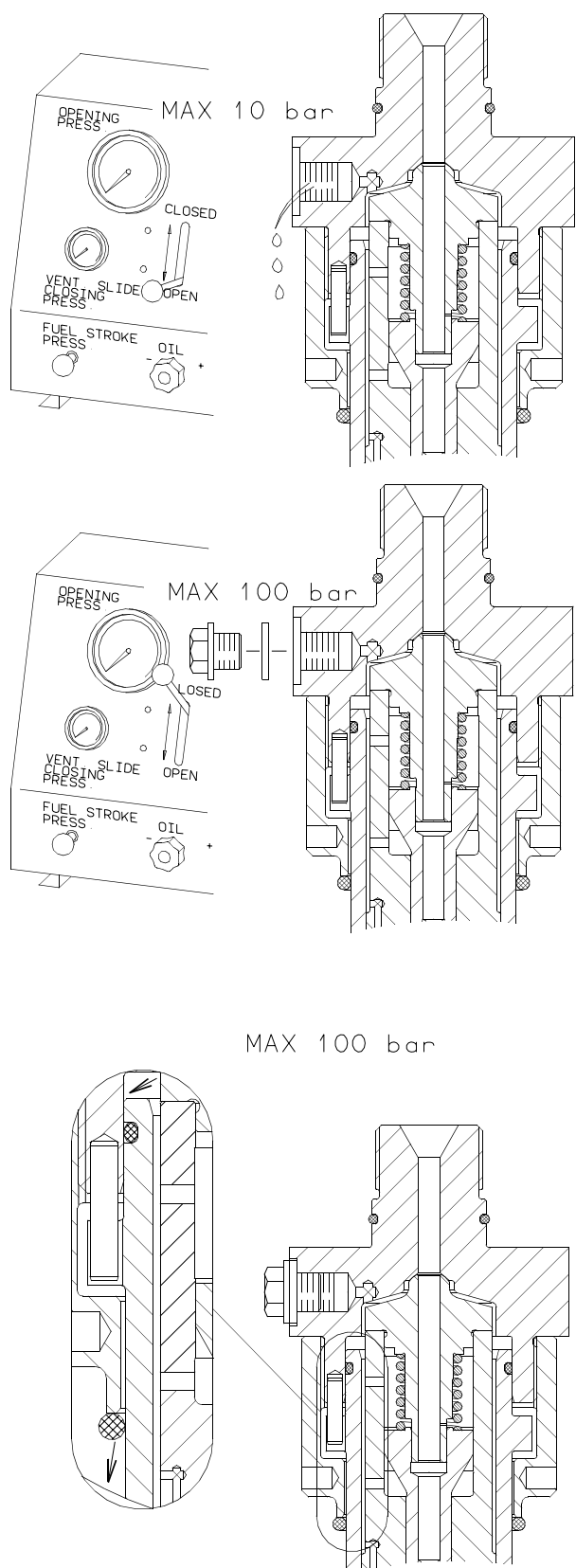
- The valve slide is sticking; or
- the vent hole in the thrust piece is blocked.

If so, disassemble and examine the spindle guide, replace if necessary.

See Procedure 909-12.3.



9.



9. Pressure test, O-ring sealings

A. Objective:

To ensure that the leak oil (circulation oil) remains in the closed system.

B. Procedure:

The control handle is to be in the OPEN position.

Build up a working pressure of about max. 10 bar until oil flows out of the leak oil outlet.

C. Acceptance criteria:

Close the leak oil outlet with a gasket and plug screw.

Increase the working pressure to about 100 bar.

Move the control handle to the CLOSED position.

The built-up pressure of about 100 bar should be maintained.

D. Cause of fault:

If oil leaks out at the union nut, the O-ring inside the fuel valve head is defective, and must be replaced.



1. Close the fuel oil inlet and outlet valves, and drain the high-pressure pipe and the fuel valve.

Dismantle and remove the fuel oil high-pressure pipe.

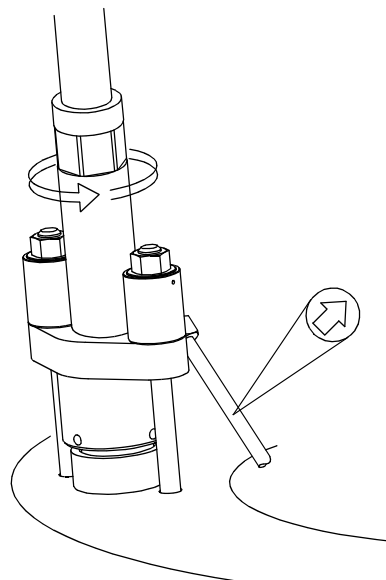
See *Procedure 909-14.2*.

Disconnect the return oil pipe from the fuel valve.

2. Remove the nuts and the spring housings.
3. Take out the valve. If the valve is sticking, use the fuel valve dismantling tool to pull the fuel valve clear of the top cover.

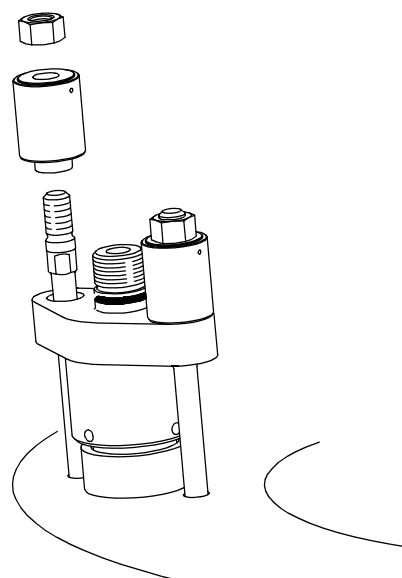
If the valve is not to be overhauled immediately, the valve should be placed immersed in diesel oil until overhauling.

1.



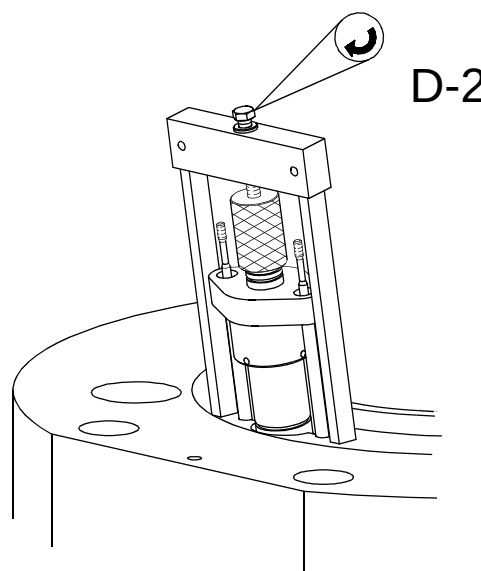
KB901-2.1 104 01

2.



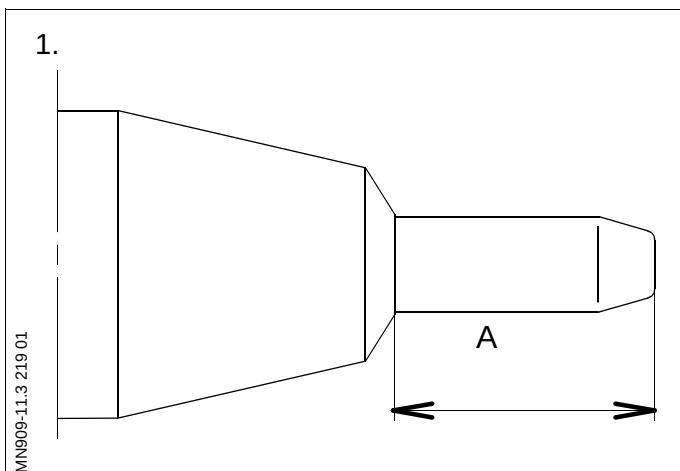
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3.



D-2

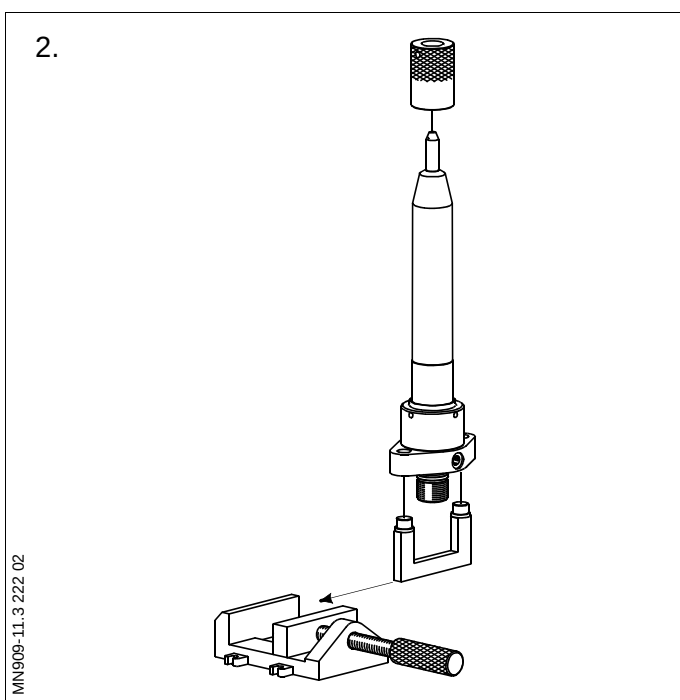
MA909-11.2 216 03



When fuel valves are overhauled, all parts should be handled carefully and be kept clean.

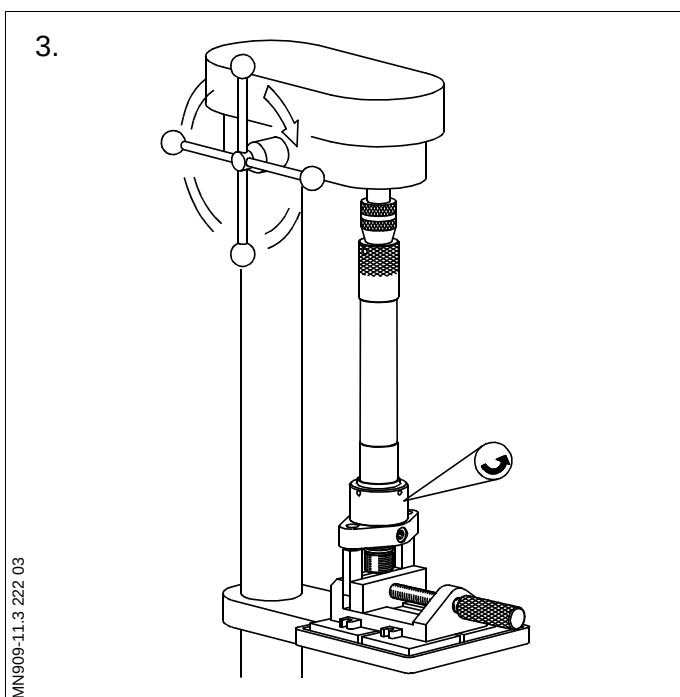
Use only clean, non-fluffy rags for wiping purposes. Make sure to remove all liquid or solid impurities. Whenever fuel valves are overhauled, all sealing rings should be discarded and replaced by new, faultless sealing rings before reassembly.

1. Measure the length **A** of the protruding part of the nozzle, and write down the result for correct re-assembly of the valve.



2. Place the valve holder in a machine vice, mount the fuel valve in the holder and fit the valve with the guide disc from the grinding tool.
3. Compress the fuel valve and the spring inside, by means of a drilling machine, to avoid seizures in the union thread. Hold the fuel valve compressed and unscrew the union nut with a hook spanner.

Remove the valve from the valve holder.



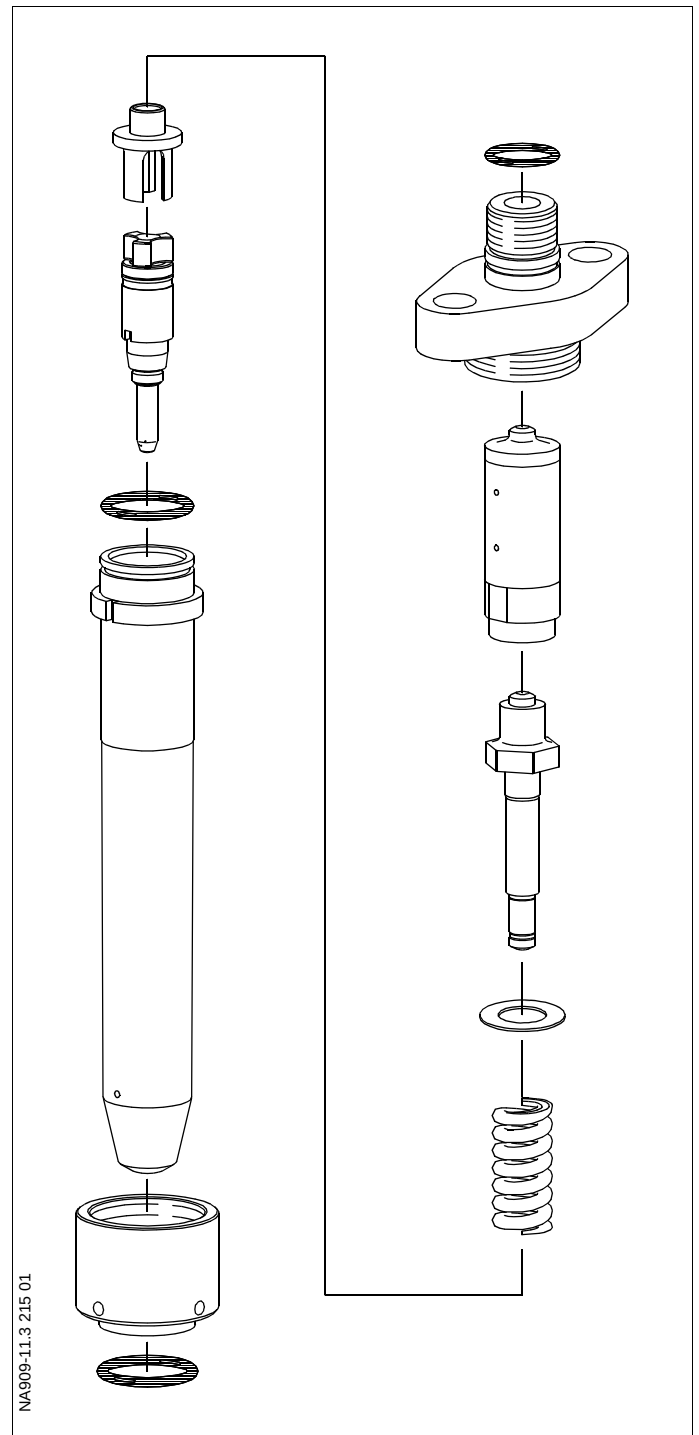
Pull the valve head clear of the valve housing.

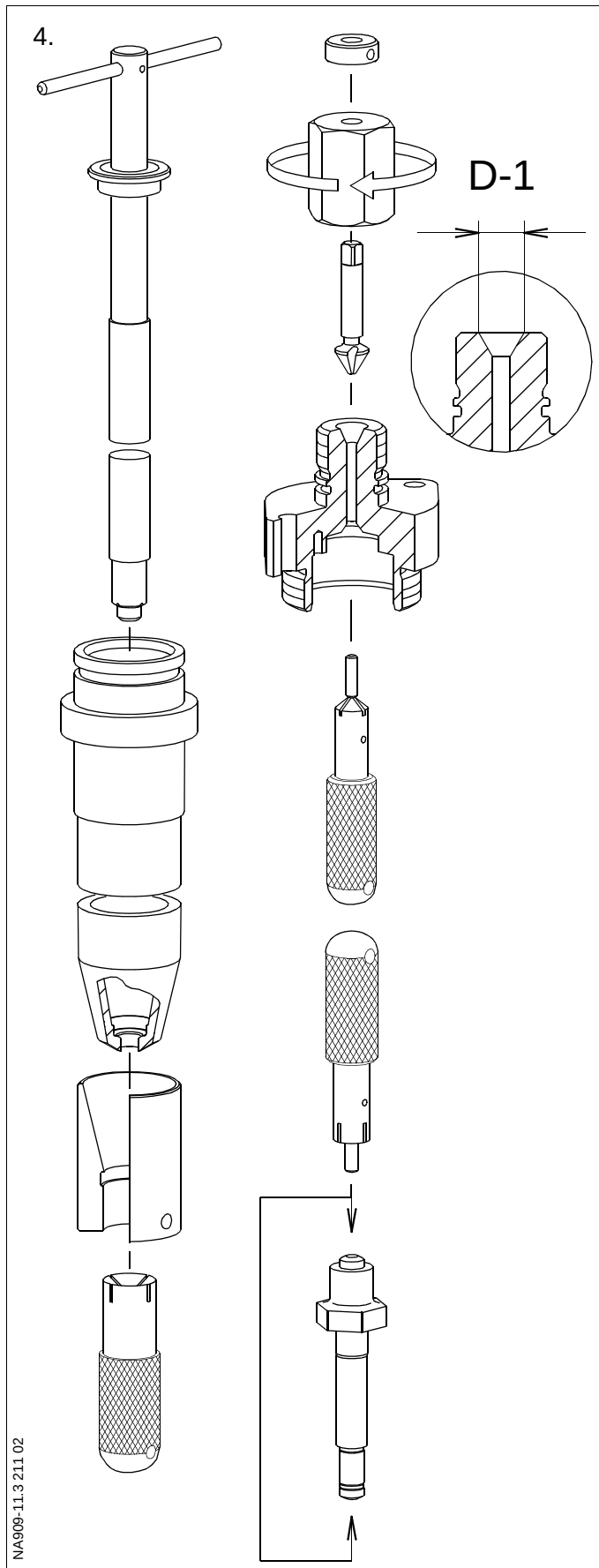
Remove the:

- Non return valve
- Thrust spindle parts
- Thrust foot
- Spindle guide and fuel nozzle

from the valve housing.

Remove and discard all the O-rings.





4. Carefully clean and examine all surfaces of the:

- Fuel valve housing
- Fuel valve head
- Thrust spindle

If necessary, grind the seating surfaces by means of the grinding mandrels supplied and a fine-grain abrasive (such as Carborundum No. 500).

This grinding must only be carried out manually.

After the grinding, wash the parts in gas oil and blow clean by means of compressed air to remove any remains of the grinding compound.

In the event of more serious damage to the seating surface for the high-pressure pipe in the valve head, the milling tool can be used.

Normally, the milling tool is turned by hand, but it may be fitted in the chuck of a column-type drilling machine provided that the number of revolutions is kept at a minimum (not exceeding approx. 100 r/min). An ample supply of cutting emulsion must be used.

Note!

Take care not to exceed the maximum diameter of the seat, see *Data*.

5. The complete spindle guide, including the fuel nozzle, should be sent to an authorised MAN B&W repair shop for overhaul. If this is not possible, the spindle guide may be overhauled on board.
See Procedure 909-12.3.

Note!

Do **not** attempt to remove the fuel nozzle from the spindle guide unless the spindle guide has been dismantled. Otherwise the cut-off slide on the spindle may be damaged.

6. The non-return valve should be sent to an authorised MAN B&W repair shop for overhaul. If this is not possible, the non-return valve may be overhauled on board.
See Procedure 909-13.3.

7. Mount the complete spindle guide, including the fuel nozzle, in the fuel valve housing.

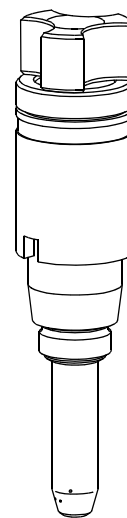
Carefully slide the spindle guide down into the valve holder, and turn the nozzle until the spindle guide engages correctly with the guide pin. Check that distance **A** corresponds to the measurement taken before the valve was disassembled.

Note!

Make sure that the fuel nozzle and spindle guide engage correctly with the guide pin in the fuel valve housing. This can be ascertained by attempting to turn the nozzle after mounting. It must **not** be possible to turn the nozzle.

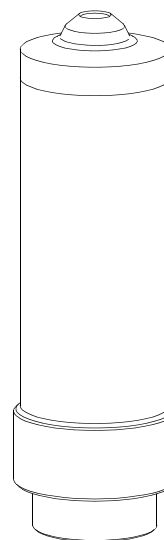
5.

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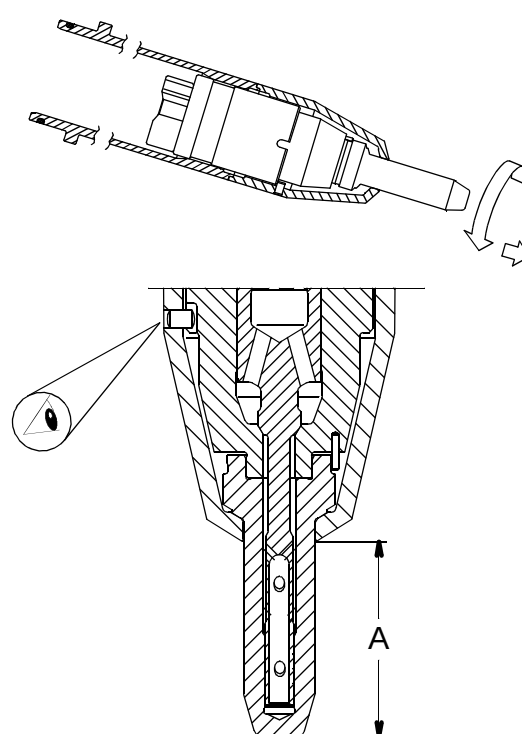
6.

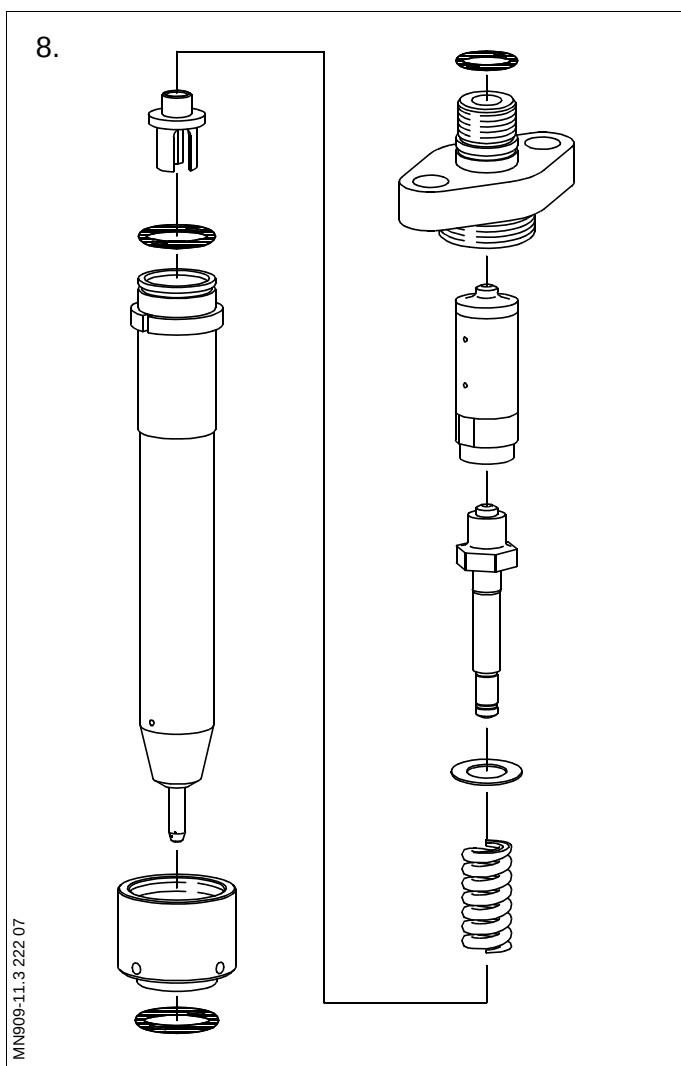
MC909-6.1 99 04



7.

MAN909-11.3 219 05





8. Mount:

- the thrust foot
- the parts of the thrust spindle
- the non-return valve

in the fuel valve housing.

Mount a new O-ring in the uppermost groove of the fuel valve housing.

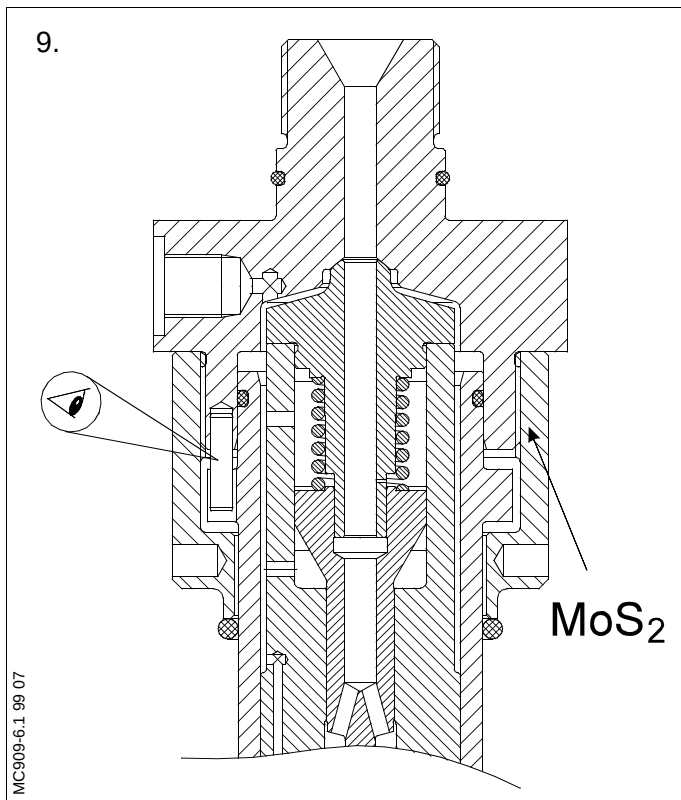
Lubricate the thread of the valve head with molybdenum disulphide (MoS_2).

For the correct use of this lubricant, see Procedure 913-11.

Fit the valve head with new O-rings.

9. Make sure that the guide pin between valve housing and valve head is intact, and press the valve head down into the valve housing.

See that the guide pin between valve housing and valve head engages correctly so as to prevent relative turning of the parts.



10. Assemble the valve by means of the union nut.

Place the valve in the valve holder in a drilling machine.

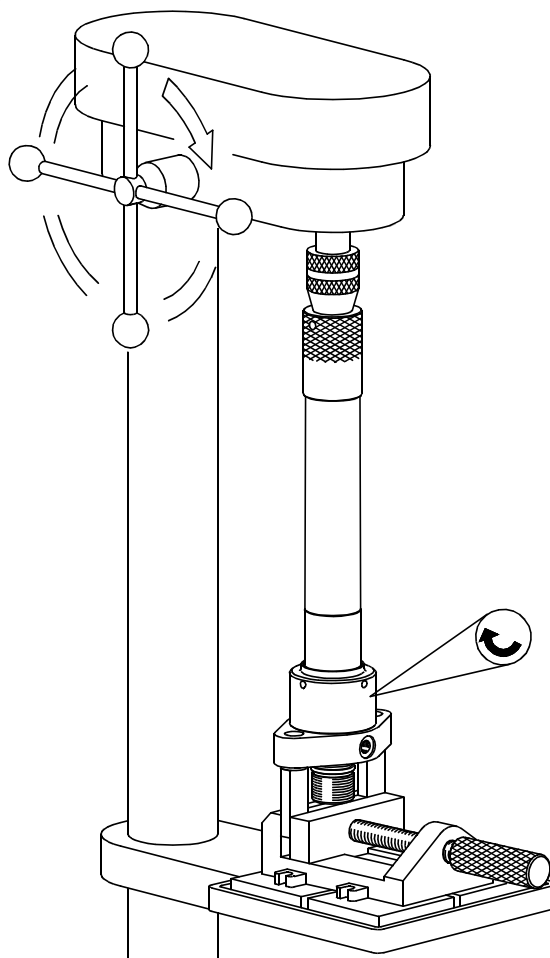
Compress the fuel valve and the spring inside. Keep the valve compressed and tighten the union nut with a hook spanner.

After overhaul, the fuel valve must be tested in the test rig.

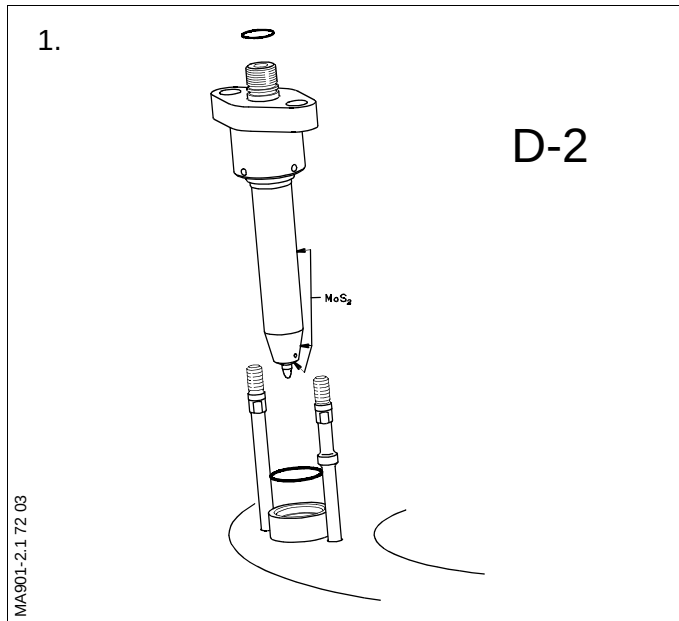
See *Procedure 909-11.1*.

11. If the fuel valve is not to be mounted in the engine immediately after the overhaul, cover all openings of the valve with plastic to prevent dirt from entering the valve during storage.

10.



MN909-11.3 222 09

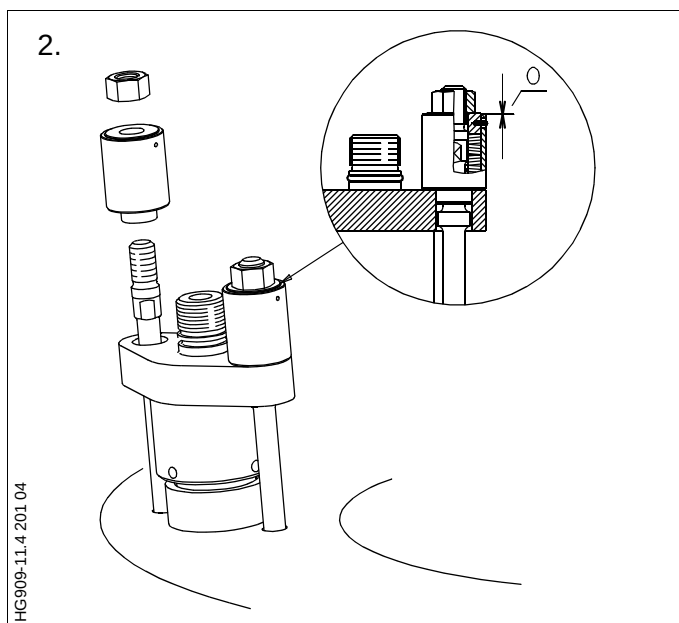


- Before mounting the fuel valve, thoroughly clean the valve bore in the cylinder cover and check the seating in the bore for marks which, if any, must be eliminated.
(For reconditioning of the valve bores in the cylinder cover, see Procedure 901-1.3).

If not already done, mount new O-rings on the fuel valve. Lubricate the valve with molybdenum Disulphide (MoS₂).

- Mount the valve in position in the cylinder cover.

Mount the spring housings and the nuts. Tighten the nuts until the top face of the pressure disc is flush with the top face of the spring housing. This must be done with great care, as the spring tension in the housing determines the correct tightening of the fuel valve to the cylinder cover as well as the correct compression of the fuel valve.



- Lubricate the thread on the union nipple of the fuel oil pipe with a heat resistant anti seize grease before mounting.

Note!

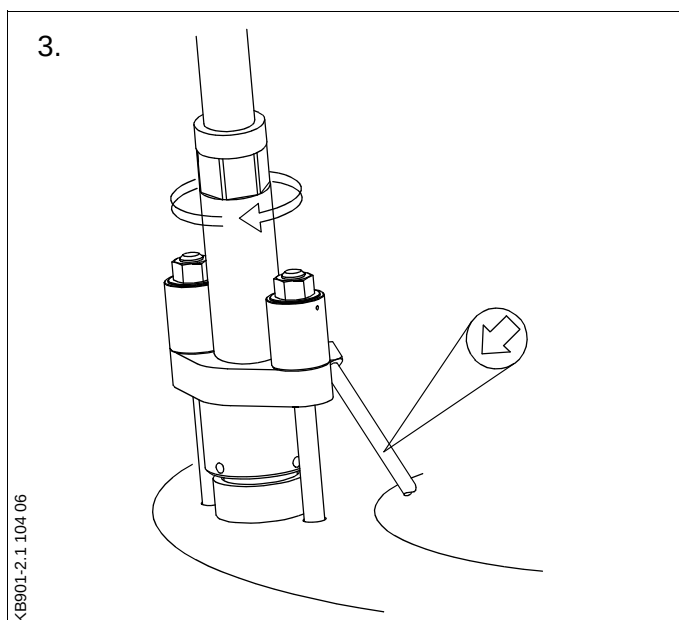
It is recommended to overhaul the fuel oil high-pressure pipe before mounting.
See Procedure 909-14.3.

As a minimum, the distance between the fuel oil pipe ends and the thrust bushings **must** be checked and, if necessary, adjusted.

Mount the overhauled fuel oil high-pressure pipe and the return oil pipe.
See Procedure 909-14.4.

Note!

All fuel valves must be function-tested before being mounted in the cylinder cover, see Procedure 909-11.1.



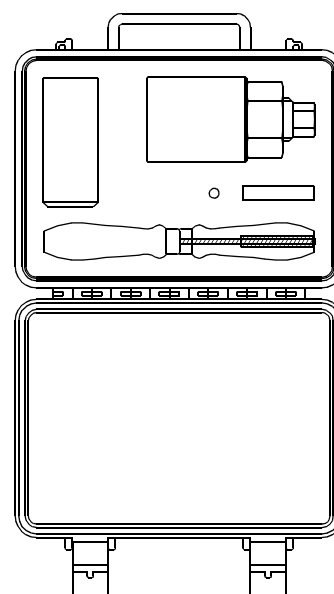
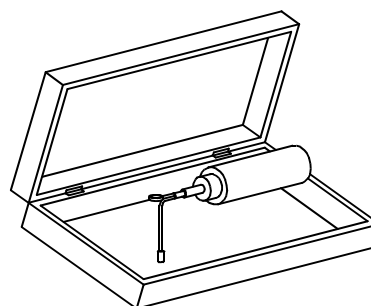
SAFETY PRECAUTIONS

- ☐ Stopped engine
- ☐ Block the starting mechanism
- ☐ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubricating oil
- ☐ Lock turbocharger rotors

Data

Ref.	Description	Value	Unit
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Standard Tools: See Section 913



BLANK



Note!

This instruction is only valid for spindle guides of the slide valve design.

Extreme care and accuracy should be exercised when carrying out this operation.

1. Clean the outside of the spindle guide in pure gas oil or kerosene. The individual parts of the spindle guide are not interchangeable, therefore only one guide is to be disassembled at a time.

Note!

The spindle guide, thrust piece and spindle are matched parts and may not be replaced individually.

2. Place the spindle guide in a bench vice provided with "soft" jaws, and use the brass mandrel as shown to disassemble the spindle guide.
3. Mount the pulling tool around the fuel nozzle on the spindle guide. Turn the nut to pull the fuel nozzle off the spindle guide.

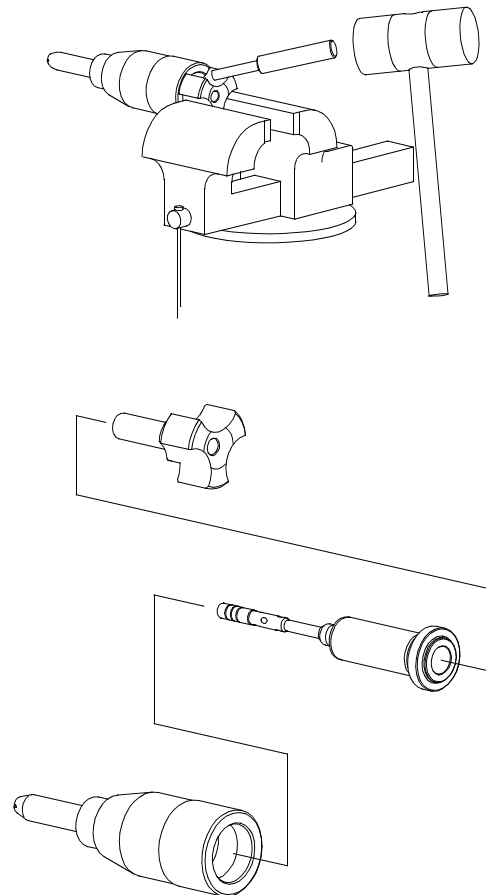
Note!

The pulling tool is not standard for all engines, but may be delivered as an optional extra.

4. If no pulling tool is available, the fuel nozzle can be dismantled from the spindle guide using two screwdrivers.

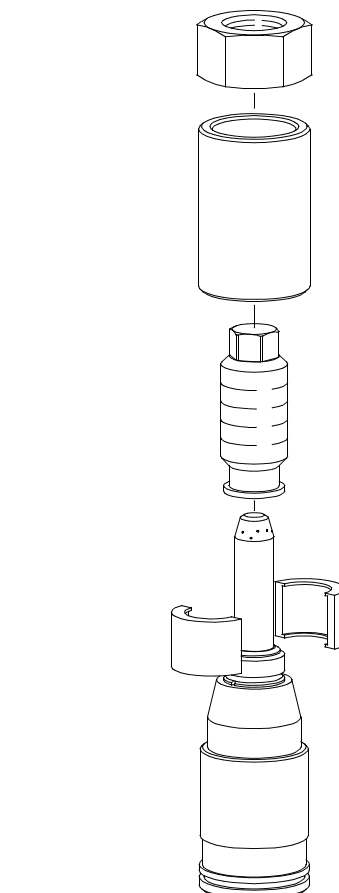
Place the screwdrivers opposite each other in the small gap between the fuel nozzle and the spindle guide and very carefully force the fuel nozzle off the spindle guide.

2.

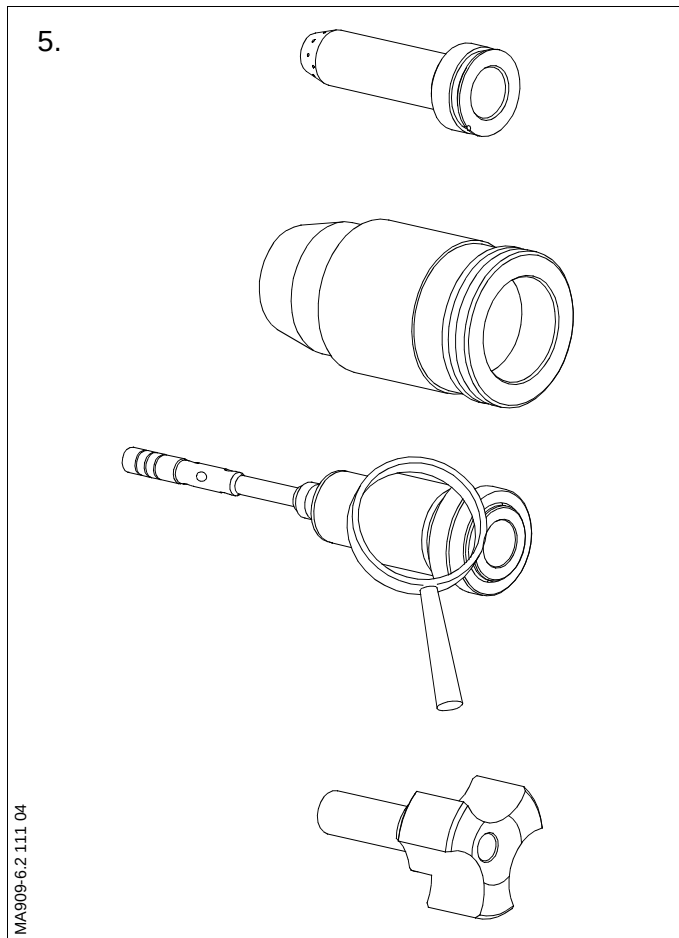


MA909-6.2 111 02

4.



MA909-6.2 111 03



5. Clean all the parts of the spindle guide in gas oil and wipe dry with a clean piece of cloth.

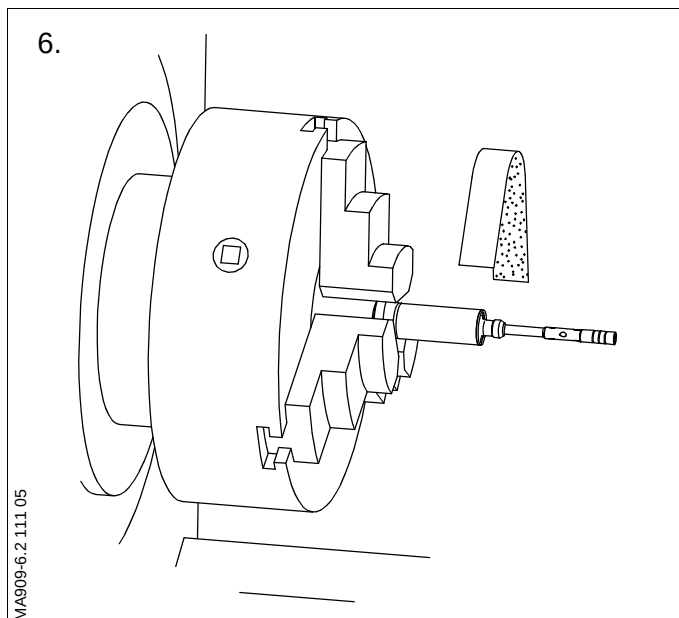
Clean all parts again in kerosene or 'Electrocleaner' and wipe dry with a clean piece of cloth.

Place all the parts on a clean, lint-free cloth and examine them through an 8-10 times magnification magnifying glass and an inspection lamp.

During the examination, pay special attention to the seating surfaces and sliding surfaces of the parts.

6. Remove any deposits or very fine scratches by placing the spindle, thrust piece or spindle guide respectively in a lathe, as shown, and polishing with a very fine conventional polishing linen 'grade 360'.

Use also a little oil for the polishing (a coarser polishing linen must **absolutely not** be used).



Note!

The sliding surface of the cut-off slide may **NOT** be polished under any circumstances.

After polishing, clean the parts again and re-check the seat on thrust piece/spindle, the seat on slide valve/spindle, and the seat on spindle/guide. Use an inspection lamp and an 8-10 times enlargement magnifying glass.

If the seats are not in order, i.e. if there are pressing-in marks or similar on the seats, the complete spindle guide must be discarded.

7. Clean any carbon deposits from the central bore of the fuel nozzle by means of the special brass brush. Clean the spray holes, using gas oil and the special drills supplied.

Note!

During this operation be very careful not to push the drill too far to avoid scratching the snug-fit surface on the inside of the fuel nozzle.

Clean the fuel nozzle with kerosene and wipe dry with a clean cloth.

Then test the spray holes with the test pin. If the test pin is able to enter just one of the holes, the fuel nozzle must be discarded.

This also applies to nozzles with oval holes (can be ascertained with a magnifying glass).

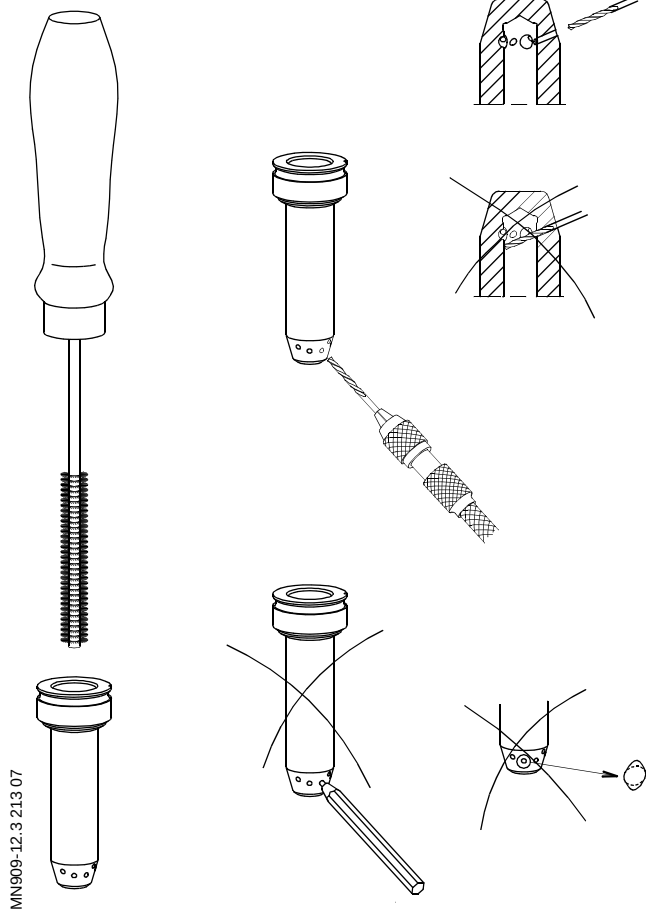
Check the fuel nozzle before mounting on the spindle guide, the cut-off slide must be able to move freely inside the nozzle.

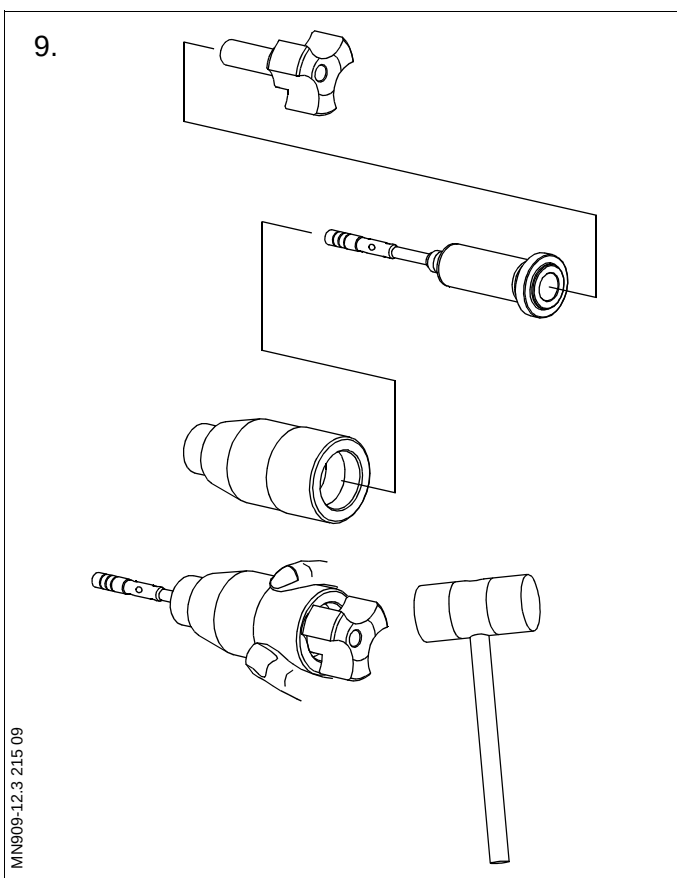
Note!

It is recommended always to change the fuel nozzle whenever the spindle guide is being overhauled.

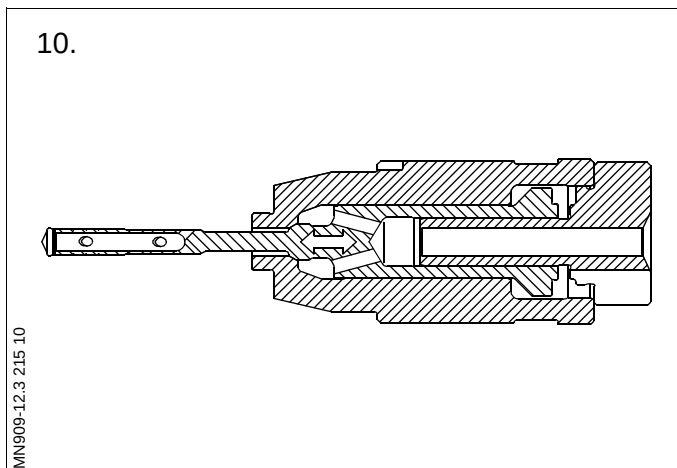
However, the fuel nozzle may be re-used if the nozzle holes are in order.

7.





8. Lubricate the spindle and the thrust piece with the cut-off slide with a little Molybdenum Disulphide (MoS_2), see *Procedure 913-11*.
9. Assemble the thrust piece, the spindle and the spindle guide and carefully knock the parts together using a soft hammer.
10. Shake the spindle guide back and forth. The spindle with the cut-off slide must be able to slide freely back and forth inside the spindle guide, with a 'clicking' sound.



11. Lubricate the sliding surfaces of the nozzle and the spindle with a little Molybdenum Disulphide (MoS_2). See *Procedure 913-11*.

Mount the nozzle on the spindle guide.

Make sure that the half-circle shaped groove on the nozzle and the spring pin are in line.

If nozzle and spindle guide are provided with scratch marks opposite the spring pin, they must be in line.

Place the parts on the plane of a drilling machine or hydraulic press and position the mounting tool over the parts. Make sure that all the parts are perfectly aligned.

Press the nozzle on to the spindle guide.

Note!

The mounting tools are not standard for all engines but may be delivered as optional extras.

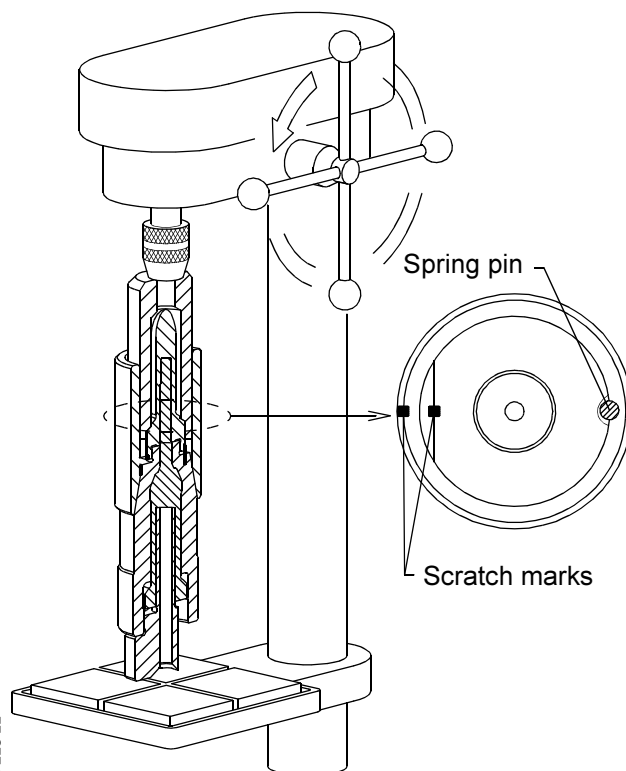
If no mounting tools are available, the nozzle can be mounted on the spindle guide using a short piece of pipe.

Place the pipe around the nozzle, so that the lower end of the pipe rests on the 'foot' of the fuel nozzle. Then press the parts together the same way as when using the mounting tools.

Check that the spindle inside the spindle guide is able to move freely as in step 10.

12. If the spindle guide is not to be mounted in a fuel valve immediately after the overhaul, cover all openings of the spindle guide with plastic to prevent dirt from entering the spindle guide during storage.

11.



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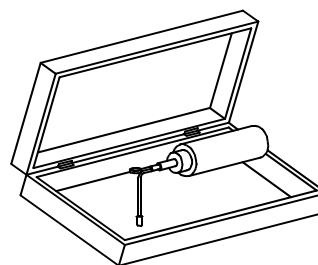


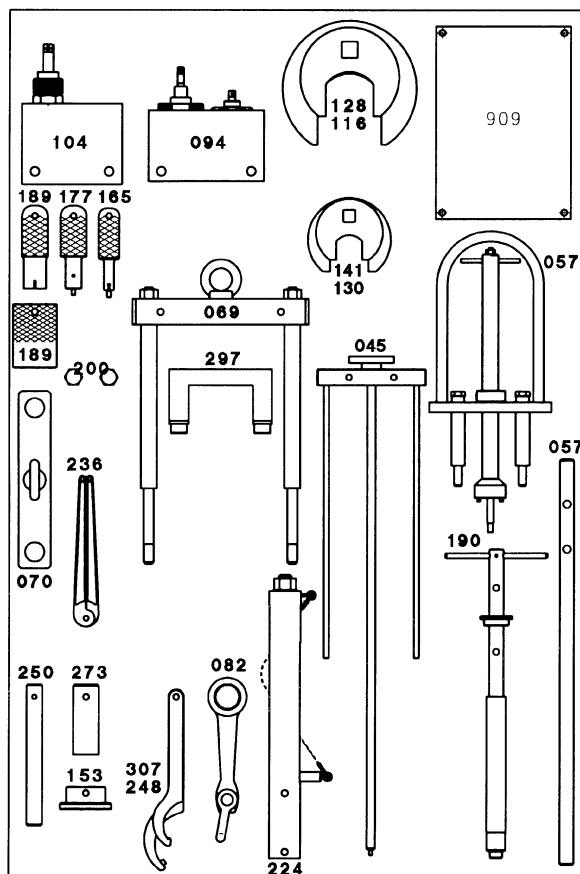
SAFETY PRECAUTIONS

- ☐ Stopped engine
- ☐ Block the starting mechanism
- ☐ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubricating oil
- ☐ Lock turbocharger rotors

Data

Standard Tools: See Section 913





Note!

Extreme care and accuracy should be exercised when carrying out this operation.

1. Clean the outside of the non-return valve with pure gas oil. The individual parts are not interchangeable, therefore only one guide is to be disassembled at a time.

Note!

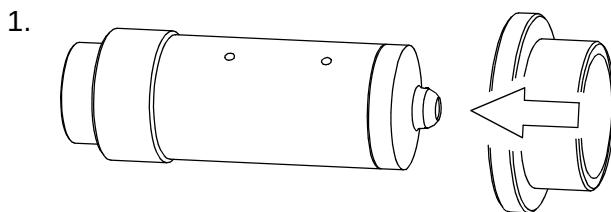
Except for the slide valve spring, defective parts cannot be replaced individually by new ones.

Place the non-return valve as shown in Fig. 1 in a bench vice provided with "soft" jaws, and disassemble the non-return valve, using the disassembling tool and a hammer as shown.

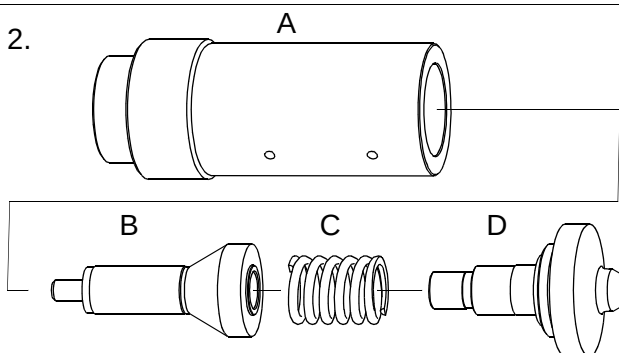
2. Clean all the parts for the spindle guide in gas oil and wipe them dry with a clean piece of cloth.

Finally, clean in either gas oil, kerosene or 'Electrocleaner', and wipe the parts dry with a clean piece of cloth.

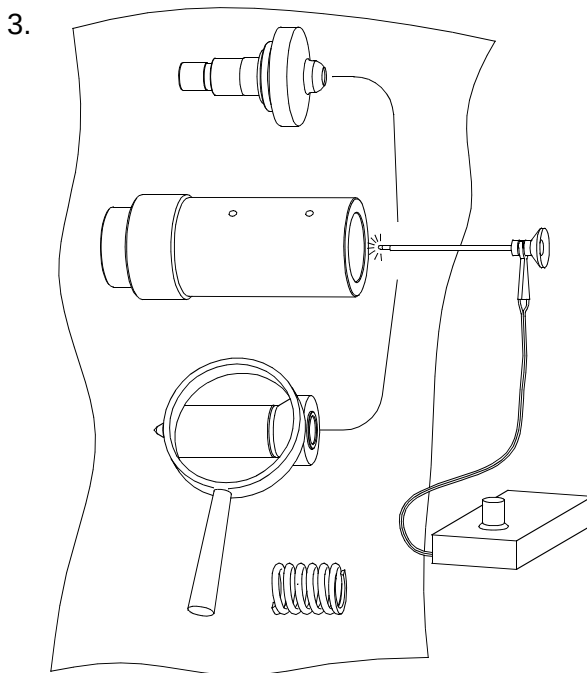
3. Now place the parts on clean, lint-free rags and examine with an 8-10 times enlargement magnifying glass, and an inspection lamp with magnifying glass as shown in Fig. 3.



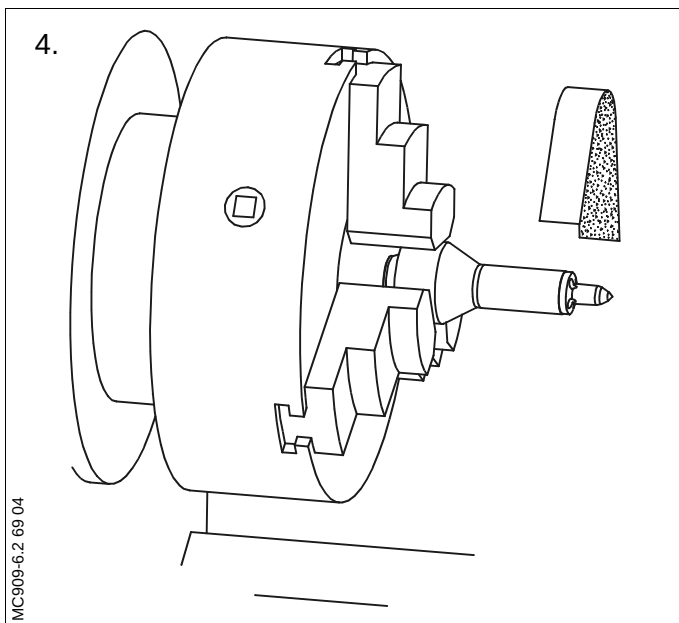
MC909-6.3 99 01



NB909-13.3 206 02



MC909-6.3 99 03

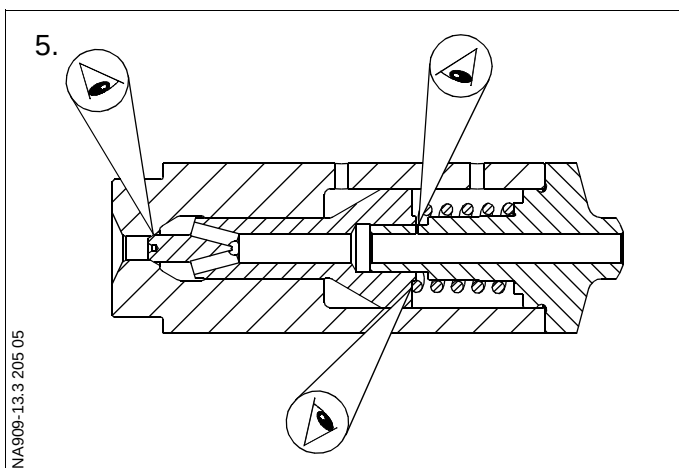


4. Examine the slide faces of movable parts for coating. Vent slide **B**/housing **A** will be too tight if there is a coating. (The letters **A-D** refer to the letters/parts in Fig. 2).

Fix vent slide **B** and, subsequently, housing **A** in a lathe as shown in Fig. 4 and remove the coating by means of very fine conventional polishing linen 'grade 360'.

Also a little oil should be used (a coarser polishing linen must **absolutely not** be used).

5. Check spring **C** for the thrust piece for outside wear marks. If defective, it should be exchanged.

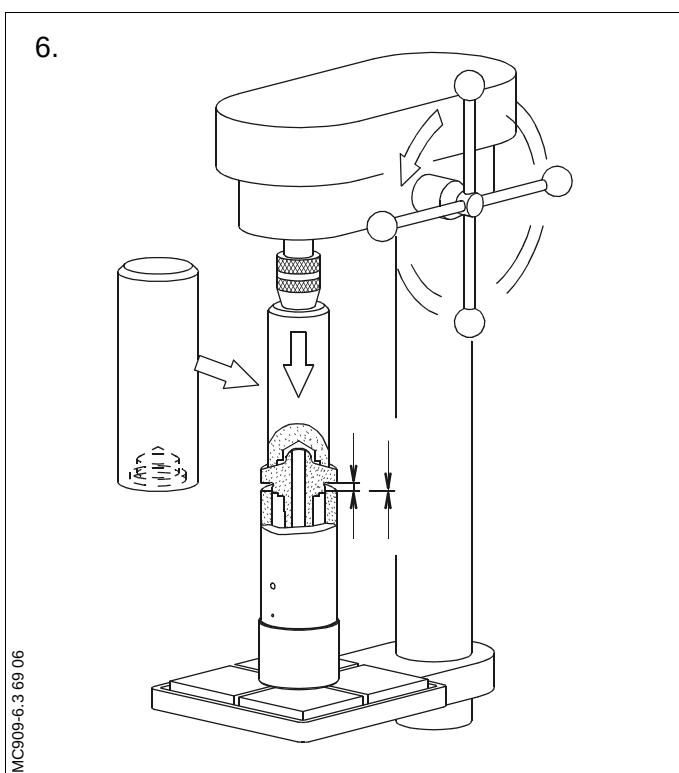


Check the seat on thrust piece **D**/vent slide, and the seat on vent slide/housing. Use an inspection lamp and an 8-10 times enlargement magnifying glass.

If the seats are not in order, i.e. if there are pressing-in marks or similar on the seats, the complete spindle guide must be discarded.

6. Mount the non-return valve as follows:

- Lubricate all movable parts with molybdenum disulphide (MoS_2).
- Place the loosely-assembled non-return valve on the plane of a drilling machine, with the tool positioned as shown in Fig. 6.
- Make sure that the thrust piece and the other parts are perfectly aligned and that the thrust piece is guided in the vent slide.
- Press the handle until the housing and thrust piece meet.



7. If the non-return valve is not to be mounted in a fuel valve immediately after the overhaul, cover all openings of the non-return valve with plastic to prevent dirt from entering the valve during storage.

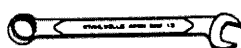


SAFETY PRECAUTIONS

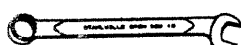
- | | |
|-------------------------------------|------------------------------|
| ☒ | Stopped engine |
| ☒ | Block the starting mechanism |
| ☒ | Shut off starting air supply |
| ☐ | Engage turning gear |
| ☐ | Shut off cooling water |
| ☒ | Shut off fuel oil |
| ☐ | Shut off lubrication oil |
| ☐ | Lock turbocharger rotors |

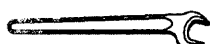
913

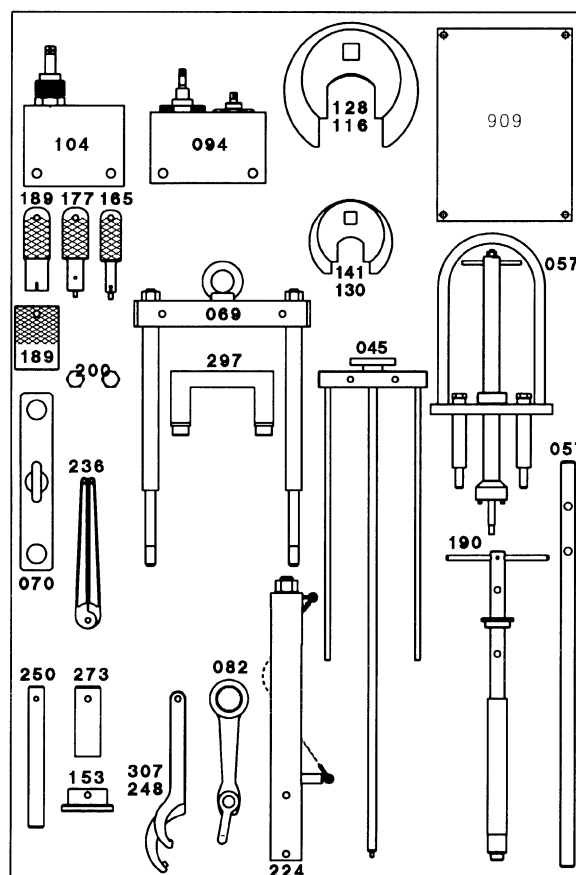
Type I pipe

 50 mm

Type II pipe

 22, 30 mm

 50, 60, mm



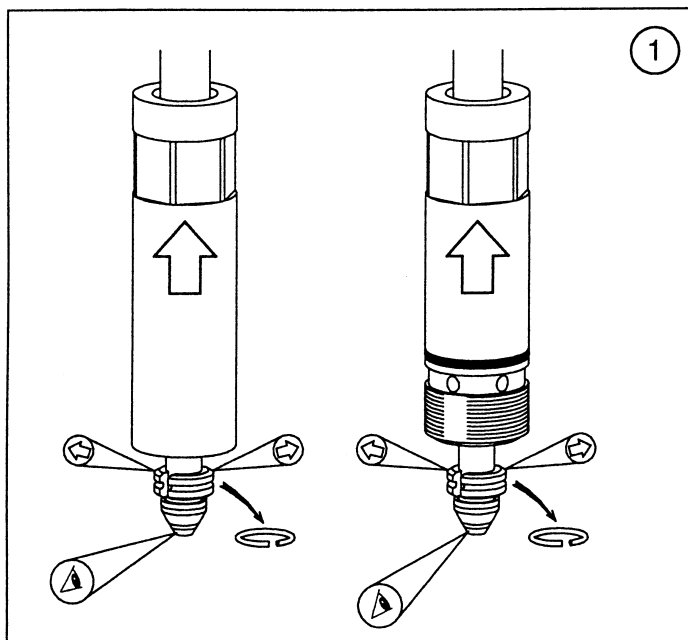
DATA:

For Type II pipe:

D-1 Distance from pipe end to thrust bushing lower edge 14 mm
(fuel pump end and fuel valve end)

D-2 Weight of fuel oil pipe..... 17 kg





Whenever the fuel oil high-pressure system is dismantled, it is necessary, before re-mounting the high-pressure pipes, to carefully inspect the tapered contact surfaces of the pipe ends, together with their seats in fuel valves and fuel pump top cover.

For overhaul of fuel valve, see Procedure 909-6.

For overhaul of fuel pump top cover, see Procedure 909-3.

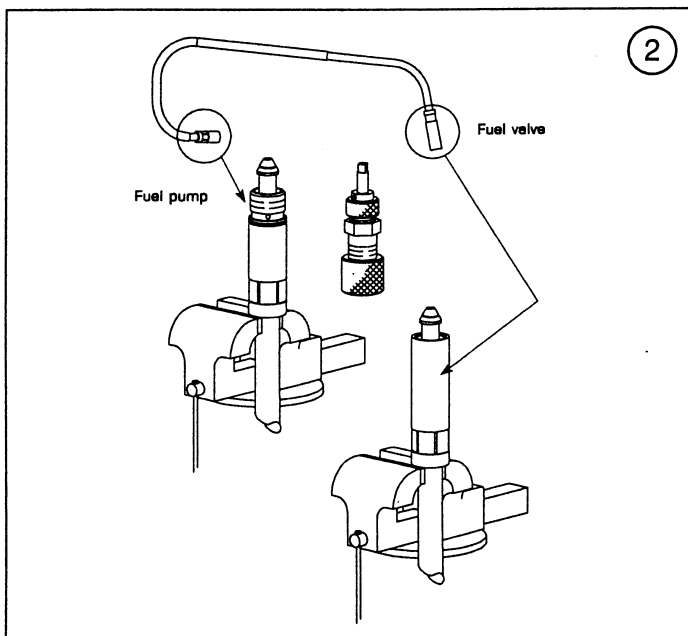
If the pipe ends require reconditioning, proceed as follows:

1. Lift up the union nut.

Remove the spring ring from the two-part sleeve.

Remove the sleeve.

2. Fasten the pipe in a vice with soft jaws.
3. Mount the miller on the pipe end.



Note !

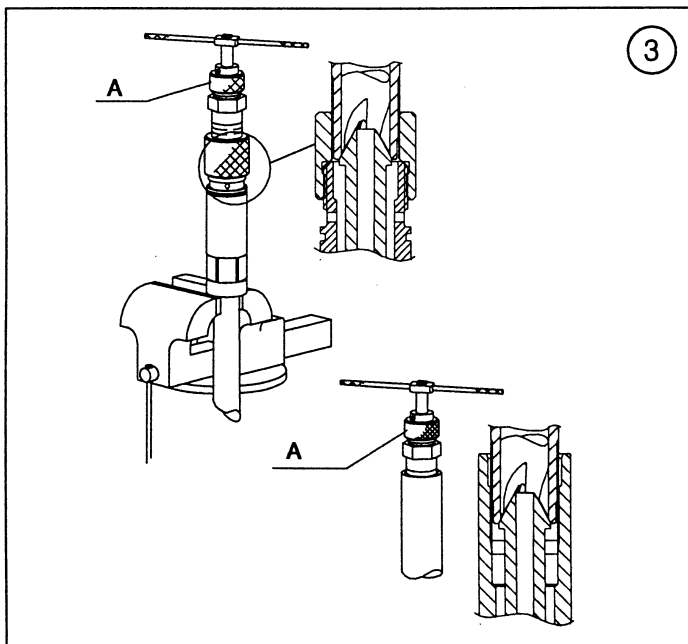
The two pipe ends are of different designs - see sketch.

Turn the upper tightening ring (A) until the miller presses against the pipe end.

Turn the miller with, for instance, a tap wrench while lightly tightening the upper tightening ring (A) to provide a suitable pressure between the miller and the pipe end.

During the milling process, add drilling oil emulsion liberally.

After completing the milling, carefully clean the high-pressure pipe, and blow through the bore with compressed air.

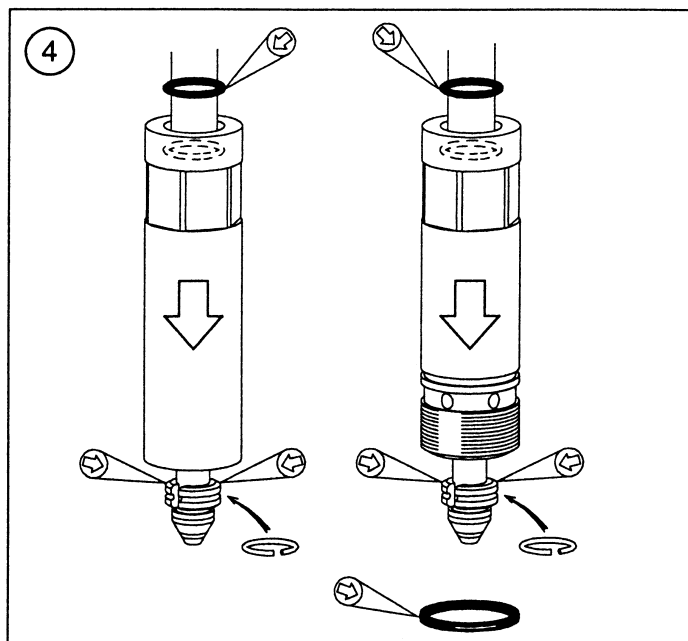


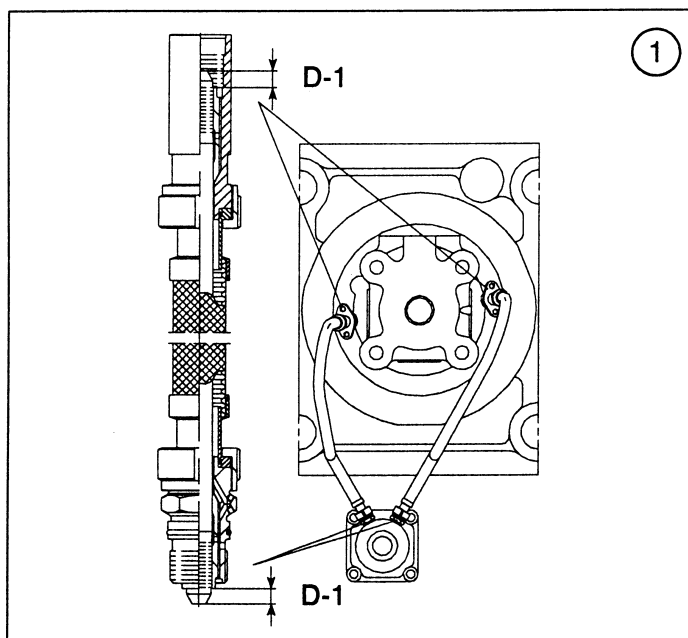
- Remove and discard both the internal and external O-rings.

Mount new O-rings.

Mount the two-part sleeve and lock the sleeve with the spring ring.

Ensure that all parts are completely clean before mounting the high-pressure pipe.





1. Whenever the fuel oil high-pressure system is dismantled, it is necessary, before remounting the high-pressure pipes, to carefully inspect the tapered contact surfaces of the pipe ends, together with their seats in fuel valves and fuel pump top cover.

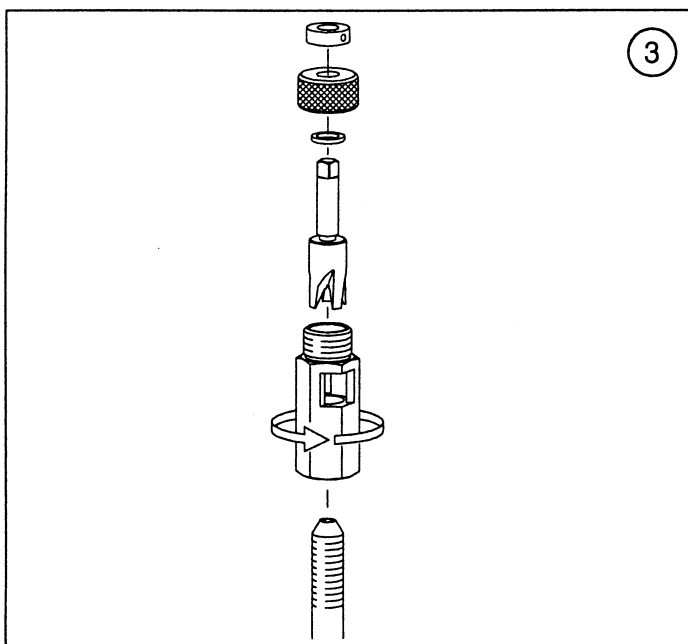
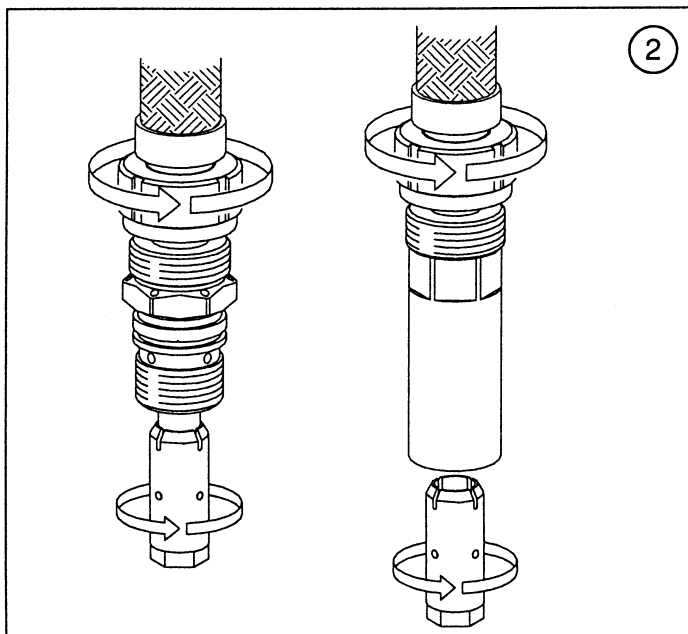
Furthermore, the position of the thrust bushing on the pipe end must be checked and if the distance is incorrect, compared to the measurement stated in Data, it should be adjusted by screwing the thrust bushing up or down the pressure pipe.

2. If the pipe end requires reconditioning, the high-pressure pipe must first be dismantled:

- Lift up the union nut with flexible protective hose, together with the coupling nut, on the high-pressure pipe and screw off the thrust bushing.
- Take off the coupling nut and, when the thrust bushings at both ends of the pipe have been dismantled, pull the flexible protective hose with union nuts off the high-pressure pipe.

3. Tools for reconditioning of high-pressure pipes consist, for each pipe dimension, of:

- Guide
- Miller
- Union
- Stop ring.



- Reconditioning of the pipe ends is carried out by milling according to the following procedure:

Shape-up the threaded pipe ends by means of the nut die.

- Mount the guide on the pipe end, place the miller in the guide and lightly screw on the union nut.

Turn the miller with, for instance, a tap wrench while lightly tightening the union nut to provide a suitable pressure between miller and pipe end. During the milling, add drilling oil emulsion liberally.

For overhaul and reconditioning of the fuel pump top cover, see Procedure 909-3.3.

After completing the milling, carefully clean the high-pressure pipe as well as the top cover, and blow through the various bores with compressed air.

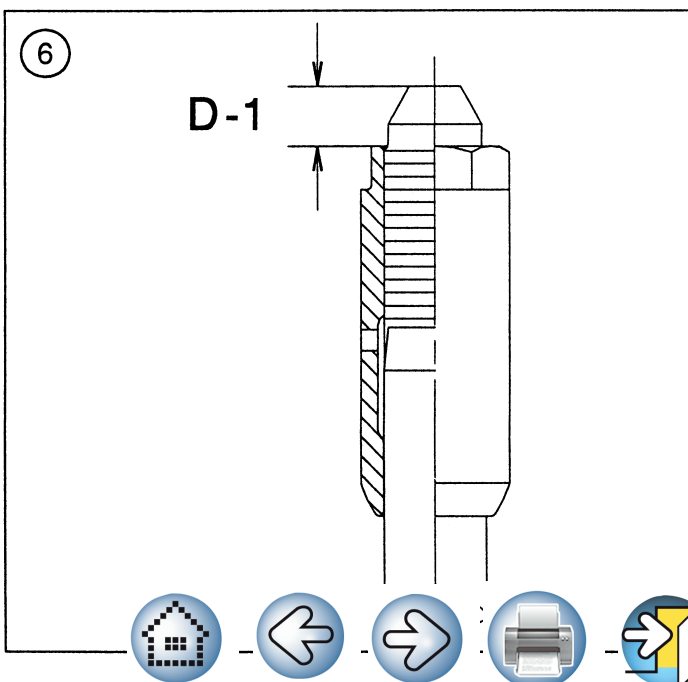
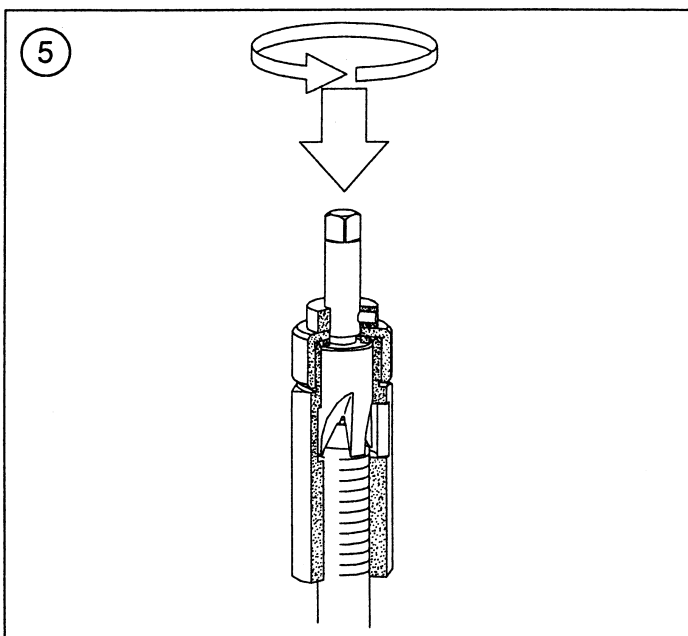
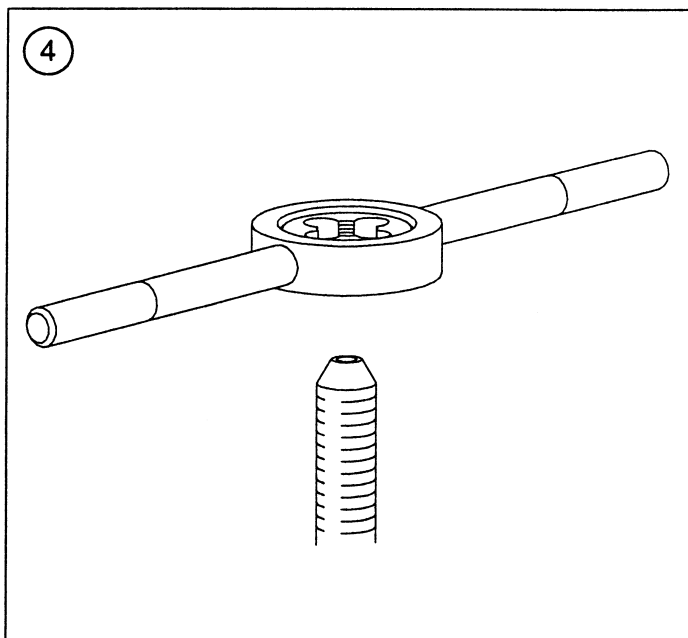
- When assembling the high-pressure pipe, screw the thrust bushings so high up on the thread of the pressure pipe that the distance between the pipe end and the bottom edge of the thrust bushing is as stated in Data. Replace the O-rings.

Before mounting a high-pressure pipe, check the centre distances between pipe ends and seats, and lubricate the threads of the union nuts with molybdenum disulphide (MoS_2).

It is of great importance for the mounting, and a condition for obtaining tight joints, that the pipes fit the seats accurately.

For reconditioning of seats in fuel valve, see Procedure 909-6.

For mounting of high-pressure pipes, see Procedure 901-2.1.



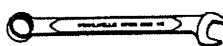
BLANK

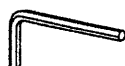


SAFETY PRECAUTIONS

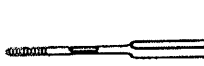
- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☒ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

 10, 16, 30 mm

 6 mm

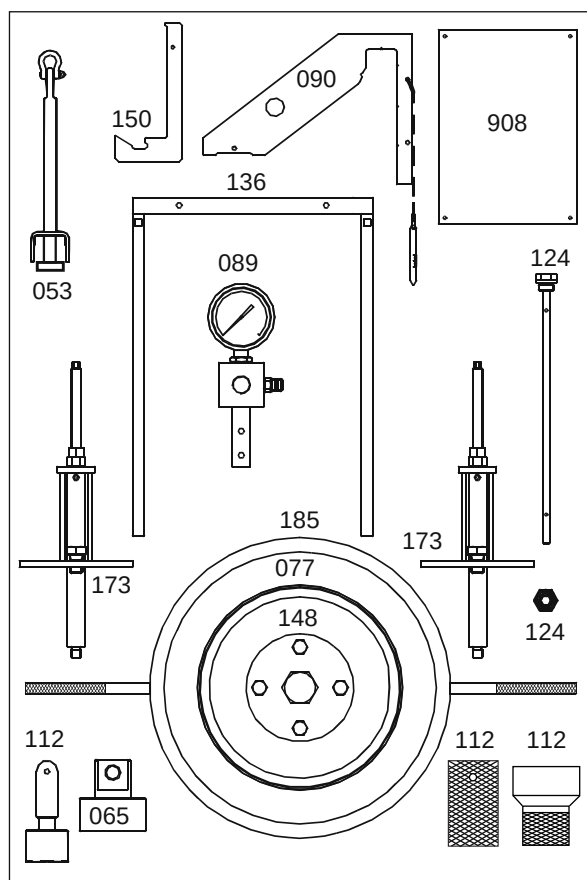
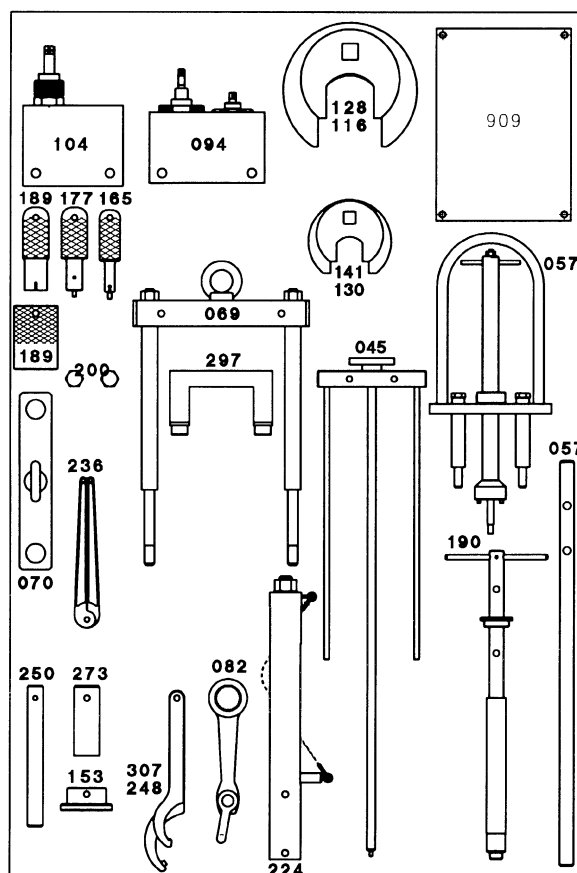
 46, 75 mm

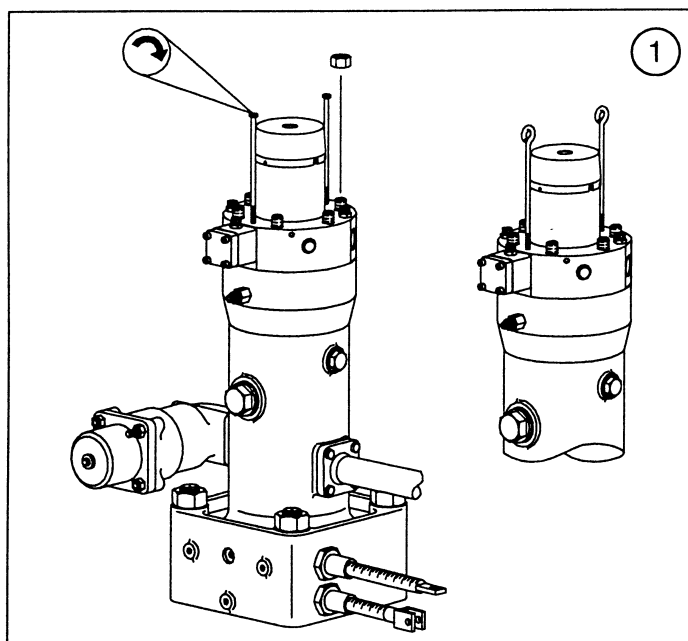
 40-200 Nm
750-200 Nm

 2 x M16

DATA:

D-1	Weight of pump housing	276 kg
D-2	Weight of barrel assembly	77 kg
D-3	Pump base.....	163 kg
D-4	Fuel pump roller guide.....	161 kg
D-5	Max. clearance, roller/bushing/shaft pin.....	0.5 mm
D-6	Discard spacer rings when wedge-shaped oil grooves are worn away	
D-7	Tightening torque – fuel pump housing..... or	1320 Nm 80°
D-8	Tightening torque – nut, reversing shaft.....	160 Nm

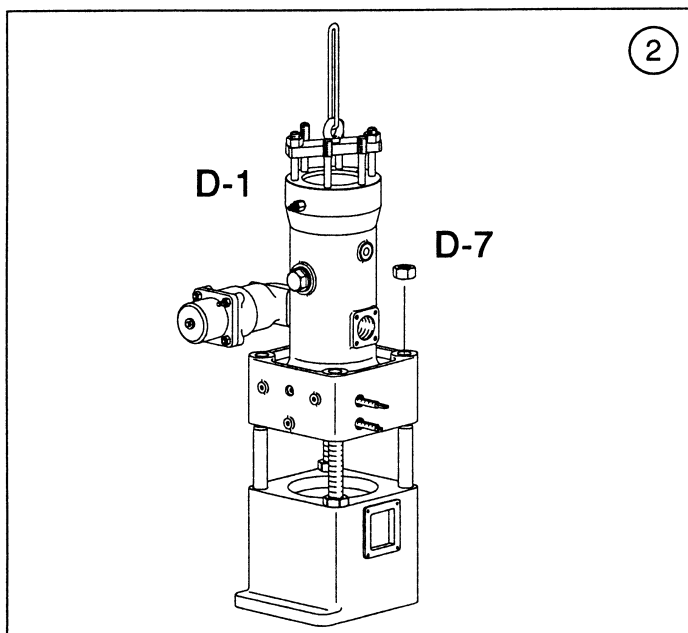




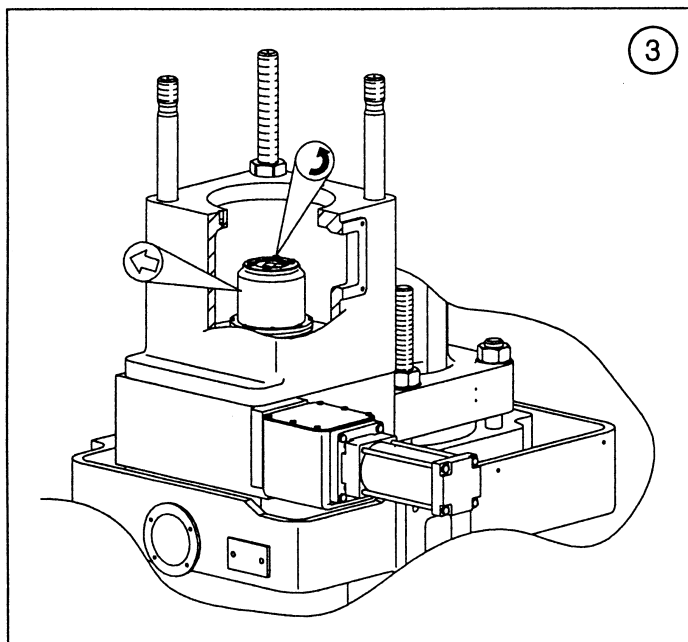
The roller guide can be partially checked while mounted on the engine.
See Procedure 908-4.

Dismantling

1. Dismantle the top cover and the fuel pump barrel assembly of the fuel pump housing.
See Procedure 909-3.1.
2. Unscrew the nuts, mount the lifting tool and remove the fuel pump housing.
3. Loosen and remove the screws from the sealing cap on top of the roller guide inside the pump base.



Remove the sealing cap from the roller guide/pump base.



4. Loosen the nuts on the two threaded studs successively until the roller guide springs are relieved.

Remove the nuts, mount two eye screws in the pump base and lift it away.

Take out the springs of the roller guide.

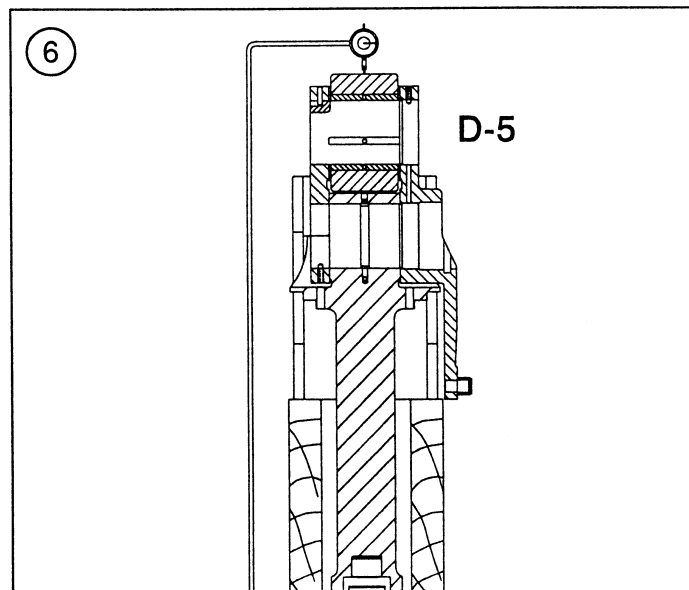
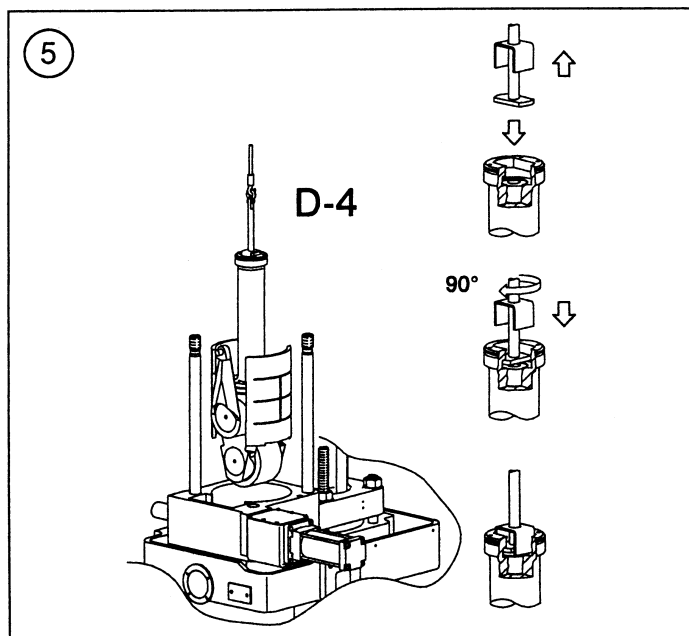
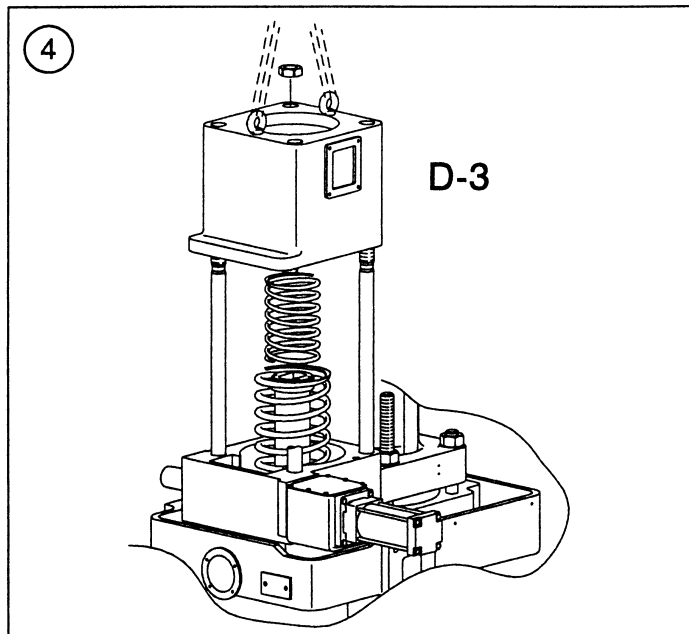
5. Mount the roller guide lifting tool for the roller guide as follows:

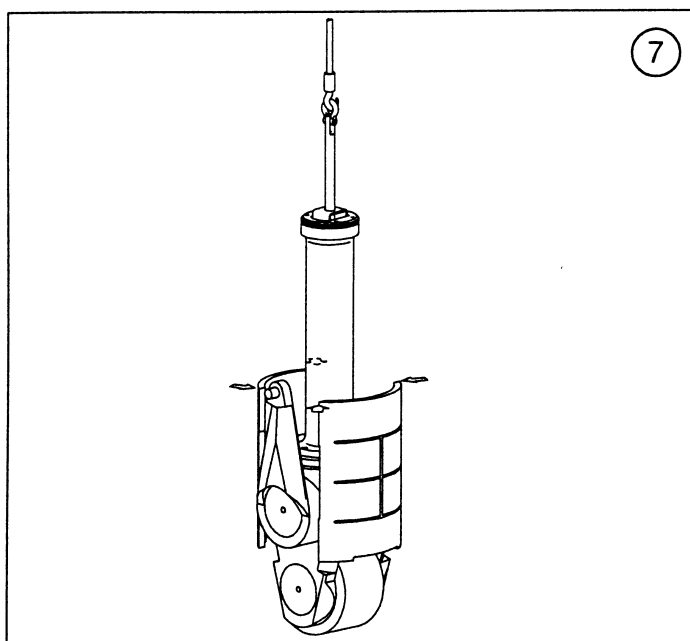
- Lift the lock plate of the tool up on the shaft of the tool.
- Position the tool so that its foot rests on the thrust piece in the bayonet joint of the roller guide.
- Turn the tool 90° so as to allow the foot to engage properly in the bayonet joint.
- Lower the lock plate, thereby securing the foot in the locked position.
- Lift the roller guide out of the roller guide housing, using the crane.

6. Check the surface of the roller.

The most expedient time of measuring the clearance in the slide bearing is when the roller guide is placed in a vertical position on a couple of planks, with the roller hanging freely.

To read the clearance directly, place a dial gauge against the roller, then lift the roller as much as the clearance permits.





7. It is recommended that the roller guide should only be dismantled if, during the checking, irregularities when turning the roller, damage on the roller, or larger clearance than indicated on the data sheet, have been observed.

Before dismantling, measure any ovalness of the roller guide, and then continue the procedure as follows:

8. Dismount the lock screw from the shaft pin for the roller.

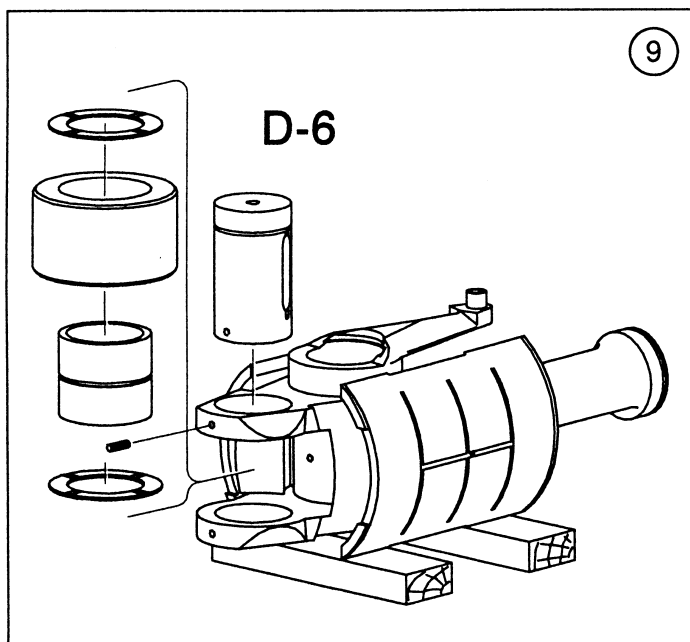
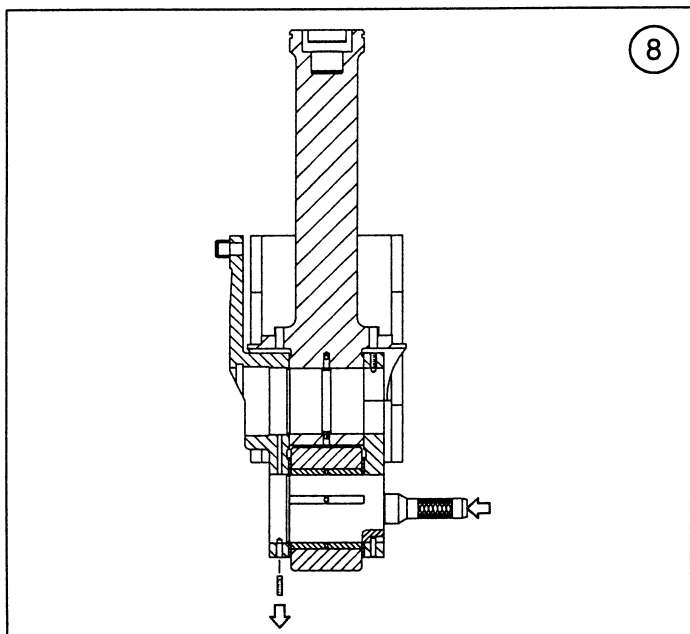
Remove the shaft pin from the reversing link by means of the driving-out mandrel.

9. Take out the roller together with its bearing bush and spacer rings.

Inspect the surfaces of the roller facing the spacer rings and the sliding surface of the shaft pin for marks and seizures.

Inspect the spacer rings and replace them if the wedge-shaped oil grooves have been worn away.

Replace the slide bearing bushing and any defective parts.



10. Dismount the lock screw from the shaft pin for the reversing link. By means of the driving-out mandrel, remove the shaft pin from the reversing link.

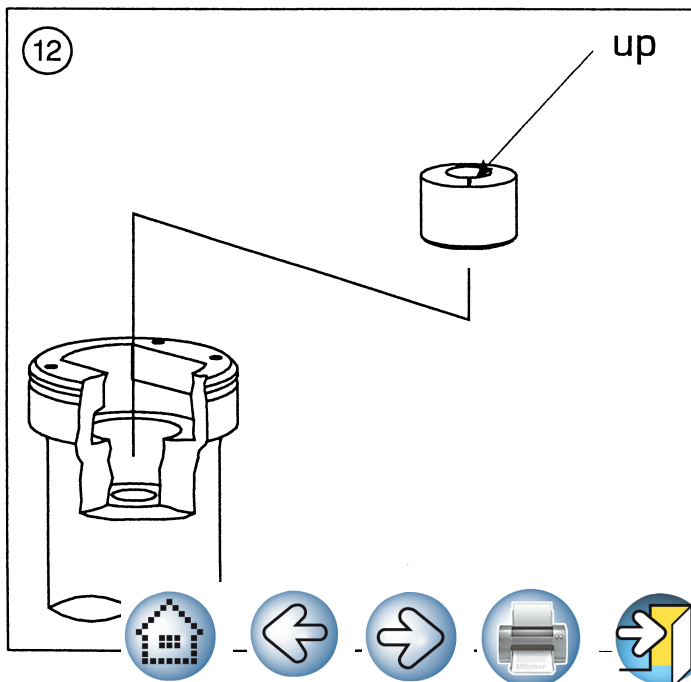
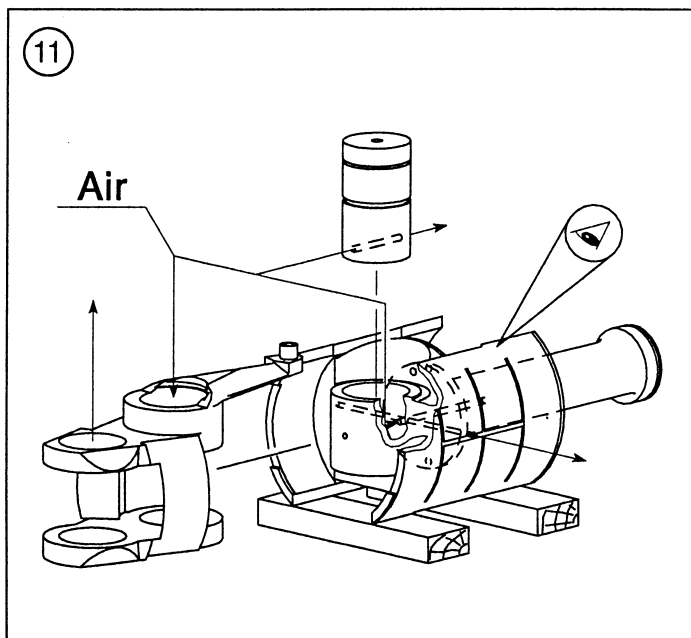
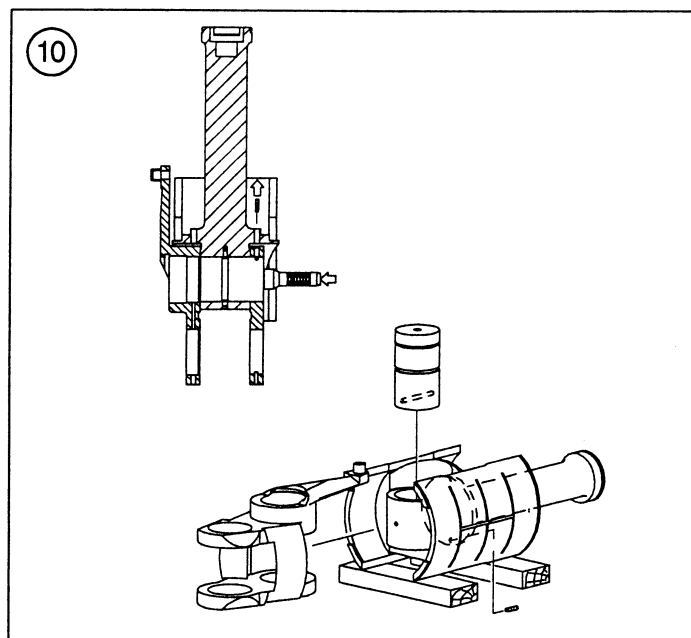
11. Blow the lubricating ducts and bores of the roller guide and the reversing link clean with compressed air.

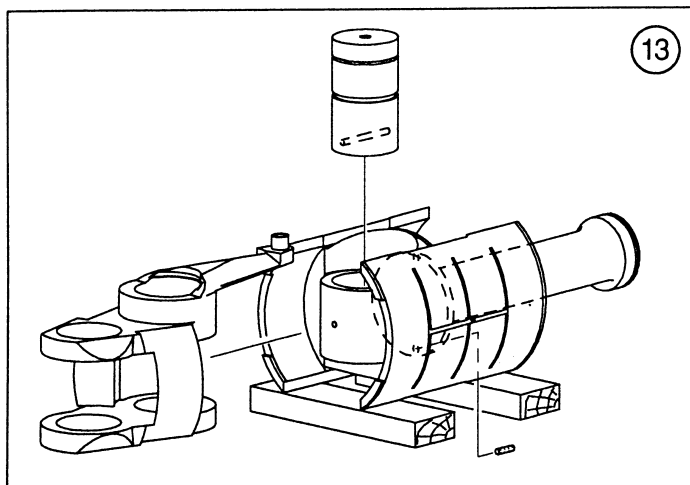
Inspect the sliding surfaces of the roller guide and guide faces of the reversing link for marks and seizures.

Remedy any damage found.

12. Inspect the thrust piece of the roller guide for deformations (replace, if necessary).

When mounting the thrust piece in the roller guide, check that the chamfered surface marked **UP** faces upwards.
See the sketch.



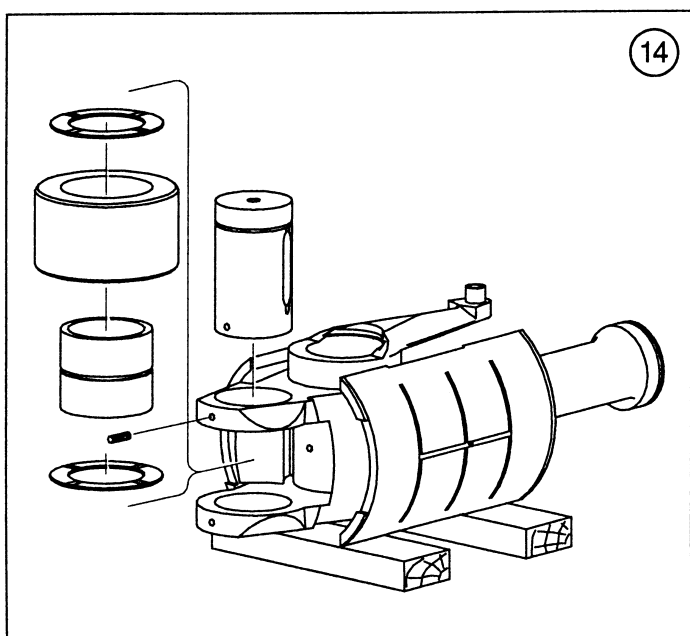


13. Assemble the roller guide, the reversing link and the shaft pin.

By means of the mandrel, press the shaft pin in place in the reversing link, taking care that the locking hole in the shaft pin coincides with the threaded hole for the stop screw in the reversing link.

Then mount the stop screw (ascertain that the stop screw enters the locking hole in the shaft pin).

Lock the screw with 'Loctite Type EN243S'.



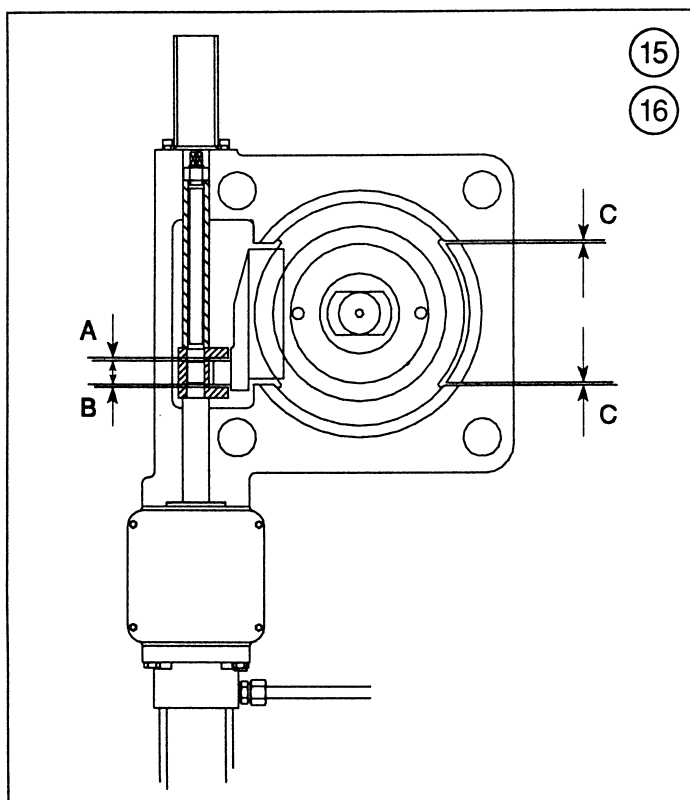
14. Place the roller guide with the reversing link on a couple of planks (with the bores for the shaft pin vertically).

Mount the roller, the bearing bush and the spacer rings in the roller guide so that all the bores coincide.

By means of the mandrel, press the shaft pin in place in the reversing link, taking care that the machined groove in the shaft pin coincides with the guide pin in the reversing link, and make sure that the marking scratches coincide.

Then mount the stop screw (ascertain that the stop screw enters the locking hole in the shaft pin).

Lock the screw with 'Loctite Type EN243S'.



15. When mounting the roller guide with the reversing link, check the clearance between the roller guide and the guide plate mounted in the liner for the roller guide.

Turn the camshaft so that the roller guide is lifted approx. 20 mm.

The clearance **C** between the roller guide and the guide plate must be the same at both ends ± 0.1 mm.

16. The clearances **A** and **B** between the guideway and the pin of the reversing link (arm) must be checked in the AHEAD and ASTERN position.

By means of working air connected to the air cylinder, check that the reversing mechanism is working smoothly.

The clearances **A** and **B** shall approx. be



17. If adjustment is necessary, it must take place in the ASTERN position.

Remove the cover over the shaft connection.

Loosen nut **D** and carry out the adjustment.

After adjustment, shift to AHEAD position and check the clearances **A** and **B** once more.

Finally, shift again to ASTERN.

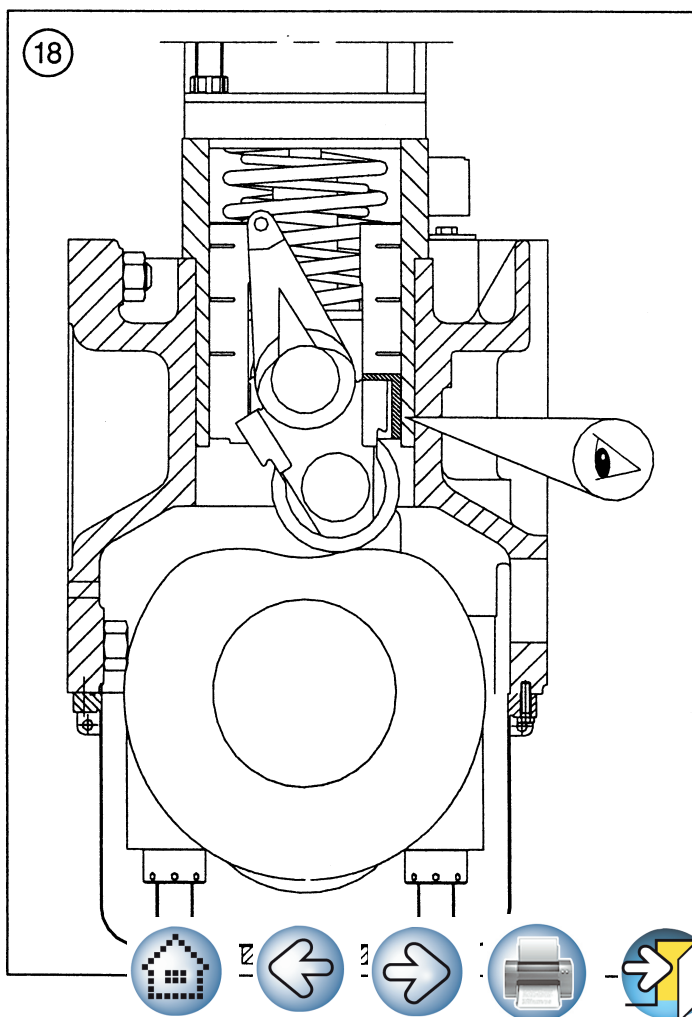
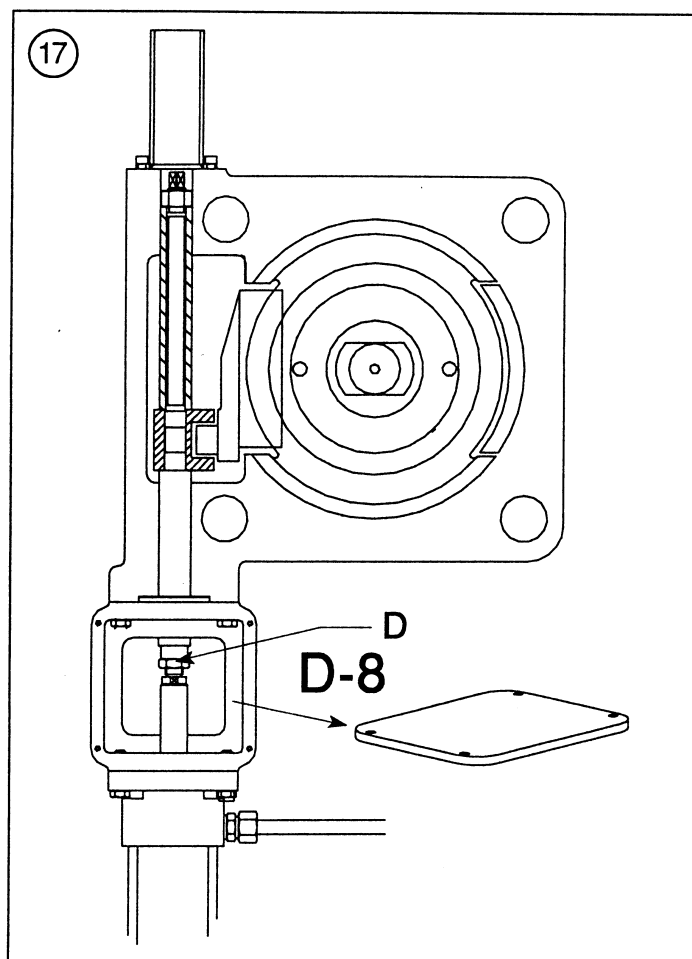
Tighten nut **D** (*see data*), and lock the nut with Loctite type: Screw Lock No. 59.

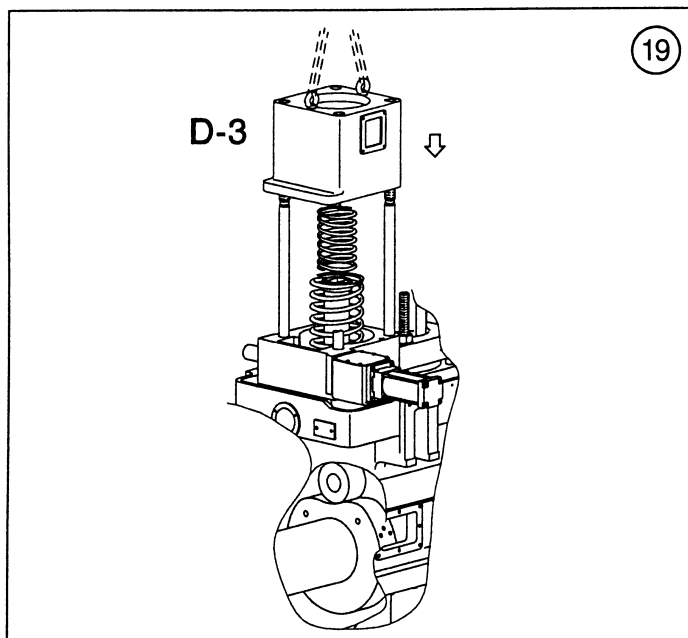
Mount the cover over the shaft connection.

If the clearances cannot be obtained after adjustment, the fuel pump should be removed for inspection of the reversing system.

18. By means of the telegraph, move the roller guide to AHEAD position.

Check that there is no clearance between the reversing link and the guide. The same check has to be made in ASTERN position.





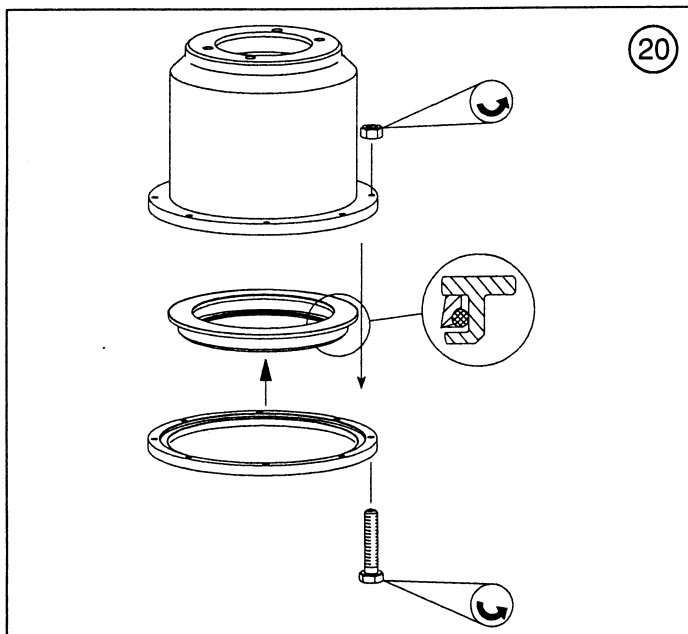
19. Turn the camshaft until the roller guide is in its lowest position.

Mount the spring over the roller guide.

Mount the pump base over the roller guide/spring and tighten the nuts on the two threaded studs until the pump base is fastened tightly to the roller guide bushing.

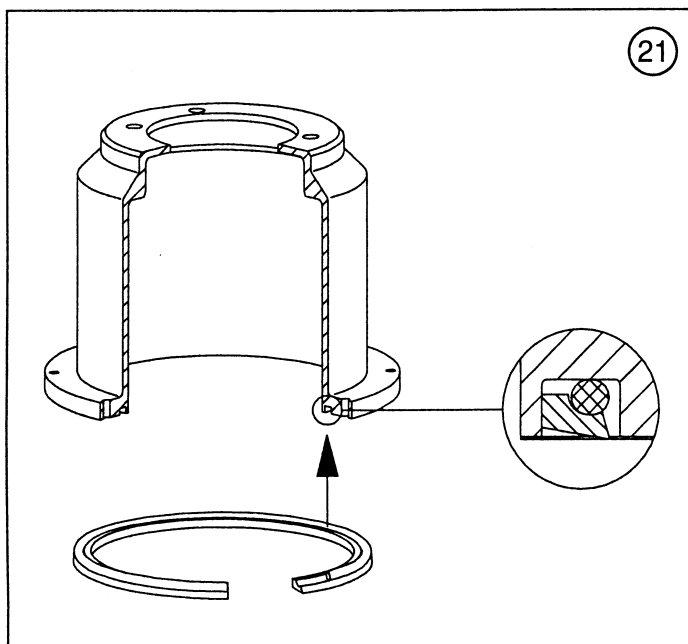
20. The scraper rings in the sealing cap are replaced as follows:

Loosen and remove the screws and nuts from the bottom of the cap, remove the retaining flange and ring holder with scraper ring.



21. Replace the axial scraper ring in the bottom of the cap.

Check that the O-ring and scraper ring are mounted correctly. *See the sketch.*



22. Remove the scraper ring and O-ring from the ring holder.

Place a new O-ring in the ring holder.

Before mounting, the new scraper ring must be heated in 100°C hot water or oil for at least five minutes.

Note !

When mounting the scraper ring in the groove, fold the ring without making any sharp edges and be careful not to cut the scraper ring on the edge of the ring groove when pressing it in.

Check that the O-ring and scraper ring are mounted correctly. *See the sketch.*

23. Assemble the sealing cap, the ring holder and retaining flange.

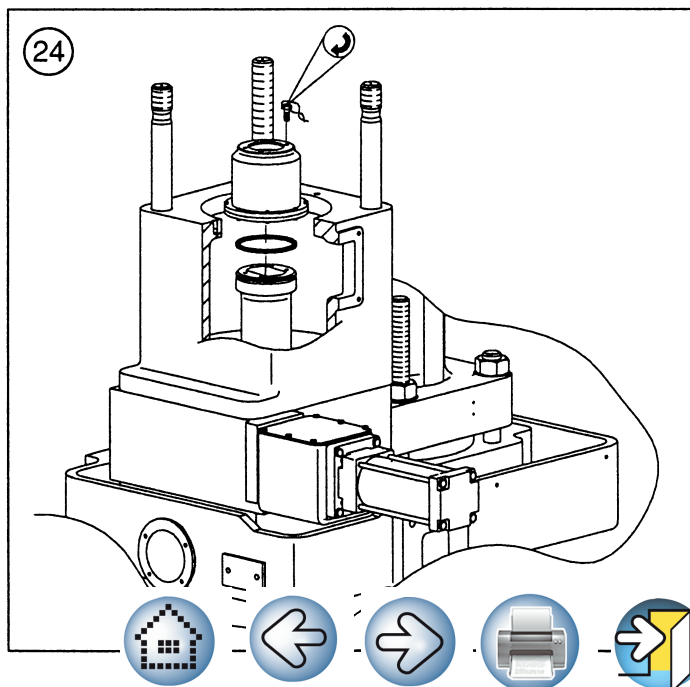
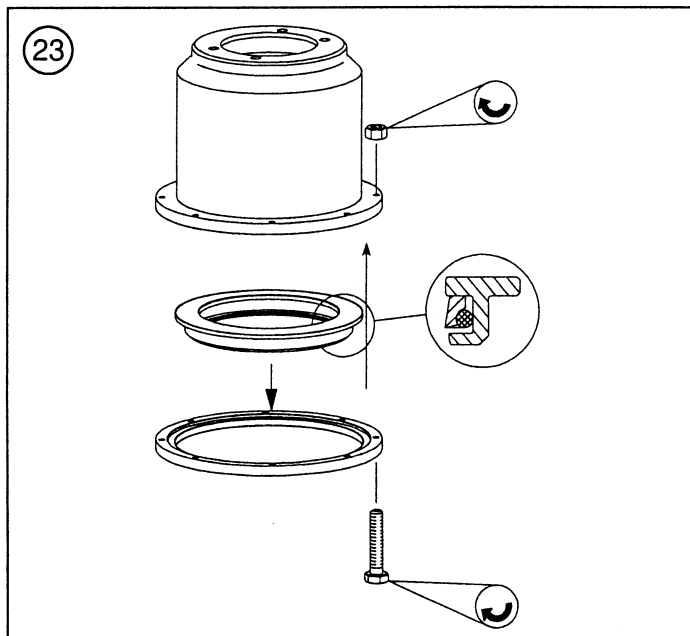
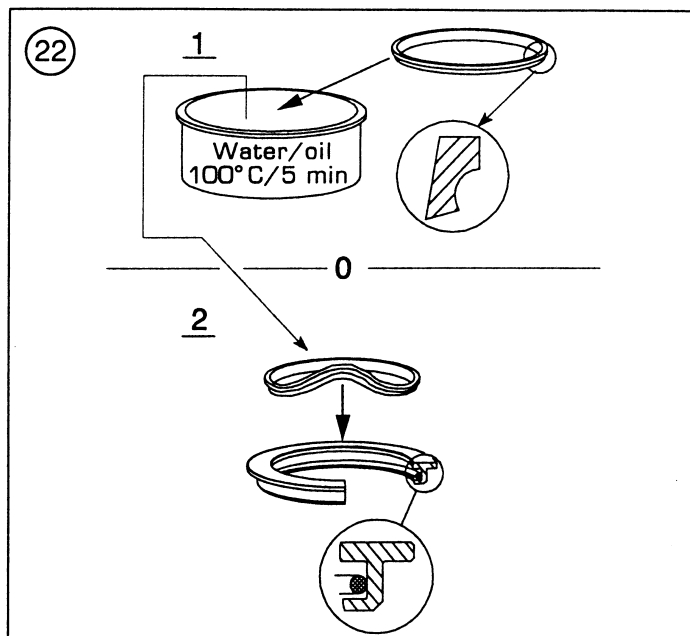
Tighten the nuts on the screws.

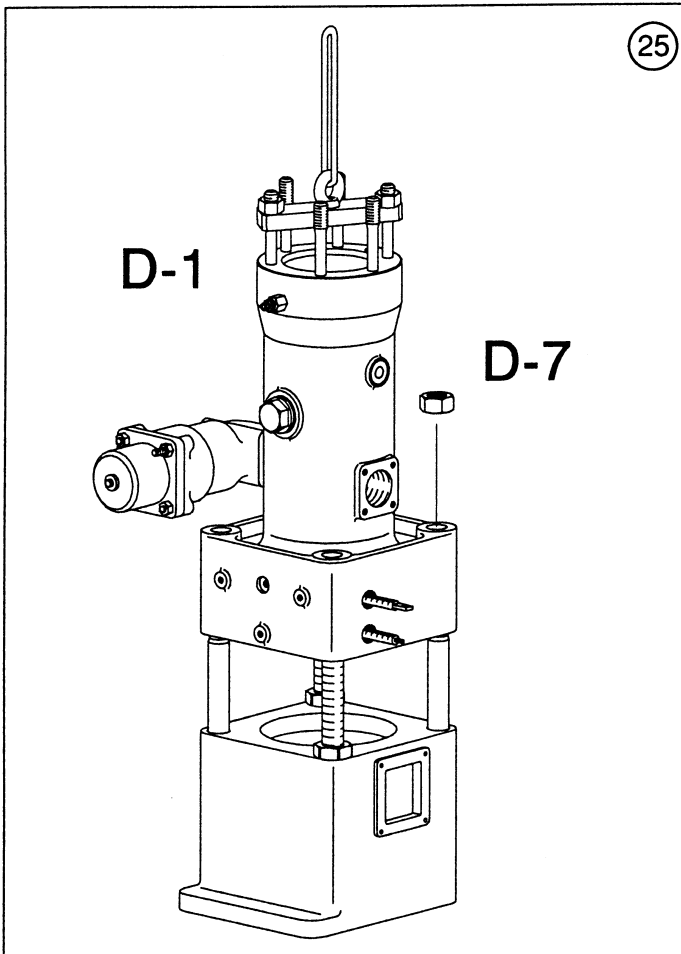
After tightening, check that the holder can be moved.

24. Mount a new O-ring in the groove on top of the roller guide.

Mount the sealing cap on top of the roller guide, over the sealing bush inside the pump base.

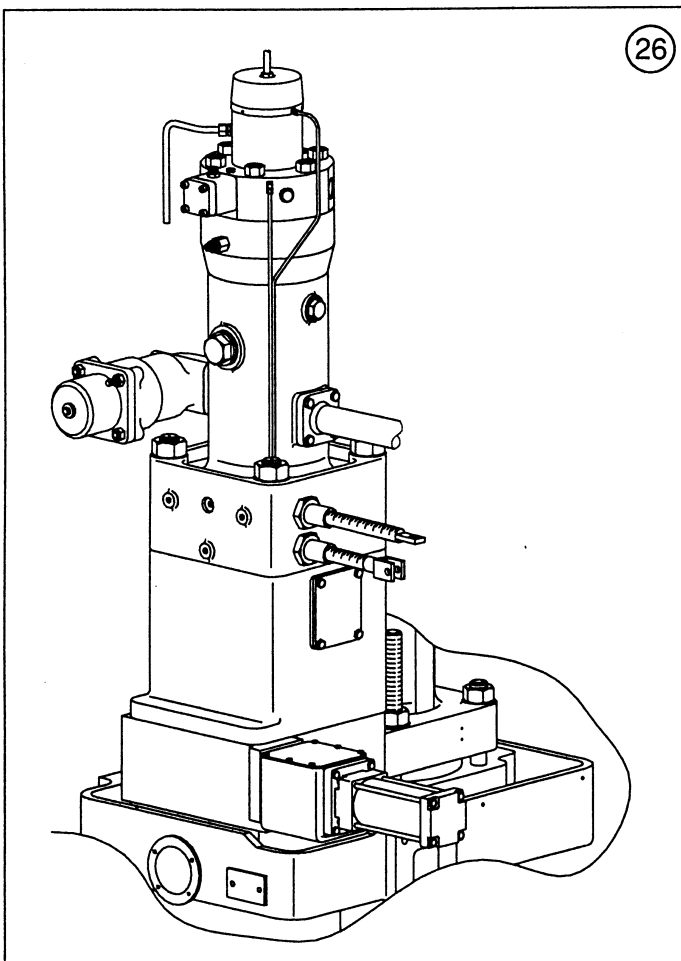
Tighten the screws and lock with locking wire.

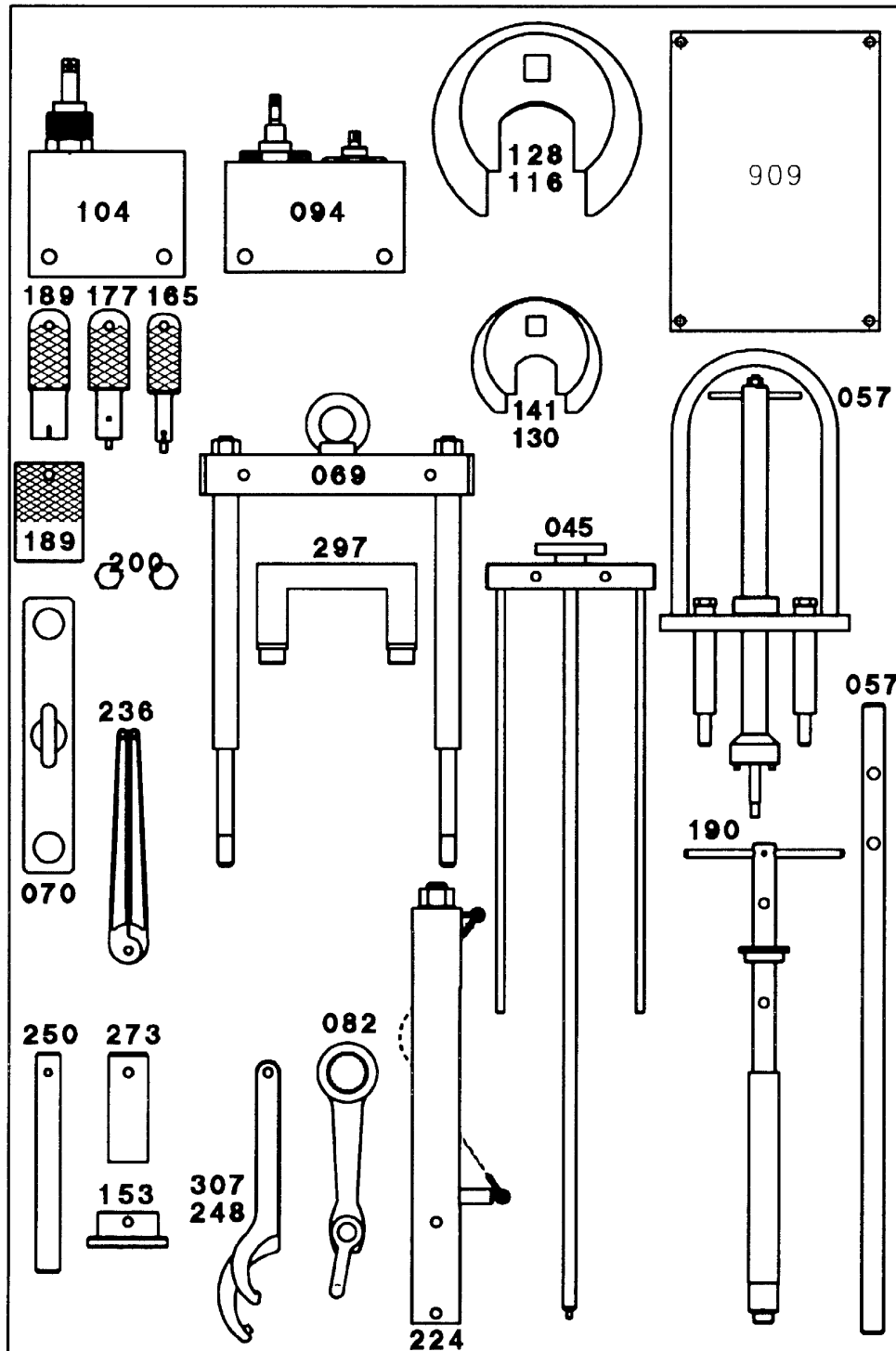




25. Mount the fuel pump housing on top of the pump base and tighten the nuts.
See Data.

26. Mount the plunger/barrel in the pump housing, mount the top cover, the VIT- and fuel index pointer and pipe connections.
See Procedure 909-3.

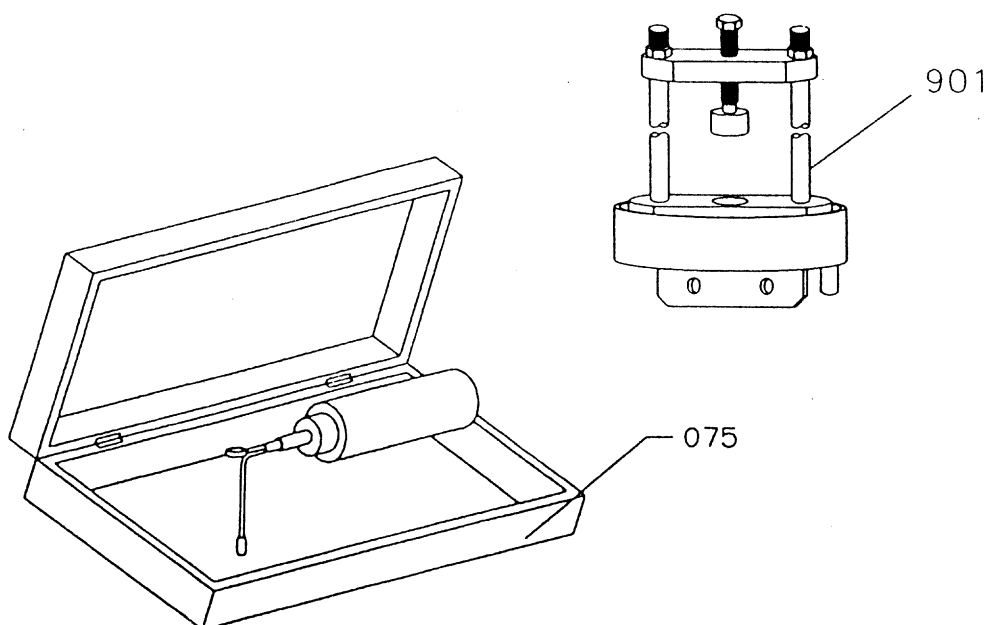
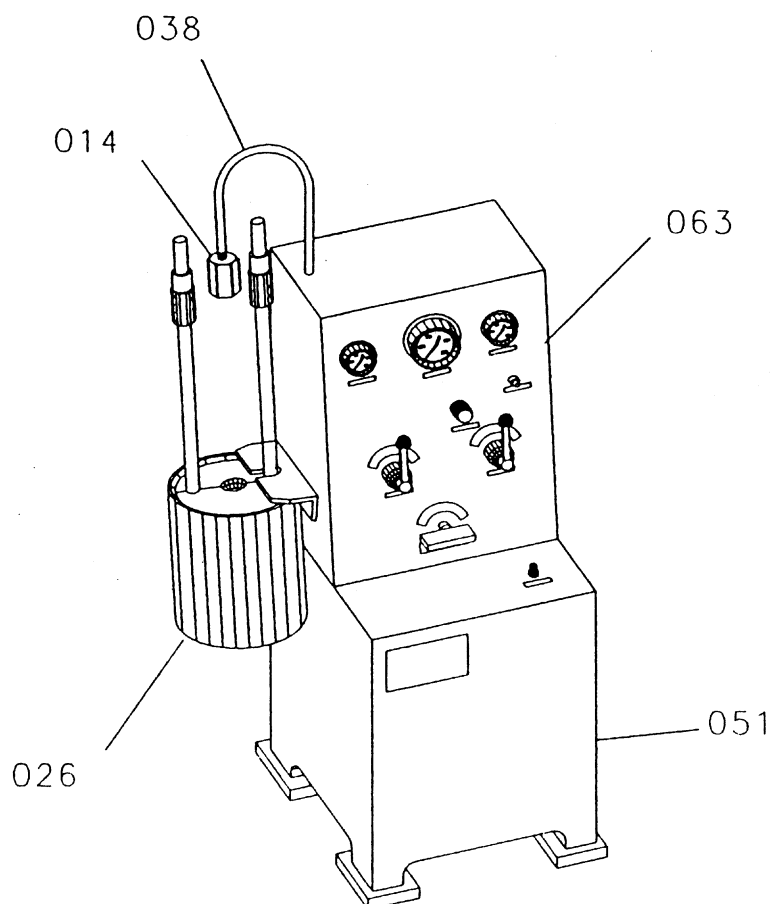




Item No.	Item Description
909	Tool panel *)
045	Measuring tool for fuel pump lead
057	Lifting tool for fuel pump
069	Lifting for fuel pump
070	Lifting tool for fuel pump housing
082	Lifting tool for roller guide
094	Milling tool for seats for fuel oil pipe
104	Milling tool for fuel oil pipe
116	Crowfoot spanner, for puncture v/v
128	Crowfoot spanner, for suction v/v
130	Crowfoot spanner, for fuel oil pipe
141	Crowfoot spanner, for fuel oil pipe
153	Flange dism non return v/v
165	Grinding mandrel for valve head
177	Grinding mandrel for thrust spindle
189	Grinding mandrel for holder-outside
190	Grinding mandrel for holder-insert
200	Hexagon screws for dism. of top cover
212	Cleaning tool for automizer
224	Tool for p _{max} rack
236	Pin wrench special
248	Hook wrench, 68/75mm
250	Drift for spindle guide
273	Drift for non return v/v
297	Assembling tool for fuel valve
307	Hook wrench, 95/100 mm
909	*)Tool panel
307	with tools
	*)Optionnal extras

Item No.	Item Description

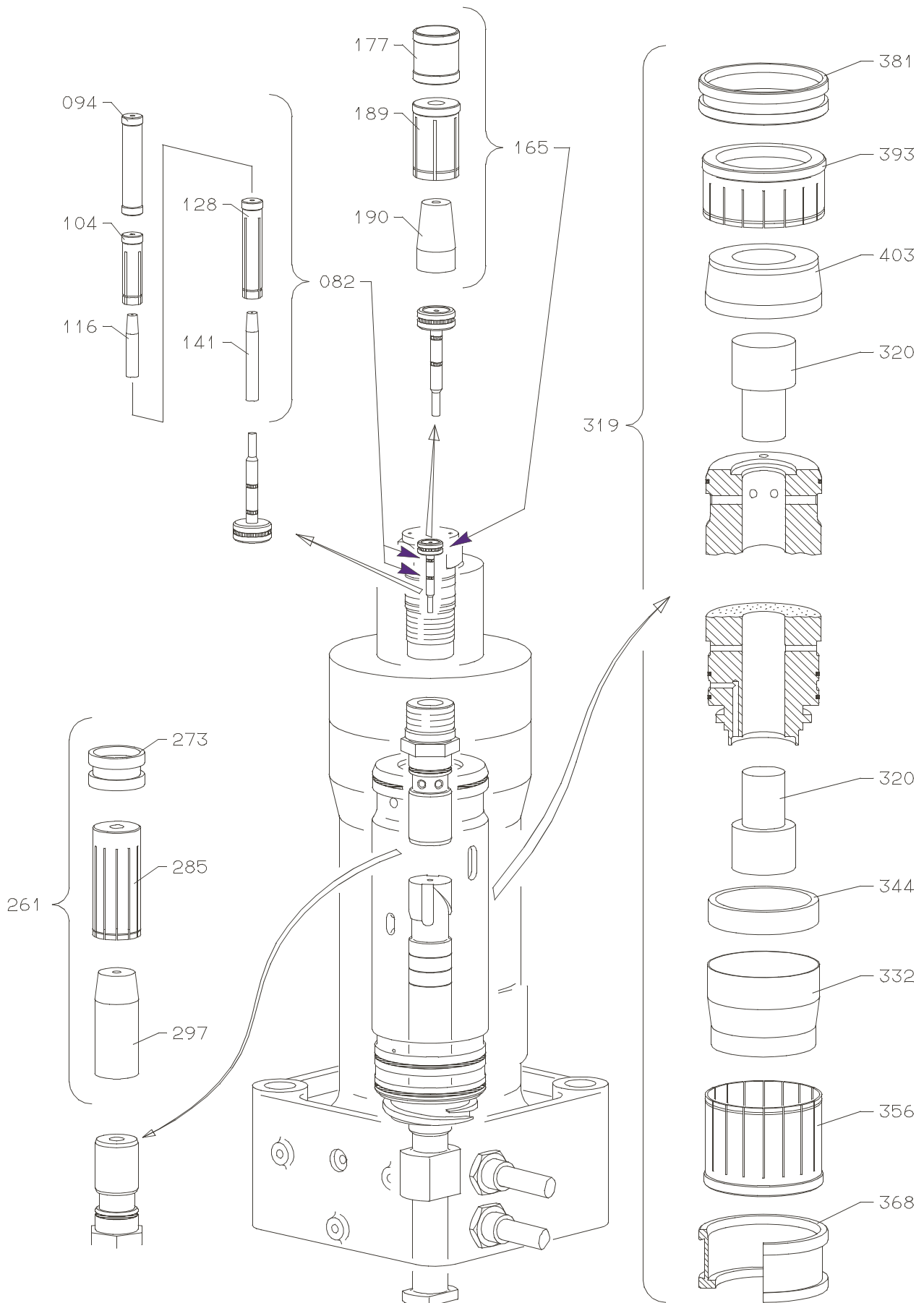




Item No.	Part Description
014	Connection piece
026	Test rig
038	High-pressure hose
051	Table
063	High-pressure pump
075	Probe light
901	Dism, stand for fuel valve

Item No.	Part Description



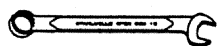


Item No.	Item Description

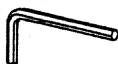
SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☒ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

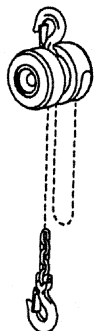
913



13, 15, 16, 18, 24 mm



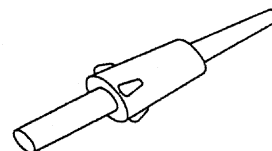
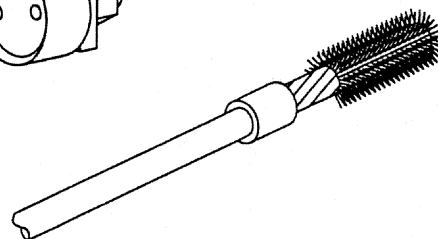
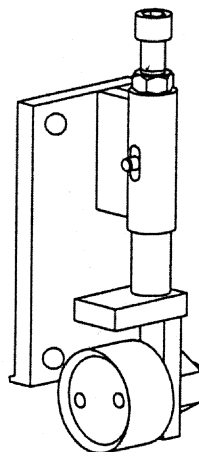
14 mm

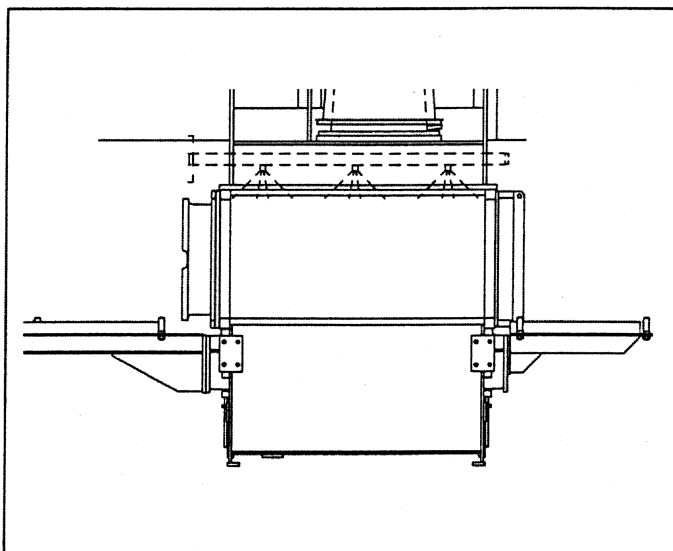


500 kg

DATA:

D-1	End cover – water side	310 kg
D-2	End cover.....	155 kg
D-3	Waterflow reversing chamber.....	209 kg
D-4	Cooler element.....	1512 kg
D-5	Water mist catcher.....	375 kg





Cleaning of air side:

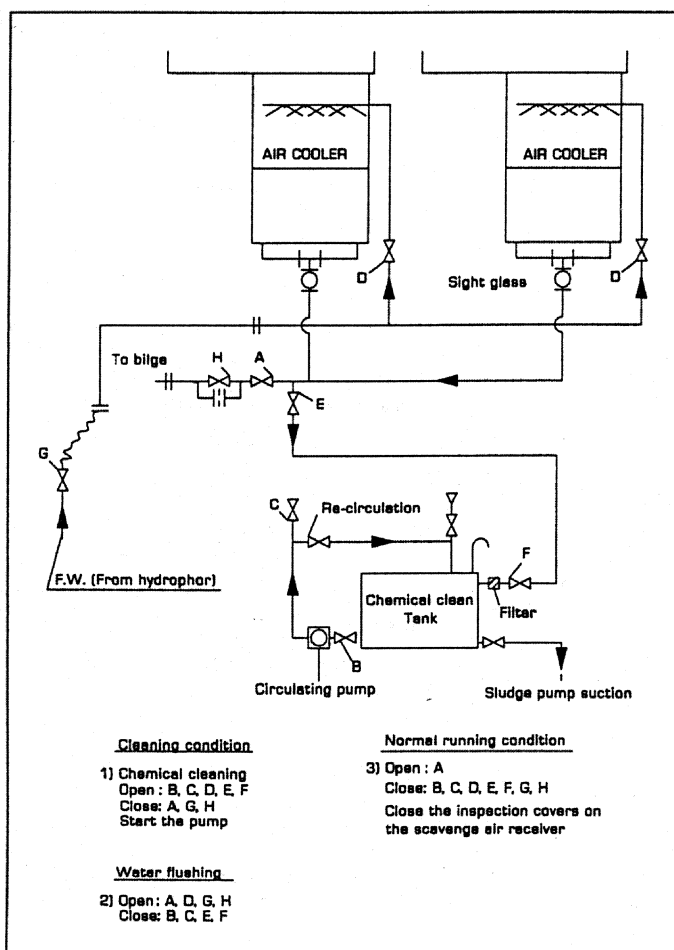
The air side of the cooler is cleaned by injecting a chemical fluid through the spray pipe arrangement fitted to the air chamber above the cooler element.

It is recommended to use one of the following cleaning fluids, or a similar product.

- 1) Product: ACC 9, produced by Drew Chemical Corp., New York, USA
- 2) Product: 80B, produced by Vecom Int., Maassluis, Holland

Cleaning should be carried out in the following sequence:

1. Do not start cleaning until the engine has been at a standstill for about 30 minutes. Do not disconnect the compressed air supply to the exhaust valve.
2. Follow the detailed cleaning instructions displayed at the cleaning pipe on the engine. To ensure satisfactory spraying of the cleaning fluid, the circulating pump pressure must be at least 0.7 bar.
3. Continue the cleaning process for at least 30 minutes. The time required depends on the frequency with which cleaning is carried out and on the chemical product used.
4. After cleaning, flush the cooler with clean water until the water appearing in the sight glasses is clean and pure.
5. Inspection is carried out either by removing the cover on top of the cooler or by dismantling the charging air pipe.



Cleaning of water side:

Close the cooling water inlet and outlet valves.

Drain the cooler of water at the plug screw.

Lowering of waterflow reversing chamber:

Mount a screw shackle at the top of the end cover of the cooler housing.

Suspend a tackle from the lifting mounting on the cooler bracket.

Fasten the chain hook in the shackle.

Remove the screws from the end cover and lower the cover.

Mount another shackle at the top of the waterflow reversing chamber, and lower it in the same way, after removing the screws.

Lowering of the inlet and outlet end cover:

Attach an eye screw to the top of the end cover.

Fasten a tackle to the lifting mounting at the inside of the cooler bracket.

Attach the chain hook to the shackle and remove the screws from the end cover and from the inlet and outlet valves.

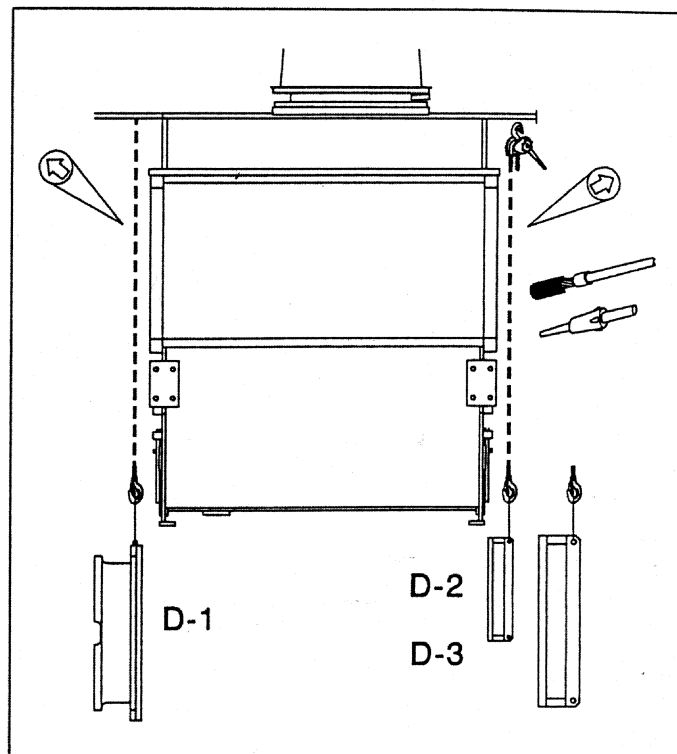
Then lower the end cover.

Cleaning of the water side:

By means of the cleaning brush mounted on a drilling machine, the tubes are to be cleaned inside. In case of leakages between cooling tube and tube plate, the tubes are rolled with the tube expander.

The end cover and the waterflow reversing chamber are to be cleaned inside with a stiff brush and then rinsed with fresh water.

Mounting of end cover and waterflow reversing chamber: – The covers are to be mounted in the opposite order to dismantling.



Note:

As regards cast cooler components:
The inside coating is to be repaired with the original coating, or a similar product.

Replace the anti-corrosion blocks, if necessary.

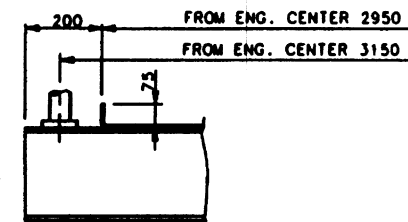


A/C Maintenance Procedure

- 1. Remove the stanchion(①) and handrail(②) on lower gallery.**
(See fig.1 & 4, ① & ②)
- 2. Pipe, electric cable, light & tray beneath upper gallery should be separated from the gallery bracket.**
- 3. Remove the check plate(③) from the upper gallery.**
(See fig.2 & 4, ③)
- 4. Remove the gallery bracket(④) from upper gallery.**
(See fig. 3 & 4, ④)
- 5. Extract the A/C element(⑤) by standard procedure (see maintenance manual as enclosed page 9/14~10/14).**
(See fig. 5 & 6, ⑤).
- 6. Turn the A/C element at an angle of 90° in order to easy lifting of the A/C element. (See fig. 7, ⑥)**
- 7. Lift the element up by engine room crane (be careful of touch with scav. air receiver, hand rail, upper gallery bracket and exhaust gas outlet pipe to T/C).**
(See fig. 8, 9 & 10, ⑦ & ⑧)
- 8. Transfer it to free landing space in engine room and then outside.**

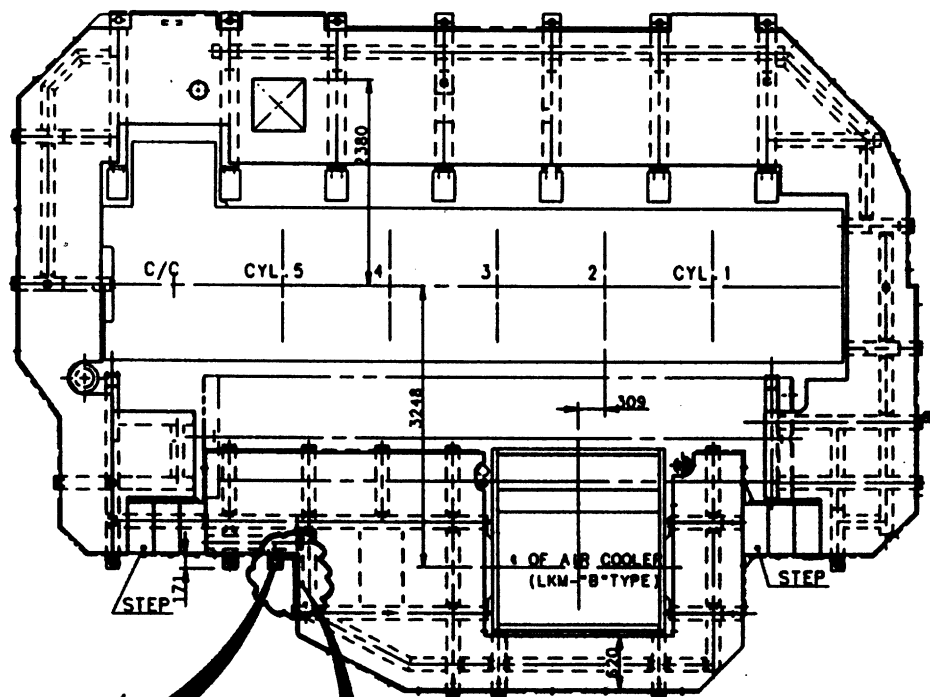


LOWER GALLERY



SECTION "A" - "A"

AFTER

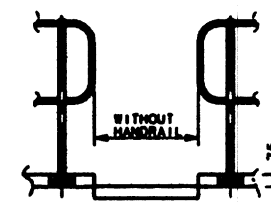


Stanchion
(Remove)

handrail
(Remove)

Fig. 1

FORE

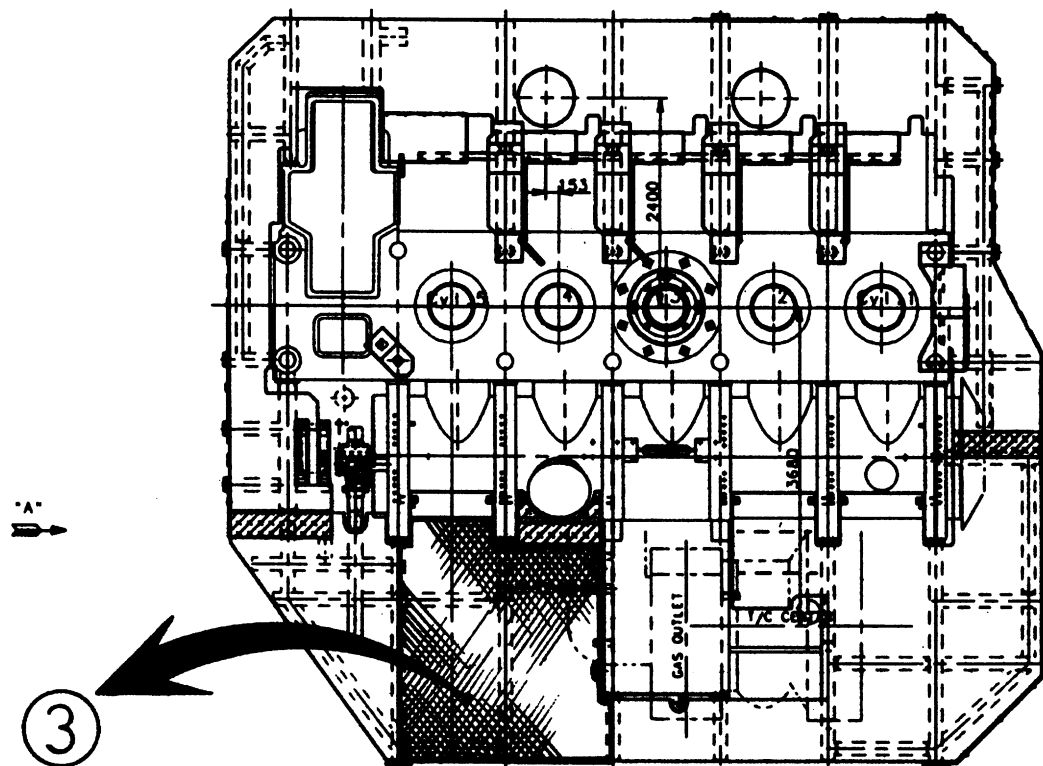


WITHOUT HANDRAIL ONE

[illegible]

AFTER

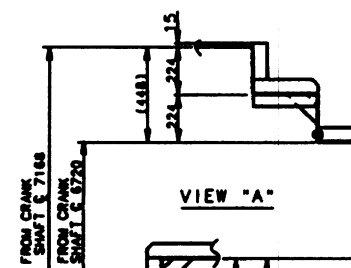
UPPER GALLERY



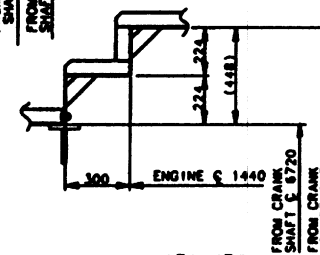
check Plate
(Remove)

Fig. 2

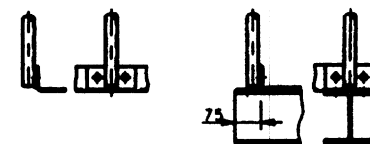
FORE



VIEW "A"



VIEW "B"



HANDRAIL POST DETAIL

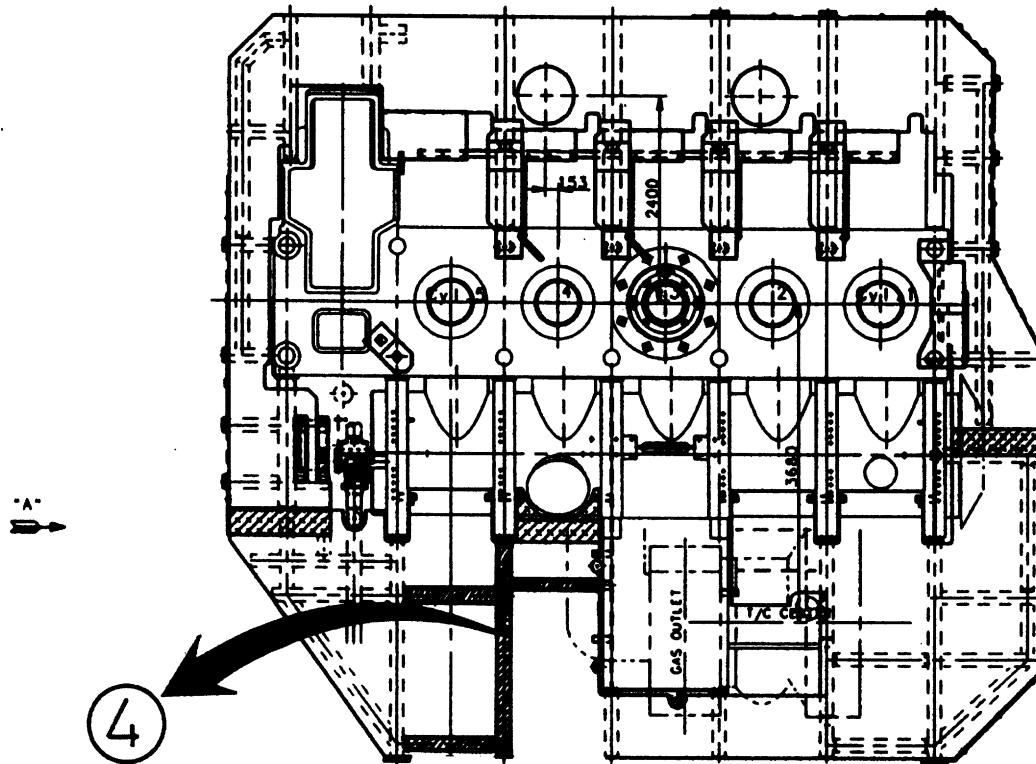
1		5		6		
No.	Drawing no.	Description	Q'ty	Material	Weight	Size

20010619	0000	0000	0000	FIRST ISSUED	
Date	Drawn	Calc'd	App'd	Description of Revision	Revised By
Blank (S/L)	Revised By			Rev. (Name and drawing no.)	
				Bill and drawing no.	
Propositions		Type:			
	1	5S70MC		LKM-B	
Notes	Size	Title			
1:40	A2	UPPER GALLERY			



AFTER

UPPER GALLERY

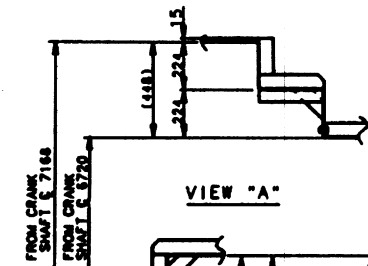


gallery bracket
(Remove)

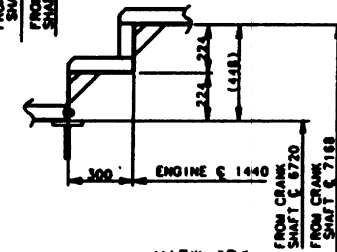
Fig. 3

1		5		6		
No.	Drawing no.	Description	Q'ty	Material	Weight	Size

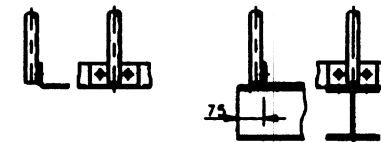
FORE



VIEW "A"



VIEW "B"



HANDRAIL POST DETAIL

20010619	0222	0222	0222	FIRST ISSUED	0
Date	Drawn	Chk'd	App'd	Description of Revision	Rev
REVISIONS				Ref. Standard ordering no. *	
				Ref old drawing no. *	
QUANTITIES		TYPE			
		5S70MC		LKM-B	
Notes:	Scale:	Title:			
1:40	A2	UPPER GALLERY			



4		5		6		
Drawing no.	Description	Q'ty	Material	Weight	Size	

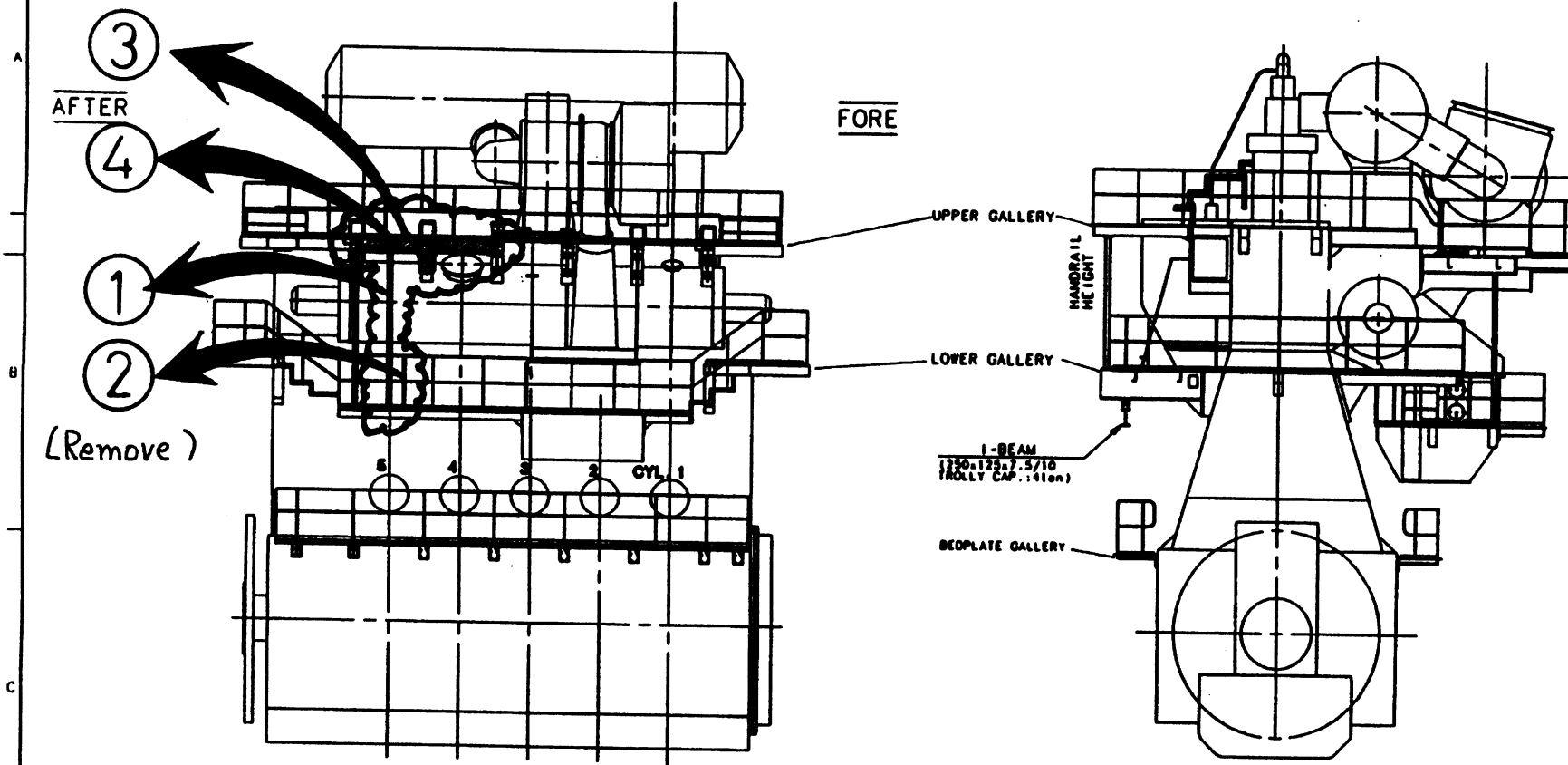


Fig. 4

NOTE

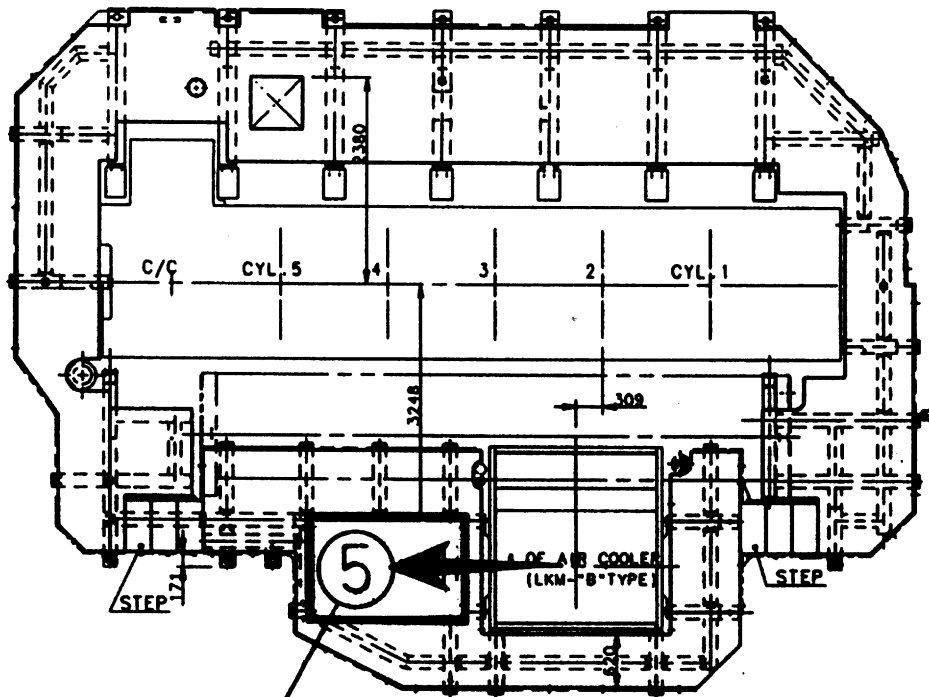
1. OUTLINE DIMENSION은 HANDRAIL POST의
BASE ANGLE 끝까지 DIMENSION함.

[illegible]

EMC'Y STAND

LOWER GALLERY

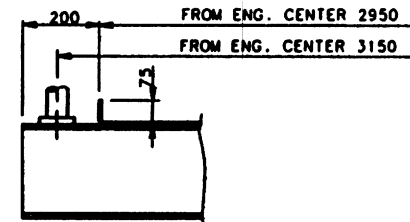
AFTER



A/C element
(Extract)

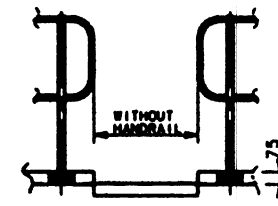
Fig.5

No.	Drawing no.	Description	Q'ty	Material	Weight	Size



SECTION "A"-"A"

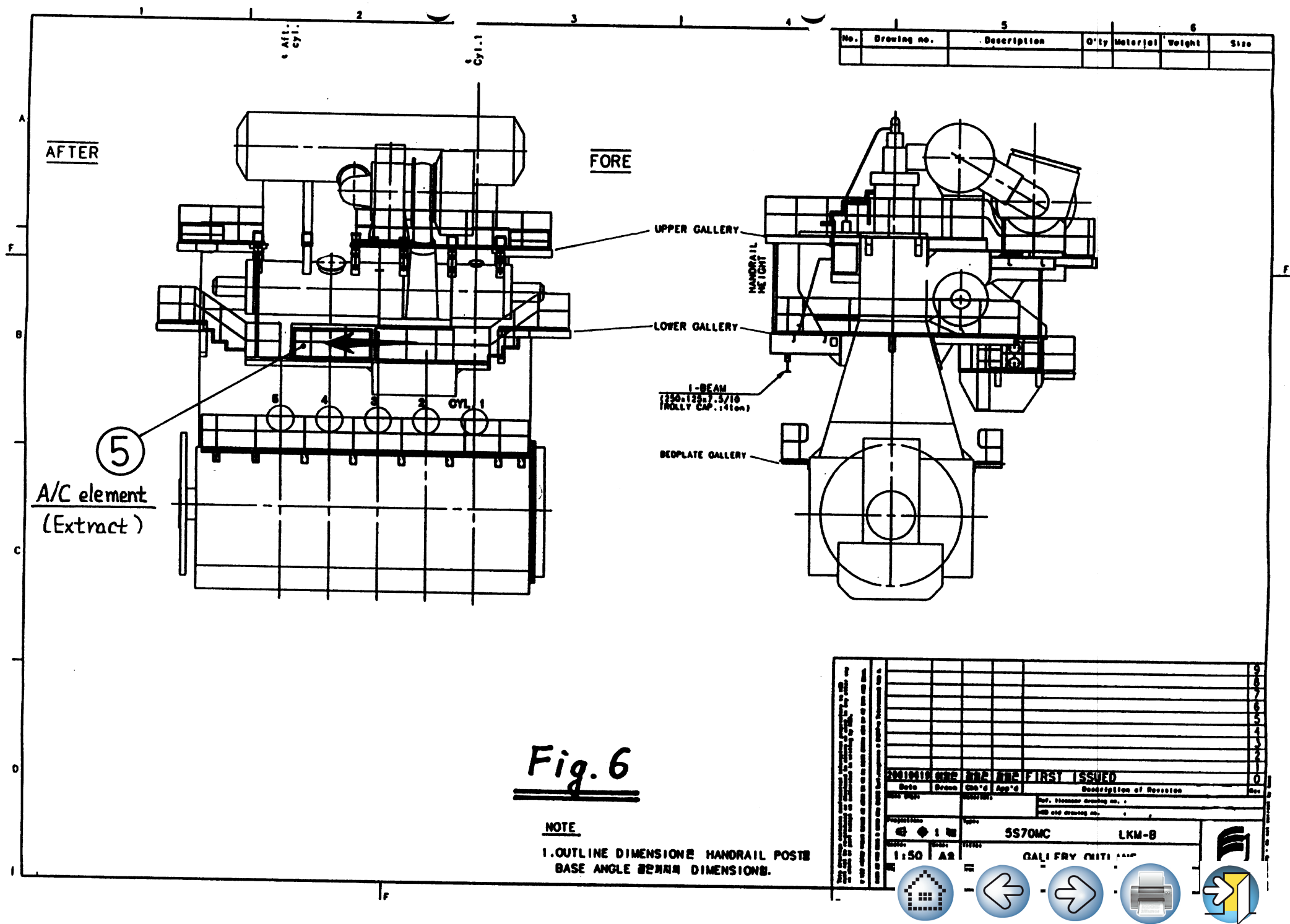
FORE

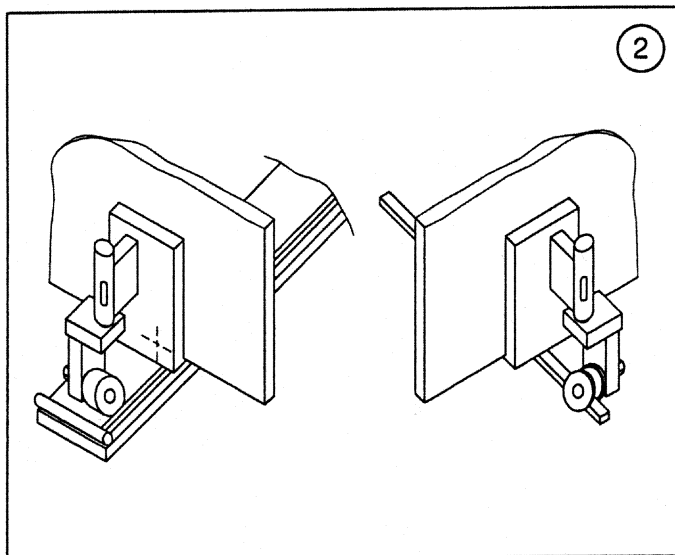


WITHOUT HANDRAIL #45

20010619 0000 0000 0000 FIRST ISSUED									
Date	Drawn	Chk'd	App'd	Description of Revision					
Project name				Title					
5S70MC (LKM-B)				LOWER GALLERY					
Scale: 1:40				Sheet: A2					







The cooler element is not normally to be dismantled for inspection purposes.

It is only if the cooler element has suffered damage that it has to be dismantled for replacement.

Dismantling:

1. Close the cooling water inlet and outlet valves.

Drain off the cooling water at the plug screws on the end cover.

2. Dismount the cooling water inlet and outlet pipes.

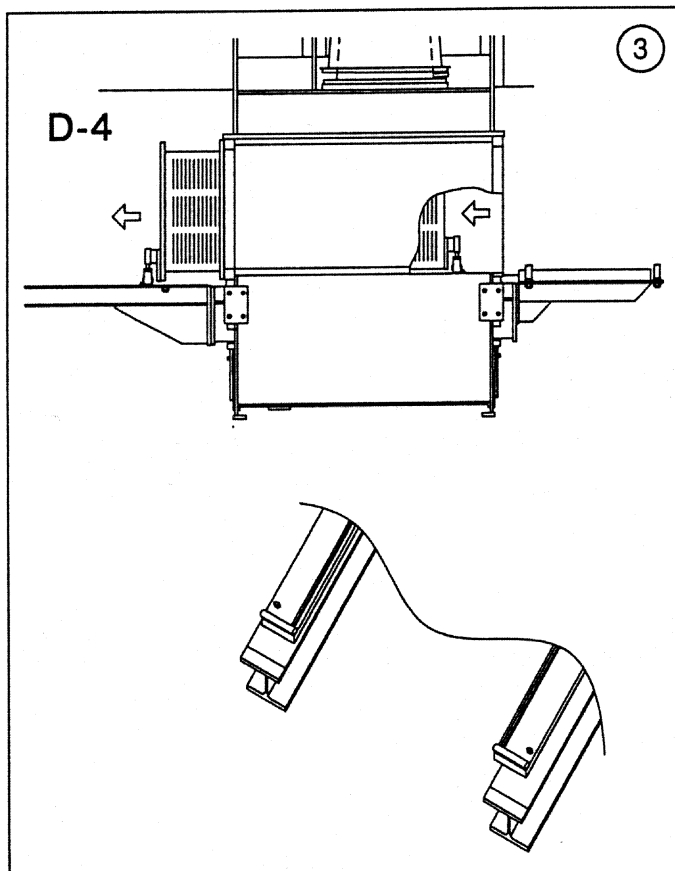
Take off the side cover, end cover, reversing chamber, and the water chamber on the front end of the air cooler.

Mount the pair of wheels for the innermost tube plate, and tighten the thrust screws to make the wheels support the cooler element.

3. Mount two rails, each with a guide rail on top, on the gallery.

4. Mount the pair of wheels for the outermost tube plate, and tighten the thrust screws to make the wheels support the cooler element.

5. Remove the screws which fasten the cooler element to the cooler housing.



6. Press the cooler element free, using dismantling screws.
7. Pull the cooler element halfway out of the cooler housing, checking during this procedure that the outermost pair of wheels is being guided between the two guide rails.
8. When the cooler element has been pulled halfway out, mount the supports on which the innermost pair of wheels can run.

Mounting:

9. Mounting is carried out in the reverse order to dismantling.

Hang-up a new gasket on the four screws which fasten the cooler element to the cooler housing, and tighten the end cover as well as the water inlet and outlet pipes.



LOWER GALLERY

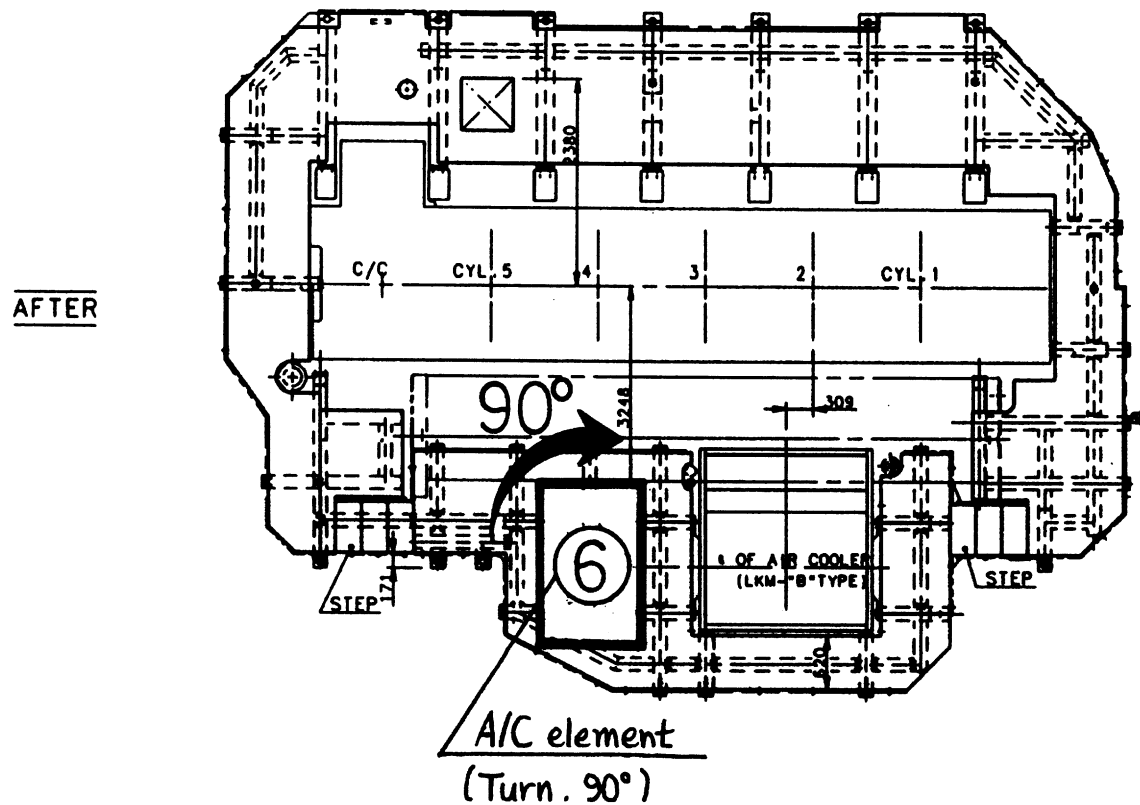
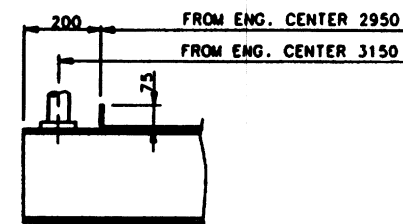


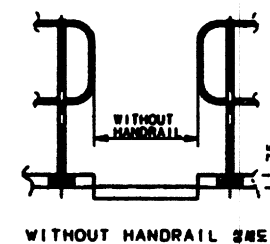
Fig. 7

1		5		6		
No.	Drawing no.	Description	Q'ty	Material	Weight	Size

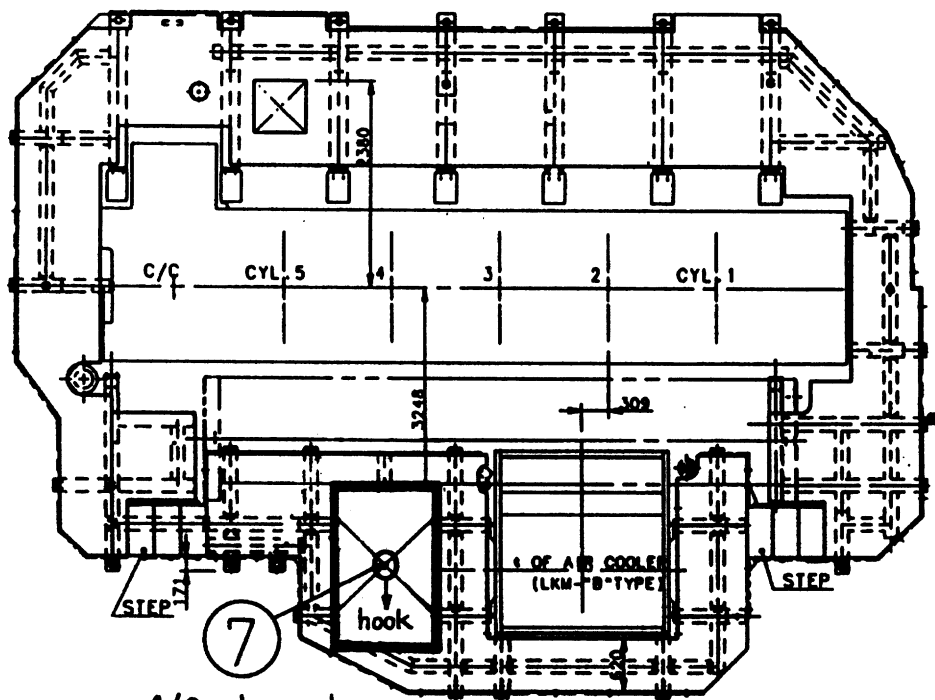


SECTION "A" - "A"

FORE

[illegible]

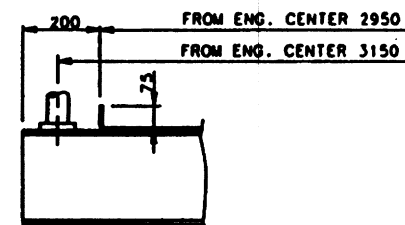
LOWER GALLERY



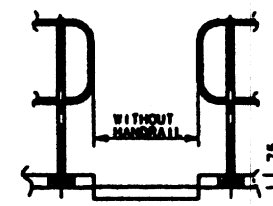
A/C element
(Lift up)

Fig. 8

1		5		6		
No.	Drawing no.	Description	Qty	Material	Weight	Size



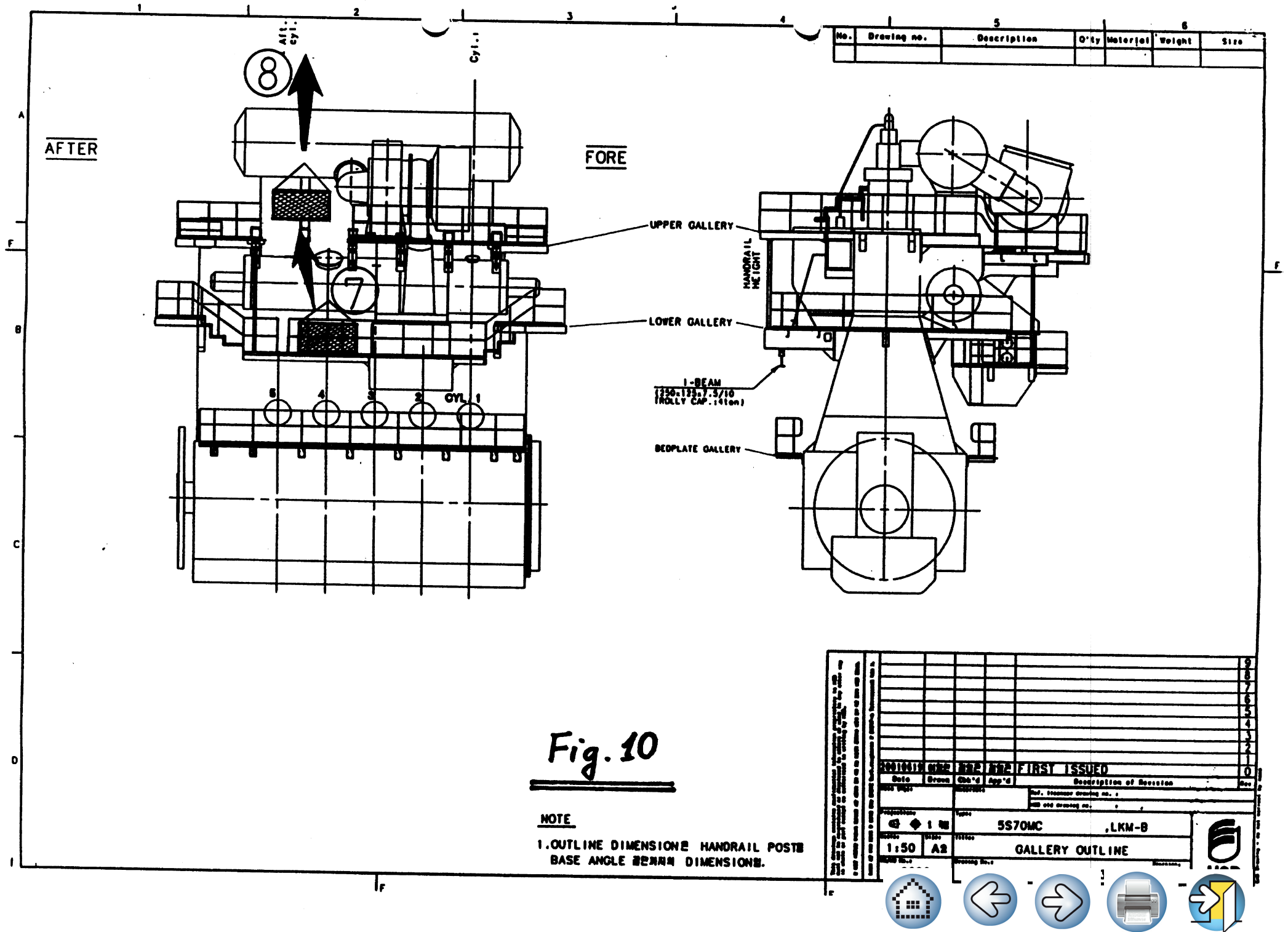
SECTION "A" - "A"

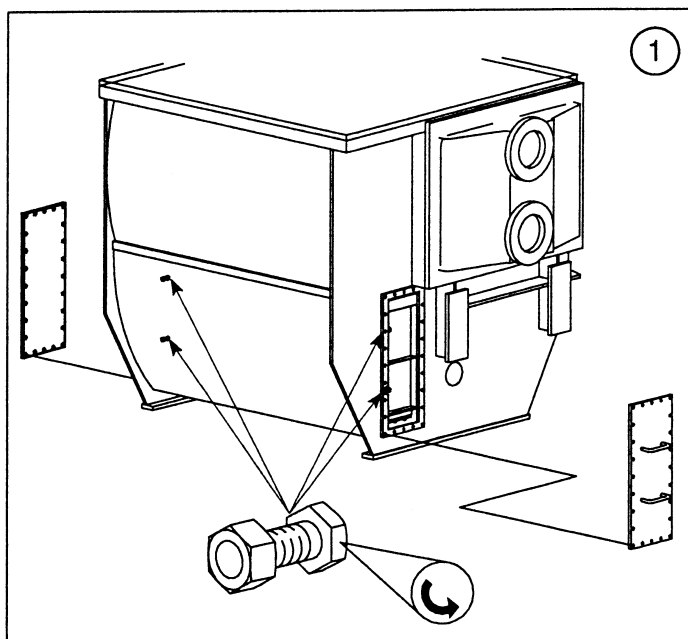


WITHOUT HANDRAIL 345

20010819	0808	0808	0808	FIRST ISSUED
Date	Drawn	Ch'd	App'd	Description of Revision
Rev (Qty)	Description			Ref. Change Drawing No.
Rev (Qty)	Description			Ref. Change Drawing No.
Proj: 001-000	Type:	5S70MC (LKM-B)		
Scale: 1:40	Sheet: A2	LOWER GALLERY		







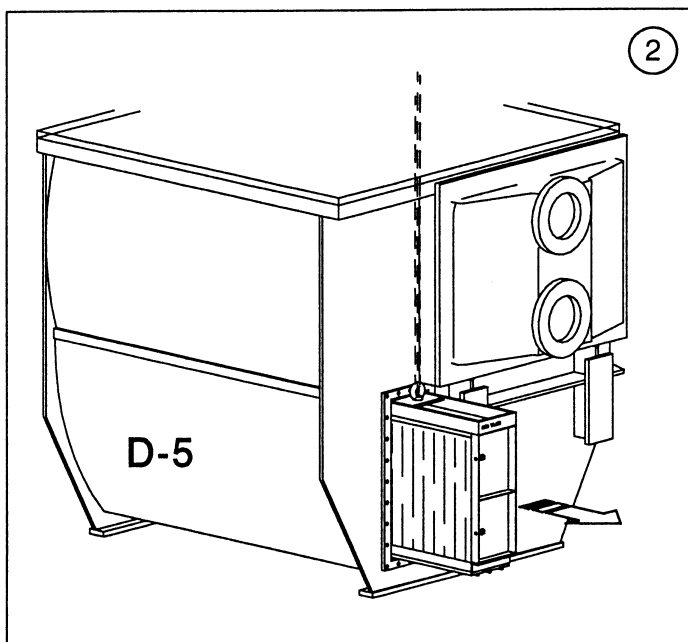
The water mist catcher is only to be dismantled for cleaning purposes.

Dismantling

1. Remove the screws from the two covers, one on each end of the air cooler frame.

Loosen the screws which fasten the water mist element to the cooler frame, through the small end cover.

2. Pull out the water mist element.



Mounting

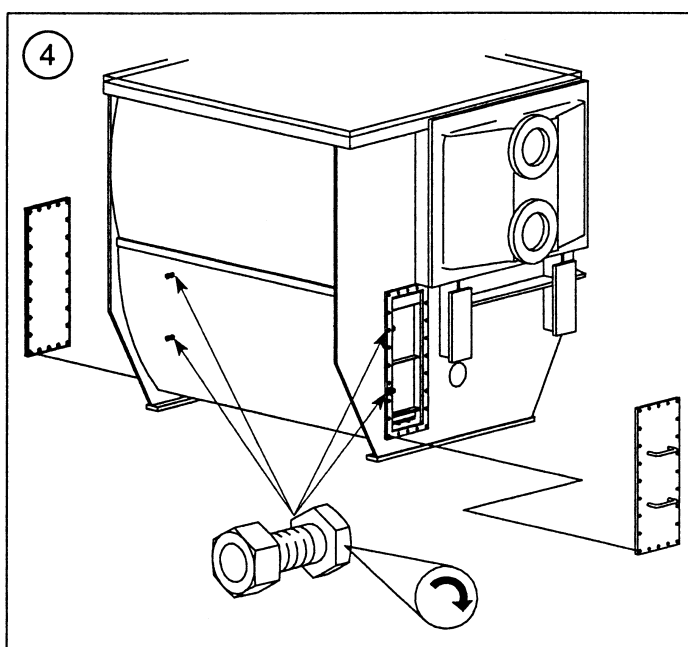
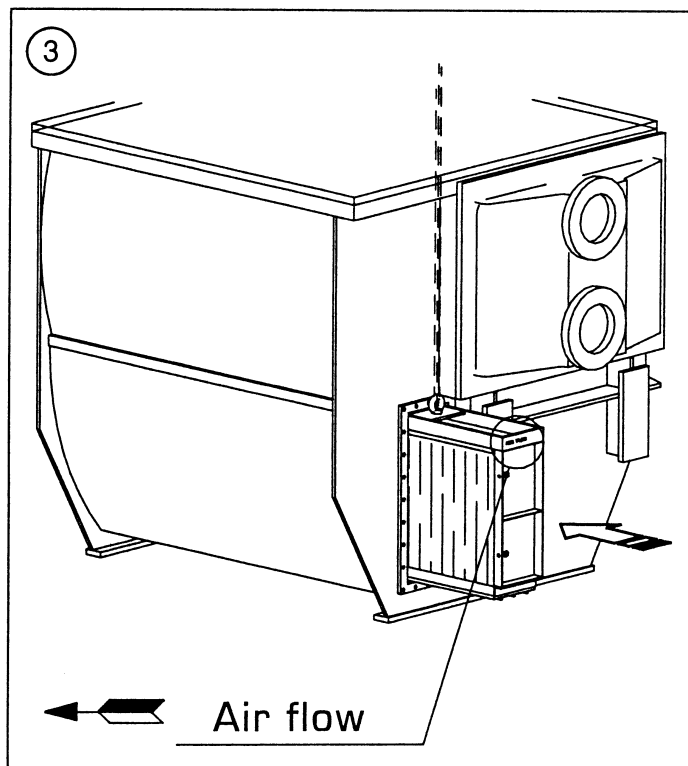
3. Mounting is carried out in the reverse order to dismantling.

OBS !

Make sure that the water mist element is mounted correctly. Check with the marking on the element.

4. After mounting, tighten the element to the air cooler frame.

Finally, mount the two covers on the cooler frame.



The dry cleaning method employs dry, solid, granules which, being blown through the turbocharger, remove most of the deposits which may have formed on the nozzle vanes and turbine blades.

On account of their hardness, nut-shells, or broken or artificially shaped pieces of activated charcoal with a size of between 1.0 and max. 1.5 mm are particularly suited as blasting agents.

We recommend **not** to use rice or grain as cleaning materials, as these can possibly stick in the exhaust gas boiler.

With this procedure, it is not always possible to remove the thicker deposits.

Therefore, in order to prevent the building up of such thick deposits, the turbine has to be cleaned after every 24 to 50 hours of operation.

Generally, the cleaning can be carried out without, or with very little, reduction of the engine load.

More detailed information regarding the amount of granules to be used, is stated on the instruction plate located close to the turbocharger.

On engines equipped with more than one turbocharger, these should be cleaned one after the other.



Cleaning Procedure:

1. Close valve **A**.
2. Open valves **B** and **C**, and blow out any deposits and/or condensate in the connecting pipe.

Close valves **B** and **C** after about two minutes.

3. Slowly open valve **A** to relieve the pressure in the tank.
4. Fill the container with the quantity of granules specified on the plate close to the turbocharger.

5. Close valve **A**.
6. The turbocharger can be cleaned at normal operation load.
7. Open valves **B** and **C** and blow the previously filled-in granules through the turbocharger.

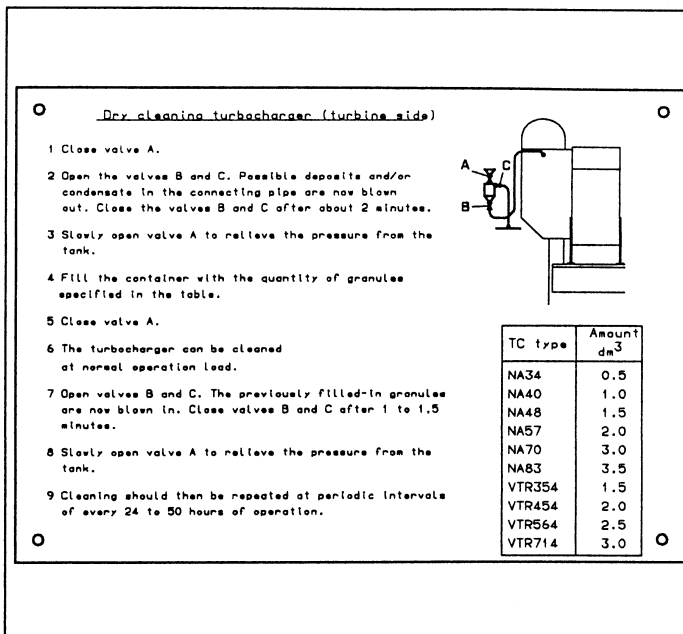
Close valves **B** and **C** after 1 to 1.5 minutes.

8. Slowly open valve **A** to relieve the pressure in the tank.
9. Cleaning should then be repeated after every 24 to 50 hours of operation.

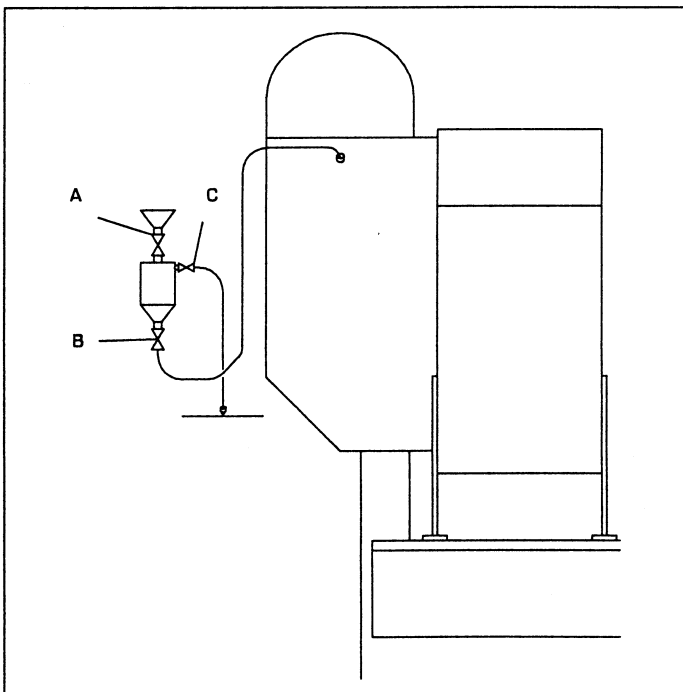
Attention !

1. The drain openings in the gas casings must remain closed while dry cleaning the turbine.
2. It is possible that during dry cleaning of the turbine, some of the blown-in solid particles or sparks will escape through the funnel.

Dry cleaning turborecharger (turbine side)



TC type	Amount dm ³
NA34	0.5
NA40	1.0
NA48	1.5
NA57	2.0
NA70	3.0
NA83	3.5
VTR354	1.5
VTR454	2.0
VTR564	2.5
VTR714	3.0



BLANK



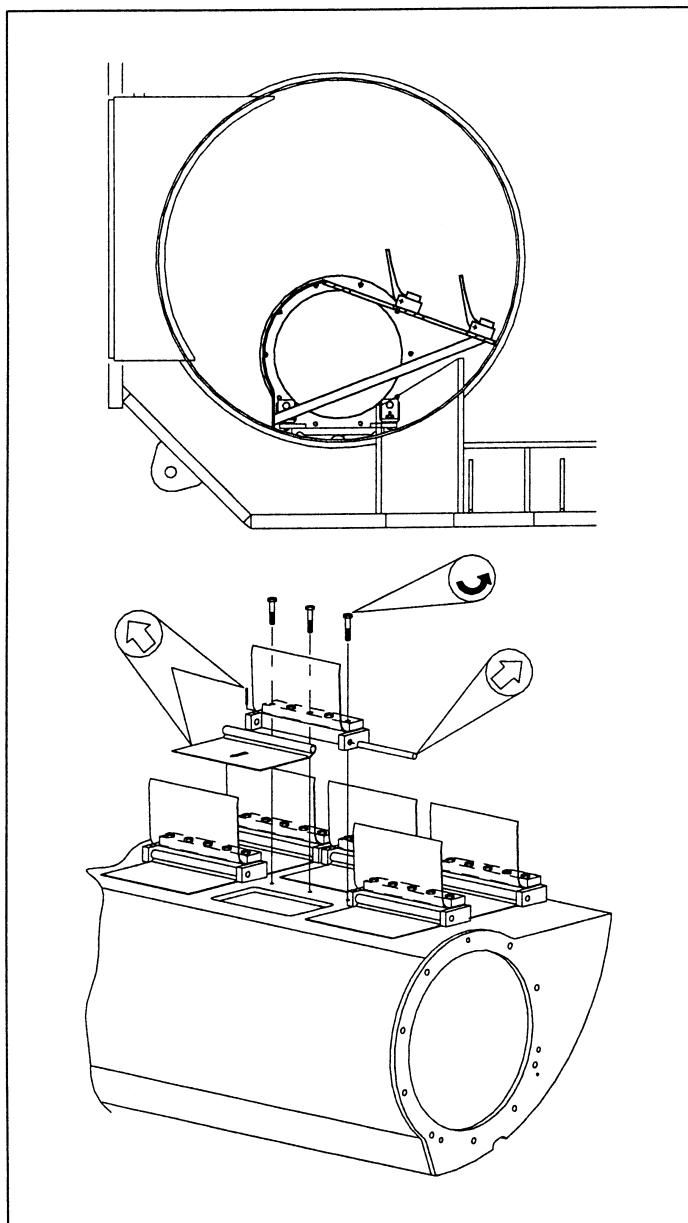
SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

DATA:

D-1 Weight of non-return valve assembly..... 11 kg



Access to the non-return valves in the scavenge air receiver takes place – after the engine has been stopped – through the inspection openings of the receiver.

OBS !

Access to the scavenge air receiver **must not** take place until the air in the receiver is clean.

Replacement of non-return valve assembly:

Remove the two outermost screws and the middle screw (which fasten the valve assembly to the housing).

Lift the complete valve assembly out and mount a new assembly instead.

Overhaul of non-return valve assembly:

Knock out the spring pin which secures the axle of the valve flap and press out the axle. Now the valve flap is free and can be replaced.

For further dismantling, remove the two screws which hold the parts together as an assembly.

When mounting, again secure the axle of the valve flap by means of the spring pin.

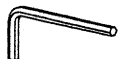


SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☒ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

 17, 24, 30, 32 mm

 6 mm

 1600 kg

 1800 kg

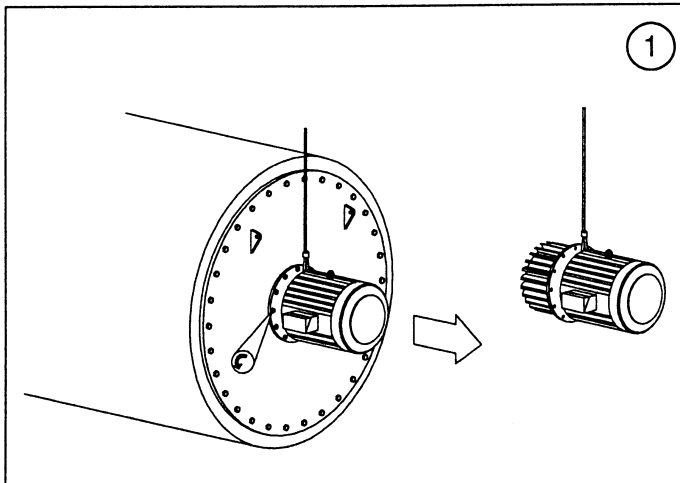
 2000 kg

DATA:

D-1 Weight of auxiliary blower *)
complete up to..... 1000 kg

*) Depending on electric motor type
and number of cylinders of engine
(size and capacity of auxiliary blower).



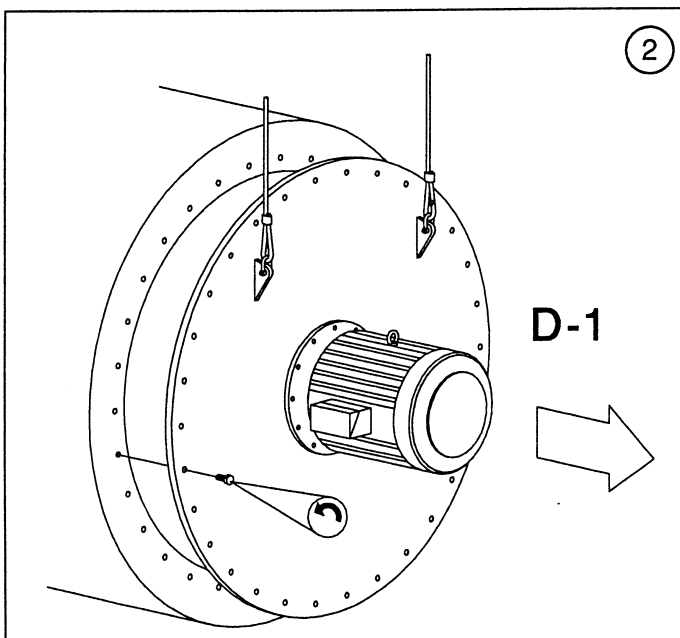


1. When cleaning and inspecting the auxiliary blower, take out the electric motor and the blower wheel as one whole assembly.

2. Disengage the cable connections to the blower motor.

Attach wire ropes with shackles to the lifting mountings on the blower flange, and hook-on the two tackles suspended from mountings on the gallery bracket.

Remove the screws in the blower wheel flange, and pull the electric motor with flange and blower wheel out of the end cover, using the two tackles.



- Inspect and clean the blower wheel as well as the blower housing.

OBS !

Exercise care when mounting the electric motor with blower wheel, as the blower wheel is to “catch” the guide in the blower housing (**A**).

If the whole blower assembly is to be dismantled, the inspection covers on the scavenge air receiver are first to be removed.

OBS !

Make sure that the air in the receiver is clean before making the access.

Suspend two tackles from the mountings on the gallery bracket above the end cover.

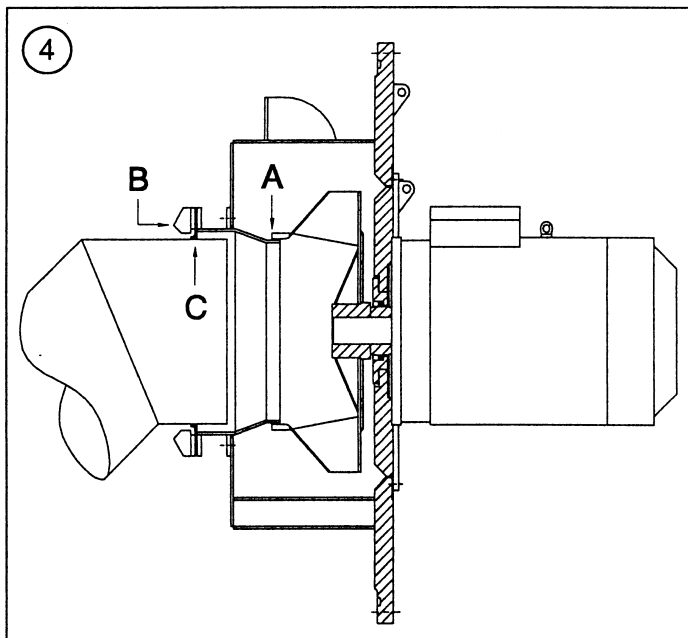
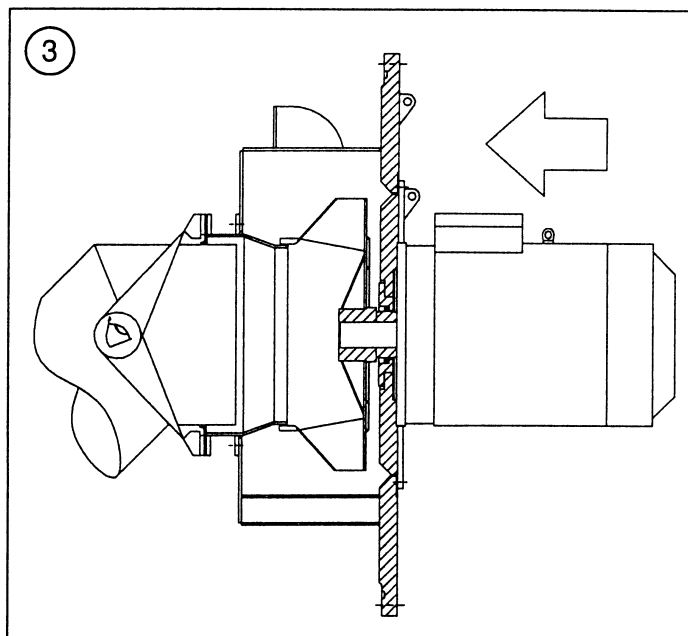
Attach two wire ropes with shackles to the lifting mountings on the end cover, and hook on the tackles.

Remove all screws holding the end cover of the suction pipe.

The end cover complete with blower can now be pulled free of the suction pipe by means of the two tackles. While pulling out the end cover with the blower assembly, make sure that the blower housing disengages from the air pipe without deforming it.

- When mounting the end cover with the complete blower, the parts are to be “guided” into place with care, making sure that the pipe in the receiver “catches” the guide bosses (**B**) of the blower housing flange.

The gasket (**C**) constitutes the sealing between blower housing and pipe.



BLANK

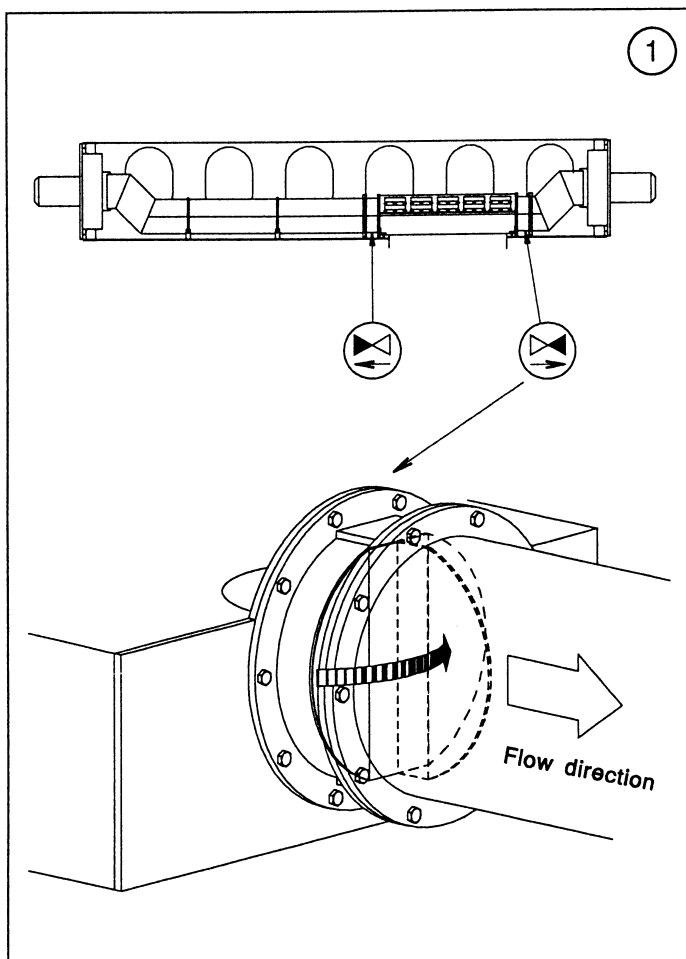


SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913





1. It is important that the automatic non-return valves (butterfly valves) are always able to function easily and unimpeded.

The movability of the valve flaps should therefore be checked at suitable intervals. The valve shall open for the air flow from the valve housing to the auxiliary blower.

Access to the butterfly valves is obtained through the manhole covers of the receiver, after the engine has stopped running.

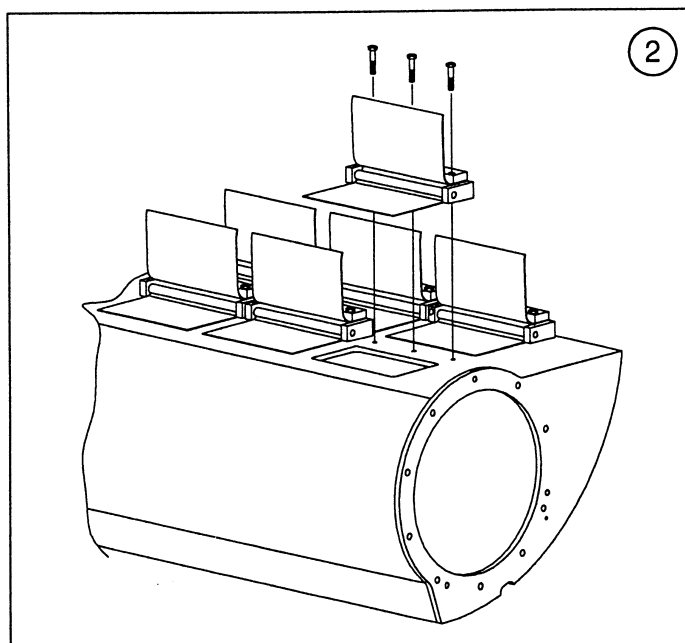
Note !

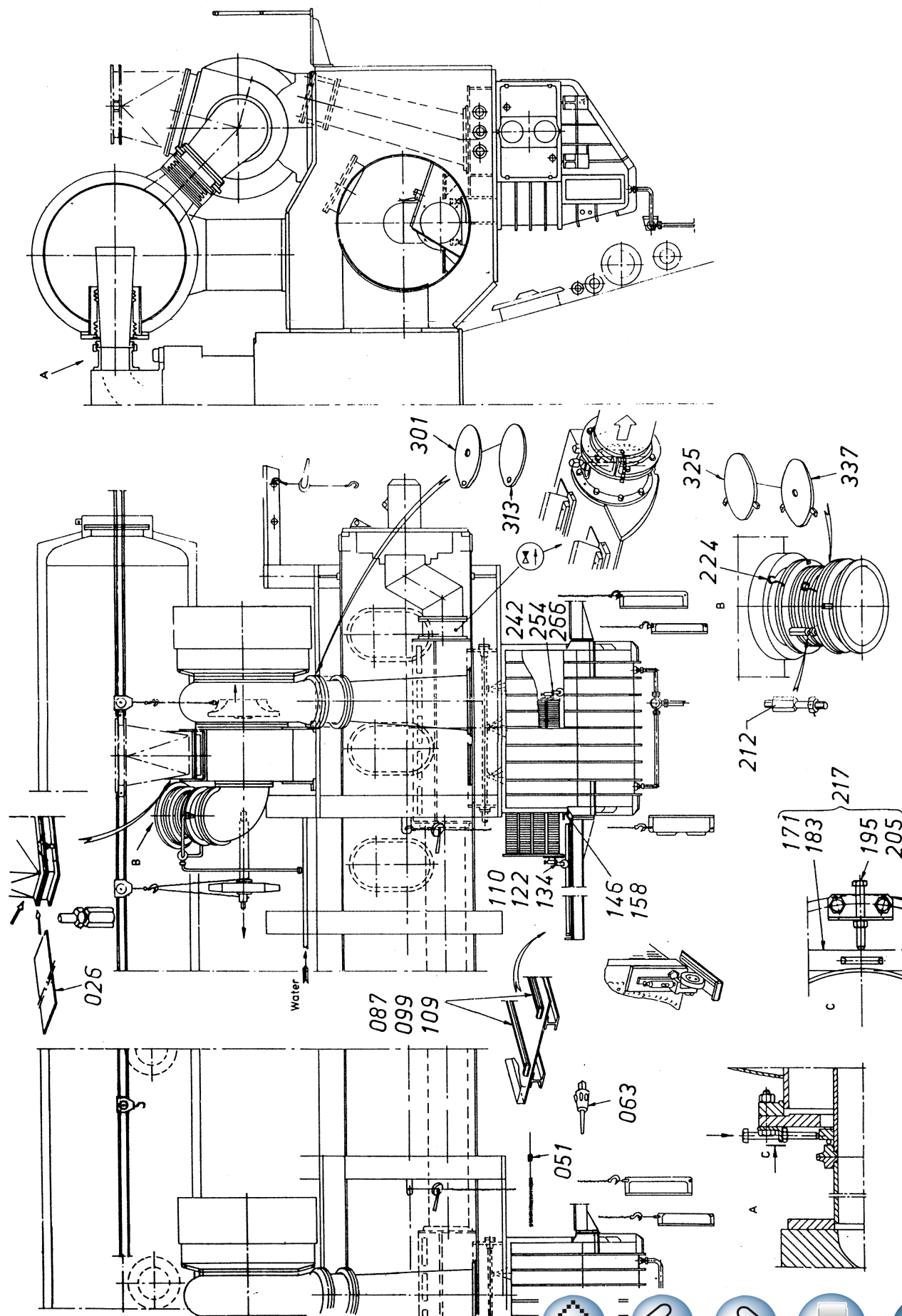
Before entering the receiver, make sure that the air in the receiver is pure.

2. In the receiver, reach through the small non-return valves to check the movability of the butterfly valves.

If necessary, remove one or more of the small non-return valves to gain access to the butterfly valves.

3. If one of the butterfly valves cannot be moved by a light touch of a fingertip, it must be dismantled and overhauled.





Item No.	Item Description
026	Blank plate, exhaust outlet *)
051	Cleaning brush
063	Tube expander
087	Raill (1) for overhauling tool for air cooler
099	Raill (2) for overhauling tool for air cooler
109	Screw
110	Roller, left
122	Roller, right
134	Screw
146	Sectional iron
158	Screw
171	Adjustment tool for expansion joint
183	Screw
195	Screw
205	Nut
217	Compensator extender, complete
212	Pulling tool for compensator
224	Lifting eye bolt
242	Roller, left
254	Roller, right
266	Screw
301	Throttle plate *)
313	Blank plate *)
325	Blank plate *)
337	Throttle plate *)
	*) Exhaust gas system blanking-off tool (only when two or more TC, or Emergency By-pass, are fitted)

Item No.	Item Description



SAFETY PRECAUTIONS

- ☐ Stopped engine
- ☐ Block the starting mechanism
- ☐ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

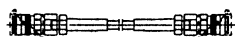
913



27, 32 mm



40 - 200 Nm



3 m

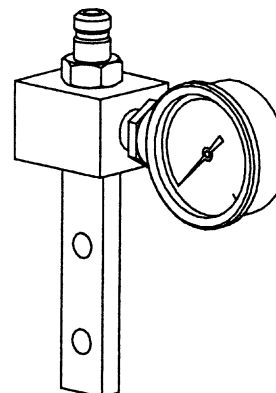
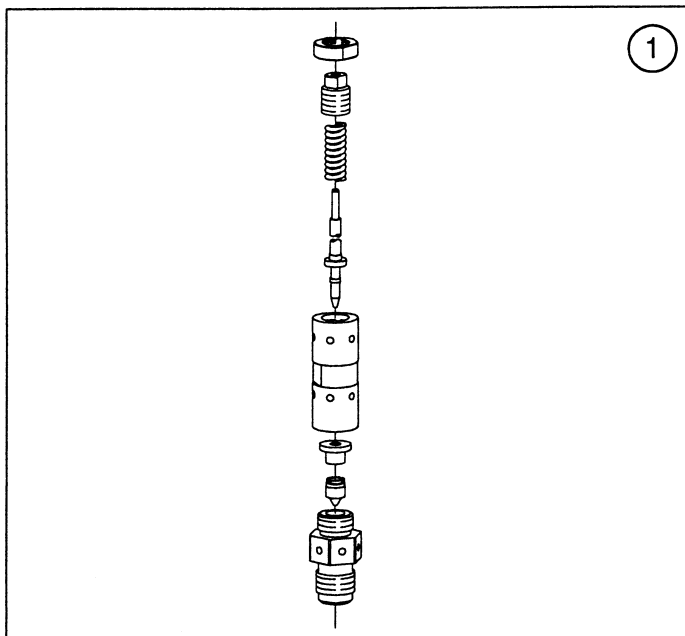


PLATE 90151

DATA:

- D-1 Tightening pressure –
valve housing..... 45 Nm
- D-2 Opening pressure..... 200 ± 5 bar

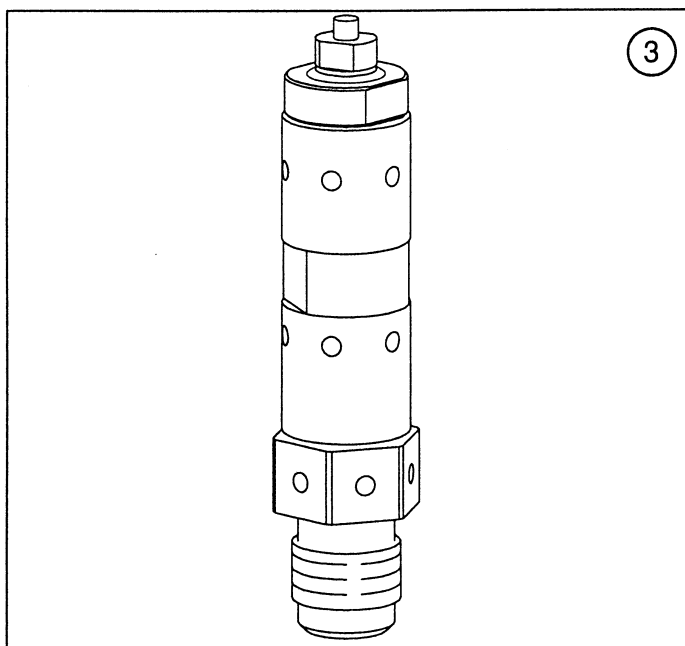
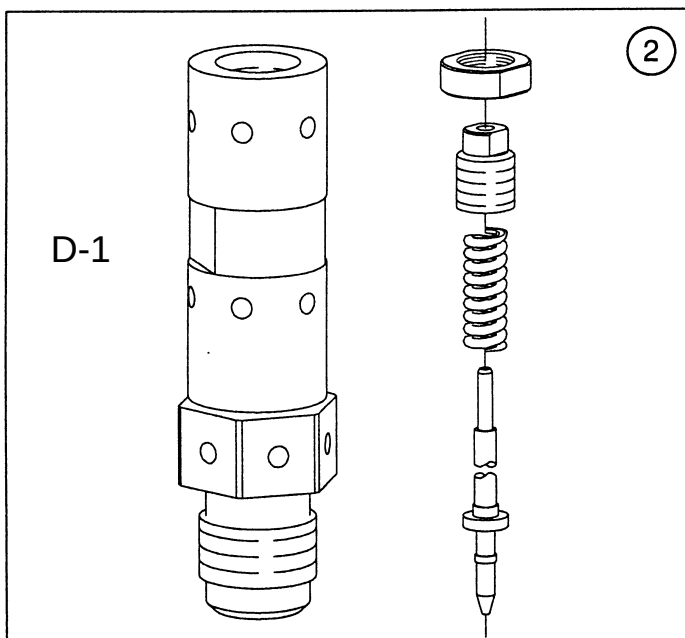




1. If necessary, dismantle the safety valve and clean all the parts in either gas oil, kerosene, or 'electro-cleaner'.
2. When assembling the safety valve, this has to be done in two steps:
 - Place the two valve flaps in the valve guide and screw on the valve housing.
 - Tighten the housing to D-1, loosen and tighten again to D-1.

3. Then mount:

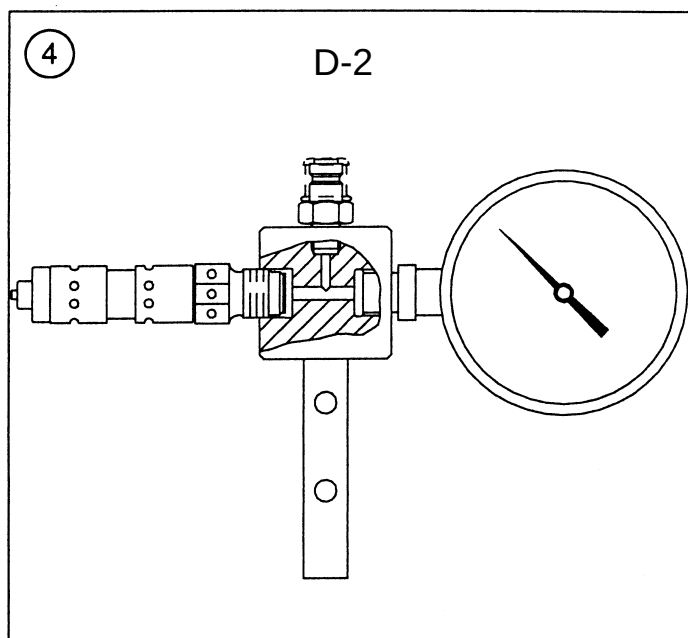
- the valve spindle
- the spring
- the adjusting screw
- the lock nut.



4. To set safety valve opening pressure:

- 1) Set up the safety valve in the testing device.
- 2) Connect the testing device to the hydraulic pump.
- 3) Loosen the lock nut on the safety valve.
- 4) Set the adjusting union nut so that the valve just closes.
- 5) Bleed valve and hose until oil, without air bubbles, flows out from the openings of the safety valve.
- 6) Screw up the adjusting screw of the safety valve until a correct pressure is indicated (see D-2).
- 7) Tighten the lock nut.
- 8) Test the opening pressure.
- 9) Dismount the valve from the testing device.

When mounting the safety valve in the cylinder cover, use only the hexagon on the safety valve.



BLANK



SAFETY PRECAUTIONS

- ☐ Stopped engine
- ☐ Block the starting mechanism
- ☐ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

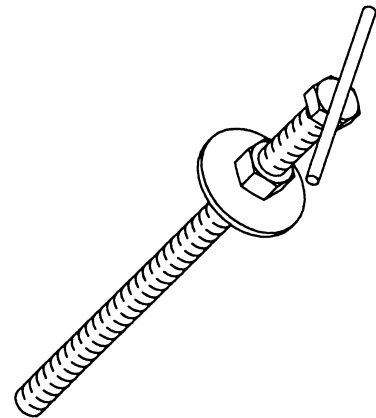
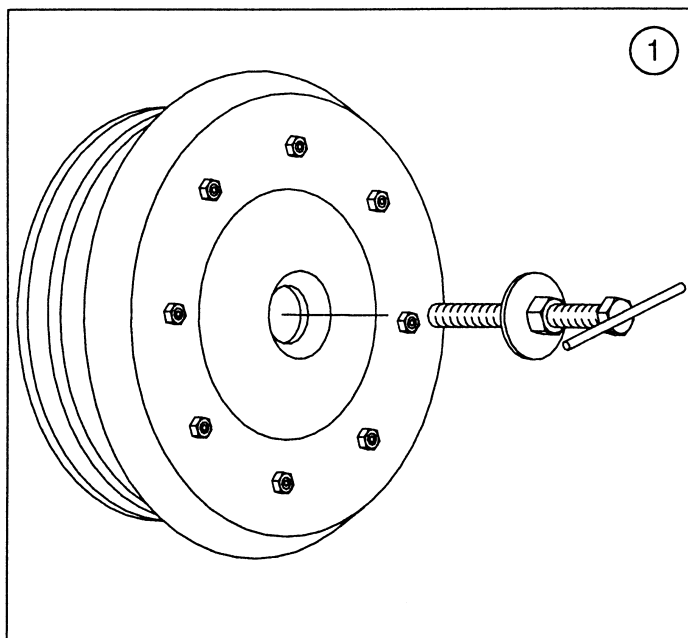


PLATE 90551

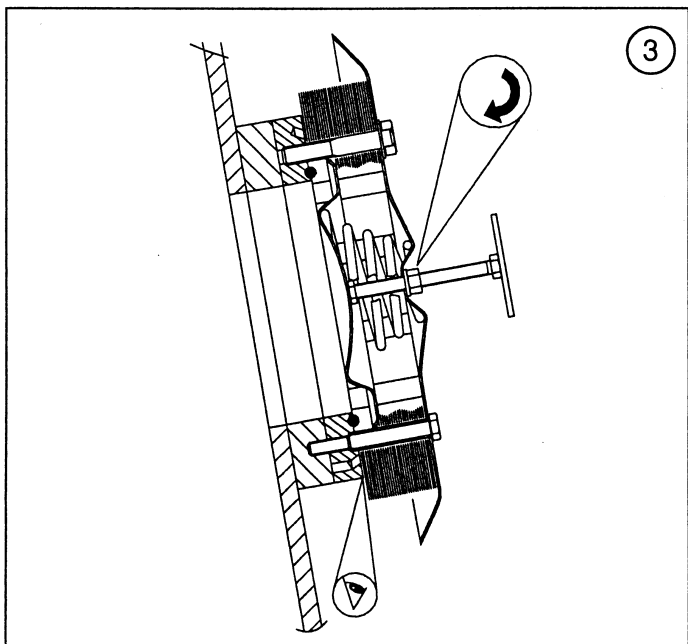
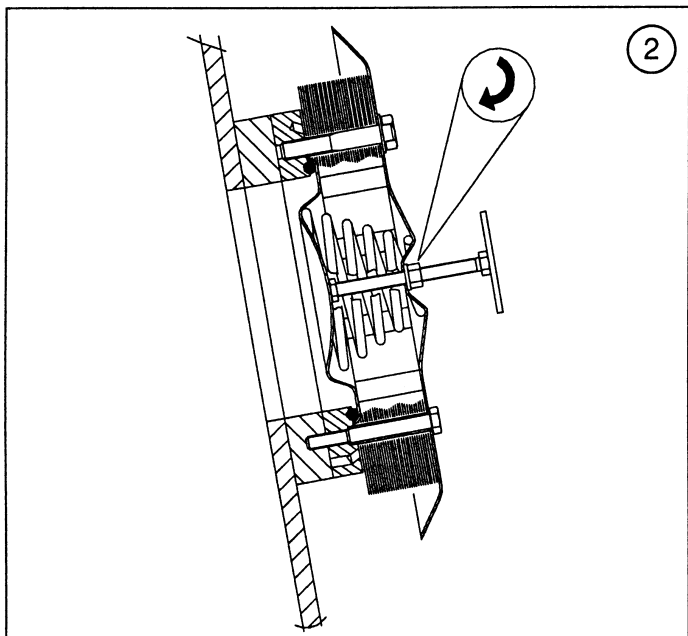




1. The functioning of the relief valves on the crankcase wall is tested by means of the tool supplied.
2. The tool is screwed into the valve plate nut.
3. Turning the nut of the tool will open the valve.

Check if there are any leaks.

If a leak occurs, dismantle the relief valve and fit a new O-ring.



SAFETY PRECAUTIONS

- ☐ Stopped engine
- ☐ Block the starting mechanism
- ☐ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

913

DATA:

- D-1 Tightening pressure for holding down bolts..... 900 bar
- D-2 Tightening pressure for end chock bolts..... 900 bar
- D-3 Increased tightening pressure (only for initial tightening of end chock bolts)..... 900 bar
- D-4 Check holding down bolts and end chock bolts for correct tightening after the following service hours:
- | | |
|-----------------------------------|-------------|
| 1st check..... | 500 hours |
| 2nd check..... | 1,000 hours |
| 3rd check..... | 2,000 hours |
| 4th check..... | 4,000 hours |
| 5th check..... | 8,000 hours |
| Subsequently at intervals of..... | 8,000 hours |

Note:

The holding down bolts and end chock bolts may have the same type and size of threads. The hydraulic jack used for tightening the holding down bolts is marked with:

- For: Holding down bolts
- For: Epoxy chocks

The larger jack used for tightening the end chock bolts is marked with:

- For: End chock bolts

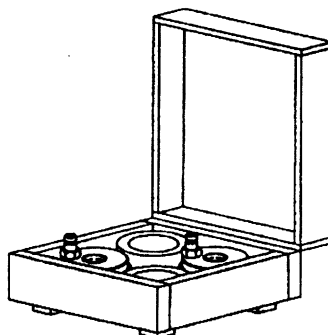
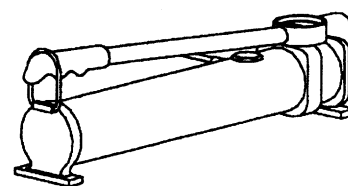
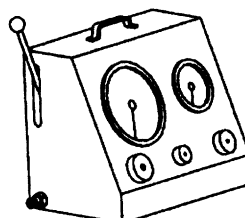
Warning !

Accidental application of the larger jack (meant for the end chock bolts) on the holding down bolts may cause serious overstressing of the epoxy supporting chocks.

Engine on Epoxy Supporting Chocks

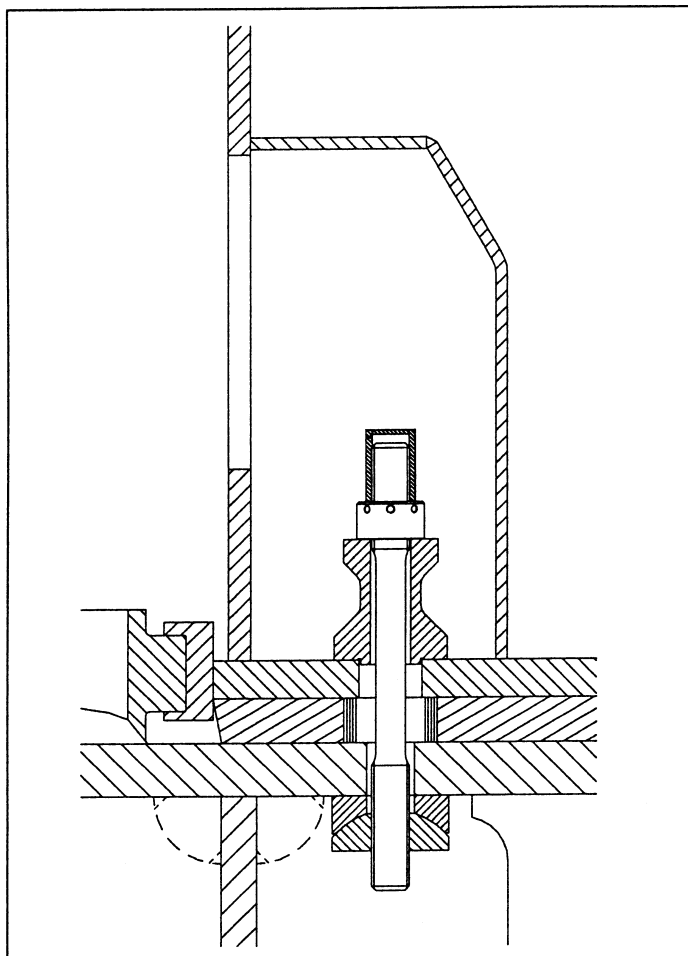


1 x 3 m
2 x 1 m



912





Hydraulic tightening of holding down bolts and end chock bolts is carried out as detailed in section 913-1. The normal tightening pressure is indicated on the data sheet and stamped on the tightening tool.

For the initial tightening of the end chock bolts, the pump pressure is to be raised to the value indicated on the data sheet. Then tighten the nut firmly and relieve the hydraulic tool completely of pressure. After about two minutes, raise the pressure again until the nut can be loosened. Now adjust the pressure to the normal tightening pressure indicated, tighten the nut firmly, and relieve the system of pressure.

For the initial tightening of end chock bolts, the following procedure can, alternatively, be followed:

Tighten the bolts to the increased pressures stated on the data sheet and leave the bolts so tightened till after the sea trials, following which they are to be retightened to the normal value indicated on the data sheet as well as on the hydraulic tightening tool.

Checking the Bolt Tightening

The holding down bolts and end chock bolts must be checked for correct tightness at the intervals indicated on the data sheet.

For this purpose, raise the pressure on the hydraulic tool slowly while constantly attempting to loosen the nut with the tommy bar. The oil pressure indicated by the pressure gauge when the nut comes loose ('loosening pressure') is to be noted down in the checking table, *see drawing Nos. 782225-0 and 782226-2*, following which the bolts are tightened to the normal tightening pressure.

The condition of the bolted joints, and thus the general condition of the foundation, can be effectively checked by comparing the tables from successive bolt checkings.



If the 'loosening pressure' is below 80 per cent of the tightening pressure, the relative chocks shall always be checked for possible defects. If the chocks are in position and in order, the bolts should be taken out for inspection of threads and contact faces.

Checking of Epoxy Supporting Chocks

If a number of measuring pins has been welded to the tanktop, the heights of the epoxy supporting chocks are to be checked immediately after finishing the checking of the loosening pressures of the holding down bolts and the retightening of these.

The distance between the measuring pins and the bedplate is to be measured with a blade gauge and noted down. Any possible settling of the chocks during the intervals between measurements can thereby be followed.

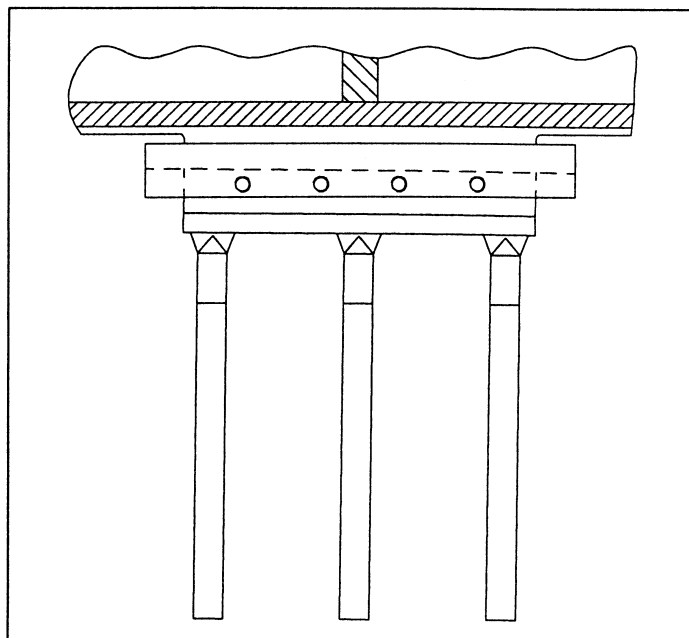
Side Chocks and Side Chock Liners

After fitting the liners to a 80 per cent contact area on both sides of the liners, the liners are to be knocked 3 to 4 mm further inwards.

The liners located in way of each main bearing at either side of the engine must be fitted and knocked into position simultaneously.

The first time the ship is sailing in a fully-loaded condition after the engine has been operating for 1,000 hours, it should be checked at all side chocks whether the liners can be knocked further home.

The liners should be checked for correct fitting with a feeler gauge each time the loosening pressure of the holding down bolts is checked, and thus at the same time intervals. The feeler gauge is applied at the 7 points indicated on drawing No. 782226-2, and the measurements found are to be entered in the relevant table. They are used for the purpose of judging whether refitting or, possibly, replacement of the liners is necessary.



If the measurements reveal that in 3 points or more they have increased 5/100 mm or more from the initial results, we recommend that the following procedure is followed:

1. Loosen the hexagon screws.
2. Try to knock the liner further home.
3. Measure again at the 7 points indicated on drawings No. 782226-2.

If this procedure does not improve the situation, the liner must be removed and it must be checked that the actual contact area is more than 80 per cent of the possible contact surface areas on both sides of the liner.

The liners are secured in their correct position by means of hexagon socket set screws with cup point.



Checking Hydraulically Tightened Holding Down Bolts MC Engines

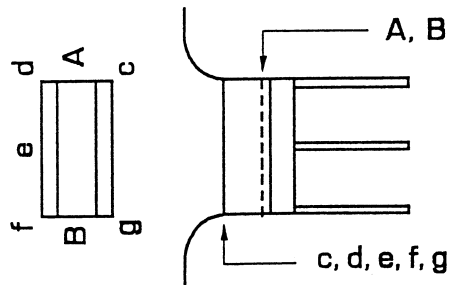
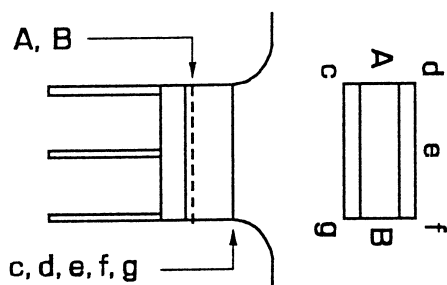
Drwg.
782225-0

Engine frame No.	Bolt No.	Port side			Cylinder No.	Starboard side			Bolt No.	Engine frame No.
		pressure	% dev.	remarks		pressure	% dev.	remarks		
1	1				1				1	1
	2								2	
	3								3	
	4								4	
2	1				2				1	2
	2								2	
	3								3	
	4								4	
3	1				3				1	3
	2								2	
	3								3	
	4								4	
4	1								1	4
	2								2	
	3								3	
	4								4	
5	1								1	5
	2								2	
	3								3	
	4								4	
6	1								1	6
	2								2	
	3								3	
	4								4	
7	1								1	7
	2								2	
	3								3	
	4								4	
8	1								1	8
	2								2	
	3								3	
	4								4	
9	1								1	9
	2								2	
	3								3	
	4								4	
10	1								1	10
	2								2	
	3								3	
	4								4	
11	1								1	11
	2								2	
	3								3	
	4								4	
12	1								1	12
	2								2	
	3								3	
	4								4	
13	1								1	13
	2								2	
	3								3	
	4								4	
14	1								1	14
	2								2	
	3								3	
	4								4	
	1								1	

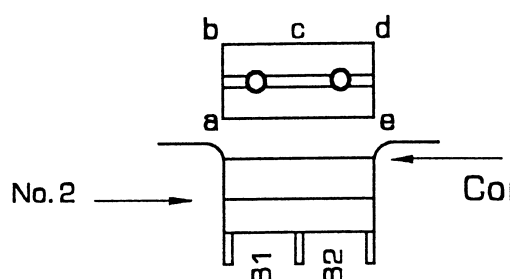


Port side								Starboard side								
Chock No.	Point							Cylinder No.	Point							Chock No.
	A	B	c	d	e	f	g		A	B	c	d	e	f	g	
1								1								1
2								2								2
3								3								3
4																4
5																5
6																6
7																7
8																8
9																9
10																10
11																11
12																12
13																13
14																14

FORE

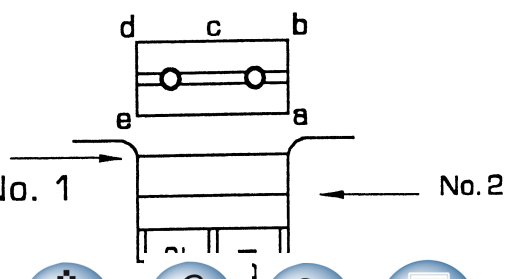


Port side									Starboard side						
Ch No.	Bolt No.	Pres- sure (kp/cm ²) bar	Devi- ation %	Point					Devi- ation %	Pres- sure (kp/cm ²) bar	Bolt No.	Ch No.			
				a	b	c	d	e							
E	1										1	E			
	2										2				



Contact face No. 1

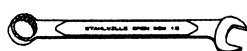
AFT



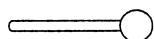
SAFETY PRECAUTIONS

- ☒ Stopped engine
- ☒ Block the starting mechanism
- ☒ Shut off starting air supply
- ☐ Engage turning gear
- ☐ Shut off cooling water
- ☐ Shut off fuel oil
- ☐ Shut off lubrication oil
- ☐ Lock turbocharger rotors

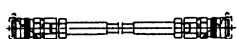
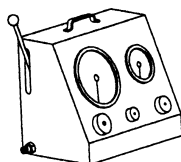
913



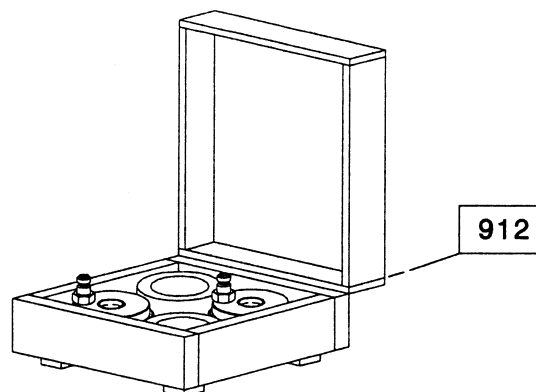
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13



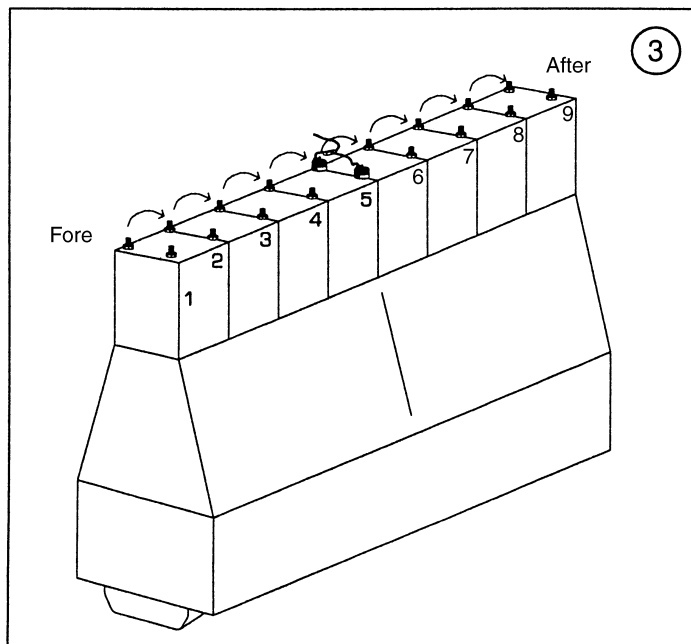
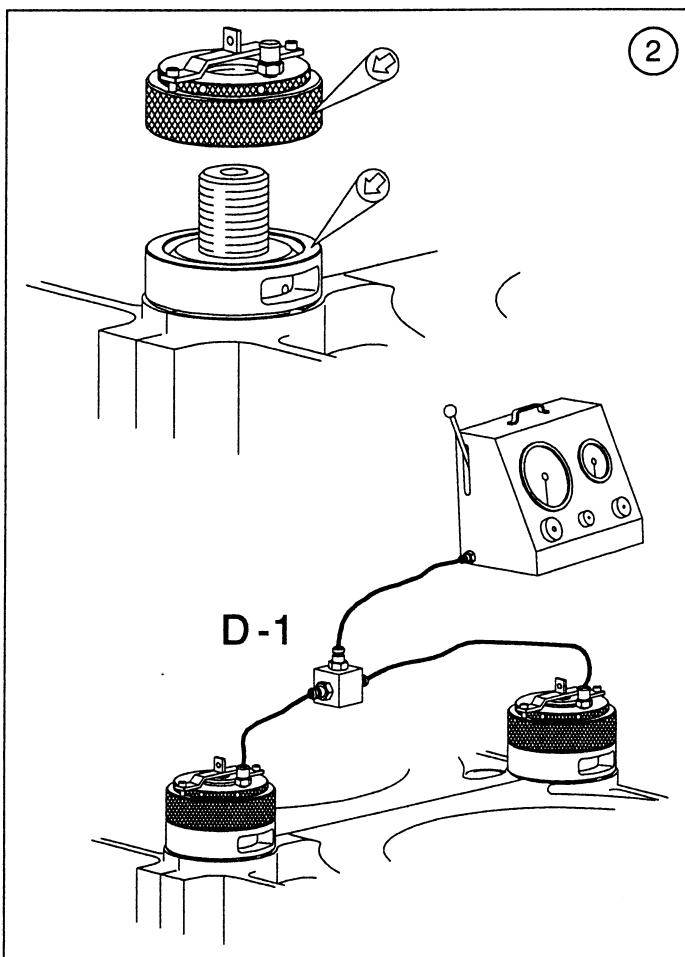
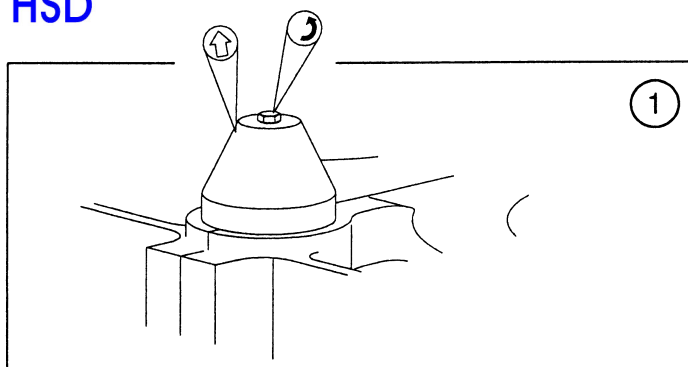
1 x 3 m
2 x 1 m



DATA:

- D-1 Hydraulic dismantling
pressure..... 900-990 bar
Hydraulic tightening
pressure..... 900 bar
- D-2 Min. clearance..... 0.4 mm





1. Before retightening the stay bolts, remove the protective caps.
2. Clean the contact faces and mount the hydraulic tool on a pair of stay bolts positioned opposite each other on the fore end of the engine. Connect the high-pressure pump by means of the high-pressure hoses, so that the two stay bolts are tightened in one operation.
3. Start the retightening of the stay bolts and proceed to tighten the stay bolts in pairs, working from the fore end toward after end of the engine.



4. Maintain the hydraulic pressure at the value indicated in D-1, and retighten the stay bolt nuts with a tommy bar. Before relieving the system of pressure, check with a feeler gauge that the nuts bear against the contact face.
5. Reconnect the hydraulic tools to the pair of stay bolts first tightened. Tighten to 10% below D-1 and check if the nut is loose.

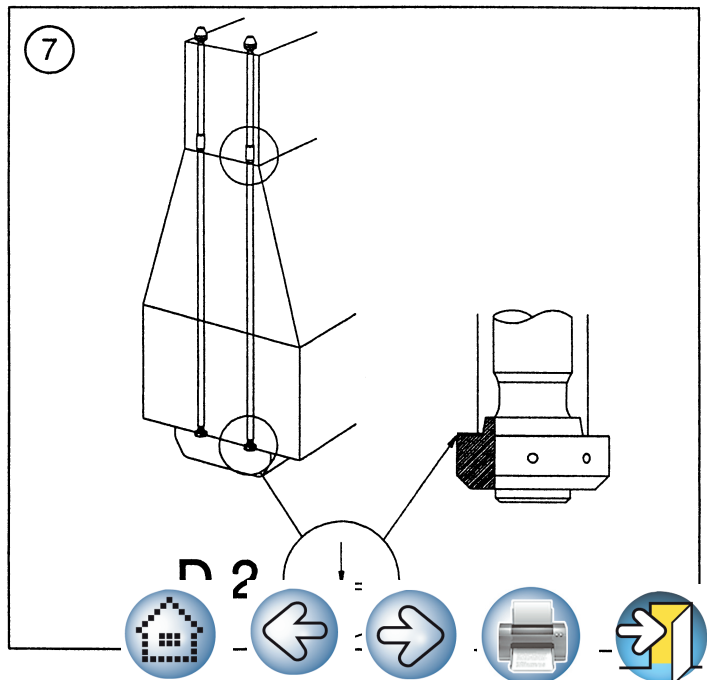
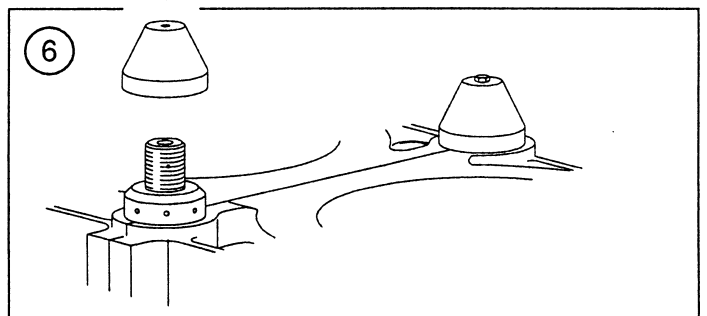
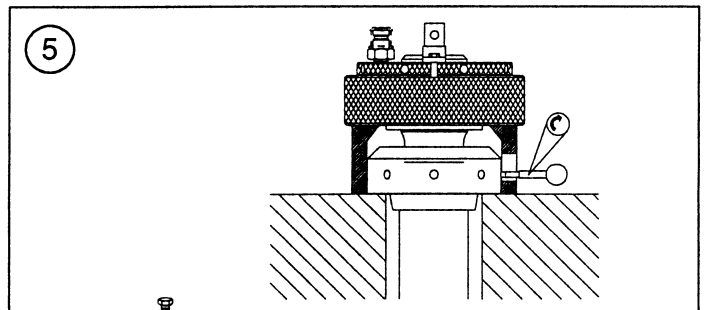
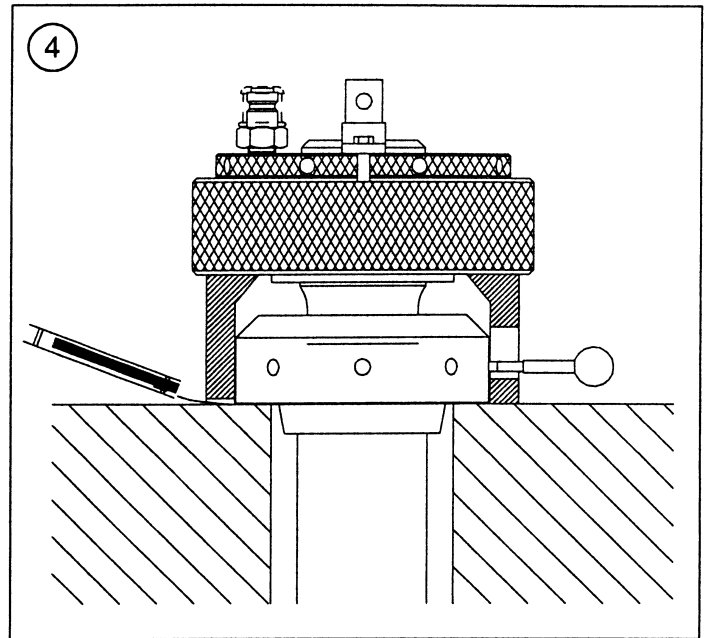
If the nut is **not** loose:

Tighten the stay bolts to D-1.

If the nut is loose:

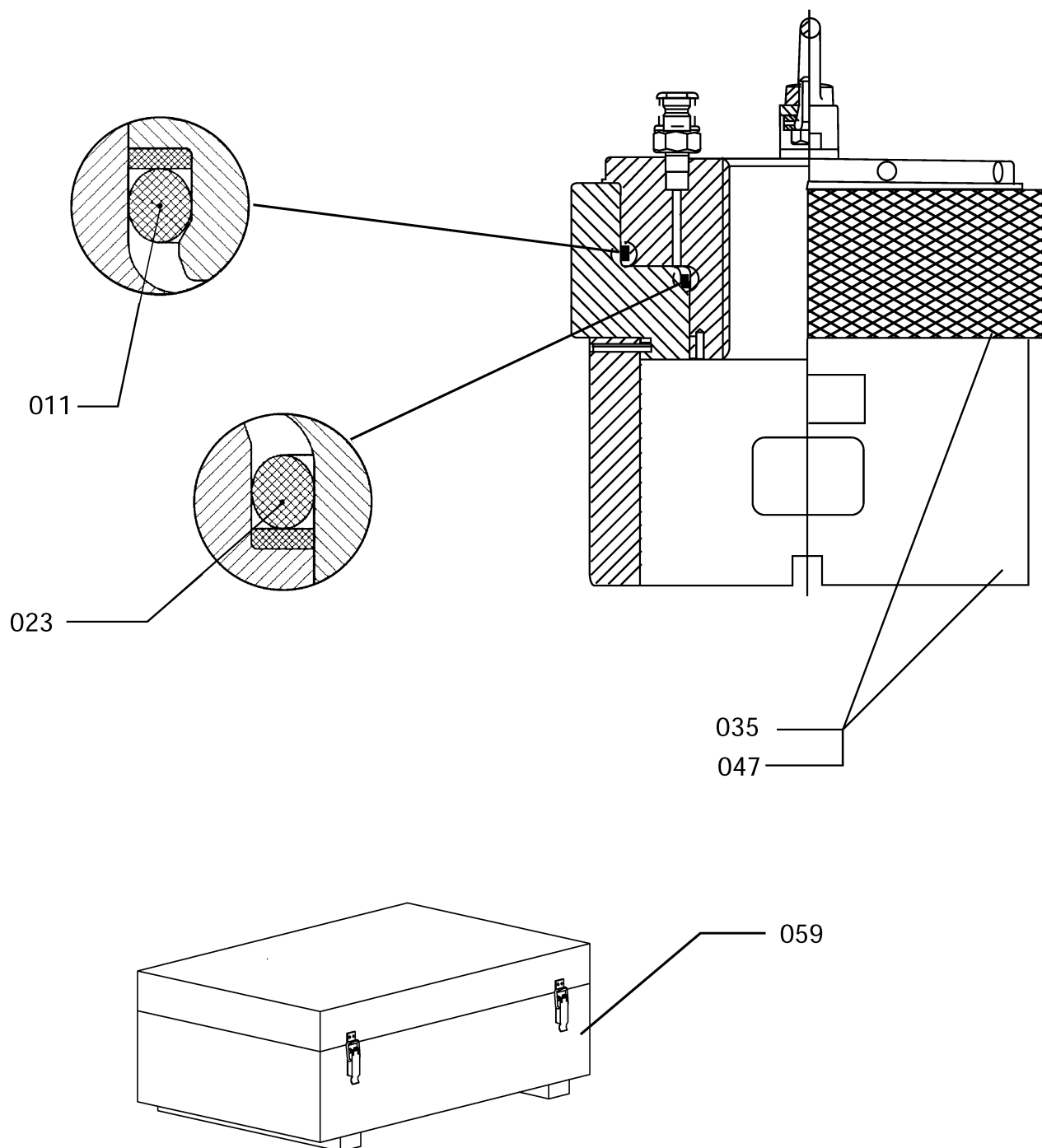
Tighten **all** stay bolts once again to D-1.

6. After completing the retightening procedure, mount the protective caps.
7. The stay bolts are mounted in such a way that, when the uppermost stay bolt nut is loosened, there is a clearance, as stated in D-2, between the contact face of the lowermost nut and the bedplate.



BLANK

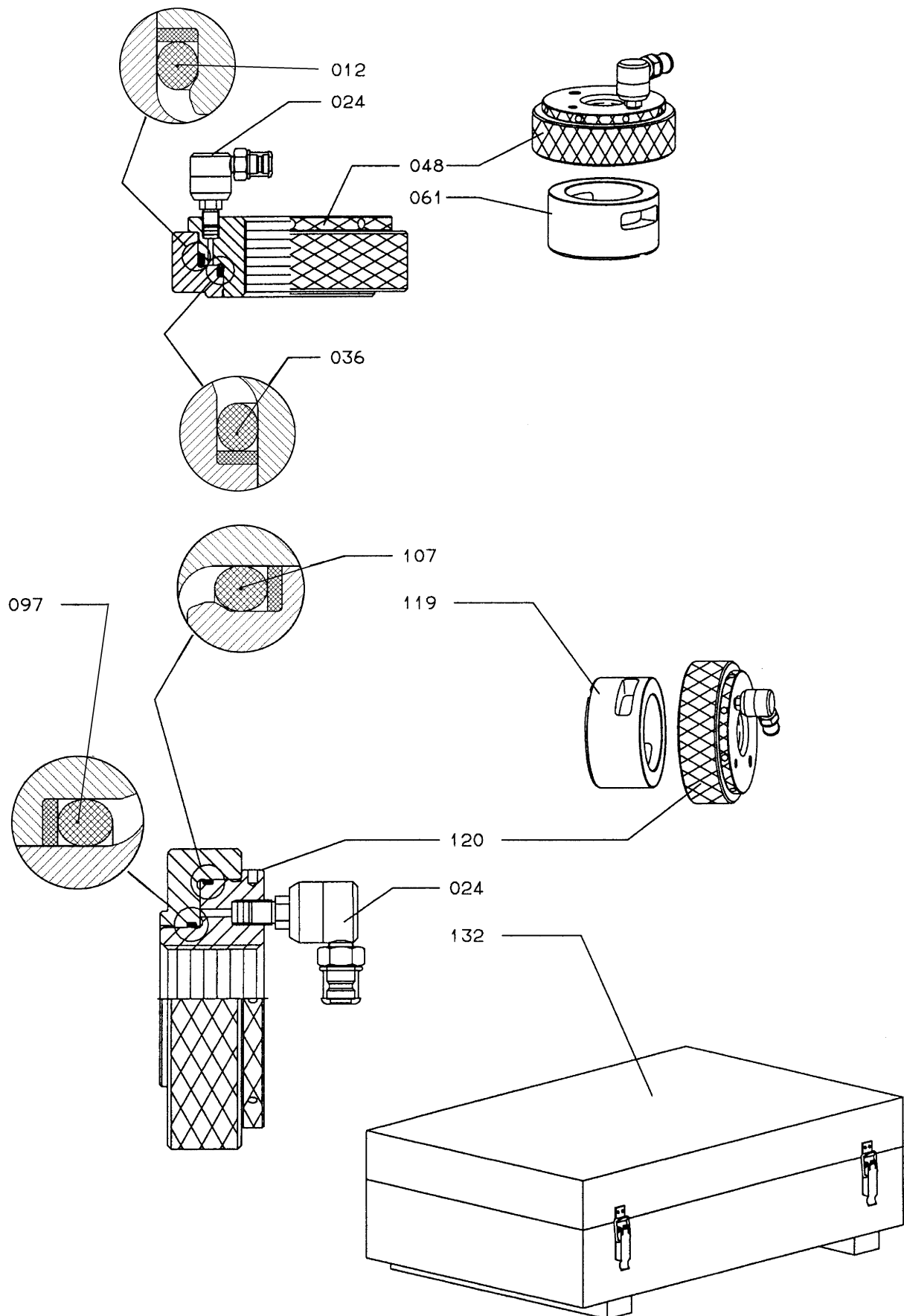




Item No.	Item Description
011	O-ring with back-up ring 280/290 mm
023	O-ring with back-up ring 135/145 mm
035	Hydraulic jack for stay bolt
047	Hydraulic jack spacerring
059	Steel box for Hyd. jack

Item No.	Item Description





Item No.	Item Description
012	O-ring with back-up ring, 105/115 mm
024	Swivel coupling
036	O-ring with back-up ring, 75/85 mm
048	Hydraulic jack for holding down bolt, M 48 x 5
061	Support for Hydr. jack
097	O-ring with back-up ring, 110/120 mm
107	O-ring with back-up ring. 170/180 mm
119	Support for Hydr. jack
120	Hydraulic jack for end chock bolt, M 76 x 6
132	Steel box for Hyd. jack

Item No.	Item Description



- A. Snap-on coupling
- B. Tool attachment thread
- C. Bleed screw
- D. Piston
- E. Cylinder
- F. Sealing rings
- G. Spacer ring
- H. Tommy bar
- I. Nut
- J. Stud or bolt
- S. Clearance
- U. Milled recess for feeler gauge
- V. Safety hole

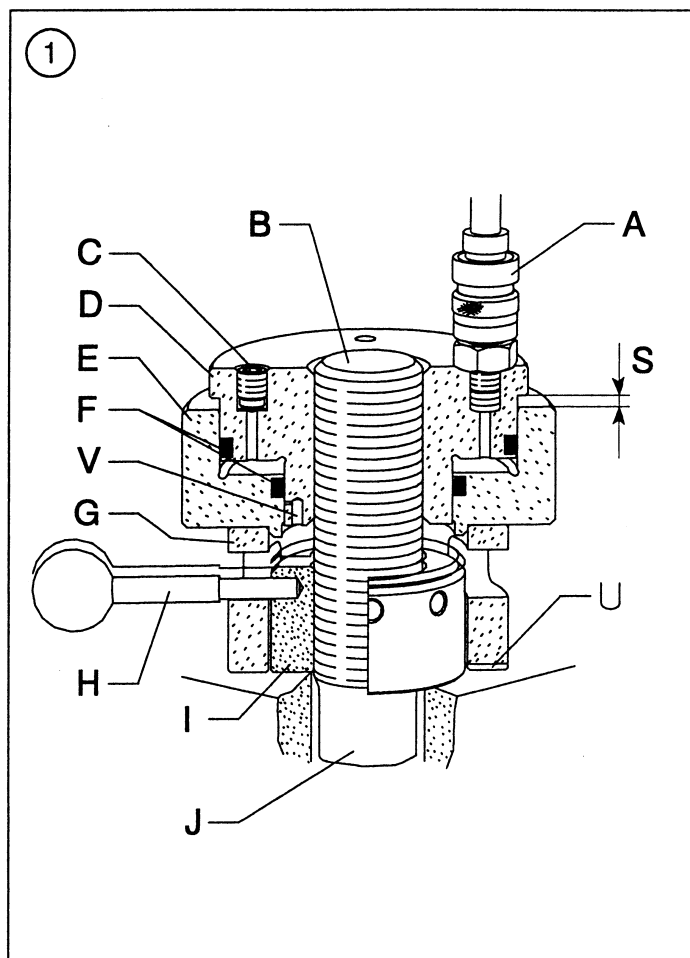
Studs or bolts provided with thread for attaching hydraulic tools and with circular nuts must be loosened and tightened up only by means of the hydraulic tools supplied.

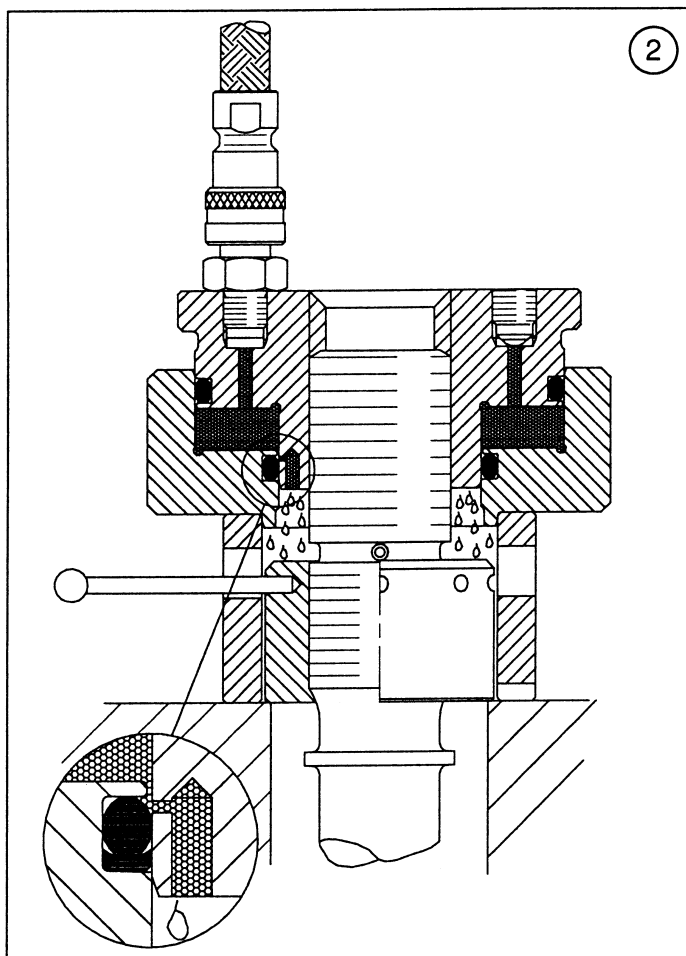
The jack(s) is/are connected, via a distributor block, to a high-pressure pump, which is set to deliver hydraulic oil at the pressure indicated on the jack and on the data sheet in the relevant section of this instruction book.

The stud or bolt concerned is thereby lengthened relative to the oil pressure applied and the piston area, and the nut can be loosened or tightened, as required, with the aid of a tommy bar.

The jacks must never be overloaded or exposed to blows or impacts. They are marked with a "Max. lift", which must not be exceeded.

1. The hydraulic tools consist of a jack with an internal thread to suit the tool attachment thread on the stud or bolt, and a spacer ring which is to be placed under the jack and around the nut that is to be loosened or tightened.





- The hydraulic jacks are so designed that the pressure is relieved at the bottom of the pressure chamber in the event that the "Max. lift" limit is exceeded. The oil will then be pressed out into the space between the stud and the spacer ring.

When the pressure is relieved in this way, the lowermost sealing ring will in most cases be damaged. Therefore, inspect and, if necessary, replace this sealing ring.

The oil used must be pure hydraulic oil or turbine oil (with a viscosity of about SAE 20). Oils such as, for instance, lubricating oil (system oil) or cylinder lubricating oil must **not** be used, as these oils are normally alkaline and can thus damage the back-up rings.

The following instructions must be closely followed to prevent accidents or damage. After use, the jacks should be cleaned and kept in the wooden boxes supplied.

Warning !

When using hydraulic tools, eye protectors and gloves **must be** used.



Loosening of Nut

- 1A. Carefully clean the tool attachment thread, the nut and the surrounding parts.

Grease the tool attachment thread with molybdenum disulphide or with graphite and oil or similar.

Place the spacer ring around the nut in such a position that the tommy bar can be applied through the slot when the nut is to be loosened.

- 2A. Screw the jack on to the tool attachment thread of the bolt/stud, until the cylinder of the jack bears firmly against the spacer ring, and check that the parts are guided correctly together.

By means of a hose, connect the jack to the distributor block and connect the block to the high-pressure pump with another hose.

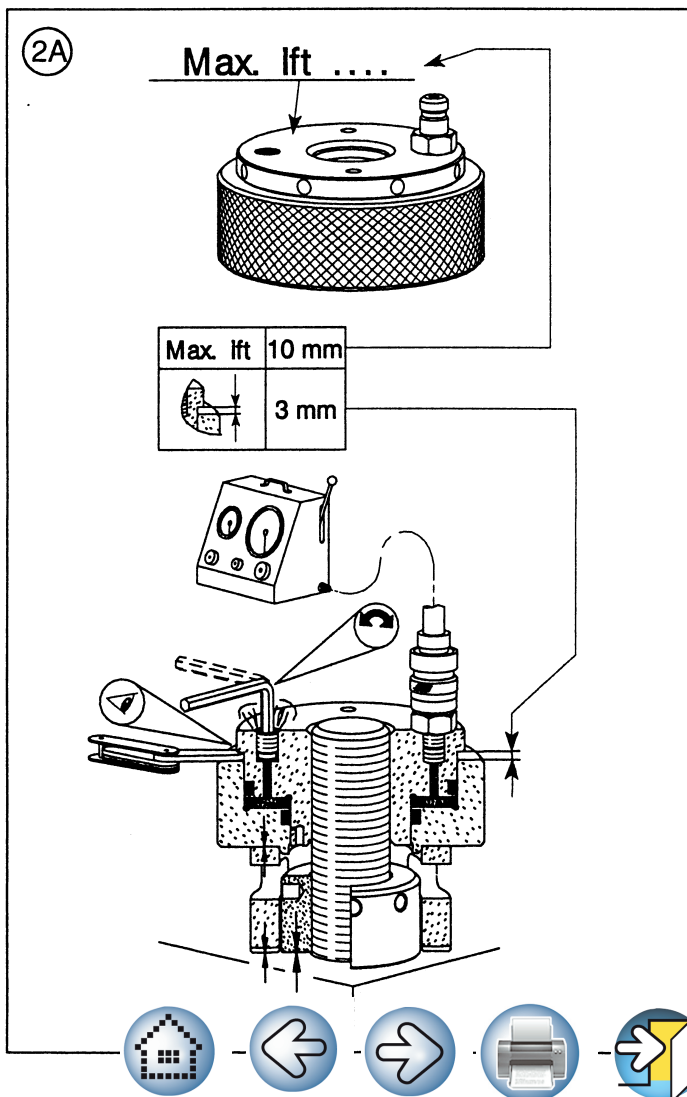
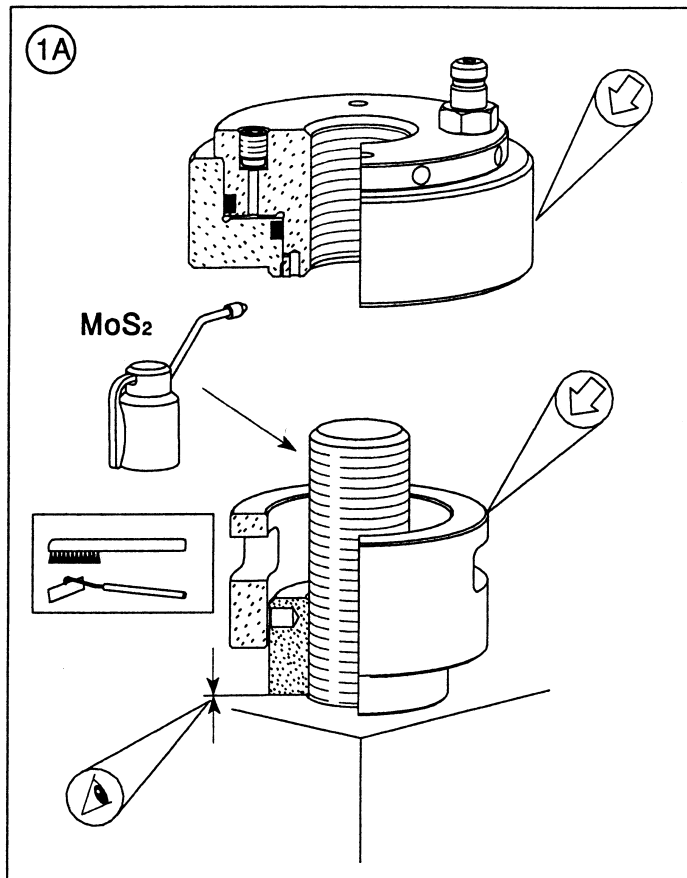
Loosen the bleed screw and fill the system with oil until oil, without bubbles, flows out of the bleed screw, which is then tightened again.

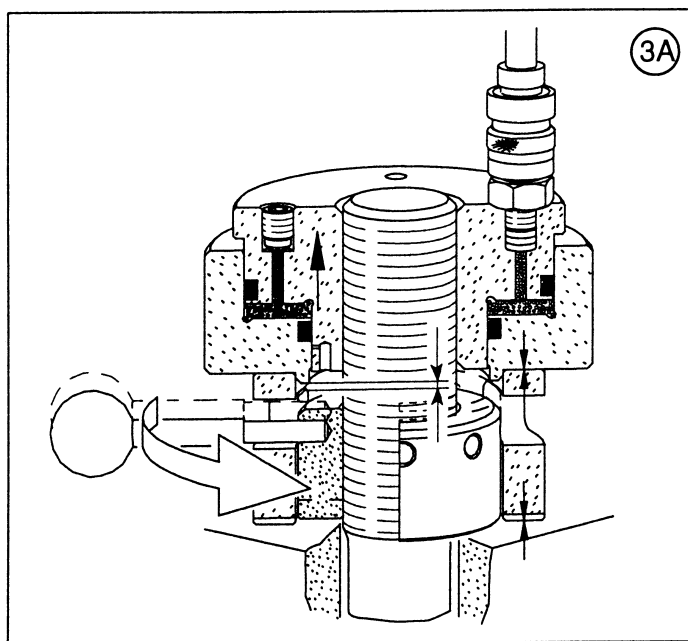
Adjust the clearance between the piston and cylinder of the jack (see the sketch and table) to provide for contraction of the bolt/stud.

If the clearance is too large, adjustment is made by loosening the bleed screw.

The clearance is to have relation to the "Max. lift" of the jack and has the purpose of making it possible to dismantle the jack after loosening the nut.

After adjustment, check again that there is no clearance between the cylinder/spacer ring/surface.

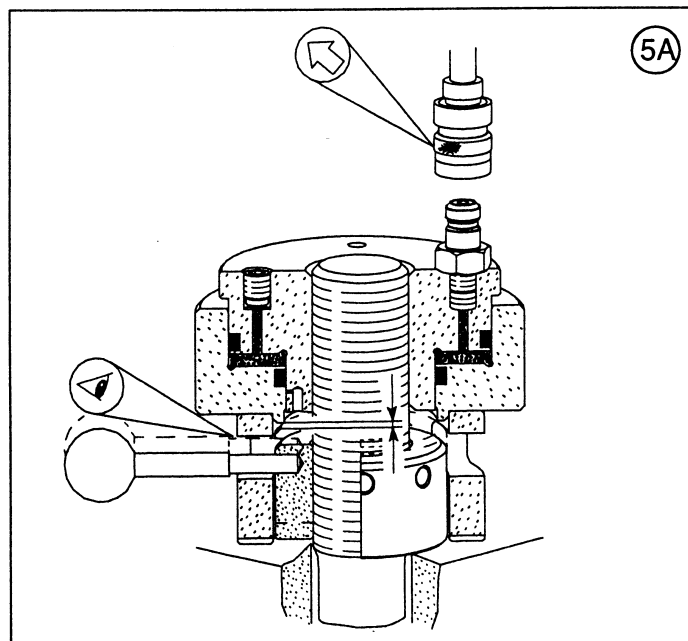
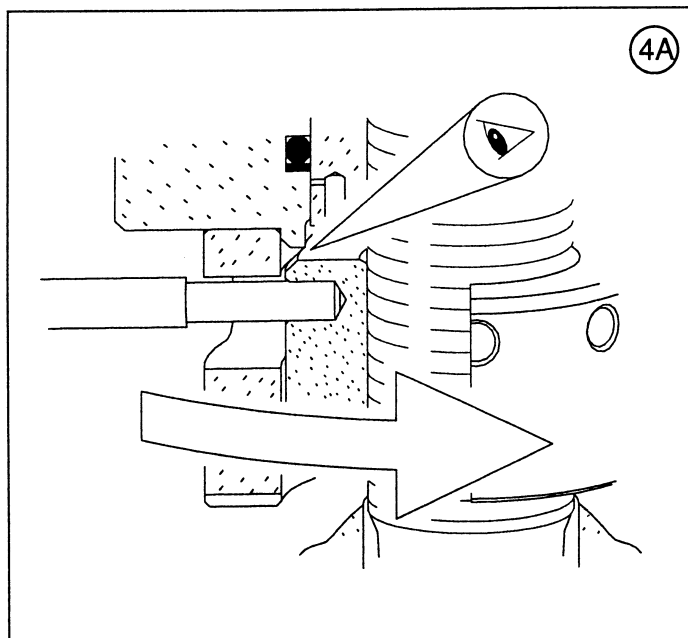




3A. Increase the oil pressure to the prescribed value. If the nut does not come loose, the pressure may be raised by approx. 90 bar.

4A. Unscrew the nut with the tommy bar, making sure that the nut is not screwed up against the jack.

5A. Relieve the system of pressure, disconnect the high-pressure pump, and remove the hydraulic tools.



Tightening of Nut

- 1B. Thoroughly clean the nut, the thread, the contact faces, and the surrounding parts.

Clean and lubricate the tool attachment thread and the thread in the nut with molybdenum disulphide or with graphite and oil or similar.

Fit the round nut on the thread and tighten it with the tommy bar.

Check with a feeler gauge that the contact face of the nut bears on the entire circumference.

Place the spacer ring around the nut in such a position that the tommy bar can be applied through the slot for the purpose of tightening the nut.

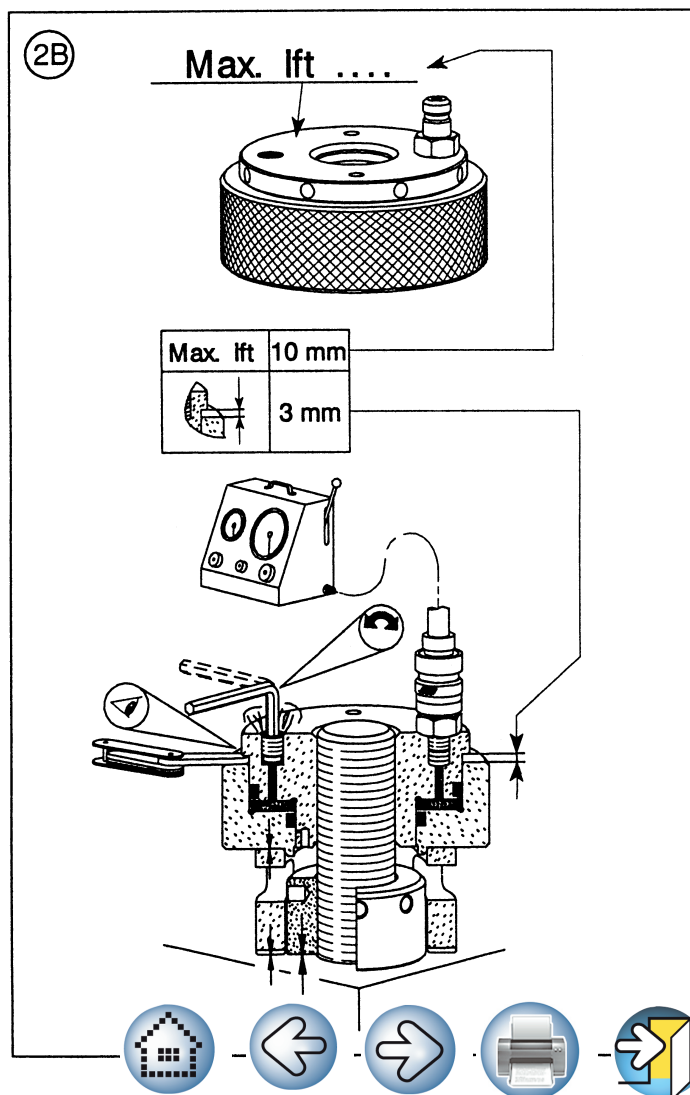
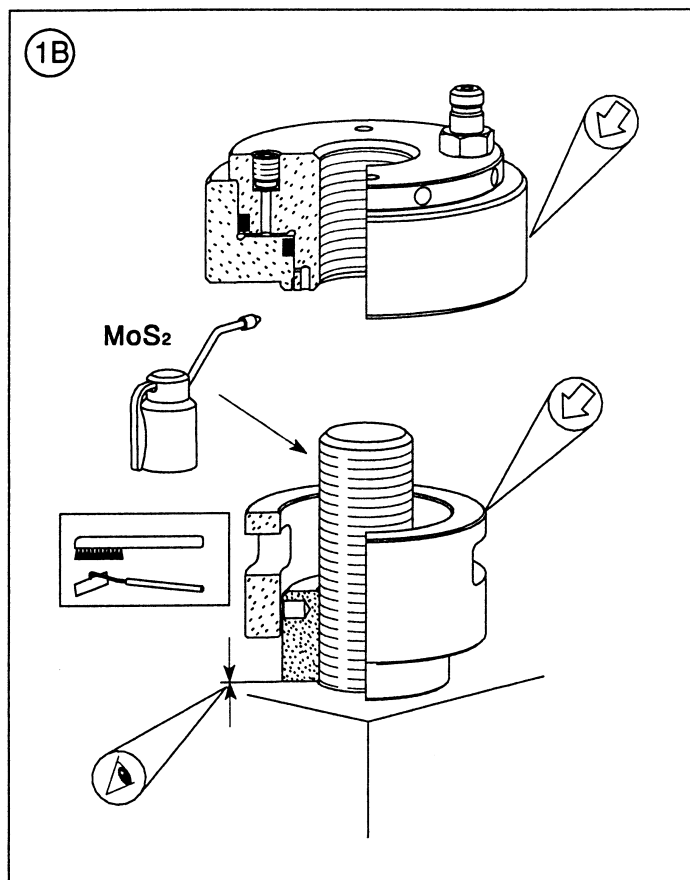
- 2B. Press the piston and the cylinder of the jack firmly together.

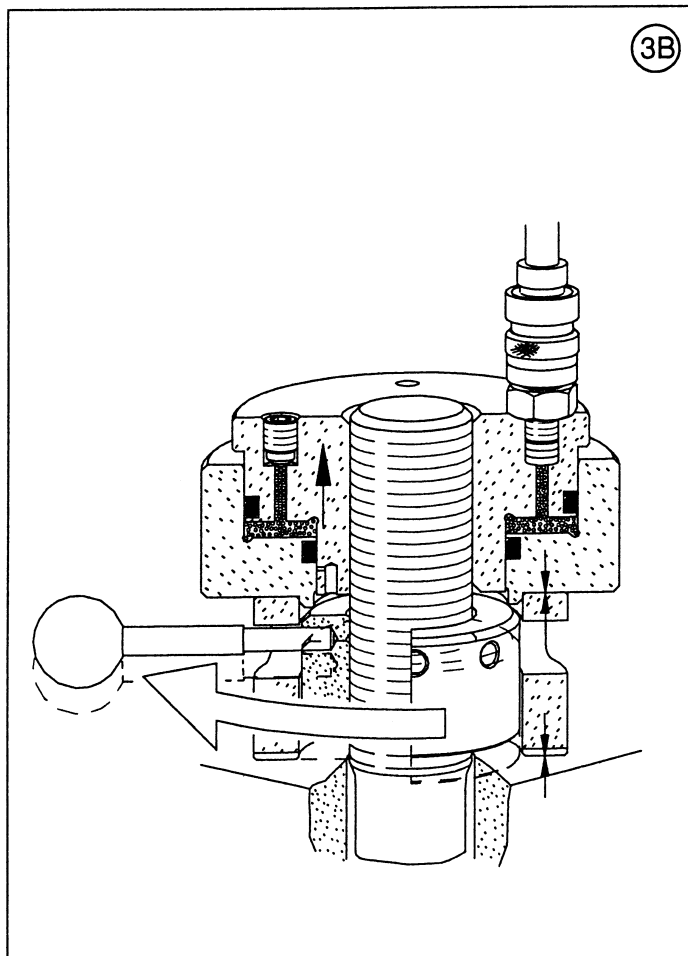
Screw the hydraulic jack on to the tool attachment thread.

Make sure that the cylinder of the jack bears firmly against the spacer ring and that the parts are guided correctly together.

By means of a hose, connect the jack to the distributor block and connect the block to the high-pressure pump with another hose.

Loosen the bleed screw, and fill up the system until oil, without bubbles, flows out of the bleed screw.
Re-tighten the bleed screw.





3B. Increase the oil pressure to the prescribed value, and tighten the nut by means of the tommy bar applied through the slot of the spacer ring.

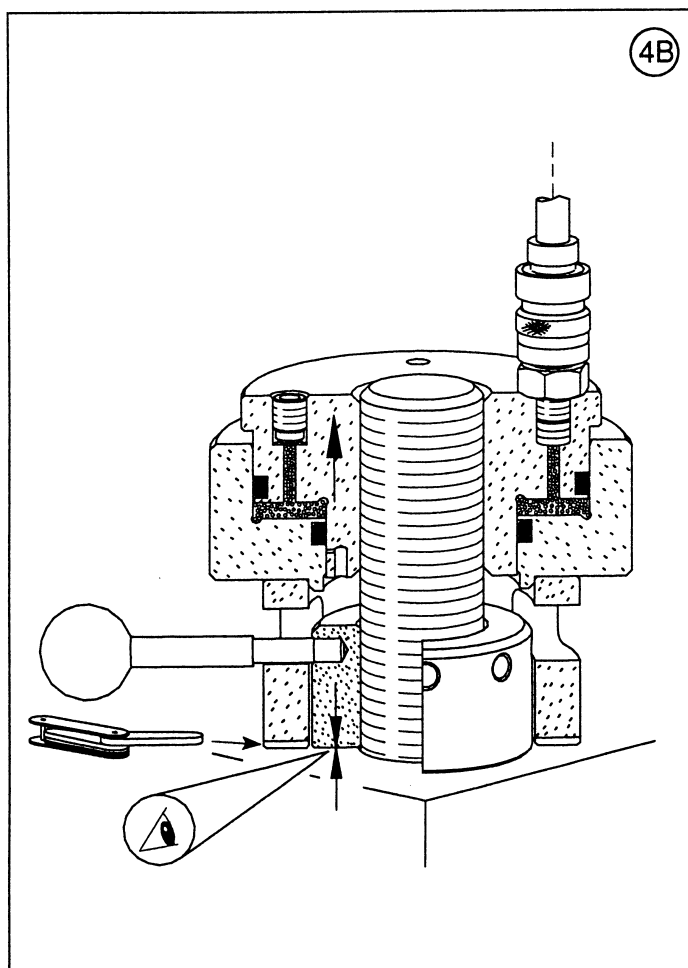
4B. While maintaining the pressure, check with a feeler gauge introduced through the recess at the bottom of the spacer ring that the nut bears against the contact face.

5B. Relieve the system of pressure, disconnect the pump, and remove the hydraulic jack.

6B.

Caution !

When new studs, bolts or nuts are tightened for the first time, do not remove the jack, but loosen the nut as described in 913-1, points 3A-4A-5A, and then tighten the nut again according to the procedure in 913-1, points 3B-4B-5B.



Maintenance

- 1C. The piston and cylinder are easily separated by taking out the bleed screw and pressing the parts apart with the help of compressed air.

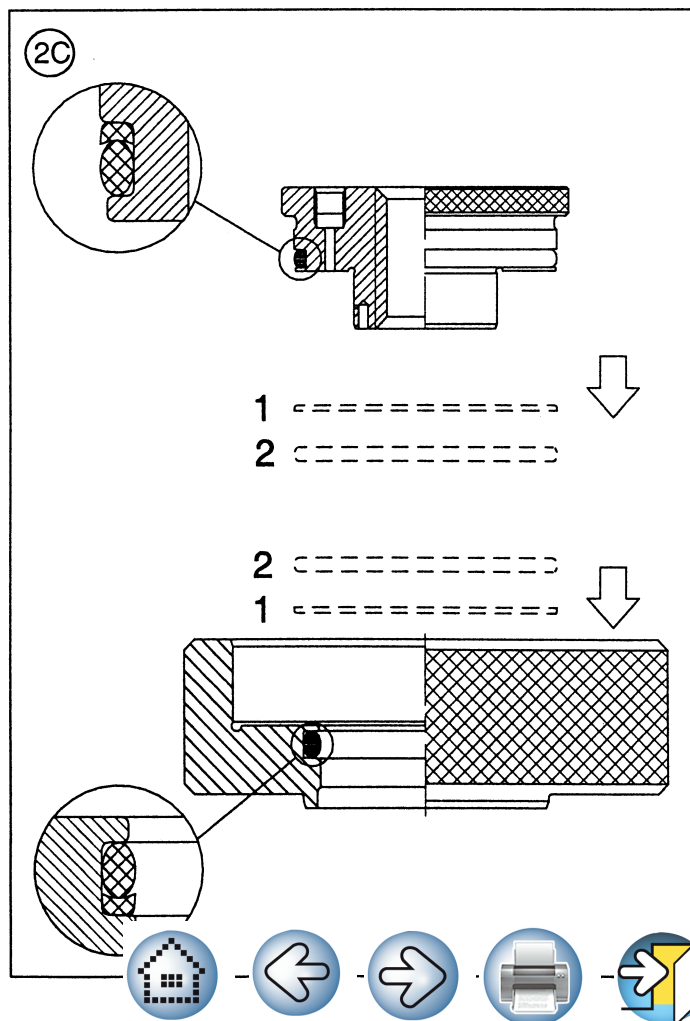
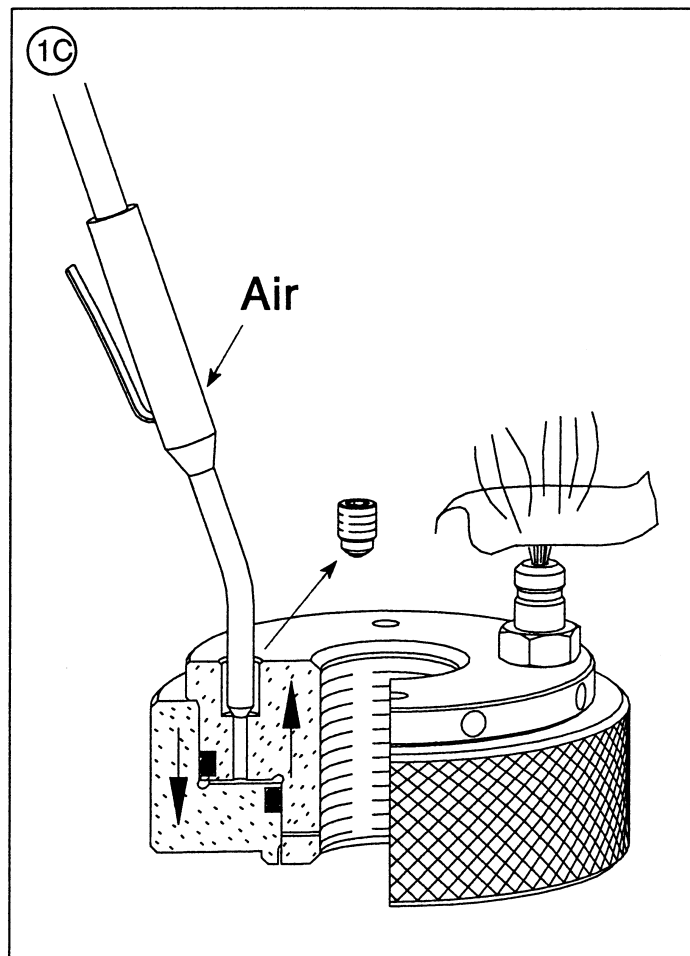
Make sure that there are no marks or scratches on the sliding surfaces of the parts. The presence of metal particles will damage the sealing rings.

- 2C. When changing the sealing rings, first mount the back-up ring and then the O-ring.

Warning !

The back-up ring **must** be away from the pressure chamber and the O-ring close to the pressure chamber.

See on the sketch the correct mounting of both the upper and the lower sealing rings. The same principle applies to all the jacks.



Before screwing the nuts on, the threads and the contact faces should be greased with a mixture of graphite and oil or molybdenum disulphide with a friction coefficient $\mu = 0.1-0.12$ (e.g. MOLYKOTE paste type G).

The nuts should fit easily on the thread, and it should be checked that they bear on the entire contact face.

In the case of new nuts and studs, the nuts are to be tightened and loosened two or three times in order that the thread may assume its definite shape; thus obviating the risk of loose nuts.

Nuts secured with a split pin are to be tightened to the stated torque and then to the next split-pin hole.

The torque spanner must not be used for torques higher than those stamped on it, and it must not be damaged by hammering on it or the like.

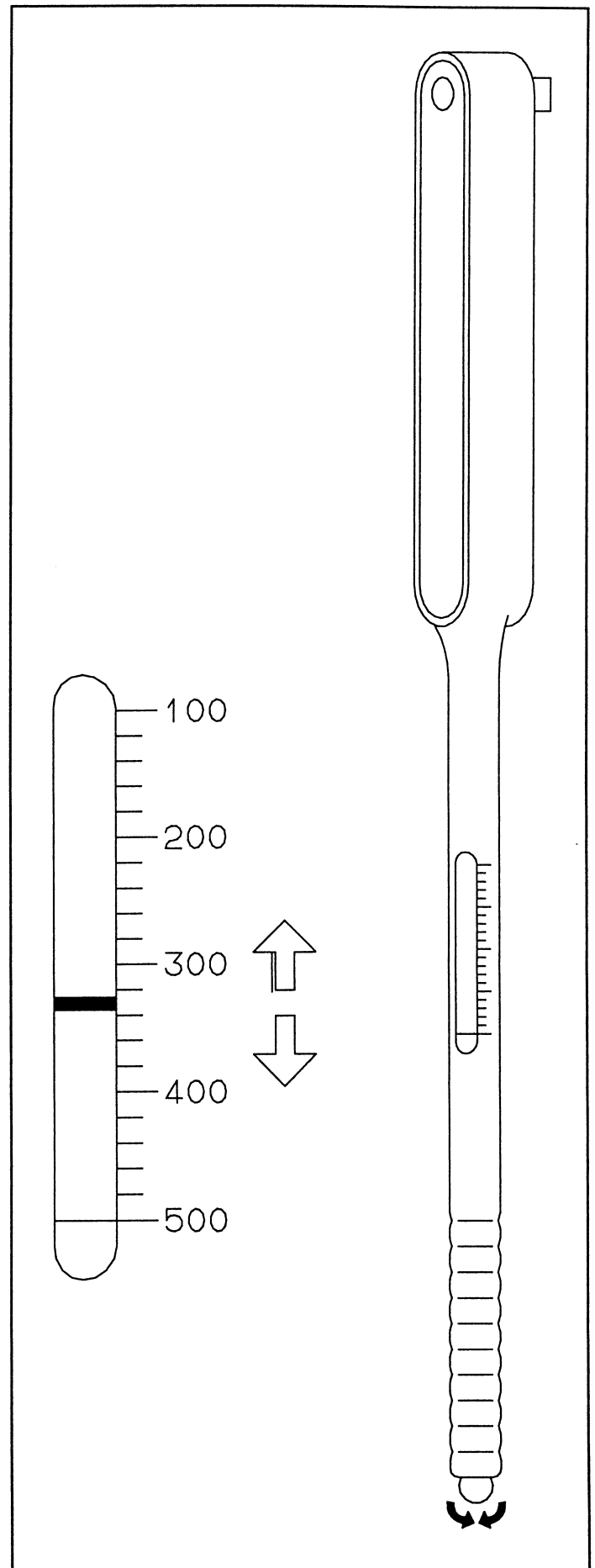
Rahsol Torque Spanner

The handle of the torque spanner is provided with a scale indicating the torques at which the spanner can be set.

For setting the spanner at the required torque, there is a ball on a small arm at the end of the handle.

By pulling the ball with the arm outwards, a small crank handle is formed. A spring-loaded slide in the handle is provided with a mark which, when turning the crank handle, can be set at the required torque on the scale. The functioning of the torque spanner is as follows:

The above-mentioned spring acts on a pawl system in the handle, and when using the spanner, this pawl system will be released when the pre-set torque has been reached, at which moment a small jerk is felt in the spanner and a small click is heard.



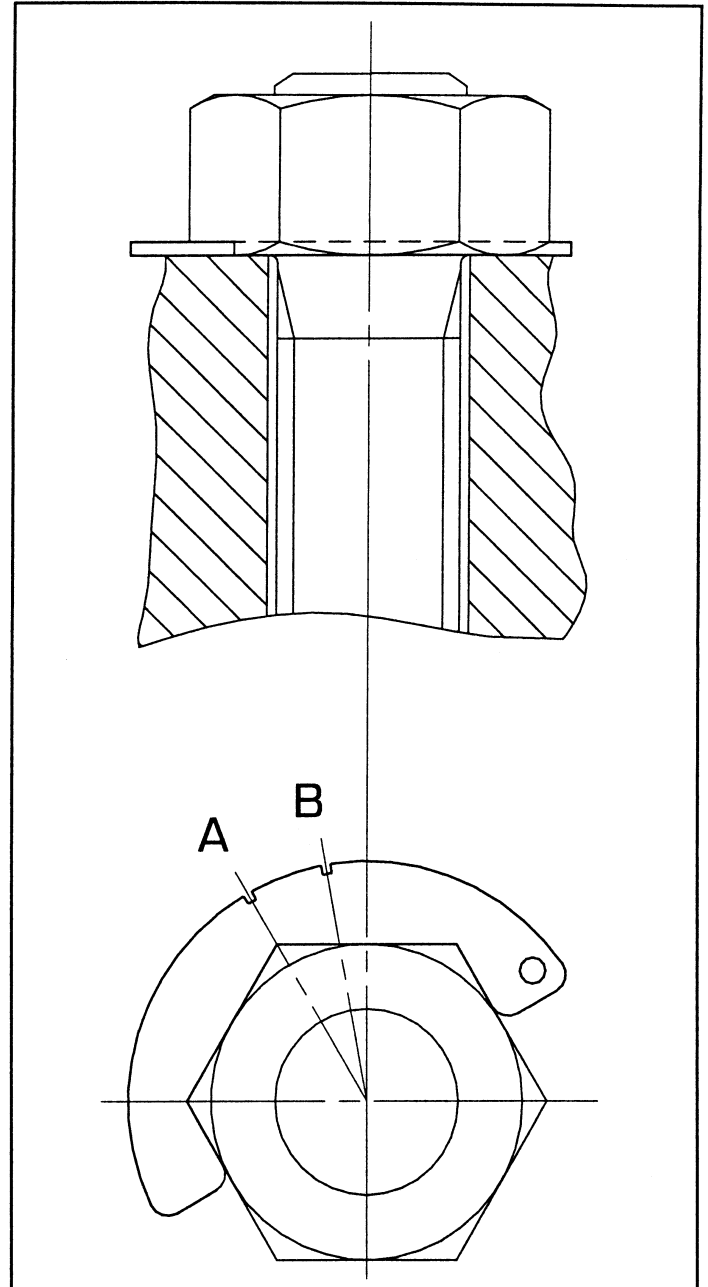
Before effecting the tightening, clean the threads and contact faces and coat with molybdenum disulphide or graphite and oil or similar.

Screw up the nut (screw) lightly with a short skeleton spanner.

Place the tightening gauge round the nut, and mark off with chalk on the nut at the slot **A** on the tightening gauge, and make another chalk mark on the contact face at the slot **B**.

Then tighten the nut until the two chalk marks coincide.

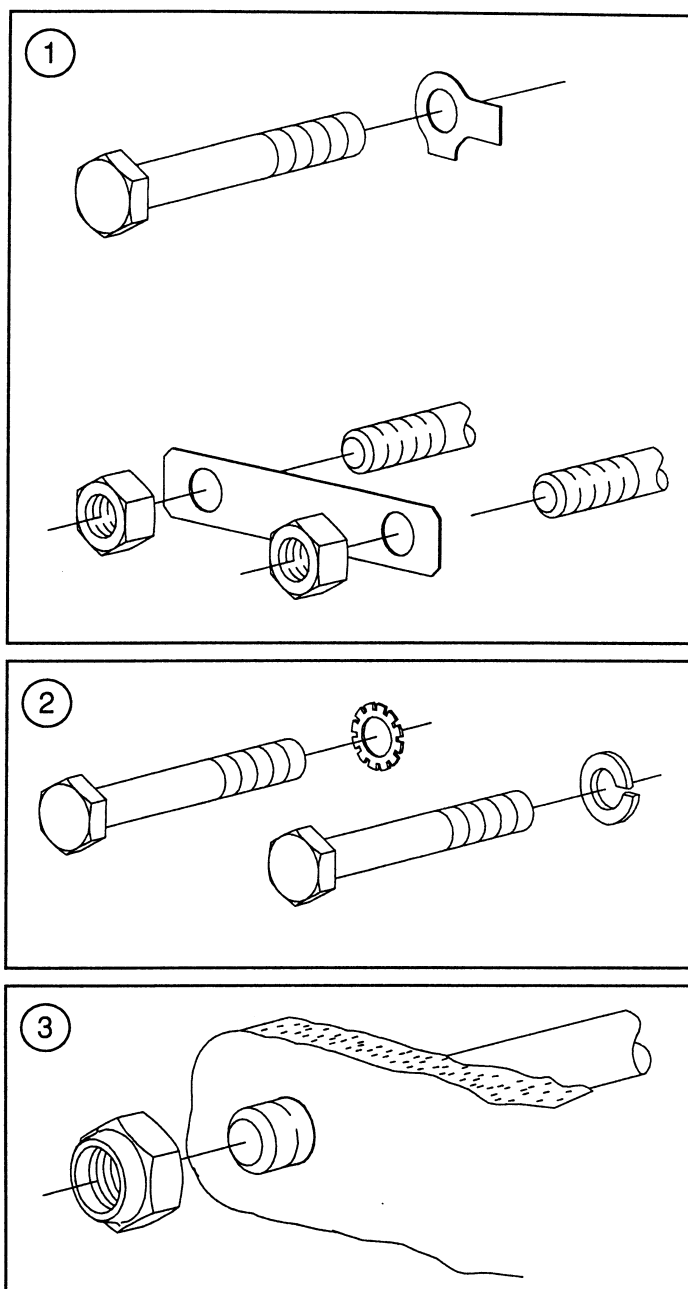
When tightening new studs or bolts for the first time, loosen again and repeat the procedure to allow the parts to settle.

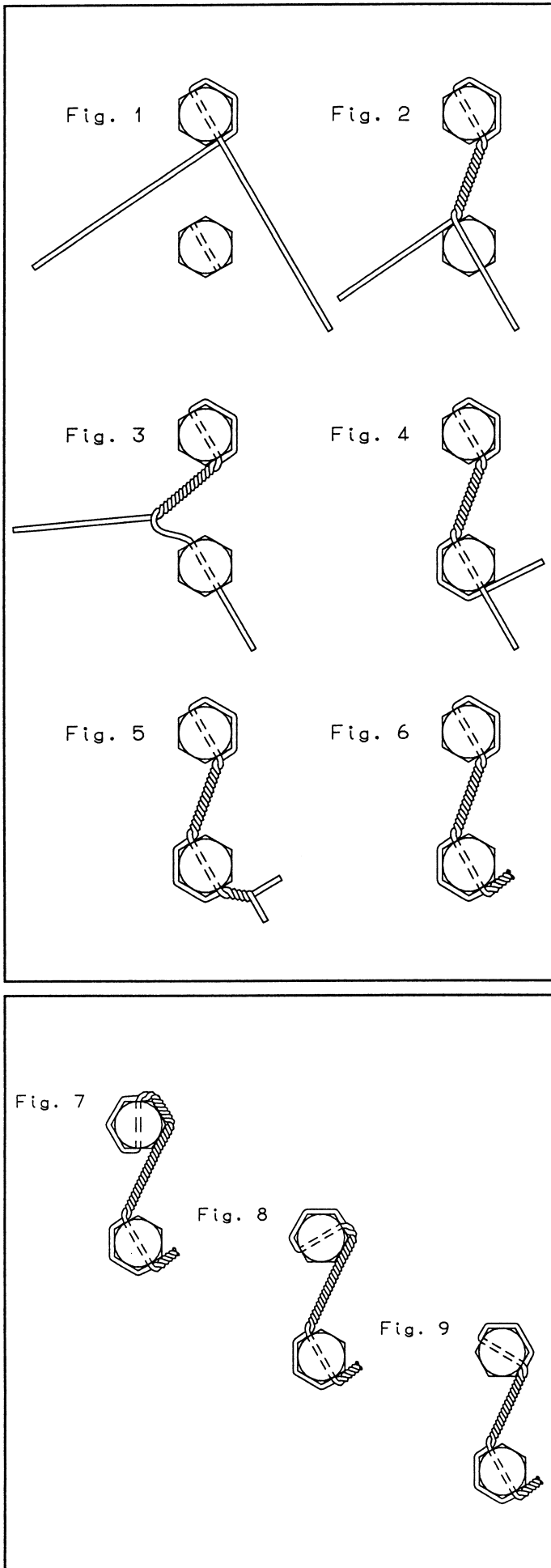


All screwed and bolted connections inside the engine, as well as all movable joints, are secured against untimely loosening by means of different types of locking devices.

When reassembling the engine after overhauls, it is vital that all such screws and nuts are again locked correctly.

1. Lock washers, tab washers, locking plates, etc., must always be replaced. The tab-like projections, etc., on the washers are to be bent back over one of the flats of the screw or nut concerned.
2. Used spring washers must be replaced.
3. Self-locking nuts may only be used five times. Therefore, give the nut a centre punch mark each time it is loosened.





Basic locking procedure:

Tighten the units correctly before securing them with wire. Do not overtighten or loosen the units to get a correct alignment of the wire holes. Always fit new wire after tightening-up the units.

Any tendency of the screws or nuts to loosen will be counteracted by a tightening of the locking wire. Do not secure more than four units in a series, unless otherwise specified.

Fig. 1: Insert wire, grasp the upper end of the wire and bend it around the head of the screw, then under the other end of the wire, be sure that the wire is tight around the head.

Fig. 2: Twist the wire **clockwise** until it is just short of the hole in the second screw. Keeping the wire under tension, twist it until tight. When the wire is tight, the wire shall have approximately 7-10 twists pr. 25 mm. One twist is a twist of the wires through an arc of 180°, equal to half of a complete turn.

Fig. 3: Insert the uppermost wire in the second screw, and pull it tight.

Fig. 4: Bend the lower wire around the screw, and under the end protruding from the screw.

Fig. 5: Keeping the wire under tension, twist it min. 3 twists, **counterclockwise** until tight.

Fig. 6: During the final twisting motion, bend the wire along the screw head. Cut off excess wire.

Fig. 7-9: Show the preferred ways of routing the locking wire on screws with wire holes oriented in different angles.

Alternative use of the securing method:

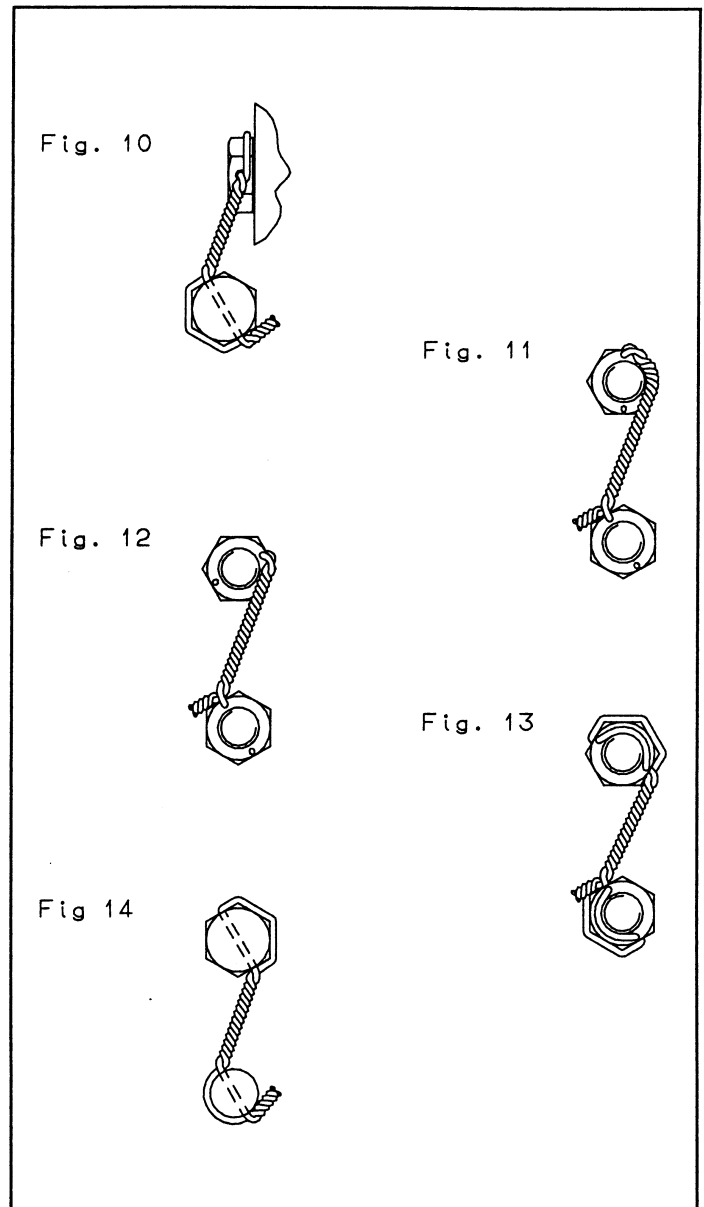
Fig. 10: Shows how to route the locking wire on screws in different planes.

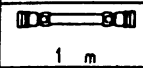
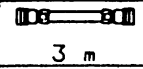
Fig. 11: Wire that passes over the top of a nut is an acceptable alternative only if it routes around the protruding screw thread.

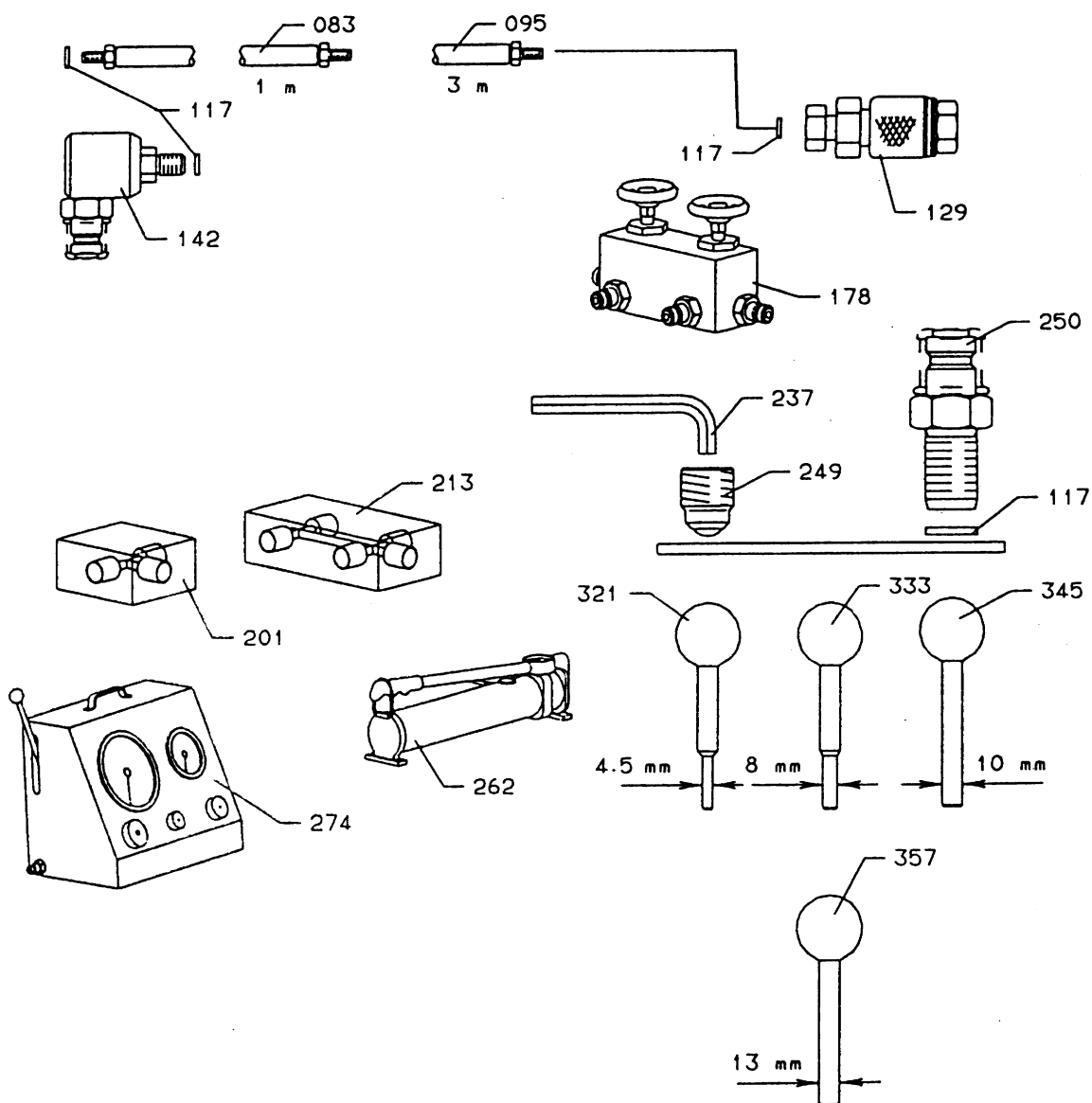
Fig. 12: Wire that passes over the top of a nut is also an acceptable alternative if the hole is located as shown in the figure.

Fig. 13: Where drilling of locking wire holes has caused a thin wall section, route the wire as shown in the figure, to prevent damage to the nut.

Fig. 14: Locking wire can be mounted to any other part of the assembly if nothing else is possible.



Part No.											
010			2	2	1						
022			2	2		1					
046		3		3				1			
058		5		5					1		

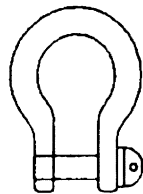


Item No.	Part Description	Item No.	Part Description
010	Flexible high-pressure hose (1 m), complete		
022	Flexible high-pressure hose (3 m), complete		
046	3-way distributing piece, complete		
058	5-way distributing piece, complete		
083	Flexible high-pressure hose, 1 m		
095	Flexible high-pressure hose, 3 m		
117	Gasket		
129	Snap-on coupling, female		
142	Angle union (90°)		
178	Distributing piece with needle valves (0-15)		
201	3-way distributing piece		
213	5-way distributing piece		
237	Wrench		
249	Bleeder screw		
250	Quick coupling male		
262	Hyd. pump hand operated		
274	Pneumatic/hydraulic high-pressure pump		
321	Tommy bar, 4.5 mm		
333	Tommy bar, 8 mm		
345	Tommy bar, 10 mm		
357	Tommy bar, 13 mm		





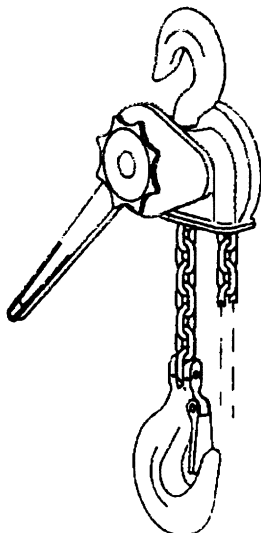
Thread	Max. Load	Stander No
M10	2.3 kN ~ 230 Kg	EN69R10
M12	3.4 kN ~ 340 Kg	EN69R12
M16	7.0 kN ~ 700 Kg	EN69R16
M20	12.0 kN ~ 1200 Kg	EN69R20
M24	18.0 kN ~ 1800 Kg	EN69R24
M30	36.0 kN ~ 3600 Kg	EN69R30
M36	51.0 kN ~ 5100 Kg	EN69R36



Thread	Max. Load	Stander No
M10	6.0 kN ~ 600 Kg	EN518E10
M12	6.3 kN ~ 630 Kg	EN518E12
M16	10.0 kN ~ 1000 Kg	EN518E16
M20	16.0 kN ~ 1600 Kg	EN518E20
M24	25.0 kN ~ 2500 Kg	EN518E24
M30	40.0 kN ~ 4000 Kg	EN518E30
M33	50.0 kN ~ 5000 Kg	EN518E33

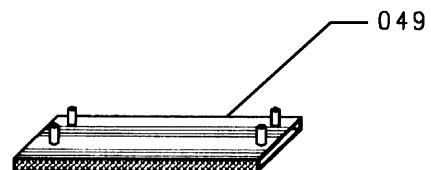
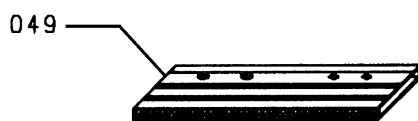
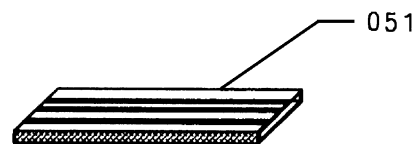
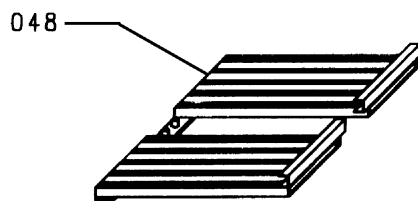
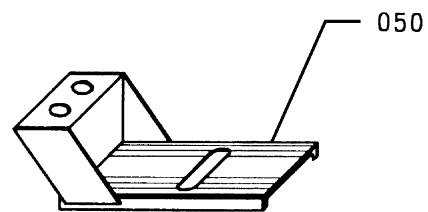
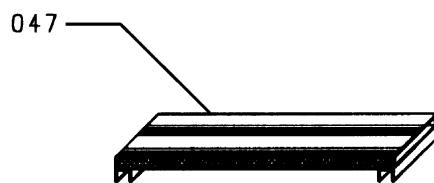
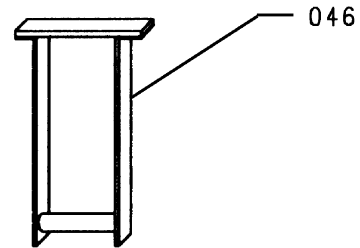
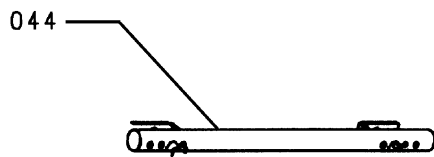


Thread	Max. Load	Item no
6.0 m	58.0 kN ~ 5800 Kg	018



Max. Load	Item no
3.0 t = 3000 Kg	114





Item No.	Part Description
044	Support for working platform
046	Support for working platform
047	Platform board
048	Platform board
049	Platform board
050	Ladder for connecting rod
051	Platform board

Item No.	Part Description





Combination spanner

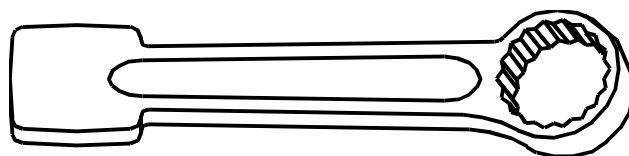
Size	Standard No.	Size	Standard No.
10	EN554K10	24	EN554K24
11	EN554K11	27	EN554K27
12	EN554K12	30	EN554K30
13	EN554K13	32	EN554K32
14	EN554K14	34	EN554K34
15	EN554K15	36	EN554K36
16	EN554K16	41	EN554K41
17	EN554K17	46	EN554K46
18	EN554K18	50	EN554K50
19	EN554K19	55	EN554K55
21	EN554K21	60	EN554K60
22	EN554K22		



Single-ended spanner

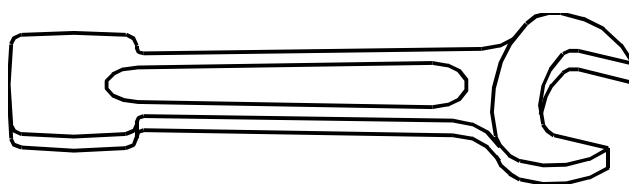
Size	Standard No.	Size	Standard No.
65	EN551F65	85	EN551F85
75	EN551F75	95	EN551F95





Ring impact spanner

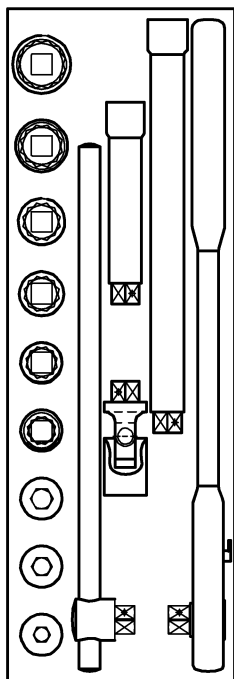
Size	Standard No.	Size	standard No.
30	EN554L30	65	EN554L65
32	EN554L32	70	EN554L70
34	EN554L34	75	EN554L75
36	EN554L36	80	EN554L80
41	EN554L41	85	EN554L85
46	EN554L46	95	EN554L95
50	EN554L50	100	EN554L100
55	EN554L55	115	EN554L115
60	EN554L60		



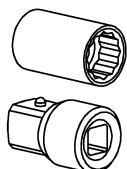
Open-ended impact spanner

Size	Standard No.	Size	Standard No.
85	EN553E85	95	EN553E95

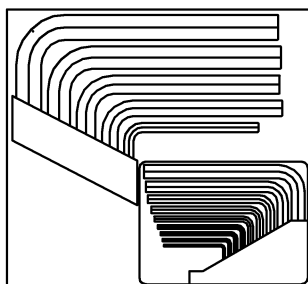




	Standard No.	Standard No.
Designation	Small set	Large set
Complete	EN563H 1	EN563H 2
Ratchet	EN563B 12,5	EN563B 20,0
Slide T-handle	EN506A 12,5	EN506A 20,0
Universal joint	EN506P 12,5	EN506P 20,0
Extension	EN506F 12,5125	EN506F 20,0200
Extension	EN506F 12,5250	EN506F 20,0400
Socket	EN506L 10	EN506L 24
Socket	EN506L 12	EN506L 27
Socket	EN506L 13	EN506L 30
Socket	EN506L 16	
Socket	EN506L 17	EN506L 34
Socket	EN506L 18	EN506L 36
Socket	EN506L 21	EN506L 41
Socket for internal hexagon	EN506G 5	EN506G 14
Socket for internal hexagon	EN506G 6	EN506G 17
Socket for internal hexagon	EN506G 7	EN506G 19
Socket for internal hexagon	EN506G 8	
Socket for internal hexagon	EN506G 10	
Socket for internal hexagon	EN506G 12	
Box	EN563G 1	EN563G 2



	S standard No.	Item
Socket spanner - Size 36 mm	EN506L36	1317
Socket spanner - Size 46 mm	EN506L46	1318
Socket spanner - Size 60 mm	EN506L60	1319
Socket spanner - Size 80 mm	EN506L80	1320
Socket spanner - Size 12.5/10 mm		016
Reducing Socket - Size 20/12.5 mm		028

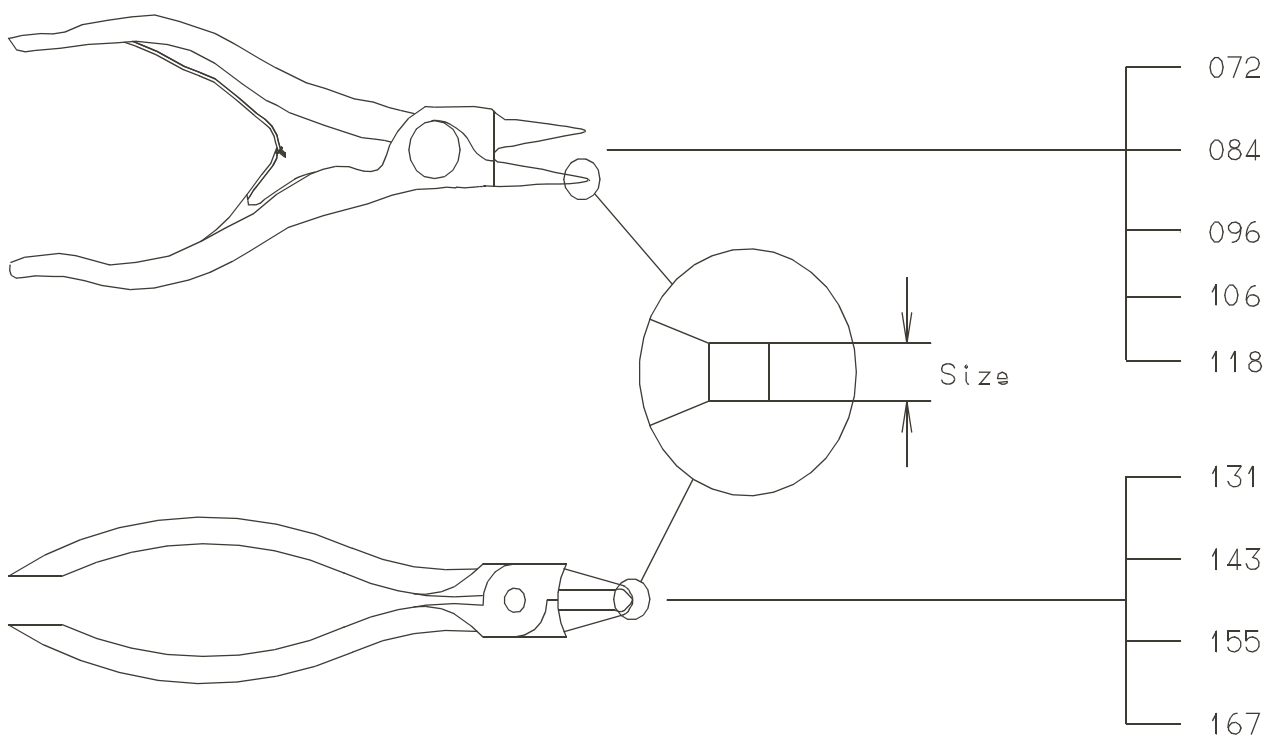
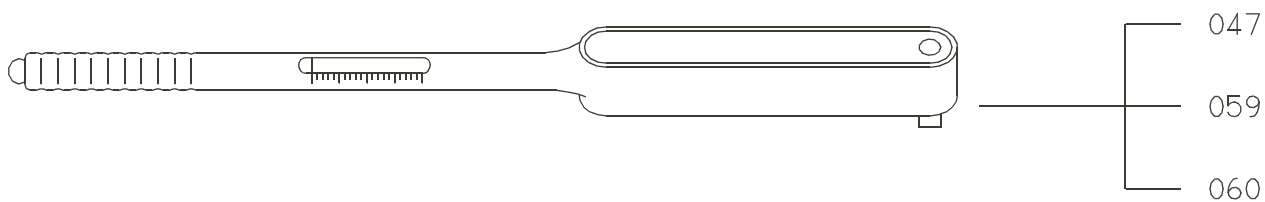
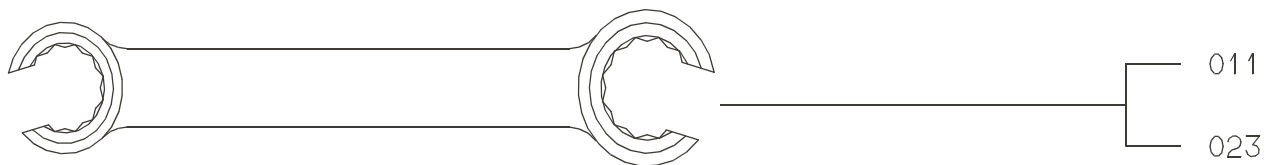


Socket wrench set for internal hexagon			
Size	Standard No.	Size	Standard No.
Small set		Large set	
Complete	EN549E 1	Complete	EN549G 1
1,5 mm	EN549A 1,5	10 mm	EN549A 10
2 mm	EN549A 2	12 mm	EN549A 12
2,5 mm	EN549A 2,5	14 mm	EN549A 14
3 mm	EN549A 3	17 mm	EN549A 17
4 mm	EN549A 4	19 mm	EN549A 19
5 mm	EN549A 5		
6 mm	EN549A 6		
7 mm	EN549A 7		
8 mm	EN549A 8		

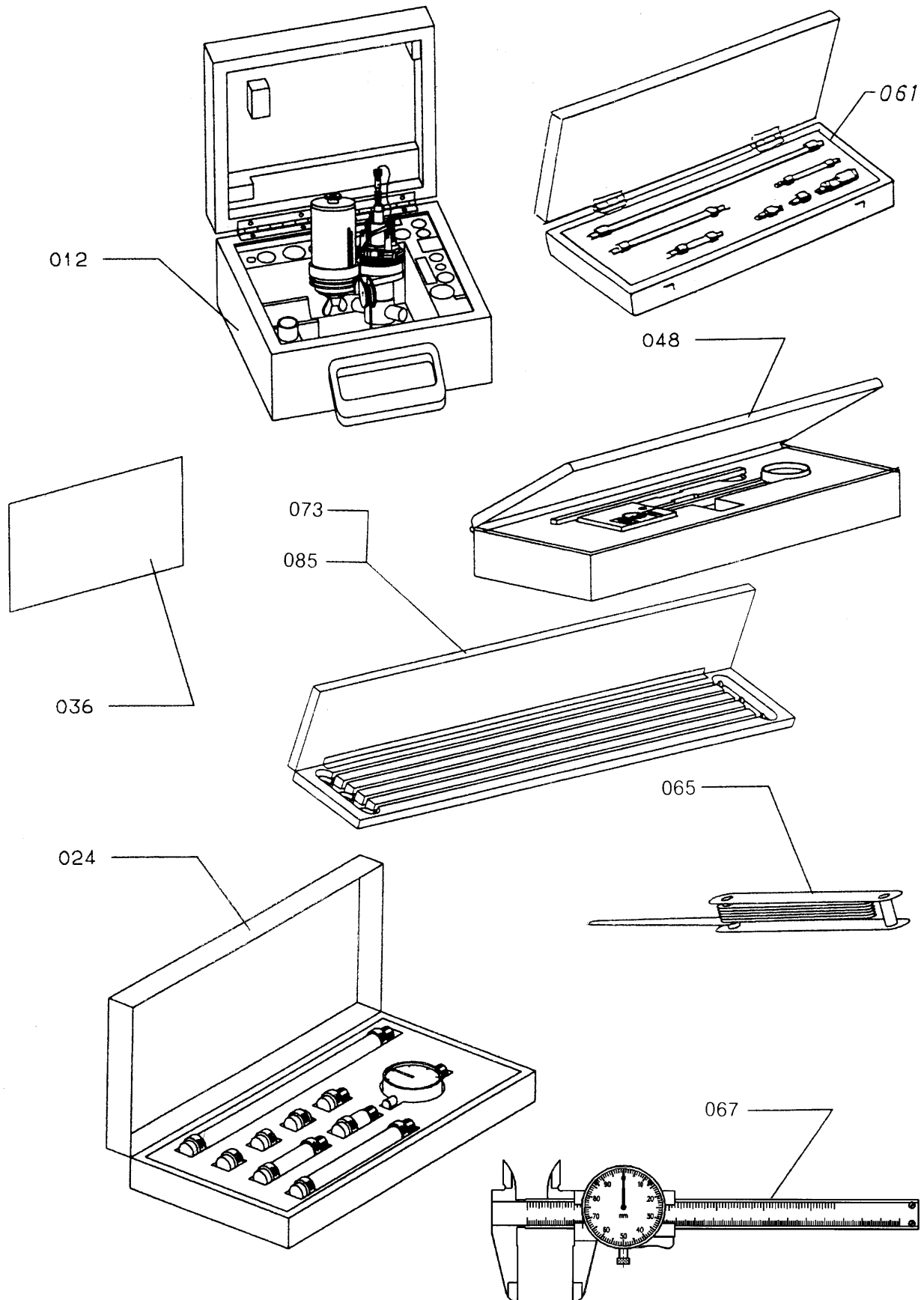


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Item No.	Part Description	Item No.	Part Description
011	Special wrench, □14/17 □mm		
023	Special wrench, □19/22 □mm		
047	Torque wrench, □ 40-200 □Nm		
059	Torque wrench, □ 140-760 □Nm		
060	Torque wrench, □750-2000 □Nm		
072	Plier □for □retaining ring -shaft type, 5 mm		
084	Plier □for □retaining ring -shaft type, 10 mm		
096	Plier □for □retaining ring -shaft type, 19 mm		
106	Plier □for □retaining ring -shaft type, 32 mm		
118	Plier □for □retaining ring -shaft type, 85 mm		
131	Plier □for □retaining ring -hole type, 10 mm		
143	Plier □for □retaining ring -hole type, 19 mm		
155	Plier □for □retaining ring -hole type, 32 mm		
167	Plier □for □retaining ring -hole type, 85 mm		



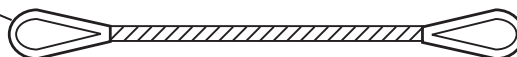
Item No.	Part Description	Item No.	Part Description
012	Indicator, complete		
024	Measuring tool for crank shaft (Autolog), complete		
036	Indicator paper		
048	Planimeter, complete		
061	Micrometer pin gauge set		
065	Feeler gauge set 0.05 - 1.0 mm		
067	Slide caliper		
073	Feeler gauge for main brg, 0.05 - 0.35 mm		
085	Feeler gauge for main brg, 0.4 - 0.7 mm		

1307
1308
1316



SIZE(L=m)			
-	5	10	20

1309
1310

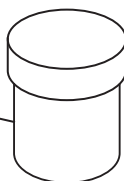


MAX. LOAD= 1800kg

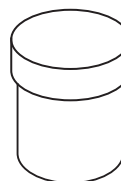
MAX. LOAD= 2500kg

1306

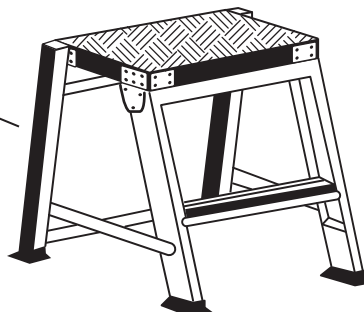
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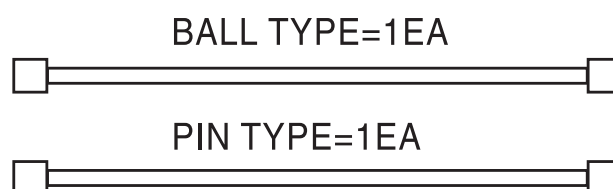
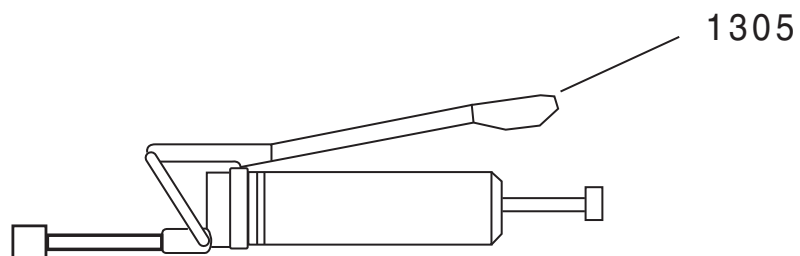
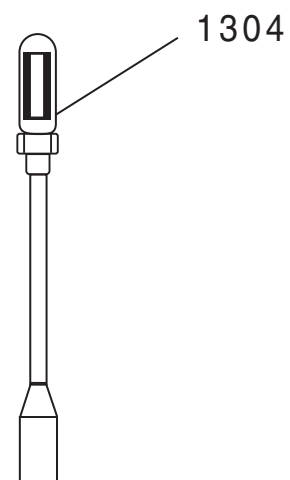
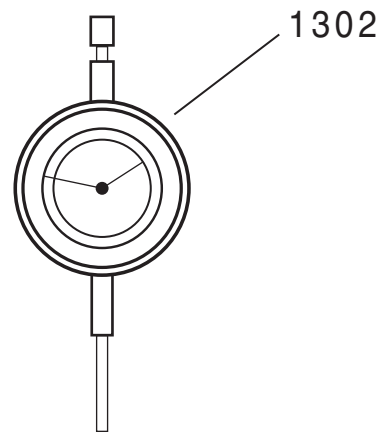
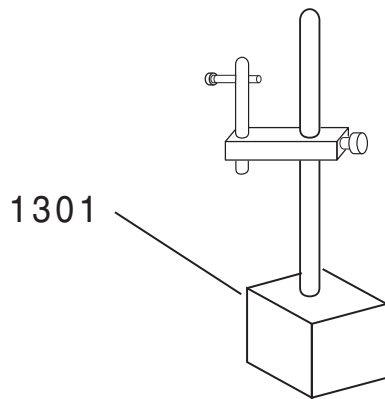


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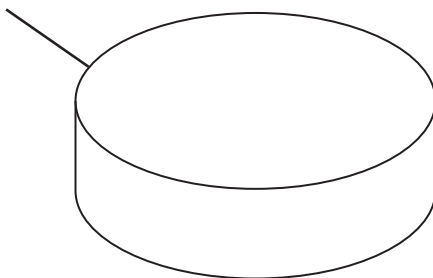


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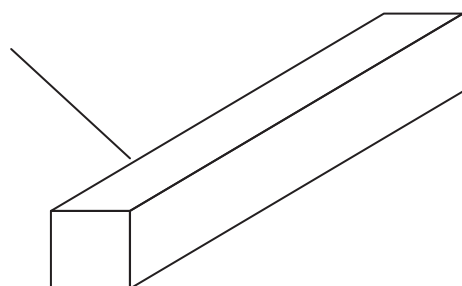




1311



1312



1313

