New Sulzer Diesel

New Sulzer Diesel Ltd
Winterthur, Switzerland

Maintenance Manual for Sulzer Diesel Engines ZAL40S

Installation / Vessel:

Type:

Engine No.:

Mailing address:

New Sulzer Diesel Ltd
PO Box 414
CH-8401 Winterthur
Switzerland

Telephone : (052) 262 49 22
Telex : 896 659 NSDL CH
Telefax : (052) 212 49 17

For Particular Attention

This manual is put at the disposal of the recipient solely for use in connection with the corresponding type of Sulzer Diesel Engine.
It has always to be treated as confidential.

Before the operator attempts to use the engine or before maintenance work will be undertaken, the Operating Manual or the Maintenance Manual respectively is to be read carefully.

To ensure the best efficiency, reliability and lifetime of the engine and its components, only original spare parts should be used.
It is to be ensured as well that all equipment and tools for maintenance are in good condition.

The extent of any supplies and services is determined exclusively by the relevant supply contract.

The data, instructions and graphical illustrations etc. in this manual are based on drawings made by **New Sulzer Diesel Ltd.** and correspond to the actual standard at the time of printing (year of printing is indicated on title page). Those specifications and recommendations of the classification societies, which are essential for the design, have been considered therein. It must be recognized that such data, instructions and graphical illustrations may be subject to changes due to further development, widened experience or any other reason.

This manual is primarily intended for use by the engine operating and maintenance personnel. It is assumed that it will always be at the disposal of such personnel for the operation of the engines and/or for the required maintenance work.

This manual has been prepared on the assumption that operation and maintenance of the engines concerned will always be carried out by personnel having the special knowledge and skill needed to handle in a workman-like manner diesel engines of the corresponding size, the pertaining auxiliary equipment, as well as fuel and other operating media.

Therefore, generally applicable rules, which may also concern such items as protection against danger, are specified in this manual in exceptional cases only. It is generally assumed that the operating and maintenance personnel are familiar with the rules concerned.

This manual has been prepared to the best knowledge and ability of its authors. However, neither New Sulzer Diesel Ltd. nor their employees assume any liability - under any legal aspect whatever - in connection with this manual, its contents, or modifications to it or in connection with its use, including possible negligence.
Further, claims relating to any damage whatsoever or claims of other nature such as e.g. demands for additional spares supplies, service or others are not being considered.

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Limited

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Switzerland

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Tools

The instructions contained in this **Maintenance Manual** are meant to contribute towards correctly handled maintenance work to be carried out at specific intervals.
In this it has been assumed that the staff put in charge of such work possesses the required mechanical knowledge and practice.
Indications on the engine operation as well as the description on the function of specific systems are contained in the **Operating Instructions.**

More detailed instructions on the operation and maintenance of components from sub-suppliers can be gathered from the instruction leaflets, of the respective manufacturers.
Outside makes are for example such engine components which are not manufactured in accordance with drawings of New Sulzer Diesel.

The maintenance manual is subdivided into the following main divisions:

- General guides to maintenance
- Maintenance schedule
- Tables of clearances and tightening values of important screwed connections
- Work sheets
- Tools list

Comments on these divisions:

The 'General Guides to Maintenance' contain next to recommendations on precautions to be taken, also hints on the work to be carried out.

In the 'Maintenance Schedule' guiding values are given on intervals in which specified maintenance work or servicing should be carried out.

The tables inform about normal and maximum permissible clearances and on the tightening values of important screwed connections.

The 'Normal Clearances' listed in the clearance table correspond to design and manufacturing values or to the settings on the new engine.
The laid down maximum clearances resp. max/min. dimensions are such values as may be reached after a lengthy operating period, which however may not be allowed to be exceeded or fall below. On components where the clearance is adjustable by modifying the thickness of shims, discs, spacers etc. the value given as 'Normal Clearance' should always be arrived at, or striven to attain. Where this is not possible, worn parts must be replaced by standard new ones or reconditioned by suitable material buildup.

If during an overhaul clearances are measured which almost have reached the permissible limit it must be left to individual judgement to decide whether a component part should be replaced or remain fitted till the next overhaul. This depends for example from the duration of the next operation period till the next overhaul and what wear has to be expected based on experience made.

On the 'Work Sheets' are found detailed instructions on the manner how to handle maintenance on certain specific parts.

The 'Tools List' is a compilation of tools and devices, required for the maintenance work and which are as a rule supplied along with the engine.

Indications in the text and illustrations in this manual correspond to the status at printing time. Modifications are taken into consideration in re-prints.

In the top left corner of each sheet the engine type is shown.
Sheets showing only ZA40S apply to ZAL40S and ZAV40S engines notwithstanding whether reversing or non-reversing engines.

The maintenance work needing to be carried out periodically on the engine at regular intervals is described in the 'Maintenance Schedule 0030' of this manual and is to be understood as a **general guide. The maintenance intervals are dependent on the mode of operation, on** the **power** as well as on the **quality of the fuel used.**
Experience will show whether the intervals may be **extended** or need to be **shortened.**

Precautionary measures for maintenance work

Before starting any maintenance work on the engine (particularly on the running gear), take the following precautionary measures:

- Installations with automatic controls: Set automatic control switch to OFF position.
- Close stop valves of starting air receivers.
- To prevent unintentional starting, as well as, in reversible engines, unintentional shifting of the camshaft please refer to Engine Control 40 chapter 'Checks and Adjustment' paragraph 2: Preparatory measures.
- Open all indicator valves on the cylinder heads and leave in this position until all maintenance work is completed.
- Engage turning gear (gear pinion must be meshed) and lock the lever.
- In case the engine had to be stopped due to overheating in the running gear or bearings, do not open the crankcase doors immediately **wait at least 20 minutes.**

Recommendations for carrying out the work

- Prior to turning the crankshaft with the turning gear, make sure that no loose parts, tools or devices can get jammed.
- For maintenance work on the engine use the tools and devices intended for the particular work, which as a rule are supplied with the engine (please refer to the tools list group 9400).
- Tools and devices should be placed in readiness **prior** to use, make sure they are in perfect condition.
- Check hydraulic tools periodically for tightness and perfect functioning.
- Carry out all work carefully, observing utmost cleanliness.
- Close all openings which appear when certain parts were removed e.g. conduits, oil holes etc. to prevent any dirt from entering the engine. (This includes also the pipes which were removed).
- Check all repaired overhauled or replaced parts for perfect functioning before starting the engine.
- Check all pipes, which have been removed, for tightness after they are refitted.
- Clearances of moving parts must be checked periodically. Should the maximum permissible values (see Clearance Table) have been reached or have even be exceeded, these parts must be replaced.
- Arrange to replace all parts taken from spares stock. When ordering new parts **refer to Code Book, mention code numbers and description.**
- When tightening studs, nuts or screws, take the utmost care not to damage their thread. They must be screwed in by hand until metal to metal contact is achieved. Always use the **prescribed lubricants** on the threads (please refer to the tightening instructions 0355).
- Keep to tightening values wherever they are indicated. Use the specified lubricant on the threads (please refer to the tightening instructions 0355).
- Fit locking device correctly and carefully. Use locking plates and locking wires only once.

- Where the reference 'D' (sealing compound) indicates that a sealing compound should be used in place of a joint, (for example on end casings, claddings, casings) use a product which **does not harden** and has good resistance water, oil, fuel.
- Before you apply the sealing compound clean the sealing faces with a suitable solvent to remove grease and oil (for example Trichlorethylene).
  The engine manufacturer uses the following sealing compounds:

Hylomar SQ 32 M (blue)	**Golden Hermetite**
Manufacturer:	Manufacturer:
	Hermetite Products Ltd.
Marston Lubricant LTD. Rock Ferry Oil Works Birkenhead, England	Tavistock Road West Drayton, Middlesex England

- Where the reference indicates 'fit with LOCTITE' **without specifying** any type use one of the mentioned LOCTITE-thread-locking products.

  LOCTITE-No. 59 (violet) or LOCTITE-No. 222 (violet)

- For threads of screws and studs which are getting very hot, (for example exhaust pipe or turbocharger fastenings) apply a high temperature resistant lubricant before assembly, to prevent a heat seizure.
  Where the remark 'use high temperature resistant lubricant' appears, the manufacturers use one of the following products:

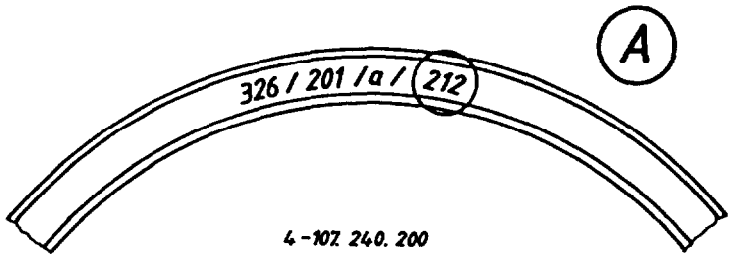
Thread Gard	**Ultra Therm**
Manufacturer:	Manufacturer:
	Walter Zepf Schmierungstechnik an der Linde 12
Crane Packing Ltd. **Slough**, Bucks England	D–7750 **Konstanz a/B.**

- Use O-rings only once. The new O-rings should comply with the requirements of table 0328 of the **Operating Instructions.**

For the crankshaft main bearings as well as for the connecting rod bottom end bearings, bearing shells of the following production types are used:

- Aluminium bearings with running layer No. 212.*)
- Riffled (grooved bearings with running layer No. 336.

For easy identification of the bearing shell type, their front faces are correspondingly marked (pl. refer to Fig. 'A'). The last three digits of the marking indicate the running layer of the bearing shell.



Depending on operating conditions the running layer of a bearing is more or less subjected to wear. Bearings are therefore considered as wear parts, and dependant on operating conditions must be replaced sooner or later. In order to ensure a trouble free operation and a long life of the bearings, the following points must be observed:

- Optimum lubrication of the bearings, prior to starting and while operating the engine.
- Optimum treatment of the lubricating oil by centrifuging.
- Perfectly working oil filters.
- Thorough cleaning of the crankcase after overhaul work, and adequately long flushing through of the oil piping system.
- Plugging the oil drillings in the crankshaft during overhaul work on the connecting rod bottom end bearing

*) Crankshaft main bearings as well as connecting rod bottom end bearings with a running layer No. 212 shut be used, for engines with an output over 660 kW per cylinder.

Criteria for the Replacement of Bearing Shells

The following indications should facilitate a decision, whether a bearing shell has to be replaced or can be fitted in again for further use. It is of paramount importance that in case of a re-fitting of used shells, they are without fail installed in the same place i.e. in the same bearing saddle or connecting rod as well shaft journal.

a) Aluminium Bearing No. 212

A bearing shell with the above running layer No. may be re-fitted provided:

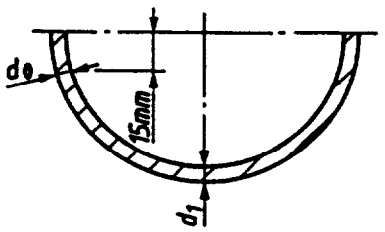
1. The wear lies within the tolerance (pl. refer to Fig. 'B').
2. The running surface and contact surface are good.
3. Only occasional scratches or isolated bedded-in dirt traces are observed in the running surface.

A bearing shell with the above running layer No. must be replaced if:

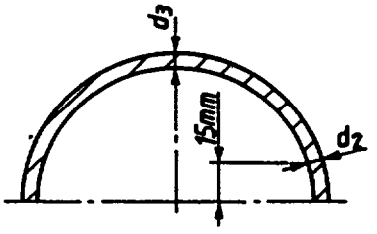
1. The wear in the bearing centre lies outside the tolerance (pl. refer to Fig. 'B').
2. The running surface is rough or damaged.
3. The running surface contains several grooves and several dirt enclosures.

B

Hauptlager
Main bearing



Unteres Schubstangenlager
Bottom end bearing



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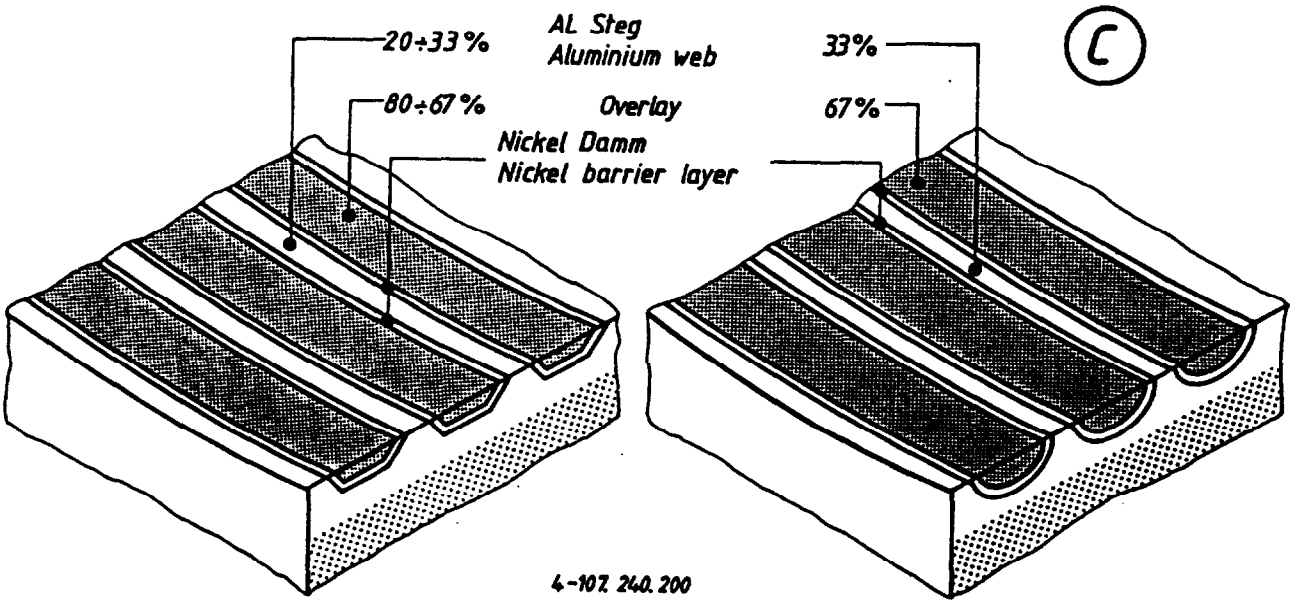
Max. Abnützung:
Wear limits: $d_0 - d_1 = \text{max. } 0.07\text{mm}$ $d_2 - d_3 = \text{max. } 0.10\text{mm}$

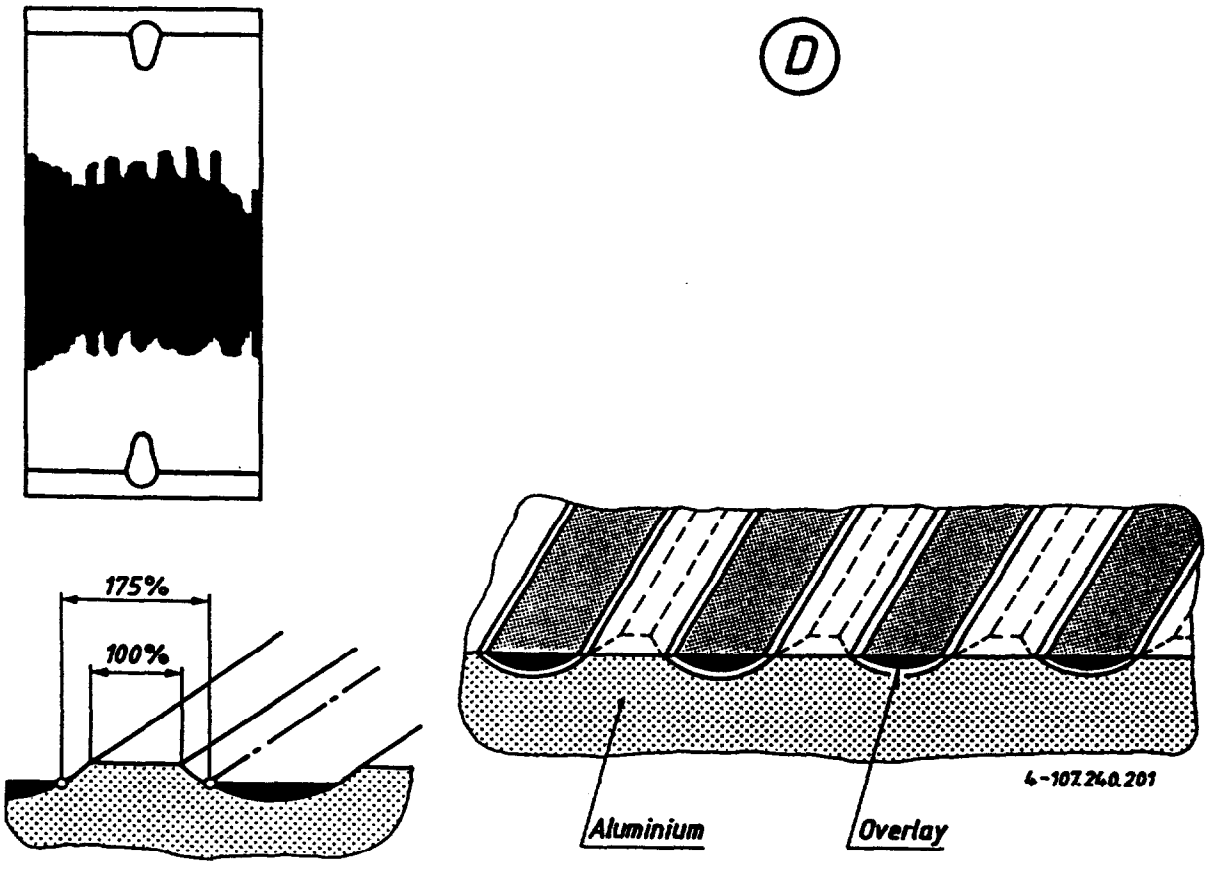
b) Riffled Bearing No. 336

The bearing surfaces of a new riffled bearing shell correspond with the values given in Fig. 'C', however these values are only meant as a general guide. From supplier to another the grove shape and dimensions may differ.

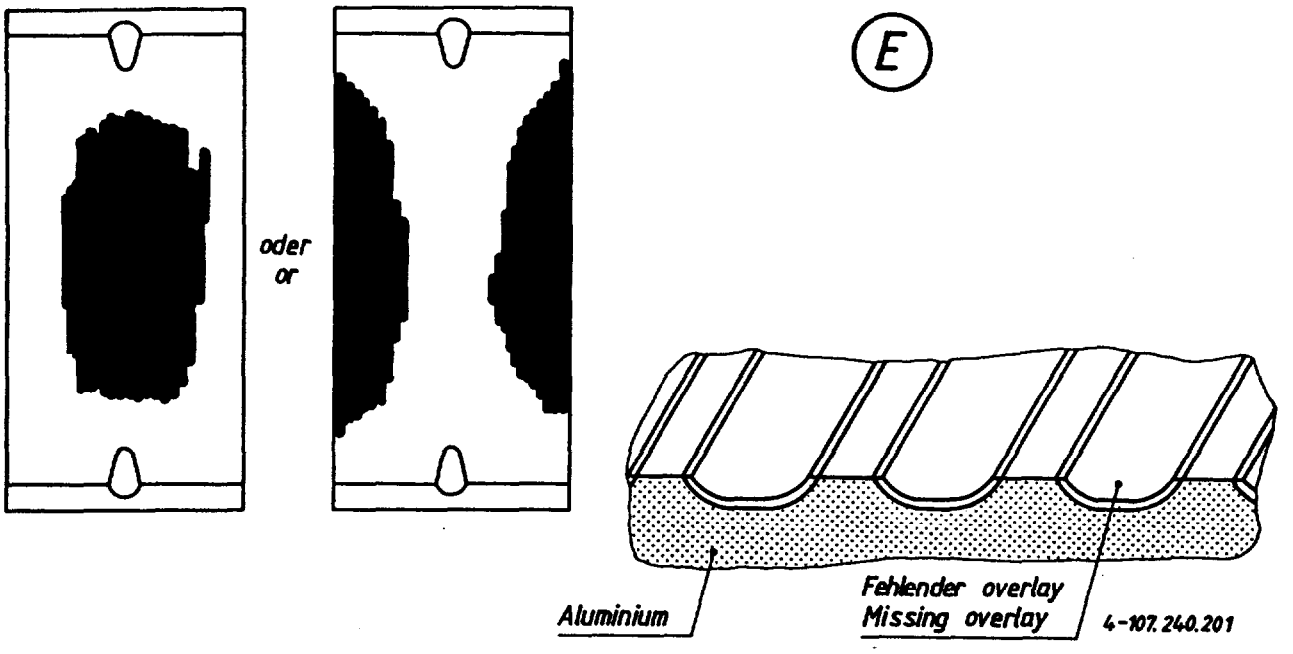


The following criteria are applicable for the replacement of riffled shells:

- A bearing shell must be replaced when on the max. loaded area of the running surface the Al-web has increased by 75% (pl. refer to Fig. 'D'). This does not apply to running surface sections, which show some wear caused during running in by small directional faults.



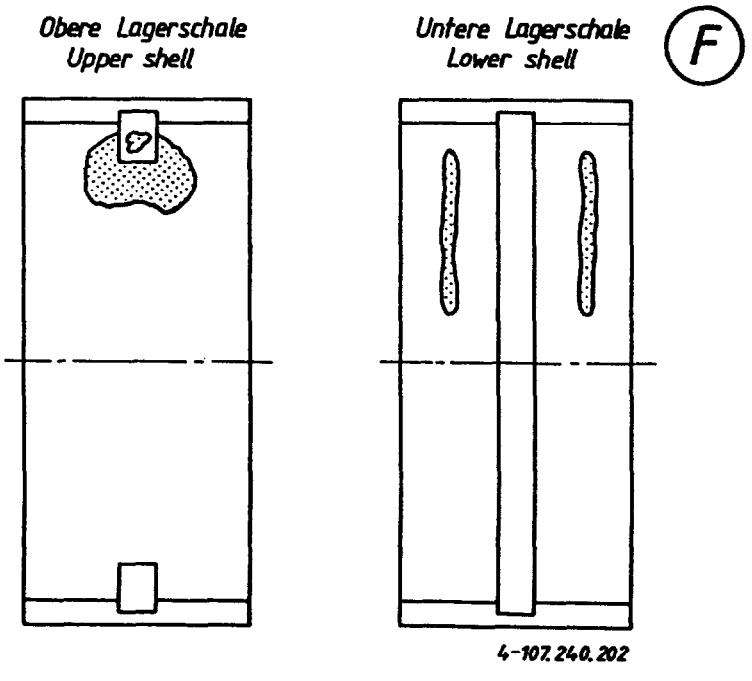
- Should the overlay be worn from its grooves on more than 30% of the complete running surface, then a new bearing shell must be fitted. (Fig. 'E').



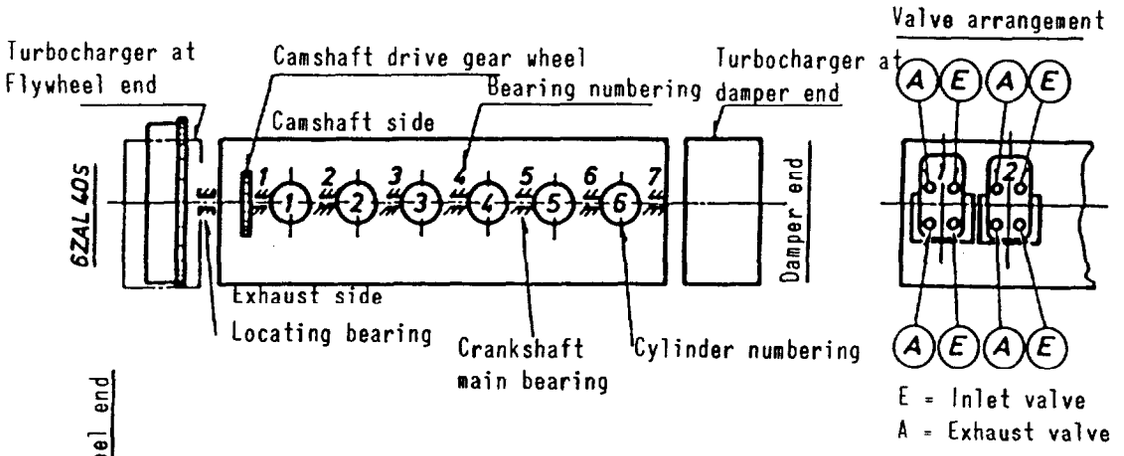
- Should in a surface without overlay 10% of the Al-webs be so much worn that their width has increased by more than 75% then a new bearing shell must be fitted.
- Should the Al-webs on either or both sides of the bearing be fully worn on a width of over 8 mm, then the bearing shell must be replaced..
- Should the overlay be worn out of its riffles on either or both sides by more than 15% of the full running width, then the bearing shell must be replaced.

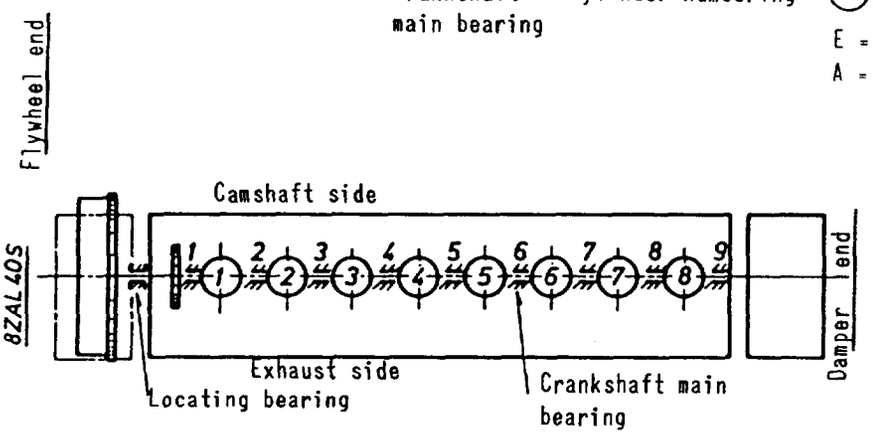
Remark:

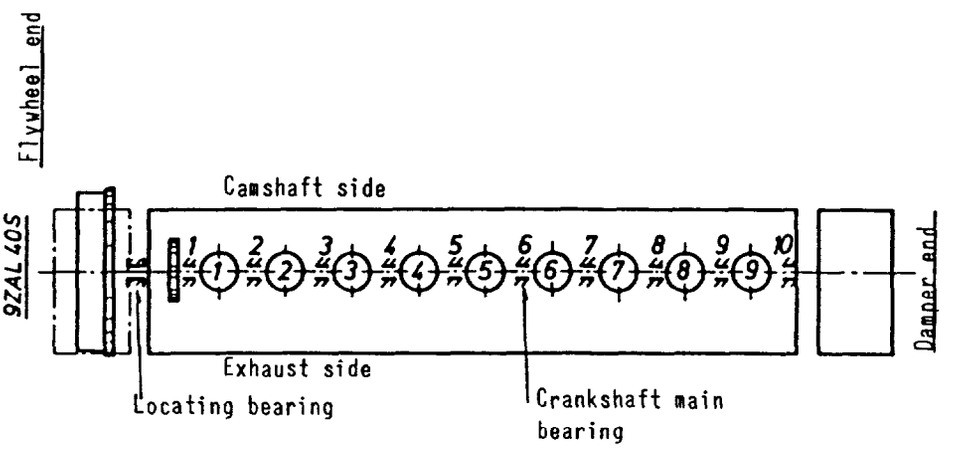
If cavitation traces are noticed in the bearing shells of the connecting rod bottom end bearing as depicted in Fig. 'F' then such bearing shells may again be fitted for re-use; provided however that the bearing shells show none of the above mentioned wear criteria.

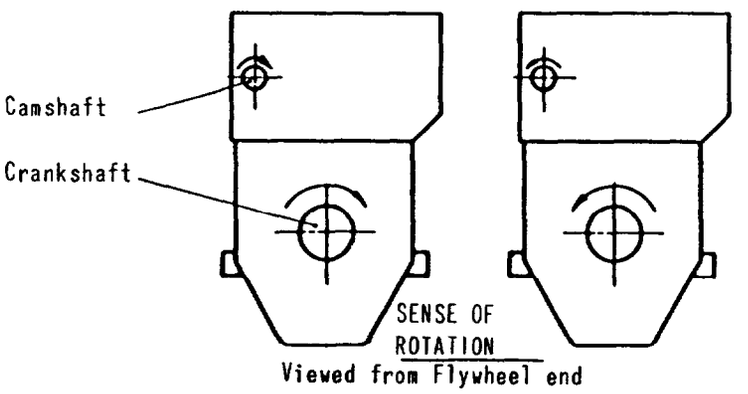


SULZER ZAL40S	NUMBERING OF BEARINGS AND CYLINDERS AND DEFINITION OF ENGINE SIDES	GROUP 0022 SHEET 1









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Expected inspection and service lifetimes

As already mentioned on sheet 0002/1, the recommended intervals in the maintenance schedule 0030/1 serve only as general guidance.

The actually applicable intervals or lifetimes depend on the following points:

- Quality of fuel and lubricating oils (section 0356 of the Operating Instructions)
- Environmental and operating conditions
- Fuel and lubricating oil care
- Maintenance work
- Use of genuine spare parts
- Engine load factor

The actual service intervals are to be determined as actual operating conditions.

Expected service life of engine components operated on heavy fuel oil

	Operating hours
Fuel nozzle	8'000
Inlet valve and valve seat	24'000 – 36'000
Exhaust valve and valve seat	24'000 – 36'000*
Piston	48'000 – 60'000
Piston rings	12'000
Oil scraper rings	12'000
Piston ring groove (re-chroming)	36'000 – 48'000
Rotating mechanism	48'000 – 60'000
Top end bearing	48'000 – 60'000
Bottom end bearing	24'000 – 36'000
Main bearing	24'000 – 36'000
Fuel pump plunger and guide bush	24'000 – 36'000
Cylinder liner	48'000 – 60'000

* Depending on actual fuel and lube oil operating conditions.

New Sulzer Diesel ZA40S	Maintenance Schedule (for Engines Operated on Heavy Fuel Oil) Inspection and Overhaul Intervals (Guide Lines)		Group: 0030 Sheet: 1
Component	Work to be carried out	Group, Sheet	Intervals
Group 0			
Low- and high temperature circuit as well as injector nozzle cooling system	– Check water level		daily
	– Check pressure, temperature, flow rate and deviation of temperature		daily
	– Determine cooling water quality as well as concentration of inhibitor and PH-value (follow instructions of inhibitor manufacturers)		quarterly
	– Clean cooling system		as required
Sea-water cooling system (only if provide with)	– Check pressure, temperature, flow rate and deviation of temperature		daily
	– Clean cooling system		as required
Engine lubricating oil	– Check oil level and when necessary top up		daily
	– Check pressure, temperature, flow rate and deviation of temperature		daily
	– Check the proper function of lube oil separators and of lube oil filter		daily
	– Take oil sample for laboratory analysis	0356/1	2'000 op. hours (= operating hours)
Lubricating oil for speed governor and turbocharger	– Check contamination and oil level, when necessary top up		daily
	– Oil change		acc. to class. society
Fuel oil system	– Check pressure, temperature, flow rate and regulation of viscosity		daily
	– Check the proper function of fuel oil separators and of fuel oil filter		daily
	– Take fuel oil sample for laboratory analysis (important for the selection of the true engine lubricating oil)		on every bunkering or as required
Starting air system	– Drain air receivers (or check water separator)		daily
	– Check air compressor		weekly
Control air system	– Check pressure		daily
	– Check air drier and filter		weekly

Component	Work to be carried out	Group, Sheet	Intervals
Safety system	– Check safety system and its proper function		monthly
Monitoring system	– Check proper function of all transmitters and its setting values		half yearly
Engine control and remote control	– Check all function ..... according to Operating Instructions		half yearly
Engine data	– Compare all engine data with the official shop trial documents		monthly
Group 1			
Foundation bolts	– Check tightness, re-tighten bolts if necessary		yearly
Engine housing	– Replace cylinder head studs	1001/1	as required
Crankshaft main bearing	– Check condition of bearing shells (random-inspection). Within a period of 4 to 5 years all bearing shells should have been (at least once) inspected	1201/1	12'000 op. hours acc. to class. society
Crankshaft locating bearing	– Check condition of the bearing shells and the locating ring halves	1202/1	12'000 op. hours acc. to class. society
	– Check axial clearance		8'000–12'000 operating hours acc. to class. society
Charge air space	– Drain off water (where no permanent water drainage is installed)		daily
	– Check permanent water drainage		daily
Crankcase	– Check all screwed fastenings and locking devices		as required
	– Visual inspection, incl. all screwed fastenings (on new or recently overhauled engines, first time after about 500 running hours)		half yearly
Group 2			
Cylinder liner	– Measure wear and grind off wear ridge	2105/1	12'000 op. hours
	– Check cooling water space by removing one cylinder liner	2105/2	12'000 op. hours
	– Check condition of running surface		12'000 op. hours
	– Replace O-rings		24'000 op. hours or as required

Component	Work to be carried out	Group, Sheet	Intervals
Cylinder head	– Removal	2701/1÷7	12'000 op. hours
	– Re-grind valve seats		12'000 op. hours
	– Overhaul relief valve, adjust blow-off pressure		as required
	– Measure valve guides		12'000 op. hours
	– Fit new O-rings for valve guides		12'000 op. hours
	– Replace O-rings for exhaust valve seats		24'000 op. hours or as required
	– Ev. replace inlet and exhaust valve seats as well as valve guides		as required
	– Check condition of valve rotating mechanism		12'000 op. hours
Rocker arm	– Check bearing bushes and axles determine clearances	2705/1	12'000 op. hours
High pressure fuel pipes	– Check, if necessary overhaul	2716/1	12'000 op. hours
Fuel delivery valves	– Check, if necessary overhaul		12'000 op. hours
Inlet valves	– Overhaul, if necessary re-grind seat surfaces on machine	2720/1, 2	12'000 op. hours acc. to class. society
	– Check valves spindle		12'000 op. hours
Exhaust valves	– Overhaul, if necessary re-grind seat surfaces on machine	2720/1, 2	12'000 op. hours (ev. 6'000 operating hours, depending on operating condition) acc. to class. society
	– Check valves spindle		12'000 op. hours
Fuel injection valve	– Check spray pattern, opening pressure and check against leakage	2722/1÷3	6'000 op. hours
	– Overhaul injection nozzles or nozzle holder if necessary		as required
Starting air valves	– Overhaul	2728/1	12'000 op. hours

Component	Work to be carried out	Group, Sheet	Intervals
Group 3			
Crankshaft	– Check crank deflections	3101/1	half yearly acc. to class. society
Counterweights on crankshaft	– Visual inspection of screwed fastenings	3101/3	yearly
	– Check waisted studs with hydr. jacks for correct pre-tensioning and if necessary re-tighten nuts		as required
Torsional vibration damper	– Fluid damper:	3130/1	
	Take silicon fluid sample and have it tested (based on the results of the first sample, the interval for taking further samples will be decided)	(4201/1)	first time after 12'000 op. hours
	– Spring damper:		
	Inspection		30'000 op. hours
Turning gear	– Check oil level	3212/1	before each start
	– Perform oil change		24'000 op. hours
Crank pin bearing	– Check condition of bearing shell (random inspection). Within a period of 4 to 5 years all bearing shells should have been (at least once) inspected	3302/1, 2	12'000 op. hours acc. to class. society
Rotating piston	– Remove all pistons and overhaul. Measure piston ring grooves. Record condition of piston crown, piston rings, piston ring grooves and piston skirt	3401/1, 2	12'000 op. hours
	– Dismantle piston, inspect cooling spaces and top end bearing		24'000 op. hours
Piston rings and oil scraper rings	– Remove and replace by **new** rings	3402/1	at each piston overhaul
Group 4			
Camshaft drive	– Inspect condition of gear teeth and measure tooth backlash	4101/1	yearly
Camshaft	– Inspect condition of cams	4201/1	6'000 op. hours, or once a year, or whenever opportune
	– Random-inspection of some camshaft bearings		12'000 op. hours
	– Check axial clearance		yearly
Starting air distributor	– Overhaul	4301/1	24'000 op. hours

Component	Work to be carried out	Group, Sheet	Intervals
Starting air shut-off valve	– Overhaul	4304/1	24'000 op. hours
Pneumatic valves on the engine	– Overhaul		24'000 op. hours, 12'000 op. hours with poor air quality
Inlet- and exhaust valve actuating gear	– Adjust valve clearances ..... (for new or just overhauled engines **first after about 150 operating hours**)	4401/1, 2	6'000 op. hours
	– Dismantle at random a few actuating gear housings and check individual components		12'000 op. hours
Reversing servomotor (only for reversible engines)	– Overhaul	4500/1	24'000 op. hours
Fuel injection pump regulating linkage	– Check freedom of movement	4501/1	monthly
	– Overhaul elastic rod		as required
Cut-out servomotor	– Overhaul	4612/1	24'000 op. hours
Group 5			
Speed governor	– Perform oil change ..... (follow makers instructions)	5101/1÷3	half yearly
Governor drive	– Check gear wheels	5105/1	yearly
	– Overhaul		24'000 op. hours
Mechanical overspeed trip and safety cut-out device	– Check function	5303/1	monthly
	– Overhaul		24'000 op. hours
Fuel injection pump	– Overhaul	5501/1	24'000 op. hours
			as required
	– Adjust setting on engine	5501/2	12'000 op. hours or as required
Group 6			
Exhaust gas turbocharger	– Cleaning in service *)	6501/1	
	a) blower wet cleaning *) ..... b) turbine wet cleaning *)		daily weekly, one to three times
	c) turbine try cleaning *)		to be carried out every one to three days
	– Perform oil change *)		*) follow instructions of turbine maker
	– Overhaul *)		

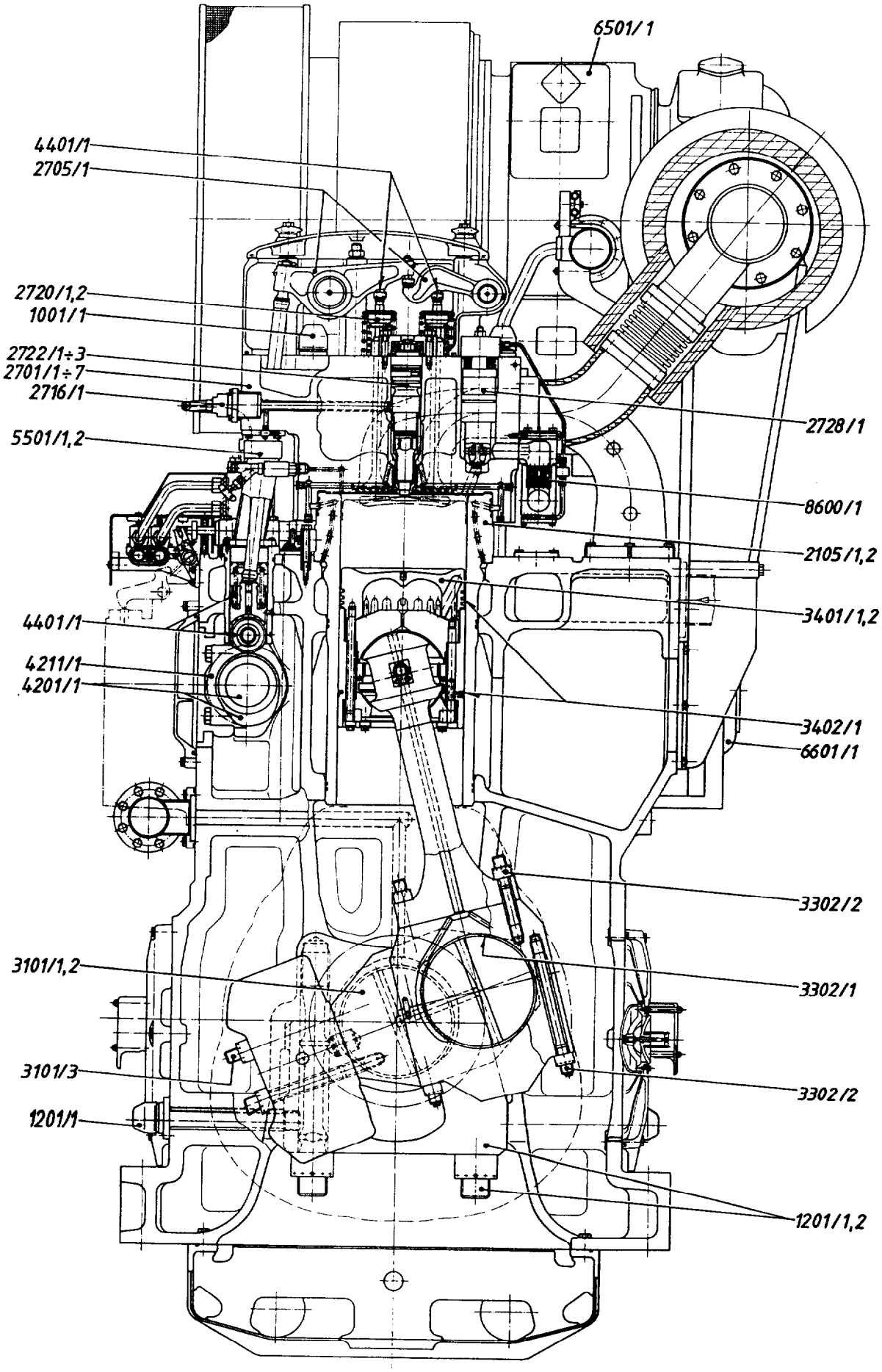
Component	Work to be carried out	Group, Sheet	Intervals
Charge air cooler	– Cleaning in operation at service load ..... (applies to engine with built-on washing system)		weekly, one to three times
	– Vent (where no permanent air vent is installed)	6601/1	daily
	– Remove and clean		when ΔP exceeds the limiting value stated on sheet 0358 of the Operating Instructions
Air filter on turbocharger	– Check filter		half yearly
	– Clean ..... (following instructions of filter manufacturer)		when ΔP exceeds the limiting value stated on sheet 0358 of the Operating Instructions
Flap to charge air bypass	– Functional check	6730/1	half yearly
	– Overhaul		as required
Charge air waste-gate	– Functional check (variant 'A')	6735/1	half yearly
	– Functional check (variant 'B') ..... lubricate movable parts		monthly
	– Overhaul		as required
Group 7			
[2]) Lubricating oil pump	– Check condition of gear teeth on driving gear wheel	7101/1	[1]) yearly
	– Overhaul pump		24'000–36'000 operating hours
[2]) Fuel booster pump	– Check condition of gear teeth on driving gear wheel	7102/1	[1]) yearly
	– Overhaul pump		24'000–36'000 operating hours
[2]) Cylinder cooling water and raw water pump	– Check condition of gear teeth on driving gear wheel	7103/1	[1]) yearly
	– Overhaul pump		24'000–36'000 operating hours
[2]) Fuel nozzle cooling water pump	– Check condition of gear teeth on driving gear wheel	7105/1	[1]) yearly
	– Overhaul pump		24'000–36'000 operating hours

Remark:

[2]) Applies only to engines with built-on pumps

[1]) For new engines initially after about 500 operating hours

Component	Work to be carried out	Group, Sheet	Intervals
SCAMATIC-fine filter for cylinder lubricating oil	– Check function	7203/1	
	a) On installations with continuous flow through the filter		weekly
	b) On installations where oil flows through the filter only when separator fails		half yearly
	– Dismantle and overhaul		yearly
Cylinder lubricating oil pump drive	– Dismantle and overhaul		follow manufacturers instructions
Cylinder lubricating oil pump	– Rinse casing	7220/1	half yearly
Group 8			
Exhaust waste-gate	– Function check	8136/1	half yearly
	– Overhaul		as required
Starting air pipes	– Overhaul flame arresters and safety valves	8600/1	24'000–36'000 operating hours
Group 9			
Oil mist detector	– Check indicator lamp SYSTEM ON		daily
	– Check function		monthly
	– Clean and overhaul		follow manufacturers instructions
Tools	– Protect hydraulic pre-tensioning jacks from corrosion and dirt	9400/0a	after each use, or before storing resp.
	– Check proper function and its completeness		yearly


6501/1
4401/1
2705/1
2720/1,2
1001/1
2722/1÷3
2701/1÷7
2716/1
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8600/1
2105/1,2
3401/1,2
4401/1
4211/1
4201/1
3402/1
6601/1
3302/2
3101/1,2
3302/1
3101/3
3302/2
1201/1
1201/1,2

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Tools:

1 Cylinder head turn–over device (only supplied against specific order)	9427.17
1 Valve seat grinding machine	9427.18
1 Hand grip	9427.35
Marking blue	

Key to Fig. 'A'

1 Cylinder head
2 Valve guide bush
3 Grinder spindle
4 Valve seat
5 Nut
6 Brake (wooden staff, pipe etc. for steadying)
7 Centring device

For information on the grinding of valve spindle seat please refer to sheet 2720/2

Valve seat should only be ground with the valve seat grinding machine.

Lapping–in of valve with valve seat **using grinding paste** should not be attempted.

When is the grinding of valve seats indicated?

- Every time **new** valve seats have been fitted in the cylinder head.
- When **new** or reconditioned valve spindles are being fitted. An exception may be made, when the valve seat surface is neither worn nor corroded, pitted.
- When the seat surface of the exhaust valve seats is badly impaired, on heavy fuel operation. (pitting, corrosion scars).

Inlet valve seats with a valve seat angle of $30^{\circ}\,^{+2'}_{0}$ are usually free from damage like pittings, or corrosion. However it can happen that the seat surface becomes slightly embossed due to wear. As this **does not impair** the reliability of operation it is usually not necessary to undertake this grinding operation, which reduces the life-span of the valves. Condition for this is of course that the valve in question is refitted to the same valve seat with unchanged seat surface. (Please refer to sheet 2720/2).

Exhaust valve seats for ZA40S engines may have valve seat angles of either $30^{\circ}\,^{+2'}_{0}$ or $45^{\circ}\,^{+2'}_{0}$ respectively. Valve seats of $45^{\circ}\,^{+2'}_{0}$ are fitted in ZA40S engines rated at 720 kW/cyl and also in engines with ER I / ER II at 660 / 600 kW/cyl. The criteria for grinding are the same for both types of valve seats.

Grinding of valve seats

Illustration 'A' shows an example how an electric driven seat grinding machine is used. Before starting the grinding operation the grinding device has to be mounted in the 30° or the 45° guide of the valve seat grinding machine tool No. 9427.18.
When grinding the valve seats care has to be taken to prevent grinding dust from entering the cylinder head. It is essential that after completing the grinding the cylinder heads are **thoroughly cleaned.**

For the use of the grinding machine please refer to the instructions supplied with the machine.

A clean and smooth surface must be obtained with the grinding of the valve seat.

The valve seat grinding machine **must** be well centred in the valve guide bush as well as in the valve seat with the aid of the inbuilt centring device 7. This is of paramount importance.
Experience has shown that chatter marks appear when valve seat surfaces are re–ground in the vicinity of engines or machines producing vibrations. This phenomenon can be successfully prevented when the cylinder head is laid on a thick rubber mat during the grinding operation. On board ship this grinding operation **should never be attempted without such a rubber mat.**

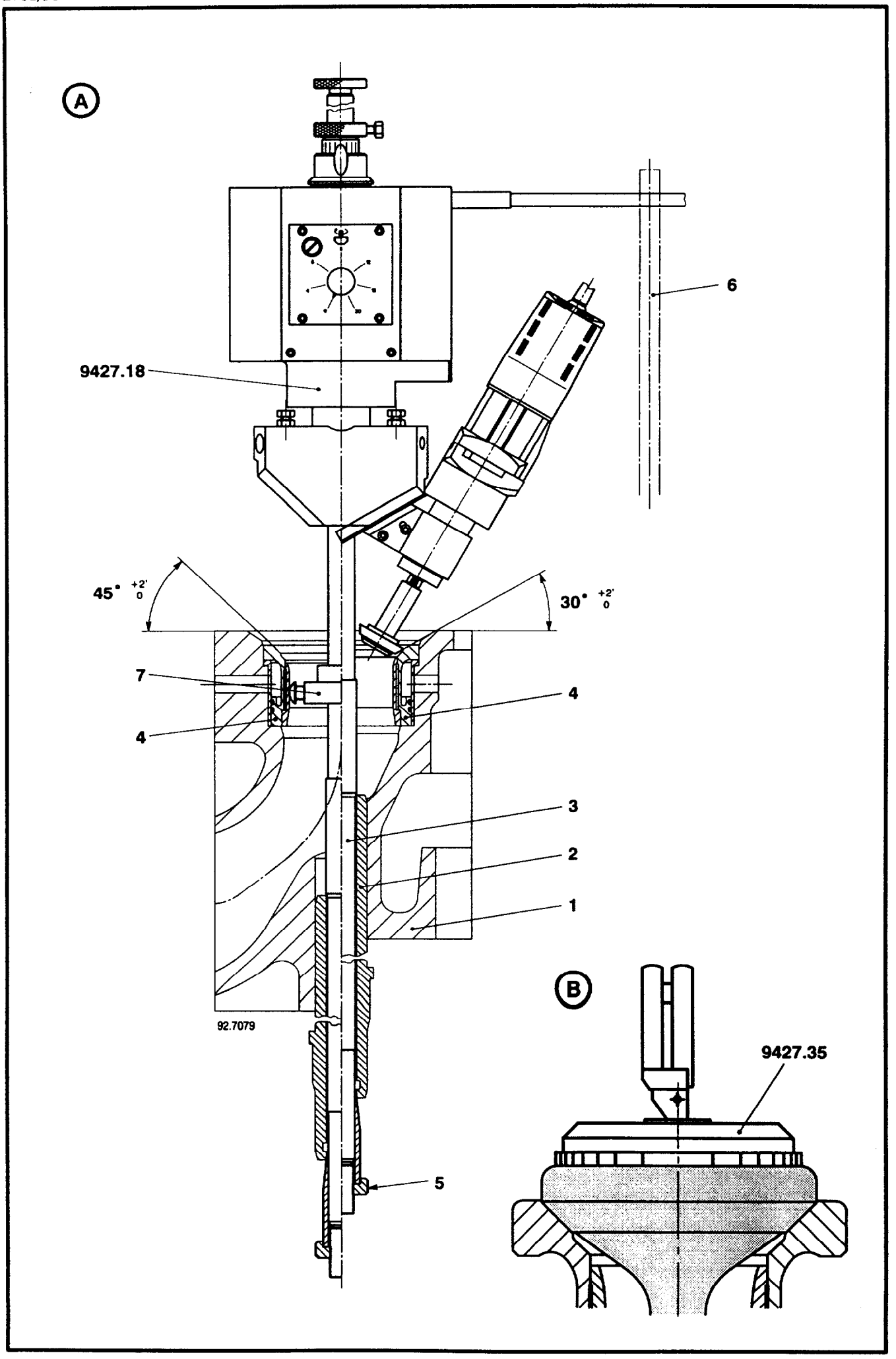
To prevent the machine from twisting a wooden staff or a pipe is inserted in a bore of the cylinder head.

For grinding of valve seats, only discs which are specified by the maker of the valve seat grinding machine are to be used. Such discs may be ordered also through **New Sulzer Diesel.**

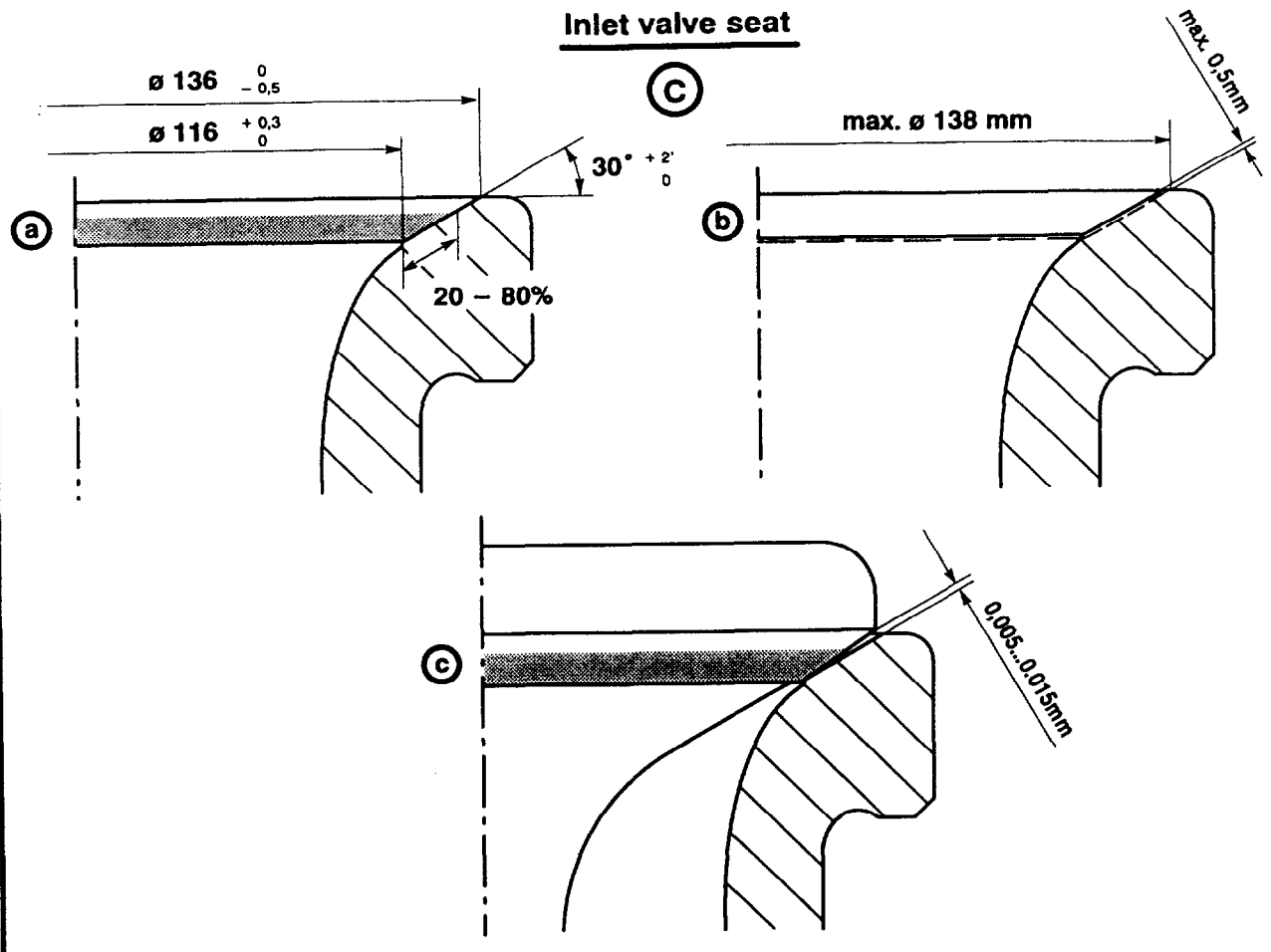
Cut:	Coarse;	= 0,1 mm
	Fine;	= 0,03 mm

Checking
On the finish machined seat surface a crack detection test by dye penetration must be carried out. No cracks are permitted!
After completing the grinding check whether the new or reground valve (pl. refer to sheet 2720/2) sits correctly on the valve seat. To check this, apply some marking blue onto the valve spindle seat. The valve spindle is inserted into the guide bush, the cylinder head being laid flat with combustion face upwards.
Move the spindle 3 to 4 times by about a 1/3 turn to and fro, if necessary use the hand grip 9427.35. Place this grip with the movable part of the strap folded down onto the clean surface of the valve disc (if the surface is rough, apply some oil). By folding the movable part of the strap upwards the grip fastens itself by suction to the valve disc. (Fig. 'B').
If the angle tolerances on valve and valve seat have been adhered to, then the bearing portion on the seat surface of the inlet valves amounts to 20– 80% of the seat width. The bearing imprint must run from the inner diameter outwards (see Fig. 'a' Illustr. 'C'). Besides the imprint check the gap between valve and seat can also be measured; As shown in Fig. 'c' Illustr. 'C' this should be between 0.005 mm and 0.015 mm.
On correctly ground exhaust valves having seat angles of 30° or 45° respectively the bearing portion must be 50 – 100% of the seat width, here however in contrast to the inlet valves the bearing imprint must run from the outer diameter inwards (see Fig. 'a' Illustr. 'D' and 'E').

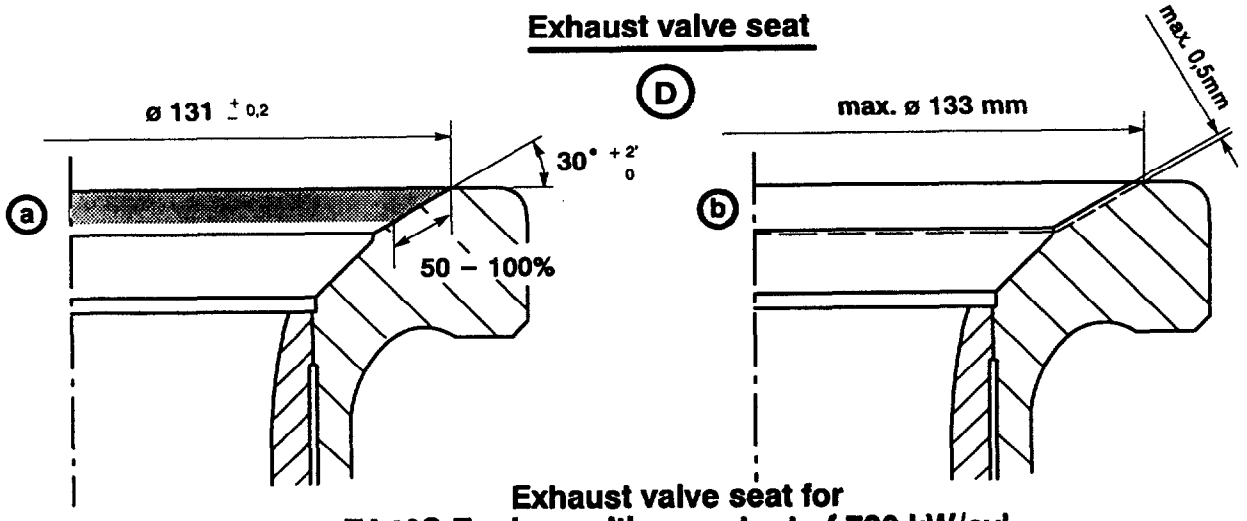
For inlet as well as for exhaust valve seats in the cylinder head it is important that the outer diameter of the valve seat surface must be **bigger** than the outer diameter of the valve plate, and that the inner diameter of the valve seat is **smaller** than the small diameter of the valve plate. Valve seats in the cylinder head may only be ground to the limit shown in Fig. 'b' Illustr. 'C', 'D', 'E'.


A
9427.18
6
45° +2' 0
30° +2' 0
7
4
4
3
2
1
92.7079
5
B
9427.35

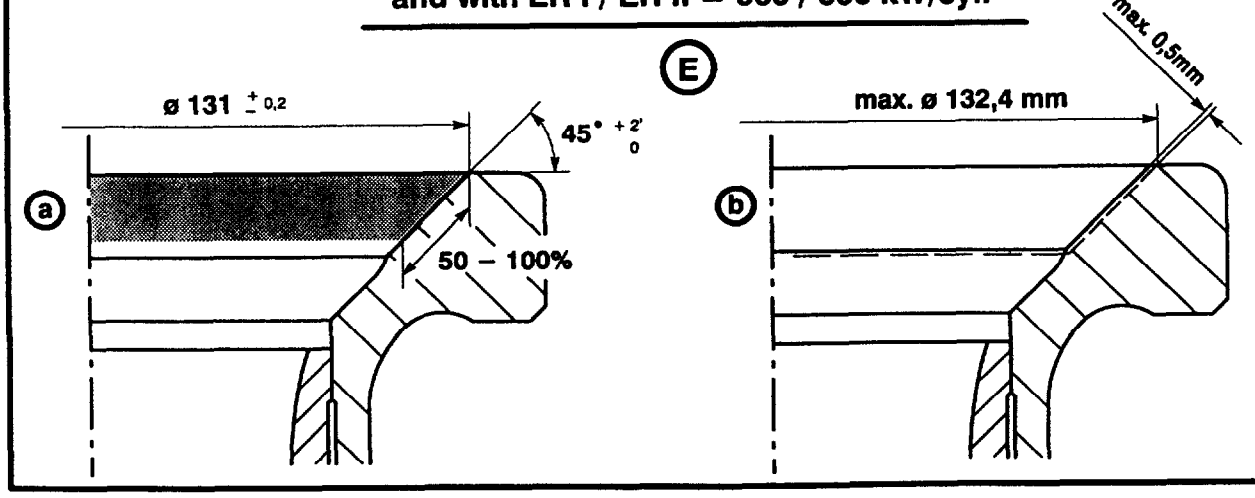
Inlet valve seat



Exhaust valve seat



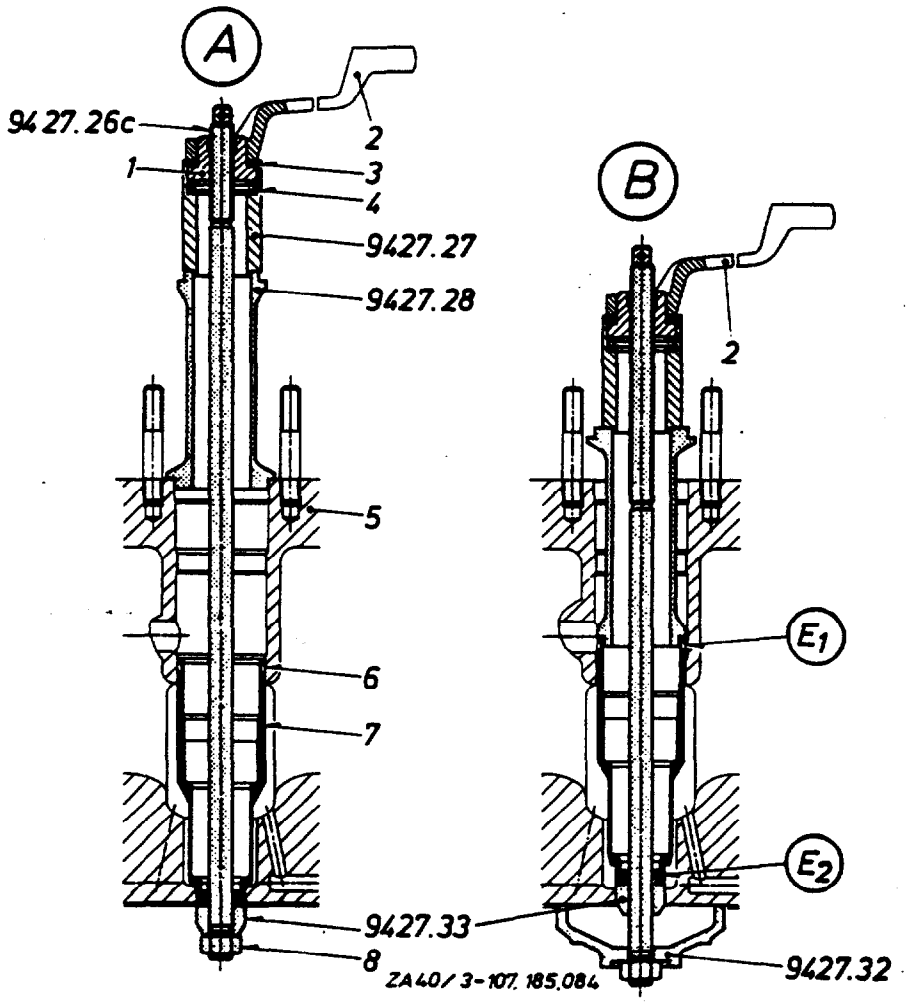
Exhaust valve seat for ZA40S Engines with an output of 720 kW/cyl and with ER I / ER II = 660 / 600 kW/cyl.



SULZER ZA40S	CYLINDER HEAD Replacing the Insert Bush for the Fuel Injection Valve and Lapping the Seating Surfaces	GROUP 2701 SHEET 4

Tools:

1	Spindle M24x880	9427.26c	1	Special nut	5 Cylinder head
1	Upper sleeve	9427.27	2	Double end ring spanner AF 46/50	6 O-Ring
1	Lower sleeve	9427.28	3	Locking ring	7 Insert bush
1	Centering disc	9427.32	4	Ball thrust bearing	8 Nut M 24
1	Guide cone	9427.33	F	Seating surface for fuel injection valve	9 Cleaning cloth
1	Double ring spanner AF 46/50				
1	Mandrel with centering disc	9427.10			
1	Cleaning tool	9427.11			



Removing an Insert Bush (Fig. 'A')

- Fit the tool as shown in Fig. 'A' and turn the special nut 1 with spanner 2, until the insert bush 7 has been withdrawn from its guide bore.
- Remove the insert bush and clean the guide bore in the cylinder head with a degreasing cleaning agent. Do not use emery cloth except in exceptional cases and then only with greatest care to avoid enlarging the guide bores.

Fitting an Insert Bush (Fig. 'B')

- The guide bores and the seating surface in the cylinder head must be clean, dry and undamaged.
- Degrease the insert bush in the region 'E2' and coat it with a sealing compound. (Regarding sealing compounds please refer to sheet 0002/1a).
- Fit the O-ring 6 at 'E1' and smear the area with oil.
- Mount the insert bush in the cylinder head and fit the tool as shown in Fig. 'B'.
- Rotate the special nut 1 with the spanner 2 and press the insert bush into its guide bore until fully seated. (Finally the cylinder head must be subjected to a pressure test. (Please refer to sheet 2701/6).

Lapping in the Seating Surface for the Fuel Injector Valve

The seating surface inside the insert bush must be inspected prior to each fitting of the fuel injector valve. It must not be either dirty or damaged, as it has to seal against very high pressures. The sealing in this part must be metal to metal, i.e. no sealing ring may be fitted.

Special tools are contained in the engine tools collection, to service this seating surface. They are to be used as described below. (Tool No. 9427.10 and 9427.11).

- Insert the guide ring in the bore in the center of the cylinder head. (Fig. 'C').
- Put a few spots of grinding paste on the face of the mandrel, insert it into the insert bush and lapp the seating surface by turning the mandrel to and fro several times.
- Fasten a soft cleaning cloth at the bottom end of tool 9427.11 and clean the seating surface with this contraption . (Fig. 'D').
- If you carry out this reconditioning work with the cylinder head fitted, pay particular attention, that no grinding paste can enter the combustion chamber, not any other objects.