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Work shop Manual
for
BUKH diesel engine

TYPE DV24

Engine Type: DV24M, DV24ME, DV24SME, DV24RM, DV24RME and DV24ST

DV24M:	DV24 Marine Engine with Marine Reduction gear box and Hand Start.
DV24ME:	DV24 Marine Engine with Reduction gear box, Hand Start and Electrical Starting.
DV24SME:	DV24 Marine Engine with Sail Drive, Hand Start and Electrical Starting.
DV24RM/RME:	DV24 Marine Engine build to Customer Specification as Lifeboat Propulsion according to Solas Requirements.

Contents

SECTION A

LIST OF TOOLS

CONTENTS

On the following pages A4 to A8 is shown the different combinations of standard tools and spares following the different models of DV24.

Page A4 and A5 shows the standard supply “Kit no. 022D4103” for the RM and RME models according to Solas Requirements.

Same supply with exceptance of Item 1, 2, 13, 14, 15, 17 and 18 is standard supply for the models ME and SME.

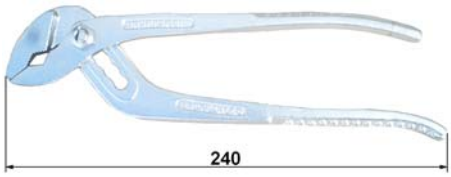
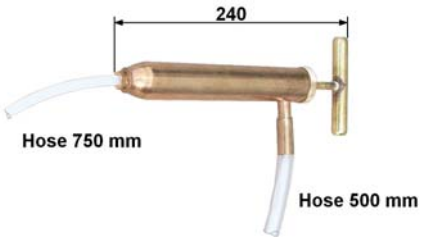
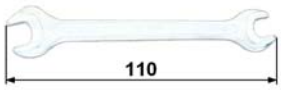
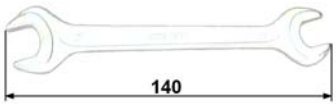
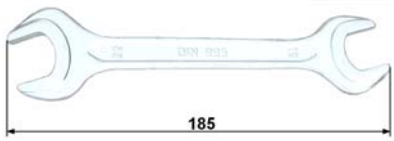
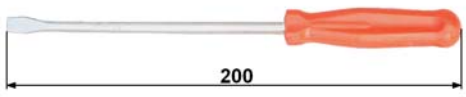
Page A6, A7 and A8 are showing the Additional Spare Parts delivered together with the standard supply for some Lifeboat Engines.

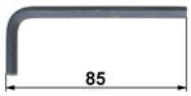
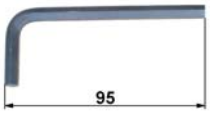
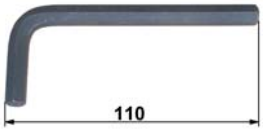
Page A9 to A13 shows the Special Tools required for major repairs.

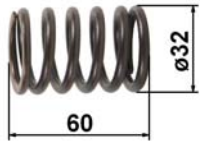
TOOLS AND SPARES FOR BUKH LIFEBOAT ENGINES

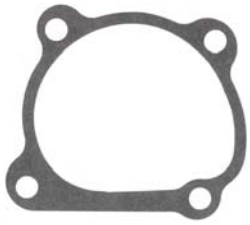
STANDARD SUPPLY ACCORDING TO SOLAS REQUIREMENTS

DV24/29/32: KIT No. 022D4103

	ITEM	QUANT.	DESCRIPTION	MATERIAL	WEIGHT	PART NO.
	1	1	ADJUSTABLE SPANNER	STEEL	0.150 Kg	529V0052
	2	1	POLYGRIP TONG	STEEL	0.324 Kg	529V9910
	3	1	HAND PUMP FOR LUB. OIL	BRASS	0.342 Kg	020D4101
	4	1	DOUBLE FORK SPANNER, 8/10 mm	STEEL	0.018 Kg	529V0002
	5	1	DOUBLE FORK SPANNER, 12/14 mm	STEEL	0.044 Kg	529V0007
	6	1	DOUBLE FORK SPANNER, 13/17 mm	STEEL	0.076 Kg	529V0010
	7	1	DOUBLE FORK SPANNER, 19/22 mm	STEEL	0.122 Kg	529V0017
	8	1	DOUBLE FORK SPANNER, 24/30 mm	STEEL	0.228 Kg	529V0021
	9	1	SCREWDRIVER	STEEL/ PLASTIC	0.038 Kg	529V0102

	ITEM	QUANT.	DESCRIPTION	MATERIAL	WEIGHT	PART NO.
	10	1	ALLEN KEY, 5 mm	STEEL	0.012 Kg	529V0325
	11	1	ALLEN KEY, 6 mm	STEEL	0.018 Kg	529V0326
	12	1	ALLEN KEY, 8 mm	STEEL	0.030 Kg	529V0328
	13	1	V-BELT, ROFLEX	SYNTHETIC	0.096 Kg	542A0611
	14	1	FUEL FILTER	STEEL/ PAPER	0.406 Kg	610D0201
	15	1	LUBE OIL FUEL FILTER	STEEL/ PAPER	0.322 Kg	610J0050
	17	1	START PILOT (ONLY FOR HAND START)		0.280 Kg	611Z0275
	18	1	OIL CAN, 0.3 LITER	PLASTIC	0.044 Kg	529V9920

	ITEM	QUANT.	DESCRIPTION	MATERIAL	WEIGHT	PART NO.
	19	1	INLET VALVE	STEEL	0.090 Kg	000E4887
	20	1	OUTLET VALVE	STEEL	0.085 Kg	000E4888
	21	2	VALVE SPRING	STEEL	0.060 Kg	000E4891
	22	1	PISTON RING SET	STEEL	0.060 Kg	030D0304
	23	1	FUEL PRESSURE PIPE, CYL. 1	STEEL	0.100 Kg	008E7903
	24	1	FUEL PRESSURE PIPE, CYL. 2	STEEL	0.100 Kg	008E7904
	26	1	COOLING WATER PUMP SHAFT WITH BEARING	STEEL	0.245 Kg	545B1030
	27	1	COOLING WATER PUMP SEAL, CONC. PUMP	PLASTIC	0.018 Kg	530Q9975

	ITEM	QUANT.	DESCRIPTION	MATERIAL	WEIGHT	PART NO.
NOT AVAILABLE ANYMORE	28	1	COOLING WATER PUMP IMPELLER	STEEL	0.200 Kg	000E8256
	29	1	FUEL VALVE , COMPLETE	STEEL	0.233 Kg	610B9250
	30	1	GASKET FOR COOLING WATER PUMP	PAPER	0.002 Kg	000E3555
SEE SPECIFICATION NEXT PAGE	31	1	SET OF GASKETS COMPLETE		0.560 Kg	032D4215
	32	1	OIL SEAL ø20 / ø35x7	RUBBER	0.005 Kg	561B0201
	33	1	FEELER GAUGE	STEEL	0.030 Kg	529V9911
	34	1	SPAREPARTS & TOOL SUITCASE 50 x 35 x 13 cm CONTAINING ITEMS 1 - 33	PLASTIC	1.600 Kg	569B1018

Specification for Complete set of Gaskets no. 032D4215 for DV 24/29/32 RME

Part No.	Quantity	Item
000E2462	1	Gasket for water inlet
000E2584	1	Gasket for thermostat
000E3225	4	Thrust collar for shaft
000E4784	1	Gasket for lift pump
000E7425	1	Gasket for Lub.oil pump cover
000E7668	1	Gasket for valve cover
000E7671	1	Gasket for cylinder head
000E9069	1	Gasket for oil pump
000D9196	1	Gasket for front end cover
000D9197	1	Gasket for rear end cover
000D9312	2	Gasket for cover for regulating of fuel cam
000D9643	1	Gasket for governor cover
000D9734	1	Gasket for base cover
000D9762	1	Gasket for exhaust
000D9881	2	Gasket for watercooled exhaust pipe
000E0053	1	Gasket for chain case
000E0054	1	Gasket for chain case
000E0055	1	Gasket for raised handstart
000E0975	1	Gasket for cover for rotating weights
522C3005	6	Gasket - Copper
522C3008	2	Gasket - Copper
522C3012	6	Gasket - Copper
522C3014	2	Gasket - Copper
522C3016	6	Gasket - Copper
522C3020	3	Gasket - Copper
522C3021	5	Gasket - Copper
522C3025	1	Gasket - Copper
522C3027	1	Gasket - Copper
522C3033	1	Gasket - Copper
522C3082	2	Gasket - Copper
560B1017	1	O-ring
560B1032	1	O-ring
560D0006	1	O-ring
560D0025	1	O-ring
560F0009	1	O-ring
560F0011	2	O-ring
560F0013	5	O-ring
560H0048	1	O-ring
560M1091	4	O-ring
561B0350	1	Oil seal ring
561B0356	1	Oil seal ring
561B0595	1	Oil seal ring
562J0000	4	Valve seal

Special Tools

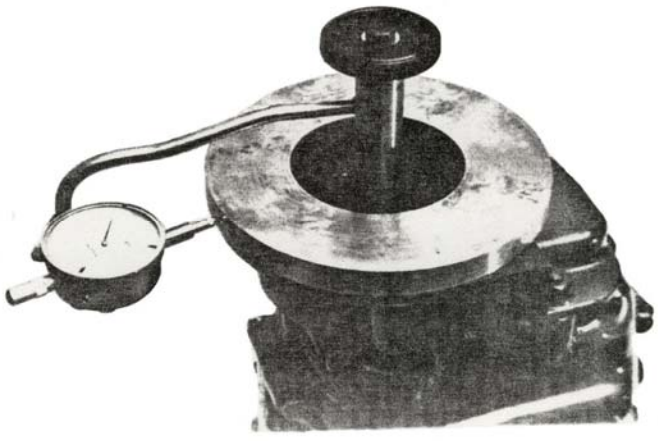
Part No.	Drawing No.	Description and application
009P2235	V 2109	Puller for cylinder liner
009P2958		Slip-on ring for mounting of pistons
009P3100		Testing set for fuel injection nozzles
009P3101		Cleaning tool for fuel injection nozzles
009P3102		Pressure device for fuel pump spill point
009P3103		Dial micrometer
009P3104		Magnet holder for dial micrometer
009P3106		Tachometer
009P3107	Autotest	Valve milling set
		Suction cup with handle for valve grinding
		Set of double ended spanners (Gedore 19 PMXZ (½"))
		6 mm Allen top
		8 mm Allen top
		4 mm Allen top
009P3108		Torque spanner (Stahlwille 73/6 1.5-6.5)
009P3109		Torque spanner (Stahlwille 73/25 8-26)
009P3115	V 1669	Tools for removing valve springs
	009P2211	Cranked 10 mm open-end spanner for fuel cam
		Circlip rod (outside) A 1, 10-28 mm
		Circlip rod (inside) J 2, 19-75 mm
		Side cutting pliers (Stahlwille 10581, $5^3/_4$")
		Flat nose pliers (Stahlwille 10646, $5^3/_4$")
60680		SKF hook-spanner HN10 for SKF nut on crank
60681		SKF hook-spanner HN12 for SKF nut on crank
		Piston pin ejector (Kukko 27/2)
		Puller for gear wheel (Kukko 20/10)
		Puller for flexible coupling
009P2189	V 2110	Erection tools for intermediate housing
	529W0000	Compression measuring equipment
	000E2085	Extension for setting up of compression measuring equipment
	009P2183	Tools for removing and mounting of main bearings
	Heyco 540-983-03-99	19 mm crawfoot wrench for tightening up of cylinderhead
009P2235		Puller for cylinder liner
009P3100		Testing set for fuel nozzles
009P3102		Pressure gauge (for adjusting of injection timing for fuel pumps)
009P3103		Dial indicator (for use when adjusting injection timing)
009P3104		Magnet holder for dial indicator
		12 mm Allen top
		Tool box
		Double-ended spanners closed or open,
		nos. 10, 11, 13, 14, 16, 17, 19, 22, 27 and 32
008E4223		Milling tools for tightening at rear end cover
008E4224		Erection tools for tightening at rear end cover
		Niji-lock 105Q or 105K Abrasive compound for fuel valve
		Carborundum

Slip-on ring for fitting of pistons
Order No. 009P2958

SKF hook spanner HN10 and HN12 for nuts on crank
Order Nos. 60680 and 60681

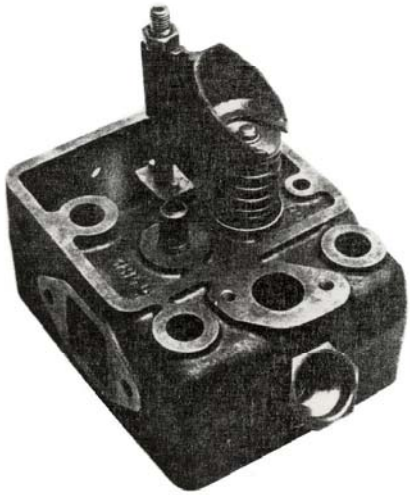
Tools for removing and fitting of main bearings
Order No. 000P2183

Lining-up tool for intermediate guard
(dial micrometer not included)
Order No. 009P2189



Puller for cylinder liner
Order No. 009P2235

Puller for flexible coupling
Order No. T 41069



Tools for removal of valve springs
Order No. 009P3115

Dial micrometer with magnetic holder.
For use in adjusting spill point and lining-up of intermediate guard.
Order Nos. 009P3103 and 009P3104

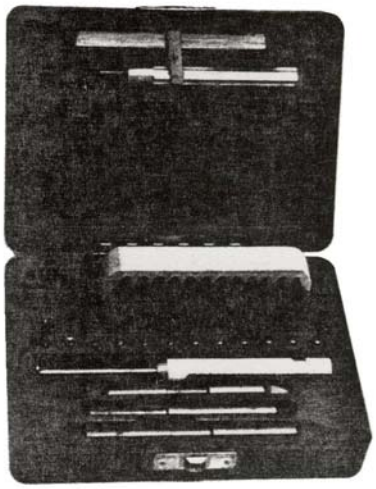
Pressure gauge for adjusting of spill point
Order No. 009P3102

Manometer compression gauge with special DV extension.
Order No. 529W0000

Extension
Order No. 000E2085

O-ring
Order No. 560H1015

Cleaning tool for nozzles
Order No. 009P3101



Testing set for fuel valves
Order No. 009P3100

Tachometer
Order No. 009P3106

SECTION B

TECHNICAL DATA

CONTENTS

TECHNICAL MAIN DATA		DV24
WORKING PRINCIPLE		4-STROKE
NUMBER OF CYLINDERS		2
CYLINDER BORE/STROKE		85 mm / 85 mm
SWEPT VOLUME		0.964 Litres
COMPRESSION RATIO		18,5:1
COMPRESSION PRESSURE	at 3600 rpm	47 Bar
OUTPUT, CONTINOUS RATING	at 2000 rpm	15.8 BHP - 11.7 kW
ACCORDING TO ISO 3046	at 2400 rpm	17.9 BHP - 13.2 kW
	at 3000 rpm	22.4 BHP - 16.5 kW
	at 3600 rpm	24.0 BHP - 17.7 kW
MAX. TORQUE		5.7 Kpm at 2000 rpm
MAX. AIR CONSUMPTION		1476 Litres/min
ENGINE ROTATING, LOOKING AT FLYWHEEL		CLOCWISE
IDLING SPEED		800 – 1000 RPM
MAX INCLINATION, FORE AND AFT		12°
HEEL, MAX. CONTINOUS		25°
ENGINE NET WEIGHT DV24M / DV24ME / DV24SME		200 kg / 210 kg / 220 kg
LOCATION OF ENGINE SERIAL NUMBER		PORT SIDE
EXHAUST TEMP. MAX/NORMAL		600°C – 580°C

VALVE TIMING AND INJECTION POINT		
FLYWHEEL DIAMETER		391 mm
INLET VALVE OPENS	BEFORE TDC	32° (arc measure: 109 mm)
INLET VALVE CLOSES	AFTER BDC	64° (arc measure: 218 mm)
EXHAUST VALVE OPENS	BEFORE BDC	64° (arc measure: 218 mm)
EXHAUST VALVE CLOSES	AFTER TDC	32° (arc measure: 109 mm)
VALVE CLEARANCES (COLD ENGINE) INLET/EXHAUST		0.25 / 0.30 mm

FUEL SYSTEM		DIRECT INJECTION
INJECTOR OPENING PRESSURE		184 Bar
INJECTION STARTS	BEFORE TDC	14,7°(arc measure: 50 mm)
FUEL LIFT PUMP		CAM SHAFT DRIVEN DIAPHRAGM PUMP
STATIC PRESSURE OF FUEL LIFT PUMP		350 mBar
FUEL FILTER		THROW AWAY FILTER INSERT
FUEL QUALITY GAS OIL		BS 2869 CLASS A

LUBRICATING SYSTEM		
TYPE OF LUBRICATING OIL PUMP		ROTARY VANE PUMP
LUBRICATING OIL PRESSURE: WARM ENGINE / MINIMUM		2-4.5 Bar / 1 Bar
LUBRICATING OIL QUALITY		SERVICE CC or CD
LUBRICATING OIL VISCOSITY	BELOW+5°C	SAE 10 or SAE 10W-30
	BETWEEN +5°c and +25°C	SAE 20 or SAE 15W-40
	ABOVE +25°C	SAE 30 or SAE 15W-40
LUBRICATING OIL CONTENT INCL. FILTER		3.5 Litres
LUBRICATING OIL FILTER		THROW AWAY FILTER INSERT

ZF MARINEGEAR	
LUBRICATING OIL QUALITY	API CC or CD, MILL-L-46152
LUBRICATING OIL VISCOSITY	SAE 30 or SAE 15W-40
LUBRICATING OIL TEMPERATURE	MAX. 120°C
LUBRICATING OIL CONTENT	1.1 Litres
STERN TUBE (FLEXIBLE) LUBRICANT	OUTBOARD GEAR OIL

SAIL DRIVE	
LUBRICATING OIL CONTENT	3.3 Litres
LUBRICATING OIL QUALITY	API CC or CD, MILL-L-46152

COOLING WATER SYSTEM - KEELCOOLING	
COOLING WATER TEMPERATURE	50 – 75°C
TYPE OF CIRCULATING PUMP/MAX. CAPACITY	CENTRIFUGAL / 11 Litres/min
PUMP BACK PRESSURE / SUCTION HEAD	Max. 6 m / Max. 3 m
COOLING WATER, DIRECT COOLING	3.25 Litres
COOLING WATER, HEAT EXCHANGER	4.80 Litres

ELECTRICAL SYSTEM	
BATTERY VOLTAGE/CAPACITY	12 Volt / 88Ah
STARTER TYPE / OUTPUT	GEAR DRIVEN 1 kW
ALTERNATOR TYPE / OUTPUT	BELT DRIVEN 700 W
ENGINE STOP	SOLENOID/MANUAL
RELAY	ELECTRONIC, BUILT-ON

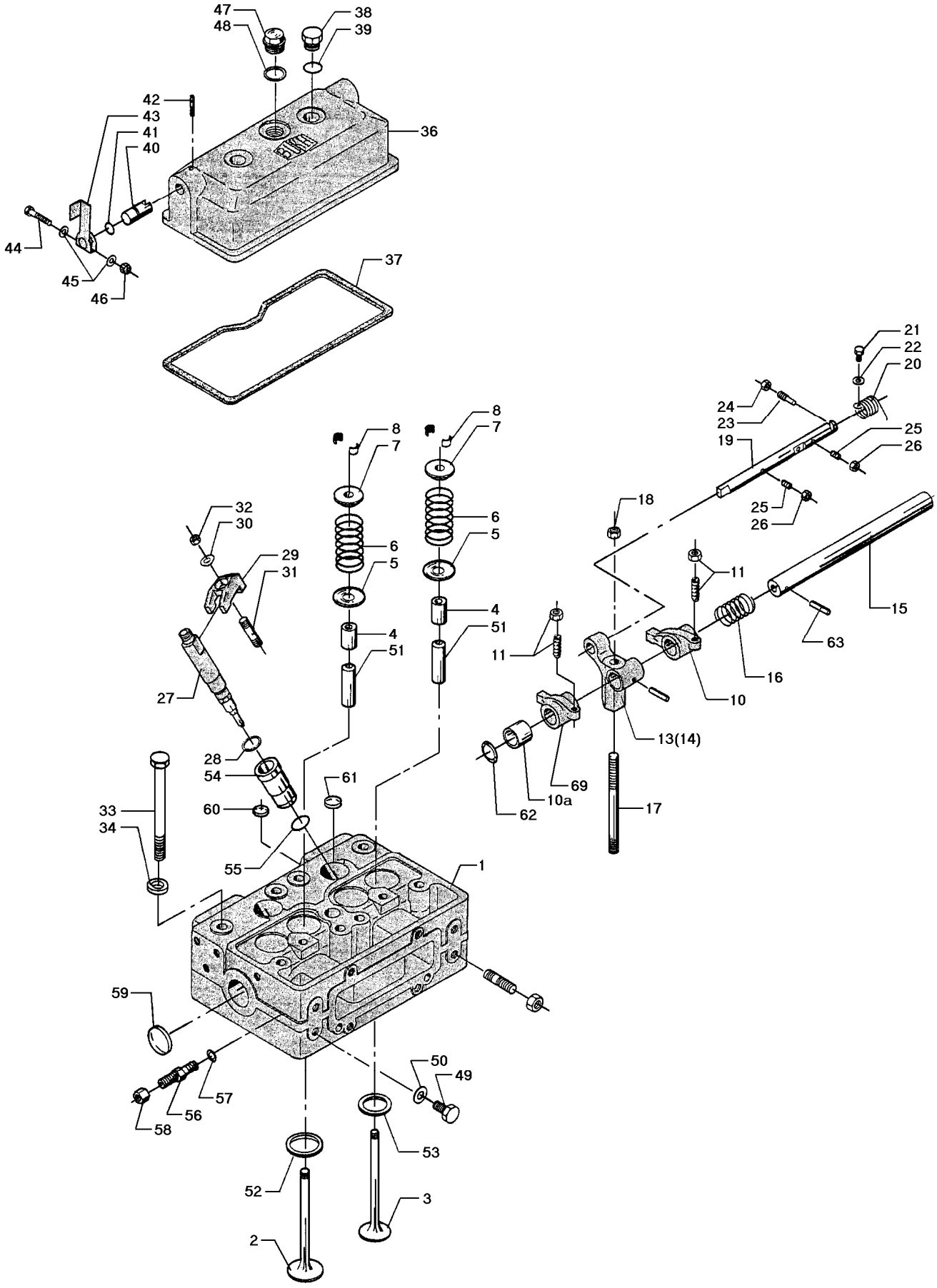
TORQUES	
CYLINDER HEAD BOLTS/BEARING TOP SECTION	118 +/- 5 Nm (12 +/- 0.5 Kpm)
CONNECTING ROD BOLTS	69 +/- 3 Nm (7 +/- 0.3 Kpm)
FLYWHEEL/COUNTERWEIGHTS	81 +/- 3 Nm (8.3 +/- 0.3 Kpm)
FLEX. COUPLING	61 +/- 3 Nm (6.3 +/- 0.3 Kpm)
ASSEMBLY OF FUEL VALVE	59 +/- 3 Nm (6.0 +/- 0.3 Kpm)
BRACKET FOR ENGINE SUPPORTS	69 +/- 3 Nm (7 +/- 0.3 Kpm)
BRACKET FOR GEAR SUPPORTS	39 +/- 3 Nm (4 +/- 0.3 Kpm)
ZF- GEARBOX	25 +/- 5 Nm (2.5 +/- 0.5 Kpm)

SECTION C

CYLINDER HEAD

CONTENTS

Exploded view of cylinder head

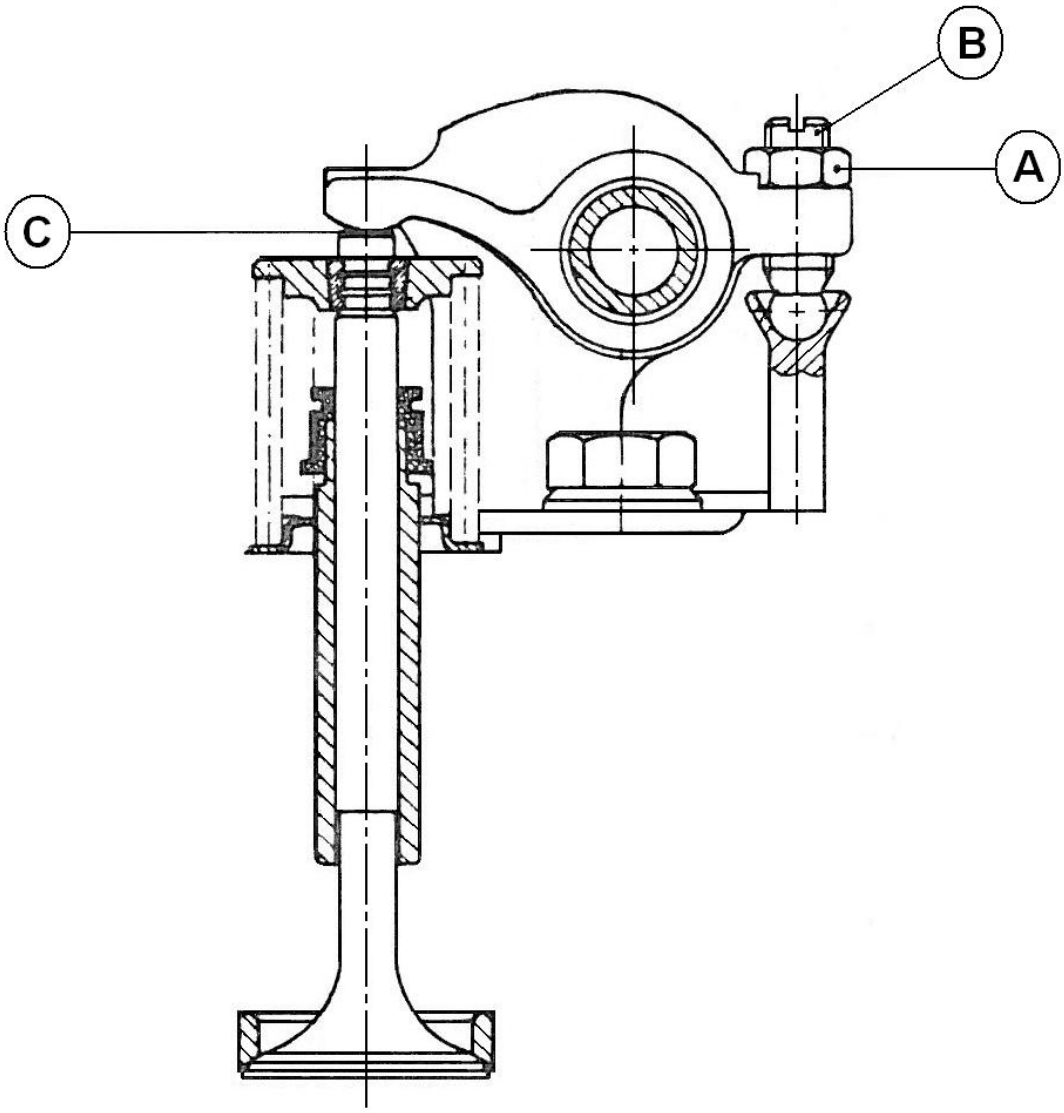


Valve adjustment

The clearance of the inlet and exhaust valves should be adjusted at **0.3 mm** for the exhaust valve and **0.25 mm** for the inlet valve when the engine is **cold** and the clearance of the valves should always be checked after ti ghtening-up of the cylinder head. The valves are adjusted when the pistons are alternately at their highest point in the working stroke.

Adjust the valves by loosening the counter nut **A** which makes it possible to adjust the clearance by means of the adjusting screw **B**.

Measure the clearance with a feeler gauge at **C**.



Removal and refitment of cylinder head

1. Drain off the cooling water.
2. Remove the top cover.
3. Remove valve rocker arms.
4. remove the inlet and return pipes of the fuel valves.
5. Remove the charging alternator.
6. Remove the exhaust and inlet manifold.
7. Loosen the top bolts, after which the cylinder head can be lifted out of the engine block.
8. Refitment of the cylinder head is made in reverse order and the bolts are tightened evenly at a torque of **120±3 Nm (12±0.3 kpm)**.

Replacement of rocker arm or rocker shaft

For each cylinder, a rocker arm column wit h two rocker arms for inlet valve and exhaust valve, respectively, is fitted on a common shaft with corresponding rocker arm columns and rocker arms for the other cylinder.

1. Remove the top cover.
2. Unscrew the central nuts on the rocker arm columns.
3. Lift off the shaft arrangement.
4. Knock out the tube pin and washer in one of the shaft ends.
5. Then the rocker arms and the intermediate springs can be taken out.

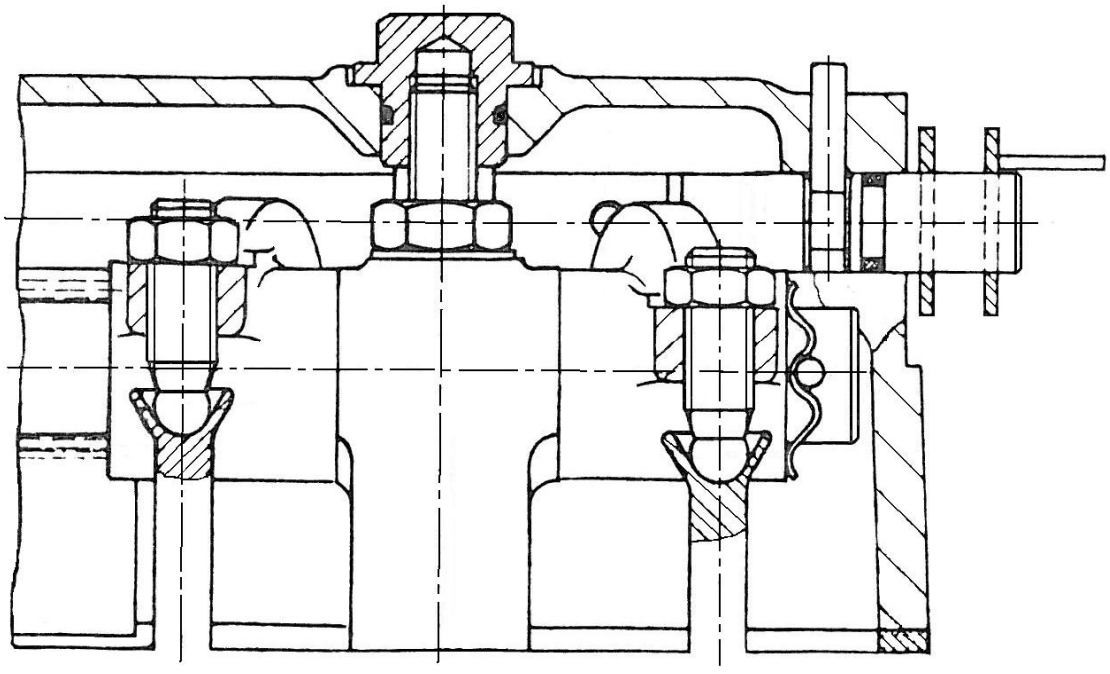
Reassembly is a reversal of the dismantling procedure.

Adjustment of valve lifter arrangement

Furthermore, a common shaft for decompression is fitted on the three rocker arm columns.
For a possible removal of the shaft, remove first the pins going down on the rocker arms at decompression, after which the shaft can be pulled out.

When adjusting, adjust the pins so that you faintly see a single groove of the pin thread (about 1.5 mm free pin) just on the side facing the rocker arms.

When fitting the top cover, ensure that the slot in the decompression handle in the top cover mesh with the corresponding pin on the decompression shaft.



Replacement of rocker arm bushing

1. Remove the rocker arm as indicated on page C6 and check it as to wear and tear as well as fracture.

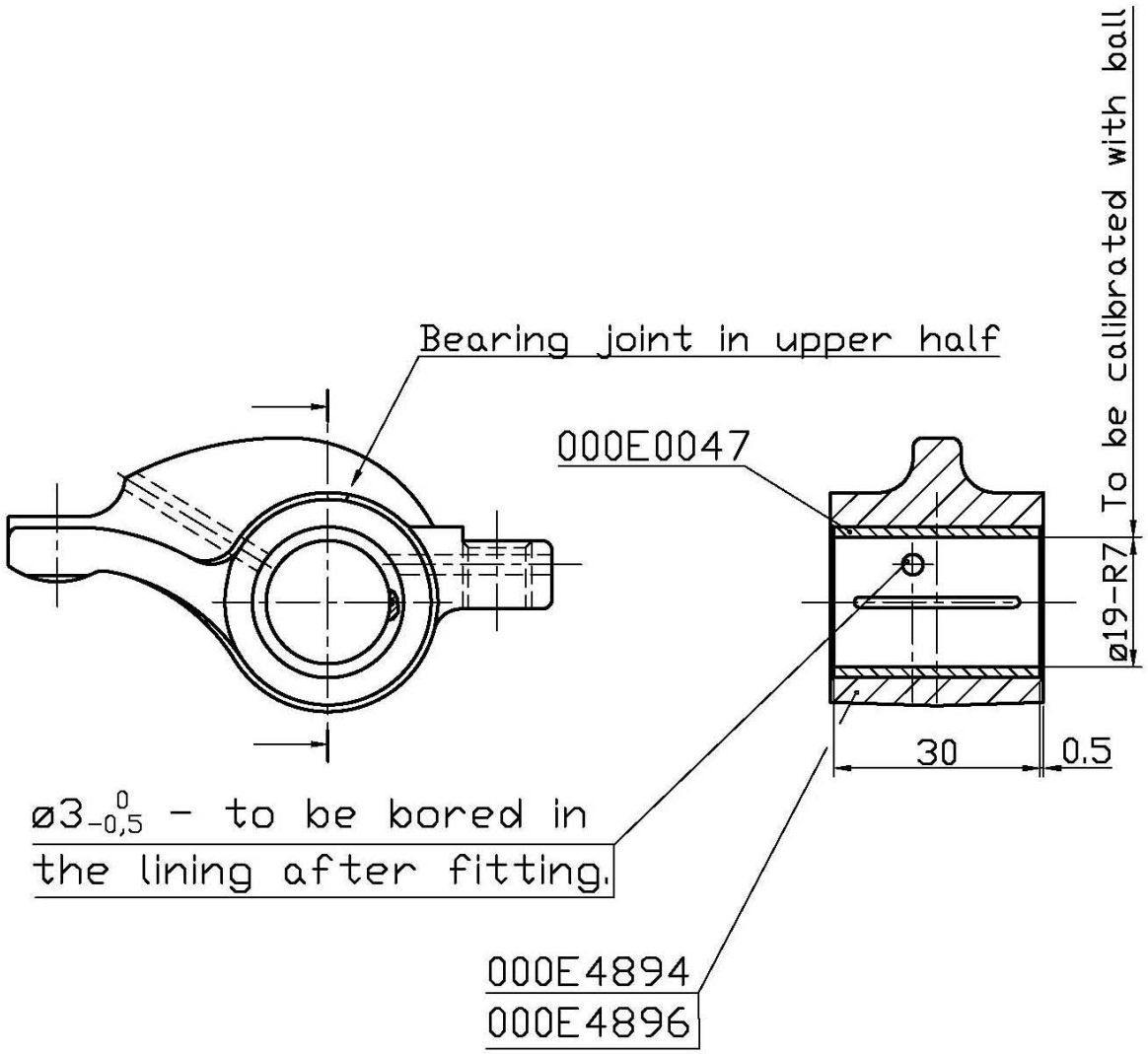
2. Press out the defective bushing with an adequate tool.

3. Fit the new bushing as shown below paying special attention to the position of the bearing joint and the oil grooves.

4. When fitted, calibrate the bearing bush so that the tolerance ø19-R7 is observed. Do this either with a calibration ball or with a reamer having the mentioned tolerance.

5. After refitting the rocker arm, check the axial play with a feeler gauge. The axial play may be 0.1 – 0.2 mm.

6. Finish refitting the rocker arm arrangement.



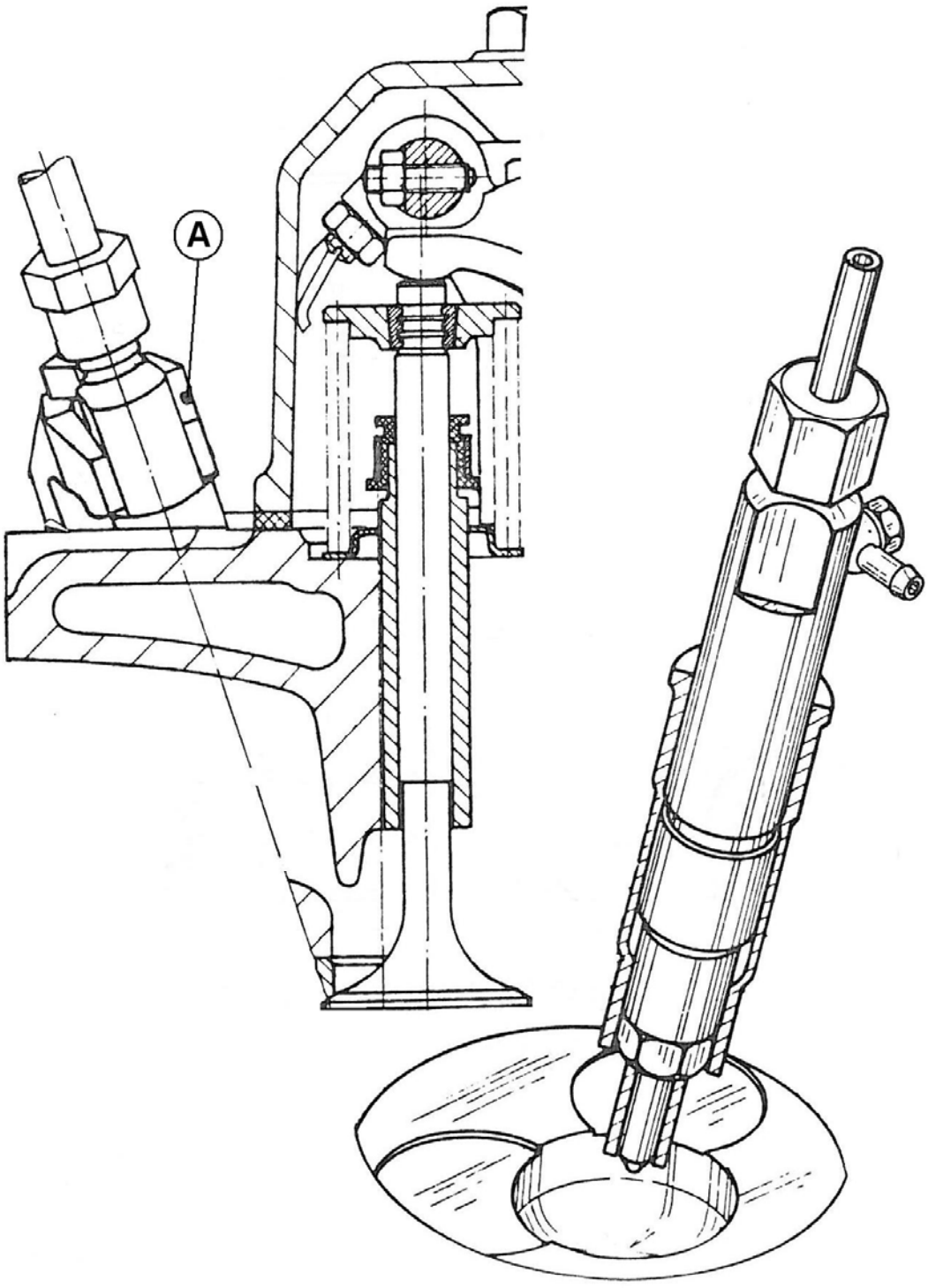
drwg. No. 008E4893

Removal of fuel valves

The fuel valves are removed by loosening the clamping nuts for the flanges **A** as indicated on the sketch below after removal of the inlet and return pipes of the fuel valves.

The drawing at the bottom right-hand side indicates the placing of the fuel valve in proportion to the piston.

For repair of the fuel valves, we refer to section H.



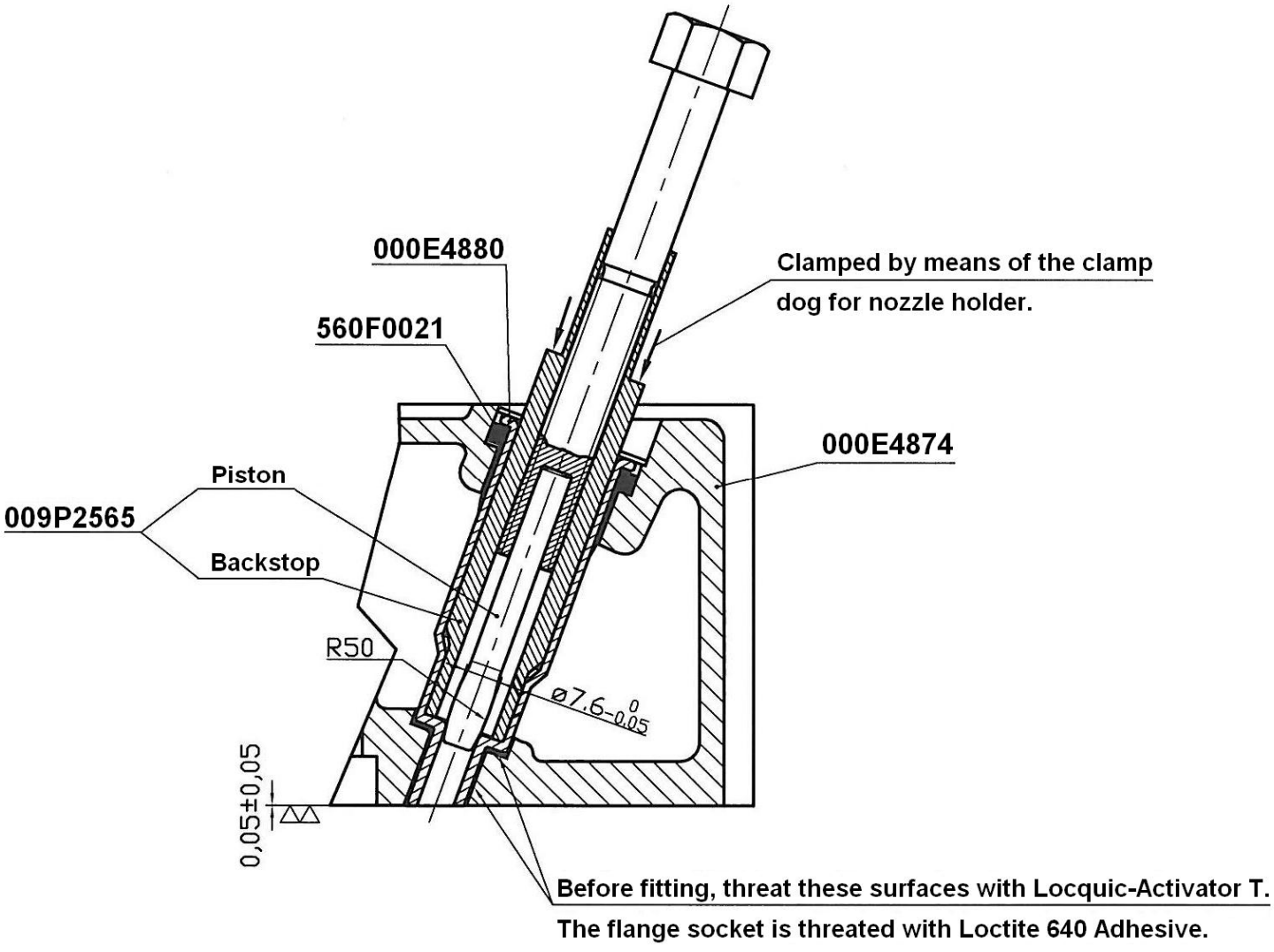
Nozzle holder insert

The nozzle holder inserts are placed in the cylinder head and form – a the name indicates – an insert for the placing of the fuel valves in the cylinder head.

The nozzle holder inserts can be replaced, which demands that the special tools below for flanging (piston and backstop) are used and that the surfaces are treated as indicated on the drawing.

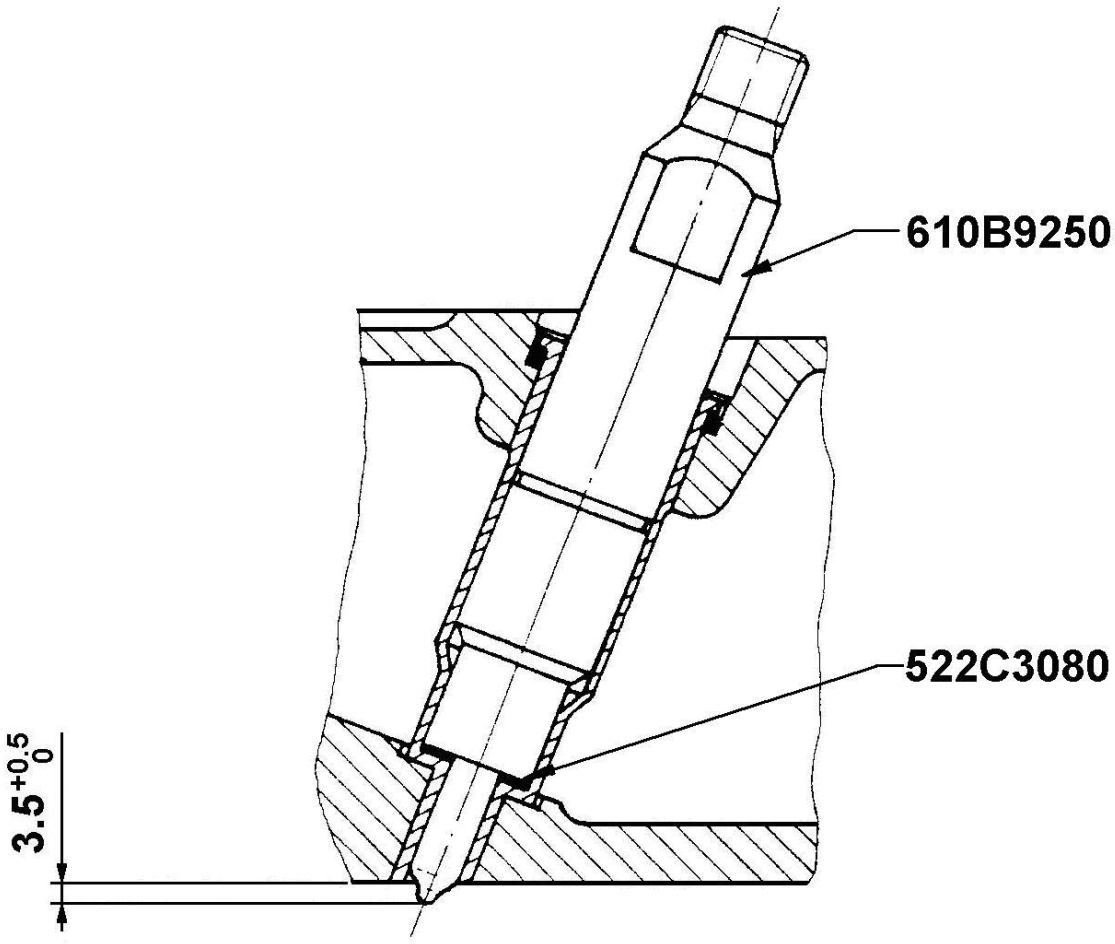
Remove the old nozzle holder inserts by boring-up the flanged end of the nozzle holder inserts with a ø8 – ø9 mm drill, and then knock out the nozzle holder inserts with a 10 mm punch.

After having fitted the new nozzle holder inserts, test the cylinder head for pressure with water in order to check the flanged seals.



drwg. No. 008E4881

Fitting measurements for the fuel nozzle into insert.



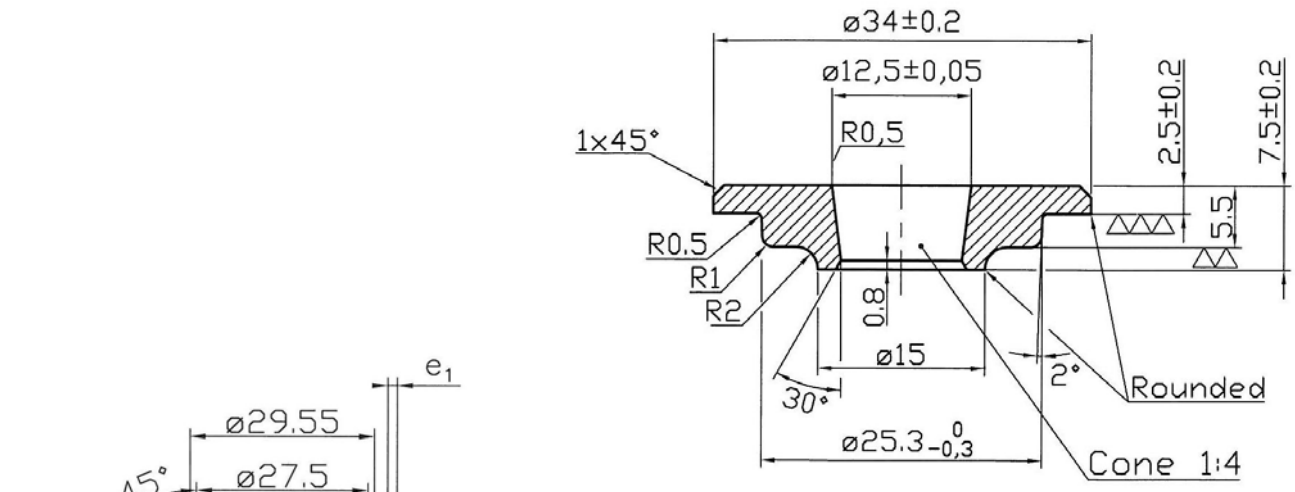
Valve springs

Four identical springs for inlet and exhaust valves, respectively, are fitted in the cylinder head.
The springs are identical in both ends, and therefore fitting up or down is of no importance.

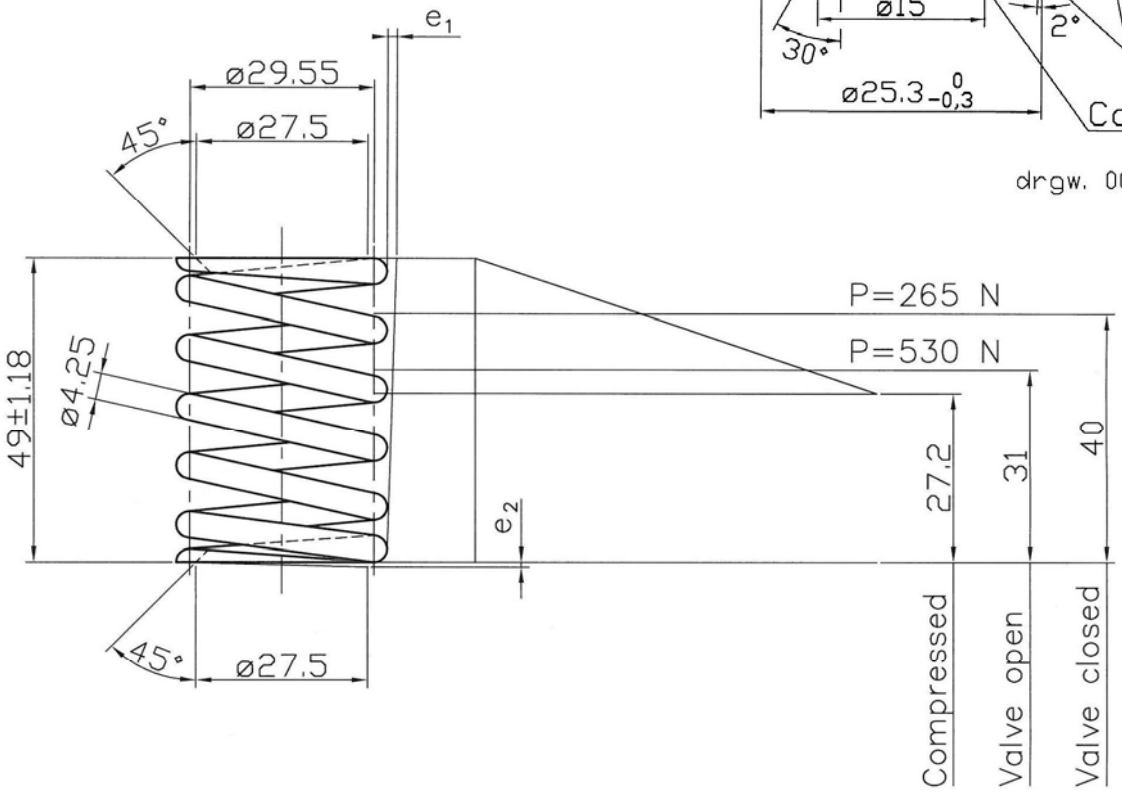
The springs are locked in their position in proportion to the valve stems by means of two conical halves for each valve spring and guided by a guide for valve spring and a corresponding disc, respectively.

The valve springs are removed by compressi ng the valve springs and removing the c onical locking halves with s pecial tools or the like so the valves are cut off fro m following the movement of the springs.

When refitting the valve springs, make sure t hat the conical loc king halves are correctly placed in their trace on the va lve stems. This can be done by knocking gently with a plastic hammer on top of the valve stem while the cylinde r head is lifted from t he file bench so that the valve heads can move so as to be clear of the valve seats.



drgw. 000E5014



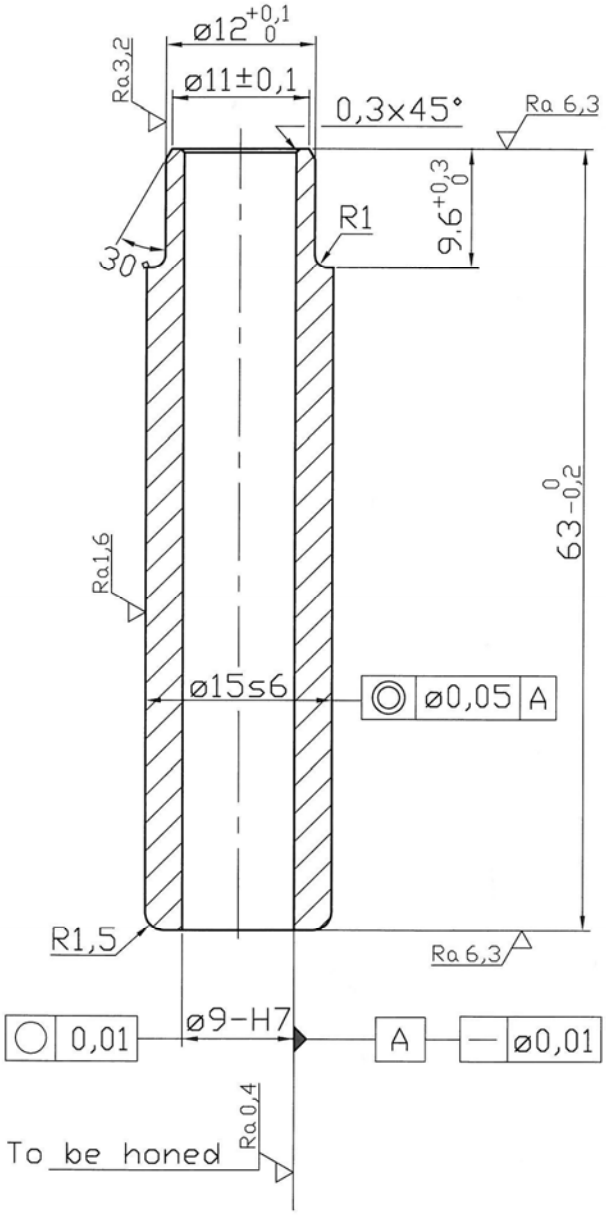
drwg. 000E4891

Replacement of valve guides

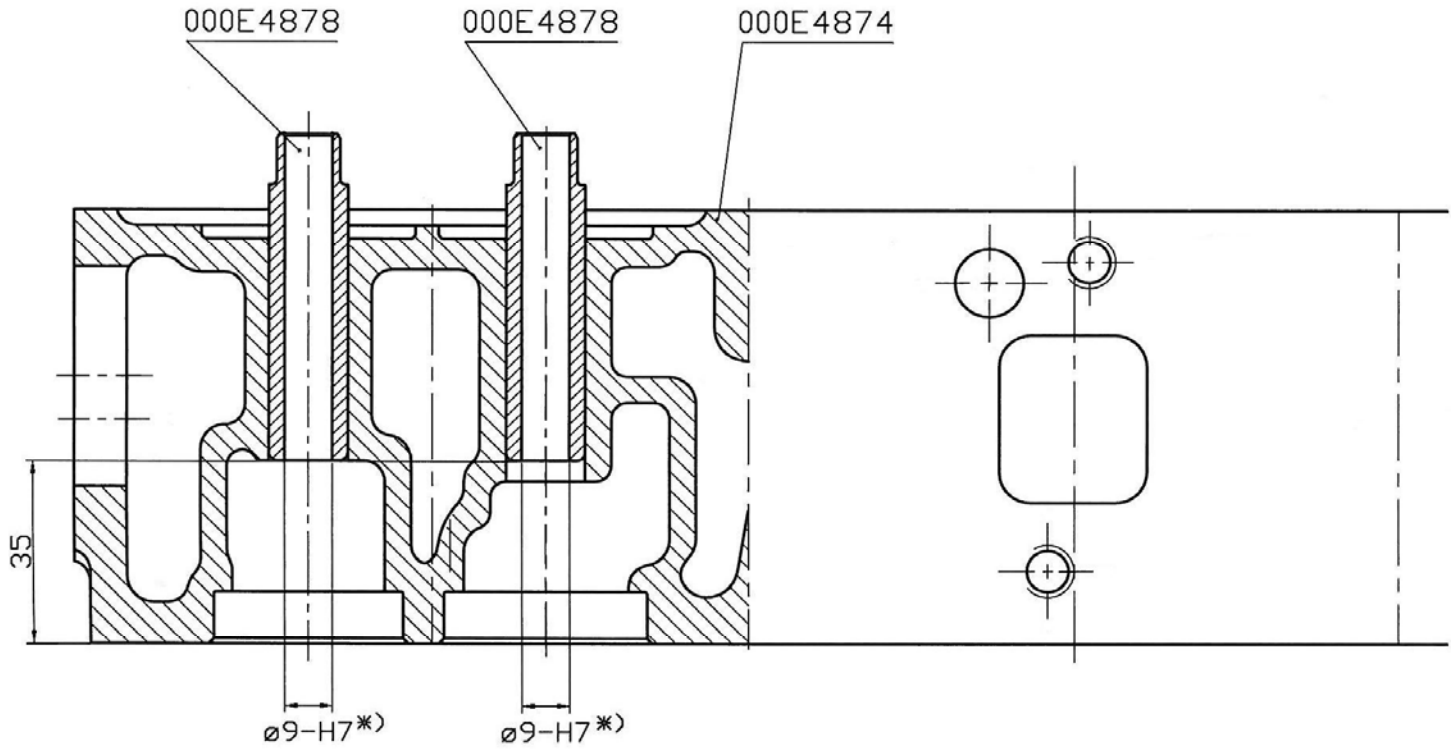
Replace the valve guides whic h are pressed into the cylinder head if the tolerance is exceeded because of wear and tear by 0.05 mm. Check the measure with a ø9 – H7 internal gauge according to the drawing below of the valve guide.

Fit new valve guides according to the drawing on page C13. Before fitment, heat the cylinder head in an oven or heat it in boiling water and cool down t he valve guides in a deep freezer or otherwise.

After fitment of new valve guides, broach the bore of the valve guides with a broach in order to remove possible ups ettings from the fitti ng. Use a broach ø 9 – H7 for the broaching.



Pressing-in dimensions for valve guide.



*) The valve guides tolerance after fitting

drgw.no. 008E4879

Valve guide stuffing box

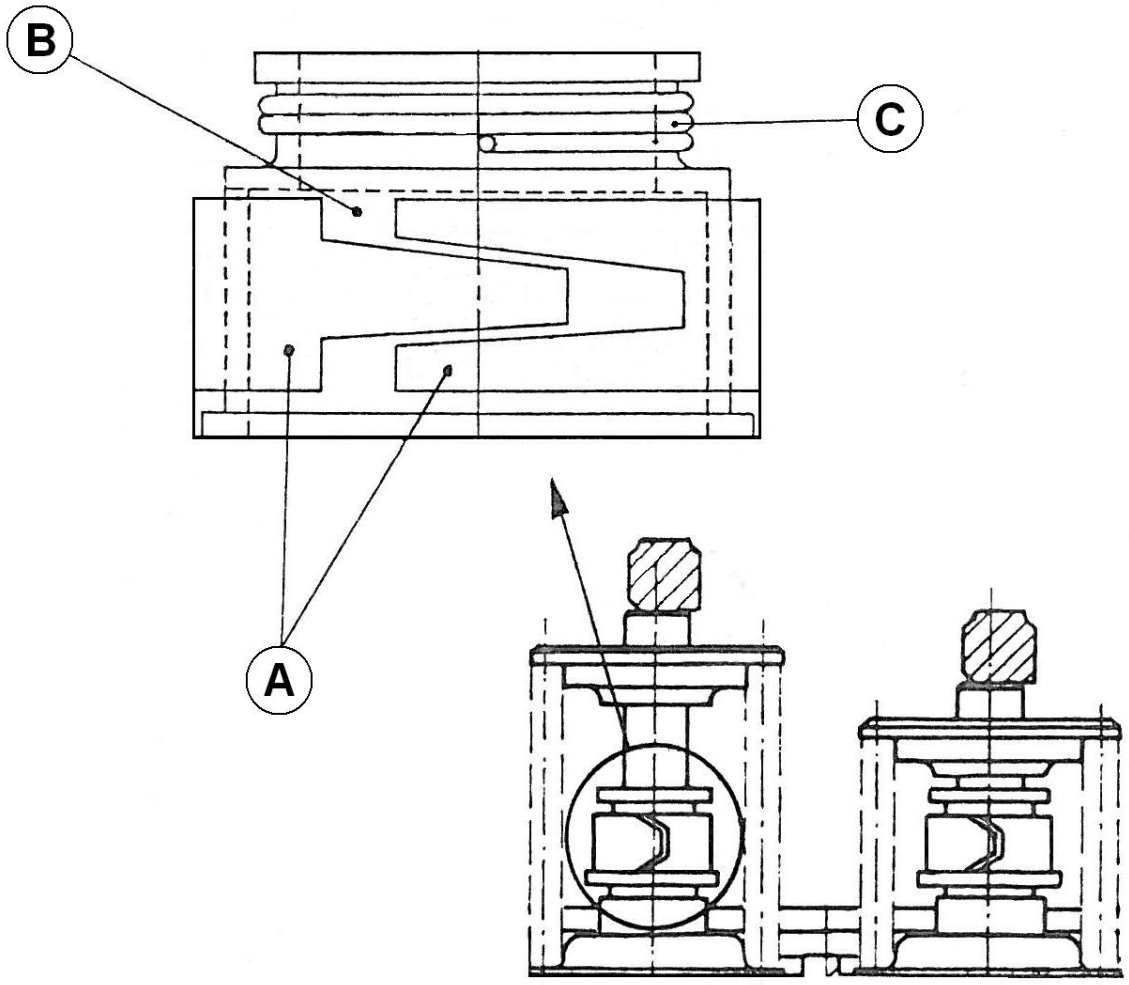
In order to avoid lubricating oil consumption because of lubricating oil passing between valve guide and valve stem causing the valves to be burnt or to be carbonized, a stuffing box has been mounted on the upper end of the valve guides.

The stuffing box is as shown schematically on the drawing below and consists of:

A: Metal spring coat
B: Plastic bushing
C: Spring wire

The stuffing box compensates for wear and tear of the valve guides so that the lubricating oil consumption because of leaky valve guides is reduced to a minimum.

The stuffing box cannot be repaired but has to be replaced if necessary.



Repair or replacement of inlet and exhaust valves

1. Remove the cylinder head from the engine (page C5).

2. Then place the cylinder head on a file bench or the like with the valve seats at the bottom.

3. Compress the valve springs with a special tool or the like and remove the conical valve locking halves.

4. Then place the cylinder head upright and remove the valves from the cylinder head.

Refitment is a reversal of removal procedure.
Note! Refit the valves in the same valve guides again.

Replace the valves if they are so damaged that a refacing with special tools and subsequent grinding are impossible without exceeding the tolerances indicated on page C18 and C19.

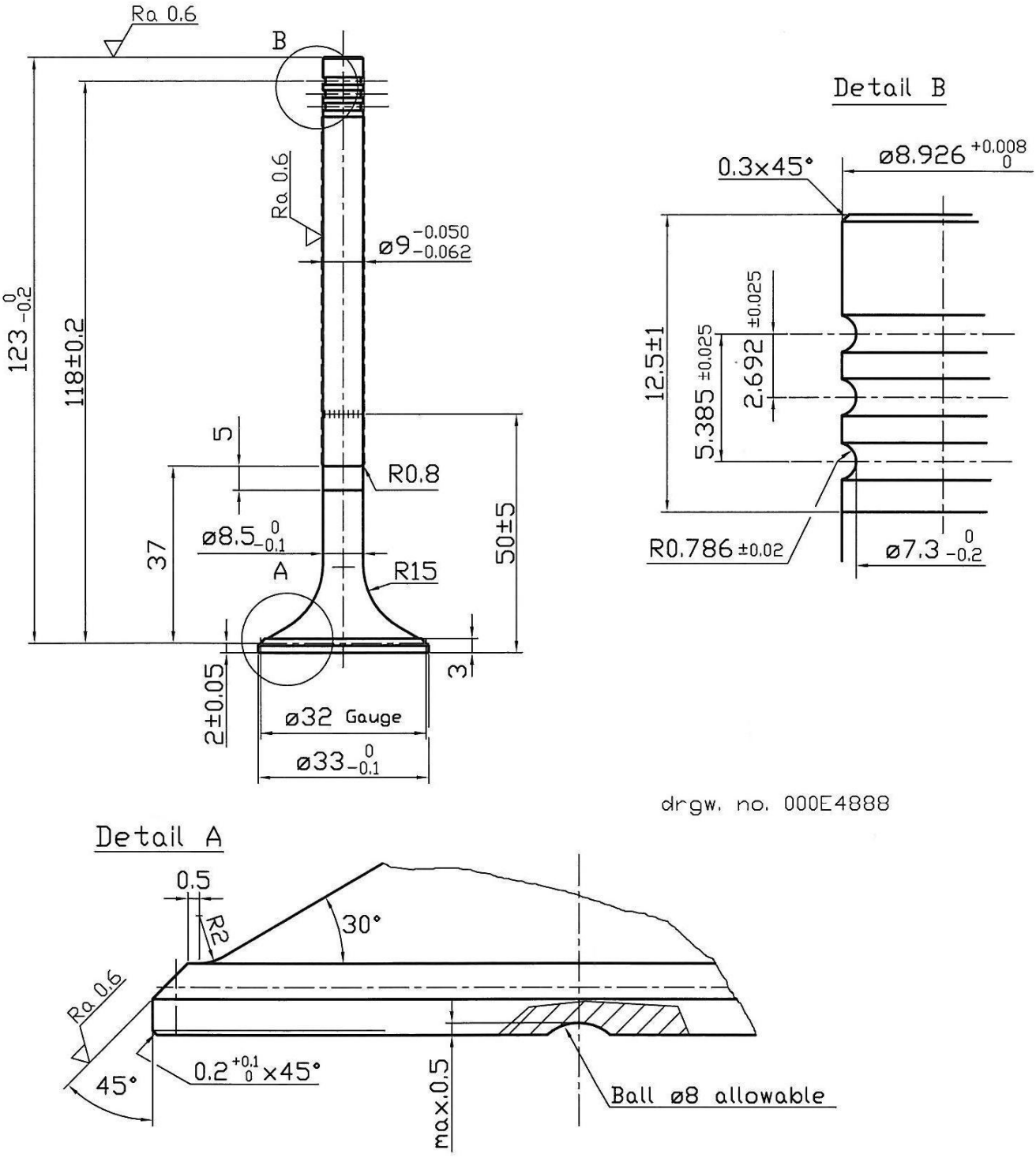
A refacing of the valve seats with fixed guide should always be made if the valve does not function satisfactorily.

After replacement of valve or valve seat, grind together with abrasive compound seat and valve so that total tightness is obtained. It is an indispensable condition for the compression of the engine that this work is performed carefully.

Grinding of valves is made as described on page C18.

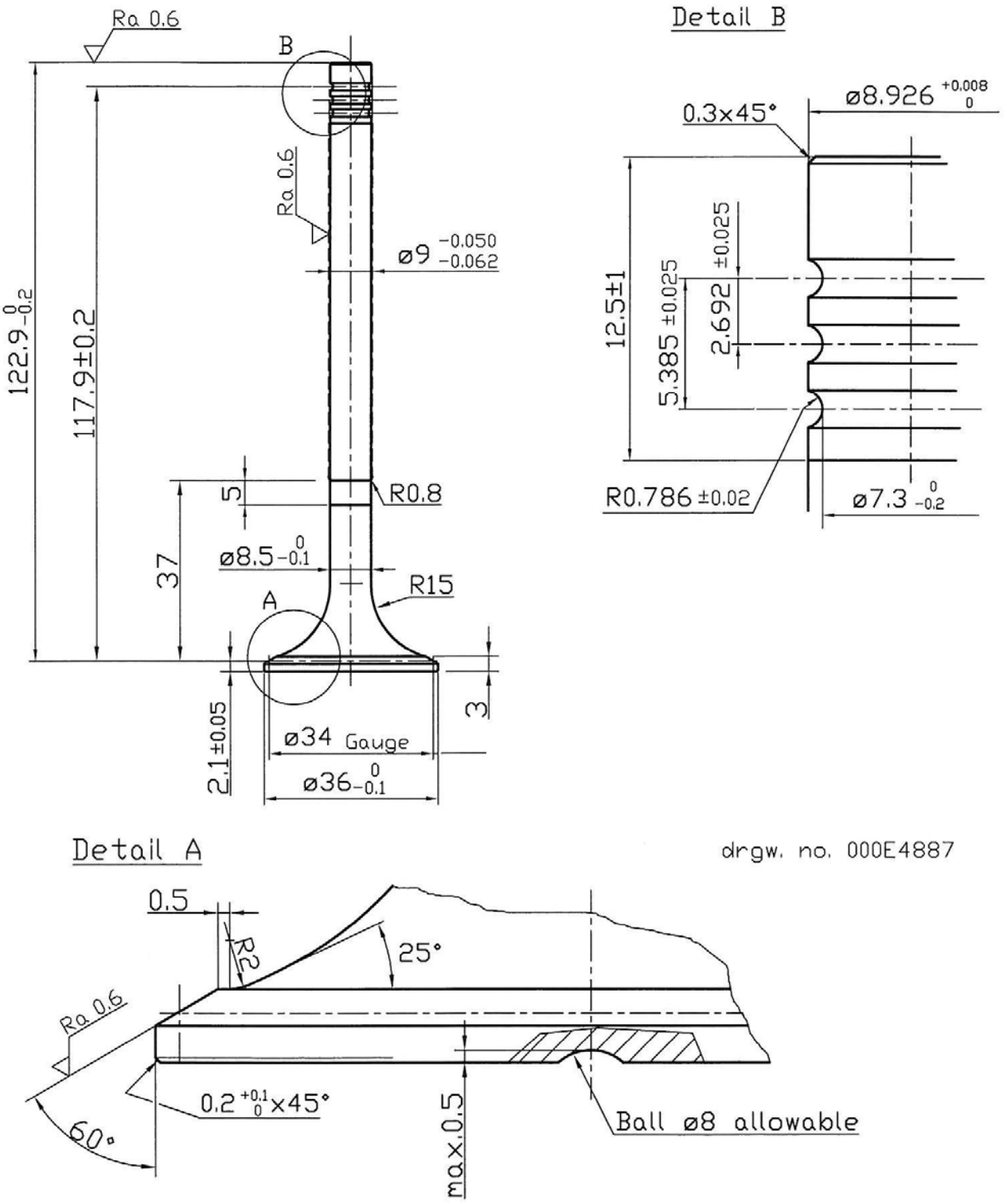
Exhaust valve

Tolerances and repair measures.



Inlet valve

Tolerances and repair measures.



Grinding of valves

1. Place the cylinder head with the valve seats upwards. Block the cylinder head so that the valves fit tightly against the seats and can be turned freely by means of a rubber suction disc or the like.

2. Apply abrasive compound to valve and seat, after which grinding can take place.

3. When grinding, turn the valve by means of the rubber suction disc in various directions while fitting it at the same time with an equal pressure against the seat. When grinding, lift frequently the valve and spread all over the seat the abrasive compound applied.

4. You can check whether the valve is tight by cleaning off the abrasive compound carefully by for example cleaning liquid. Then make 4 pencil marks staggered 90 degrees from each other on the contact face of the valve. Insert the valve and turn it about 20 degrees. If the valve is tight, the marks will have disappeared.

5. Before refitment in the cylinder head, clean the valve carefully for abrasive compound and apply a thin coat of oil to it. Do the same with regard to the valve seat.

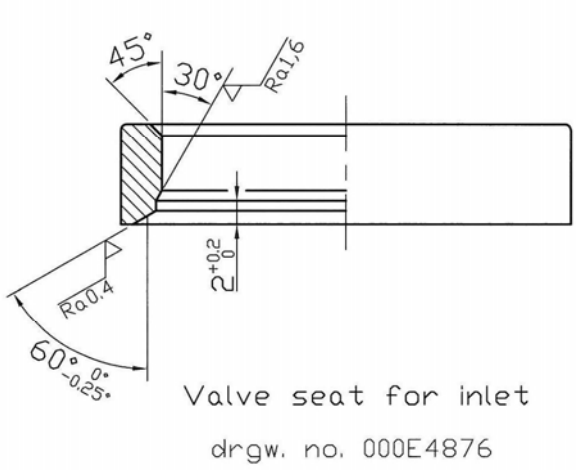
Measures for new valves

Valve stem diameter ..... ø9 $^{-0.050 / -0.062}$

Valve guide bore ..... ø9 – H7

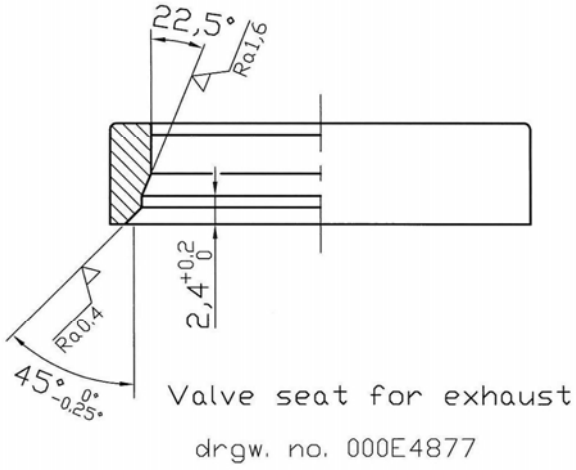
Clearance between valve stem and valve guide ..... 0.050 – 0.077 mm

The valve stems have been specially treated and therefore they must not be ground.



Valve seat for inlet

drgw. no. 000E4876



Valve seat for exhaust

drgw. no. 000E4877

Replacement of valve seats

The valve seat rings should be replaced when, after repeated millings and grindings, they have been milled so far down that the valve heads are more than 0.3 mm below the face of joint of the cylinder head (see the sketch below).

1. Remove the valve springs and valves as indicated previously in this section.

2. Place a lead plate or an annealed copper plate between the cylinder head and a bent chisel and knock out the valve seat ring with this (crowbar principle) by sticking one end of the chisel under the rear edge of the valve seat ring.

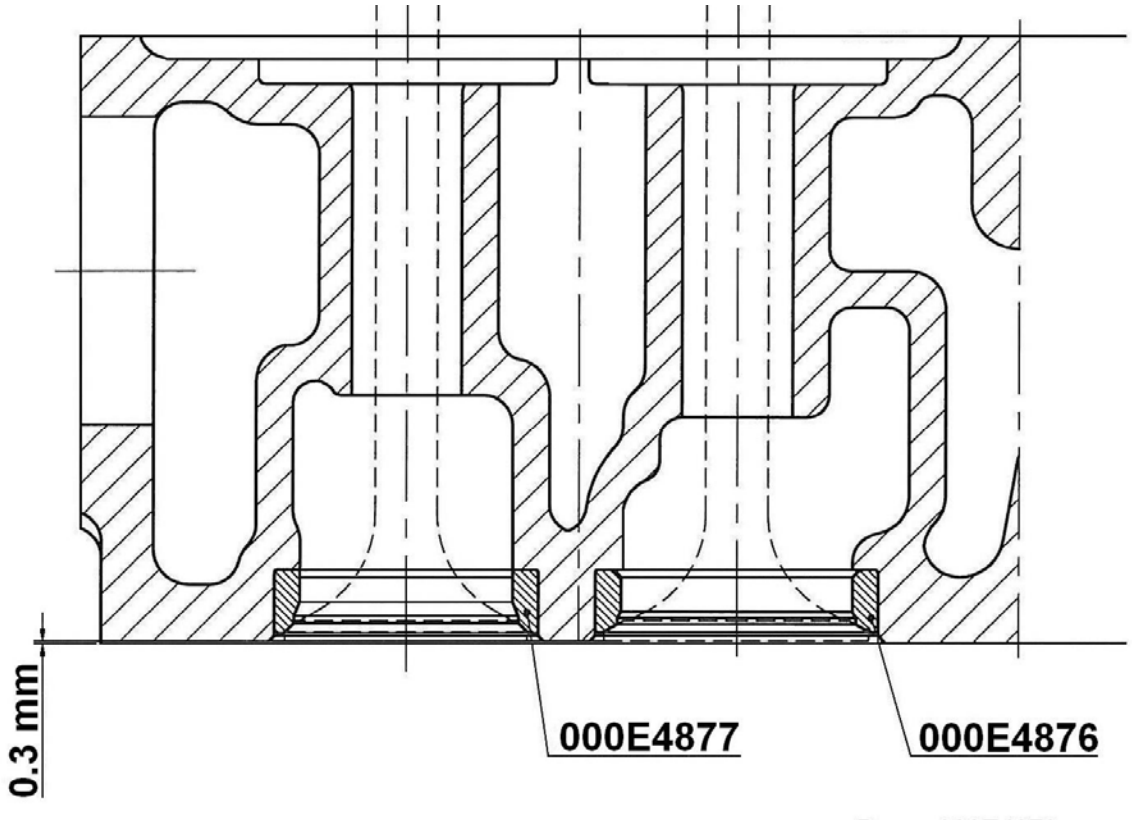
IT IS IMPORTANT THAT THE FILLING PIECE IS USED BETWEEN CYLINDER HEAD AND CHISEL IN ORDER TO AVOID DAMAGING THE CYLINDER HEAD.

Before fitting new valve seat rings, clean the bores in the cylinder head for same and check that the holes are not oval.

Then warm up the cylinder head in hot water to about 100° C (212° F), after which fit, by means of a punch, the valve seat rings having been cooled down beforehand in nitrogen or carbon dioxide.

When fitting the valve seat rings, the difference of temperature between cylinder head and valve seat ring is to be 220 – 250° C (430 – 480° F).

DO NOT KNOCK IN THE VALVE SEAT RING VIOLENTLY. ONLY ACTIVATE THE PUNCH WITH A RATHER GENTLE BLOW IN ORDER TO FIT THE VALVE SEAT RING.



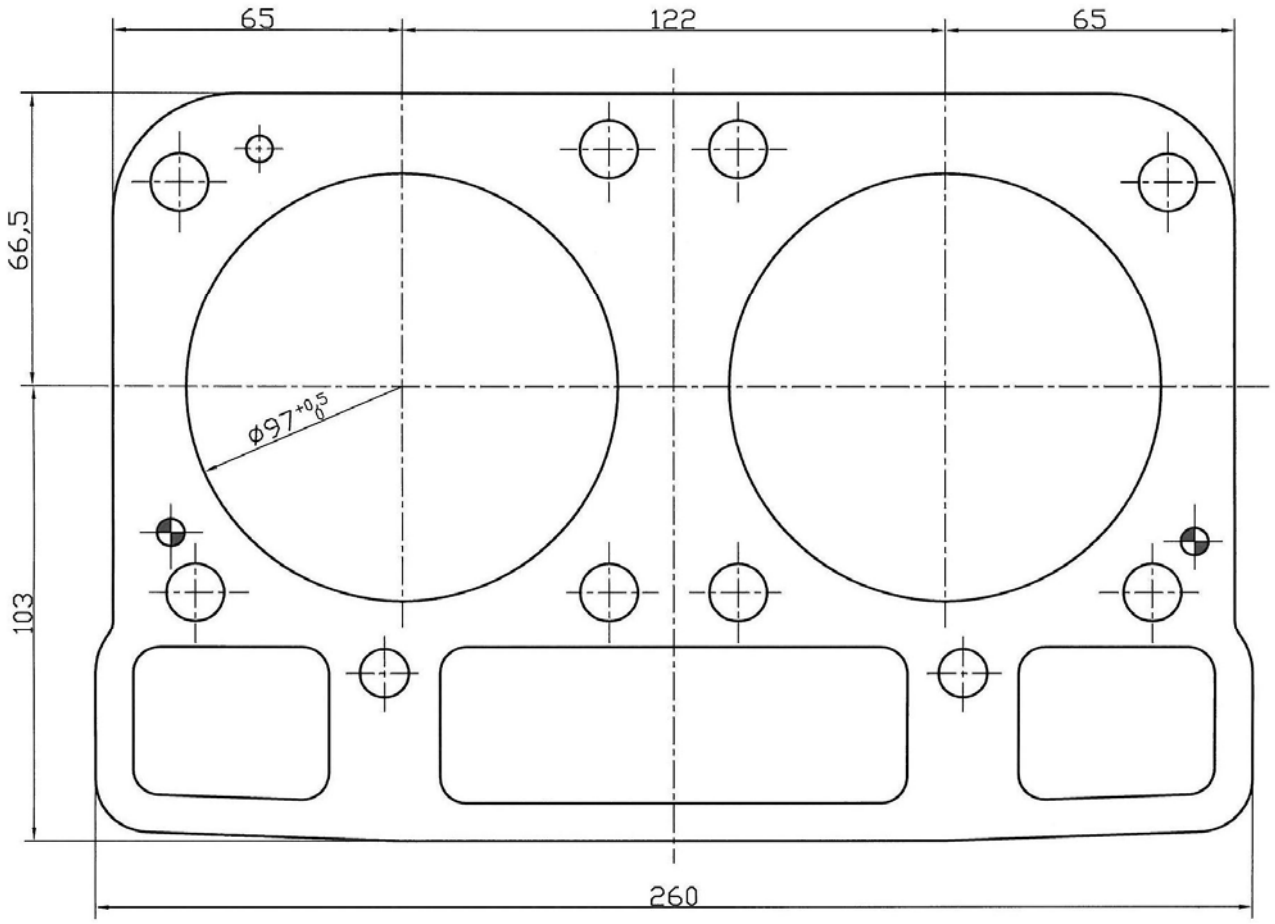
Drgw. 008E4873

Cylinder head gasket

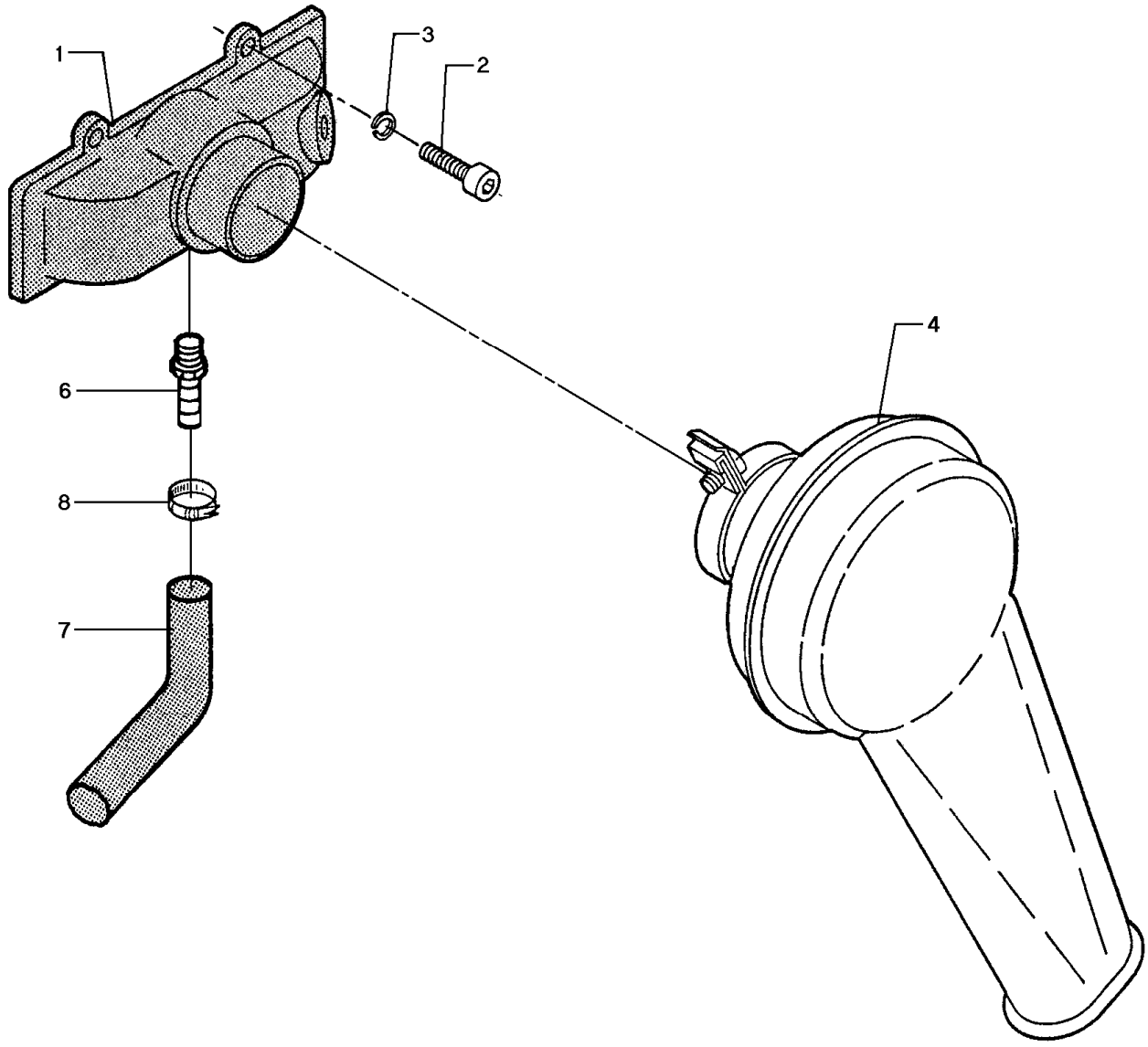
The cylinder head gasket is made from “Grafos eal” (Asbestos free) which is an expanded graphite which is strengthened with a special 0.2 mm carbon steel inlay.

When replacing the cylinder head gasket, t he grooves in the cylinder head must be completely clean to obtain tightness.

If the cylinder head has been removed several time s, the metal around the studs may have risen which can be checked by m eans of a straight-edge. If the me tal has risen, it must be planned.

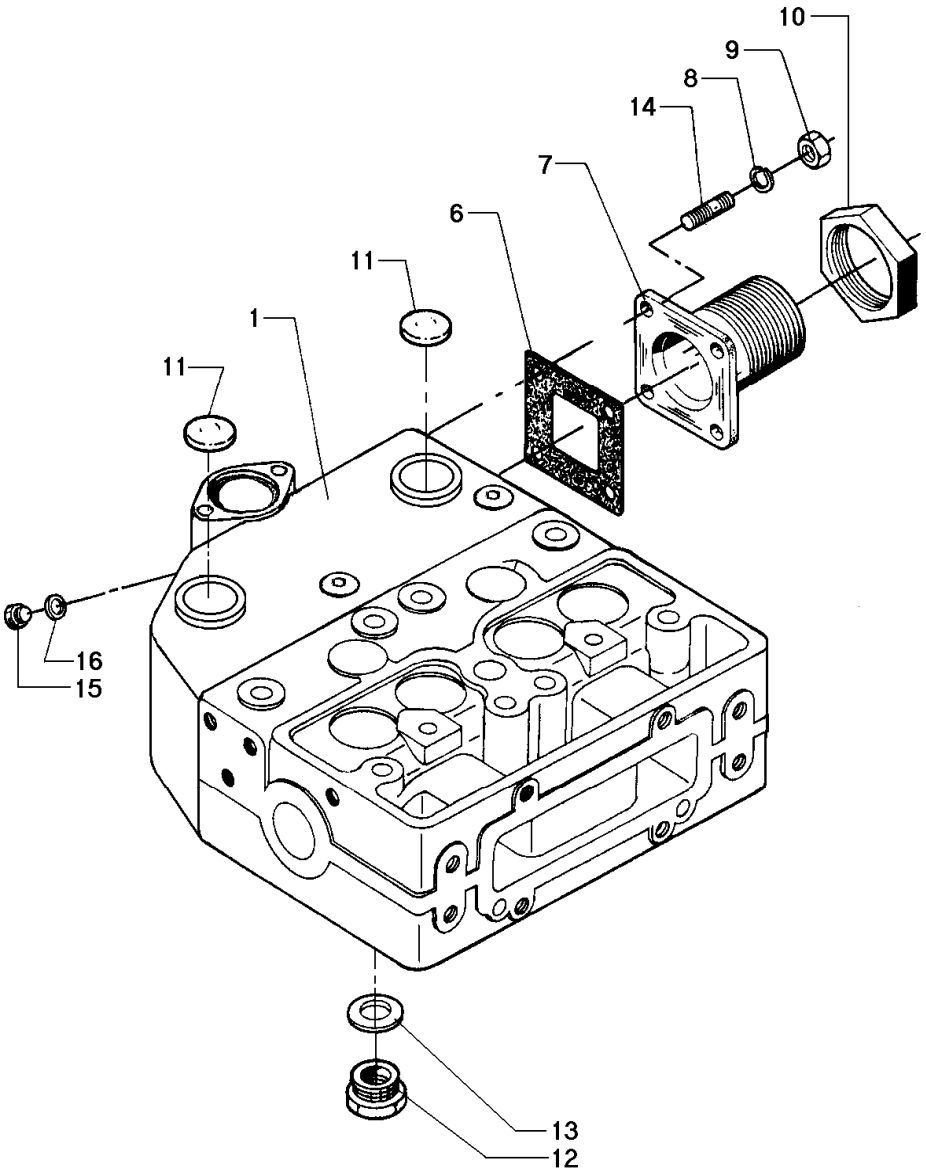


Air inlet manifold arrangement.



Pos.	Part No.	Qty.	Beskrivelse	Description	Benennung
1	000E7672	1	Indsugningsstuds	Inlet pipe branch	Einlasstutzen
2	501A2363	4	Cylinderskrue	Unbraco screw	Unbracoschraube
3	522F1020	4	Fjederskive	Spring washer	Federscheibe
4	008E7310	1	Luftfilter	Air filter	Luftfilter
6	532V0040	1	Slangenippel	Nipple	Nippel
7	530P0008	1	Slange, 35 cm	Hose, 35 cm	Schlauch, 35 cm
8	569A0010	2	Spændebånd	Clamping ring	Klemmband

Exhaust manifold arrangement.



Pos.	Part No.	Qty.	Beskrivelse	Description	Benennung
1	008E9522	1	Cylinderdæksel, komplet med ventiler	Cylinder head, complete with valves	Zylinderkopf, Komplett mit Ventilen
6	000D9762	1	Pakning for udstødning	Nipple	Nippel
7	008E2484	1	Udstødningsstuds	Hose, 35 cm	Schlauch, 35 cm
8	522F1020	4	Fjederskive	Spring washer	Federscheibe
9	510A3208	4	Møtrik	Nut	Mutter
10	510B2454	1	Kontramøtrik	Counter nut	Gegenmutter
11	539A0168	2	Slutdæksel, ø28	Expansion disc, ø28	Verschlussdeckel, ø28
12	504E1120	1	Prop, 3/4" RG	Plug, 3/4" BSP	Pfropfen, 3/4" RG
13	522C3044	1	Pakning, kobber	Gasket, copper	Dichtung, Kupfer
14	503N2363	4	Tapskrue	Stud	Stiftschraube
15	009R2012	1	Prop, 3/8" RG	Plug, 3/8" BSP	Pfropfen, 3/8" RG
16	522C3025	1	Pakning, kobber	Gasket, copper	Dichtung, Kupfer

SECTION D

FLYWHEEL

CONTENTS

Removal and refitment of flywheel

1. Mark the flywheel in proportion to the crankshaft out of consideration for the other marking of the outer diameter of the flywheel.
2. Slacken the V-belt for the charging alternator and take it clear of the V-belt pulley of the flywheel.
3. Remove the six bolts securing the flywheel to the crankshaft.
4. Lift off the flywheel.

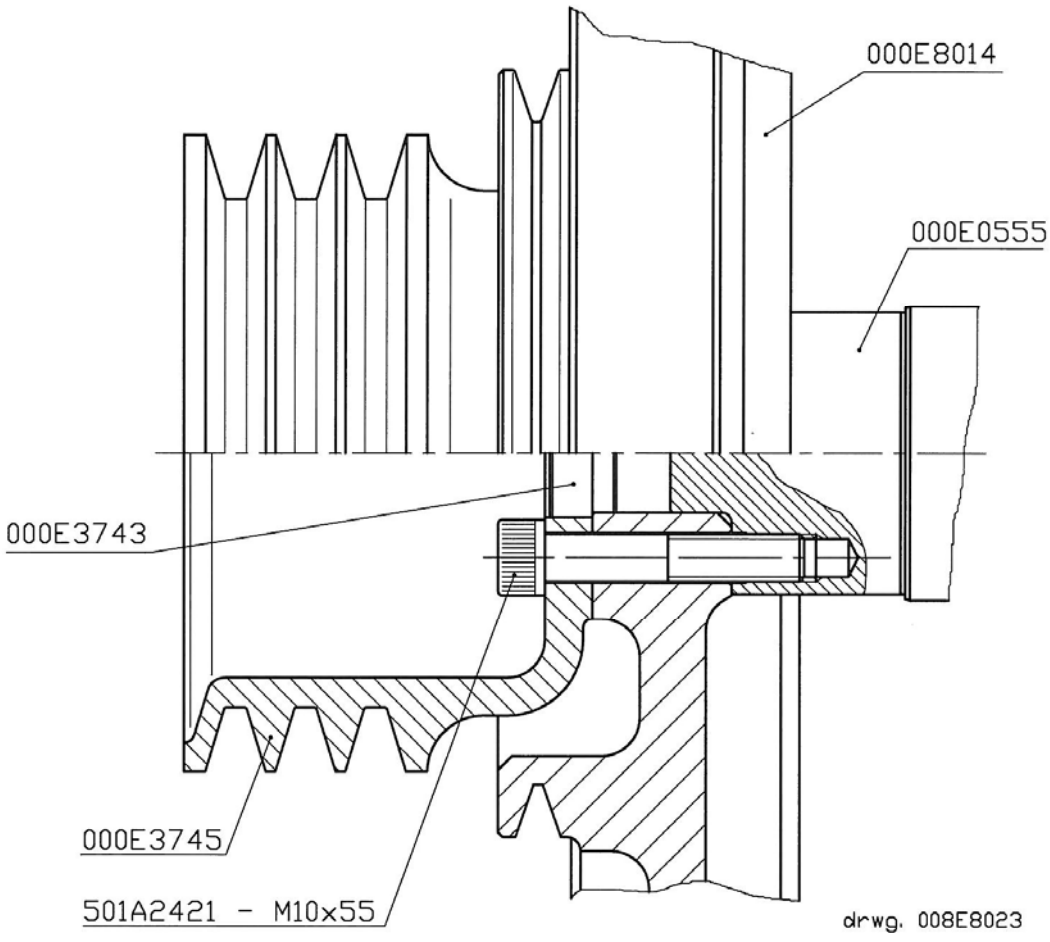
Refitment is to be carried out in reverse order. Smear the bolts with some Loctite or something similar and tighten them with a torque of 81±3 Nm (8.3±0.3 kpm).

V-belt pulley fitted on flywheel.

A V-belt pulley, as indicated on the drawing below, is fitted on the front end of the flywheel. As optional a V-belt pulley with three "A" grooves and diameter 125 mm can be added for operation of e.g. bilge pump, winch or the like. However, only max. 10 HP must be loaded from the front of the engine.

When a pulley is fitted on the flywheel longer bolts have to be used. The longer bolts are included in the kit 020D2801 containing the pulley.

Use Loctite or similar when fitting the bolts and tighten the bolts with a torque of 81±3 Nm (8.3±0.3 kpm).

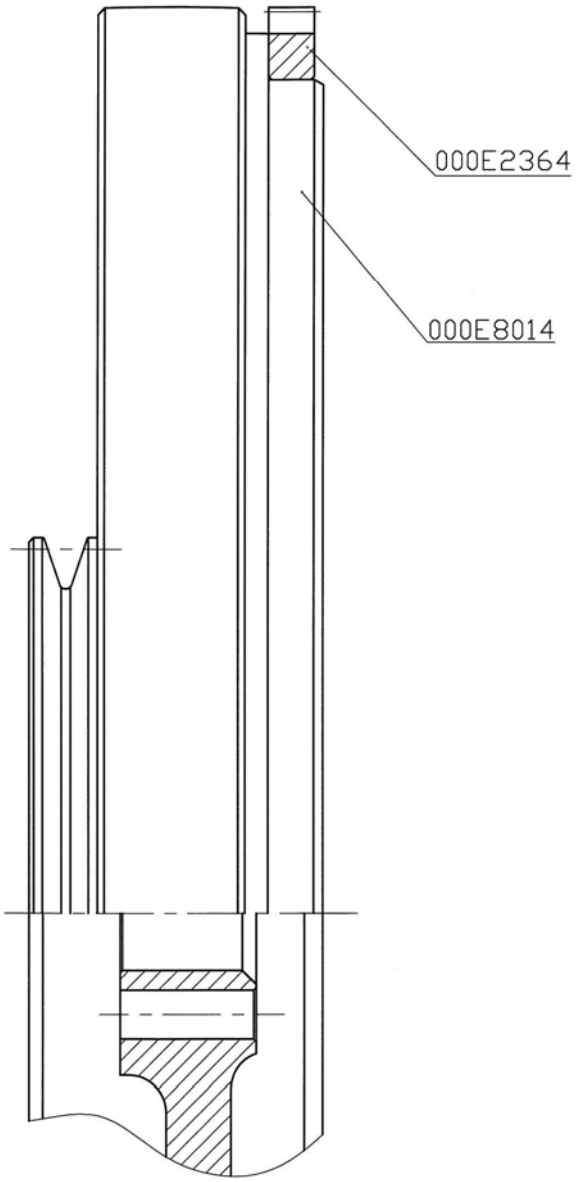


The flywheel is fixed to the crankshaft by means of six M10 bolts as shown on the sketch before.

When dismounting the flywheel please note to fit the flywheel in the same position as before. This only due to the timing marks on the flywheel and not due to the balance of the flywheel.

Replacement of gear rim

1. Remove the flywheel.
2. Saw with a hacksaw as far into the gear rim as possible without damaging the flywheel.
3. Split the gear rim in the sawed slot with a chisel.
4. Clean the recess on the flywheel.
5. Heat the new gear rim gradually to about 225°C (dark blue) and fit it. Make sure at the fitting that the gear rim lies true against the recess and that the chamfered edge turns towards the starter engine.



SECTION E

FRONT END COVER

CONTENTS

Front end cover

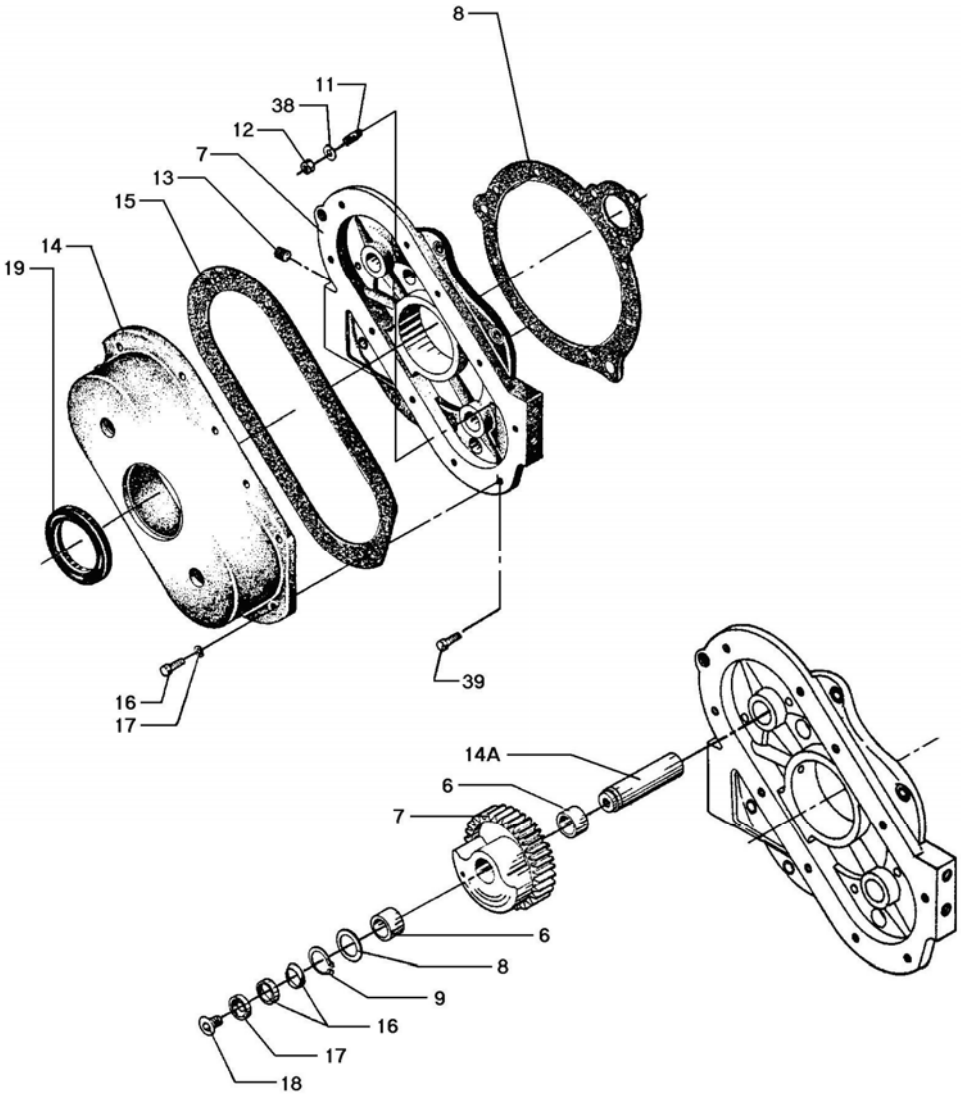
The engine front end cover 7 shown on the drawing below is made from cast iron and contains the front main bearing lining.

Pressed into the front end cover there are the axle journals 14a carrying the counterweights 7 which give the fine balance of the engine. The counterweights are covered by a guard 14.

Dismounting of counterweights

1. Dismount the flywheel (see page D3).
2. Unscrew the unbraco screw 18 in the guard 14 and remove the collar 17.
3. Dismount the guard 14.
4. Dismount the seeger ring 9 and the disc 8.
5. Then remove the counterweights.

For replacement of bearings for counterweights, please see section G.

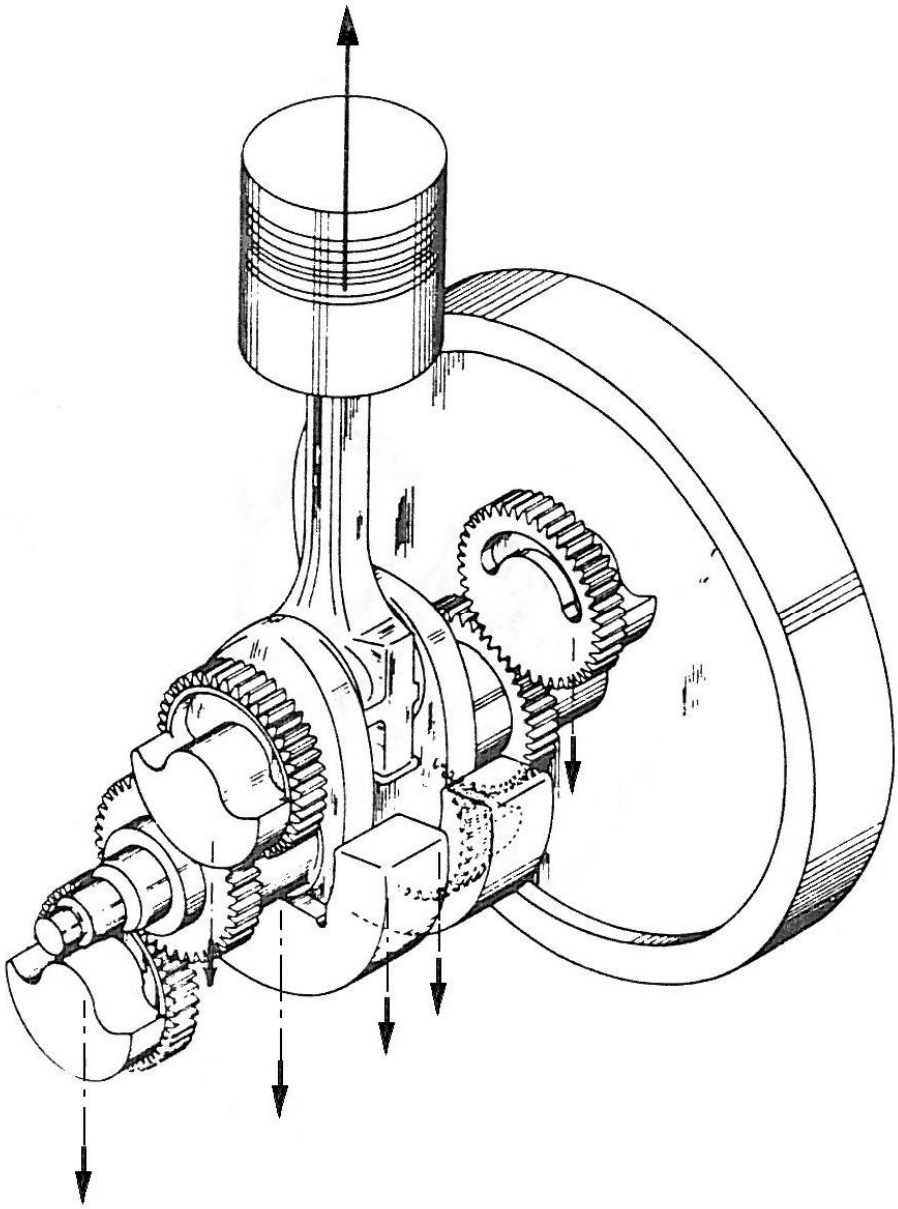


Mounting of counterweigths

Refitment is generally carried out in reverse order of removal. However, please note:

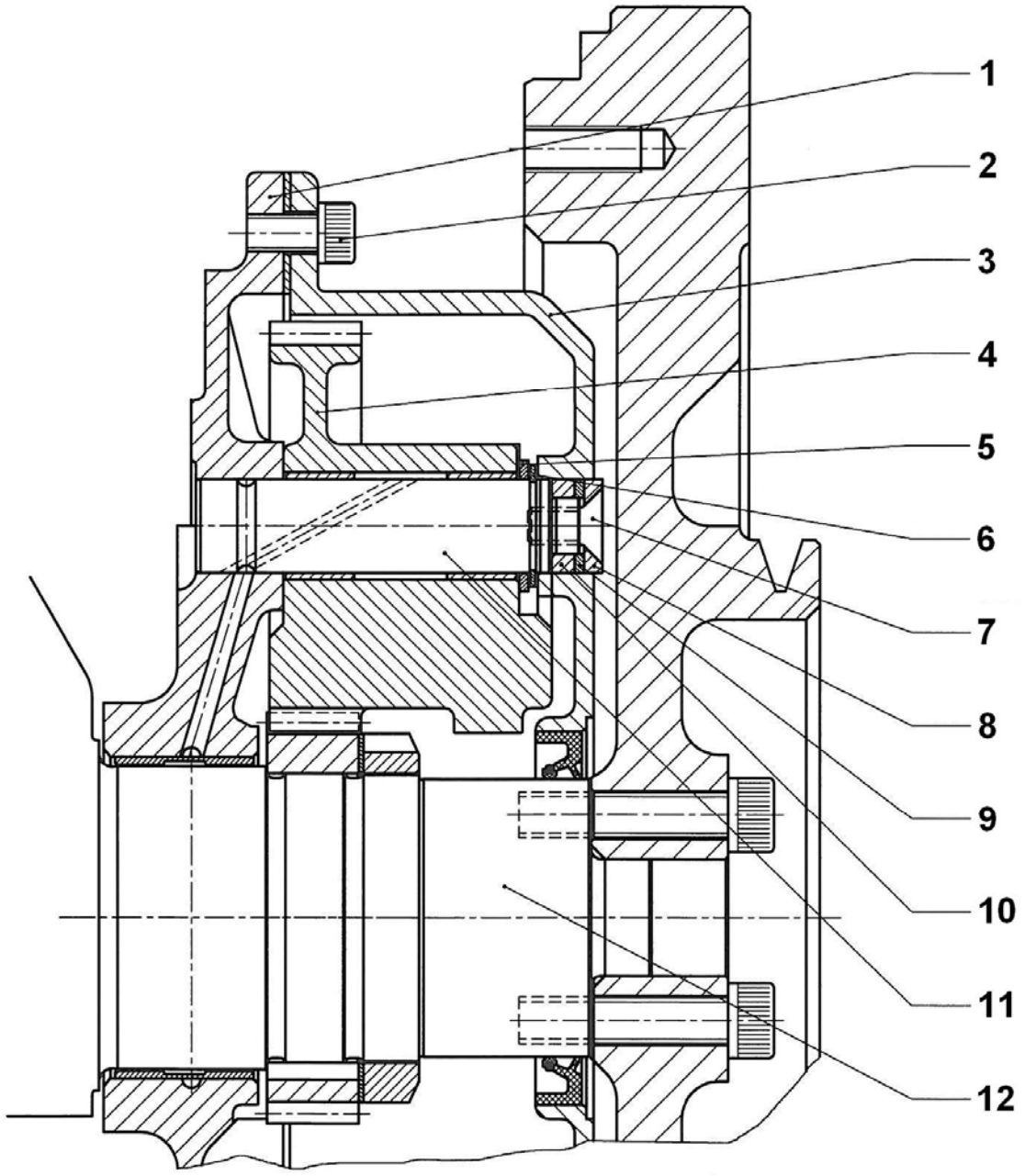
1. The pistons have to be in the T. D.C position, and the counterweights are to be refitted with the heavy part downwards so that this part is horizontal. It i s recommended to turn the counterweight one or two teeth to each side in order to find the exact position.

Axial clearance should be 0.1 – 0.4 mm.



Mounting of counterweight

Arrangement of counterweight



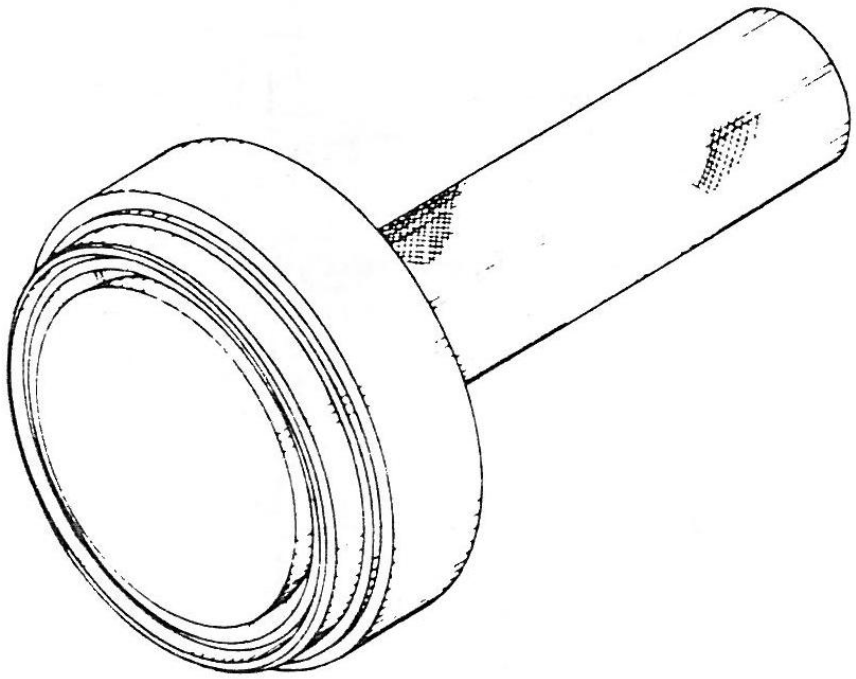
Pos.	Part No.	Qty.	Beskrivelse	Description	Benennung
1	000E0972	1	Forreste endedæksel	Front end cover	Vorderer Enddeckel
2	501A2361	10	Unbrakoskrue	Unbrco screw	Unbracoschraube
3	000E0974	1	Skærm	Cover	Schirm
4	008E1501	4	Roterende vægt	Rotating weight	Rotationsgewicht
5	522A9016	4	Støtteskive	Support washer	Stützscheibe
6	522A1020	4	Seegerring	Circlip	Seegerring
7	501E2361	4	Undersænket skrue	Screw, countersunk	Senkschraube
8	000E0792	4	Trykskive	Thrust washer	Druckscheibe
9	000E3226	4	Mellemskive	Washer	Zwischenscheibe
10	000E3225	4	Trykring	Trust ring	Druckring
11	000E3223	2	Aksel for roterende vægt	Shaft for rotating weight	Welle für Rotationsgewicht
12	008E4561	1	Krumtapaksel, komplet	Crankshaft, complete	Kurbelwelle, komplett

Replacement of oil seal ring in guard

If the oil seal ring is worn, i.e. that the surface exceeds 1.5 mm, the ring must be replaced. This is carried out as follows:

1. Dismount the flywheel (see section D page 3).
2. Remove the set screws and the guide pins in the guard.
3. Remove the guard and press the oil ring out of the guard with a pipe or the like.
4. Mount new oil seal ring with the mounting punch below.

Note: The open side of the ring must turn towards the engine!



Mounting punch for oil seal ring

Replacement of front end cover

1. Dismount the flywheel.
2. Dismount the guard for counterweights.
3. Dismount the counterweights. (see page E3).
4. Remove the ring nut of the crank when the cover plate is loosened.
5. Pull off the gear-wheel of the crank.

   If the engine is equipped with raised hand start on the engine front end, dismount this.
6. Dismount the nuts of the end cover and remove the end cover.

Mounting takes place in reverse order of the dismounting, and fasten the end cover on the crankcase with a torque of 2 – 2.3 kpm (14.5 – 16.6 ft.lbf.).

Replacement of axle journals for counterweights

The axle journals being 19.939 – 19.960 mm on new engines can be replaced by removing the front end cover and pressing the journals out.

By replacement of the axle journals it must be observed that the lubricating oil channel of the new journals is facing the lubricating oil inlet hole in the end cover.

Replacement of front main bearing lining

The front main bearing lining being a thin steel lining with a very thin layer poured bearing metal is placed in the front end cover. Replacement must take place if the bearing is scratched or if the reddish layer between bearing metal and lining can be seen.

Replacement of the lining takes place as follows:

1. Dismount the front end cover according to the above.
2. Drive the lining out with a punch or press it out.
3. Lubricate the new lining with oil on the outside and insert it with a punch or press it in so that the outer edge of the bearing flush with the front edge of the bearing hole in the end cover.

REMEMBER that the lubricating hole of the of the lining must face the lubricating oil inlet hole in the end cover.

SECTION F

RAISED HAND START & COLD START ARRANGEMENT

CONTENTS

Raised hand start on front edge

Raised hand start on front the edge is most common, but can also be supplied for fitting on rear edge.

The two sorts of raised hand start are built the same way and consist of a handle which is in connection with the camshaft via a set of conical gear-wheels and a chain.

The cooling water pump is fitted on the chain box which contains gear-wheel and chain.

Checking of chain for raised hand start

When the raised hand start has been assembled, the endless chain is tightened to the correct tightness.

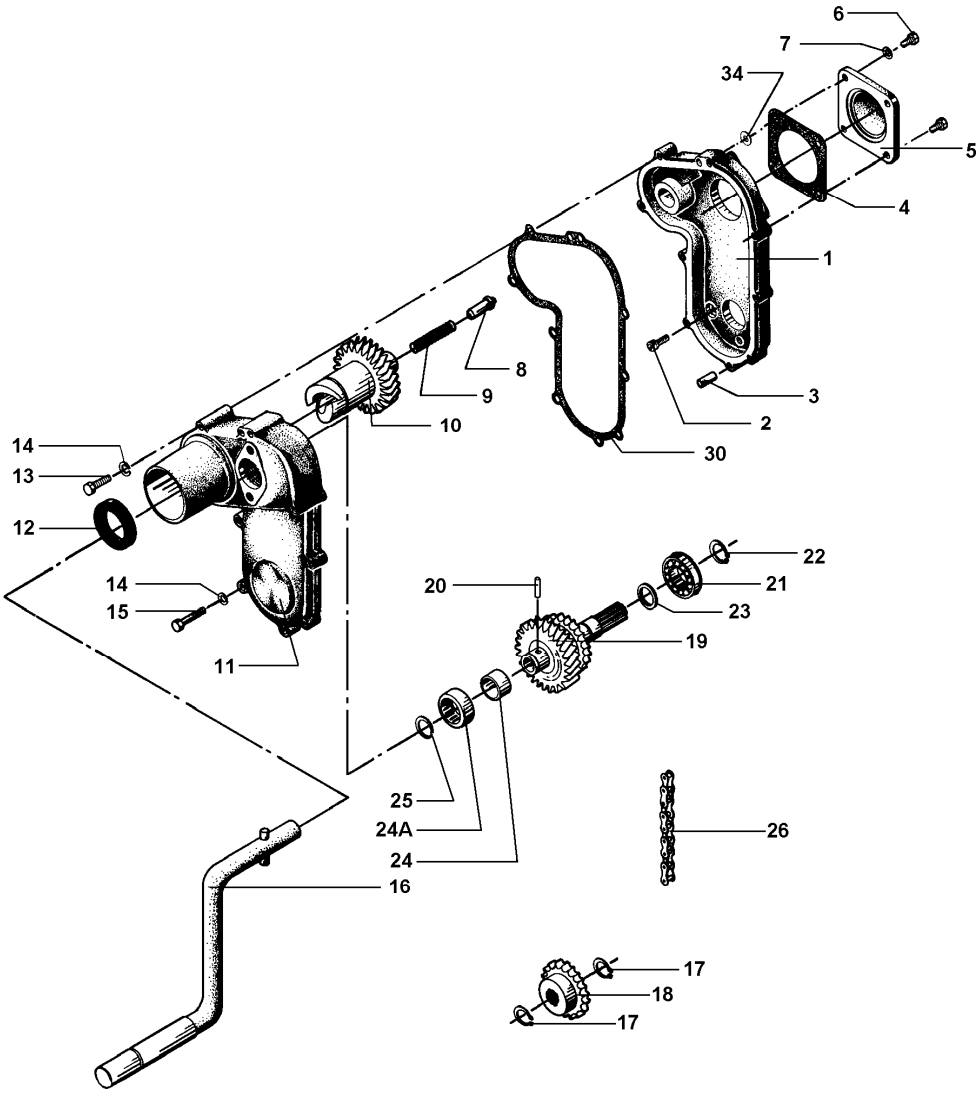
However, if noise from the chain box should occur, this may be due to wear and tear on the chain.

The normal length of the chain is 438 mm and must max. have an increase of the length to 440 mm. This corresponds to a center distance between the gear-wheels of 133 mm and 134 mm respectively.

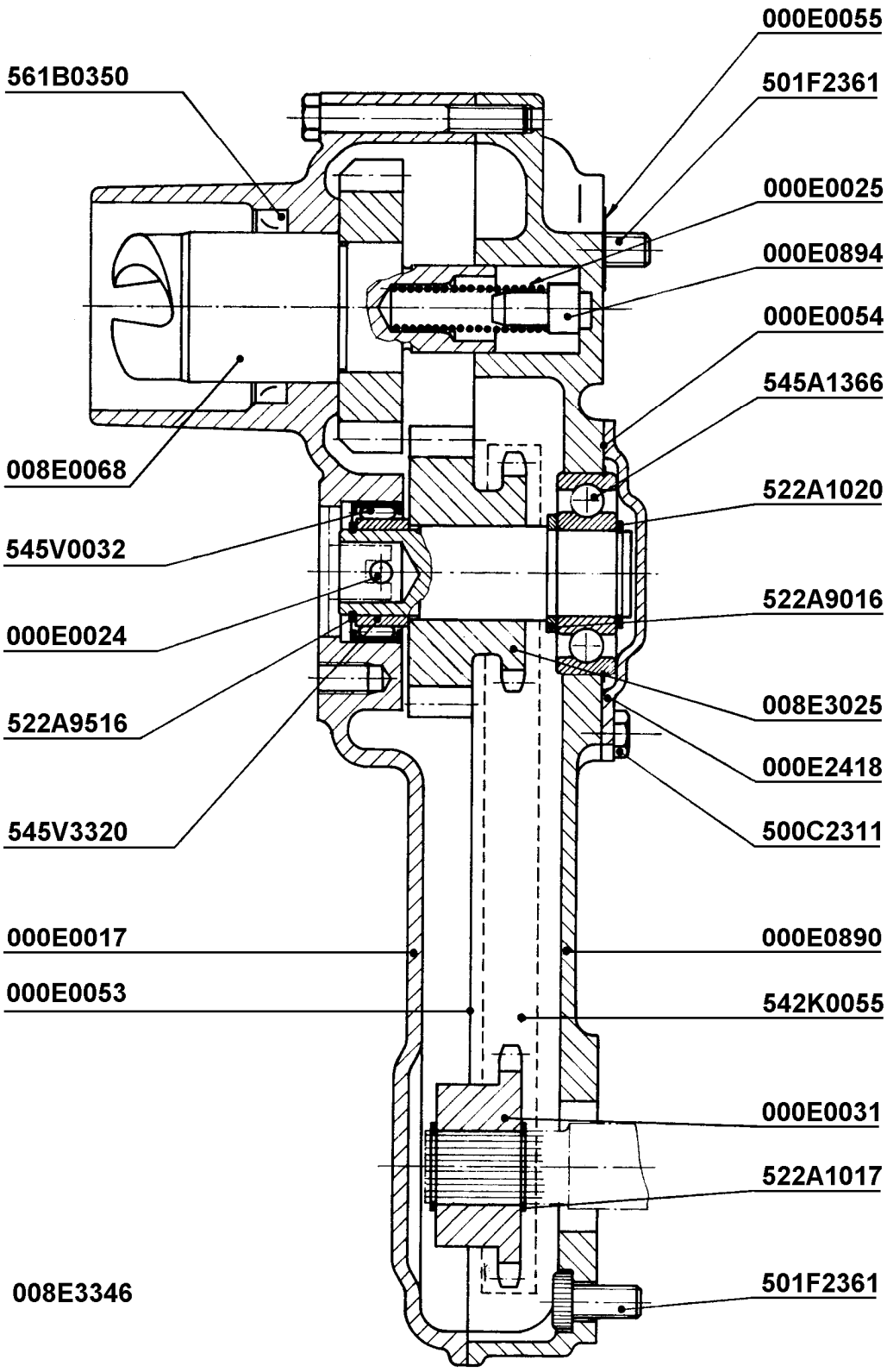
Dismounting of raised hand start on front edge

1. Remove the handle [16].
2. Dismount the cooling water pump when the water has been drained off the engine and the inlet and exhaust pipes have been loosened from the pump.
3. Dismount the bolts [13] and pull off front chain box half [11] (take care of the spring [9] and the guide [8]).
4. Pull the gear-wheel [10] carefully out of the chain box.
5. Press the outer ring in the roller bearing [24] out of the chain box half through the water pump wheel.
6. Dismount the cover [5] and pull it off.
7. Dismount the seeger ring [22] and the front seeger ring [17].
8. Dismount the large seeger ring behind the bearing [21] and remove the chain gear-wheel by knocking slightly on the shaft end with a plastic hammer.
9. Remove the endless chain [26].
10. Remove the inner ringof the roller bearing if it is worn.

At the mounting taking place in reverse order tighten the chain box halves with a torque of 0.9 – 1.0 kp*m (6.5 – 7.23 ft.lbf.).



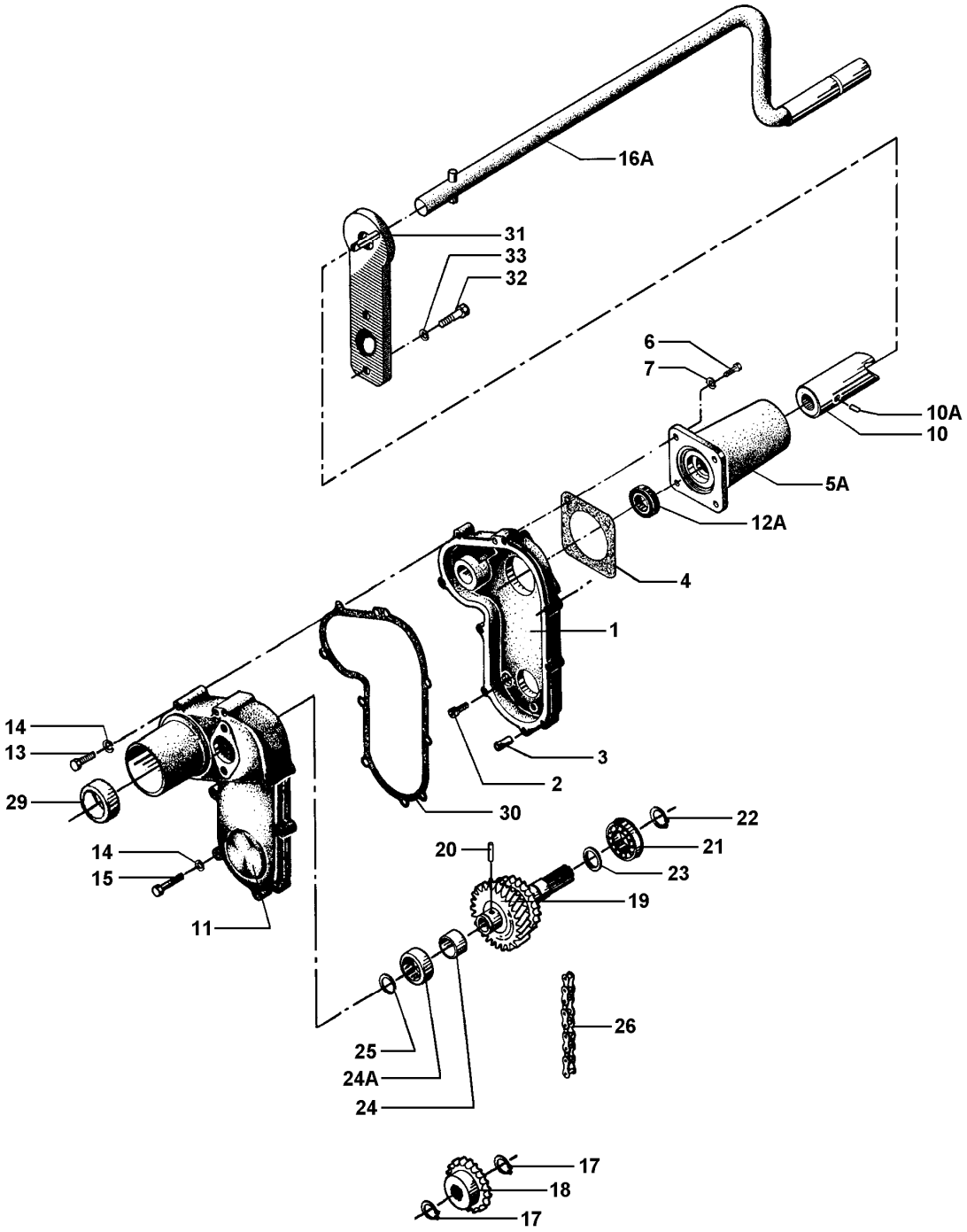
Arrangement of raised hand start on front edge



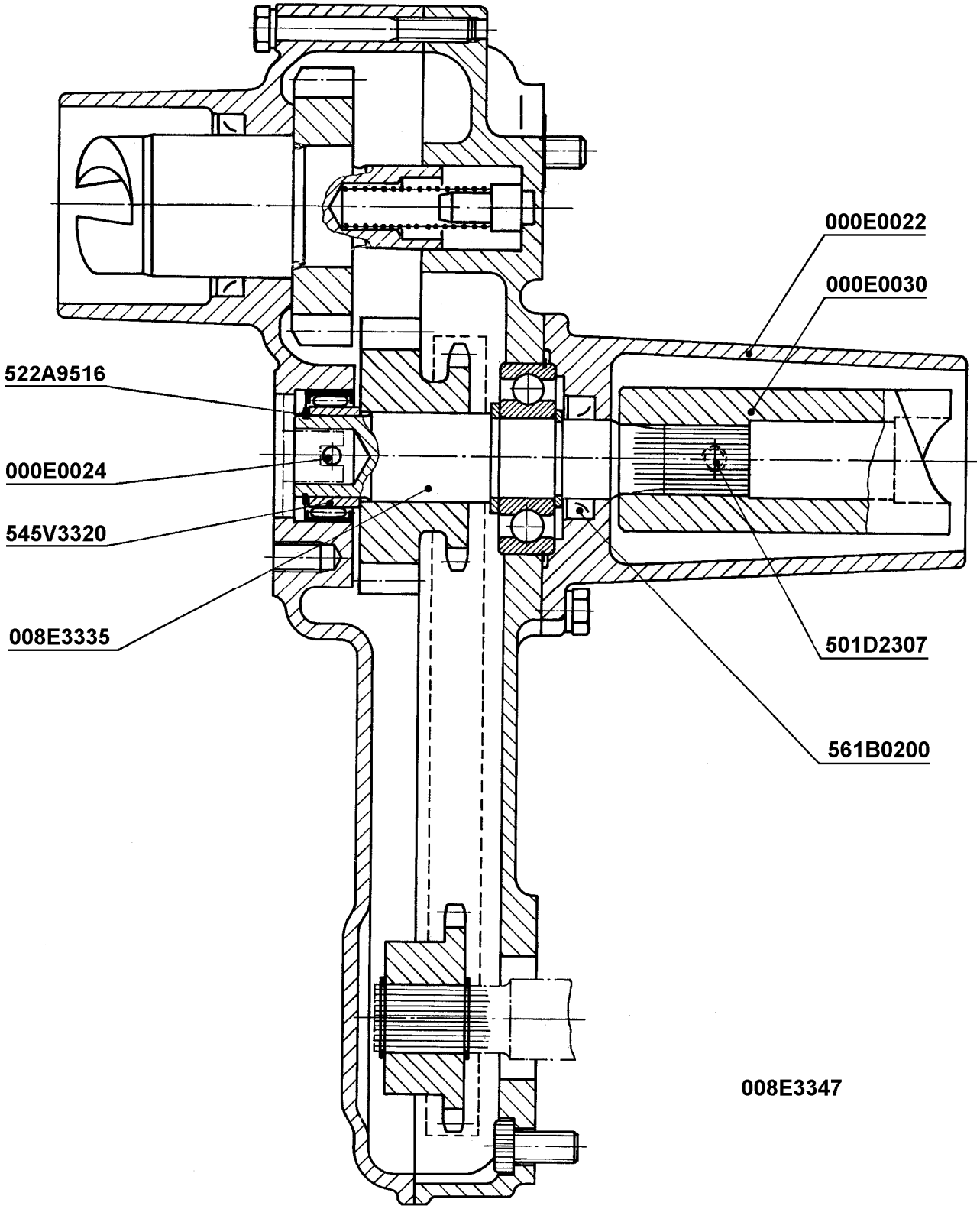
Dismounting of raised hand start on rear edge

1. Remove the handle [16].
2. Dismount the cooling water pump when the water has been drained off the engine and the inlet and exhaust pipes have been removed.
3. Dismount the bolts [13] and pull off front chain box half [11] .
4. Dismount outer ring of the neddle bearing [24] through the water pump hole.
5. Turn the engine until the pointed screw [10A] is facing the hole in the cover [5A].
6. Loosen the pointed screw and pull off the starting clutch [10].

Now carry out the dismounting as mentioned for raised hand start on front edge point 6 -10.



Arrangement of raised hand start on rear edge



Cold starting arrangements

For lifeboat engines with hand start a cold starting arrangement is required by the maritime authorities for hand starting down to minus 15°C within 2 minutes.

The cold starting arrangement consist of a fixed mounted ether-start which is activated as mentioned on the lifeboat engine starting instruction below.

For operation of the engines in cold conditions it is also possible to have either a cooling water heater or a lubricating oil heater fitted.

Betjeningsvejledning for BUKH diesel type DV24/29/32 RME og DV36/48 RME

Elektrisk start: (uden start pilot)
a) Tænd for hovedafbryderen.
b) Sæt gearet i neutral stilling.
c) Stil afbryderen på "RUN".
d) Tryk på "START" knappen indtil motoren starter.

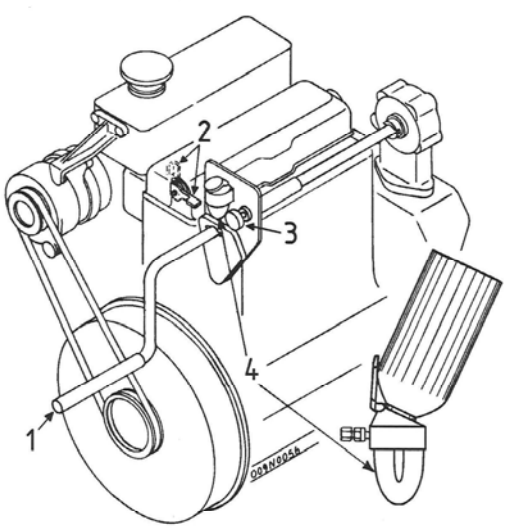
Håndstart: (med start pilot)
a) Sæt gearet i neutral stilling.
b) Sæt startsvinget (1) i startkloen.
c) Løft dekompressionshåndtaget (2).

Kun for koldstart (under 0°C):
Starthjælp: Træk pumpen (3) ud og skub den ind igen 2-3 gange.

d) Drej startsvinget så hurtigt som muligt (DV24/29/32 med uret - DV36/48 mod uret), løsn dekompressionshåndtaget, men bliv ved med at dreje, indtil motoren starter.

Påfyldning af trykbeholder (4):
a) Åbn dækslet.
b) Anbring gascylinderen oven på ventilen og fyld beholderen til max. afmærkningen.

Stop:
Tryk på "STOP" knappen indtil motoren står stille.
Når motoren står stille:
Stil afbryderen på "OFF".



Operating Instructions for BUKH Diesel Type DV24/29/32 RME and DV36/48 RME

Electric Start: (Without Start Pilot)
a) Switch on the main switch.
b) Put the gear into neutral position.
c) Put the switch in "RUN" position.
d) Push the "START" button until the engine starts.

Hand Start: (With Start Pilot)
a) Put the gear into neutral position.
b) Put handle (1) into crank claw.
c) Lift decompression lever (2).

Only for Cold Start (below 0°C):
Start pilot: Pull and push the pump (3) 2-3 times.

d) Turn the starting handle as quickly as possible (DV24/29/32 clockwise - DV36/48 counter-clockwise) release the decompression lever but keep on turning until the engine starts.

Filling the pressure tank (4):
a) Open the cover.
b) Put the gas cylinder on top of the valve and fill up the tank to max. marking.

Stopping the engine:
Push the "STOP" button until the engine stops.
After the engine stands still:
Put the switch in "OFF" position.

BUKH since 1899 powering marine safety

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SECTION G

REAR END COVER

CONTENTS

The rear end cover of the engine is made from cast iron. The built-in fuel pump is placed on the top side of the rear end cover. Further the revolution control is incorporated in the cover. Besides the injection timing control, which is built on in continuation of the camshaft, is placed in the rear end cover.

Dismounting of rear end cover

1. Dismount the gear (see section R).

2. Remove remote control for throttle control if any.

3. Remove the fuel pipes from the fuel filter to the fuel pump and from the fuel pump to the fuel valves. Remove the fuel pump.

4. Unscrew the two pipe plugs in the rear edge of the end cover.

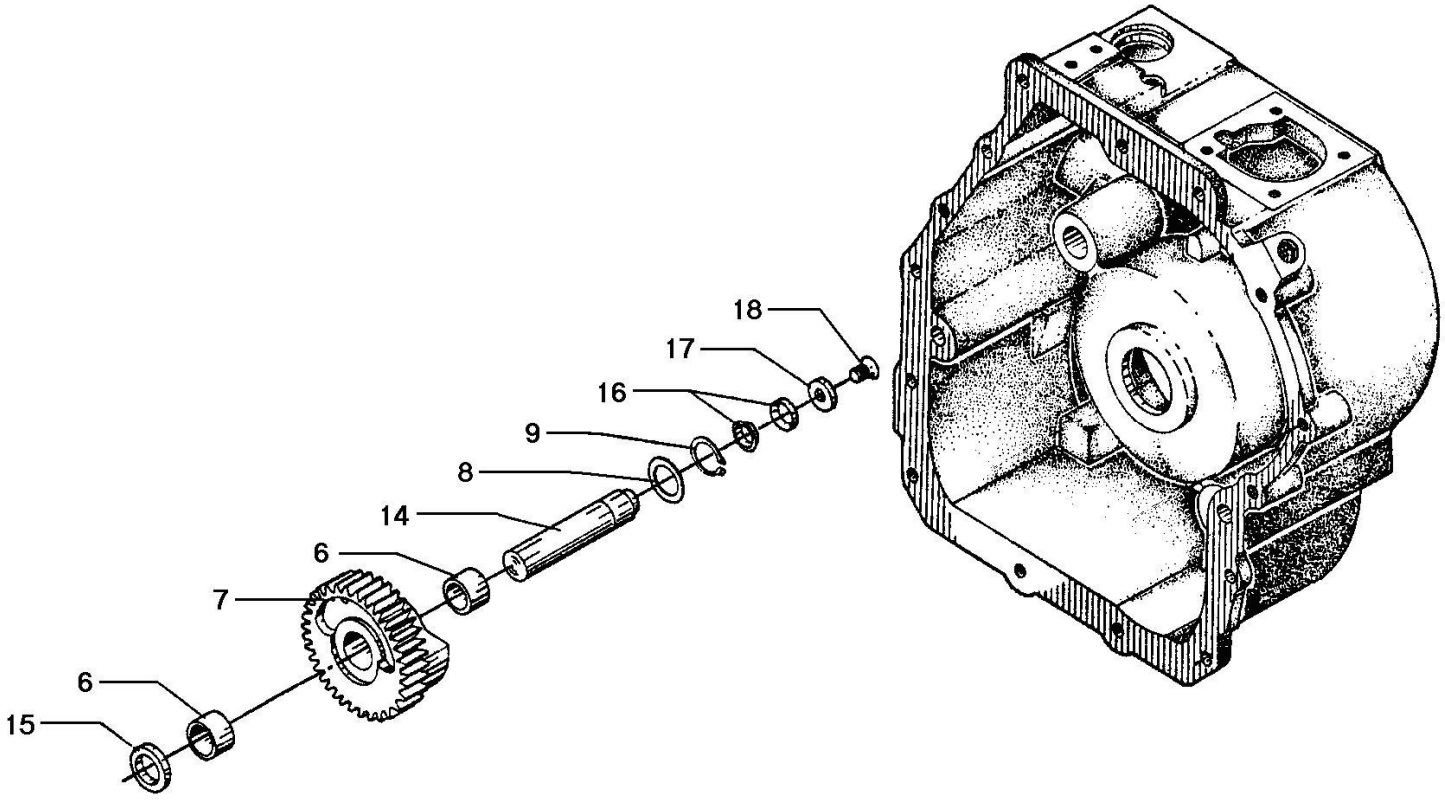
5. Unscrew the unbraco screw [18] and remove the expansion washers [17 and [16].

6. Dismount the lubricating oil pump placed on the rear of the end cover.

7. Unscrew the flange bolts of the end cover and remove the end cover.

When fitting observe that the flange bolts of the end cover are tightened before the unbraco screws [18] and before the thrust washers [17] are fitted.

Smear the unbraco screws [18] with Loctite.
Carry out the remaining fitting in reverse order.



Removal of rear counterweights

1. Remove the rear end cover.
2. Remove the circlip [9] on the axle journal for the counterweights.
3. Remove the washer [8].
4. Then the counterweights can be removed.

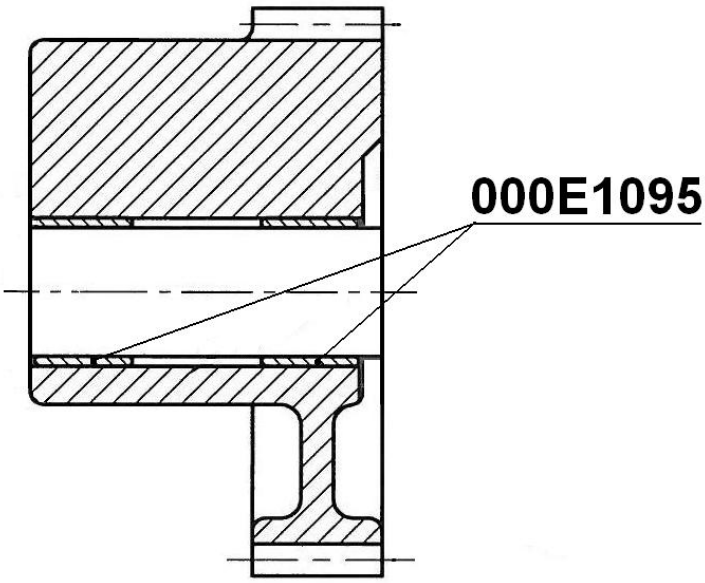
Exchange of bearings for counterweights

As a special calibration of these bearings has to be carried out when they have been fitted, an exchange should only be made when the necessary special tools are available.

Normally an exchange will only be necessary when the bearings are seized or when there has been a heavy wear and tear.

Exchange as follows:

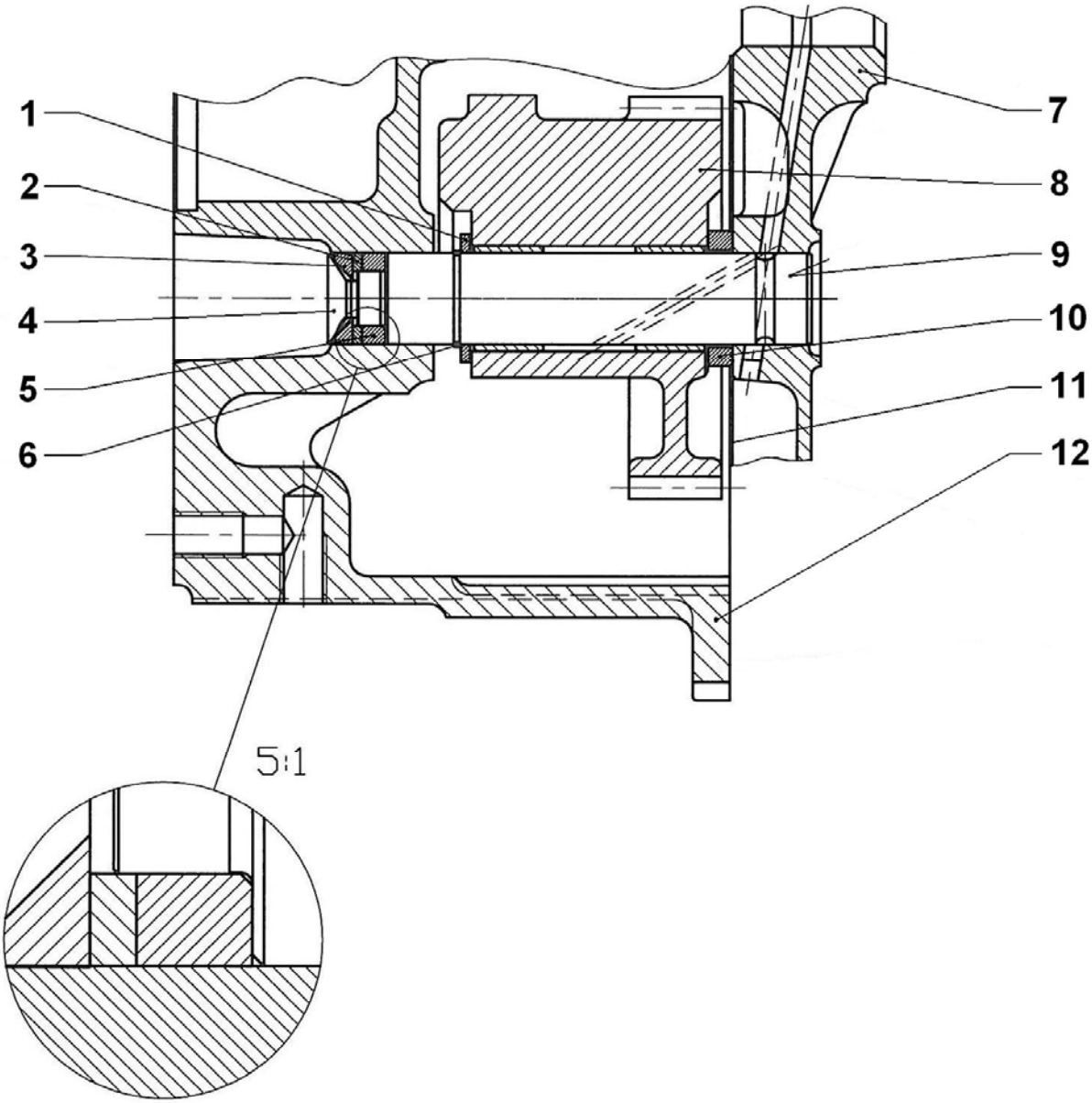
1. Remove the counterweight.
2. Press out the bearings no. 000E1095 on the drawing below with a suitable tool.
3. Press in the new bearings from either side as shown on the drawing.
4. Calibrate the bearings when they have been pressed-in to the tolerance (20.020 – 20.041 mm). This is either carried out with a calibration ball or a reamer with the mentioned tolerance.



Fitting of counterweights

The fitting of the counterweights is carried out in accordance with the instructions stated on pages E4 and E5.

Arrangement of rotating weights

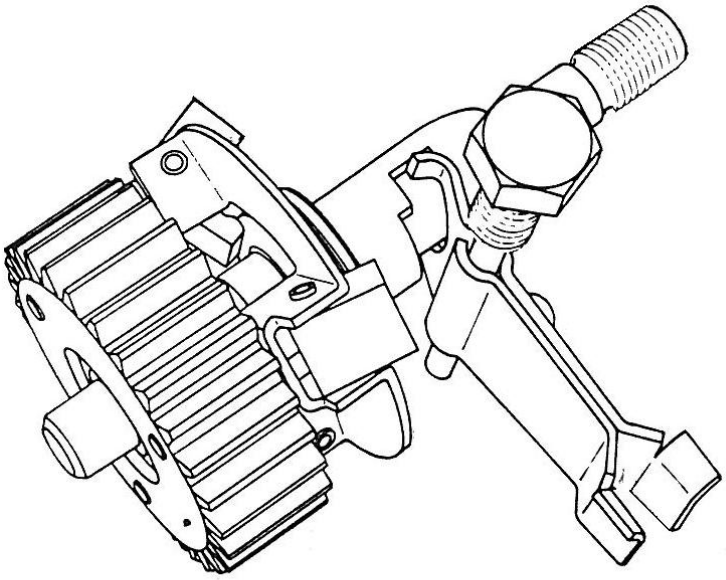


Pos.	Part No.	Qty.	Beskrivelse	Description	Benennung
1	522A9016	4	Seeger støtteskive	Seeger support washer	Scheibe - Seeger
2	000E3226	4	Mellemskive	Intermediate disc	Zwischenscheibe
3	000E0792	4	Trykskive	Thrust washer	Druckscheibe
4	501E2363	4	Undersænket skrue	Screw, countersunk	Senkschraube
5	000E3225	4	Trykring (nylon)	Thrust collar (nylon)	Druckring (nylon)
6	522A1020	4	Seegerring	Circlip	Seegerring
7	000E7666	1	Krumtaphus	Crank case	Kurbelgehäuse
8	000E1501	4	Roterende vægt med lejebøsning	Rotating weight with bearing bush	Rotationsgewicht mit Lagerbuchse
9	000E3224	2	Aksel for roterende vægte, bag	Shaft for rotating weights, rear	Welle für Rotationsgewichte, hinter
10	000E0789	2	Afstandsring	Distance ring	Distanzring
11	000D9197	1	Pakning	Gasket	Dichtung
12	000E7866	1	Bagerste endedæksel	End cover, rear	Enddeckel, hinterer

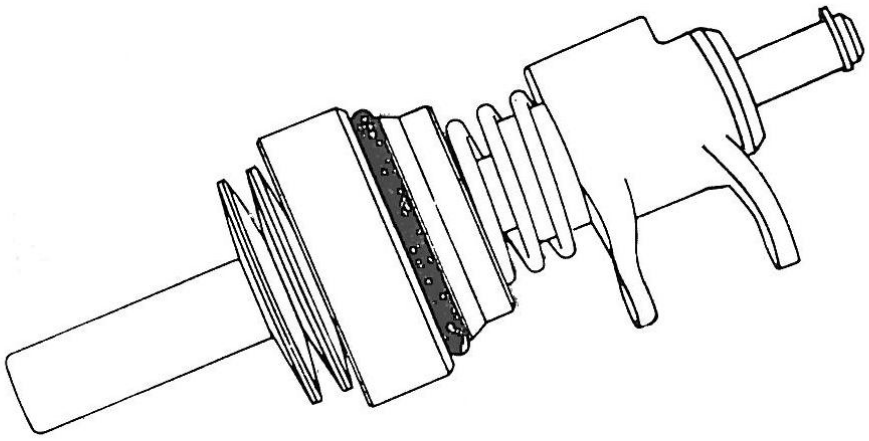
Governor system

The revolution regulation can be divided into two systems:

1. The centrifugal governor which must keep constant revolutions at varying loads.
2. Manual governor which must alter the revolutions according to requirements.



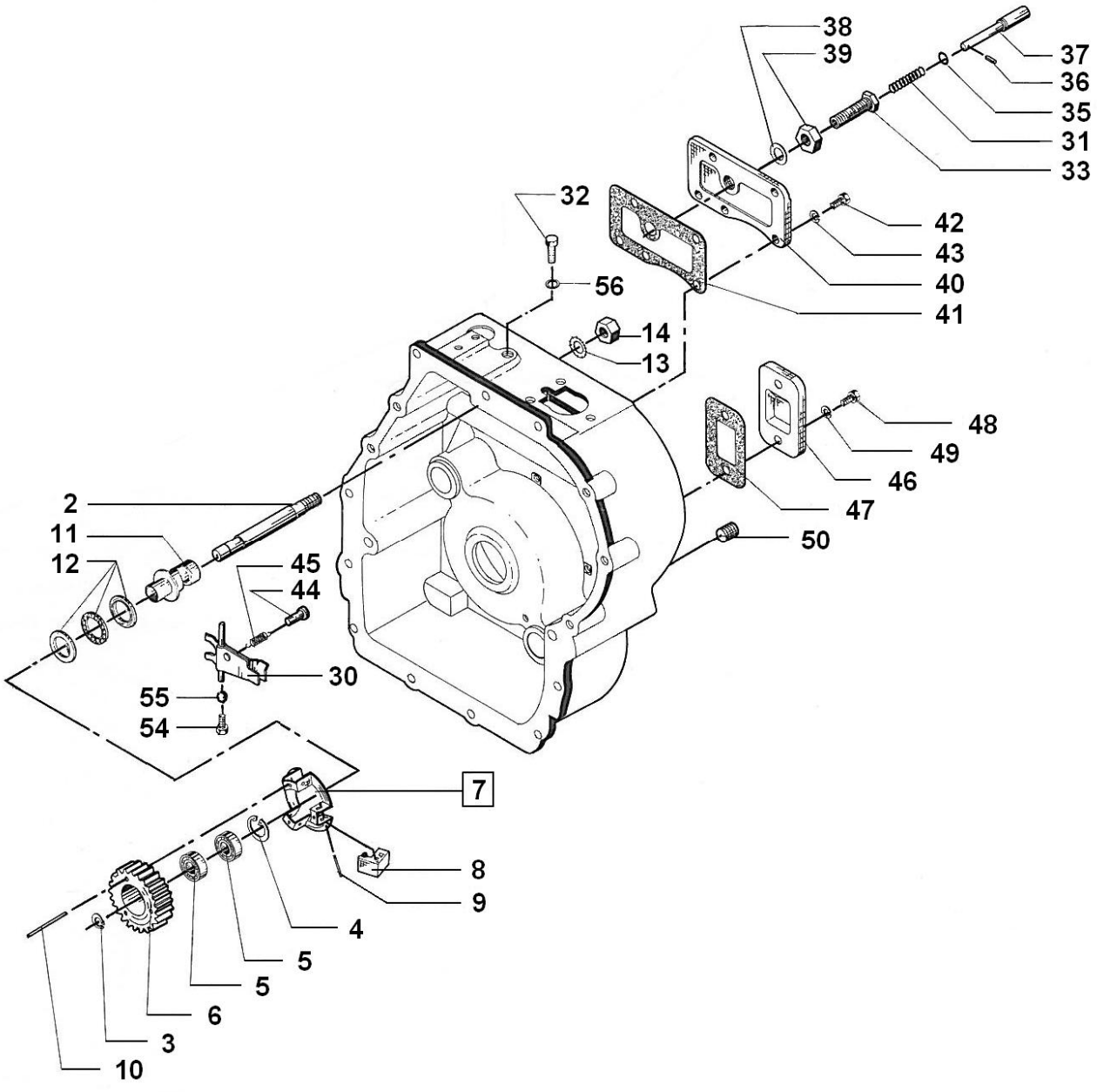
Centrifugal governor



Manual governor

Dismounting of centrifugal governor

1. Dismount the rear end cover (see page G3).
2. Remove the circlip [3] and pull off the gear-wheel [6] with the centrifugal governor [7].
3. Remove the circlip [4] and press the ball bearings [5] out of the gear-wheel.
4. Unscrew the bearing screw [32] and remove the spring [45].
5. Lift the governor arm [30] so that the axle journal lets the bracket go. Now the governor arm can be pulled out.
6. Dismount the pipe collar [11] with the thrust bearing [12].
7. Remove the governor shaft [2].



Fittting of centrifugal governor

1. Place the governor shaft [2] in the bore in the rear end and tighten the nut [14] with a torque of **7.0 – 7.5 Kpm** (50.6 – 54.1 ft.lbf).

2. Fit the governor arm [30] in the bore and check that the clearance is the same on both sides of the shaft [2]. Adjust by adjusting the screw [54]. At the same time check the function of the ball [55]. Then lock theadjusting screw [54] with Loctite and a centre mark. Then remove the governor arm [30].

3. Fit the thrust bearing [12] on the pipe collar [11] and fit them assembled to the governor shaft.

4. Fit the governor arm [30] by thrusting the upper part of the shaft up into the thread bore in the cover and then place the lower gudgeon of the shaft in the bracket. The two legs of the governor arm must grasp the cut-out in the sliding bolt as shown on page G9. Fit the spring [45] between the governor arm and the key bolt which is pressed into the cover from outside and is hidden by the cover [40]. Fit the thrust screw [32] in the end cover.

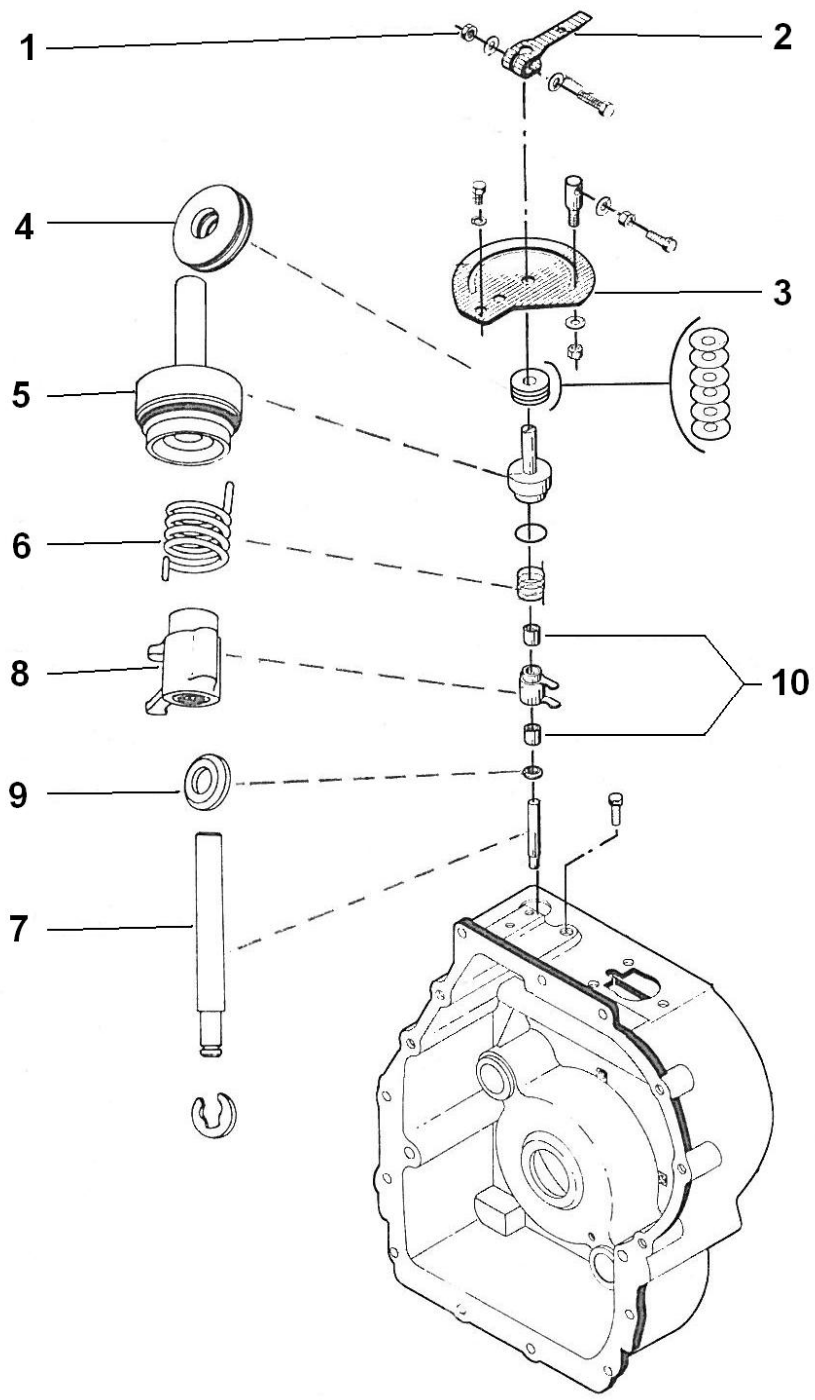
5. Fit the gear-wheel ball bearings [5] in the gear-wheel and lock them with the circlip [4].

6. Fit the gear-wheel [6] on the shaft and fit the circlip. The arm of the centrifugal blocks must lie true against the thrust bearing as shown on page G9.

7. Fit the end cover.

Dismounting of manual governor

1. Dismount the rear end cover (see page G3).
2. Loosen the nut [1] and remove the governor arm [2].
3. Unscrew the set screws holding the regulating quadrant [3] and remove the regulating quadrant, the disc springs [4] and the shaft [5].
4. Take up the spring [6].
5. Pull up the shaft [7] and remove the governor arm and the thrust washer [9].
6. Press the neddle bearings [10] out of the governor arm.



Mounting of manual governor

1. Press the two needle bearings into the governor arm so that they are flush with the lateral faces.

2. Place the governor arm and the thrust washer on the bracket so that the chamfer turns towards the governor arm. The two legs on the governor arm must be placed on the terminal surface of the pipe collar of the governor arm.

3. Mount the shaft [7] (on page G9) through the governor arm and the thrust washer down into the bracket in the end cover.

4. Place the spring so that the bended spring wire catches in the hole in the governor arm.
   The spring can be supplied in 4 different executions depending on which maximum revolutions that are required on the engine.

   Thichness of spring wire 2.0 mm (0.0787 inch)……..... 1500 rpm.

   Thichness of spring wire 2.2 mm (0.0866 inch)……..... 1800-2000 rpm.

   Thichness of spring wire 2.5 mm (0.0984 inch)……..... 2500-3000 rpm.

   Thichness of spring wire 2.8 mm (0.1102 inch)……..... 3600 rpm.

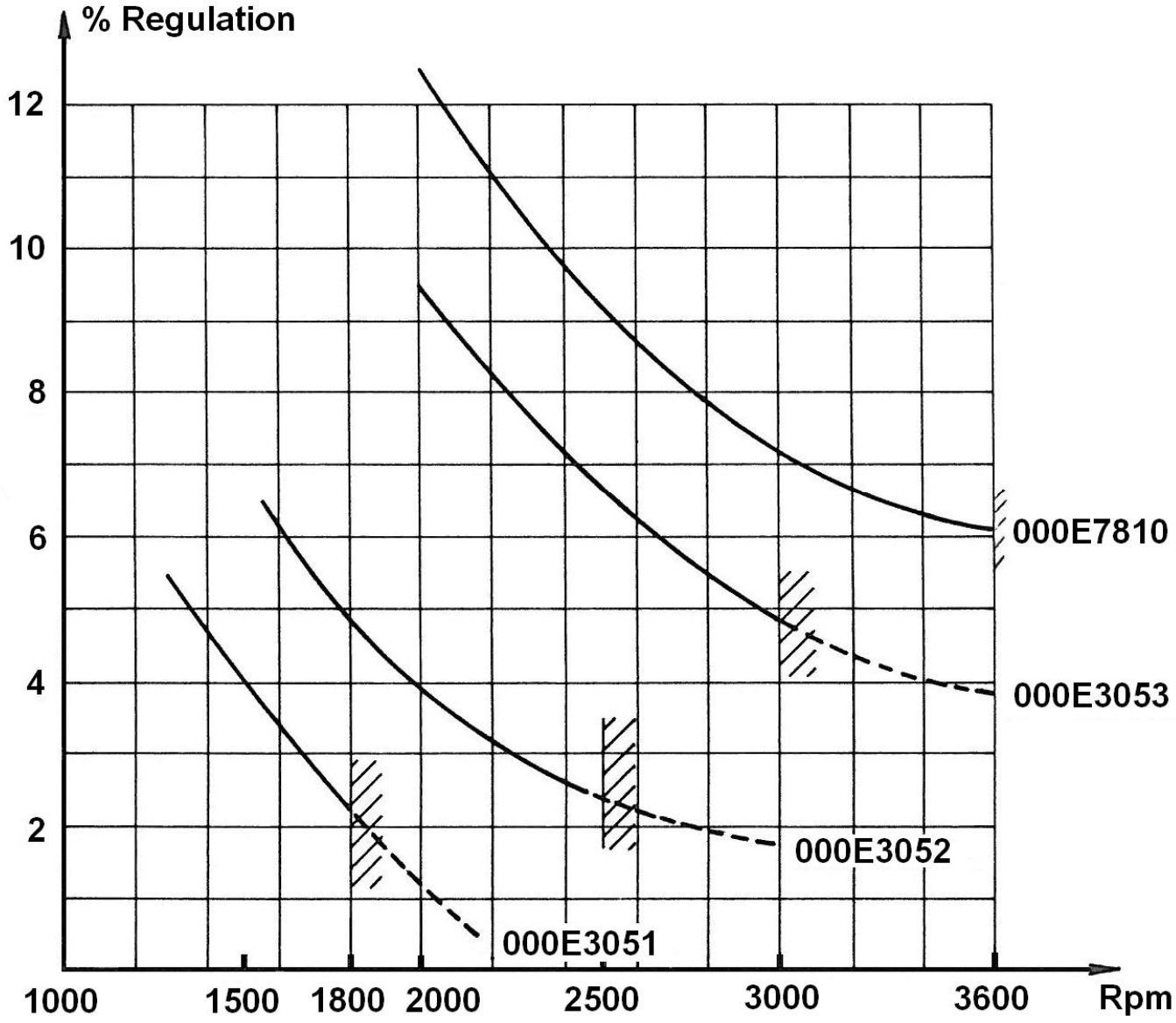
5. Mount the shaft so that the spring wire catches in the hole in the bottom of the shaft.

6. Mount the disc springs on the shaft.

7. Place the regulating quadrant on the shaft above the disc springs and tighten it with a torque of **2.0 – 2.3 Kpm** (14.5 - 16.6 ft.lbf).

8. Mount the governor arm and tighten it with a torque of **0.9 – 1.0 Kpm** (6.5 – 7.2 ft.lbf).

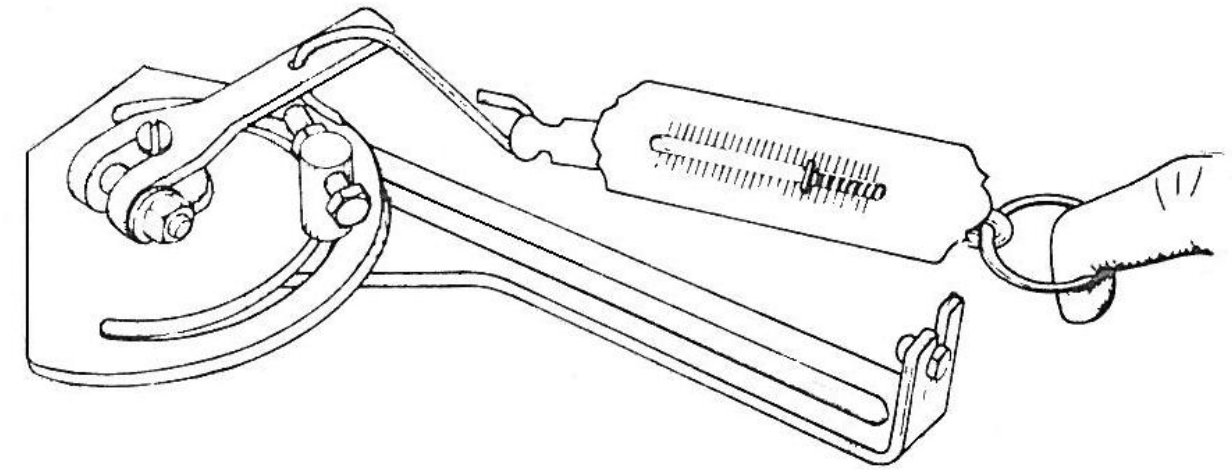
Characteristic for governor spring



The below-mentioned can be used when choosing spring:

Bukh drg. no.	Wire diam.	1500 rpm	1800 rpm	2000 rpm	2500 rpm	3000 rpm	3600 rpm
000E3051	**2.0 mm**	**X**					
000E3052	**2.2 mm**		**X**	**X**			
000E3053	**2.5 mm**				**X**	**X**	
000E7810	**2.8 mm**						**X**

Adjustment of governor system



1. Adjust the tightness of the governor arm by altering the number of disk springs belowsthe regulating quadrant.

   The arm must go so tight that the throttle control system does not change position during operation. This means that engines with remote control for instance with cables shall not be as tight as engines with direct control due to the resistance in the cables.

   When drawing with a spring balance as shown above and in the outer hole in the governor arm the “tightness” must be approximately **6 Kp** (13.2 lbs) at direct control and **4.5 Kp** (9.9 lbs) at remote control.

2. Start the engine and regulate it down to idling, 900 – 1200 rpm.

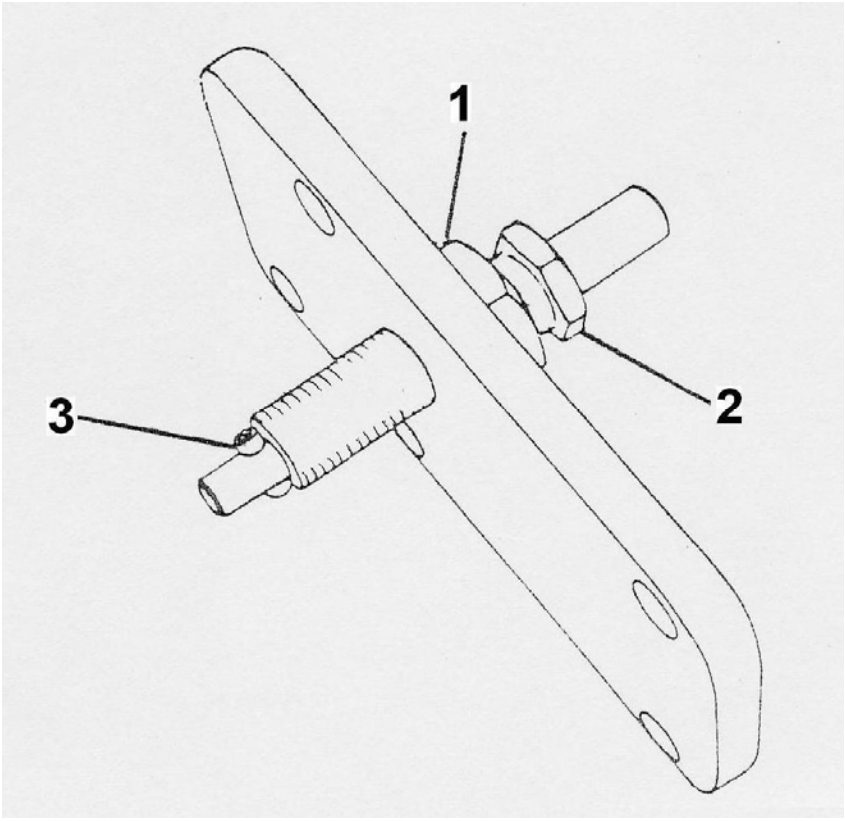
   Loosen the nut on the governor arm and turn the governor arm towards the stop for idling, and tighten with a torque of **0.9 – 1.0 Kpm** (6.5 – 7.2 ft.lbf).

3. Turn the governor handle to the right until the engine runs 3750 rpm. unloaded.

4. Loosen the counter nut on the r egulating screw and adjust the regulat ing screw for stop against the governor arm.

If the full-load capacity of the fuel pumps turns out to be too low when loading the engine this must be adjusted by adjusting the stop button (see next page).

Dismounting and Adjustment of Stop Button



For engines without electrical Stop Solenoid.

The stop button is correctly adjusted from the factory. At possible repairs it will not be necessary to readjust. In case of dismantling of stop button this is carried out as follows:

Dismounting:

1. Loosen the counter nut [1].
2. Unscrew the headless screw [2] from the cover.
3. Knock out the pin [3] and dismount the stop pin and the spring.

Mounting takes place in reverse order.

Adjustment:

1. Set the headless screw [2] 4-5 threads from the counter nut [1].
2. Start the engine and load it with 24 HP at 3600 r.p.m.
3. Loosen the counter nut [1] and screw the headless screw [2] in until the engine just starts to loose revolutions and screw it ¼ turn back before the counter nut is tightened.

SECTION H

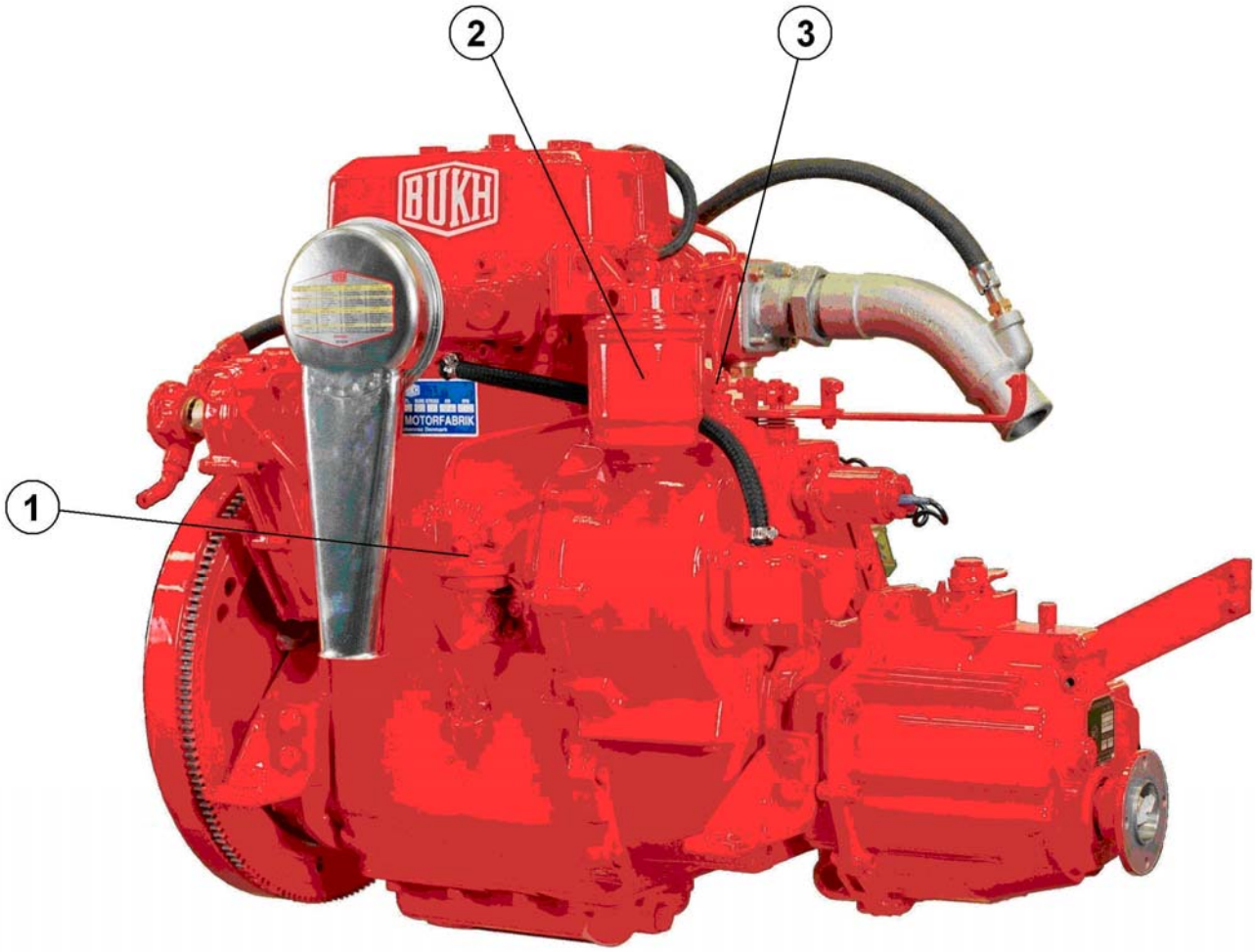
FUEL SYSTEM

CONTENTS

The fuel system

The fuel is common gas oil contained in a fuel tank from where it is drawn by the lift pump (1) which pumps it through the fuel filter (2) to the fuel pump (3). The fuel pump passes the fuel on to the respective cylinders with a pressure of 210 Bar through the fuel valve which is placed on the right side of the cylinder head.

By means of the handle of the lift pump it is possible to pump pressure to the fuel system while the engine is stopped (used for bleeding of the fuel system).



Bleeding of the Fuel System

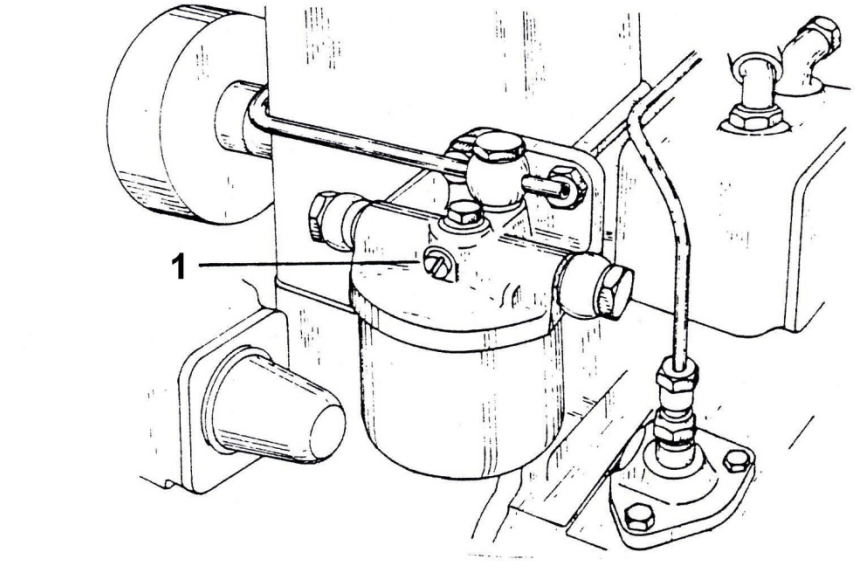
If repairs have been carried out on the fuel system or the engine has been out of operation for a long period or if the tank has been dried out , it is necessary to bleed the fuel system. This is done as follows:

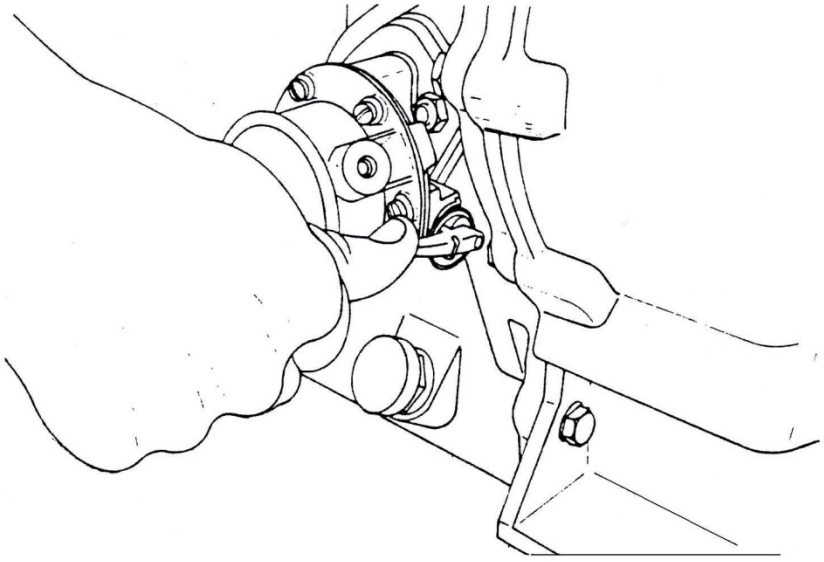
1. Loosen the slotted screw (1) on the fuel filter.

2. Pump with the handle on the fuel lift pump until the fuel flow is without air bubbles at the slotted screw. Then tighten the slotted screw.

3. Loosen the fuel pipe union nut on the fuel valve. Turn the engine by means of the handle or the starter until the oil is without air bubbles. Tighten the union nut.

4. On Bryce fuel pumps the vent screw on the fuel pump can also be used.





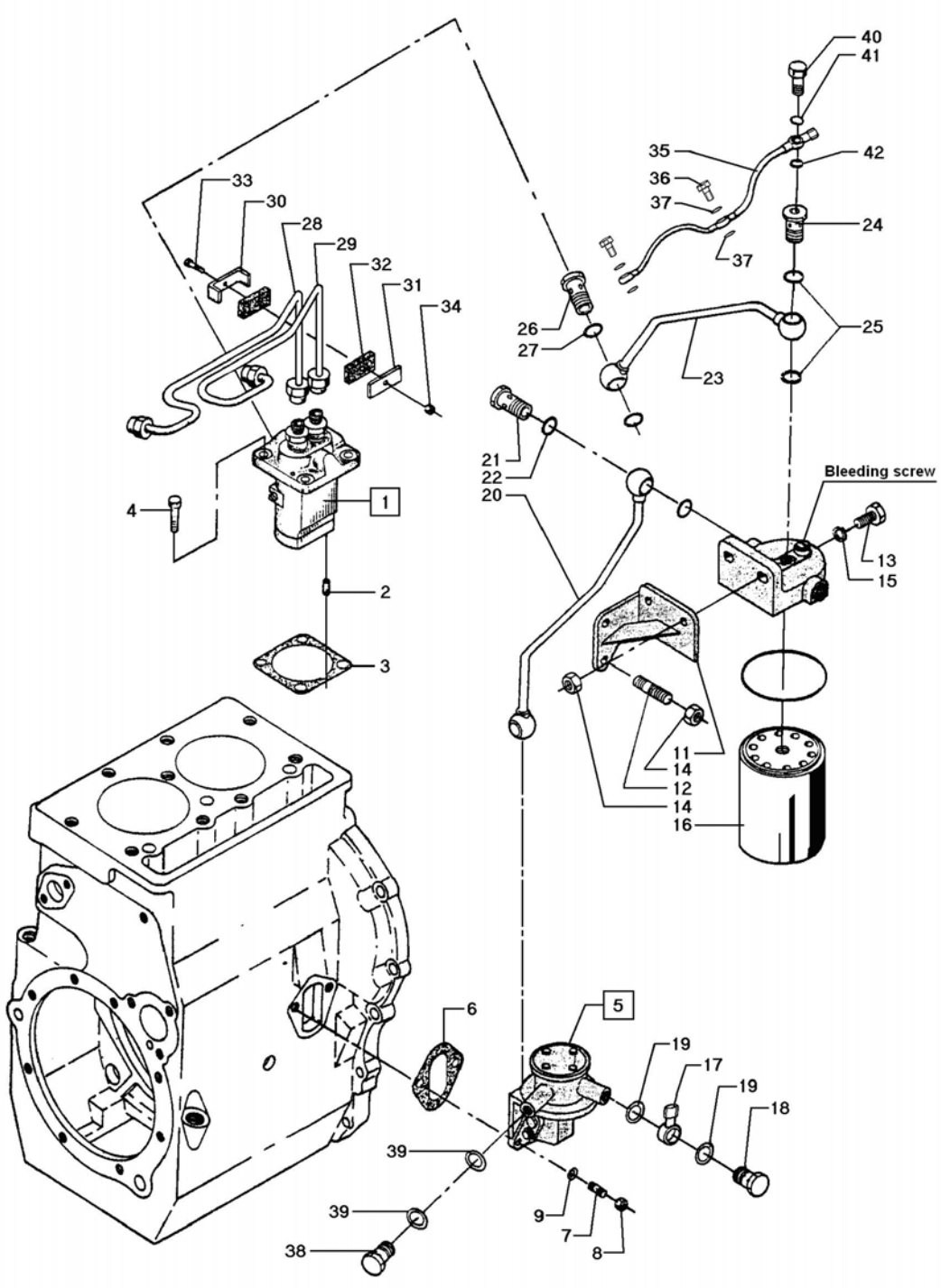
Fuel Lift Pump

The fuel lift pump pos. 5 is of type SOFABEX and cannot be repaired and needs to be changed completely if failing.

The pump is removed from t he engine by loosening the two nuts pos. 8.

Fuel Filter

The fuel filter cartridge is changed every year or for every 300 hours of running.
The cartridge pos. 16 is screwed into the fuel filter cover.
Every time the cartridge is changed, also the O-ring seal must be changed.



Fuel Valve

The fuel valves are mounted in the cylinder head and are secured here with tightening bars which are loosened when dismounting the fuel valves.

Disassemble the fuel valves after the sketch below and so the nozzles can be exchanged and the pressure can be adjusted at the washers pos. 5.

Adjust the fuel valves by means of pressure test apparatus at 210 Bar opening pressure.

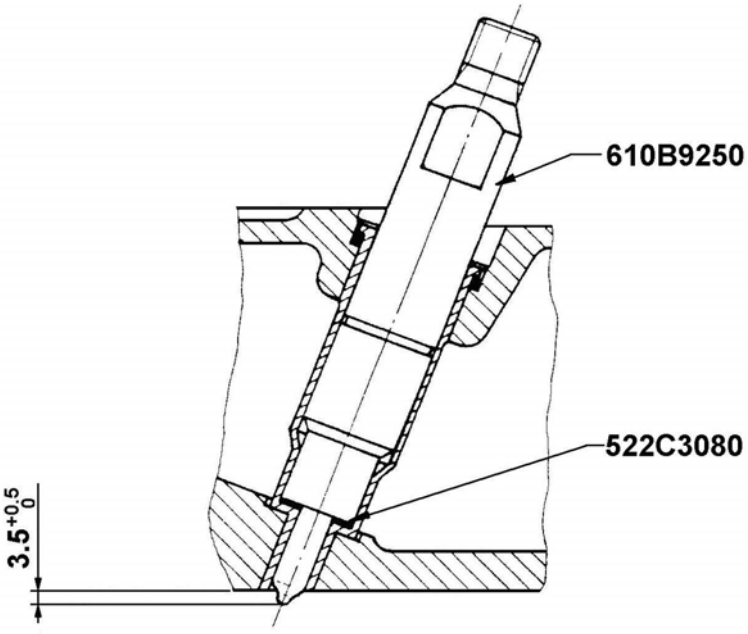
When using Bosch pressure test apparatus for nozzles you are referred to Bosch information WPP 320/2 DK (500.8.76) and this states test procedure and measures in detail.

The nozzle pos. 2 is a Bosch nozzle DLLA 150 P34 combined with nozzle holder KBEL 78P 10/13 and this combination makes the fuel valve.

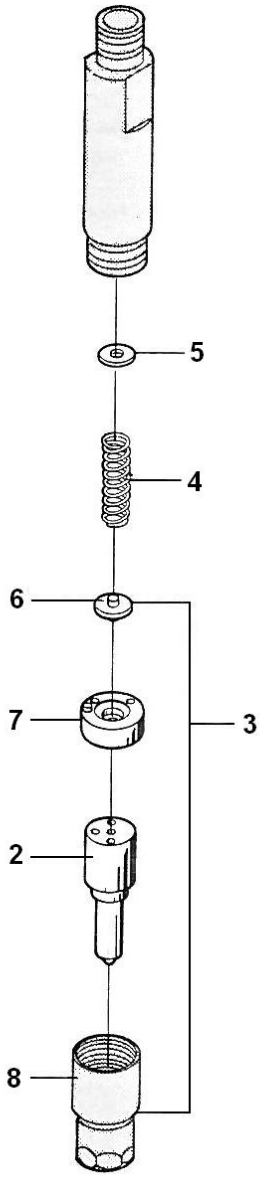
The adjusting filling pieces for injection pressure are obtainable from 1 mm to 1.975 mm thickness with 0.05 mm from washer to washer.

When exchanging the nozzle the new nozzle has to be cleaned in petrol as it has been prepared with a protective oil. Both nozzle needle and nozzle housing should be carefully cleaned.

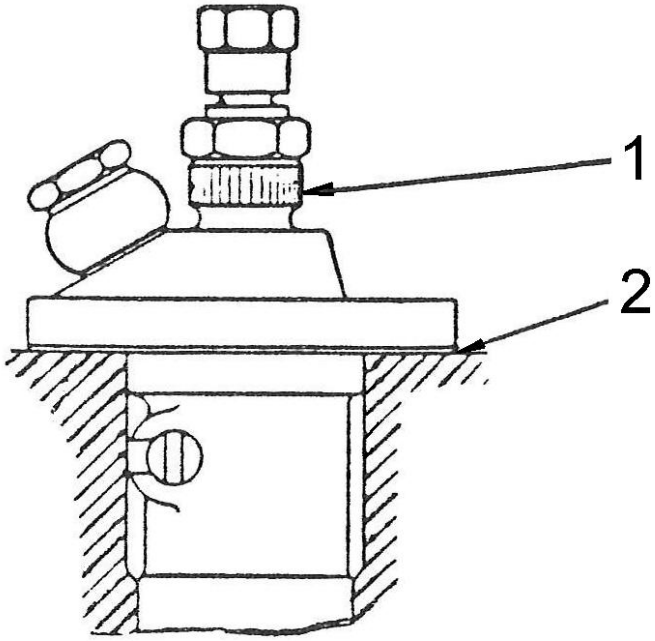
When assembling the fuel valve tighten with 6 – 8 Kpm.



Fuel Valve fitted into the Cylinder Head.



Adjustment of Injection Timing (Spill Point)



Usually it is not necessary to adjust the injection timing in case of small engine repairs which do not affect the fuel system direct.

If, however, the fuel pump has been dismounted , or if there are smoke development , spark knock, and increasing cooling water temperature the injection timing must be adjusted.

It is important that these adjustments are strictly observed so as not to damage the engine.

In case of too early injection the combustion pressure gets too high resulting in bad combustion, hard running and increased load of the bearings.

Too late injection results in higher exhaust temperature, bad economy, bad power output and difficult starting.

Data for injection timing

Scale:	14.71° before top
Arc measure (measured on flywheel):	50 ±1 mm
Piston motion (cylinder) before TDC:	1.766 mm (0.0695”)

Shims for adjustment of injection timing are available in thicknesses of 0.1 – 0.15 – 0.2 mm.

Adjustment of injection timing

1. Remove a valve spring so that the valve can “step” direct on the top of the piston. In case of great repairs the adjusting is carried out before the cylinder head is fitted.

2. Dismount fuel pressure pipes and the delivery valve of the fuel pump.

3. Refit the valve housing (1) without delivery valve and pressure spring.

4. Fit a sphygmomanometer or a capillary tube on the fuel pump.

5. Fit a dial micrometer so that the measuring is made on the crown of the valve stem or directly on the piston top.

6. Set the piston in the top dead centre position in the compression stroke and the dial micrometer in 0 position. Mark this position on the flywheel from a fixed point on the engine block.

7. It is now necessary to eliminate clearance and wear between the direct and indirect connection of the piston and the fuel pump.

8. Now lower the piston down into the cylinder (e.g. 2 mm) in the direction of rotation and towards it respectively.

9. These positions should correspond to the timing mark on the flywheel and arrow on the engine block.

10. Adjust the centre mark on the flywheel so that it is exactly halfway between the extreme points. The measuring should be carried out with a sliding gauge. Turn the flywheel so that the new centre point is opposite the fixed point on the engine block. Set the dial micrometer in 0 position again (usually only a small deviation).

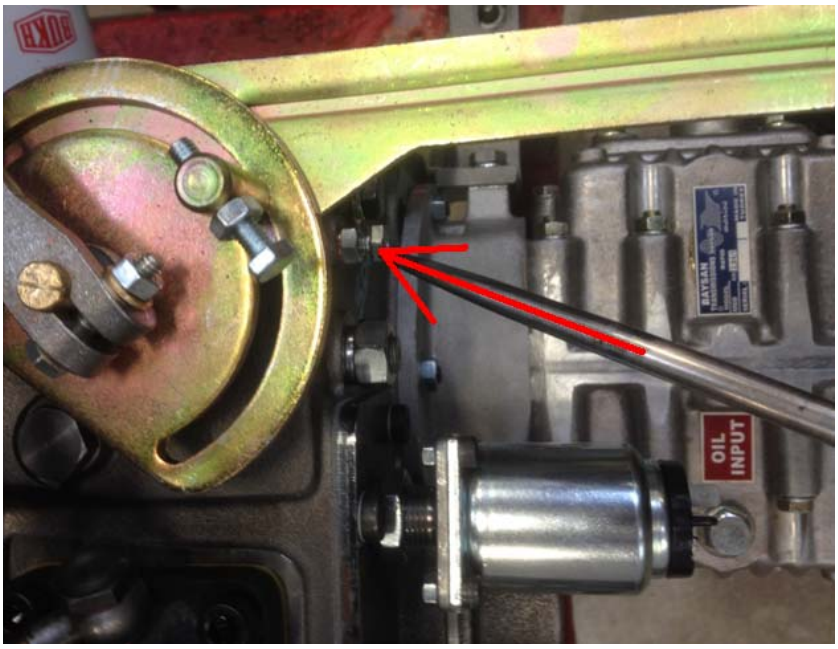
11. Set the throttle control on full output.

12. Actuate the sphygmomanometer and let down the piston 1.766 mm in the cylinder (at 3600 r.p.m.). The pressure should begin falling to 0 within 5 to 10 seconds, that is quite slowly). In case the pressure is falling too rapidly, an intermediate washer of adequate thickness has to be removed at (2). If the pressure does not fall, an intermediate washer has to be inserted.

13. Dismount the tools and fit the engine.

Fuel adjustment

The adjustment has to be made at normal engine operation temperature (run the engine for minimum 15 min. at different load and speed from idling to full speed). Thereafter the fuel amount can be reduced by turning the M6 screw on below photo (RED ARROW).



The engine seen from above and the fuel adjustment screw is pointed out with a red arrow.

The needed tools are 2 pcs. 10 mm fork spanner.
Start loosening the M6 counter nut (see photo below) – thereafter turn the M6 bolt (1/6 turn or one “face”) clockwise. (Clockwise will reduce fuel amount). Retighten the M6 counter nut.
Test boat speed. Continue until the speed is reduced – and then turn 1/6 counter clock wise again and retighten the M6 counter nut.

SECTION IJ

PISTON, CONNECTING ROD AND CYLINDER LINER

CONTENTS

Dismounting of Pistons and Connecting Rods

1. Drain the cooling water and the lubricating oil from the engine.

2. Dismount the cylinder head (see section C page 5).

3. Remove any wear or soot edge which may be at the top of the cylinder liner with a scraper.

4. Turn the engine “upside down”.

5. Remove the oil pump.

6. Unscrew the connecting rod nuts and remove the bearing cap from the connecting rod.

7. Fit the connecting rod bolts with protective caps (soft plastic hose or the like) in order to avoid the crank being damaged.

8. Turn the piston in top position and press out the piston and the connecting rod of the cylinder liner. The crank must be in the exact top position.

   Note! On later engines the connecting rod nuts have been replaced by unbraco screws and therefore item 7 can be omitted.

Exchange of Pistons

If the piston is defective, it must be changed.

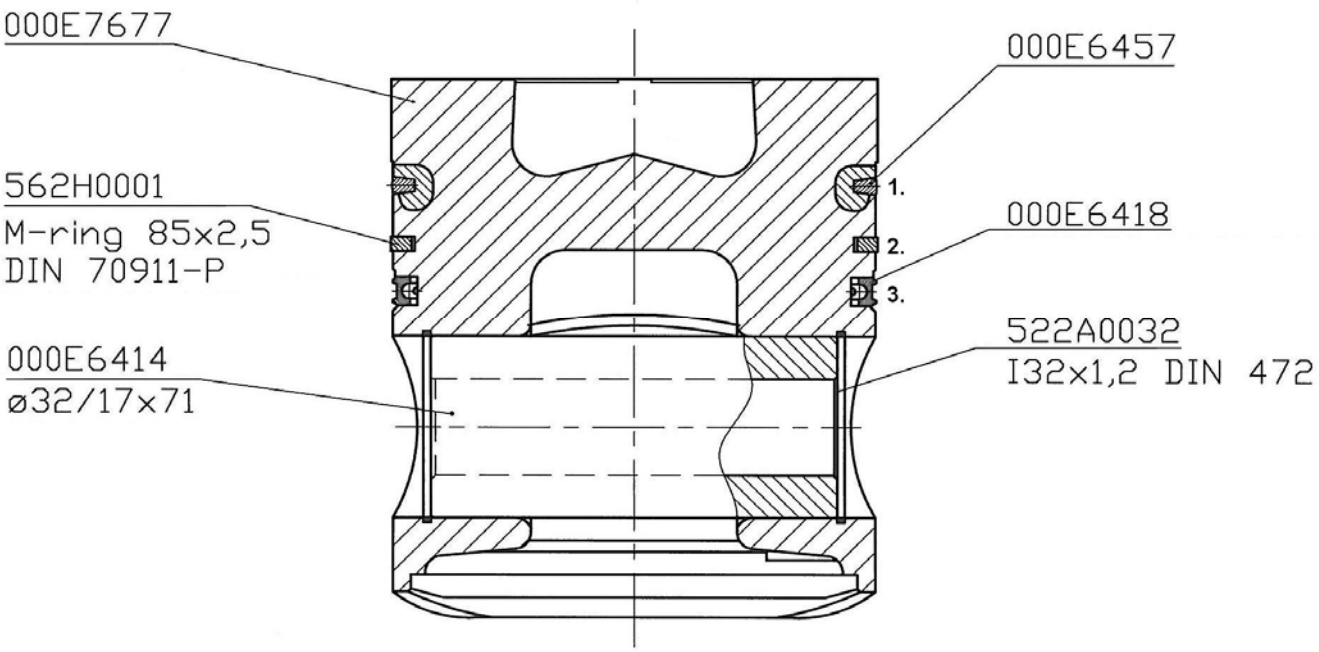
This takes place as follows:

1. Dismount the piston with connecting rod (see page IJ 3).
2. Take off one of the lock rings at the piston pin.
3. Knock out the piston pin with a punch.
4. Place the new pistons upside down. Pour a little spirit into them and light it.
   The heating can also take place on a boiling plate.
5. Smother the fire when the piston is about 100°C. Place the connecting rod in the piston before the oiled piston pin is pushed in.

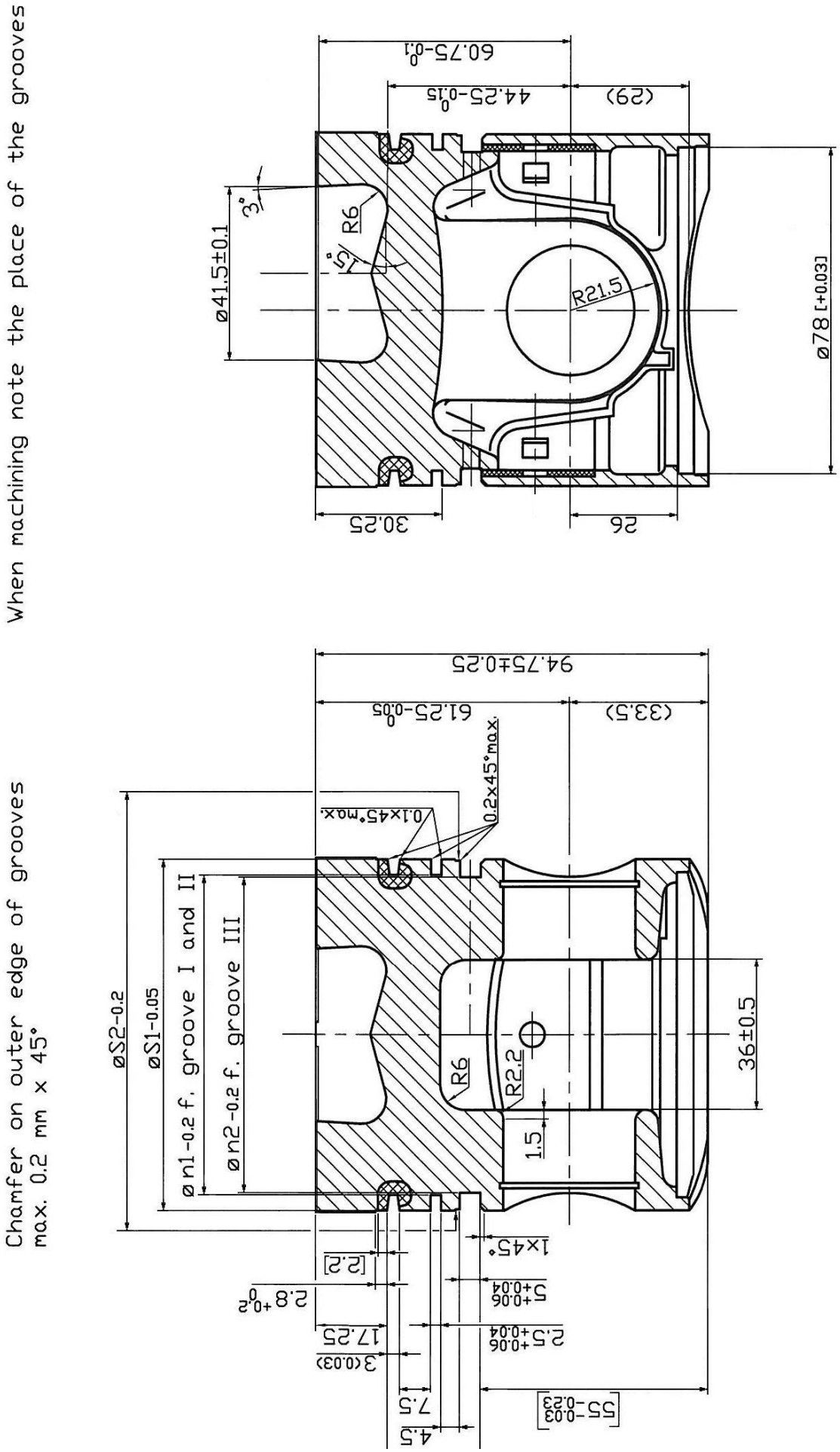
   If it is possible for you, it is recommended to cool down the piston pin first, e.g. in a deep freezer.
6. Then lock the piston pin with the lock ring.

Observe carefully that the piston is placed in the same direction as before in proportion to the numbers on the connecting rod.

Weight of piston complete: 1,122 grams ± 7 grams.



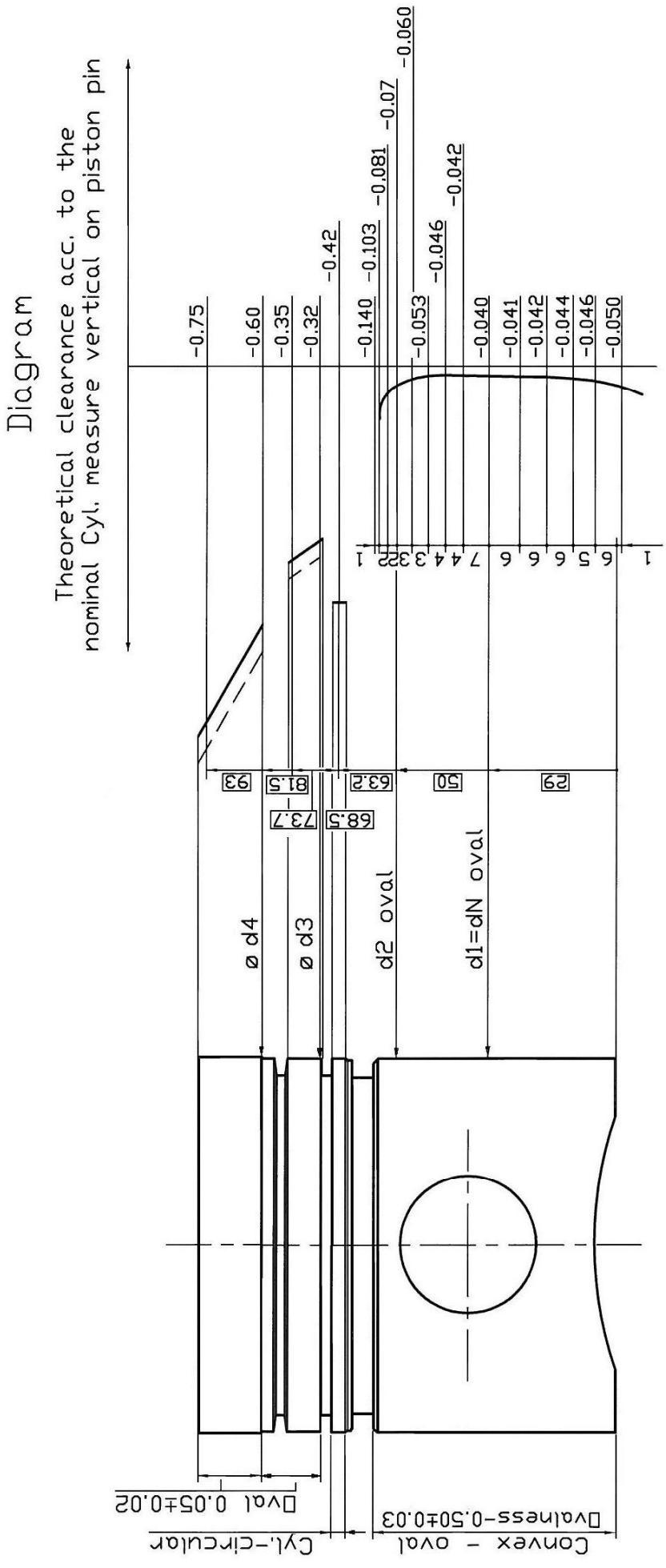
Measurements for Piston



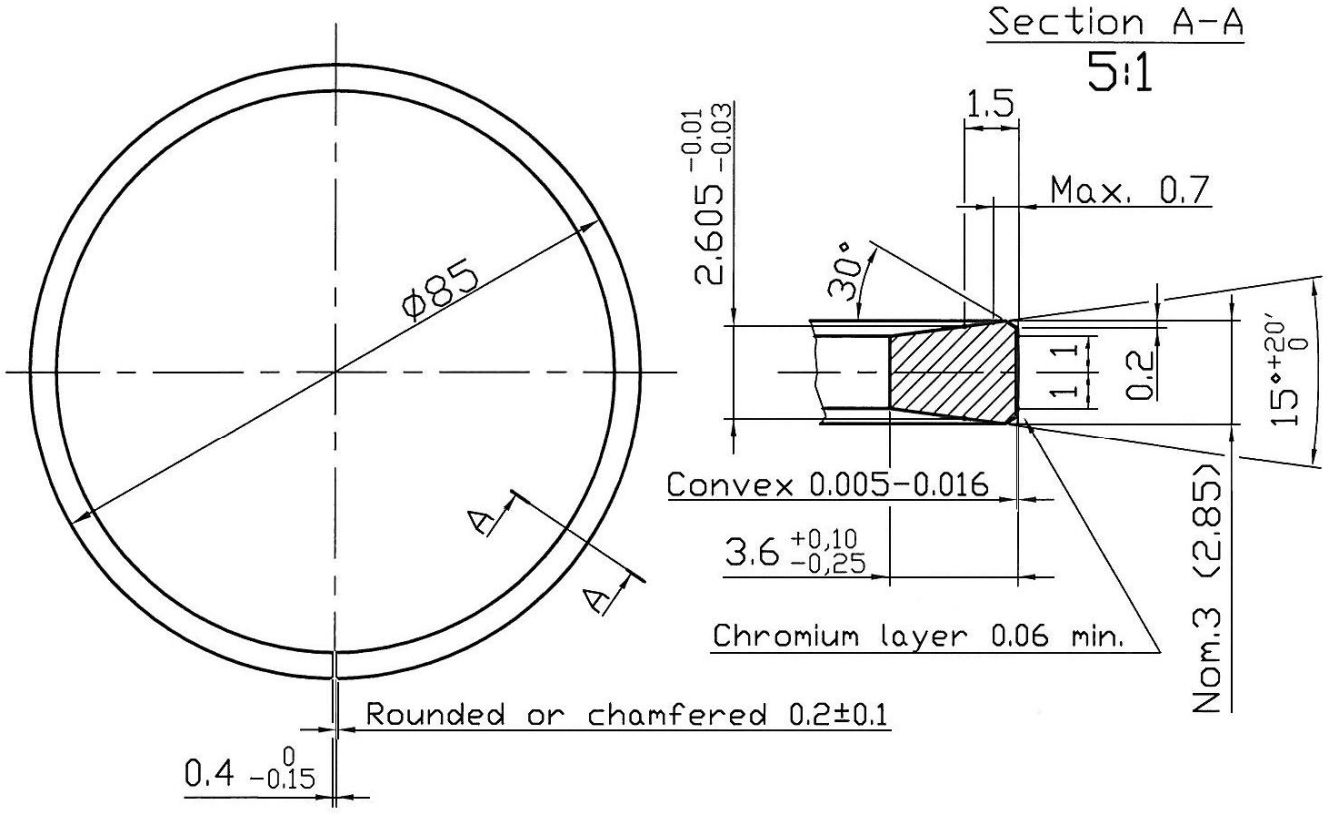
IJ6

Piston sign	Cyl. ø	dN	n1	n2	B	S1	S2
Grade							
Std.	85.0	84.96	76.7	75.7	82.0	84.25	83.5

d1 = dN ±0.009
d2 = ⟨dN eff −0.03⟩ ±0.007
d3 = ⟨dN eff −0.38⟩ ±0.012
d4 = ⟨dN eff −0.56⟩ ±0.012



Piston Ring 1 (Please note page IJ4)



1. Material: Cast iron (TP□1301)
   (1) Analysis (%):

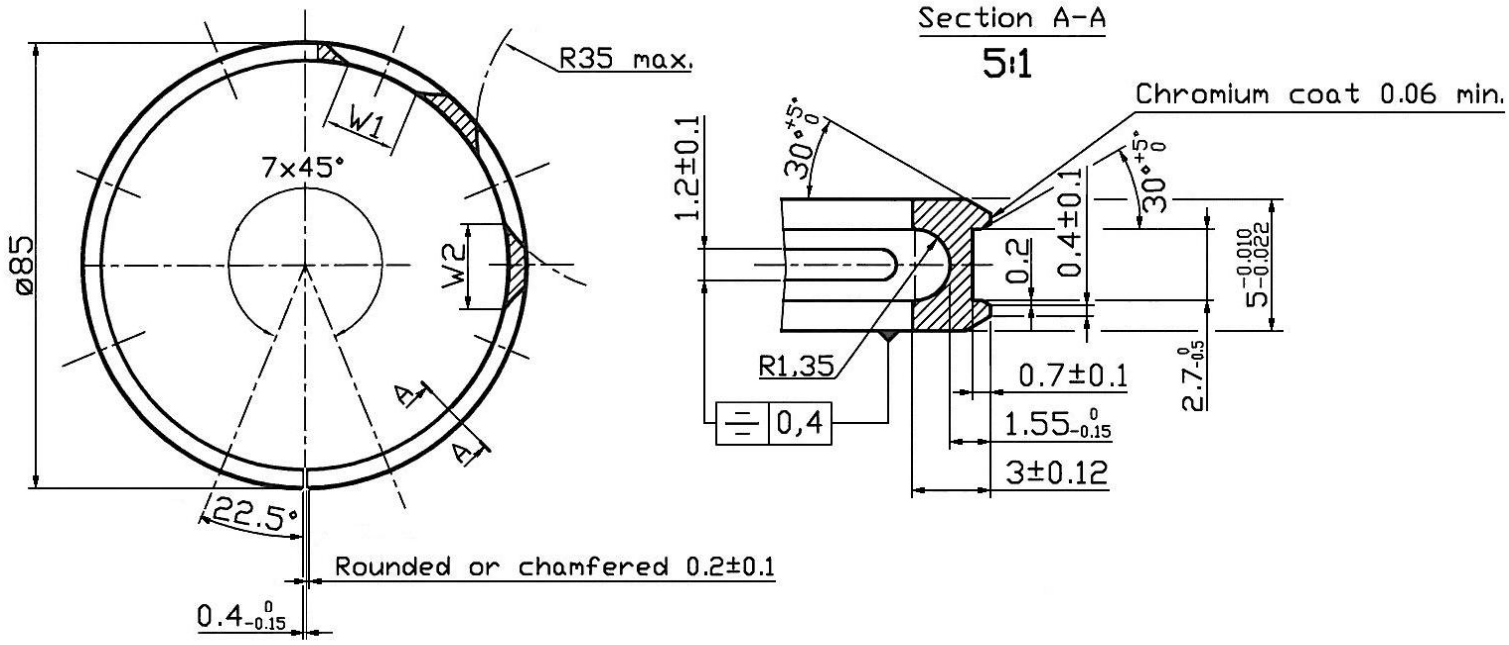
T.C	Si	Mn	P	S
3.3 ~4.1	2.0 ~3.2	0.2 ~0.6	0.15 Max.	0.03 Max.

   (2) Modulus of elasticity: Min. 14000 kp/mm^2
   (3) Ultimate strength: Min. 55 kp/mm^2
   (4) Hardness: 100-110 HRB
2. Tangential force: 2.6±0.41 kp
3. Surface threatment: Phosphated

TP. nr.: K01-087977

Drg.no. 000E6457

Piston Ring 3 (Please note page IJ4)



1. Material: Cast iron (TP01101)
   (1) Analysis (%):

T.C	Si	Mn	P	S	Cr
3.2 ~4.0	2.1 ~3.1	0.4 ~1.0	0.2 ~0.6	Max. 0.12	Max. 0.4

   (2) Modulus of elasticity: Min. 8000 kp/mm²
   (3) Ultimate strength: Min. 25 kp/mm²
   (4) Hardness: 95-107 HRB
2. Tangential force (with spring): 4.76±0.95 kp
3. Surface treatment: Nitrated
4. Allowable diff. between W1-W2: 4 mm
5. Spring: ø2.5±0.05

TP nr. K01-089745-00

Drg.no. 000E6418

Exchange of Piston Rings

The piston ring gap is 0.3 – 0.45 mm (0.0118 - 0.0177 inch) in a new engine.

The wear of the piston rings can be seen by measuring the piston ring gap, and the piston rings must be changed when this is max. 2.0 mm (0.0787 inch).

This is done as follows:

1. Take out the piston with connecting rod (see page IJ 4).

2. Take out the piston rings either by a special pair of tongs or by means of two pieces of twine which are folded. With the closed ends around the ends of the piston ring, the piston ring is extended and can be taken up.

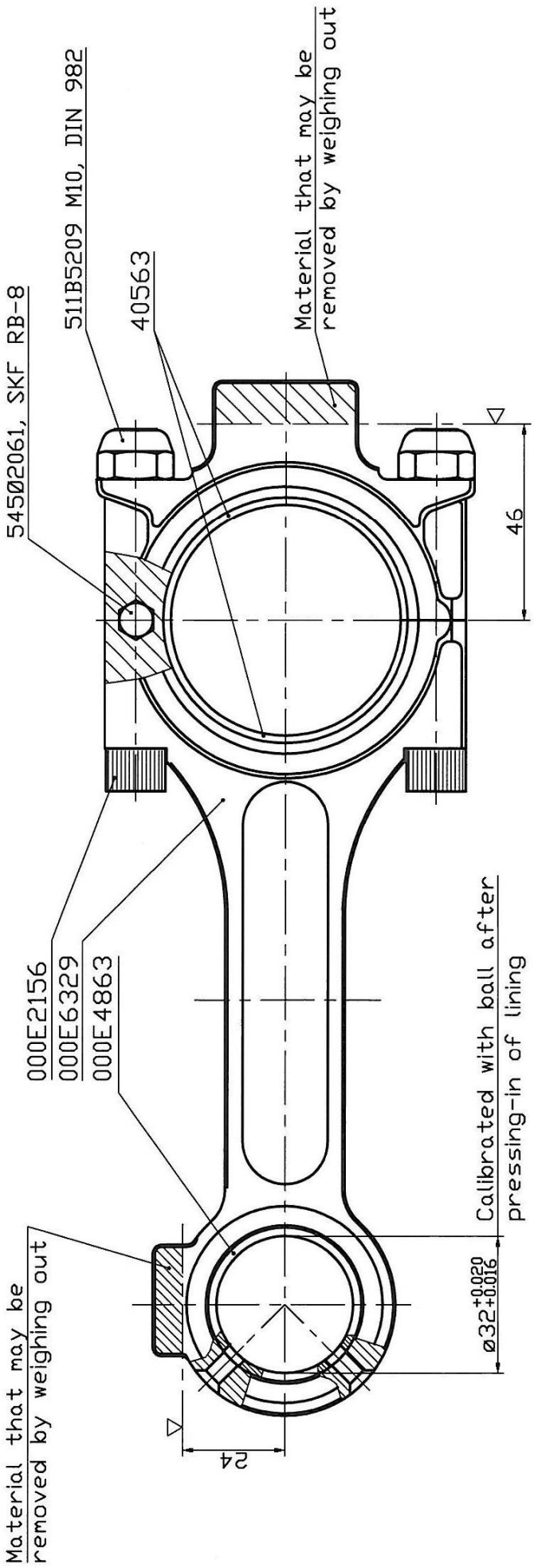
The mounting take place in the reverse order when the piston grooves in the piston have been cleaned with for example a steel brush. You must not use a rotating steel brush or a steel scraper as cleaning tools.

Each piston has three piston rings: 2 compression rings and one oil scraper ring. The upper compression ring are shown on page IJ 7 the lower compression ring is a so called M-ring and the oil scraper ring is shown on page IJ8.

Exchange of Piston Pin Bearing in connecting rod

If heavy wear of the piston pin bearing in the connecting rod is found, it may be necessary to exchange it. Particular attention should be paid when exchanging, as the bearing must be calibrated to correct roundness and clearance after the fitting. This is either done with a calibration ball, as indicated on page IJ10, or with a reamer with the tolerance mentioned.

Arrangement of Connecting Rod



Weighing of connecting rod:

Weight of connecting rod complete:	1548 gram $^{+8}_{-20}$ g
Weight of heavy end:	1156 gram ±4g
Weight of light end:	392 gram ±4g
Weight without kush and bearings:	1430 gram ±14g

Mounting of Pistons and Connecting Rods

1. Put a slip ring over the cylinder liner.

2. Place the crank in the top position.

3. Fit the connecting rod bolts with protective caps.

4. Lower the piston and the connecting rod down into the cylinder liner by means of the slip ring while observing that the piston ring gaps are staggered. It should further be checked that the milled recess in the piston top is turned towards the fuel valve. Before fitting the pistons and connecting rods lubricate the crank journals abundantly with lubricating oil.

5. Turn the engine “upside down”.

6. Remove the “protective caps”.

7. Fit the bearing cap with the bottom bearing shells.

8. Tighten the connecting rod bolts with a torque of 7 kp*m (50.7 ft.lbf). Use self-locking nuts for the connecting rod bolts and replace the nuts after each disassembling of the connecting rod.

Remark! The numbers on the connecting rods must be placed as before the disassembling
The numbers on the connecting rod and the bearing cap must fit.

Connecting Rod Bearings

The connecting rod bearings are in two parts and consists of two steel shells in which a thin layer of bearing metal is cast.

The connecting rod bearings must be exchanged if they are scratched or if the “red” layer between the bearing metal and the steel shell can be seen faintly.

When grinding the crank journal, connecting rod bearings can be supplied in following undersize: 0.6 mm (0.02362inch) (see section L).

Cylinder liner

The bore of the cylinder liner is 85.000 – 85.020 mm (3.3464 – 3.3472 inch). The cylinder liner must be exchanged when it is worn max. 0.3 mm (0.012 inch).

Measuring of Cylinder Wear

Place a new piston ring in the upper end of the liner where this is not worn. Measure the piston ring gap with a feeler gauge. This will be e.g. 0.3 mm (0.012 inch). Place the piston ring lower in the liner where it is worn and measure the piston ring gap again which is now e.g. 0.9 mm (0.0354 inch).

The wear of the liner is then (0.9 – 0.3) / 3 = 0.2 mm. That is: Largest measure less smallest measure divided by 3 (approximate value for ¶).

The cylinder liner can also be measured with a cylinder template gauge.

Dismounting of Cylinder Liner

1. Remove the cylinder head (see section C page 7).

2. Take out the pistons (see page IJ 3).

3. Cover the connecting rod journals with a piece of oil paper or plastic.

4. Pull out the cylinder liner with a special tool or turn the engine upside down and knock out the cylinder liner carefully from the bottom with a wooden block as filling piece.

Mounting of Cylinder Liner

There is no gasket between cylinder liner and the engine block at the top., The joint faces must therefore be completely clean and without burrs. Grind with abrasive compound, if required.

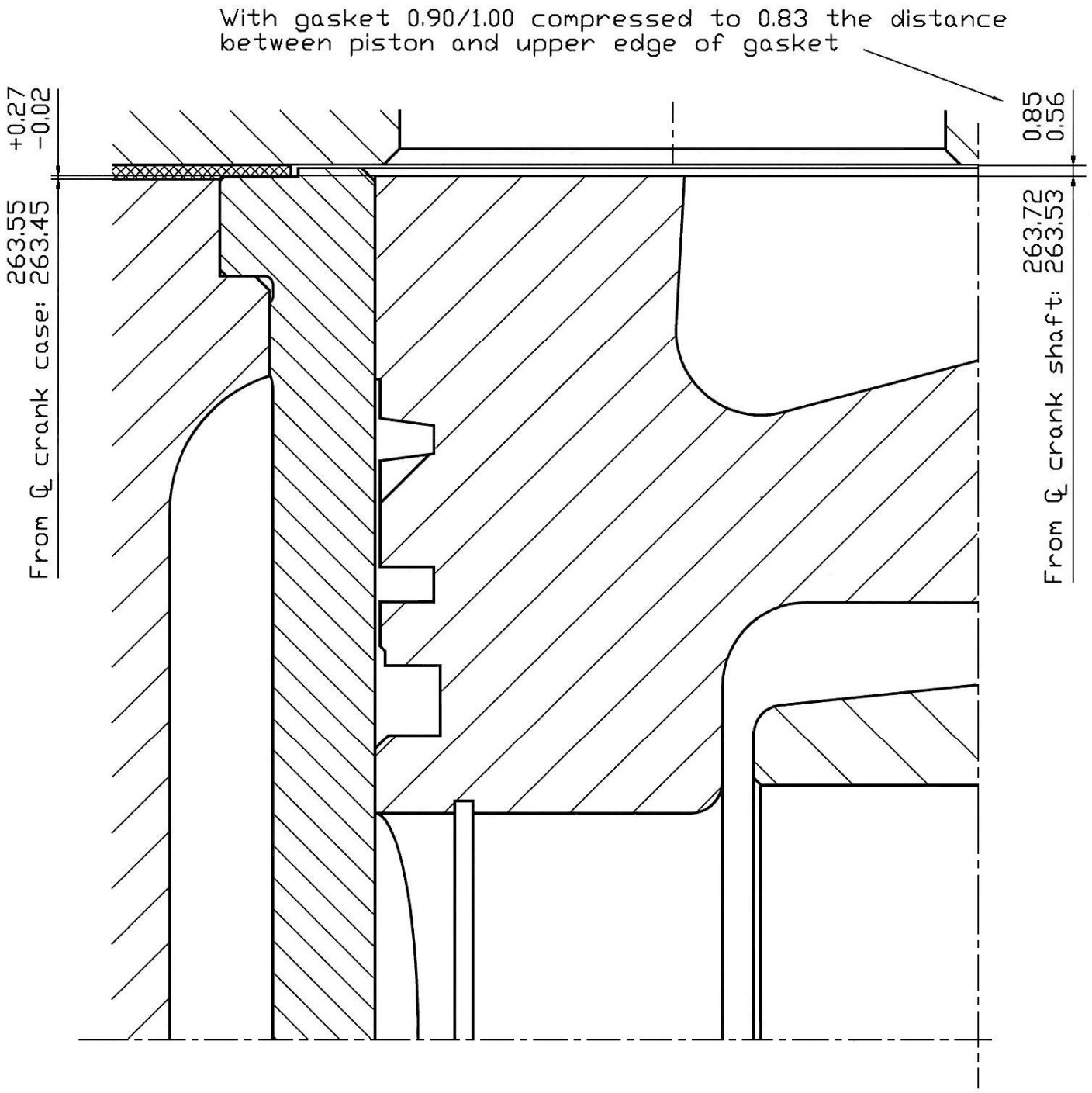
The rubber rings of the lower edge of the cylinder liner must be renewed at each disassembly and they must not be twisted when mounting.

The rubber rings and the collar may be supplied with a thin coat of jointing paste at the mounting.

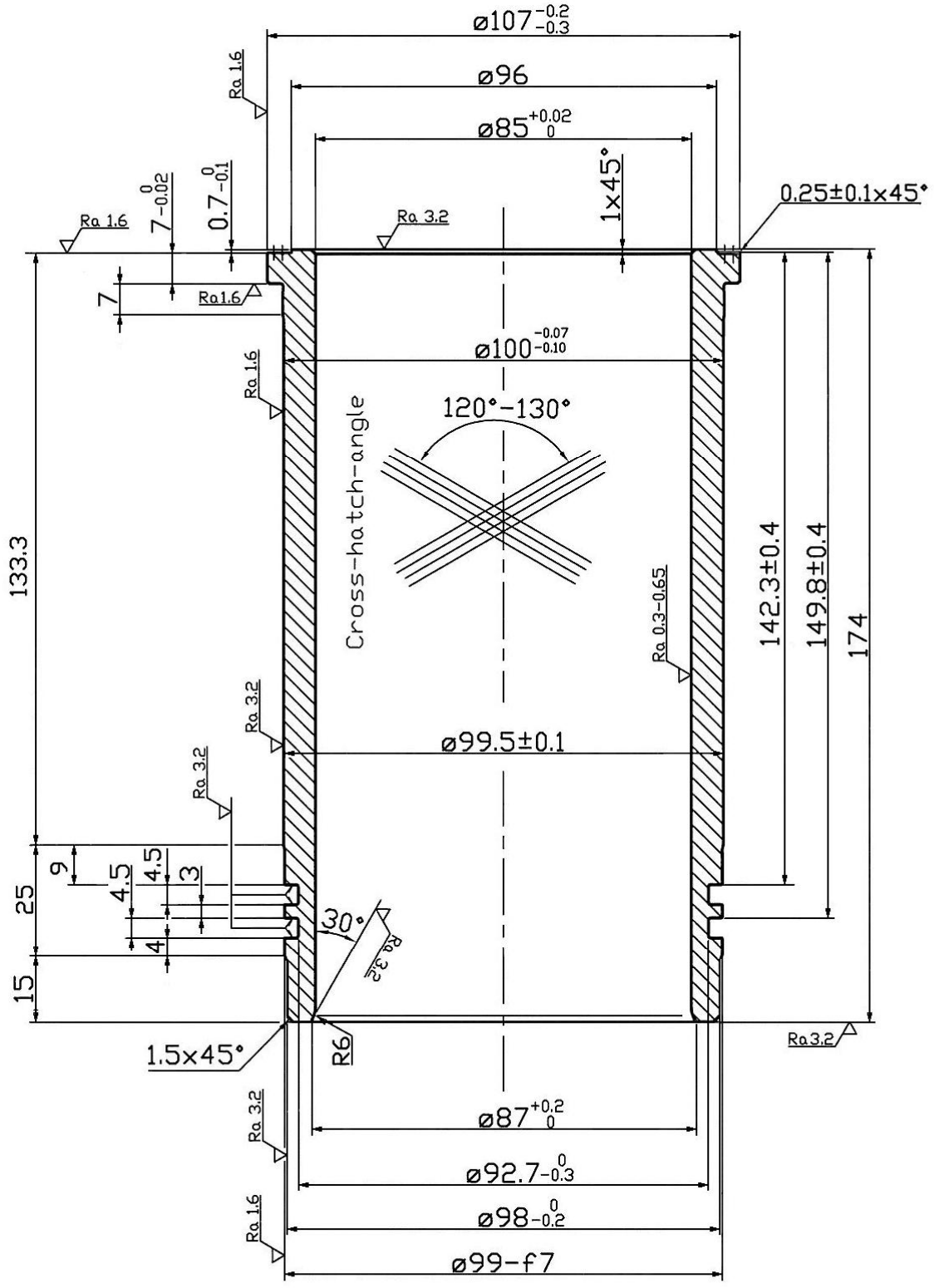
When the above things are in order put back the cylinder liner in the engine block – by means of a wooden block.

After the mounting you must check the clearance of the liner above the engine block. This clearance must be 0.10 – 0.20 mm (0.0039 – 0.0079 inch).

Arrangement of Cylinder Liner



Test Measurements of Cylinder Liner



Drg.no. 000E1561

SECTION K

ENGINE BLOCK AND OIL SUMP

CONTENTS

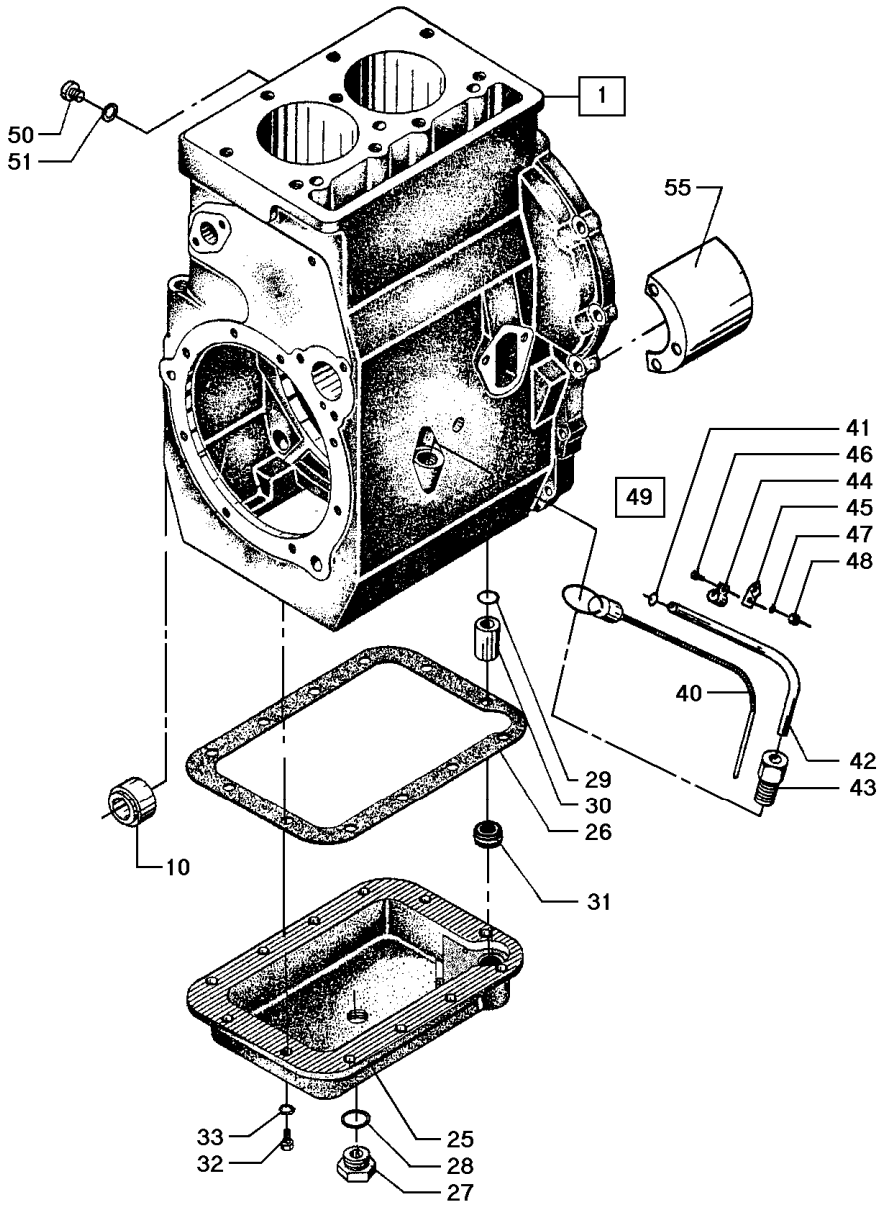
Crank case and oil sump

The crank case is made in cast iron and contains when delivered as spare part the cylinder liners and studs for cylinder head.

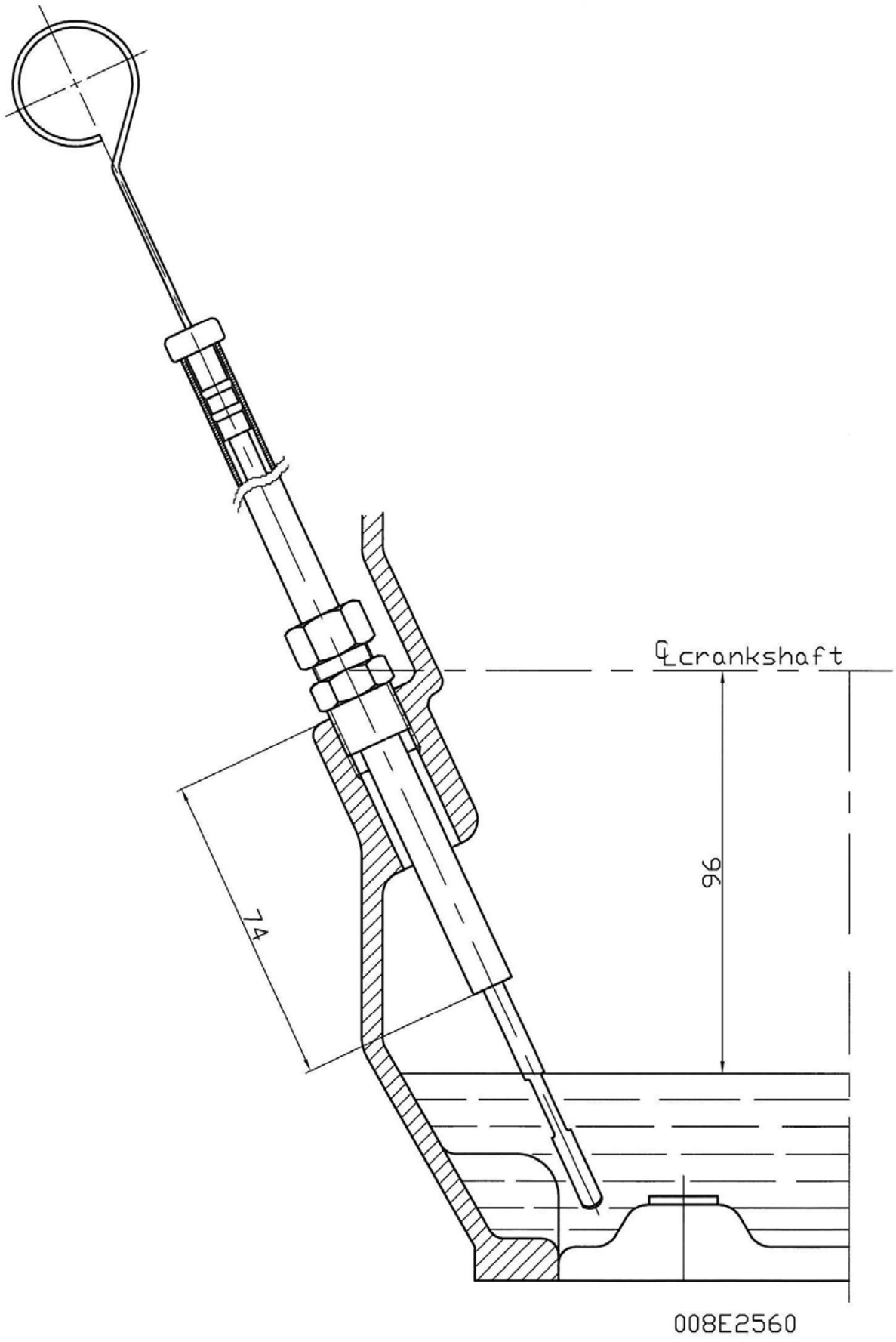
The crank case as well as the other parts of the engine are basicly designed for seawater cooling in respect of alloy and dimensions of cooling water channels etc.

The crank case contains the rear main bearing and the hub for the intermediate bearing (pls. note section L).

The shield pos. [55] is to protect the oil flow from the rear rotating weight to avoid oil leakages.

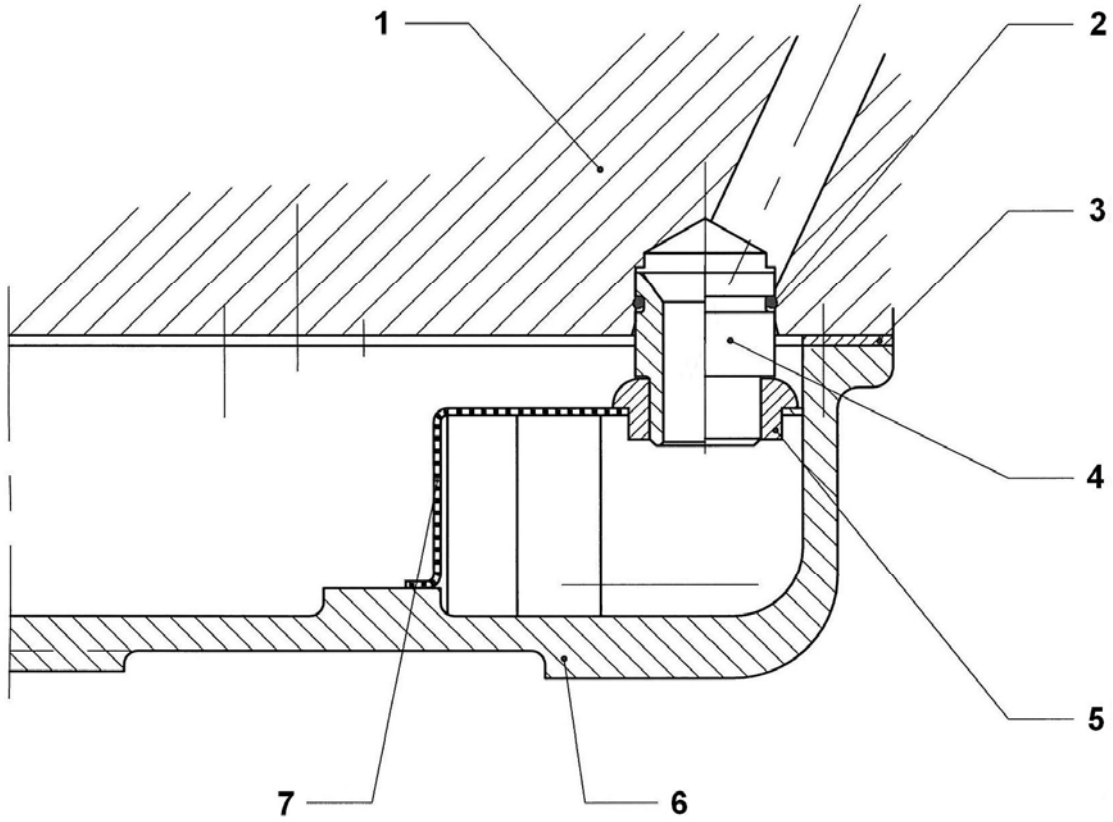


Fitting of oil dip stick



Fitting of inlet connecting piece

On the sketch below the fitting of the inlet connecting piece is indicated. Especially please note the fitting of the O-ring.



Pos.	Part No.	Qty.	Beskrivelse	Description	Benennung
1	000E7666	1	Krumtaphus	Crank case	Kurbelgehäuse
2	560B1017	1	O-ring ø17,1x1,6	O-ring ø17.1x1.6	O-ring ø17,1x1,6
3	000E0975	1	Pakning	Gasket	Dichtung
4	000D9541	1	Sugerør for grovfilter	Suction pipe for pre-filter	Saugerohr für Vorfilter
5	000D9786	1	Gennemføring for grovfilter	Leading In for pre-filter	Durchführung für Vorfilter
6	000E5764	1	Bunddæksel	Base cover	Zylinderboden
7	000E0587	1	Si for grovfilter	Strainer for pre-filter	Sieb für Vorfilter

Tightening of lubricating oil grooves

It is necessary that the O-rings which are used between the crank case and rear end cover for tightening of the lubricating oil grooves have metallic contact. The O-rings are to be placed in the recesses in the crank case. It may also be necessary to make the holes in the gasket bigger.

Upside-down valve

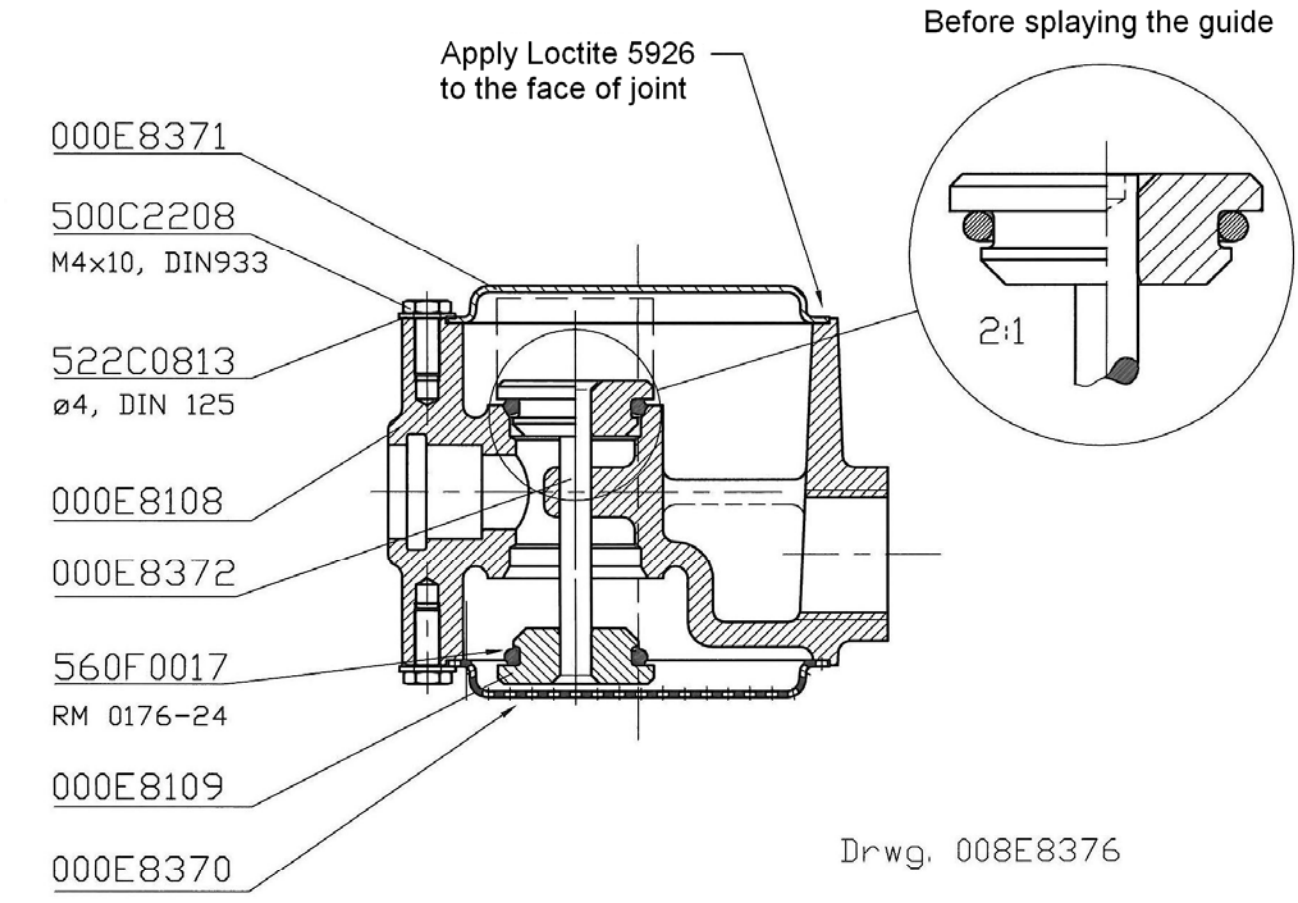
The upside-down valve is used when an engine is delivered for a closed lifeboat where it is required that the engine must be able to run during capsizing which can happen when the lifeboat enters the water.

The upside-down valve has the function to fulfil the above mentioned requirement.

The upside-down valve is fitted in the oil sump and connected through an outer pipe to the cylinder head cover. When the engine is running in its normal position the valve will secure that the lubricating oil is being sucked from the oil sump and when the boat capsizes that the oil is being sucked from the cylinder head cover.

The valve stem closes and open by means of the power of gravity.

The valve is repaired by loosening the three screws in the cover after which all internal parts can be taken out. When assembling the screws should be sealed with Lock-Tite.



SECTION L

CRANKSHAFT, INTERMEDIATE BEARING AND REAR END MAIN BEARING BUSH

CONTENTS

Repair dimensions of crankshaft

The crankshaft is made of drop-forged, heat-treated steel. Thus, the crankshaft may be ground without subsequent surface hardening.

The crankshaft must never be repaired with hard chromium-plate or metal feeding, but only by grinding in accordance with the below mentioned measures and tolerances to which we supply undersize bearings.

The crankshaft must be ground if it is oval and the smallest diameter is 0.05 mm (0.002 inch) below the diameter it had when leaving the factory.

The end play of the crankshaft must be:

DV24: **0.25 – 0.40 mm** (0.0098 – 0.0157 inch)

Front main bearing journal (flywheel side)

Standard ..... 64.987 – 65.000 mm (2.5585 – 2.5591”)

0.6 mm undersize ..... 64.387 – 64.400 mm (2.5349 – 2.5354”)

Clearance between bearing and journal ....0.032 – 0.089 mm (0.0013 – 0.0035”)

Rear main bearing journal

Standard ..... 55.987 – 56.000 mm (2.2042 – 2.2047”)

0.6 mm undersize ..... 55.387 – 55.400 mm (2.1806 – 2.1811”)

Clearance between bearing and journal ....0.029 – 0.086 mm (0.0011 – 0.0034”)

Intermediate bearing journal

Standard ..... 55.987 – 56.000 mm (2.2042 – 2.2047”)

0.6 mm undersize ..... 55.387 – 55.400 mm (2.1806 – 2.1811”)

Clearance between bearing and journal ....0.029 – 0.086 mm (0.0011 – 0.0034”)

Connecting rod journals

Standard ..... 53.987 – 54.000 mm (2.1255 – 2.1260”)

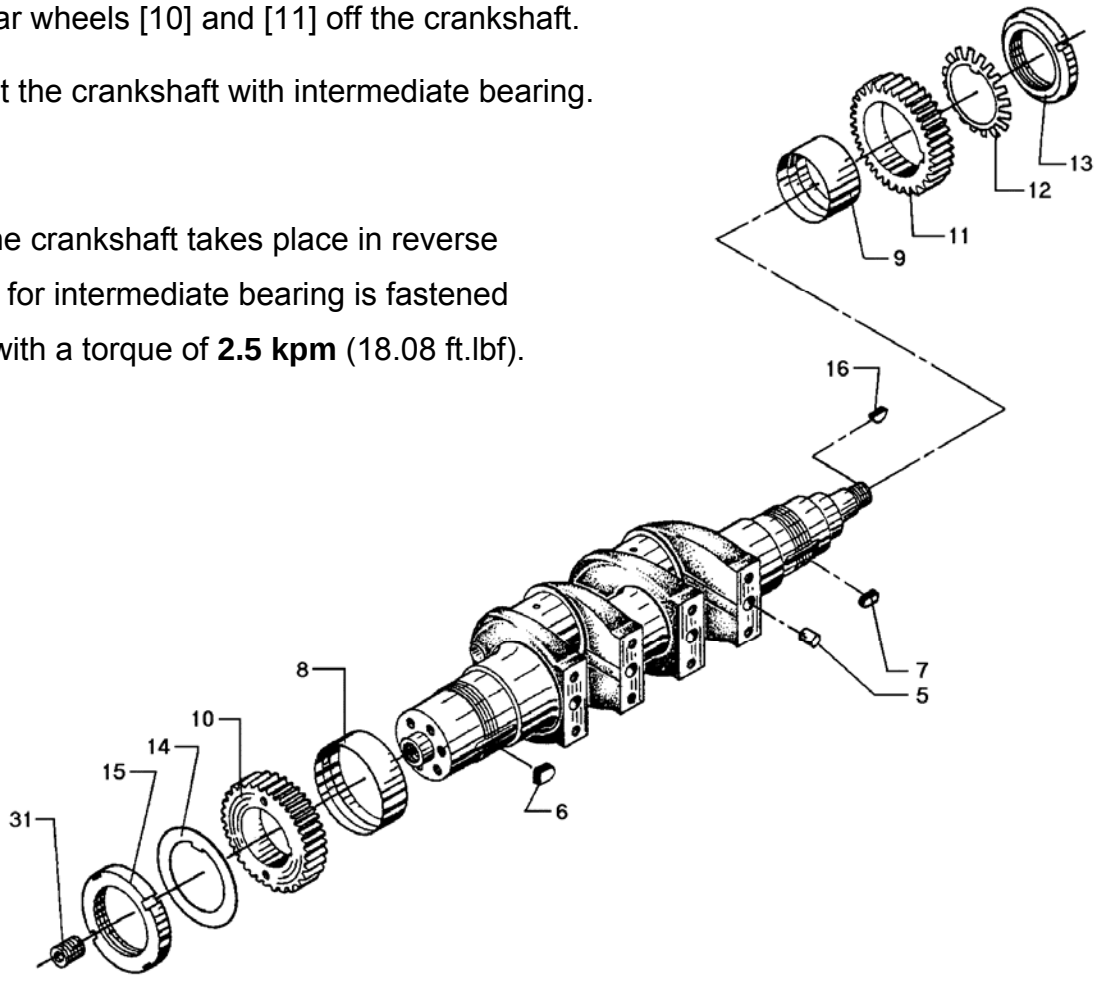
0.6 mm undersize ..... 53.387 – 53.400 mm (2.1019 – 2.1024”)

Clearance between bearing and journal ....0.028 – 0.068 mm (0.0011 – 0.0027”)
.....

Dismounting of crankshaft

1. Dismount the flywheel (see section D page 3).
2. Dismount the gear (see section R).
3. Dismount the cylinder head (see section C page 5).
4. Dismount the pistons and the connecting rods (see section IJ 3).
5. Dismount the cooling water pump (see section O page 10).
6. Dismount the lubricating oil pump (see section N page 5).
7. Dismount the raised hand starting (see section F page 4).
8. Dismount the front end cover with counter weights (see section E pages 3 and 4).
9. Dismount the rear end cover with counter weights (see section G pages 3 and 4).
10. Dismount the camshaft (see section M page 3).
11. Loosen the hub for intermediate bearing by unscrewing the two fastening bolts.
12. Take out the locking nuts [13] and [15] after having loosened the striker plate.
13. Pull the gear wheels [10] and [11] off the crankshaft.
14. Then lift out the crankshaft with intermediate bearing.

The mounting of the crankshaft takes place in reverse order, and the hub for intermediate bearing is fastened to the crankcase with a torque of **2.5 kpm** (18.08 ft.lbf).



Rear main bearing bush and intermediate bearing

When the crank has been taken out in accordance with the preceding instruction, the rear main bearing bush can be changed in the same way as the front main bearing bush (see section E page 7).

Now you can change the intermediate bearings which consist of two thin bearing shells in which a thin layer of bearing metal is cast.

A scraping of the bearings is unnecessary and must under no circumstances take place.

Change a bearing if it is badly scratched, or if the “red” layer between the steel liner and the bearing metal can be seen faintly.

Exchange of intermediate bearing

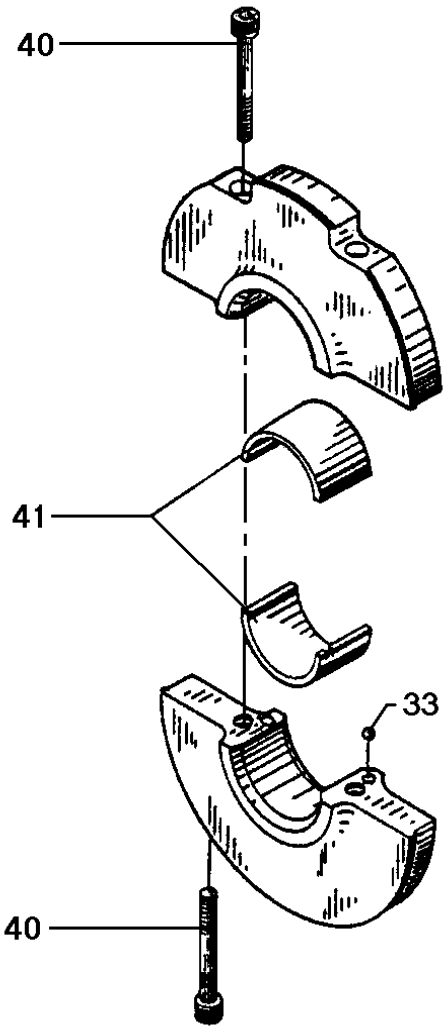
Unsrew the two unbraco screws and take out the two bearing halves. The bearing halves are assembled round two steel balls, [33].

At the mounting you must check that the upper part is the one with oil groove.

At the mounting you must tighten the bearing lightly first, then knock gently with a plastic hammer in order to secure that the guide balls are in place.

Then tighten the intermediate bearing evenly with a torque of **5.2 – 5.8 kpm** (37.6 – 41.9 ft.lbf).

When placing a crank with intermediate bearing in the crank case, you must take care that the oil groove in the bearing is facing the oil groove in the crank case.



SECTION M

CAMSHAFT, COMPLETE

CONTENTS

Camshaft

The cams which are casted together with the camshaft are made of hardened steel.

The camshaft is driven via a gear-wheel from the crankshaft.

The correct position of the camshaft must be between 0.2 – 0.5 mm (0.008 – 0.020 inch). The axial clearance must be adjusted with shims between rear end cover and camshaft or by displacing the camshaft bearing.

Dismounting of the Camshaft

1. Dismount the fuel pump (see section H).
2. Dismount the fuel lift pump.
3. Dismount the top cover.
4. Remove the push rods.
5. Dismount the cooling water pump (see section O).
6. Dismount the lubricating oil pump (see section N).
7. Dismount the raised hand starting (see section F) and the circlip at the end of the camshaft.
8. Dismount the circlip behind the chain wheel for raised hand starting.
9. Dismount the gear with coupling (see section R).
10. Dismount the rear end cover with counter weights (see section G).
11. Then the camshaft can be taken out of the crank case.

The mounting takes place in reverse order while observing carefully the marking of the gear-wheels of the crankshaft and the camshaft.

If during the dismounting some of the push rods guides have fallen down into the crank case, you must dismount the oil sump and grease the push rods before remounting through the bottom hole.

The mounting of the push rods is easiest made by using a magnet with a flexible extension.

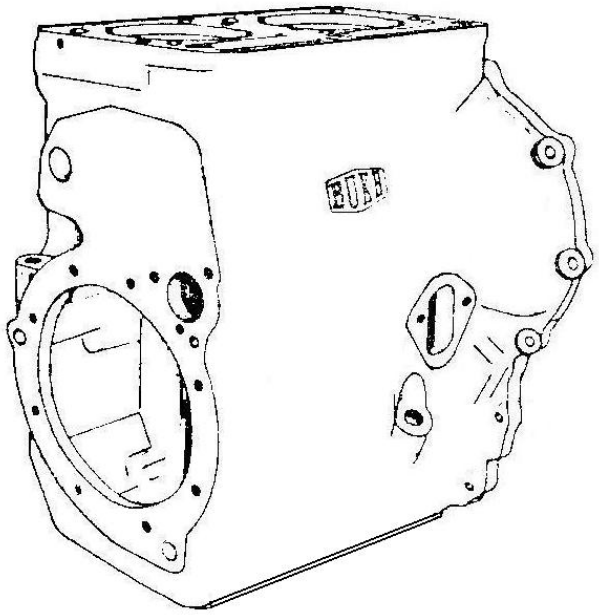
Change of Front Bearing Bush for Camshaft

1. Dismount the camshaft (page M3).
2. Dismount the front end cover (see section E).
3. The bearing bush can now be driven out by neans of a suitable punch.

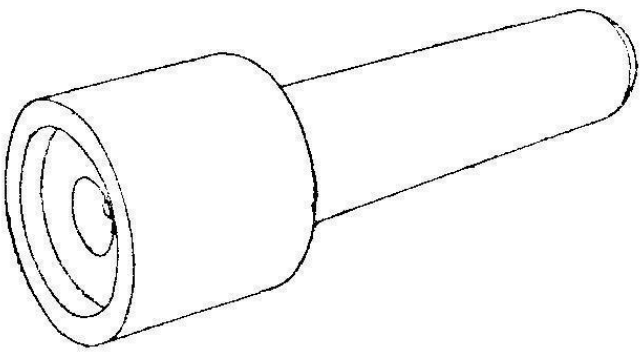
The mounting takes place in reverse order and the bearing must be pressed into the crank case by means of the special punch below.

Rermark! The bearing bush should be correct placed acc. to the lub. oil groove.

When the bearing bush is mounted the bearing tolerance should be calibrated to ø20-F7 (20.020 – 20.041 mm (0.7882 – 0.7890 inch))



Placing of bearing bush in the crank case



Mounting punch

Check of the camshaft

1. Dismount the top cover.
2. Dismount the rocker arm of the suction valve.
3. Dismount the spring of the suction valve.
4. Lower the valve cautiously into the cylinder so that it touches the piston top.
5. Turn the engine slowly until the valve is in top position.
6. Place a dial micrometer at the cylinder head with the feeler on the valve top.
7. Find the exact top position of the valve by means of the dial micrometer and place the pointer in zero position.
8. Mark the flywheel with a scriber and using a right angle. Mark the crank case in the same way. These two markings must be exactly at the same level.
9. Turn the flywheel until the valve has sunk 0.10 mm (0.004 inch) and mark the flywheel with a scriber and right angle again.
10. Repeat this procedure on the other side of the TDC. The top point of the piston is now right in the middle of these two markings.
11. Adjust the clearance of the exhaust valve to 0.3 mm and place the dial micrometer on the valve. (spring disc).
12. Check the exhaust times after the valve times and valve diagramme below.

It is only necessary to check the exhaust times. If the valve times differ considerably from the times stated below, the camshaft must be scrapped.

Valve timings and injection point

Flywheel diameter		391 mm
Inlet valve opens	before TDC:	32° (arc measure: 109 mm (4.29”))
Inlet valve closes	after BDC:	64° (arc measure: 218 mm (8.58”))
Exhaust valve opens	before BDC:	64° (arc measure: 218 mm (8.58”))
Exhaust valve closes	after TDC:	32° (arc measure: 109 mm (4.29”))
Injection starts	before TDC:	14.7° (arc measure 50 mm (1.97”))

Valve clearances (cold engine)	inlet:	0.25 mm (0.00984”)
	exhaust:	0.30 mm (0.01180”)

Injection timer

The purpose of the injection timer is to change the time of injection so that it corresponds with the RPM.

The injection timer is placed on the camshaft as shown below.

Dismounting

1. Dismount the fuel pump (see section H).
2. Dismount the gear (see section R).
3. Dismount the rear end cover (see section G).
4. Dismount the driving piece [4], the springs [5], and the centrifugal weights [3].

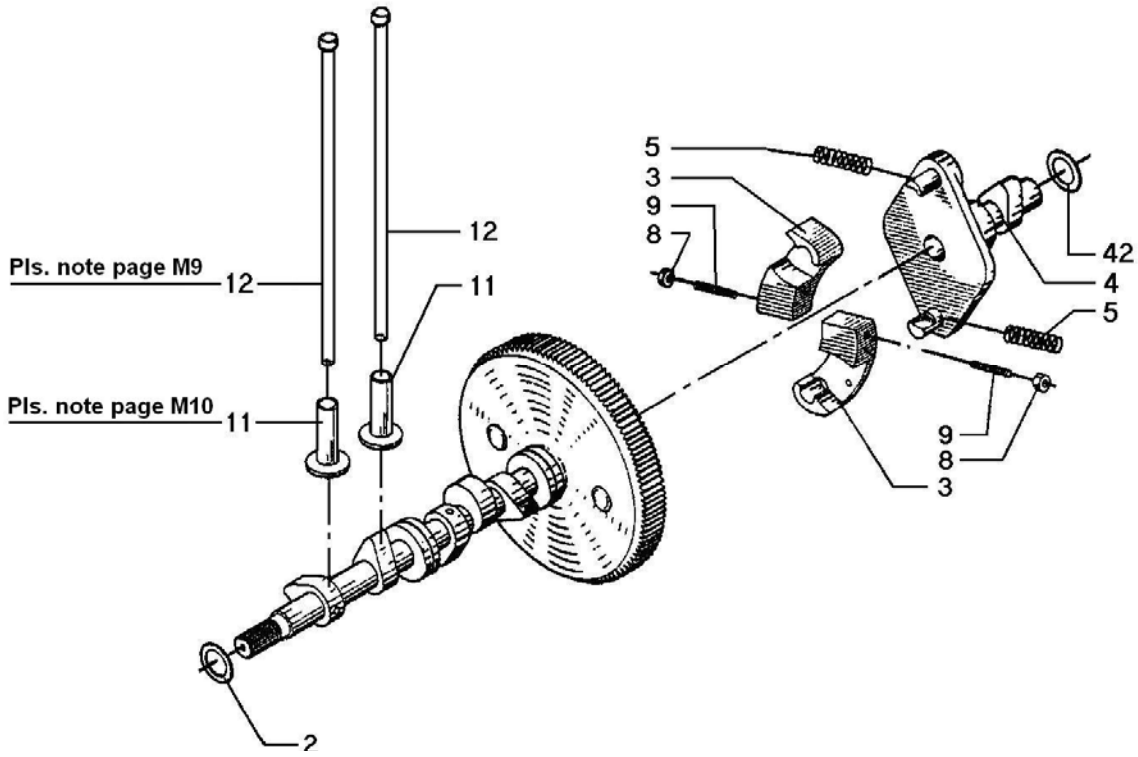
Mounting

The mounting takes place in reverse order and it must be checked that all parts operate smoothly.

Check that the length of the springs is approx. 40.5 mm (1.5945 inch). If this is not the case, they must be changed.

Adjust the threaded pin [9] so that the distance from the end of the thraded pin to the touch against the inner rim of the gear wheel is 11 mm (0.473 inch). Lock the pin with the nut [8].

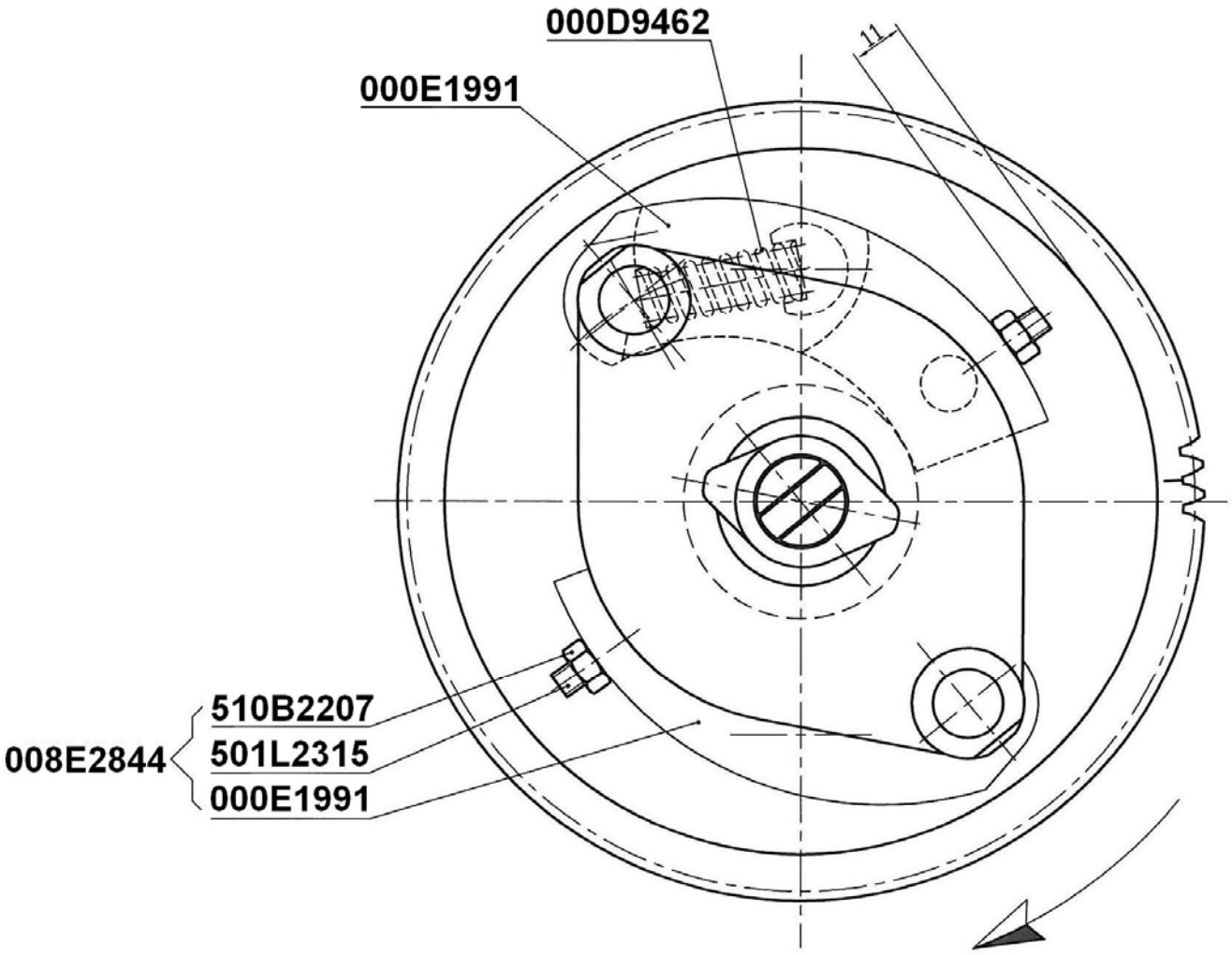
After the mounting it might be necessary to adjust the time of injection, and this must be done in accordance with the instruction in section H.



Check of Injection Timer

Turn the camshaft in its sense of rotation by means of a torque wrench with a socket spanner, and the centrifugal weights must start moving at a torque of **0.9 kpm** (6.525 ft.lbf.).

Where the threaded pin just touches the inner rim of the gear wheel, the torque must be **3.5 kpm** (25.3 ft.lbf.).



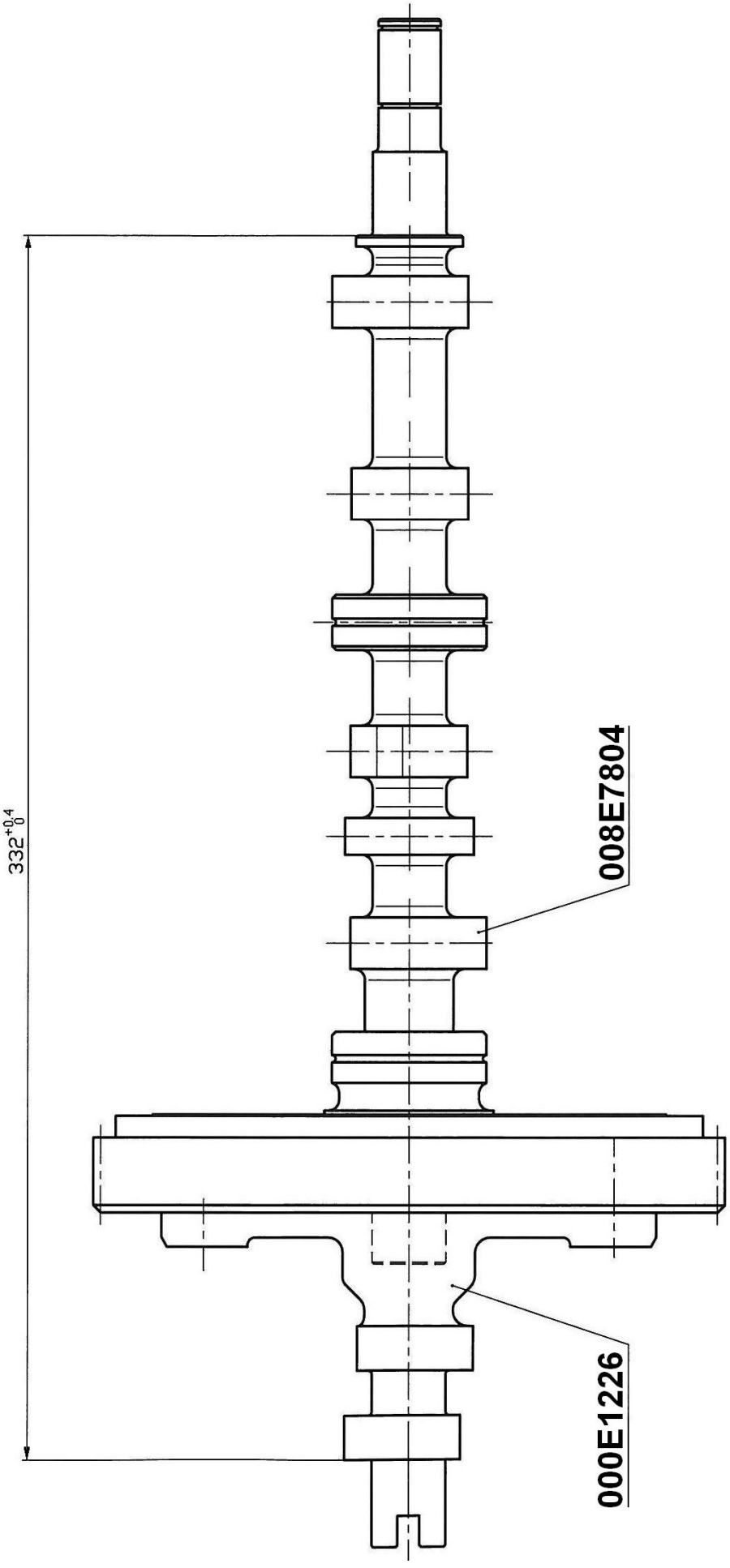
If the above torques cannot be achieved, you must change the spring force by grinding off the turns or by placing adjustment washers under the spring.

- Too high torque:..... grind off
- Too small torque: ..... use adjustment washers.

Please Note: Fitting of the injection timer in proportion to the gear-wheel mark.

M8

Drawing of camshaft



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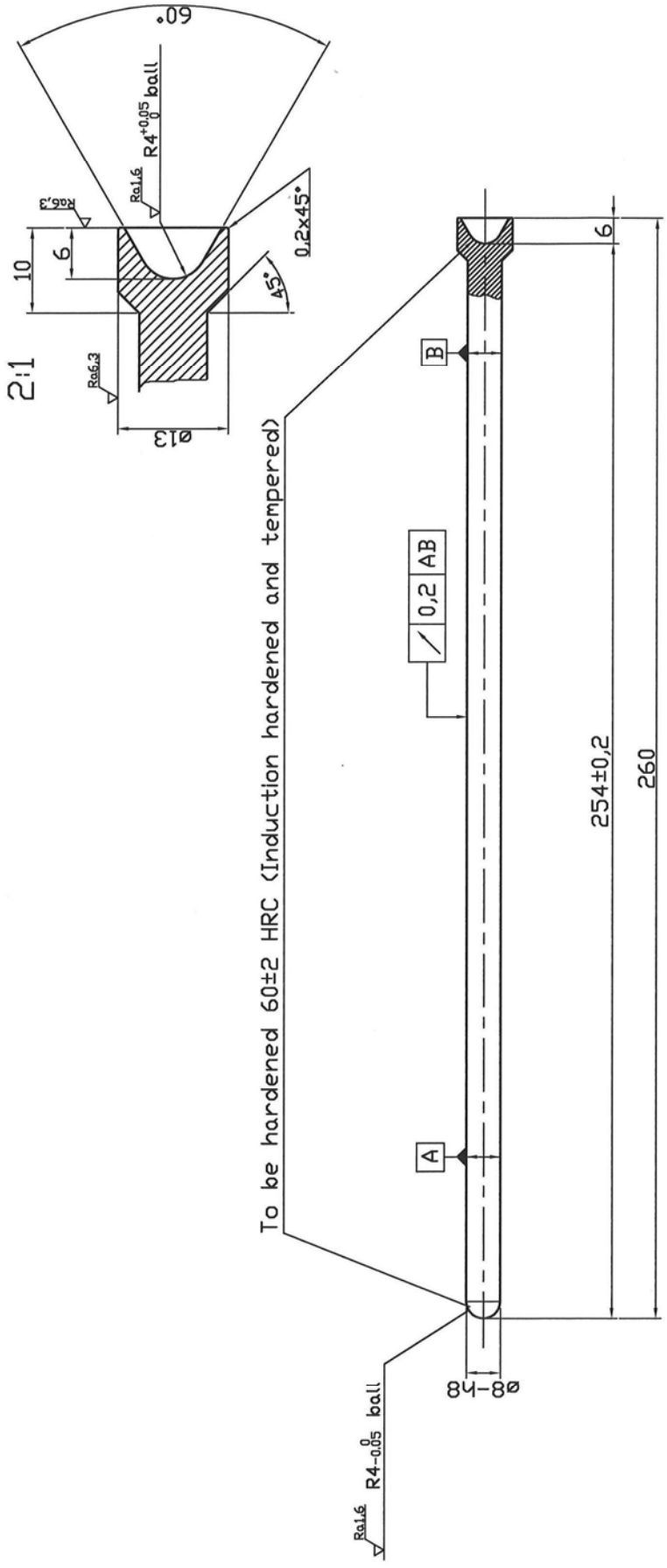
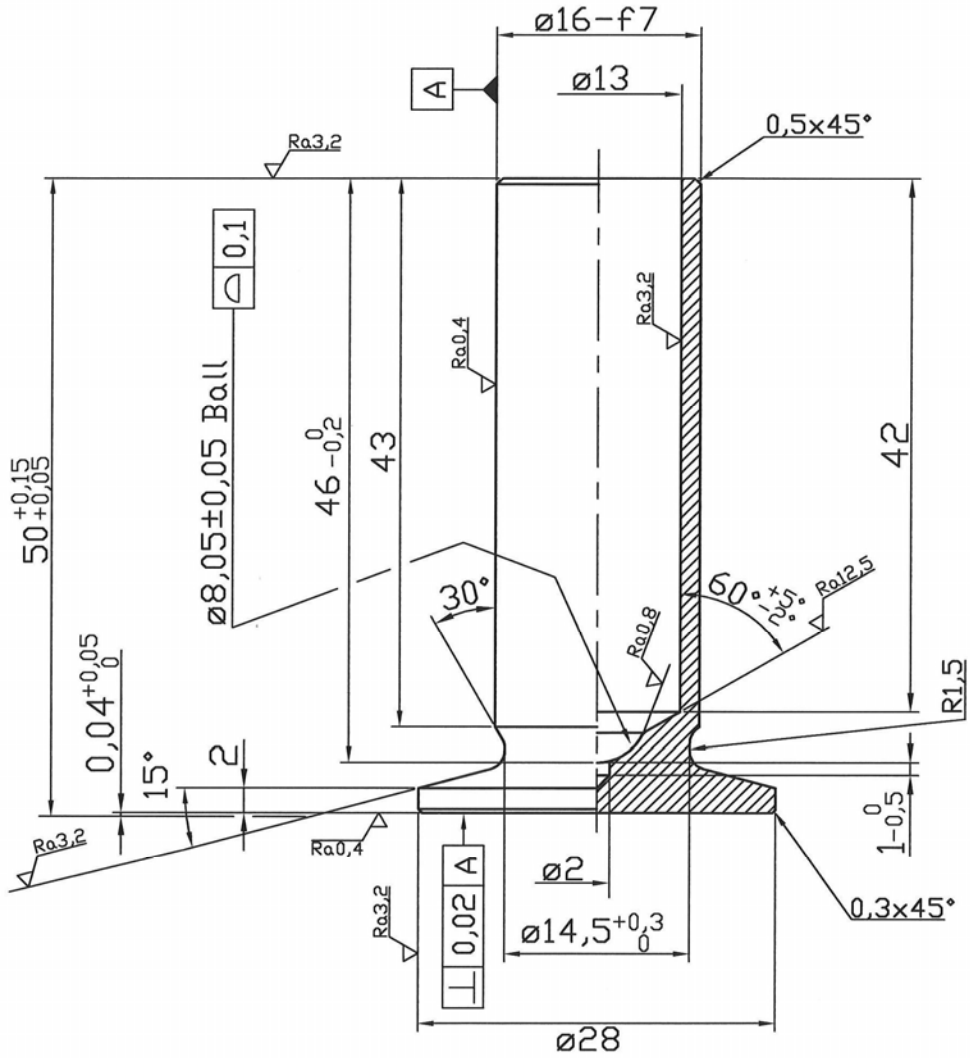
Drawing of pushrod



Drawing of Push Rod Guide



SECTION N

LUBRICATING OIL SYSTEM

CONTENTS

Lubricating system

The engine is lubricated through a pressure lubrication system. The lubricating pump driven by the camshaft sucks oil from the oil sump through a rough filter. From the lubricating pump the oil is pressed through a fine filter to the respective lubricating points through oil ducts bored in the goods. A reduction valve in the lubricating system secures that the oil pressure is kept between **2.0** and **4.0 Bar** at hot engine and max. revolutions.

Lubricating oil must be exchanged every 150 working hours or once a year.

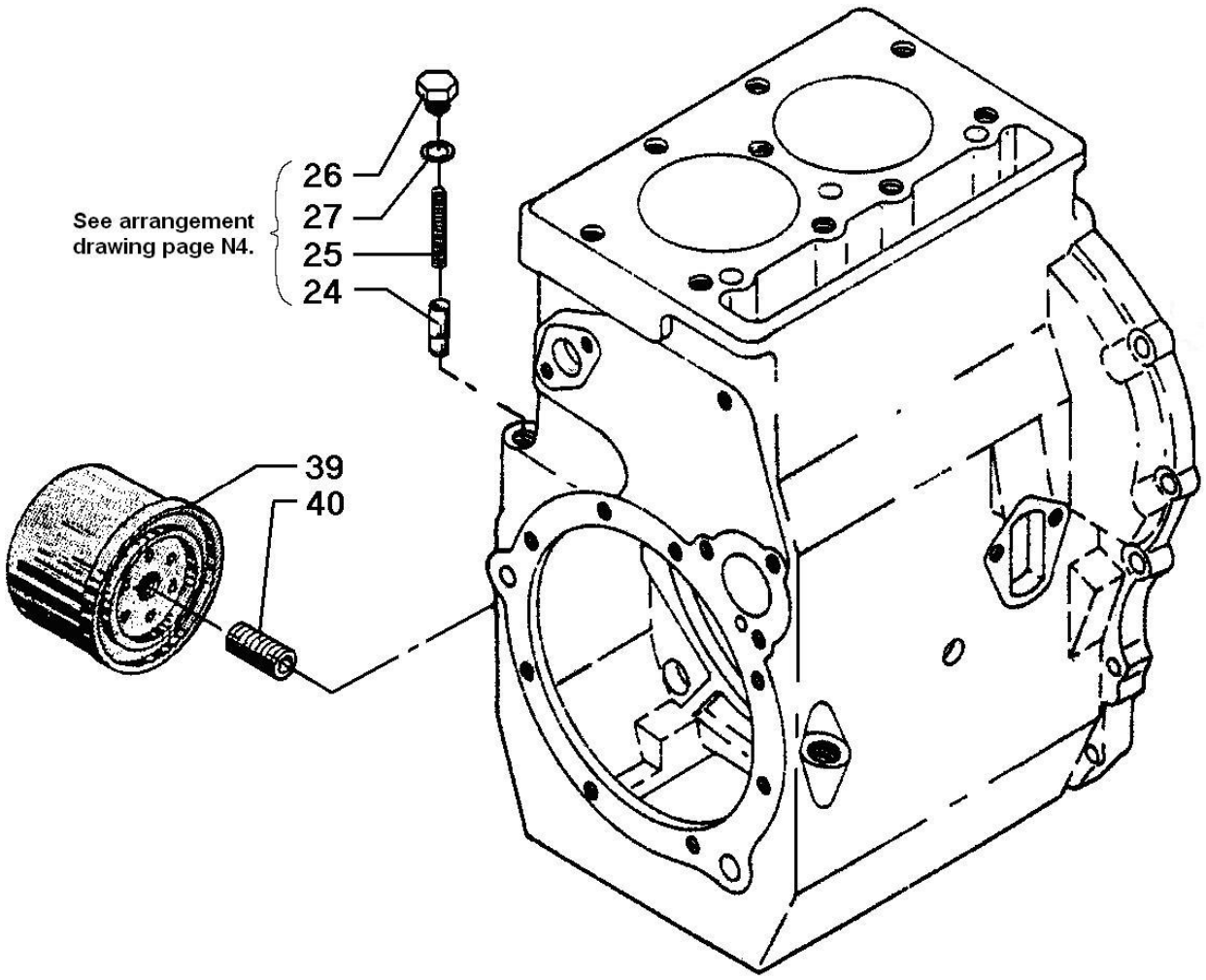
Excess – pressure valve

The excess-pressure valve shown on the drawing below can be adjusted by stretching the spring. This is done when the oil pressure lies below the allowable. Smallest allowable oil pressure is **0.8 Bar** at hot engine.

If the oil pressure is too high, possible after replacement of the spring, the spring tension can be reduced by mounting two copper gaskets between the plug and support.

Dismount the excess-pressure valve by unscrewing the plug [26] and removing the spring [25] and the piston [24].

When adjusting the oil pressure you must always check with a pressure gauge.



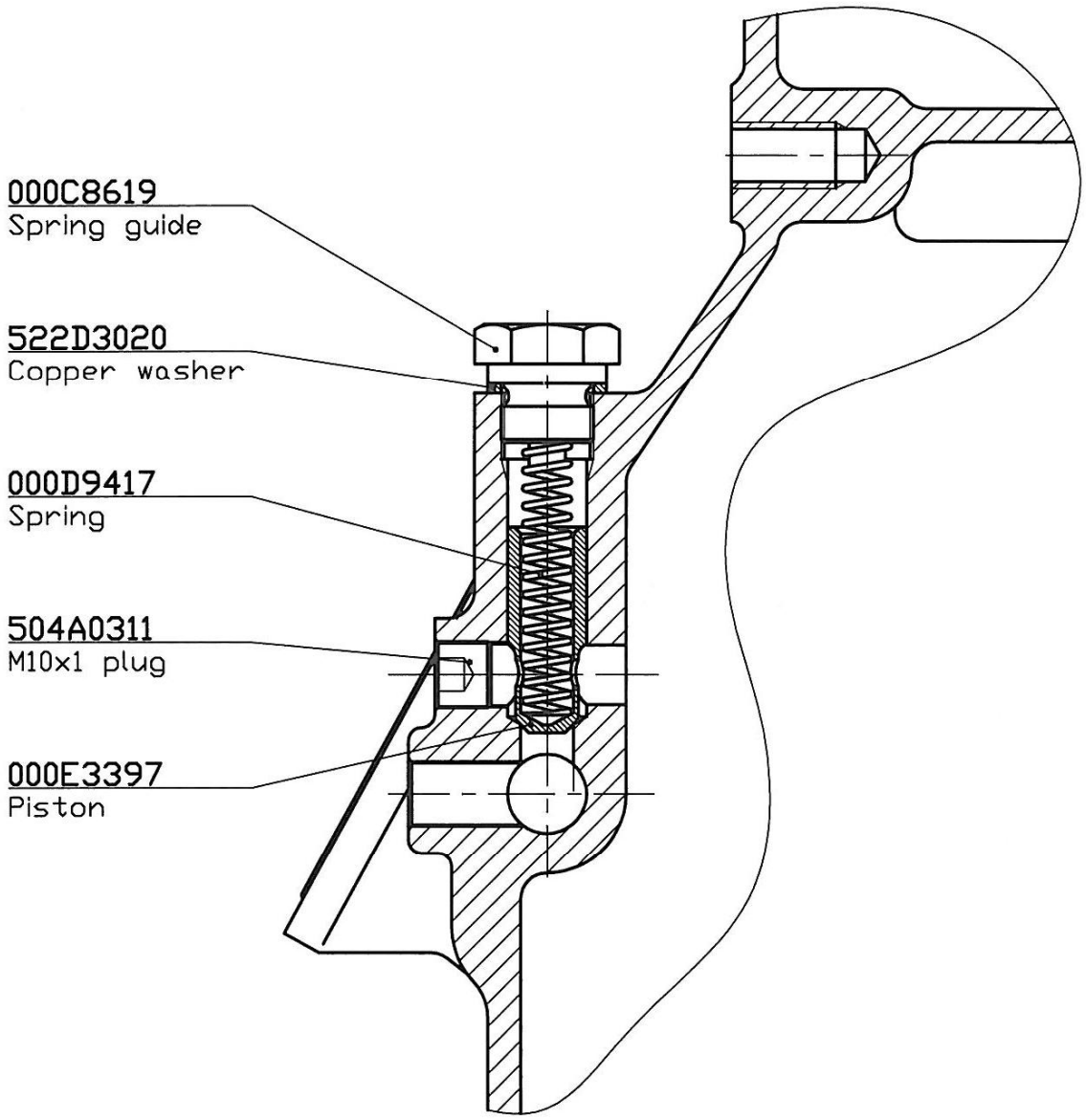
Lubricating oil filter

The lubricating filter [39] on page N3 cannot be cleaned, but must be replaced ev ery 150 working hours or once a year. Dismount the filter by the hand and scrap it.

A new filter must also be screwed on by hand.

When replacing the filter clean the bearing surface on the engine if necessary.

Arrangement drawing of the lubricating oil reduction valve.



The above fig. nos. show the lubricating oil reduction valve.

Free length of spring: 46±1 mm.

Lubricating oil pump

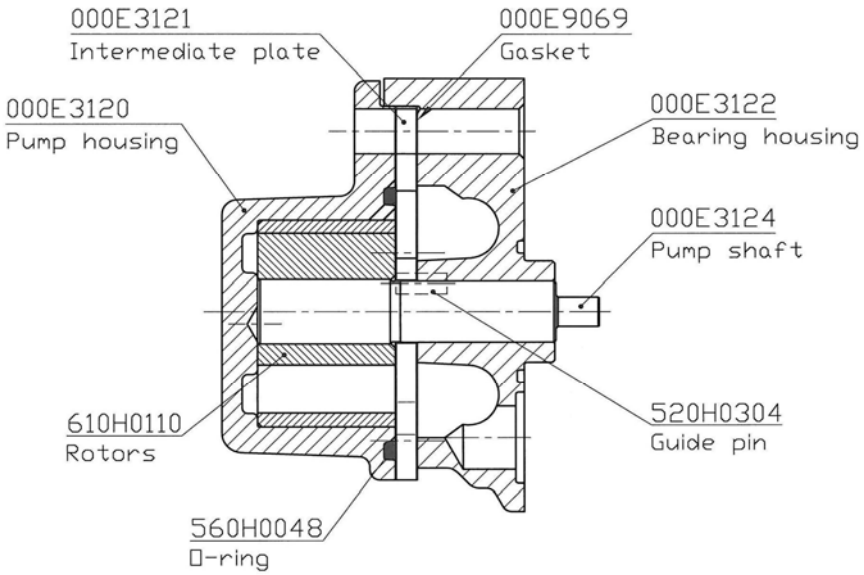
The lubricating oil pump has a capacity of 10 L/min.

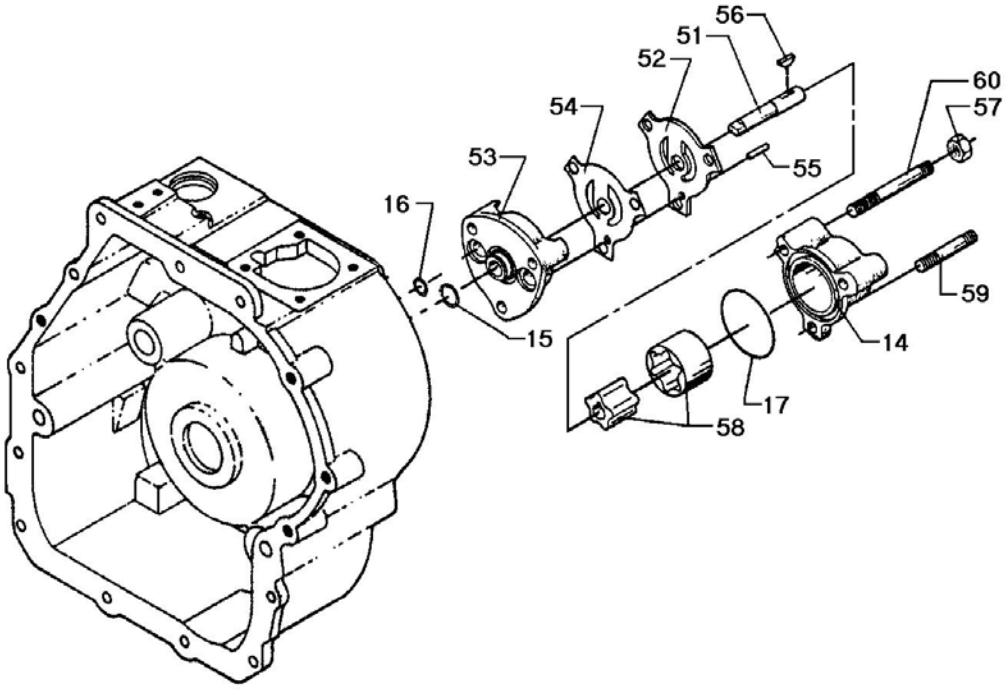
Dismounting:

1. Dismount the three nuts pos. [57] and pull off the cover pos. [14].
2. Pull out the inner rotor and the outer rotor pos. [58].
3. Dismount the pump housing with the intermediate plate pos. [52], [53] and [54].
4. Dismount the O-rings pos. [15] and [16] (2 pcs.).

Mounting takes place in reverse order. Check and exchange the O-rings.

Tighten the nuts with a torque of **2.0 – 2.3 Kpm**. (14.5 – 16.6 ft.lb.).





Lubricating oil quality

Normally a lubricating oil quality mark “Service CC” must be used, but for operation under difficult conditions, i.e. frequent cold starting, short working periods, very varying load, quality marked “Service CD” must be used.

Besides, quality marked “Service CD” must be used if the sulphur content of the fuel is higher than 1 per cent.

In air temperatures at the engine below 5°C viscosity SAE 10 is used or 5W/30 multigrade.

In air temperatures at the engine between 5°C and 25°C viscosity SAE 20 is used or 10W/30 multigrade.

In air temperatures at the engine above 25°C viscosity SAE 30 is used or 15W/40 multigrade.

As many lubricating oils today are multigrade the above should be used as a guidance for choosing an oil with the correct spectrum of viscosity.

For lifeboat engines where cold start is required down to minus 15°C within 2 minutes MOBIL OIL NO 1 or similar must be used for the engine as well as for the gearbox.

SECTION O

COOLING WATER SYSTEM

CONTENTS

DV24 is water cooled and is supplied with various cooling systems according to the use of the engine:

1. Direct cooling with seawater. keel cooler.
2. Indirect cooling with heat exchanger.
3. Indirect cooling with keel cooler.

Direct cooling with seawater is standard for all engines and the two types of indirect cooling are optional equipment.

Generally the basic design of engine as a marine engine does that indirect cooling will not be benefitial unless the engine is used for more than 500 hours of running per year. However other circumstances like use in proluted river and narrow waters can do that i.e. a keel cooling system is recommended. Keel cooling is always used for Lifeboat Engines due to SOLAS requirements.

Direct cooling with seawater:

The system consist of an impeller pump, connection pipes and thermostat. Please note page 04 and 05.

Indirect cooling with heat exchanger:

The system consist of an impeller pump (same as for direct cooling), freshwater circulation pump, heat exchanger and thermostat. Please note page 06 and 07.

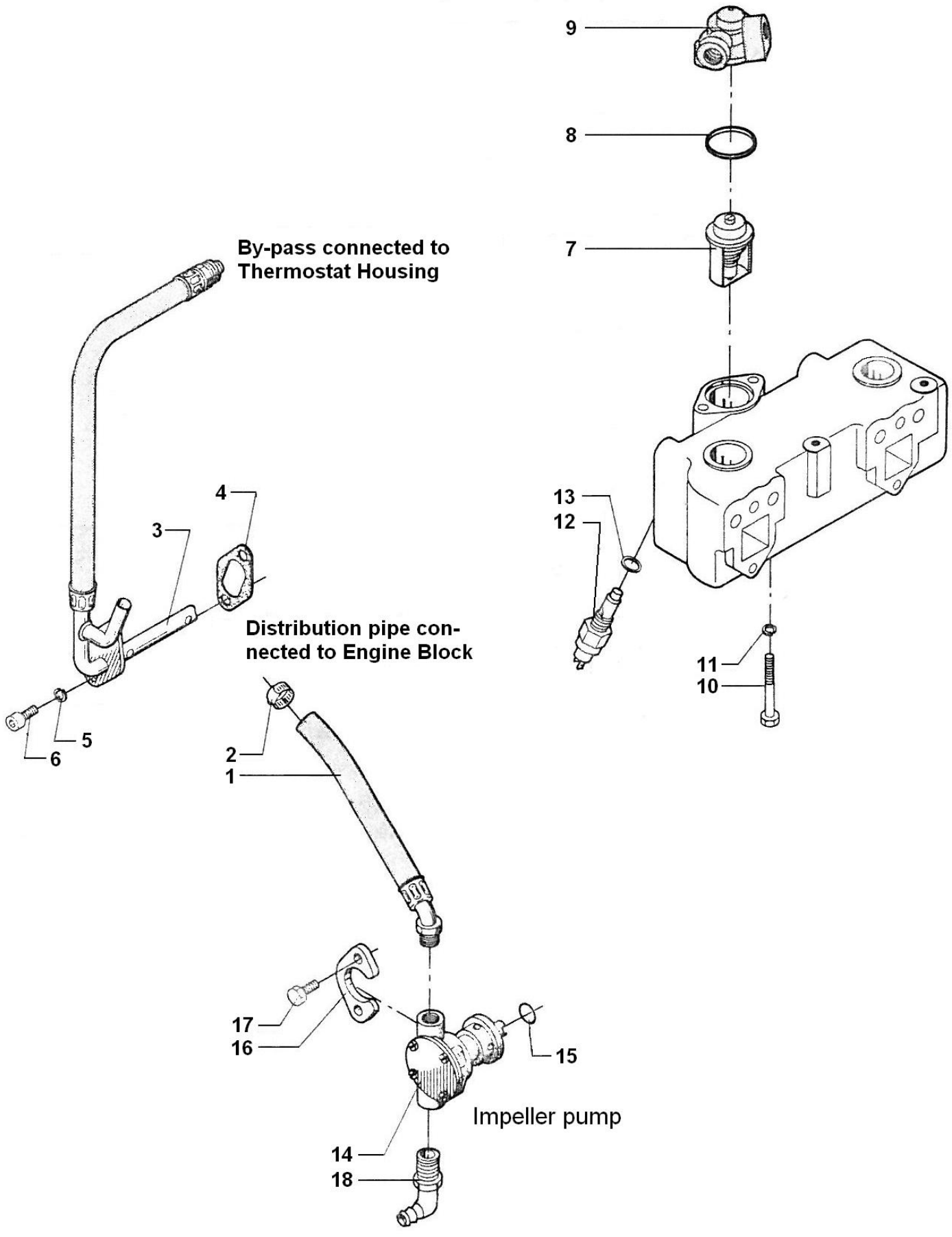
Indirect cooling with a keel cooler:

The system consist of a freshwater circulation pump (same as for cooling with heat exchanger), expansion tank, keel cooler element and thermostat. Please note page 08.

In some cases also the keel cooling system has the impeller pump but only for supplying cooling to the exhaust pipe if this is a flexible rubber hose.

For Lifeboat Engines keel cooling system and dry exhaust system is always used.

Direct cooling



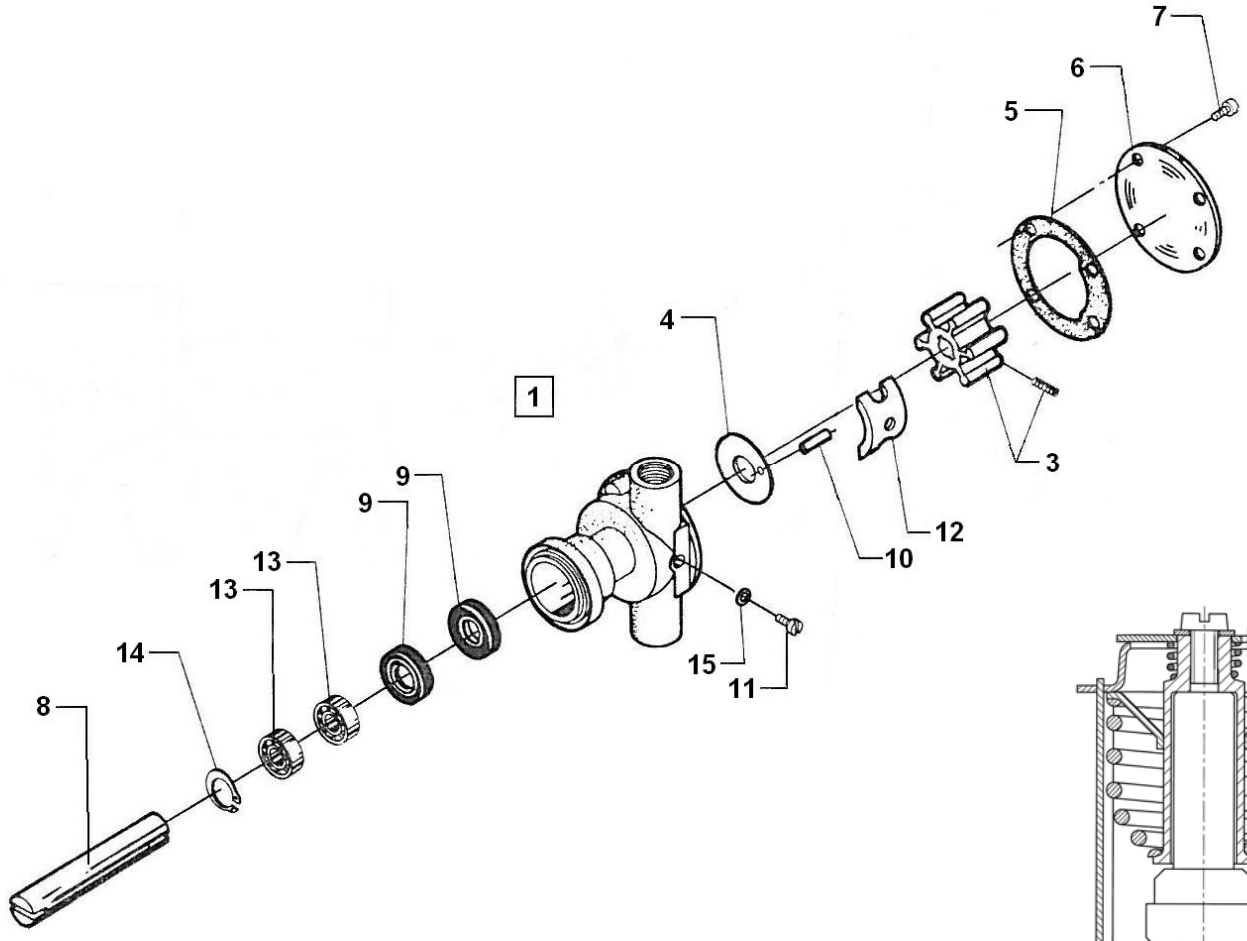
Impeller pump:

Technical data:
Make.....Johnson
Capasity.....11 L/min.
Counter pressure....6 M.W.C.
Suction.....3 M.W.C. (Manometric)

The pump is dismounted from the engine by removing the in let pipe connection and the pipe pos. 1 and the clamp pos. 16 on page O4.

When the pump is leaking water co ming out of the hole in the pu mp housing will indicate that the seals, pos. 9 on the below shown sketch, are leaking and needs to be changed.

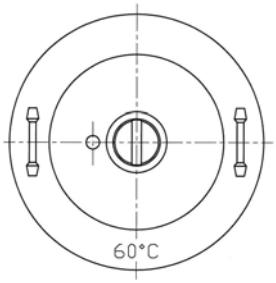
If the impeller pos. 3 is damaged and not complete when changing the missing parts is likely to be found blocking the outlet of the pump or the connection pipe.



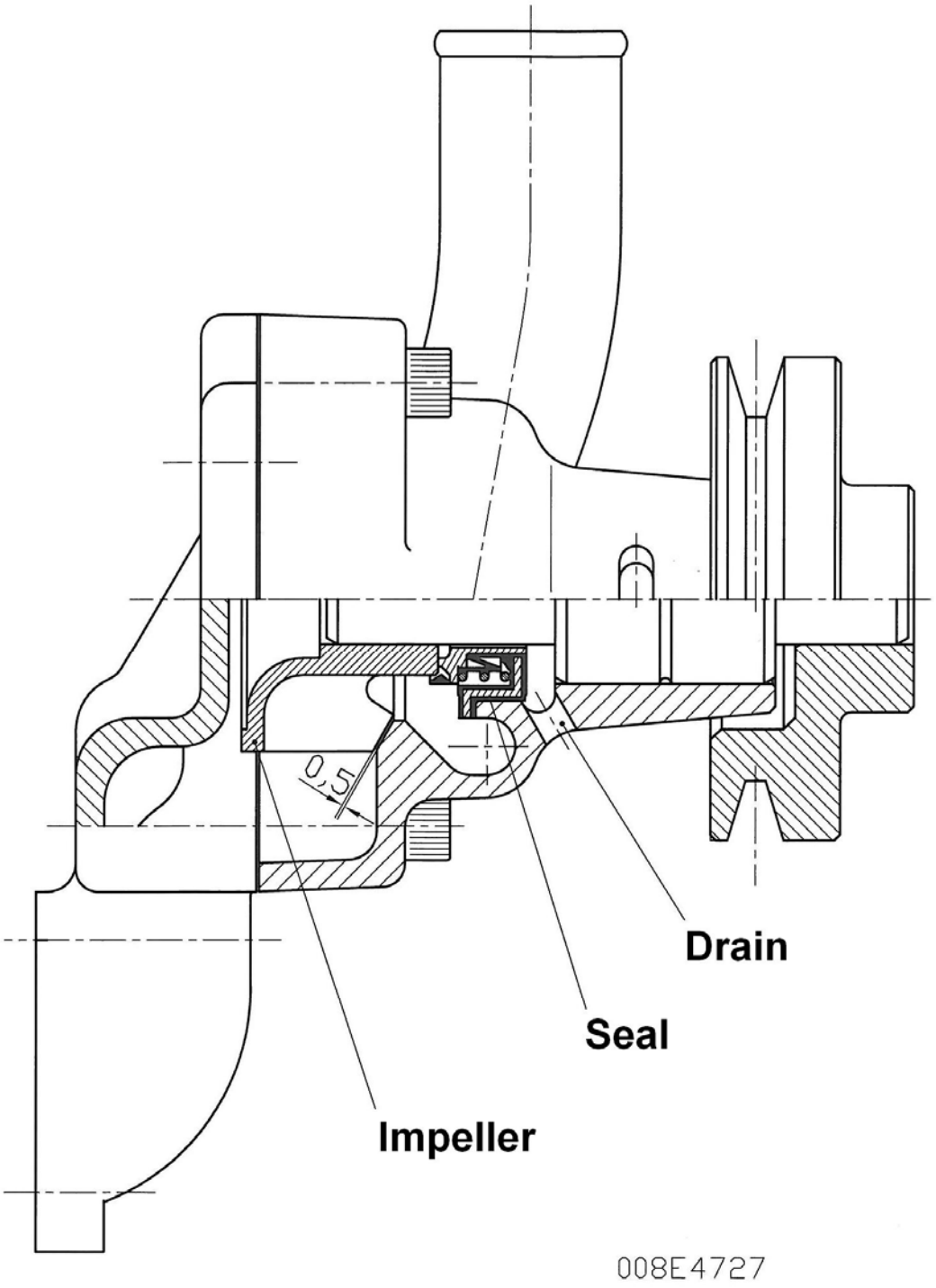
Thermostat:

The thermostat is as shown on the sketch at the right side of this page and has a opening temperature of approx. 60°C.

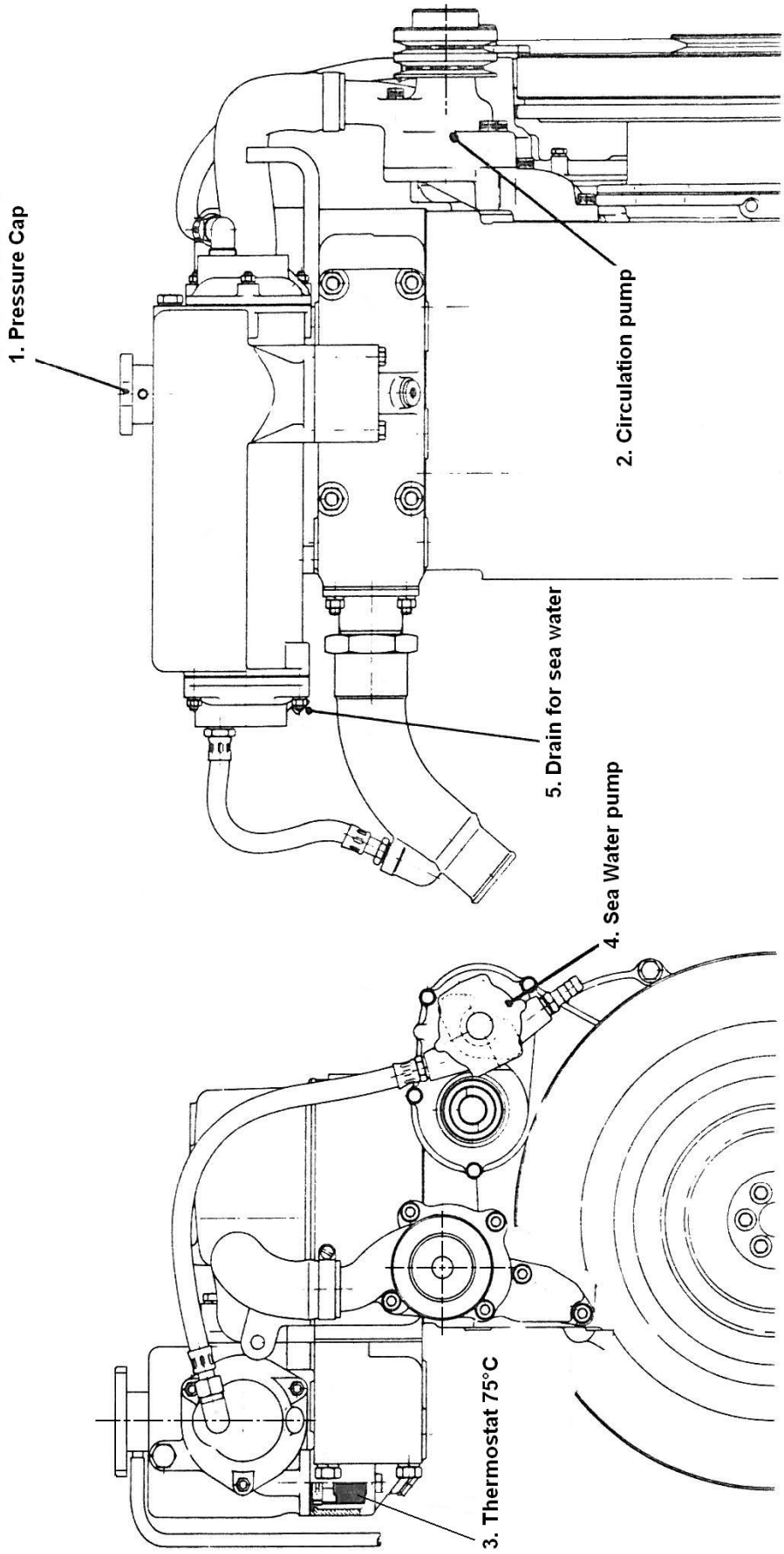
The thermostat can be taken out by dismounting the thermostat housing (pos.9 on page O4).



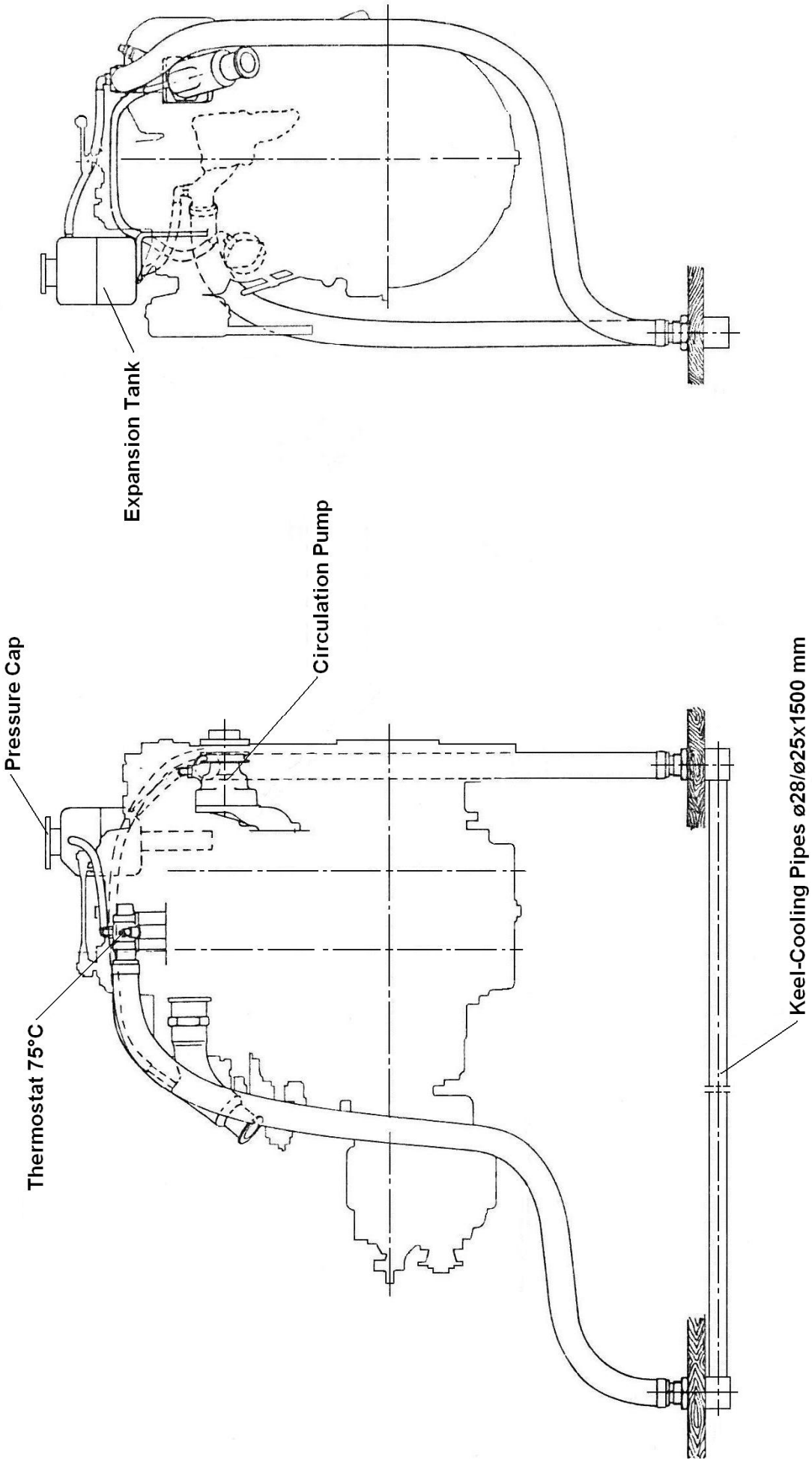
Circulation pump



Heatexchanger



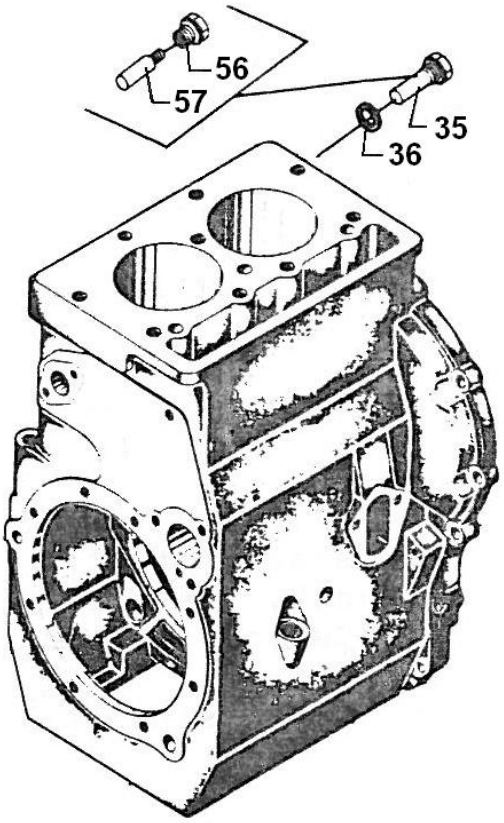
Keel cooling



Zinc Rod

The zinc rod is placed in the cooling jacket of the engine block. The zinc rod crumbles away gradually when it has its normal function.

Examine the zinc rod after one month and later at intervals of 25 working hours. Replace the zinc rod when only half of it is left.



Dismantling, Cleaning and Reassembly of Heat Exchanger

1. Turn of the seawater intake and drain off the fresh and salt cooling water through the respective drain plugs.

2. Remove inlet and outlet hoses for the salt and fresh cooling water.

3. Remove the two end covers on the heat exchanger by loosening the 2 x 3 nuts.

4. Now the cooling element can be taken out and cleaned. The cooling element is build up as a nest of pipes made in nick olite. The pipes are tinned ins ide and outs ide, which together with the bottoms of gun metal , give an optimum protection against corrosion.

   Due to the tinned pipes there must only be used water and a soft brush for cleaning the nest of pipes. Chemicals and steel brushes must not be used.

Exchange of Thermostat (Heat Exchanger)

On DV24 with heat exchanger the heat exchanger tank must be removed.
This is done by loosening the 4 bolts securing the heat exchanger tank to the exhaust manifold

Freshwater Circulating Pump

The circulating pump is shown on page O6. If a heavy loss of water through the drain hole is observed or if there is a rising water temperature in spite of normal function of the remaining components in the system, take the pump apart and check it.

Dismantling of Circulating Pump

1. Remove the V-belt and the flywheel (see section D).
2. Remove pump from engine block by loosening the two Allen screws which fasten this.
3. Remove the V-belt pulley and the fuse wire shown.
4. Remove the cover of the pump.
5. Press bearing shell with shaft, stuffing box and rotor out of the pump housing with a punch, the diameter of which corresponds to the inner diameter of the pump housing.
6. Remove the rotor from the shaft by pressing the shaft out of the rotor.

   Now the stuffing box can be replaced.

If the shaft and the bearing shell shows signs of wear and play (max. 0.5 mm) this unit should be replaced.

The flexible stuffing box cannot be repaired but has to be exchanged, if the contact face shows signs of scratches or fractures.

The rotor can be turned off on the contact face for the flexible stuffing box. Then the rotor should be ground on toucher plate (or glass plate) with a fine grinding compound – the compound must not contain carborundom.

Reassembly of Circulating Pump

When assembling and fitting the circulating pump there must only be used original gaskets.

1. Fit the pump shaft and bearing shell in the pump housing so that the edges flush. The bearing shell is secured by means of Loctite.
2. Fit the flexible stuffing box in the pump housing.
3. Support the journal for the V-belt pulley on the terminal surface and fit the rotor on the shaft. Check that the measure of 0.5 mm is observed.
4. Carry out the points 1-4, mentioned under dismantling, in reverse order.

Before the final fitting has been finished, it should be checked that the V-belt groove on the flywheel, alternator and circulating pump are aligned.

Expansion Cover

For heat exchanger and keel cooler system the same type of cover is used as expansion cover. This cover determines the working pressure in the fresh water cooling system and thus the boiling point of the water. It is therefore important that the cover function correctly and that spring and gaskets are intact.

Type of cover: 530Q9923 (working pressure 0.5 Bar)

V-belt: 542A0611 (length 1125 mm)

Protection against Frost

Usually the fresh cooling water is not drained from engines with indirect cooling and consequently these must be secured against frost by adding anti-freeze solution.

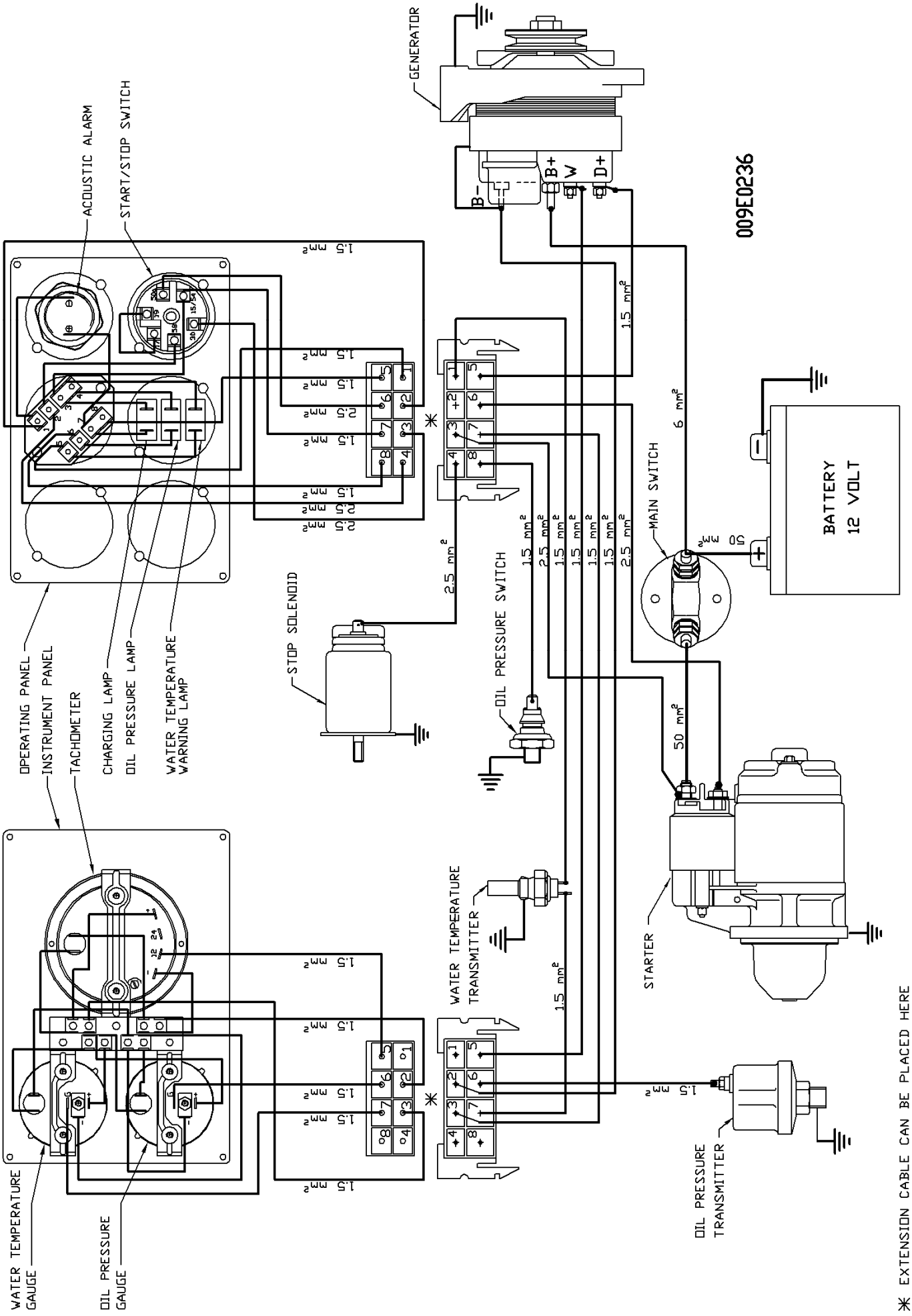
The protection against frost should be carried out considering the local conditions and in accordance with the recommendations for the used anti-freeze solution.

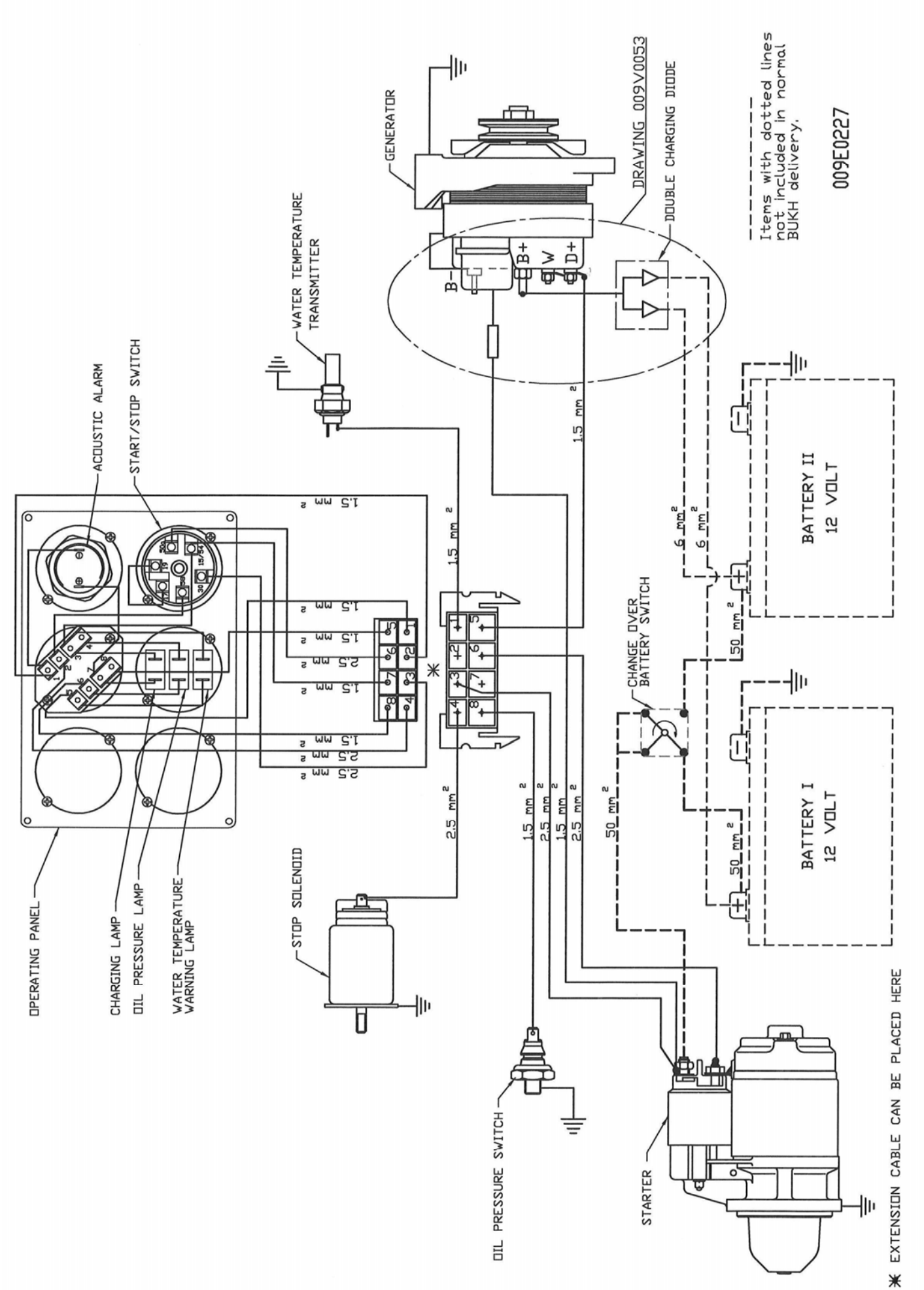
The contents of fresh water for engines with heat exchanger and keel cooling are 6 litres.

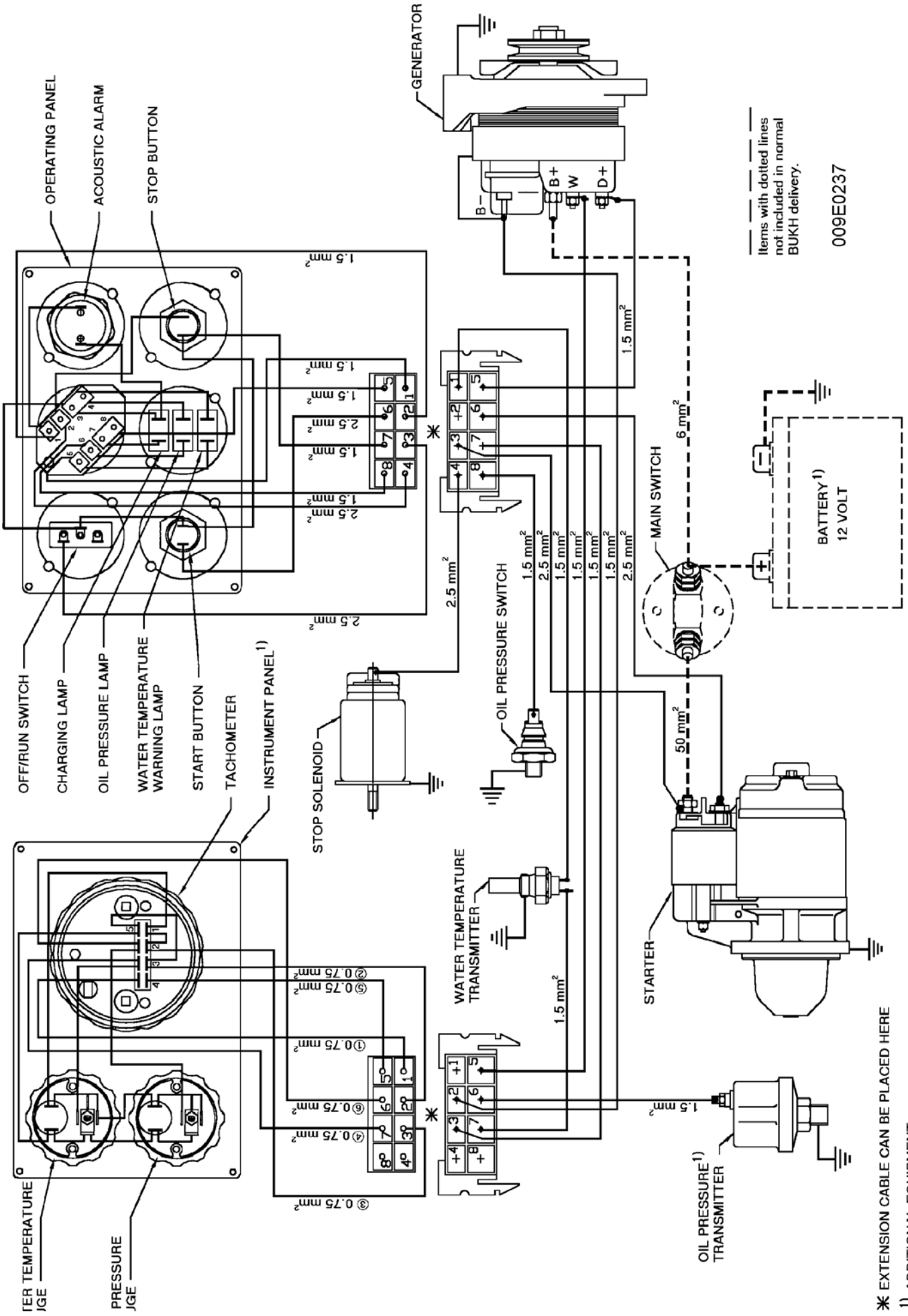
SECTION P

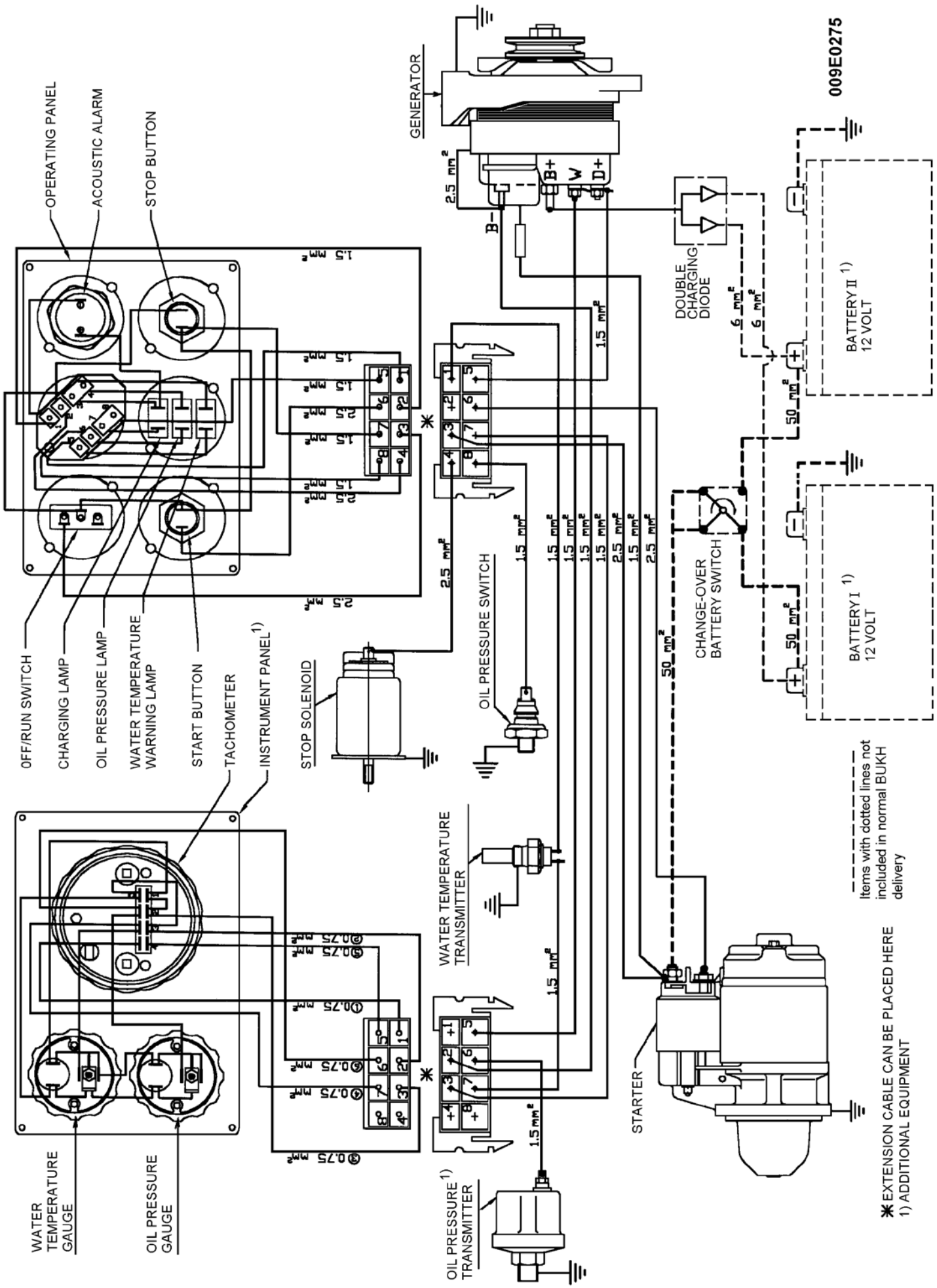
ELECTRICAL SYSTEM

CONTENTS

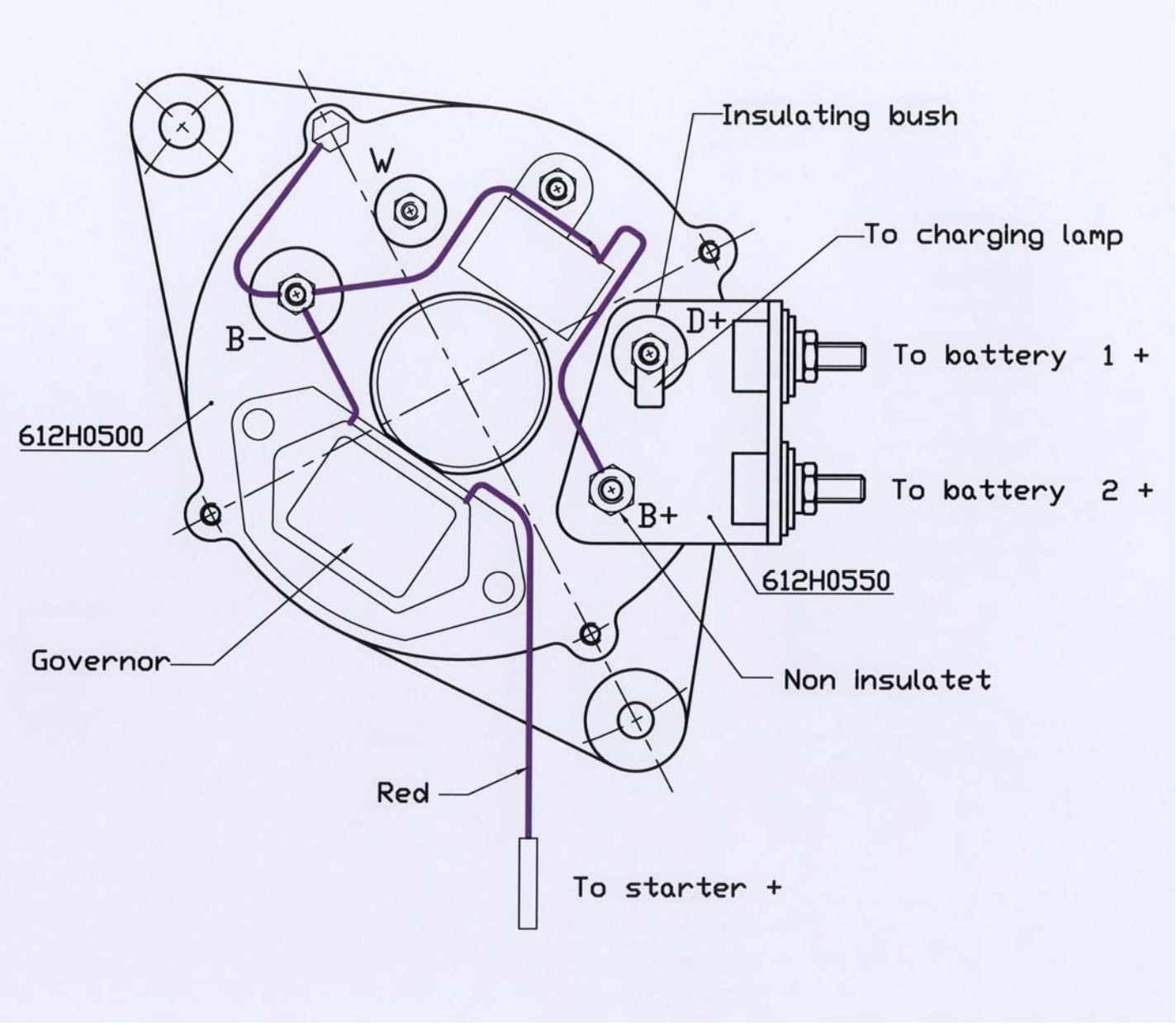

009E0236
GENERATOR
B-
B+
W
D+
ACOUSTIC ALARM
START/STOP SWITCH
OPERATING PANEL
INSTRUMENT PANEL
TACHOMETER
CHARGING LAMP
OIL PRESSURE LAMP
WATER TEMPERATURE
WARNING LAMP
STOP SOLENOID
OIL PRESSURE SWITCH
MAIN SWITCH
BATTERY
12 VOLT
STARTER
WATER TEMPERATURE
TRANSMITTER
OIL PRESSURE
TRANSMITTER
WATER TEMPERATURE
GAUGE
OIL PRESSURE
GAUGE
1.5 mm²
2.5 mm²
6 mm²
50 mm²
* EXTENSION CABLE CAN BE PLACED HERE


GENERATOR
DRAWING 009V0053
DOUBLE CHARGING DIODE
B-
B+
W
D+
Items with dotted lines not included in normal BUKH delivery.
009E0227
WATER TEMPERATURE TRANSMITTER
ACOUSTIC ALARM
START/STOP SWITCH
1,5 mm²
2,5 mm²
6 mm²
50 mm²
BATTERY II 12 VOLT
BATTERY I 12 VOLT
CHANGE OVER BATTERY SWITCH
STOP SOLENOID
OIL PRESSURE SWITCH
STARTER
OPERATING PANEL
CHARGING LAMP
OIL PRESSURE LAMP
WATER TEMPERATURE WARNING LAMP
✳ EXTENSION CABLE CAN BE PLACED HERE

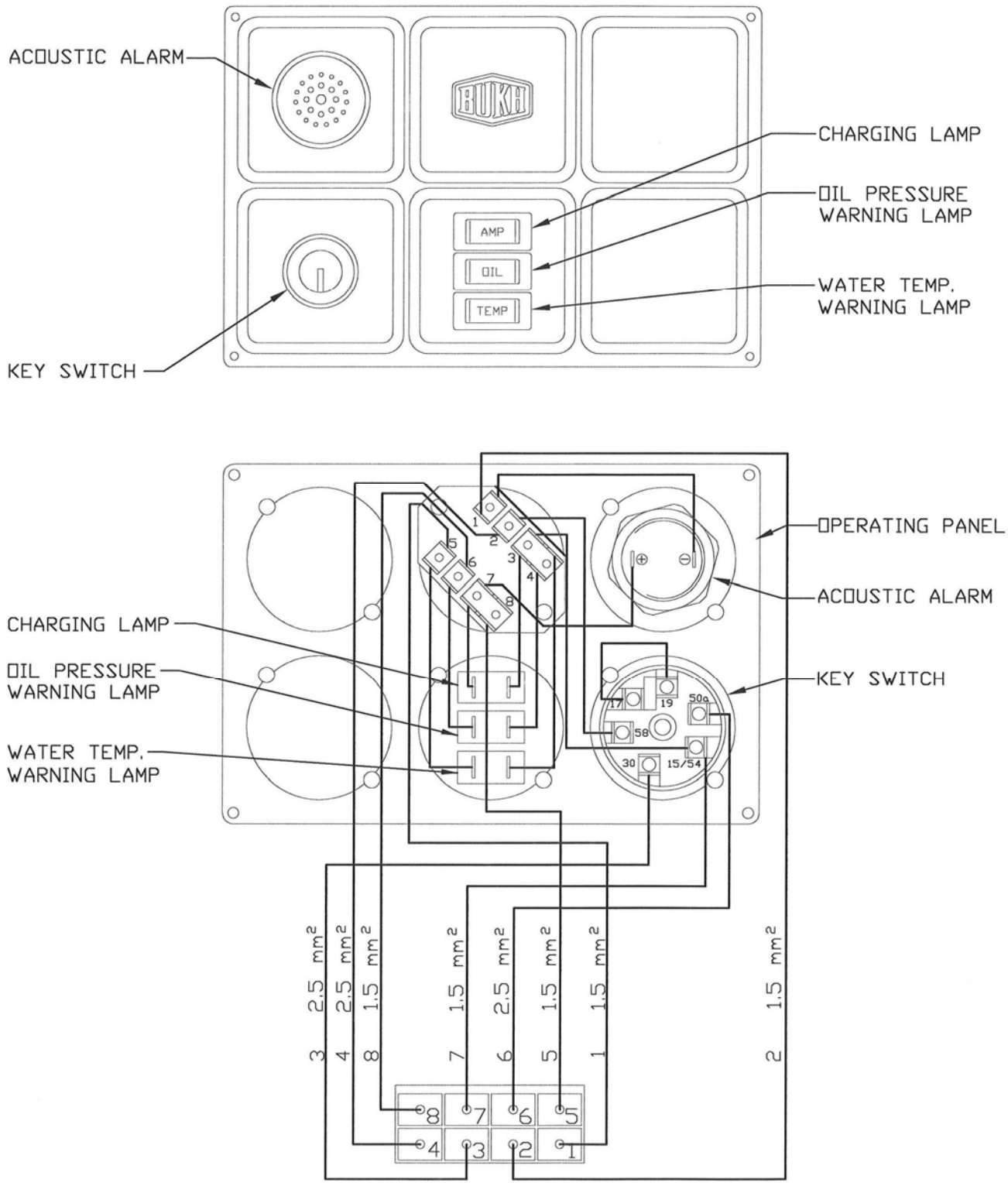

GENERATOR
B−
B+
W
D+
OPERATING PANEL
ACOUSTIC ALARM
STOP BUTTON
OFF/RUN SWITCH
CHARGING LAMP
OIL PRESSURE LAMP
WATER TEMPERATURE WARNING LAMP
START BUTTON
TACHOMETER
INSTRUMENT PANEL 1)
STOP SOLENOID
OIL PRESSURE SWITCH
MAIN SWITCH
BATTERY 1)
12 VOLT
WATER TEMPERATURE TRANSMITTER
STARTER
OIL PRESSURE TRANSMITTER 1)
Items with dotted lines not included in normal BUKH delivery.
009E0237
✳ EXTENSION CABLE CAN BE PLACED HERE
1) ADDITIONAL EQUIPMENT


009E0275
OPERATING PANEL
ACOUSTIC ALARM
STOP BUTTON
GENERATOR
B+
W
D+
B-
DOUBLE CHARGING DIODE
BATTERY II 1)
12 VOLT
BATTERY I 1)
12 VOLT
CHANGE-OVER BATTERY SWITCH
OFF/RUN SWITCH
CHARGING LAMP
OIL PRESSURE LAMP
WATER TEMPERATURE WARNING LAMP
START BUTTON
TACHOMETER
INSTRUMENT PANEL 1)
STOP SOLENOID
OIL PRESSURE SWITCH
WATER TEMPERATURE TRANSMITTER
STARTER
WATER TEMPERATURE GAUGE
OIL PRESSURE GAUGE
OIL PRESSURE 1) TRANSMITTER
Items with dotted lines not included in normal BUKH delivery
✱EXTENSION CABLE CAN BE PLACED HERE
1) ADDITIONAL EQUIPMENT

Generator with double charging diodes



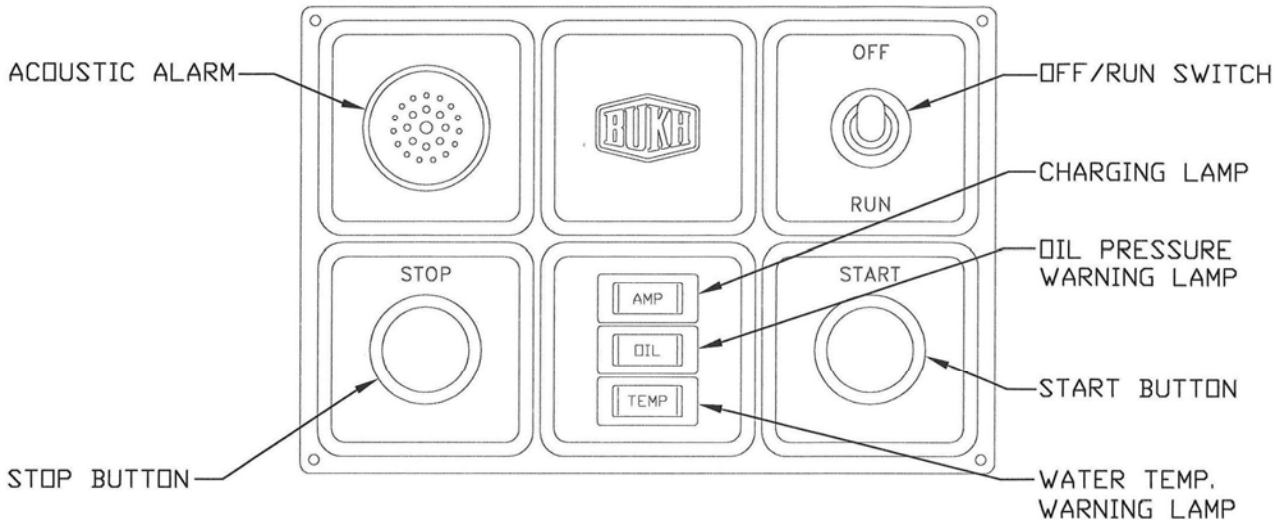
Drg.no. 009V0053

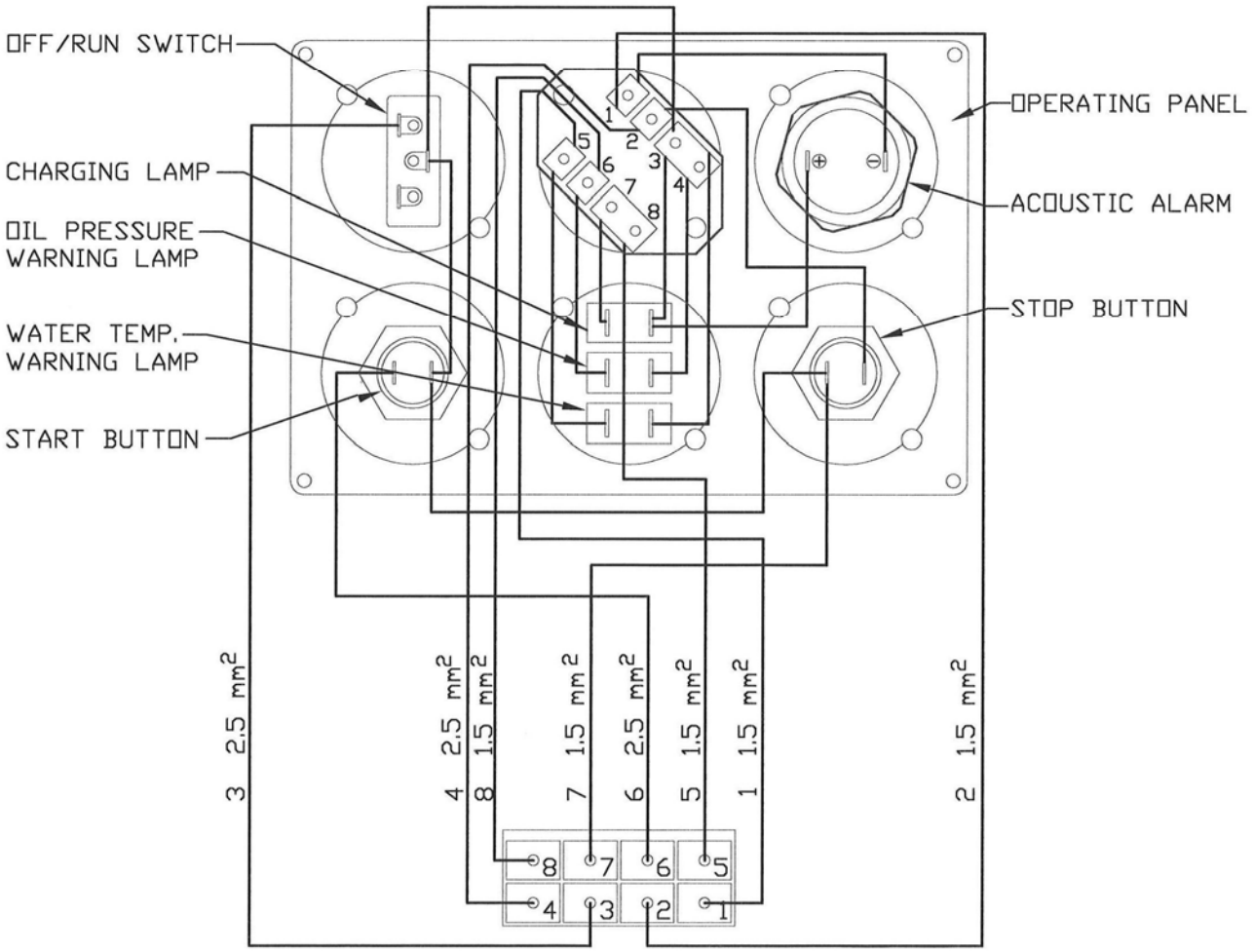


BUKH powering marine safety

ELECTRIC CIRCUIT DIAGRAM

Key Switch Starter Panel			
A4	Kontrolleret	Tegnet 070817 NL	009E0296

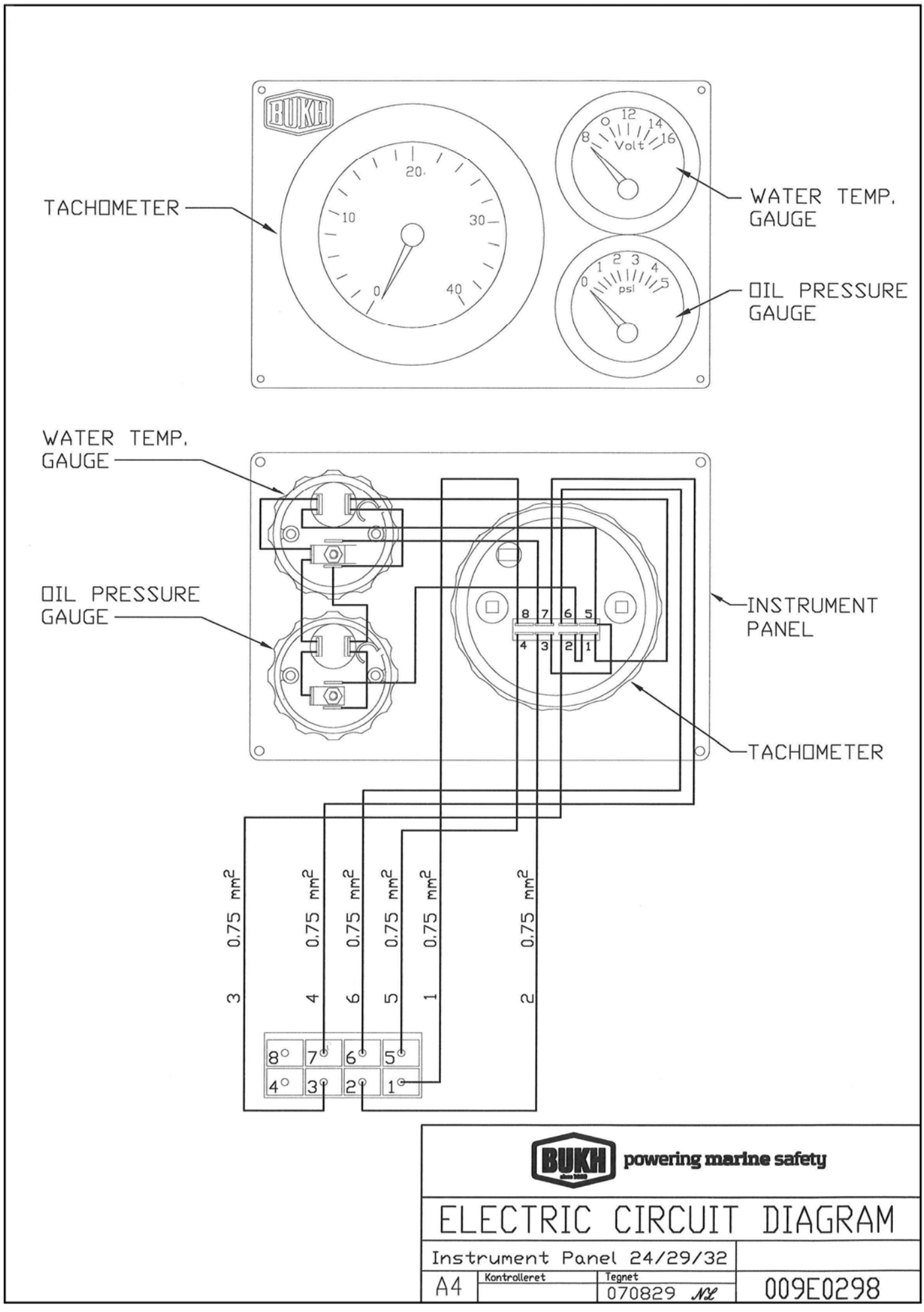




BUKH powering marine safety

ELECTRIC CIRCUIT DIAGRAM

Push Button Starter Panel			
A4	Kontrolleret	Tegnet 070817 NL	009E0297


TACHOMETER
WATER TEMP. GAUGE
OIL PRESSURE GAUGE
WATER TEMP. GAUGE
OIL PRESSURE GAUGE
INSTRUMENT PANEL
TACHOMETER
0.75 mm²
3
4
6
5
1
2
8 7 6 5
4 3 2 1
powering marine safety
ELECTRIC CIRCUIT DIAGRAM
Instrument Panel 24/29/32
A4
Kontrolleret
Tegnet
070829
009E0298

SECTION R

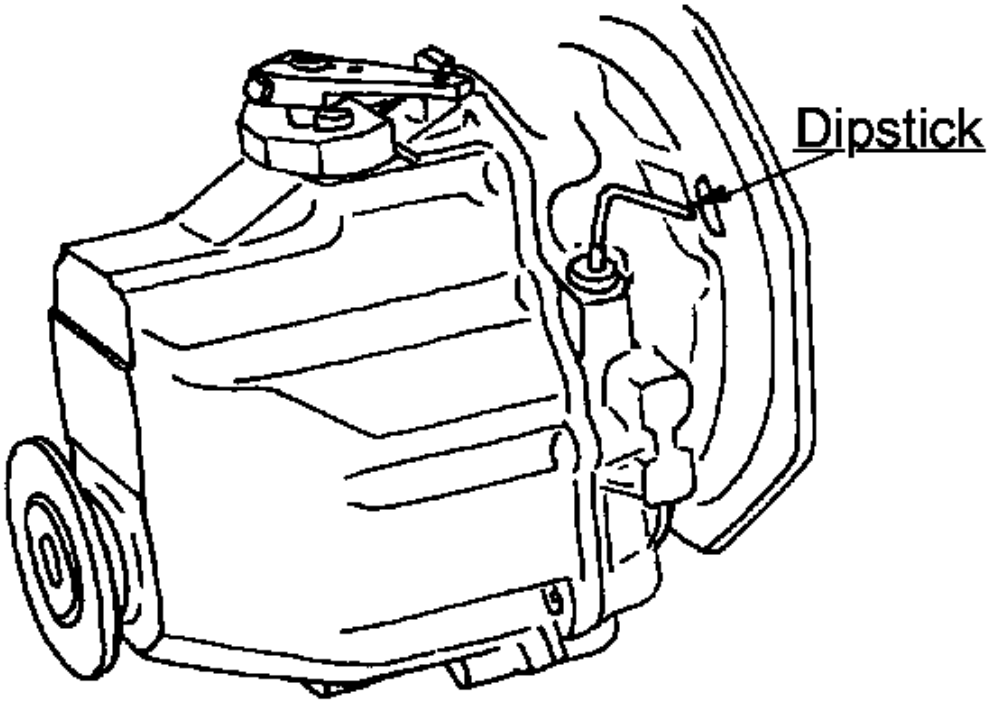
ZF GEAR – BW7

CONTENTS

Gear Ratio

The BW7 gear which is used on DV24 has normally a reduction ratio of 3.0:1 for AHEAD and 2.36:1 for REVERSE.

For special purposes it can be delivered with a reduction ratio of 2.47:1 for AHEAD and 2.36:1 for REVERSE.



Oil Change

The gear will need no other attendance than regular change of oil. This to be carried out after the first 25 hours of operation and then every 150 hours or once a year.

The oil change is carried out by means of the hand bilge pump which is delivered together with the tools for the engine.

Refill fresh oil to the quantity of 1.1 litres.

Quality of lubricating oil marked Service CC or CD with a viscosity of SAE 30 or SAE15W-40 is used. Oils covering more viscosity numbers must not be used.

R4

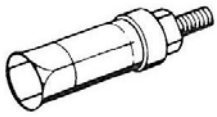
Special Tools

Order No. 009P3187

Mounting punch for seal ring 25x33x6 at input shaft

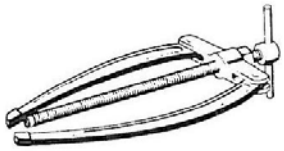
Order No. 009P3188

Internal puller for tapered roller bearings / outer ring



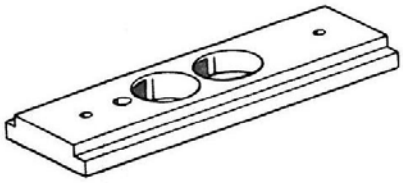
Order No. 009P3189

For fitting of tapered roller bearings / outer ring in connection with 009P3188



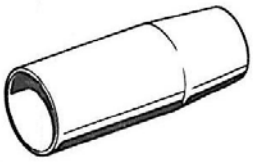
Order No. 009P3190

Measuring instrument for adjustment of tapered roller bearings



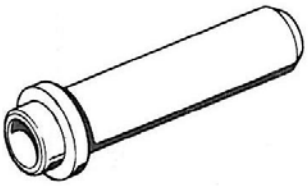
Order No. 009P3191

Protective sleeve for seal ring 25x33x6 at input shaft



Order No. 009P3192

Mounting punch for seal ring 32x45x7 at output shaft



Order No. 009P3193

Bush for stiffening of disc springs “AHEAD”

Order No. 009P3193

Bush for stiffening of disc springs “ASTERN”

Adjusting Measures and Torques for BW7

Designition	Statement of dimensions	Gauge	Remarks
Axial tightening of tapered roller bearings on input and output shafts	0.03 – 0.08 mm With a load of 30 N (3 Kp)	Dial indicator or Depth micrometer	Adjusted by means of washer (s) under bearing outer ring in the housing. The bearings are fitted with Loctite 601
Axial clearance Sliding sleeve in shifting fork	0.1 – 0.4 mm	Feeler gauge	New gear
Axial clearance Sliding sleeve in shifting fork incl. permissible wear	Max. 0.8 mm	Feeler gauge	Clearance + wear limit
Axial clearance “AHEAD” and “ASTERN” wheels	0.1 – 0.4 mm	Depth measure	“AHEAD”: Clearance appears when fitting and is examined at control. “ASTERN”: Clearance can be Adjusted by means of a thrust washer
Disc / plate clearance per disc clutch	0.9 – 1.0 mm	Feeler gauge	To be measured two places opposite one another. To be adjusted by washer
Disc / plate clearance per disc clutch with max. wear	1.5 mm	Feeler gauge	To be measured two places opposite one another. To be adjusted by washer
Tightening of disc springs	Min. 1.1 mm	Depth measure	Measured on disc springs when slack on the output shaft
Testing indication for pressure spring 0732 041 225 in star bolts	L = 15.5 mm P = 38.9±2.4 N (3.89±0.24 Kp)	Depth measure Weight	L = length of loaded spring P = spring power

Adjusting Measures and Torques for BW7

Designition	Statement of dimensions	Gauge	Remarks
Testing indication for pressure spring 0732 041 008 for shift pins	L = 11.4 mm P = 46±5 N (4.6±0.5 Kp)	Depth measure Weight	L = length of loaded spring P = spring power
Torque of hexagon nut M20x1.5 on output shaft on the output side	100 Nm (10 Kpm)	Torque wrench	Secure after having packed with liquid jointing on the contact face
Torque of hexagon nut M20x1.5 on output shaft on the input side	100 Nm (10 Kpm)	Torque wrench	Secure after tightening
Torque of hexagon nut M20x1.5 on the gear-wheel bolts	50 Nm (5 Kpm)	Torque wrench	Secure after having packed with liquid jointing on the contact face
Torque of M8 screws in the halves of the gearbox	17 Nm (1.7 Kpm)	Torque wrench	Add U-washers
Torque of M8x25 screws at the gear wheel bolts	17 Nm (1.7 Kpm)	Torque wrench	Secure with Loctite 241
Torque of vent valve	10 Nm (1.0 Kpm)	Depth measure	
Seal ring for input shaft: Depth of compression	Binding with surface of casting of half of gearbox	Ruler	Shaft seal rings inserted with sealing compound (unhardening)
Output shaft seal ring Depth of compression Measured from front of output shaft to front of shaft seal ring	22.5±0.5 mm	Depth measure	Shaft seal ring inserted with sealing compound (unhardening)

General Information for Work with the Gear

Show cleanliness when repairing the gear and before the gear is opened it must be carefully cleaned.

Use special tools as stated earlier in this section when removing and fitting the gear.

The seal face between the two parts of the housing is tightened with liquid jointing.

When dismantling the halves of the gearbox from each other, loosen the screws in the flanged joint first and push/press back the fitting pins.

Press the two halves of the gearbox from each other by means of two rods or the like. Do not use chisels.

Use special tools for loosening parts fixed to the shafts such as bearings, gear-wheels etc.

When assembling the gear and fitting the bearings it is necessary to heat the cylinder bearings in oil bath before fitting them. The temperature must not exceed 120°C.

When fitting the bearing outer rings the housing should be heated and the bearing outer rings should be fitted with Loctite.

Removal of Gear from Engine

Before the gear can be dismantled it must be removed from the engine:

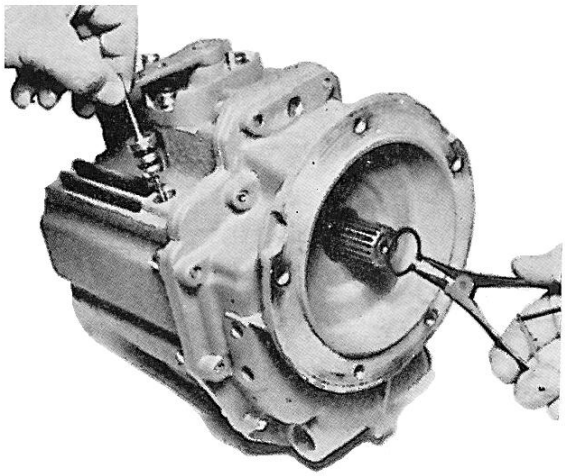
1. Loosen the propeller shaft flange and push the propeller shaft a little backwards.
2. Loosen the gear from the engine by removing the bolts of the intermediate flange between the engine and gear.
3. Lift clear the gear of the engine.
4. Dismantle the flexible coupling by loosening the central nut and pulling off the coupling half from the input shaft of the gear with special tool No. T 41069.

Dismantling of BW7 Gear

Pull the dip stick of the housing.

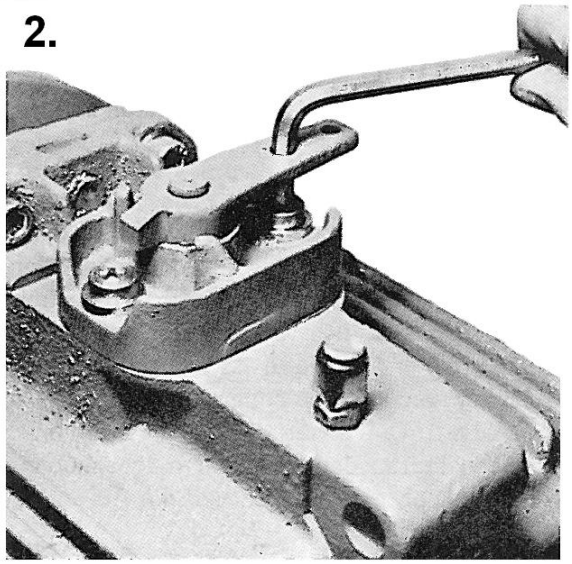
Remove the locking ring on the input shaft.

1.



Remove the shifting arrangement with gasket.

2.

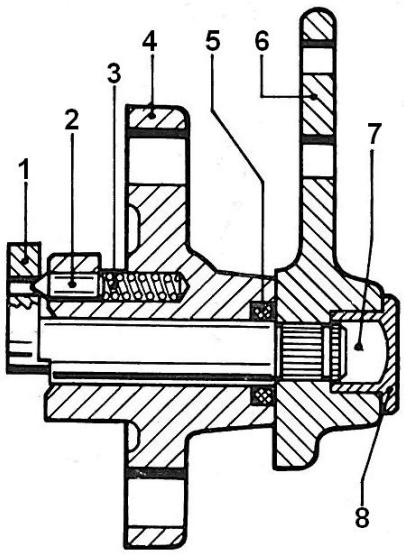


There are two different shifting levers which, however, can be built in without any problems in either cases.

Press the shifting lever out of the shifter shaft and take out the O-ring 12x2.4 and the pin and the pressure spring.

Before the shifting lever is pressed out it should be marked in proportion to the shaft out of consideration for the later assembling of the arrangement.

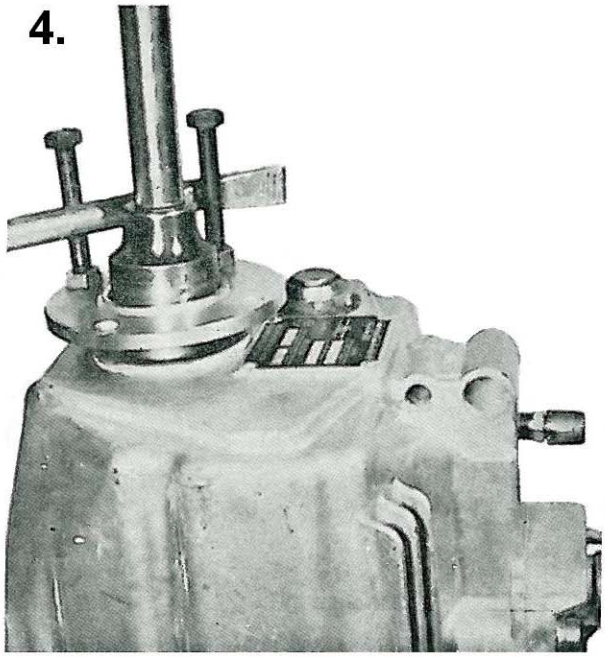
3.



1. Shifter shaft
2. Pin
3. Pressure spring
4. Shifting housing
5. O-ring
6. Shifting lever
7. Grease lubricating
8. Screw cap

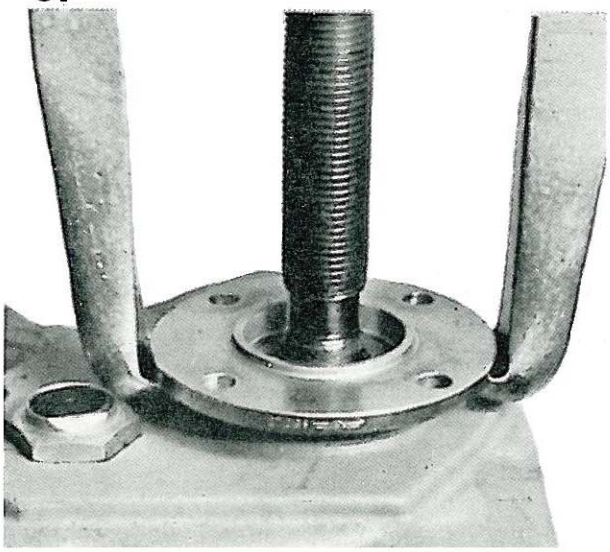
Unscrew the nut of the output shaft flange.

4.



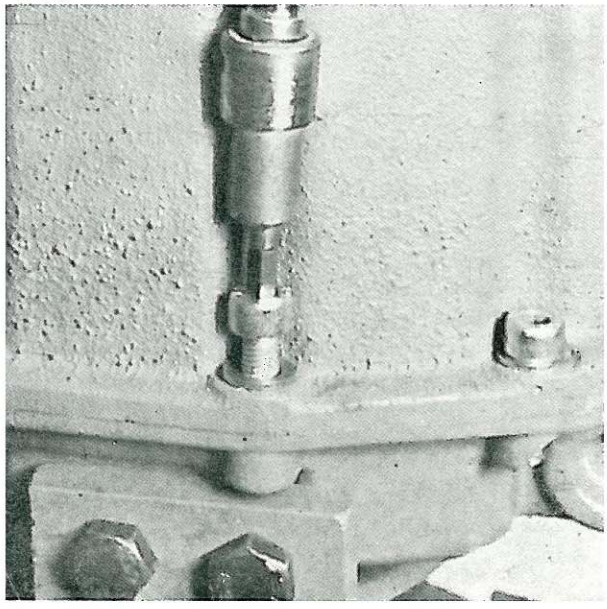
Pull off the output shaft flange.

5.



Screw off the fixing screws which hold the halves of the gearbox together.

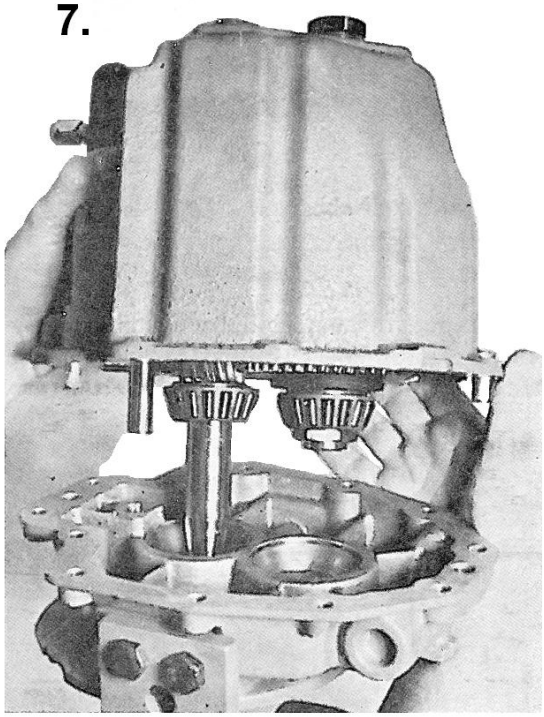
6.



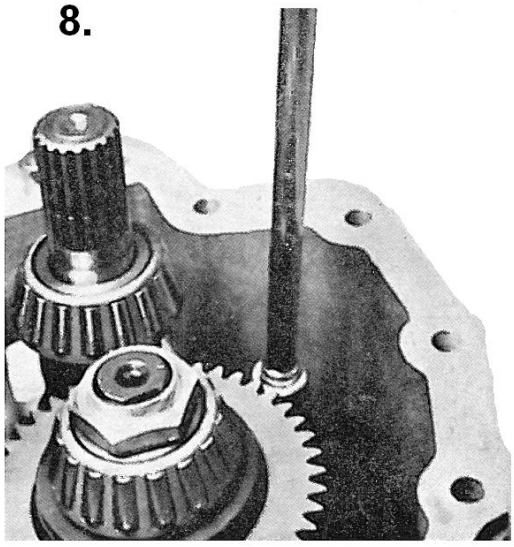
Drive back the fitting pins 2 – 3 mm in the gearbox and lift one gearbox half with reversing shaft, input and output shafts free of the other gearbox half.

Protective sleeve 1 x 56 136 992 may be fitted on the input shaft before the dismantling.

7.



8.



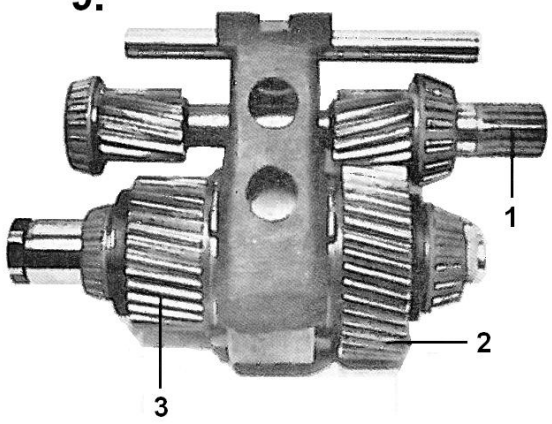
Removal of Input and Output Shaft

ProTake out the screws M8x25 and the gear-wheel bolts and remove the washer plate.

At the fitting the screws have been smeared with Loctite and consequently it may be necessary to heat before they are loosened.

Loctite No. 241 has been used.

9.



Lift the complete arrangement with input and output shafts and shifting fork out of the housing.

Now the arrangement can be lifted free of each other.

1. Input shaft
2. Wheel “ASTERN”
3. Wheel “AHEAD”

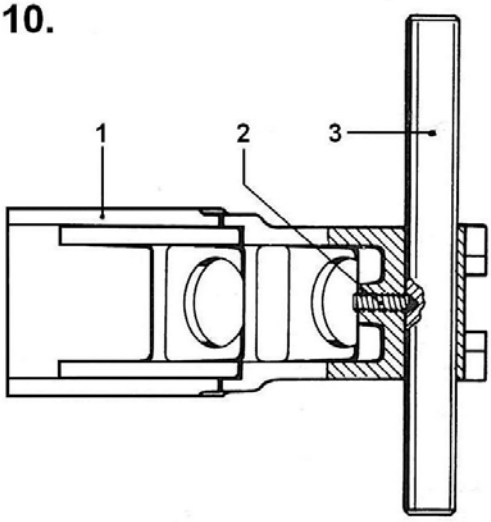
Dismantling of Shifting Fork

Screw out the pin M6x12 of the shifting fork and press out the reversing shaft of the shifting fork.

At the fitting the threaded pin has been smeared with Loctite No. 241 and so it may be necessary to heat.

1. Shifting fork
2. Threaded pin
3. Reversing shaft

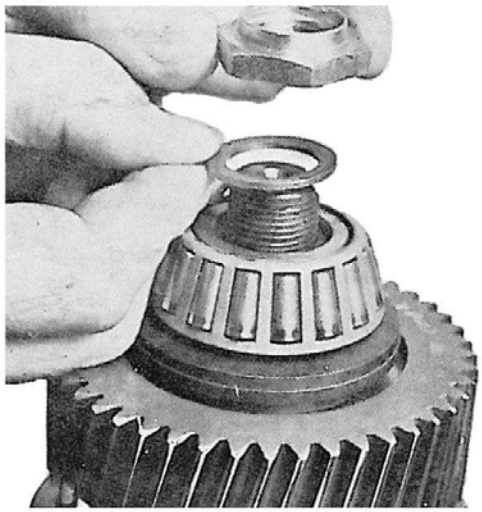
10.



Dismantling of Output Shaft

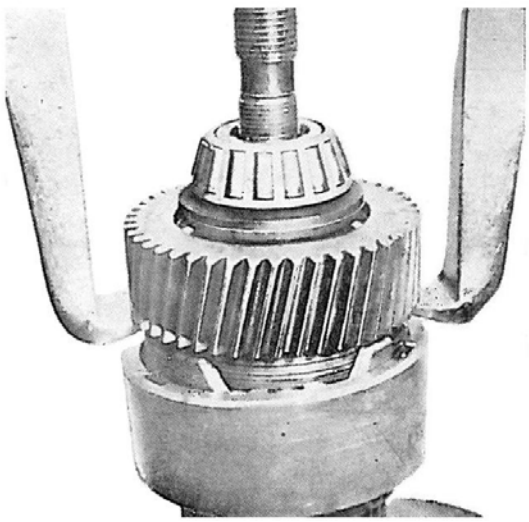
Remove nut with washer “ASTERN”

11.



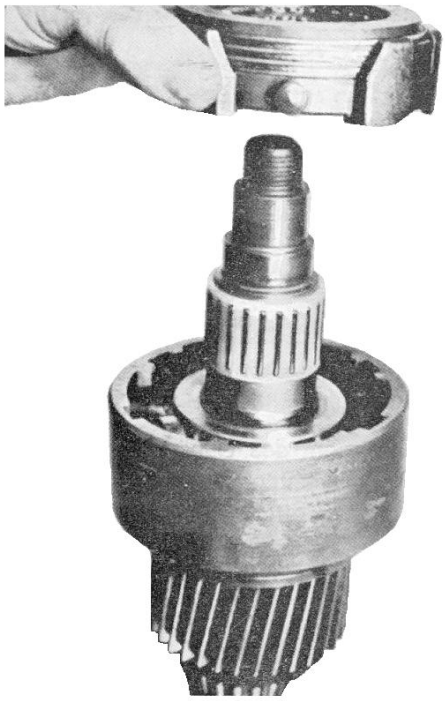
Pull off the wheel “ASTERN” with a special tool and take up washer, disc springs and tapered roller bearing inner collar.

12.



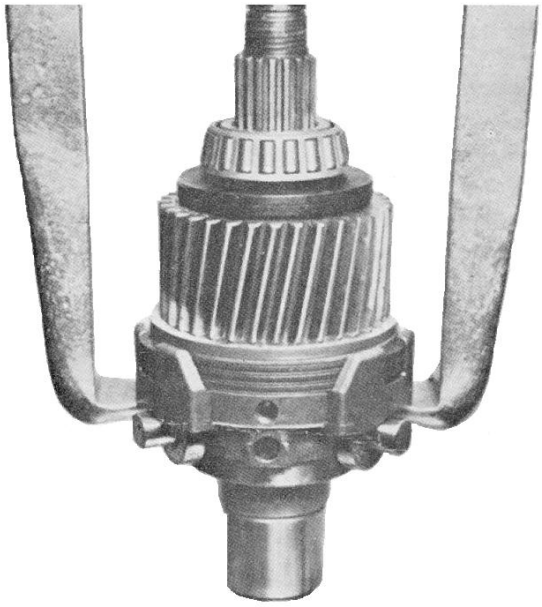
13.

Remove the thrust collar wuth bolts and washers together wuth needle bearing bushing, sliding sleeve and pressure spring.



14.

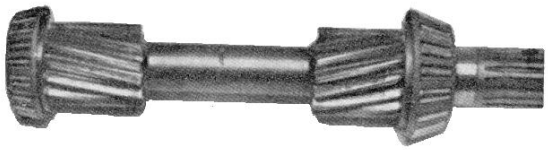
Remove the wheel “AHEAD” with a special tool and take off all parts “AHEAD”.



Dismantling of Input Shaft

Squeeze off the tapered roller bearing inner collar.

15.



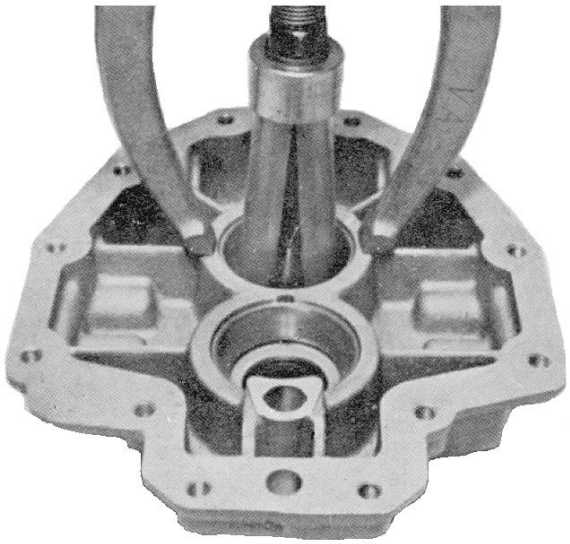
Dismantling of Lower Gearbox Half

Pull out the tapered roller bearing outer collars of the lower gearbox with an inner puller No. 1 x 56 122 208 and auxiliary tool No. 1 x 56 122 227 and take up the washers.

At the fitting the tapered roller bearing outer collars have been smeared with Loctite 601 and so heating may be necessary.

At the dismantling: Mark the adjusting washer(s) which lie below the bearing rings in proportion to the bore.

16.



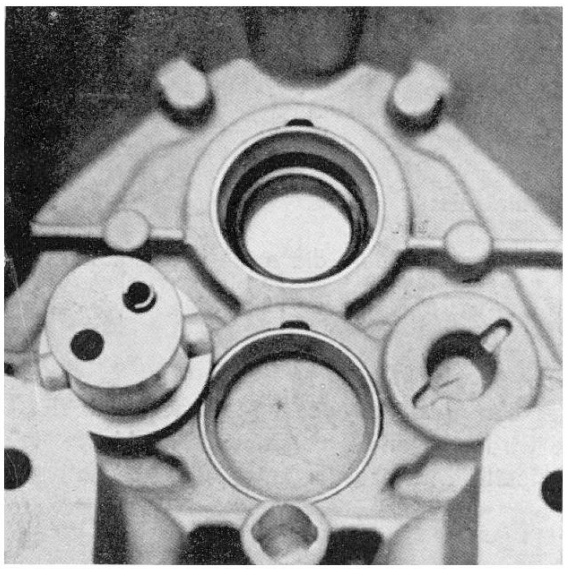
Dismantling of Upper Gearbox Half

Pull off the tapered roller bearings outer collars as described under picture No. 16 above.

Loosen the nuts at the wheel and press out the bolt of the housing.

Remove slotted pin and washer.

17.



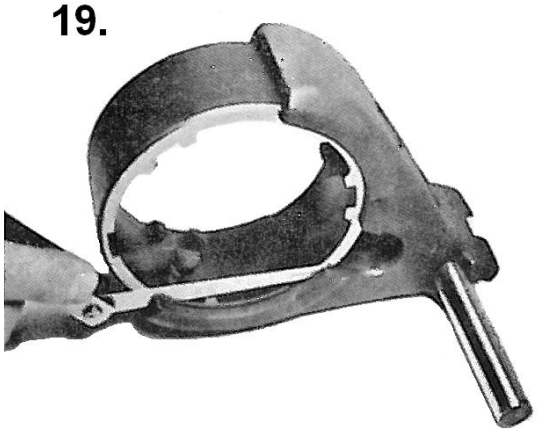
Refitment of BW7 Gear

Before refitment of the gear examine the different components for cracks and wear.

In the following description only the fitting of output shaft for “AHEAD” is described as the fitting for “ASTERN” is chiefly corresponding.

If it is necessary reference will be made to the paragraph marked “Note”.

19.



Picture 19

Insert the sliding sleeve in the shifting fork and measure the axial clearance of the sliding sleeve.

The axial clearance below the wear limit must be 0.1 – 0.4 mm.

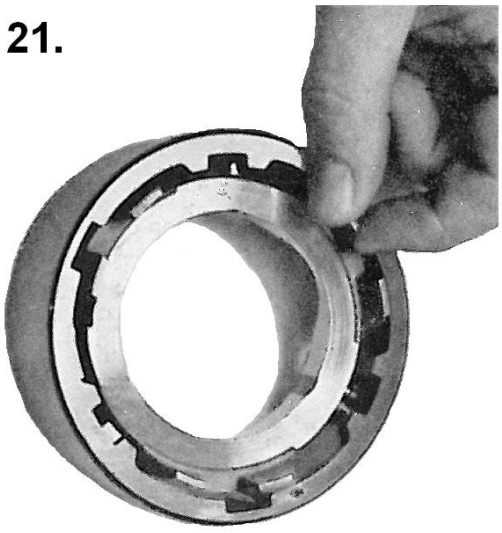
20.

Picture 20

Insert the locking bolt in the thrust collar. The locking bolt should be able to turn easily in its bore in the thrust collar.

The head of the locking bolt must adjoin the thrust collar.

21.



Picture 21

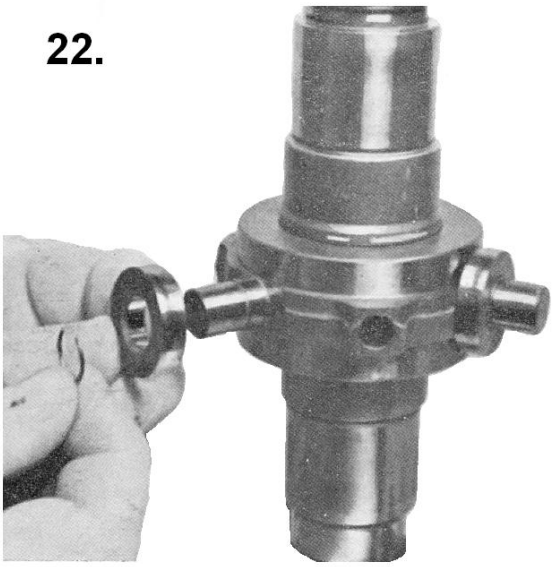
Insert thrust collar with locking bolt in sliding sleeve.

Check torsion in sliding sleeve.
The locking bolts must not pinch by this.

Fit the tension rollers on the shafts for suspension by rollers.

“Note”: The tension rollers must be placed so that the big surface lies outwards.

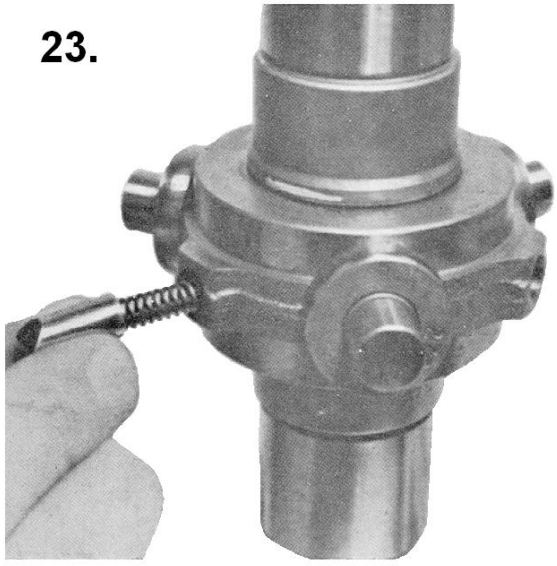
22.



Fit the pressure springs in the check bolts. Fit the check bolts in the corresponding bores.

The point of the check bolts should turn so that it is horizontal.

23.

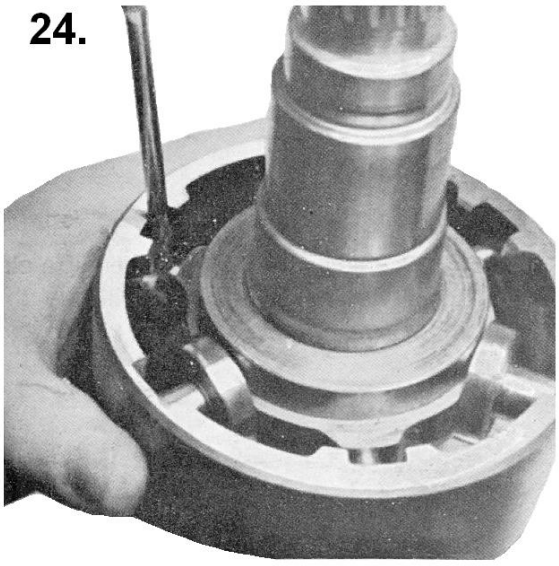


Press the sliding sleeve from the bottom against the check bolts.

Press the check bolts back with a screw-driver and at the same time press the sliding sleeve upwards.

The bolts should rest in the points of rest of the sliding sleeve.

24.

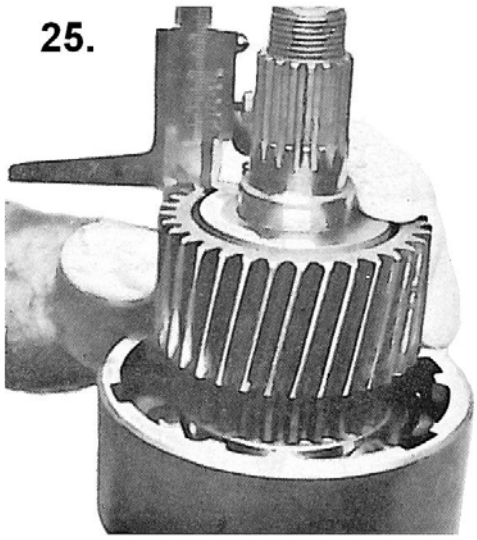


Fit needle bearing housing, wheel for “AHEAD” and washer.

Check the axial clearance of wheel for “AHEAD”. It should be 0.1 – 0.4 mm.

“Note”: For “ASTERN” the axial clearance can be adjusted by fitting an intermediate washer (thrust washer).

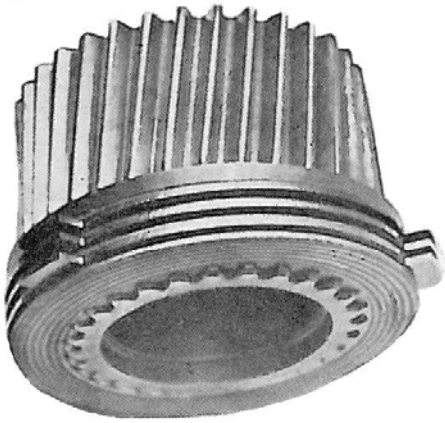
25.



First fit a washer. Then fit an inner disc and the an outer disc.

Fit 4 inner and 3 outer discs in this order.

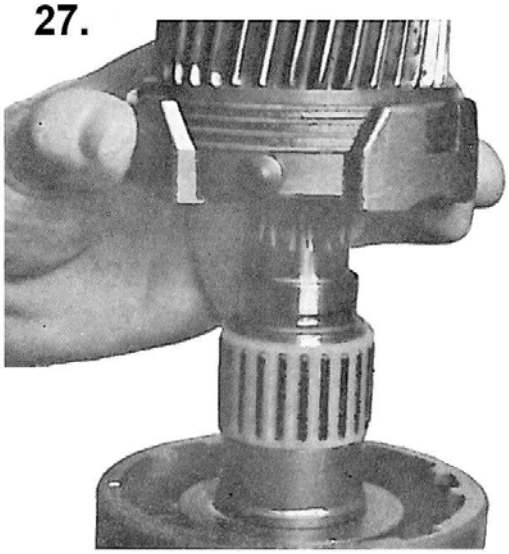
26.



Fit wheel for “AHEAD” with clutch discs on the thrust collar.

First fir the driving pins through the thrust collar and the fit the thrust collar with clutch discs and wheel for “AHEAD” over the needle case on the input shaft in the sliding sleeve.

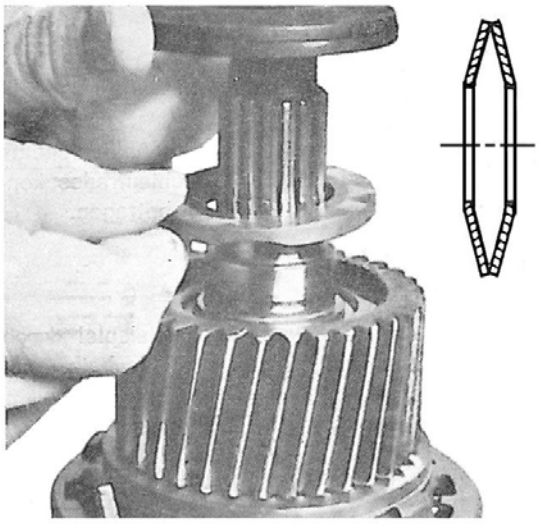
27.



Fit thrust washer, the oil pockets of which should turn towards the wheel for “AHEAD”.

Fit the disc springs which should touch with the outside diameter.

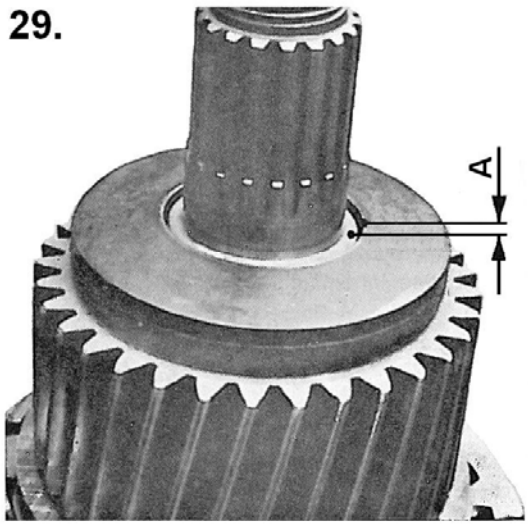
28.



Check the tightening of the disc springs.

The inside diameter of the disc springs must, when slack, in proportion to the front be min. 1.1 mm (measure A).

29.



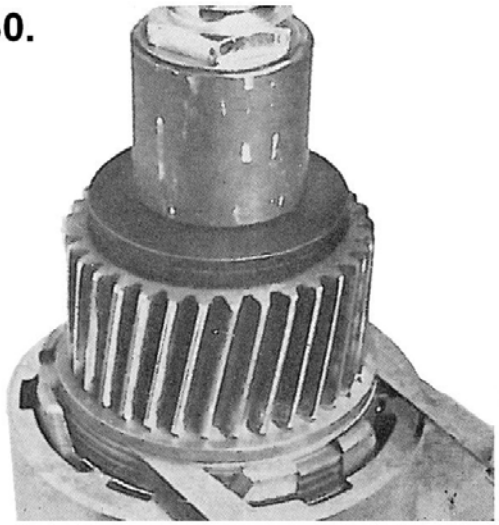
Tighten the disc springs with bush 1 x 56 136 994. Measure disc clearance between inner disc and washer with a feeler gauge in two places which are opposite one another.

The disc clearance to be 0.75 – 0.85 mm.

Deviations should be adjusted with washer available in different thicknesses.

“Note”: Tighten the disc springs on the side for “ASTERN” with bush No. 1 x 56 136 995.

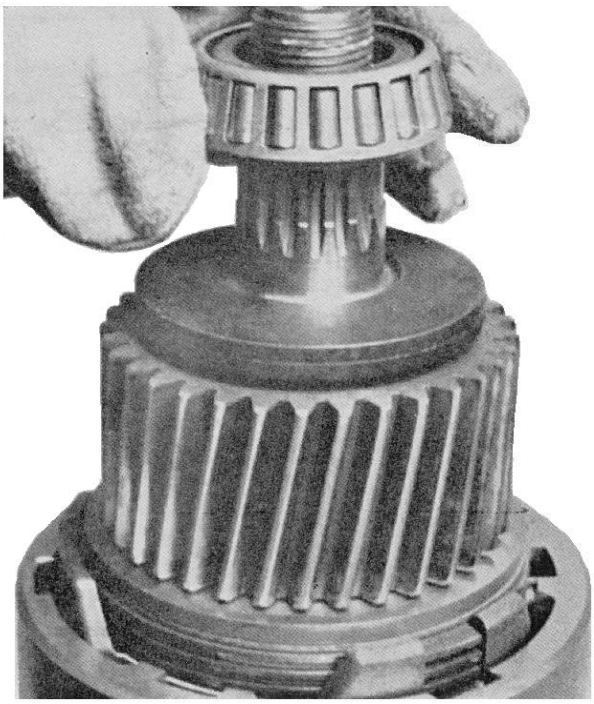
30.



Heat the tapered roller bearing inner collar to about 85°C and fit it with the thin end of the taper roller facing the shaft end of the output shaft until it fits tightly against the disc springs.

Tighten the tapered roller bearing with bush No. 1 x 56 136 995 and original hexagon nut until it fits tightly against the shaft assembly. See picture No. 33 overleaf too).

31.

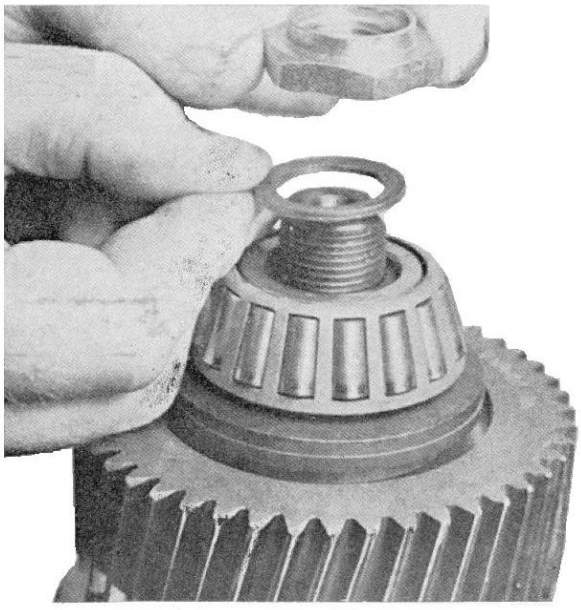


"Note": Fix the tapered roller bearing for "ASTERN" with supporting washer and original hexagon nut.

The torque of the nut is 100 Nm (10.0 kpm).

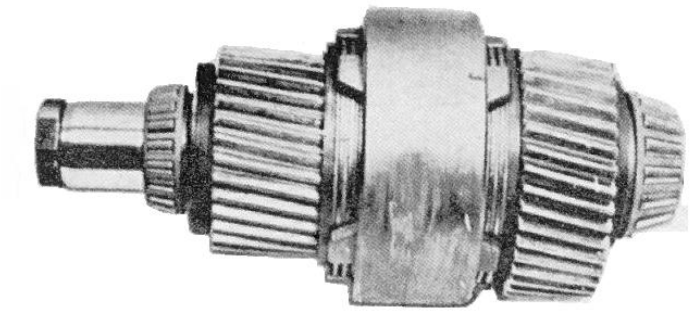
Secure the nut.

32.



The picture shows the ready-mounted output shaft.

33.

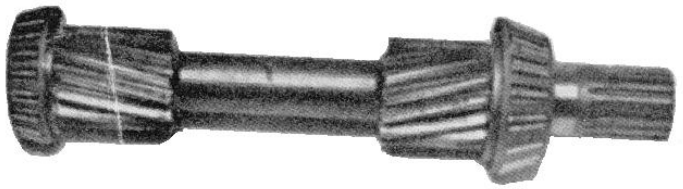


Fitting of Input Shaft

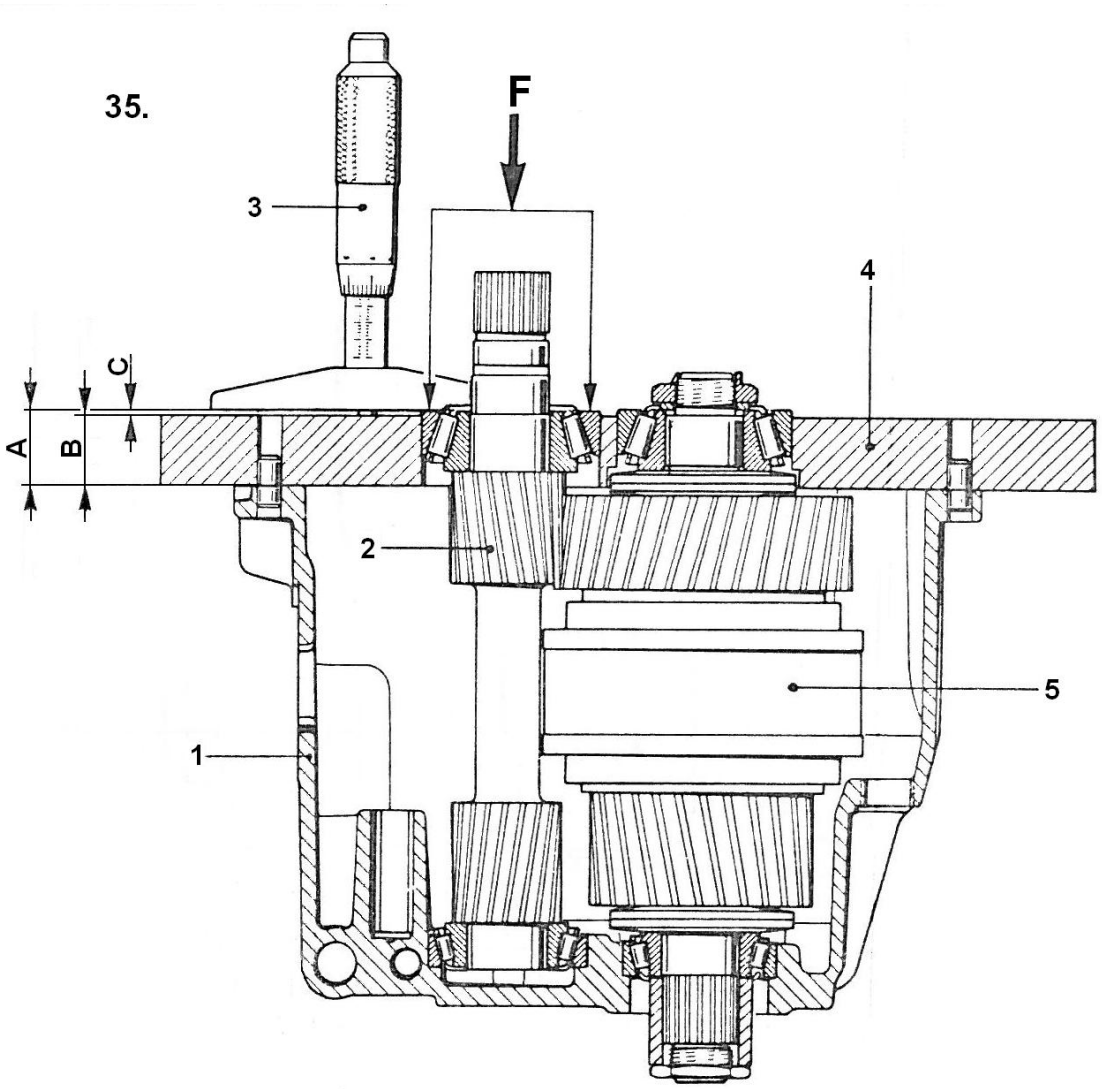
Heat the tapered roller bearing inner collars to about 85°C and fit it with the thin end of the bearings towards the shaft ends.

“NOTE”: Fit wide tapered roller bearing on the input side.

34.



Measuring of Tightening of Tapered Roller Bearing on Input and Output Shafts with Measuring Gauge.



1 = Housing
2 = Input shaft
3 = Depth micrometer
4 = Measuring gauge 1 x 56 136 978
5 = Output shaft

Heat the bearing bores in the housing to about 85°C and fit the tapered bearing outer collars with Loctite No. 601.

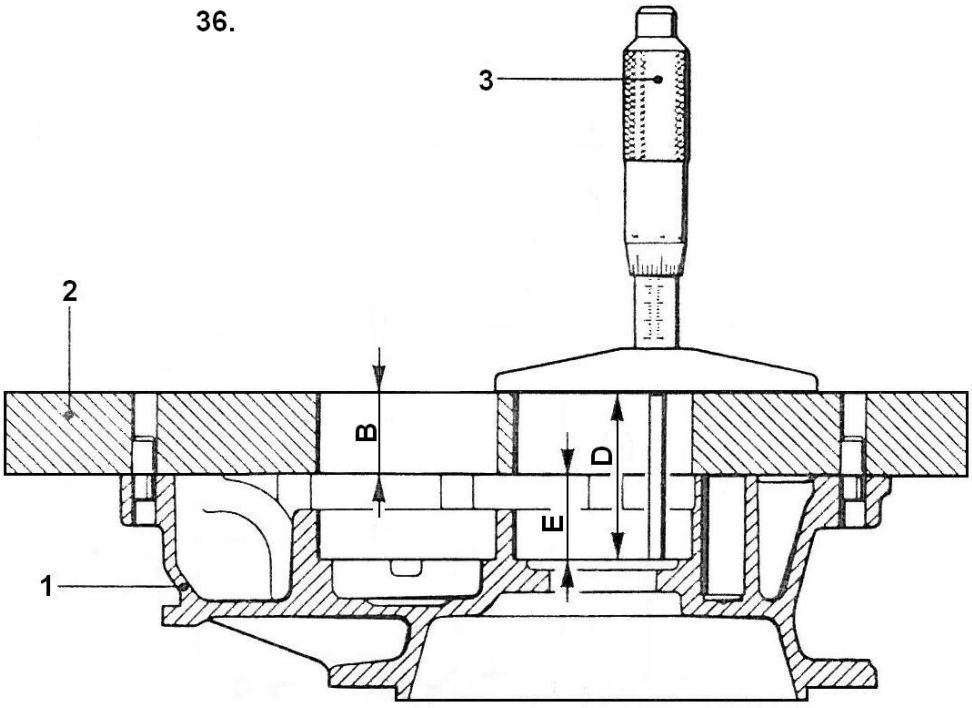
Build in the tapered roller bearings of input and output shafts with the tightening of 0.03 to 0.08 mm after the cooling.

Measure the tightening as shown on the pictures 35, 36 and 37 and adjust it with adjusting washers (measure G). Measure G: measure F (difference measure) plus tightening.

Fit the input and output shafts in the housing and fit the measuring gauge on the housing by means of the pins.

Fit the tapered roller bearing outer collars in the measuring gauge until they fit tightly against the tapered rollers while constantly turning the input and output shafts with a pressure of F = 30 N (3.0 kp) on the bearing outer collars.

Measure A = B + C, B = thickness of measuring gauge, C = bearing outer collar above measuring gauge.



1 = Bearing bushing
2 = Measuring gauge
3 = Depth micrometer

Fit the measuring gauge on lower gearbox half.

Calculate the thickness of the intermediate washer G as follows:

Establish measure E as D minus B (thickness of measuring gauge).

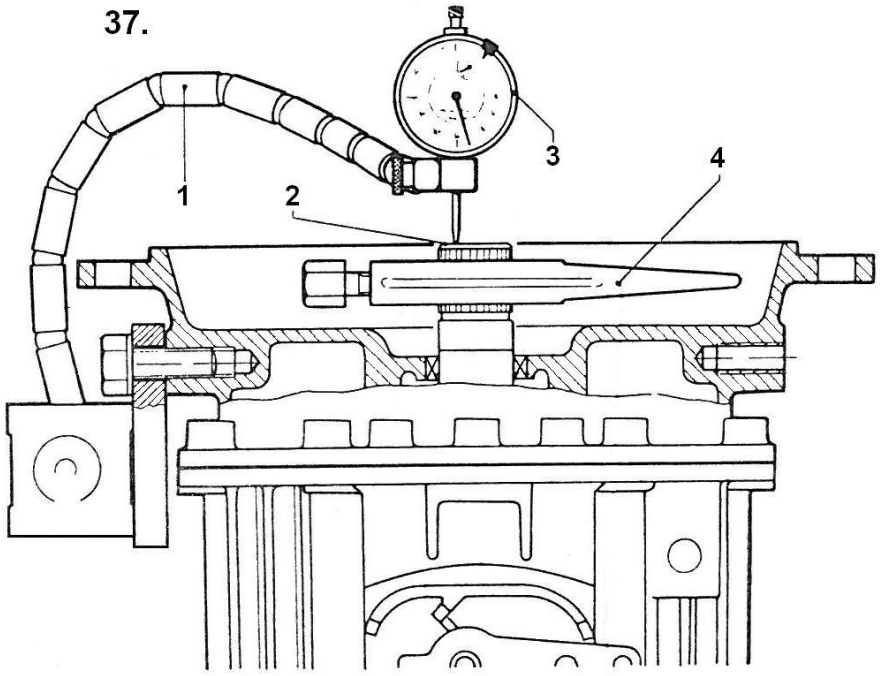
Calculate the difference measure F as E minus A (See picture No. 35 on last page).

Calculate intermediate washer G for the input shaft as F plus tightening 0.03 – 0.08 mm.

At the calculations the thickness of the liquid jointing, when compressed, should be included and an empirical value of 0.02 mm should be considered.

Then fit the necessary intermediate washers in the bearing bores (max. 2 washers per bore) and heat the bearing bores to about 85°C and fit the roller bearing outer collars with Loctite No. 601.

Measuring of Tapered Roller Bearing tightening on Input and Output Shafts without Measuring Gauge.



1 = Dial indicator holder 2 = Input shaft 3 = Dial indicator 4 = Driving arrangement

It would be an advantage, if the input shaft and the output shaft are measured individually for the adjusting of the tapered roller bearing tightening. The measuring procedure is the same both for input as well as for output. However, only the procedure for the input shaft is described here. When measuring the output shaft it should be as described at picture no. 31.

Turn the shafts when measuring in order to compensate for possible deviations, and a fixed point of measuring should be chosen for marking of the axial clearance.

Heat the bearing bore to about 85°C and fit the outer collar of the tapered roller bearing with Loctite no. 601.

In order to be able to adjust the tightening of the roller bearing it is necessary that the shafts show axial clearance. This is obtained by fitting intermediate washers which are 0.2 mm thinner than those which were removed and marked as described at picture no. 16.

Heat the bearing bore to about 85°C and fit the bearing outer collar without Loctite in the bore.

Place the input shaft in the housing after the cooling and fit the lower gearbox half without any packing and drive in the guide pins.

Fit the contact point of the dial micrometer on the front of the input shaft and turn the shaft backwards and forwards. During this the shaft should show axial clearance.

If there is no clearance shown. fit thinner washers under the bearing outer collar.

Add the roller bearing tightening of 0.03 – 0.08 mm plus further 0.02 mm (liquid jointing compressed) to the measured axial clearance and thus we get the thickness of the intermediate washer.

Picture No. 37 continued

Measuring example:

Thickness of intermediate washer during the measuring procedure:	0.60 mm
Measured axial clearance of shaft:	0.08 mm
Correct tightening 0.03 – 0.08 mm (average value):	0.055 mm
Thickness of compressed liquid jointing:	0.02 mm
Theoretical thickness of intermediate washer:	0.755 mm

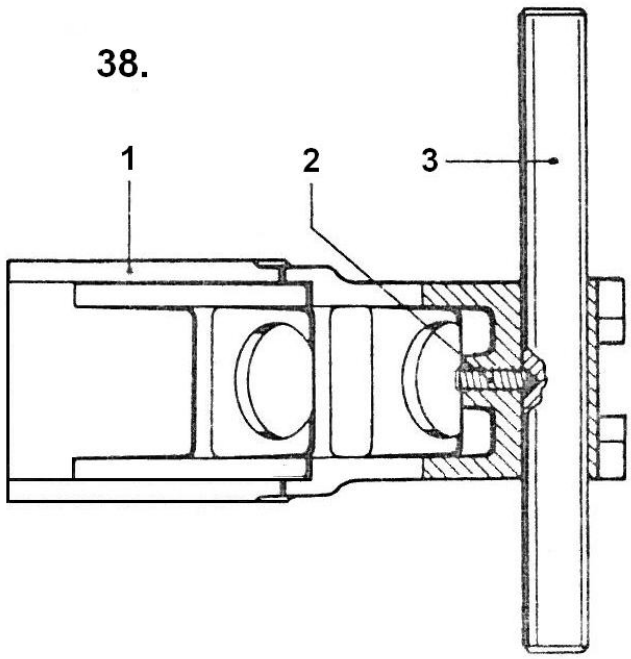
In practice the intermediate washer will be 0.73 – 0.78 mm.

Then insert the correct intermediate washers in the bores (max. 2 washers in each bore) and fit the bearing outer collars after heating with Loctite No. 601.

Pre-Mounting of Shifting Fork.

Place the reversing shaft in the shifting fork and secure it with the threaded pin and smear it with Loctite No. 241.

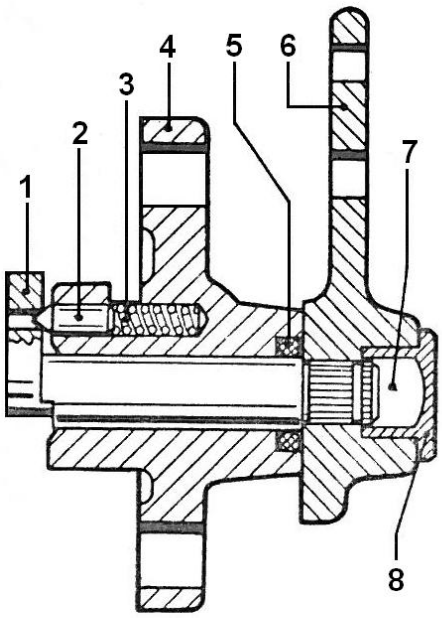
“NOTE”: the long side of the reversing shaft points to the left when the position of the shifting fork is as shown on the drawing.



1 = Shifter shaft
2 = Shift pin
3 = Pressure spring
4 = Gearbox
5 = O-ring
6 = Shift control lever
7 = Grease lubrication
8 = Screw cap

Insert pressure spring, shift pin, oiled shifter shaft and O-ring in the gearbox.

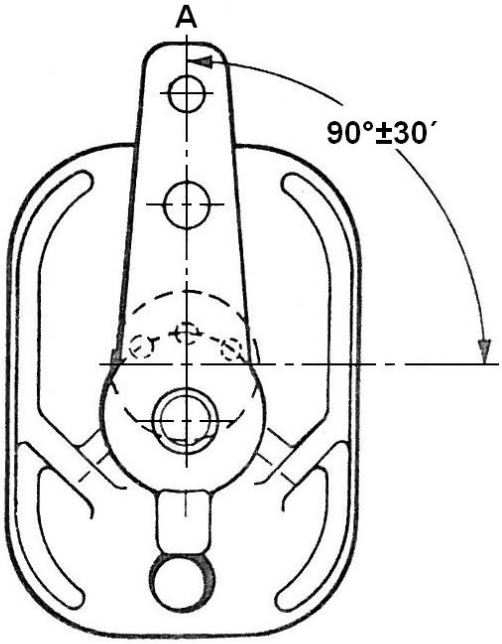
39.



Press the shift control lever on to theshifter shaft so tha t shift control leveris placed in neutral position at 90°±30'to the gear shaft length.

Fit the screw cap with grease lubrica-ting after the pressing on.

40.



Fitting of Bolts in Gearbox

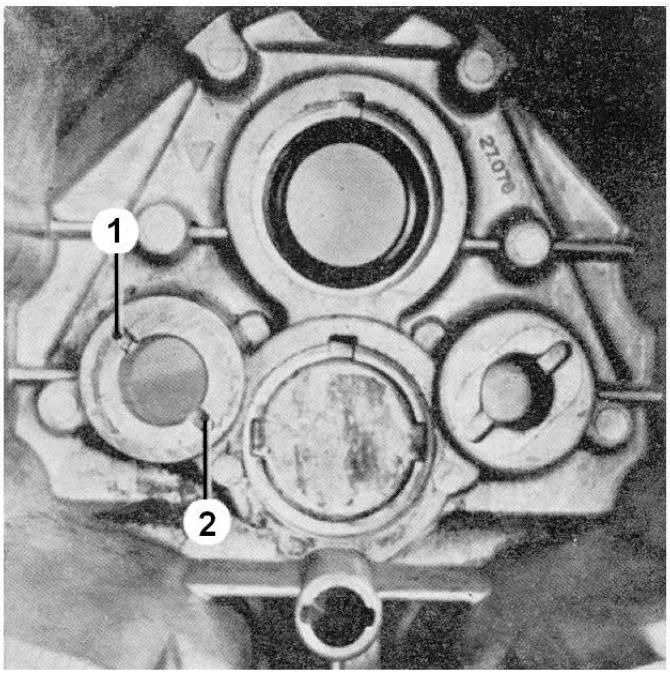
Drive in t he slotted pins 4x16 in thebolts and fit the washers on the bolts so that the lubricating groove in them point to the wheel.

"NOTE": The bolt must be fitted in pos. 1 or 2 all depending on the transmission.

Transmission:

GLL = AHEAD
GGL = ASTERN

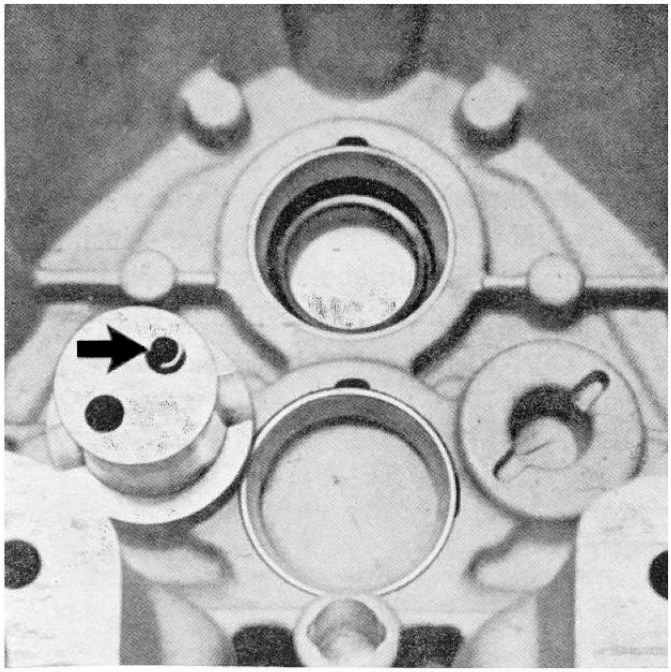
41.



Heat the gearbox and fit the bolts with slotted pins in pos. 1 or 2 all depending on the transmission.

Fit the hexagon nut and tight en it with 100 Nm (10 kpm).
Fit the sleeve in the bolt bore nearest the centre of the gear (s ee the arrow).
Smear the hexagon nut with unhardening packing material before the fitting.

42.

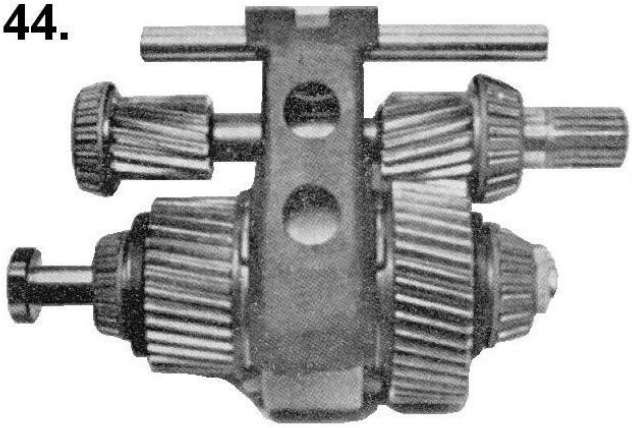


Fitting of Input and Output Shafts with Shifting Fork in Gearbox

Place the shaft arrangement as shown on the picture.

"NOTE": The long side of the reversing shaft faces the input side.

44.

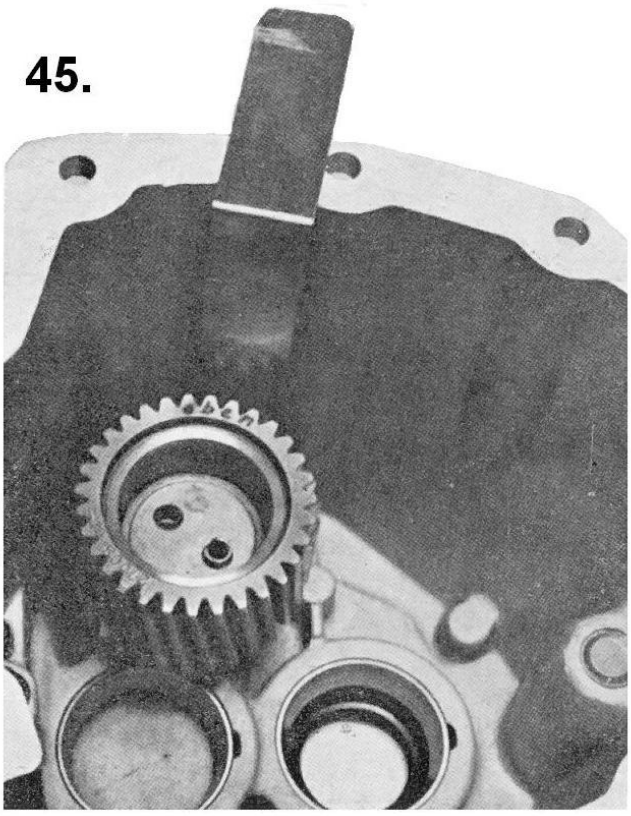


Fit the intermediate wheel and needle bearing.

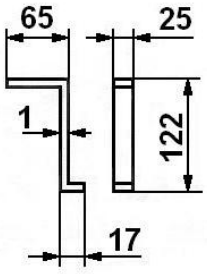
Lift intermediate wheel with s top plate (see illustration).

The intermediate wheel should be lifted about 25 mm, otherwise fitting is not possible.

45.



Sketch of Stop Plate



measures in mm

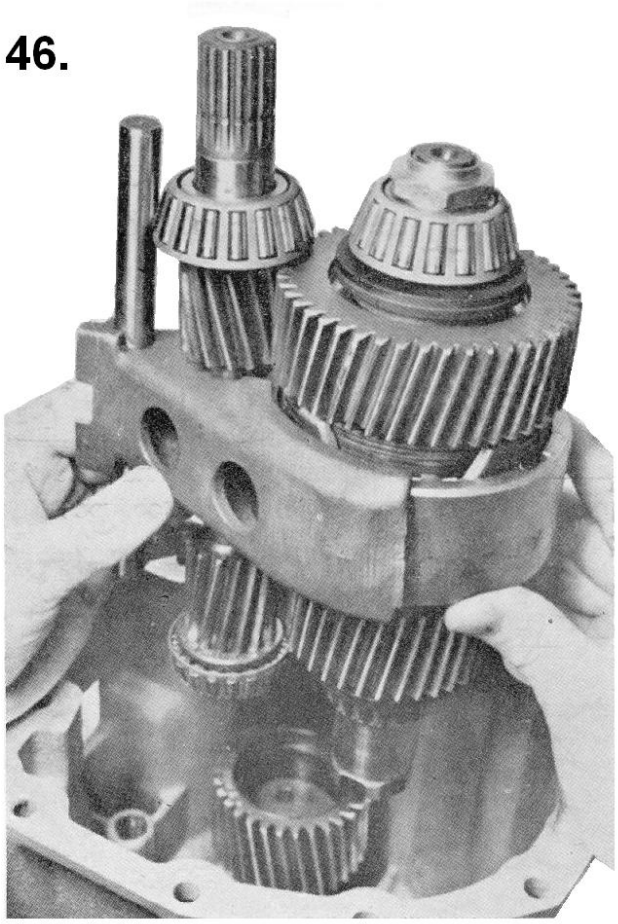
Place the housing so that the opening of it turns upwards.

Oil the roller bearings and reversing shaft and fit them together in the housing.

Remove the stop plate.

"NOTE": The long side of the reversing shaft points upwards to the input side.

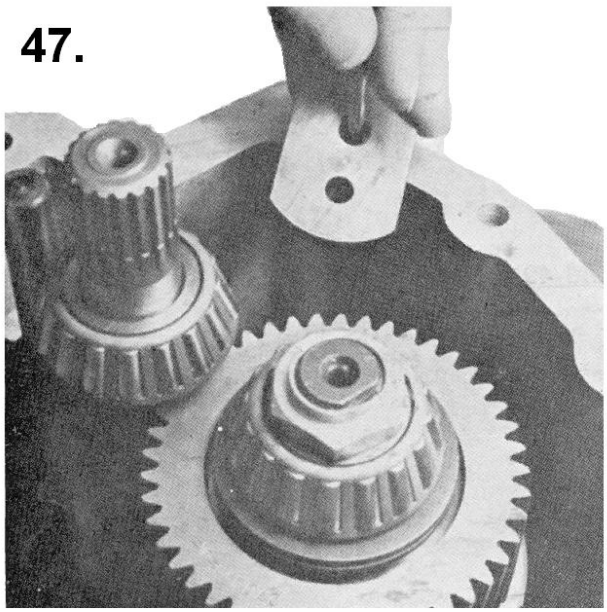
46.



Fit retaining plate for intermediate wheel and before that smear the screws M8x25 with Loctite No. 241.

Torque: 17 Nm (1.7 Kpm).

47.

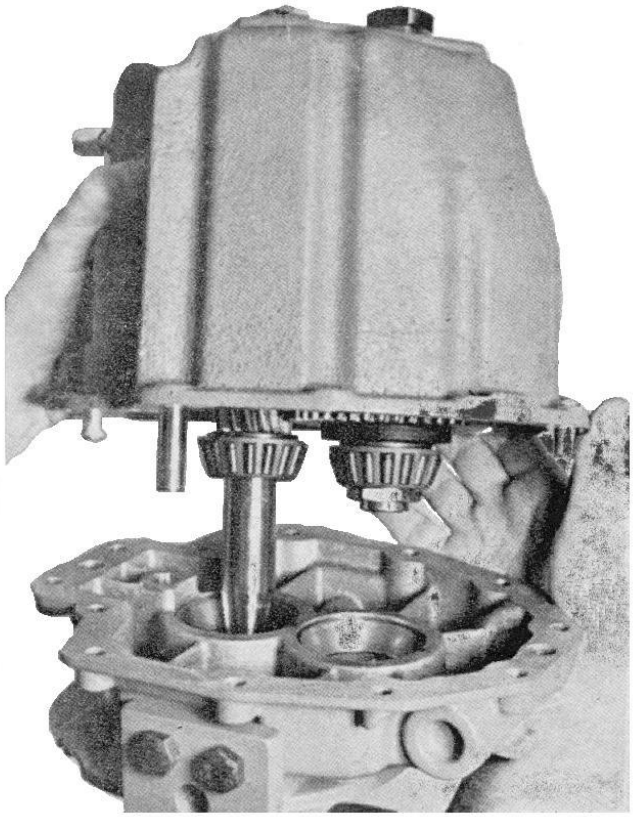


Smear the seal f aces of the gearbox halves wit h permanently plastic liquid jointing.

Oil the bearings on the input and output shafts.

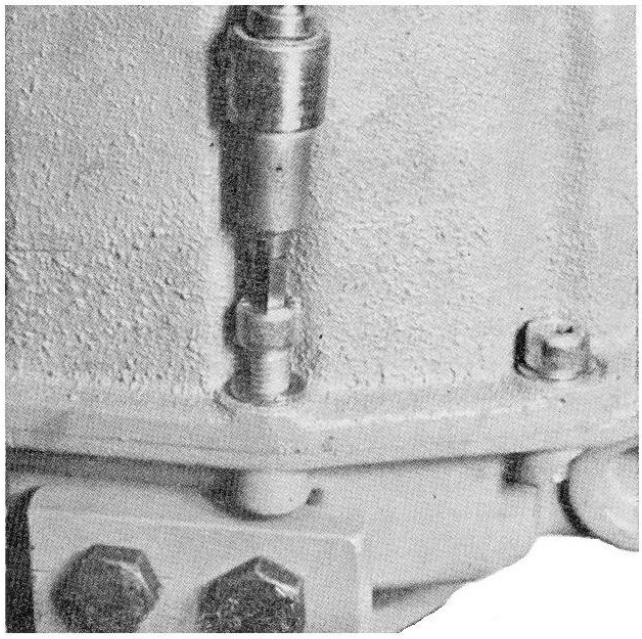
Assemble the gearbox and drive in the guide pins.

48.



Tighten the screws M8x25 with a torque of 17 Nm (1.7 Kpm).

49.

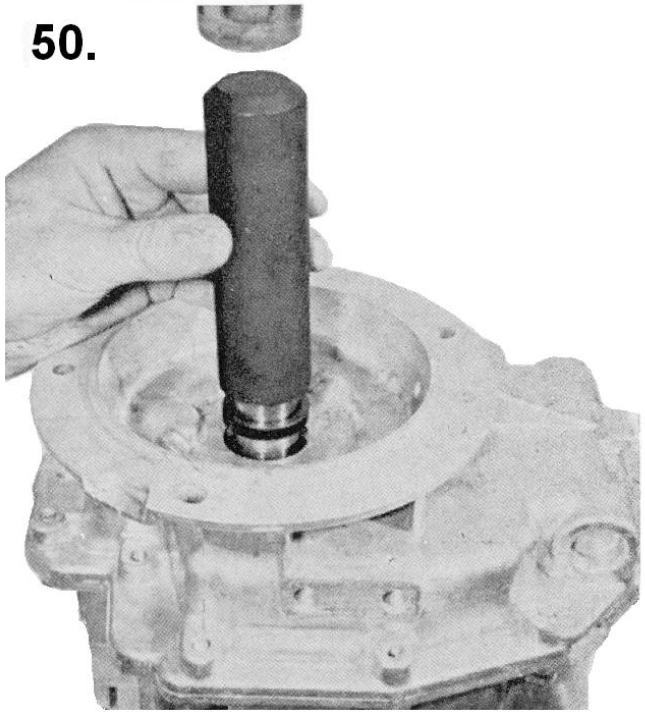


Fitting of Shaft Seal Rings

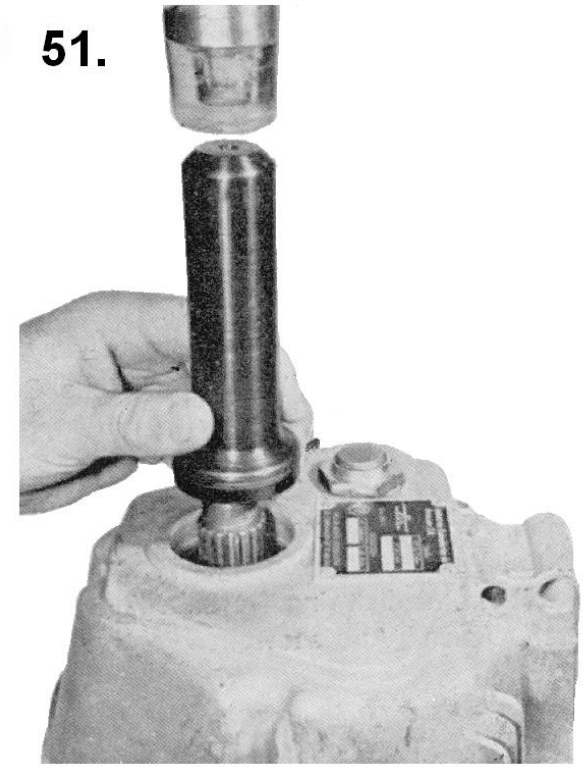
Fit the protective cap No. 1 x 56 136 992 over the input shaft.

Smear the seal ring 25 x 33 x 6 with a thin layer of grease on the lip ring and smear with a thin lay er of plastic liquid jointing on the outside.

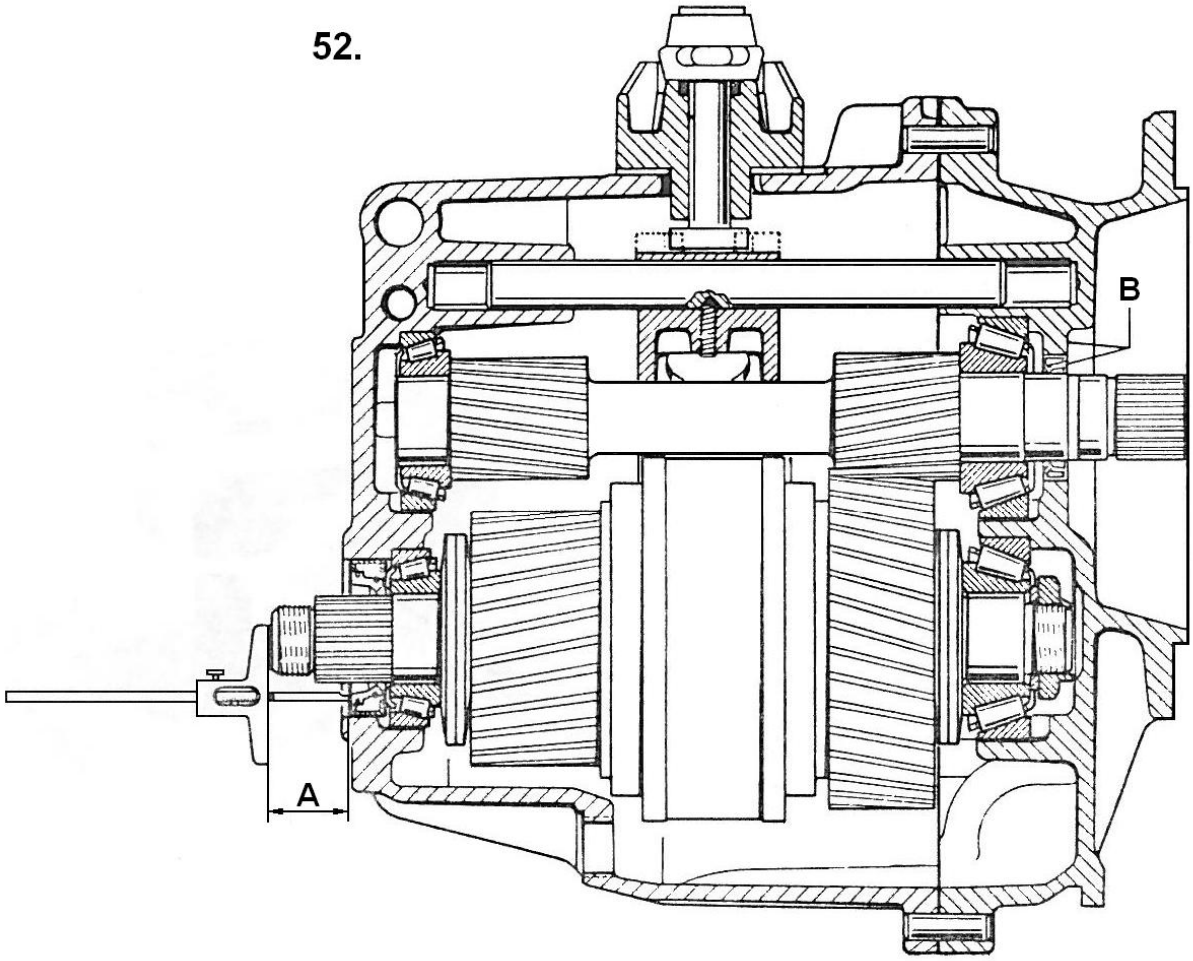
Fit the seal ring with punch No. 1 x 56 199 916 so that it fits tightly against the bore of the housing.



Smear the similar seal ring 32 x 45 x 7 for the output shaf t in the same way as the seal ring for the input shaft and fit it by means of punch No. 1 x 56 136 993 in the housing so that it fits tightly against the tapered roller bearing inner collar.



Supplement to Fitting of Shaft Seal Rings

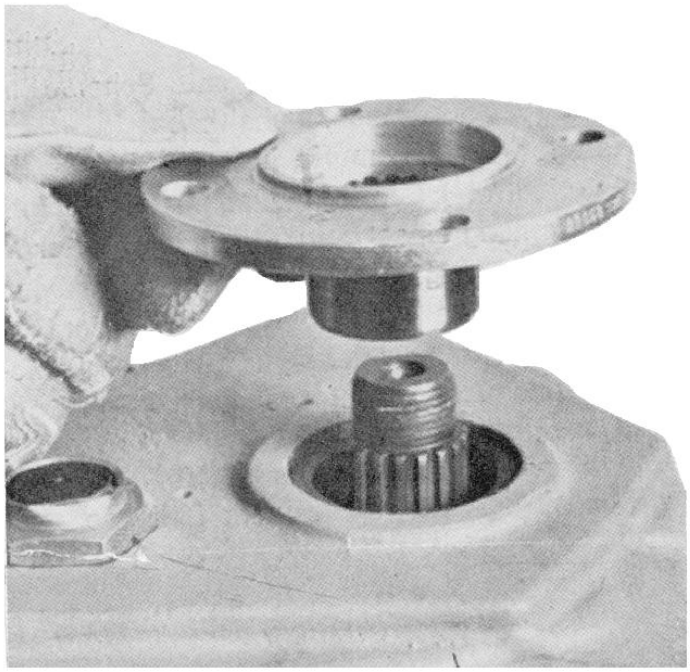


A = Distance to shaft seal ring: 22.5 ±0.5 mm.
B = Shaft seal ring binding with surface of casting on the lower gearbox half.

The picture shows the necessary mounting dimensions for the shaft seal rings on the input and output shafts.

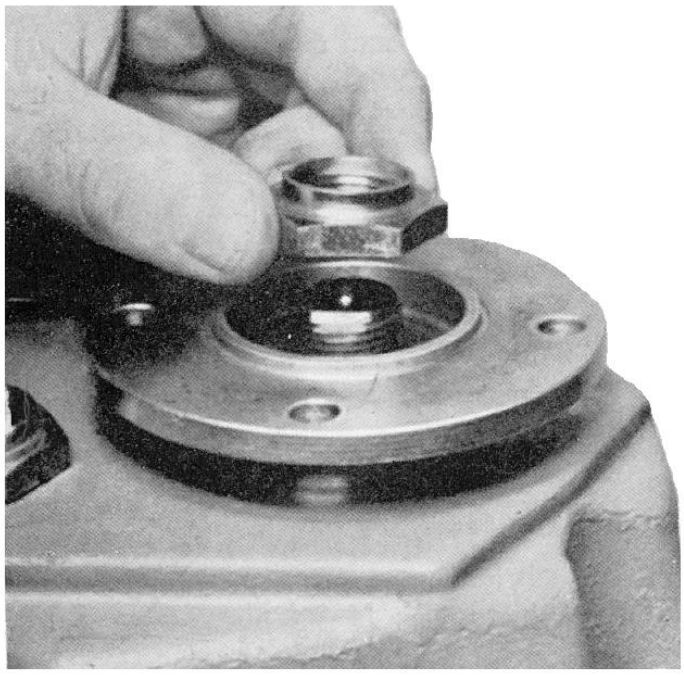
Heat the output flange to about 85°C and fit it on the output shaft.

53.



Smear the nut with permanently plastic liquid jointing and secure it with a torque of 100 Nm (10 Kpm).

54.



Picture 55

Fit the screws M8x25 with washers in the gearbox. Put the gear shift lever in "neutral" (the sliding sleev e is also in "neutral" position).

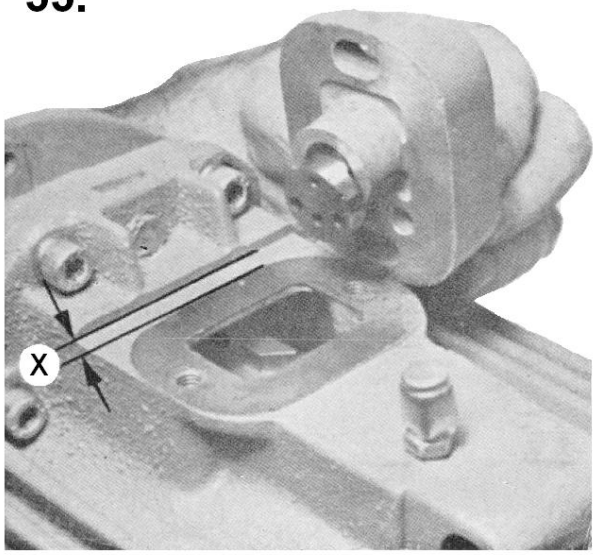
Place the gearbox with gask et in the opening of the housing and pr ess the shifting eccentric down into the shifting fork. In connection with this check at the same time with a ligh t pressure of the eccentric pointing to the assembly the axial clearance between the sliding sleeve and the shifting fork.

Secure the shifter housing in this position.

"NOTE": When checking the axial clearance it must be checked whether the fixing screws hit against the walls of the gearbo x because of the slots which may lead to wrong adjustments.

Adjustment can be c arried out by axial displacement (angle 90° m ust be maintained, see picture 40).

55.



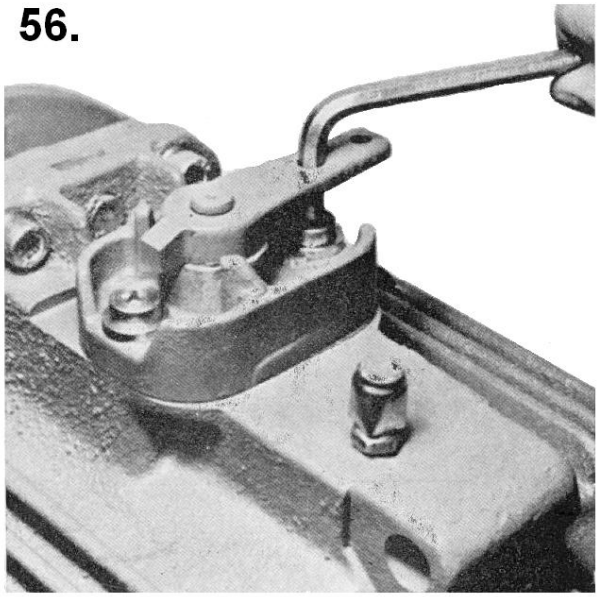
Picture 56

Tighten the shifter housing with a torque of 17 Nm (1.7 Kpm).
Shift the shift control lever in both directions and check the function of the reversing.

The sliding sleeve s hould be connected (click) in b oth directions when the angles of engagement are as equal as possible.

Besides, it must always be possible t o turn the shift control lever 37° in either direction without much resistance.

56.

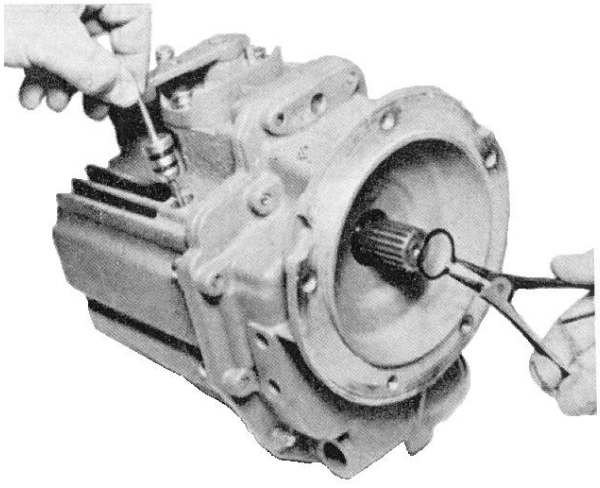


Picture 57

At last fit the dip stick and the loc king ring at the end of the input shaft when fitted.

Fill oil in the ge arbox to a quantit y corresponding to the upper mark on the dip stick.

57.



SECTION S

SAIL DRIVE TYPE Z-7

CONTENTS

Oil Change and Gear Ratio

As an alternative to the BW7 gear the DV36 can be equipped with a sail drive.

The reduction ratio is 2.25:1 for “AHEAD” and 2.25:1 for “REVERSE”.

The sail drive will need no other attendance than regular change of oil. This to be carried out after the first 25 hours of operation and then every 150 hours or once a year.

Carry out the oil change when the boat is on land by loosening the drain screw in the bottom of the sail drive enabling the oil to run out.

Refill with fresh oil through the filler hole at the top of the sail drive to a quantity of 3.3 litres corresponding to the upper mark on the dip stick.

Use the same quality of oil as for the BW7 gear.

Zinc Anode

A replaceable zinc anode is fitted at the propeller. Check this anode twice a year or as required all depending on the waters you are sailing in.

Outside Maintenance

Do not grind thoroughly when careening the boat. Damage to the surface treatment should be treated as soon as possible with special BUKH paint.

The sail drive should be coated with the same bottom paint as the rest of the bottom of the boat.

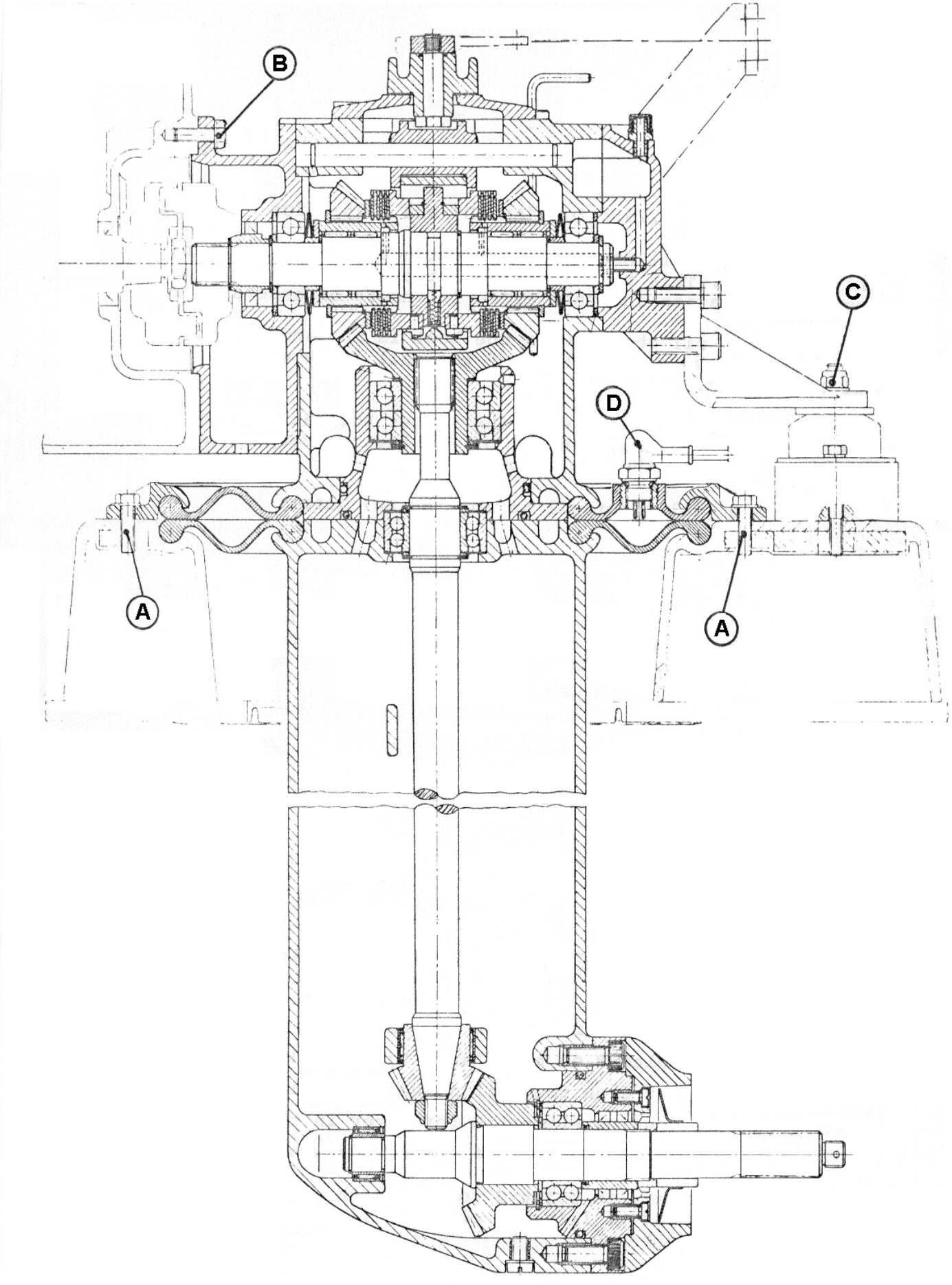
Removal of Sail Drive from Engine and Boat

(see drawing page S4)

1. Beach the boat.
2. Loosen the bolts marked **A** in the flange at the double membrane.
3. Loosen the bolts marked **B** on the flange towards the engine.
4. Loosen the sensing element marked **D** for water in the double membrane.
5. Lift the sail drive clear of the foundation.

It may be necessary in point 2 to loosen the engine mountings from the foundation and to lift the engine a little in order to loosen all the bolts marked **B**.

S4



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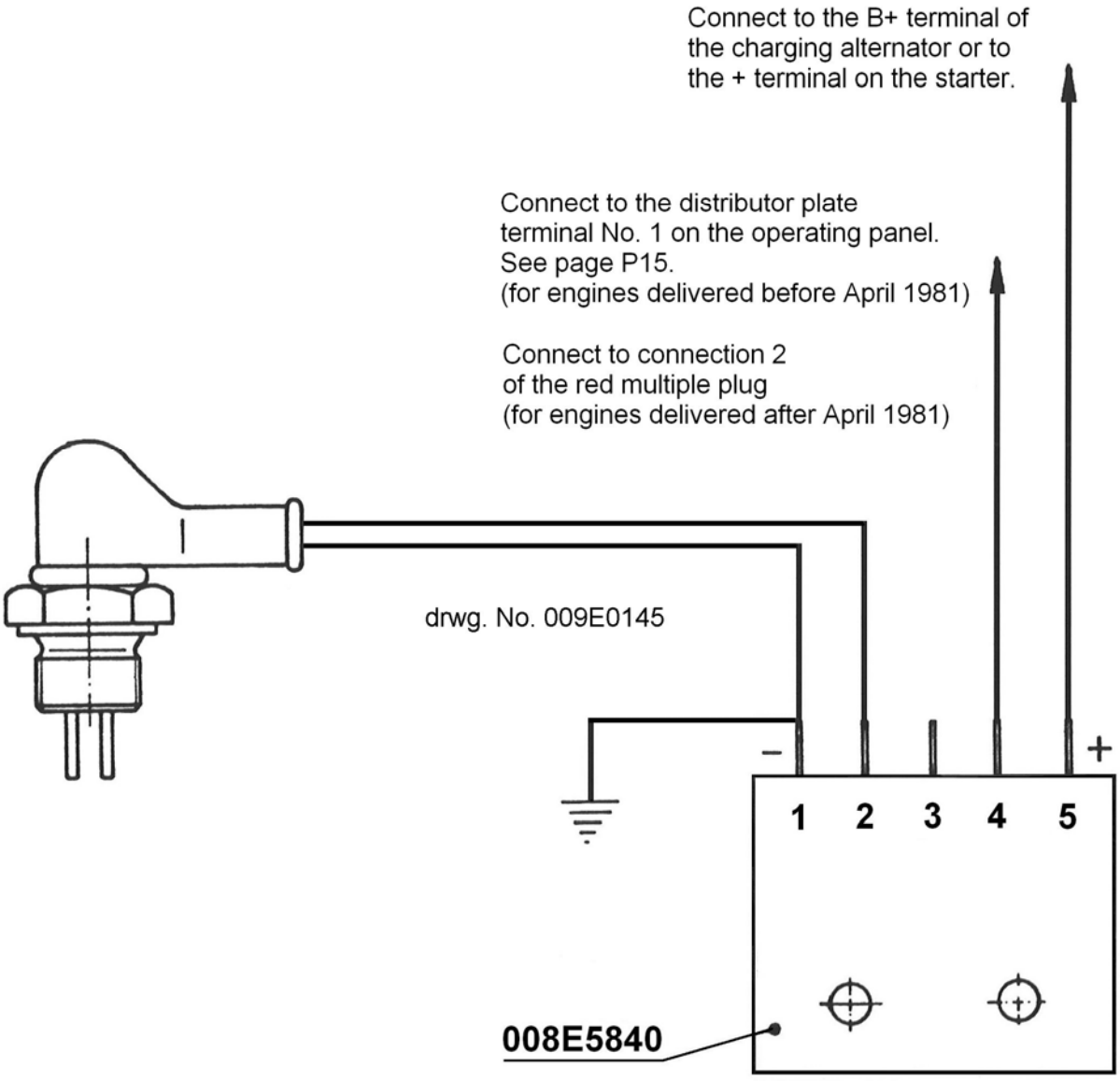
Alarm Function of Double Membrane

A sensing element is fitted in the double membrane. The element is shown on the diagram below.

The sensing element is connected to the the operating panel and if water penetrates into the double membrane it will release an acoustic alarm.

As a precaution the alarm function should be checked once or twice a year by short-circuiting the connections 1 and 2 on the plastic box No. 008E5840 placed on the engine next to the multiple plugs.



The instruction below is stated for assembling of sail drives as broadly the disassembly procedure is to be carried out in reverse order noting the thickness and the placing of the different intermediate washers.

General

At the assembly all parts must be clear, burred and free from grease.

In order to prevent wrong measuring when adjusting, the parts should normally not be oiled when being assembled.

Heat the mounting houses with a hot-air blower, an oven or the like to **80°C** when fitting the bearings in accordance with the procedure. However, the temperature must not exceed **140°C**.

When replacing gear-wheels, change them two and two, i.e. do not change one single gear-wheel, but one connected set of gear-wheels.

When replacing the coupling arrangement at the top of the sail drive, replace the whole arrangement without repairs of single components of it. This should be seen in the light of the fact that a correct repair of the coupling arrangement demands a very advanced measuring equipment which only very few have at their disposal.

The special tools mentioned in this instruction are not numbered, but can be ordered with reference to this section of the workshop manual through BUKH´s spare parts department.

Both distance measure and flange clearance are always marked on the wheels, and they apply to the wheel on which they are written.

The sail drive comprises 11 filling pieces each consisting of an intermediate washer at the least.

Assembling Procedure for Sail Drive

1. Measure the intermediate piece (between engine and clutch housing), the clutch housing and the end cover for the same, and then the "**K**" measure can be worked out.

2. Up-end the clutch shaft so that any clearance is equalized. (about 2 kg compression, if it is not possible to up-end the shaft). At the same time the gear-wheel should be engaged. Measure the "J" measure now. Measure the "**C**" measure for use later on under point 10.

3. Measure the "**H**" measure in order to find the centre of the vertical intermediate shaft. Measure the "**G**" measure as "**F**" measure + "**A**" measure, as the "**A**" measure is written on the gear-wheel.

   Measure the "**F**" measure while the shaft still stands on its edge, so that any clearance is equalized.
   Calculate the thickness of the intermediate washer "**II_v**" as: "**H**" measure minus "**G**" measure.

4. Calculate the thickness of the intermediate washer "**II_r**" as: "**K**" measure minus sum of "**J**" measure and intermediate washer "**II_v**".

5. Fit the intermediate piece on the clutch housing with liquid jointing as filling piece.

6. Fit the reversing part at the top of the clutch housing as follows:

a. Put the reversing lever in "Neutral" position and the pipe collar too.

b. Lead the reversing house with gasket into the opening of the clutch housing and press the shifting eccentric into the wedge-shaped groove of the shifting fork. In order to equalize the axial clearance between the shifting fork and the pipe collar the shifting eccentric should be fitted with the groove in the shifting fork with a light pressure.

c. Tighten the reversing house in this position.

   NOTE: The clearance of the angle between the longitudinal shaft of the gear and the one of the reversing lever must be observed. The angle is to be **90°±30`**.
   Use a reference gauge for this purpose.

   When adjusting the reversing house the fixing screws must not encounter the wall of the slots of the reversing house as this would lead to wrong adjustment.

d. Shift the reversing lever in both directions and test the shifting function. In both shifting positions the pipe collar be connected (click), when the angles of engagement measured on the reversing lever are as equal as possible.

   Besides, it must always be possible to turn the reversing lever **37°**. The adjustment is corrected by axial displacement of the reversing house, the angle of 90° being observed.

e. In order to test the function of both clutches turn the input shaft (clutch shaft) round by hand and brake the output shaft by hand when engaged.

   The upper part of the sail drive is now temporarily ready.

Measure on the intermediate wheel as follows:

7. 1.0 mm is chosen as thickness of the intermediate washer "**III**" as starting point.

8. Freeze the gear-wheel and measure the stagger between the inner collar and outer collar of the bearing. Fit the bearing with the ball filler hole facing the adjusting washer "**IV**".
   Fit the next bearing correspondingly. Punch the inner collar when fitting it to secure that the two inner collars touch each other.
   Measure the intermediate bearing housing for the measures "**D**" and "**E**".

9. Measure the "**M**" measure for use later on.

10. Calculate the thichness of the intermediate washer "**IV**" now, the intermediate washer = "**C**" measure minus the sum of "**D**" measure and "**B**" measure.
    "**B**" measure is written on the gear-wheel.

11. Measure the "**L**" measure, then calculate the thickness of the intermediate washer "**V**", this washer being = "**L**" measure minus the sum of "**E**" measure and the intermediate washer "**IV**".

12. Fit the intermediate wheel in the bearings and secure it with a Seeger circlip in accordance with the drawing for it.

13. Fit the bearing housing with intermediate wheel in the gearbox with O-rings.

14. Remove the end cover in the clutch housing together with the shifting fork arrangement for the test described in the next point (15) to be carried out.

15. Mount the clamping tools for fixing of the big gear-wheel. Mount a dial indicator on the gear-wheel of the clutch shaft through the upper opening at the reversing handle of the clutch housing, so that the indicator meets the following requirements.

    a. Point of contact about in the middle of the tooth flank and of the pitch circle.
    b. The indicator should be vertical in the longitudinal and height direction of the tooth flank.
    With the bigger gear-wheel (z=45) fastened, measure the flank clearance. Measure both the wheels of the clutch shaft in this way.
    If occasion should arise, adjust the clearance to the one stamped which is correct by changing the washers "**IV**" and "**V**".

16. Refit the end cover and the reversing arrangement as stated under point 6.

17. Measure the propeller house for "**O**" measure, "**W**" measure and "**U**" measure.

18. Fit the bottom conical gear-wheel marked "**X**" at a torque of **125 Nm±5 Nm (13 ±0.5 Kpm)** on the intermediate shaft of the propeller house.

19. The intermediate washer "**VI**" normally is 1.5 mm and must never be used smaller. Fit the intermediate washer "VI" on the shaft together with the bearing, the ball filling opening of which should turn up.

20. Measure the intermediate washer "**VII**" with a feeler gauge and fit the correct thickness together with the upper locking ring.

21. Calculate the “**T**” measure. The “**S**” measure is stamped on the gear-wheel whereas the “**R**” measure has to measure. “**T**” measure = “**S**” measure minus “**R**” measure.

22. The intermediate washer ”**$VIII_B$**” should be: the sum of “**T**” measure and “**Q**” measure minus the difference of “**U**” measure and “**O**” measure.

23. Find the thickness of the intermediate washer “**$VIII_A$**” by measuring the bearing outer collar “**N**” measure, after which the washer should be: the sum of “**M**” measure and “**O**” measure minus the sum of intermediate washer “**$VIII_B$**” and “**N**” measure.

24. Having finished the measuring of the intermediate shaft remove the gear-wheel marked “**X**” again and fit the needle bearings “**Z**” and “**Y**” after the house has been heated.

25. Fit the intermediate shaft with bearings in the propeller housing.

26. Refit the gear-wheel marked “**X**” and tighten it with the same torque as indicated in point 18.

27. Check whether the distance measures of the small gear-wheel are correctly adjusted with the fitted washers (“**T**” measure) with special tools.

28. Measure the “**V**” measure.

29. Heat the bearing housing “***Æ***” and fit the bearing with the ball filling opening facing the gear-wheel side.

30. Measure the thickness of the washer “**X**” with a feeler gauge (between locking ring and outer collar of the bearing).

31. Calculate the intermediate washer “**IX**”. The “**W_1**” measure is indicated on the gear-wheel. The intermediate washer = “**W**” measure minus the sum of “**V**” measure and “**W_1**” measure.
32. Fit the output shaft with gear-wheel in the cover for propeller house with seals.

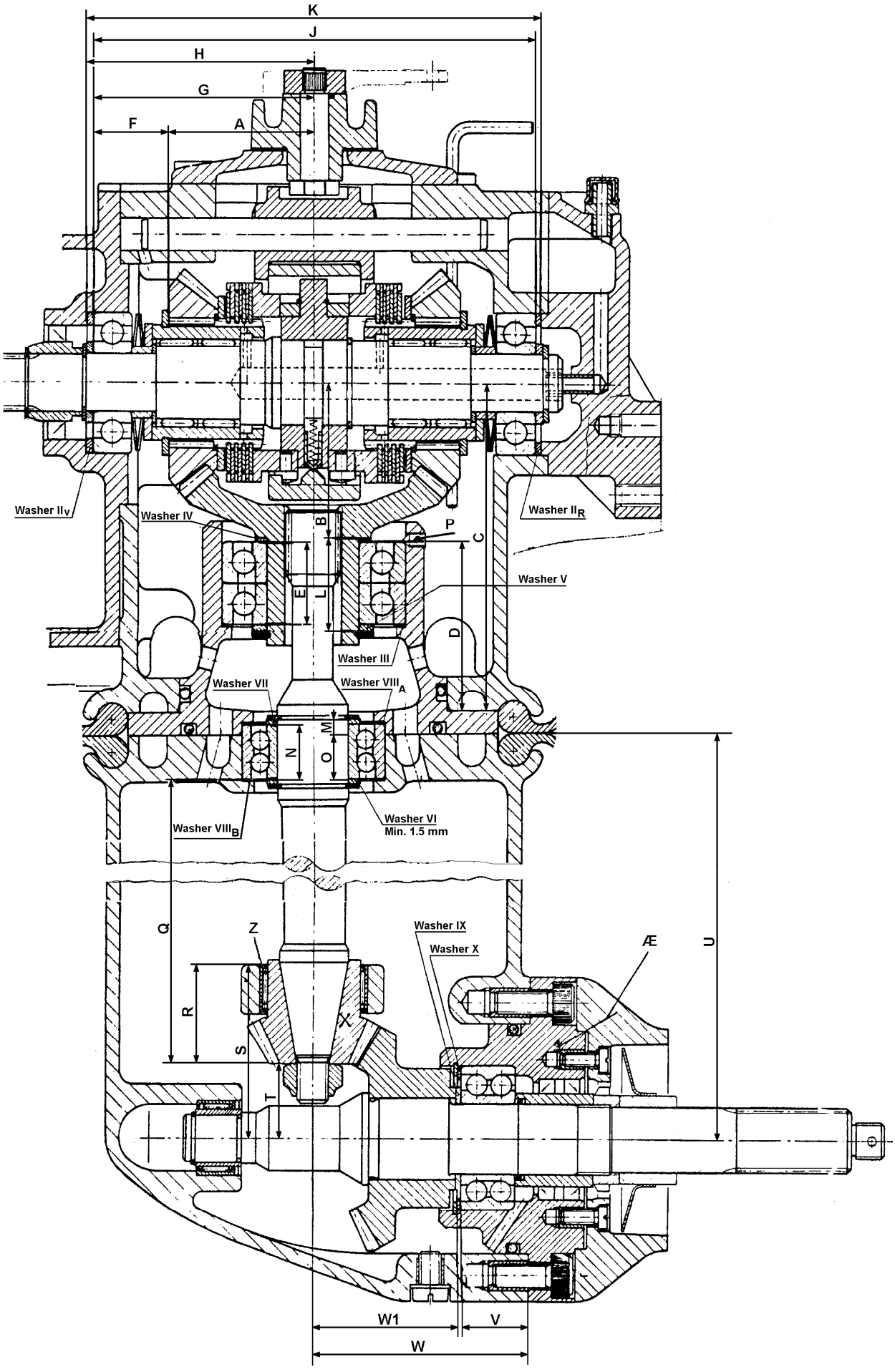
33. Fit cover with shaft and gear-wheel in the propeller housing.

34. Check the flank clearance at the output shaft.
    The intermediate shaft is blocked and on the propeller shaft a lever is placed, on which should be measured at difference radius R=40 mm. The shaft nut must be tightened.

    The correct flank clearance is indicated on the gear-wheel and is corrected at the intermediate washer “IX” if necessary.

On pages S10, S11, S12 and S13 longitudinal sections of the sail drive with places of measuring drawn in are shown, partly by a general drawing and partly by detail drawings.

S10



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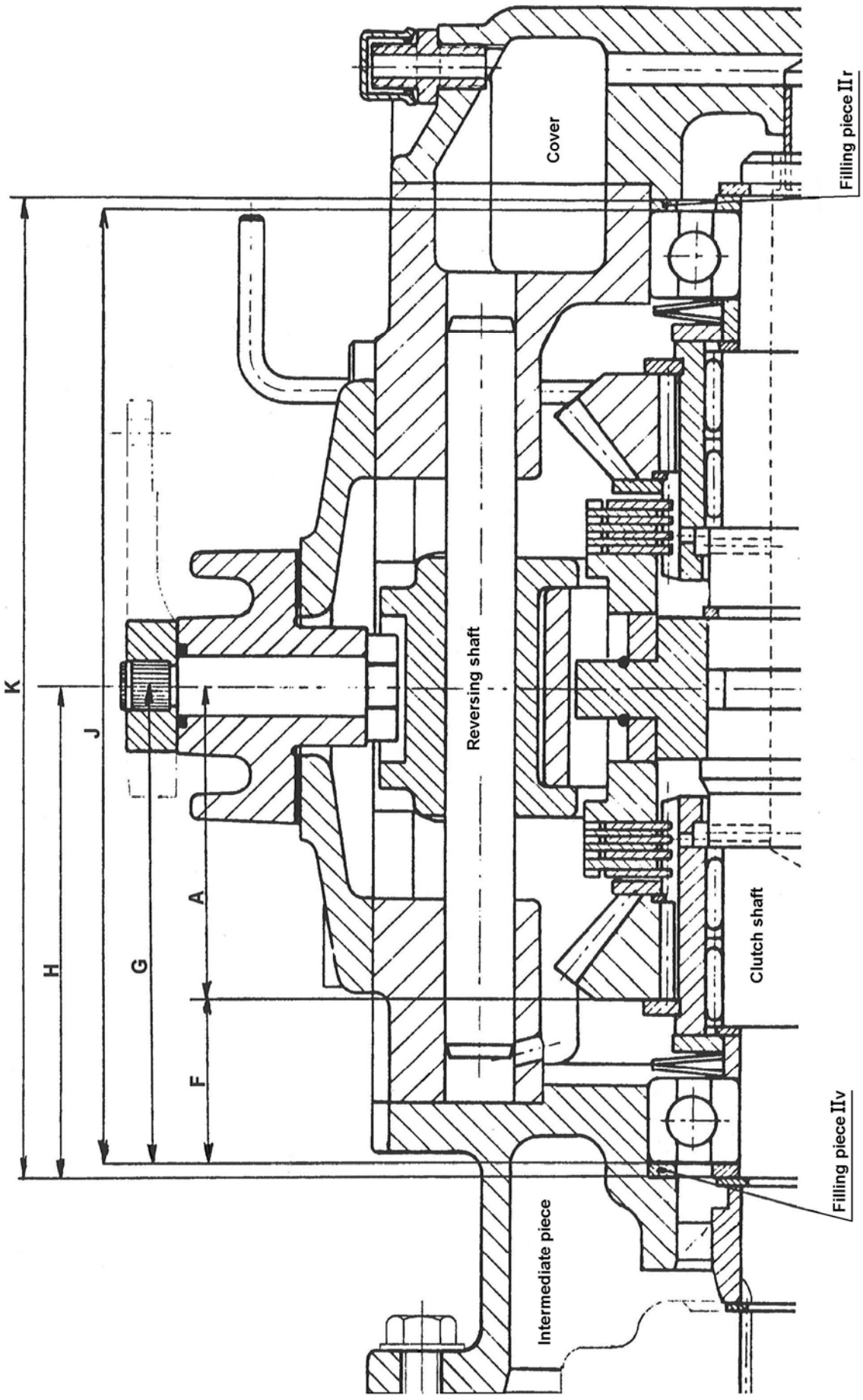
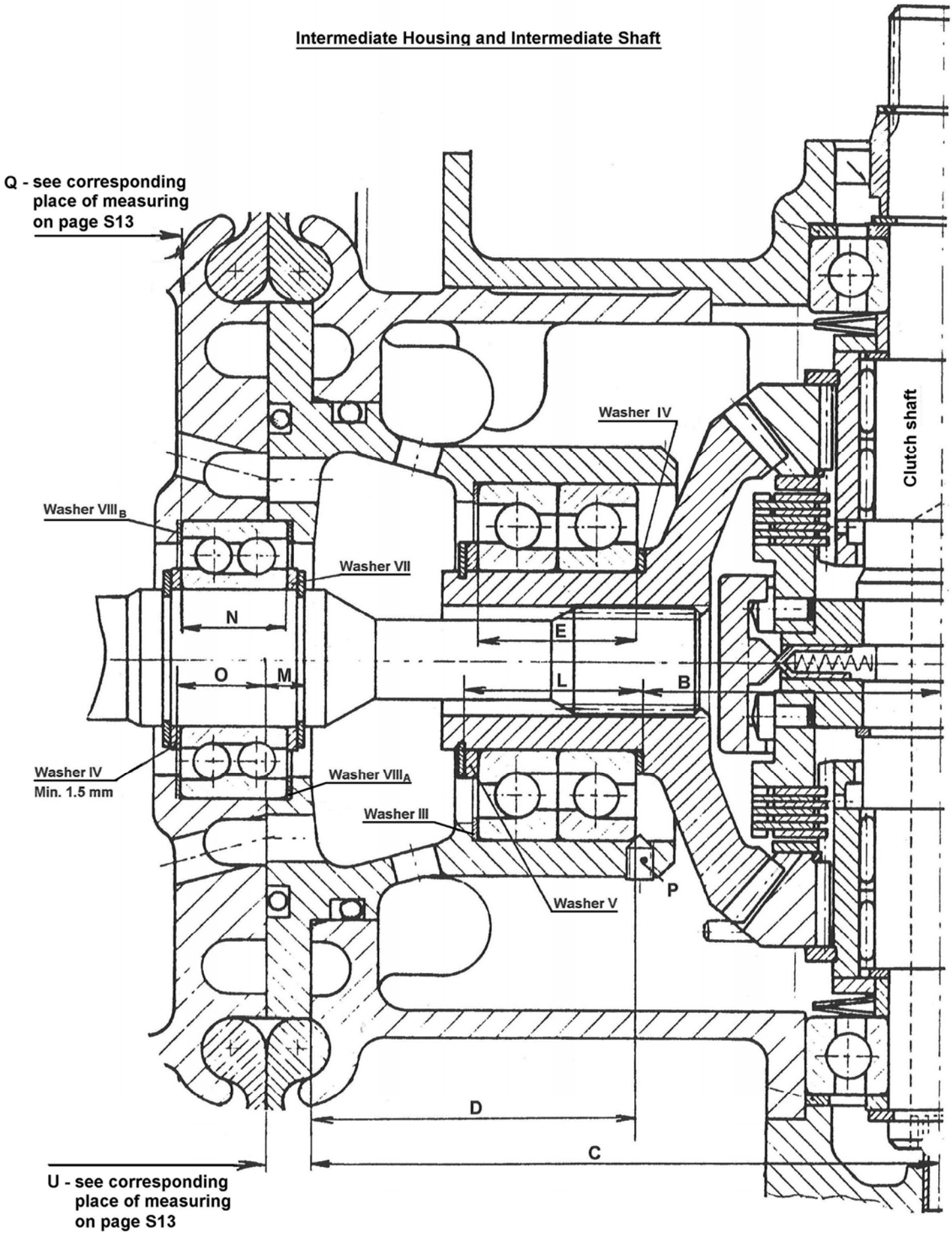
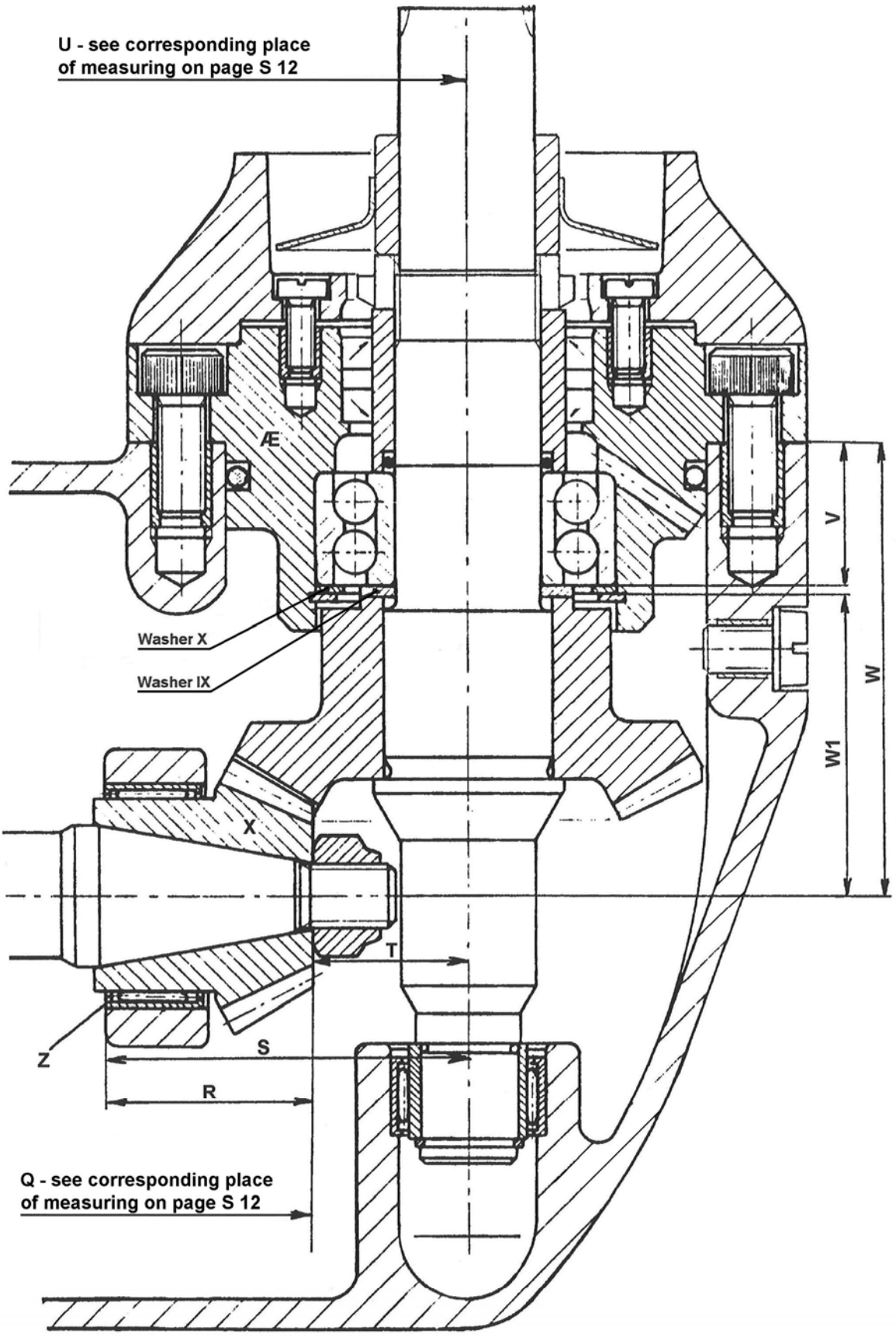

Cover
Filling piece IIr
Reversing shaft
Clutch shaft
Filling piece IIv
Intermediate piece
K
J
H
G
A
F

Intermediate Housing and Intermediate Shaft




U - see corresponding place
of measuring on page S 12
Æ
Washer X
Washer IX
V
W
W1
X
T
Z
S
R
Q - see corresponding place
of measuring on page S 12

SECTION T

IRREGULAR OPERATION, CAUSES AND REMEDIES

CONTENTS

1. Engine does not start

SYMPTOM	CAUSE	REMEDY
Insufficient or very little compression	Inlet and/or exhaust valves leaking	Grind or replace the valves, mill the seats
	Inlet and/or exhaust valves sticking	Grease valve stems with 2/3 gas oil and 1/3 lub. Oil. If necessary clean the valves.
	Insufficient rocker arm clearance	Adjust to 0.25 mm inlet and 0.3 mm exhaust when engine is cold (turn left)
	Piston rings stuck in grooves or are worn	Replace piston rings
	Valve springs broken or are weak	Replace springs
Insufficient or no pressure from fuel pump	Air in fuel system or nozzles sticking	Bleed or renew nozzles
Thermo start out of order	No fuel (valve leaking)	Fill up (renew thermo-start)
	Electric supply out of order	Check and/or replace switch and connections. Chech fuse
Engine does not reach normal revs	Unloaded battery or defective	Battery to be charged or renewed
Starter motor turns engine too slowly	Loose or corroded connections	Tighten or clean connections

2. The engine starts, but stops soon after

The engine starts, but stops soon after	Empty fuel tank	Refill and bleed
	Air in fuel system	Bleed
	Nozzle sticking	Replace nozzle
	Fuel filter choked	Replace filter element. Clean the tank

3. The engine does not reach maximum output

Difficult to start	None or insufficient compression	See ”engine does not start”
The engine revs. Is reduced considerably when loaded	Fuel supply choked up. Air/water in fuel system	Check fuel system thoroughly
	Governor incorrectly adjusted or something in the system works sluggishly	Adjust the governor. Check governor system and correct the error
Hot engine (smell of heat)	Insufficient cooling water supply	Stop engine. Check cooling water pump
	Damaged cylinder liner or bearings	Check bearings, piston and cylinder, if necessary replace them

4. The engine knocks

The engine runs unevenly	Air/water in fuel system	Bleed see ”engine does not start”

5. The engine smokes

Black smoke	Air inlet filter choked	Clean filter
	Insufficient compression	See ”engine does not start”
Blue smoke	The lube oil passes piston and oil rings an penetrates into combustion chamber, or vacuum valve defective	Replace oil rings and possibly the piston rings. Clean vacuum valve
Grey smoke	Thermostart valve is leaking	Replace

6. Excessive consumption of lubricating oil

Blue smoke	Oil- and piston rings are worn	Replace oil- and piston rings, if required
	Piston and cylinder liner highly worn	Replace
	Defective vacuum valve	Replace
Lub. oil leaks out of crankshaft bearings	Worn oil seal ring	Replace

7. The engine gets too warm or too cold

Cooling water temperature too high (smell of heat)	Unsufficient cooling water supply caused by:defective water pump, choked strainer or a defective thermostat	Investigate pump rotor for broken wings or lost driver screw. Clean strainer. Clean or replace thermostat
Cooling water temperature too low	Defective thermostat	Clean or replace thermostat

8. Insufficient or no lubrication oil pressure

Oil warning lamp lights up. Oil pressure gauge indicates abnormally low oil pressure	Insufficient lube oil in the engine	Check and refill
	Leakage in lube oil system	Tighten and refill
	Relief valve sticking or spring too weak	Clean bore and valve, stretch or replace the spring

SECTION V

MAINTENANCE

CONTENTS

RECOMMENDED MAINTENANCE AND A CHECK LIST FOR BUKH ENGINES

	CHECK	RECTIFY IF NEEDED	WEEKLY	MONTHLY	YEARLY	EVERY 5 YEARS
1. Tightness of connections through hull:						
1.1 *stern tube*	hull connection	change sealing			X	
2. Check of lubricating oil:						
2.1 a *engine*	change oil	-			X	X
2.1.b *engine*	check oil level	-	X			
2.2.a *gearbox*	change oil	-			X	
2.2.b *gearbox*	check oil level	-	X			
2.3 *lubricating oil filter*	change	-			X	
3. Check of cooling watersystem:						
3.1 *system*	system to be full	fill up	X			
3.2 *anti freeze liquid*	check for minus 25°C.	refill anti freeze liquid			X	
3.3 *cooling water connections tightness*	for leaks	renew if leaking		X		
3.4 *condition of rubber hoses*	cracks and leaks	renew				X
3.5 *V-belt* for cooling water pump	adjust or renew	-		X		
3.6 *thermostat*	renew after 5 years	-				X
4. Check of fuel system:						
4.1 *supply line*	clean water/fuel separa-tor and check line bends	repair if damaged or renew				X
4.2 *fuel tank*	drain for water	-			X	
4.3 *fuel filter*	change	-			X	
4.4 *return line*	check for bends & damages	repair if damaged or renew				X
5. Check of remote control cables:						
5.1 *cables*	check easy operation and stroke sufficient	adjust cables				X
6. Check of propeller shaft arrangement:						
6.1 *rear stern tube bearing*	check clearance for bearing insert	renew insert				X
6.2 *sufficient water flow to rear stern tube bearing*	check that water holes in bearing housing are not blocked	clean holes				X
6.3 *alignment of gear flange and prop.shaft flange*	alignment to be within 0.05-0.01mm	realign the engine				X
6.4 *stuffing box seals*	tightness	renew all three seals				X
6.5 *condition of rubber tube for stuffing box*	cracks	renew				X
6.6 *Out-Board gearoil*.	oillevel	refill		X		
6.7 *propeller*	check size and condition	renew if damaged				X
7. Starting of the engine:						
7.1 start with *electrical start*	engine start within 2 minutes	if malfunctions -the engine must be ser-viced by a mechanic	X			
7.2 start with *handstart*	same	same		X		
8. Engine maintenance						
8.1 valve clearance	clearance	adjust			X	
8.2 electric starter	rust protection of starter drive	spray rust protection spray			X	
9. Running with engine - check:						
9.1 *Idling speed* to be 900-1200 RPM	900-1200 RPM	adjust RPM	X			
9.2 *Full speed unload* / min. 3700 RPM	min. 3700 RPM	adjust RPM	X			
9.3 *Full speed loaded* with *propeller*	3300-3600 RPM	adjust RPM			X	
9.4 *Cooling water temp*. to be max. 75 degr. Celcius	max. 75°C	change termostat		X		
9.5 *Audible and visual alarms*	check function	change senders, lamps or switch			X	
9.6 *Lubricating oil pressure*	min. 1.5 kg/cm² at idling	adjust oil relief valve				X
9.7 *Gearbox change* from FW to Neutral to ASTERN	check cables	adjust	X			
10. Air supply:						
10.1 *air inlet filter*	renew	-				X
11. Bateries:						
11.1 *level of liquid*	check, refill	renew	X	X X		X
11.2 *voltage conditon*	charge	renew		X		