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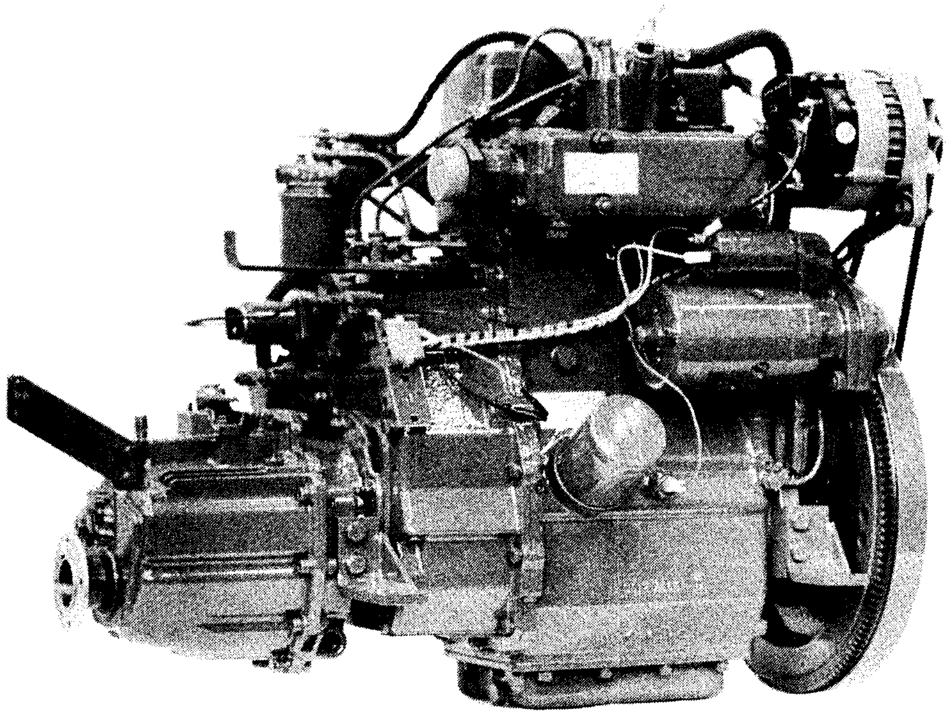
Work shop Manual

for

BUKH diesel engine type

DV10/20



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This workshop manual has been written as a guidance for fault-finding, adjustment, and repair of BUKH DV10ME and DV20ME engines.

The ordinary maintenance of the engines is of great importance to the day-to-day running. Therefore, the instructions for correct maintenance and long-term and winter storage have been indicated separately in section V.

In order that the user may be completely satisfied with the product, the installation must be made correctly. Consequently Motorfabriken BUKH has worked out complete installation instructions for the engines and the equipment to match.

This workshop manual and the mentioned instructions have been written on the basis of BUKH DV10 model E and DV20 model C. As the workshop manual and the technical instructions are frequently brought up to date, all the models will be covered by the technical information.

W O R K S H O P   M A N U A L

for

DV10 and DV20

CONTENTS

Section A

List of Tools for DV Engines

CONTENTS

LIST OF TOOLS FOR DV ENGINES

In the following the tools required for installation, service, and repair will be treated separately.

Installation tools

Used by boat-builders for installation of engines and consist of:

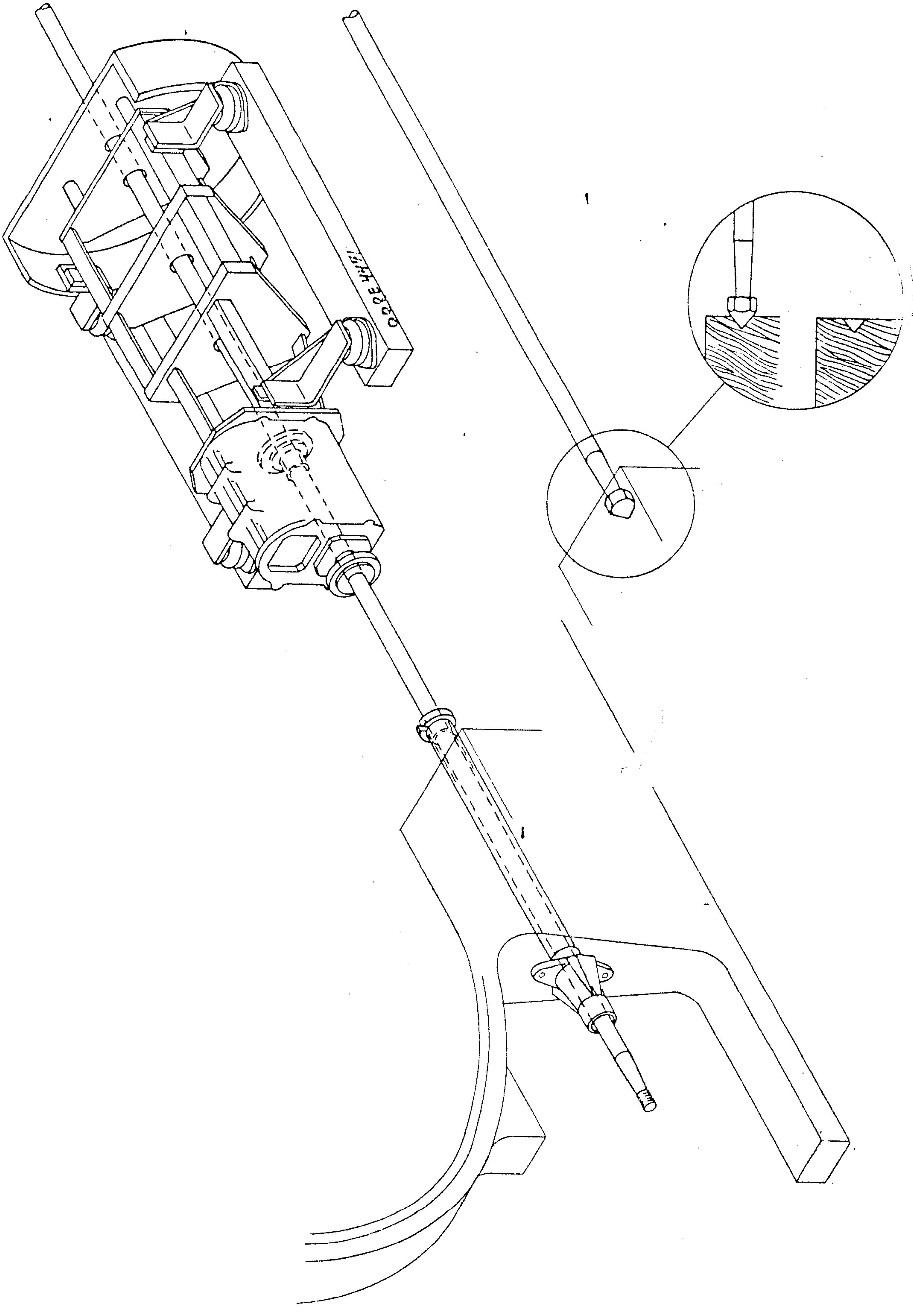
1. Belowmentioned service tools
2. 1 hack-saw
3. 1 tape measure
4. 1 dummy DV10
5. 1 dummy DV20
6. 1 centering bush for propeller shaft
7. 1 feeler gauge 0.05 mm

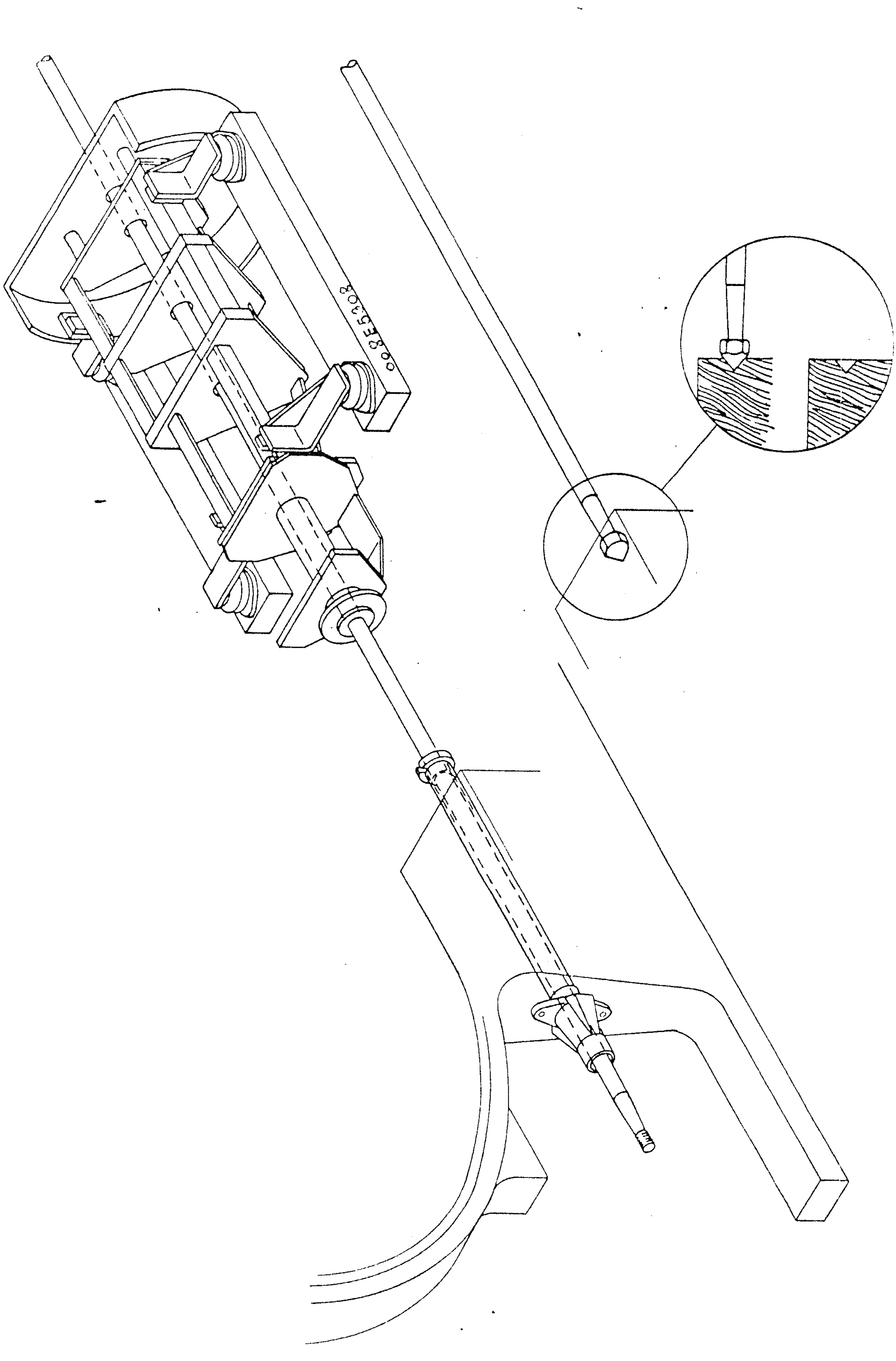
Service tools

Used by dealers who are only carrying out general maintenance such as oil change, replacement of filters, valve adjustment, etc. Not work on the fuel system.

1. Open end ring spanners: NV 8, NV 10, NV 13, NV 14, NV 17, NV 19, NV 27, NV 30
2. Adjustable wrench: (Bahco) 6" and 10"
3. Water pump tongs (Stahlwille) 10"
4. Screwdrivers: (Stahlwille) 3 mm, 5.0 mm, and 9 mm breadth of blade
5. Allen key: 2 mm
6. Hammer
7. Combination pliers (Stahlwille 10571, 8 1/4")
8. Oil sump draining pump (Enots M 924) P/N 91237
9. Feeler gauge for valve adjustment

Installation Dummy for DV10 and DV20 with BW6 Gear

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Repair tools

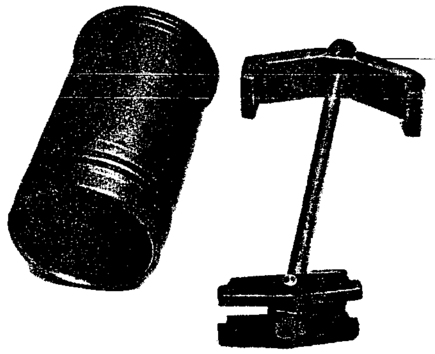
Used by dealers, who carry out regular repairs besides service as mentioned in the workshop manual for DV10 and DV20.

1. Service tools

2. Belowmentioned special tools

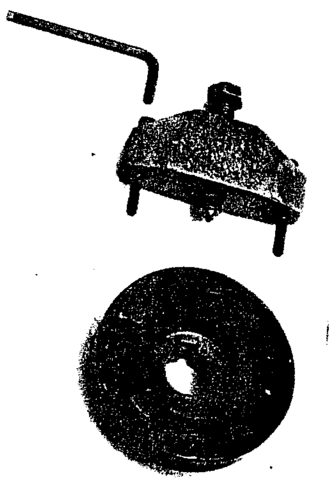
Spare Part No.	Drawing No.	Description and application
009P2235	V 2109	Puller for cylinder liner
009P3100		Testing set for fuel injection nozzles
009P3101		Cleaning tool for fuel nozzles
009P3102		Pressure device for fuel pump spill point
009P3103		Dial micrometer
009P3104		Magnet holder for dial micrometer
009P2958		Slip-on ring for mounting of pistons
009P3106		Tachometer
009P3115	V 1669	Tools for removing valve springs
009P3107	Autotest	Valve milling set
		Suction cup with handle for valve grinding
		Set of double ended spanners (Gedore 19 PMZ (½"))
		6 mm Allen top
		8 mm Allen top
		4 mm Allen key
009P3108		Torque spanner (Stahlwille 73/6 1.5-6.5)
009P3109		Torque spanner (Stahlwille 73/25 8-26)
	009P2211	Crancked 10 mm open-end spanner for fuel cam
		41 mm extended double ended spanner for precombustion chamberon DV20
		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)
	41069	Puller for flexible coupling
009P2189	V 2110	Erection tools for intermediate housing
	529 W 0000	Compression measuring equipment
	000 E 2085	Extension for setting up of compression measuring equipment
	009 P 2183	Tools for removing and mounting of main bearings
	HEYCO 540-983-03-99	19 mm crawfoot wrench for tightening up of cylinder head DV20.
		24 mm crawfoot wrench for tightening up of cylinder head DV10.

Order No.	Designation of Tools	Qty.	
009P2235	Puller for cylinder liner	1	
009P3100	Testing set for fuel nozzles	1	
009P3102	Pressure gauge (for adjusting of injection timing for fuel pumps)	1	
009P3103	Dial indicator (for use when adjusting injection timing)	1	
009P3104	Magnet holder for dial indicator	1	
	12 mm Allen top	1	
	Tool box	1	
	Double-ended spanner closed or open, spanner nos. 10, 11, 13, 14, 16, 17, 19, 22, 27 and 32	1	
008E4223	Milling tools for tightening at rear end cover	1	
008E4224	Erection tools for tightening at rear end cover	1	
	Niji-lock 105Q or 105 K		
	Abrasive compound for fuel valve	1	
	Carborundom	1	



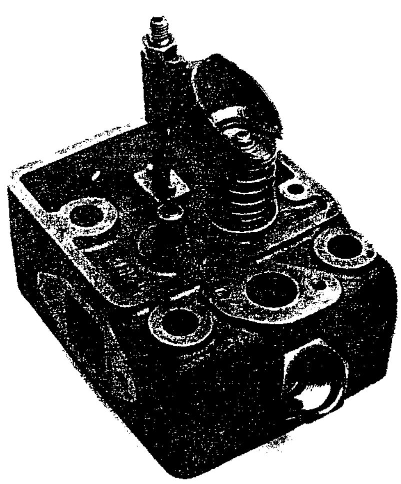
Puller for cylinder liner

Order No. 009P2235



Puller for flexible coupling

Order No. T 41069

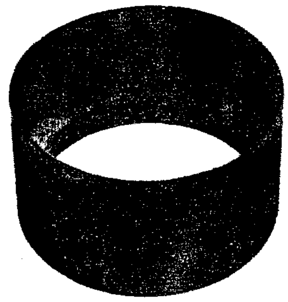


Tools for removal of valve springs

Order No. 009P3115

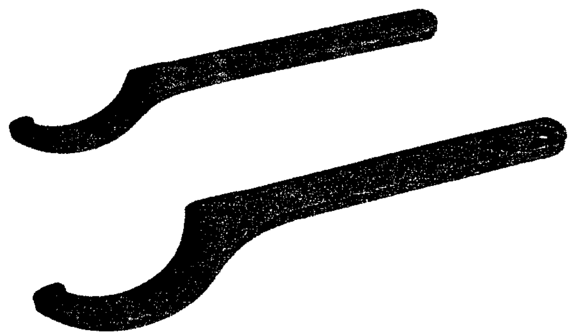
Slip-on ring for fitting of pistons

Order No. 009P2958



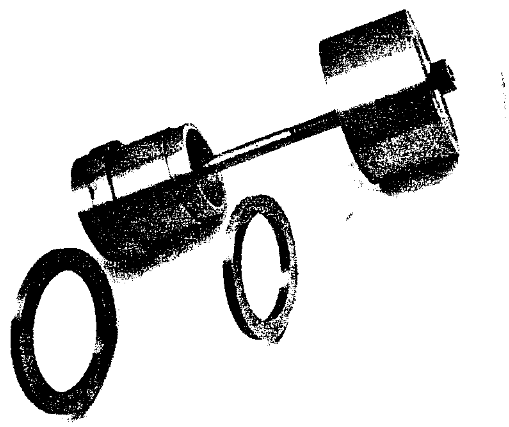
SKF hook-spanner HN10 and HN12 for nuts on crank

Order Nos. 60680 and 60681



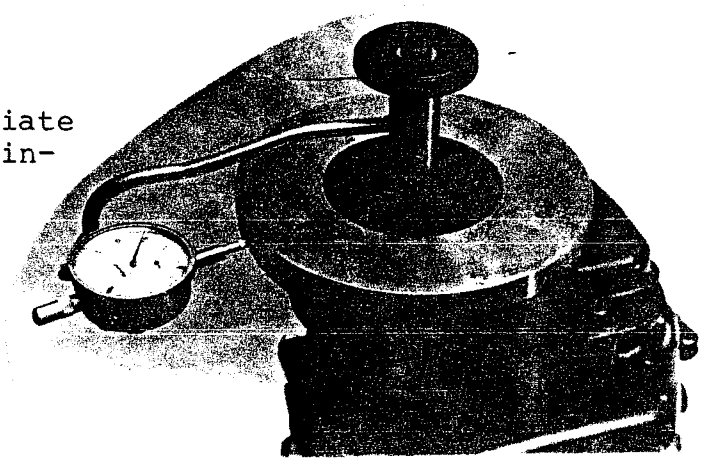
Tools for removing and fitting main bearings

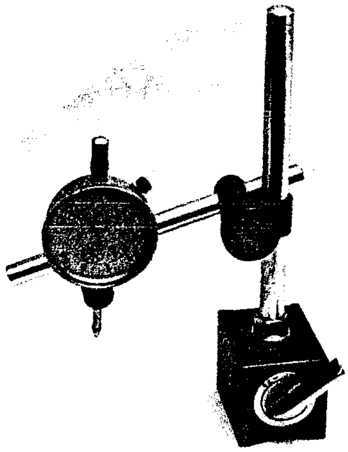
Order No. 000P2183



Lining-up tool for intermediate guard (dial micrometer not included).

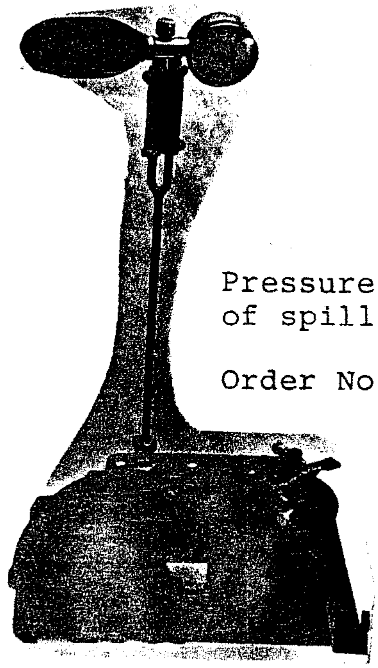
Order No. 009P2189





Dial micrometer with magnetic holder. For use in adjusting spill point and lining-up of intermediate guard.

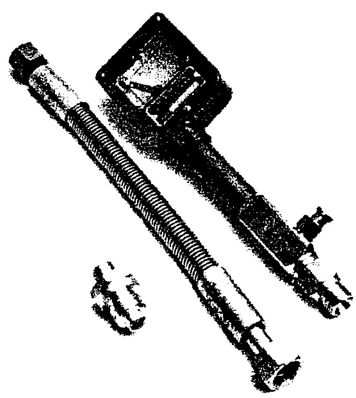
Order Nos. 009P3103 and 009P3104



Pressure gauge for adjusting of spill point

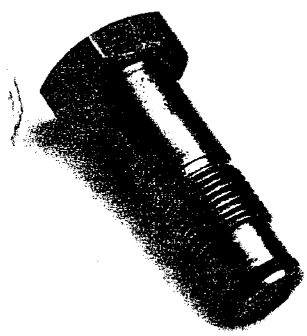
Order No. 009P3102

Manometer compression gauge with special DV extension



Order No. 520W0000

660.701

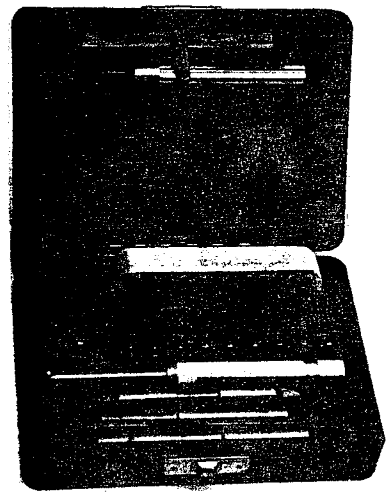


Order No. 000E2085

Order No. 560H1015

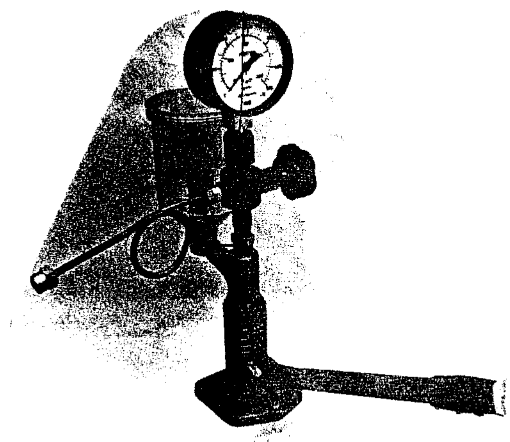
Cleaning tool for fuel nozzles

Order No. 009P3101



Testing set for fuel valves

Order No. 009P3100



Tachometer

Order No. 009P3106

Section B

General Description and Technical Data

CONTENTS

General Description

BUKH DV10 and DV20 are single- and two-cylinder watercooled 4-stroke diesel engines operating on the precombustion chamber principle with 2-stage combustion.

The engines are specially designed to comply with the heavy demands made on stability, safety and environment now.

On the following pages your attention will especially be drawn to the special designs which separate BUKH's DV10 and DV20 engines from conventional diesel engines.

Cylinder Head

The cylinder head is made from highly alloyed special cast iron which is most resistant to thermic and mechanical loads.

Each cylinder unit is fitted with an exhaust valve and a suction valve respectively. The very big suction valve secures together with the aerodynamically designed exhaust and suction manifolds a correct flushing of the cylinders.

Both valves operate in replaceable valve guides of special cast iron which ensures high wearing qualities. The valves are fitted in the cylinder head. The replaceable valve seats are shrinked into the cylinder head and they are made from heat resisting special steel with high mechanical wearing quality.

The valves are also made from special steel with high strength and toughness and great importance has been attached to resistance to heat.

Crankcase

The crankcase is made from special cast iron and is provided with strong ribs which give great toughness and strength together with the special tunnel-shaped bore to the crankshaft.

Crankshaft

The crankshaft is made from die-forged chrome steel.

Each crankshaft is fitted with special counterweights on the crank throws. These weights are balanced in order to obtain smooth running of the engine.

Each crankshaft runs in two main bearings (DV10 + DV20) and in an intermediate bearing as well (DV20).

The bearings are made from steel with a tin aluminium alloy which can stand up to high pressures.

The crankshaft is steered in axial direction by turned surfaces on the crank throws and contact faces on the end cover (DV10) and the intermediate bearing (DV20).

On the surface the engine is tightened by means of oil seal rings fitted in the end covers.

Flywheel

The flywheel, made from cast iron, is bolted on the crankshaft in the engine front end. It is large-dimensioned to secure steady operation of the engine.

The flywheel is fitted with a V-belt groove for driving the electrical equipment of the engine and cooling water circulating pump, if any. Further, the flywheel may be fitted with extra three-groove V-belt pulley or flat belt pulley.

Connecting Rod

The connecting rod is die forged with H-shaped section.

The bearing cap forms part of the connecting rod itself. The base of the bearing is separately adapted for the individual connecting rod and is guided in proportion to this by two steel balls. The connecting rod bearings are made from steel shells with a tin aluminium alloy and are fastened in the bearing cap and the base of the bearing with two Allen steel bolts.

The bearing for the piston pin consists of a special bronze bushing.

Piston and Cylinder Liner

The pistons are made from a light alloy. The cumbustion chamber is shaped in the piston head.

The pistons are fitted with three compressing rings and an oil scraper ring. The piston pin, which is floating, is hollow and made from hardened steel. The piston pin is locked in axial direction by circlips.

The cylinder liner is made from spun cast iron with a high carbon content which gives high wearing qualities.

The cylinder liner is guided in proportion to the crankcase with a recess in the top and a conical bore in the bottom.

The tightening results from the specially made cylinder-head gasket and two O-rings in the conical bore.

Camshaft

The camshaft and the cams for activation of the suction and exhaust valves are cast in one piece in order to achieve as high strength as possible. The cams are case-hardened for great stability and resistance to wear.

The camshaft is driven by a gear-wheel on the crankshaft and by one shrinked on the camshaft itself. These two gear-wheels are marked in proportion to each other, and it is necessary for the operation of the engine that this marking is observed with the greatest accuracy at removal and assembling.

The fuel pump cam is fitted in connection with an injection timing which alters the injection time according to the engine revolutions.

Lubricating Oil System

The engine is pressure lubricated by means of a lubricating oil pump of the rotary type (Eaton pump with high efficiency). The pump is driven by the camshaft and is placed on the rear end cover of the engine. The lub. oil pressure is controlled by a spring-loaded pressure relief valve.

Cooling Water System

The cooling-water temperature is thermostat-controlled which gives a constant and effective operating temperature. The engines can be delivered with either direct or indirect cooling.

Fuel System

The fuel is led to the engine from the fuel valve placed in the cylinder head. This valve gets fuel under high pressure from the fuel pumps which are activated from the camshaft. The fuel pumps are supplied from the fuel tank via a lift pump and an effective filter.

Environment

Two-stage Combustion

The engine is fitted with precombustion chamber in connection with the combustion chamber. This has been made to obtain smooth running of the engine.

The fuel is injected into the precombustion chamber where it is ignited. Some of the fuel combusts, and by the rise of pressure the rest of the fuel is pressed into the cylinder where the combustion is finished. One of the great advantages of this engine is that the rise of pressure during the combustion does not come suddenly, which means that the engine works smoothly and steadily.

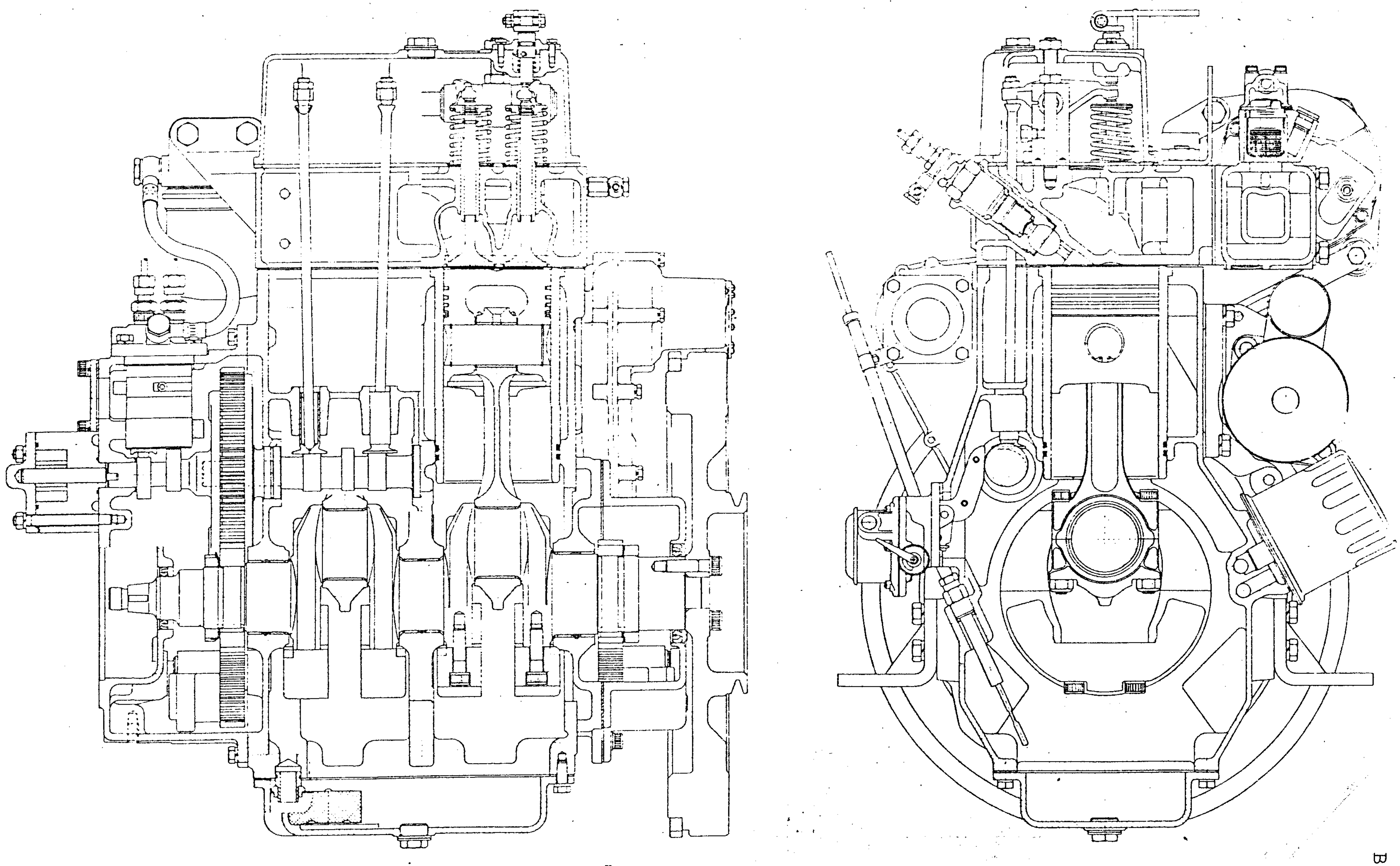
Another great advantage is that here self-cleaning tap nozzles can be used. With two-stage combustion a far better combustion is further obtained, causing that the content of harmful substances, especially carbon monoxide and soot, in the exhaust gas will be minimal and be about 4% of the exhaust gas content of the petrol engines and about 25% of diesel engines with direct injection.

Vibration Damping

The engines are fitted with four counterweights rotating in the opposite direction of that of the engine and thus they eliminate annoying vibrations.

Automatic Injection Timing

The injection timing controls the time of the fuel injection and thus causes easy starting and low noise level.



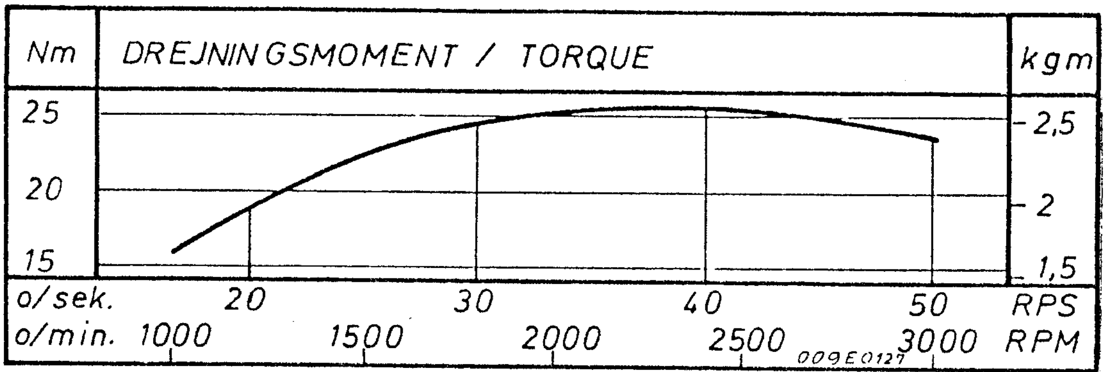
Sectional Drawing of DV20SME

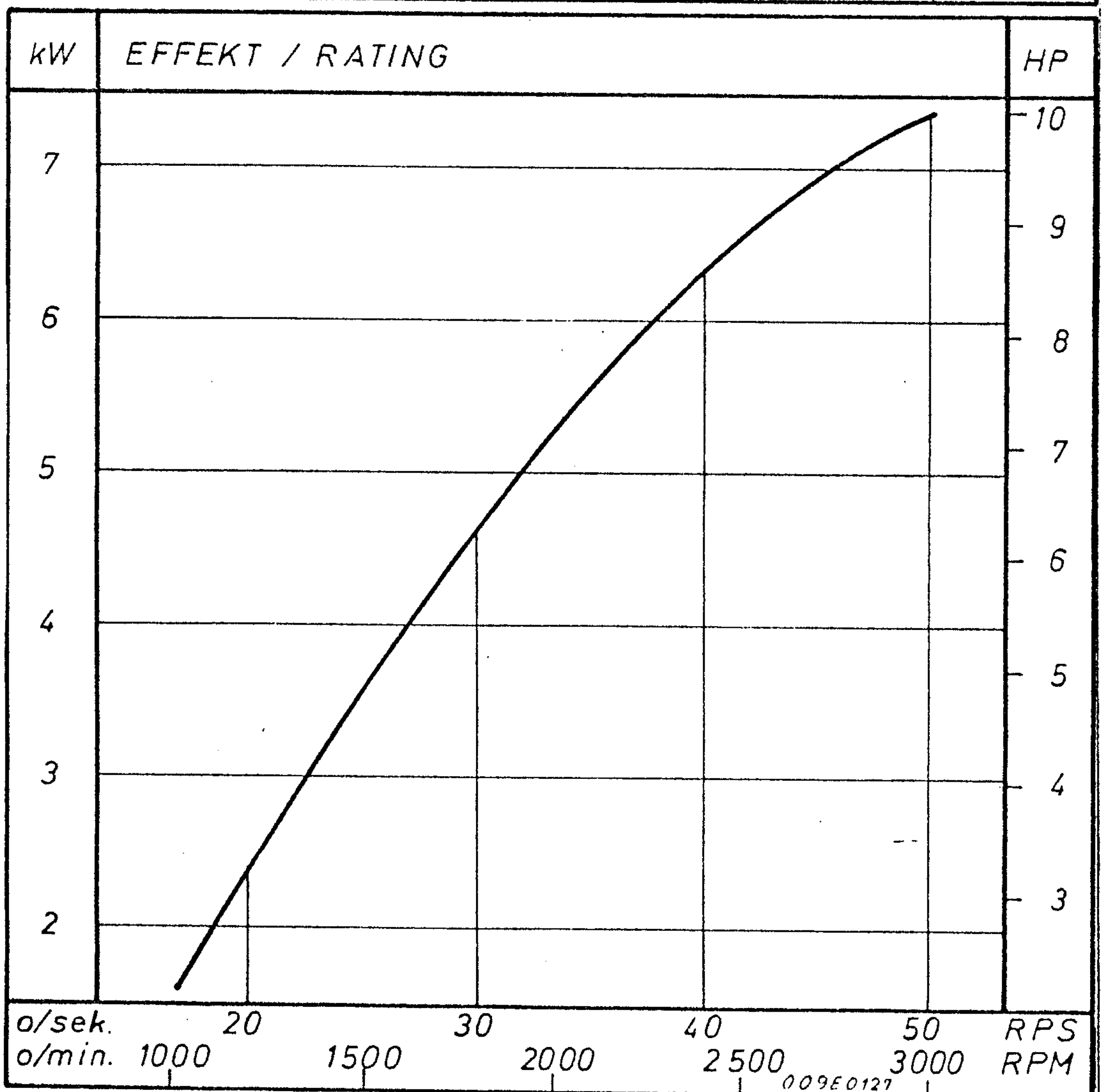
Technical data for DV10

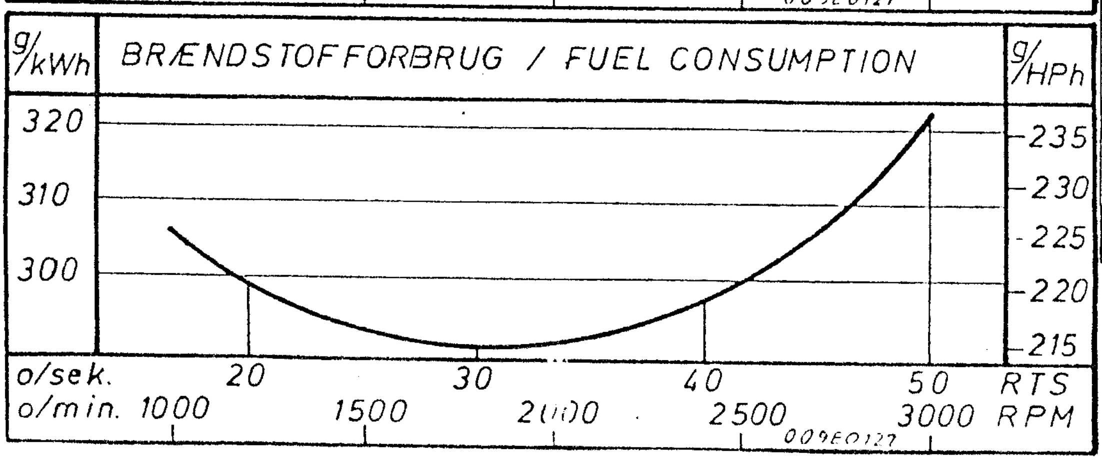
Piston diameter	85 mm (3.346 inch.)
Stroke	85 mm (3.346 inch.)
Number of cylinders	1
Displacement	0.482 litres (29.4 in^3)
Compression ratio	21.5:1
Compression pressure at 2000 to 3000 r.p.m.	48 kg/cm^2 (682.5 psi)
Combustion pressure	65 kg/cm^2 (924.3 psi)
Engine rotation seen from flywheel end	Clockwise
Idling r.p.m.	900-1200 r.p.m.
Max. inclination backwards	15^{o}
Max. inclination sideways	25^{o}

r.p.m.	2000	2400	3000
Max. output in DIN HP (6270 A)	6.4	8.2	10
Max. torque in kgm	2.3	2.5	2.4
Fuel consumption in gr/HPh	245	250	250

TORQUE, RATING, CONSUMPTION CURVE FOR DV10





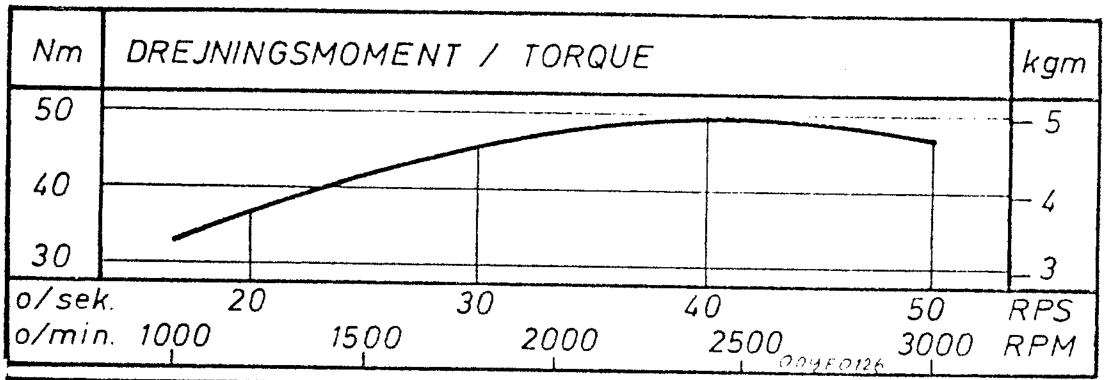


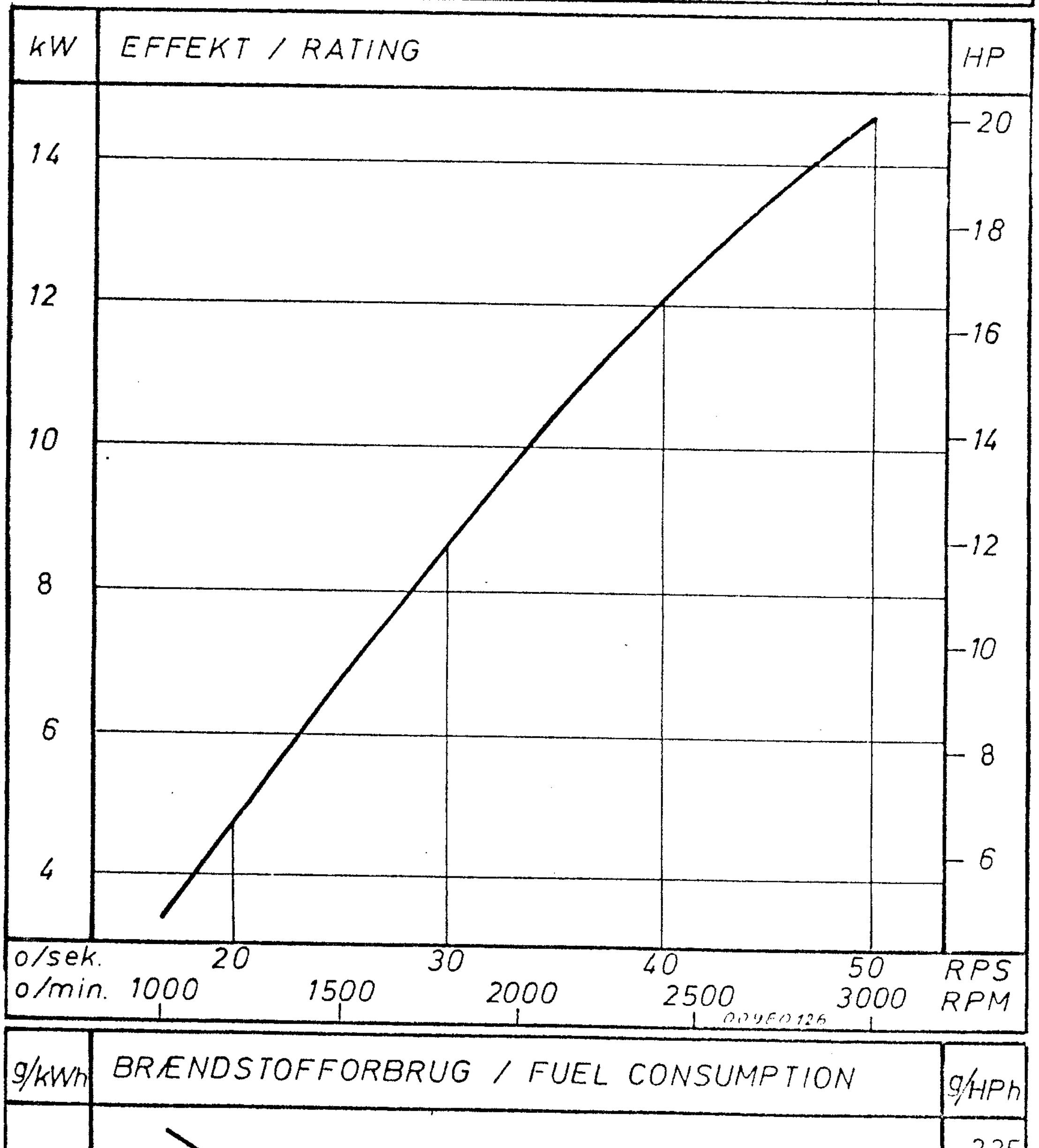
Technical data for DV20

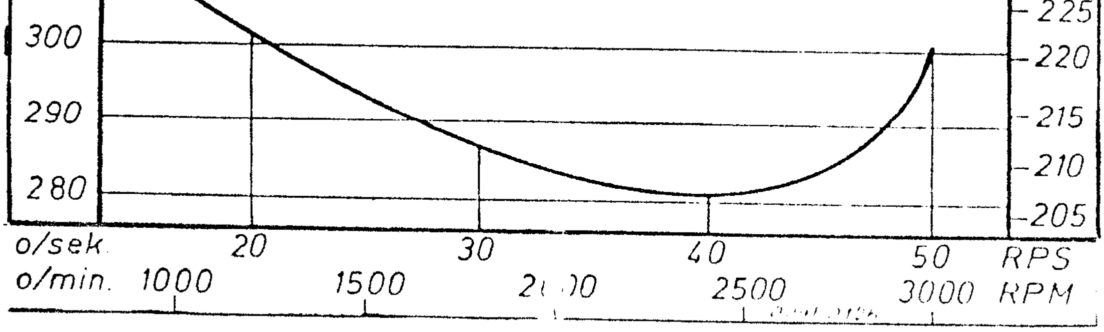
Piston diameter	85 mm (3.346 inch.)
Stroke	85 mm (3.346 inch.)
Number of cylinders	2
Displacement	0.964 litres (58.83 in^3)
Compression ratio	21.5:1
Compression pressure at 2000 to 3000 r.p.m.	48 kg/cm^2 (682.6 psi)
Combustion pressure	65 kg/cm^2 (924.3 psi)
Engine rotation seen from flywheel end	Clockwise
Idling r.p.m.	900-1200 r.p.m.
Max. inclination backwards	12°
Max. inclination sideways	25°

Revolutions	2000	2400	3000
Max. output in DIN HP (6270 A)	12.8	16.4	20
Max. torque in kgm	4.58	5.01	4.77
Fuel consumption in gr/HPh	245	250	250

TORQUE, RATING, CONSUMPTION CURVE FOR DV20







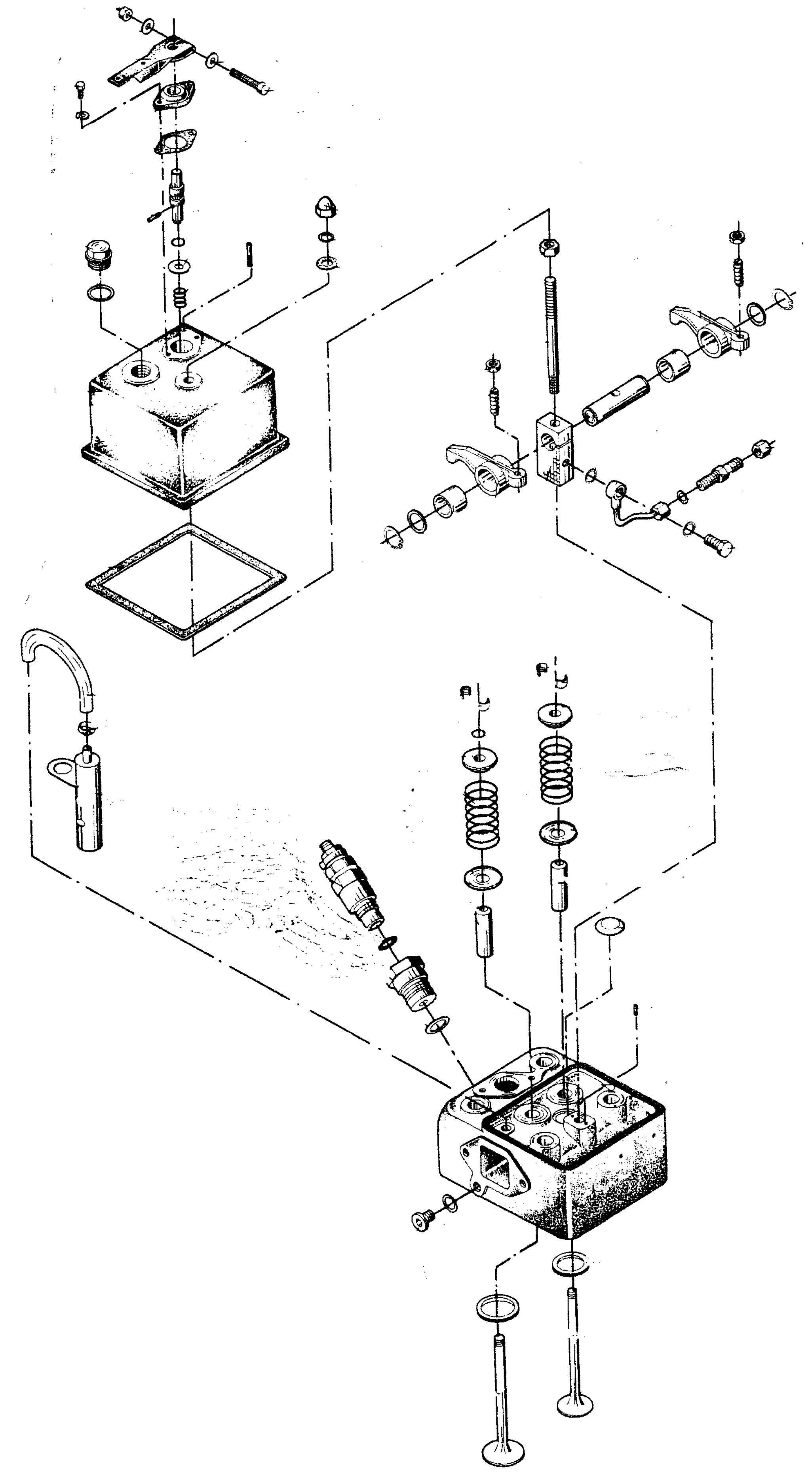
TORQUES IN KGM (FT.LBF)

	DV10	DV20
Flywheel	8-8.5 (58-61.5)	8-8.5 (58-61.5)
Counterweight	8-8.5 (58-61.5)	8-8.5 (58-61.5)
Intermediate bearing hub (7.5°)		1.5 (11)
Intermediate bearing hub (20°)		2.5 (18)
Flexible coupling	6.5 (47)	6.5 (47)
Intermediate bearing hub with key, assembled		6.2 (44.8)
Intermediate bearing hub with screws, assembled		5.2-5.8 (37.6-41.9)
Shaft for counterweights	2.5 (18)	2.5 (18)
Cylinder head	15-17 (108.5-123)	9.5-10.5 (68.7-75)
Precombustion chamber	24-25 (173.5-180.8)	24-25 (173.5-180.8)
Nozzle in nozzle holder	7-8 (50.6-57.8)	7-8 (50.6-57.8)
Nozzle holder in precombustion chamber	7-8 (50.6-57.8)	7-8 (50.6-57.8)
Pressure valve	4 (28.9)	4 (28.9)
Rocker arm bracket	4-4.5 (28.9-32.5)	4-4.5 (28.9-32.5)
Connecting rod bolt	5 (36.2)	5 (36.2)
Injection cam	1 (7.23)	1 (7.23)
Fuel lift pump	2 (14.5)	2 (14.5)
Fuel filter on mounting plate	4-4.5 (28.9-32.5)	4-4.5 (28.9-32.5)
Fuel pump on end cover	2-2.3 (14.5-16.6)	2-2.3 (14.5-16.6)
Governor shaft on end cover	5-5.5 (36.2-39.8)	5-5.5 (36.2-39.8)
Adjusting curve	2-2.3 (14.5-16.6)	2-2.3 (14.5-16.6)
Cooling water pump	2-2.3 (14.5-16.6)	2-2.3 (14.5-16.6)
Cover on thermostat housing	1 (7.23)	1 (7.23)
Dynastarter supporter	4-4.5 (28.9-32.5)	4-4.5 (28.9-32.5)
Dynastarter adjusting arm	2-2.3 (14.5-16.6)	2-2.3 (14.5-16.6)
Oil sump	2-2.3 (14.5-16.6)	2-2.3 (14.5-16.6)
Lubricating oil pump	2-2.3 (14.5-16.6)	2-2.3 (14.5-16.6)

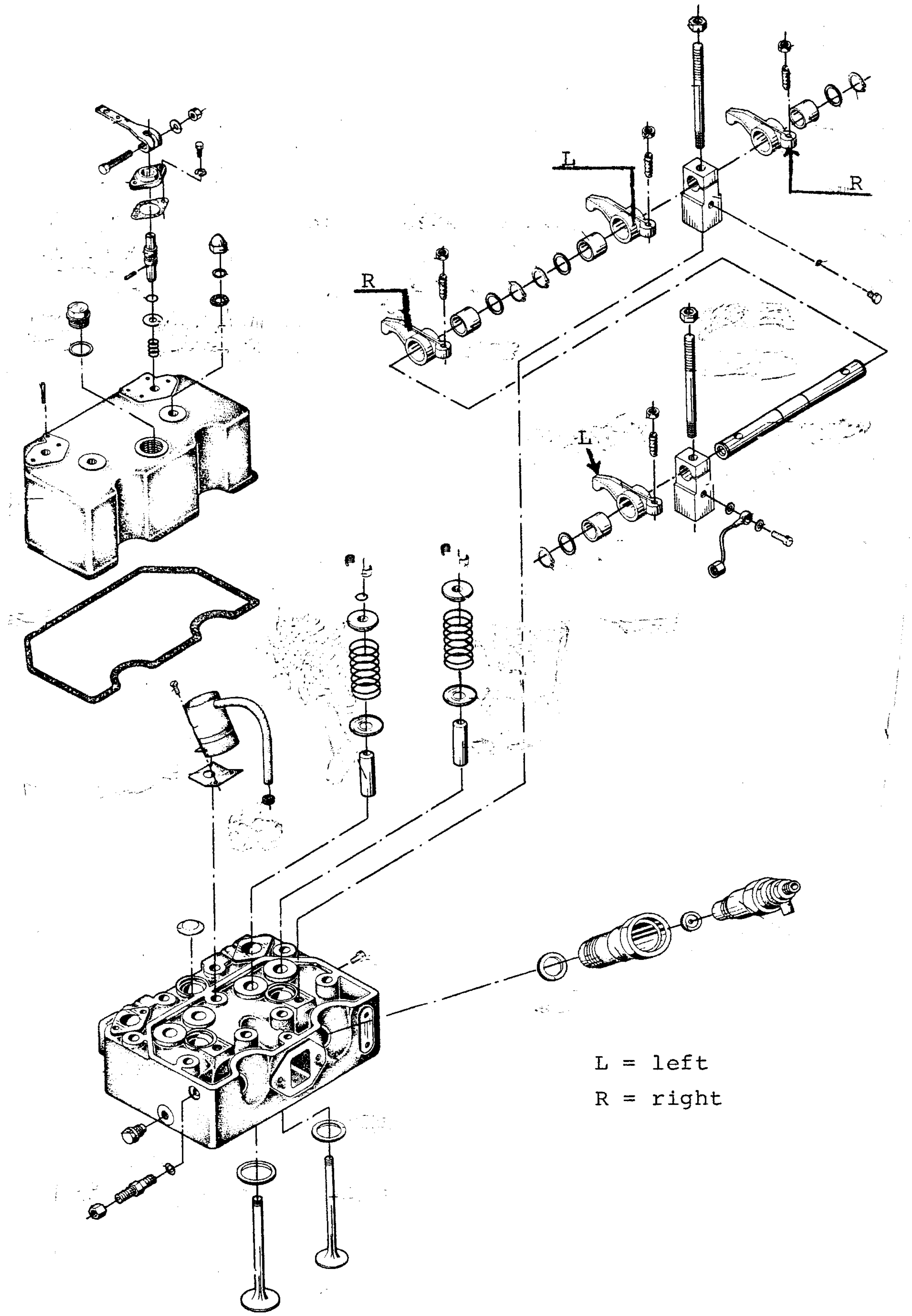
Section C

Cylinder Head

CONTENTS

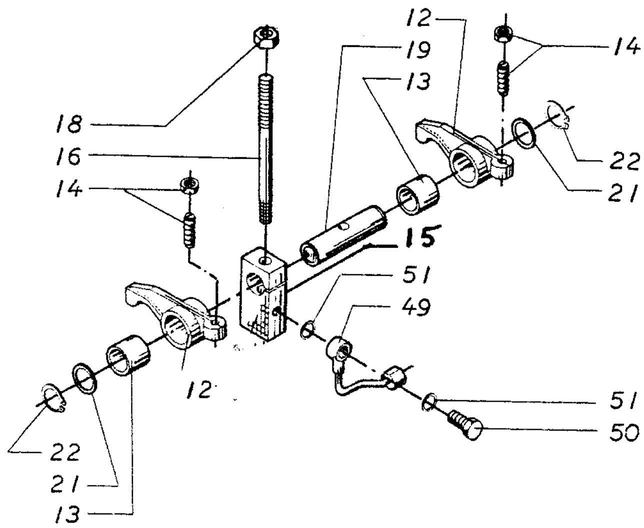


Cylinder Head DV10



Cylinder Head DV20

Change of Rocker Arm or Rocker Shaft



1. Dismount the cable drives for decompression handle, if any.

2. Dismount cylinder cover.

3. Dismount circlips 22.

4. Remove the support washers 21 after which the rocker arms can be dismounted and replaced if necessary.

5. Unscrew the nut 18.

6. Unscrew the banjo bolt 50, and lift the stanchion for rocker arm 15 from the stud 16.

   Then rocker shaft 19 can be changed.

When fitting, which should be carried out in the reverse order, special attention should be paid to the following points:

1. Fit the stanchion for rocker arm correctly in proportion to the guide pins (only DV10) and tighten with the prescribed torque (4-4.5 kpm).

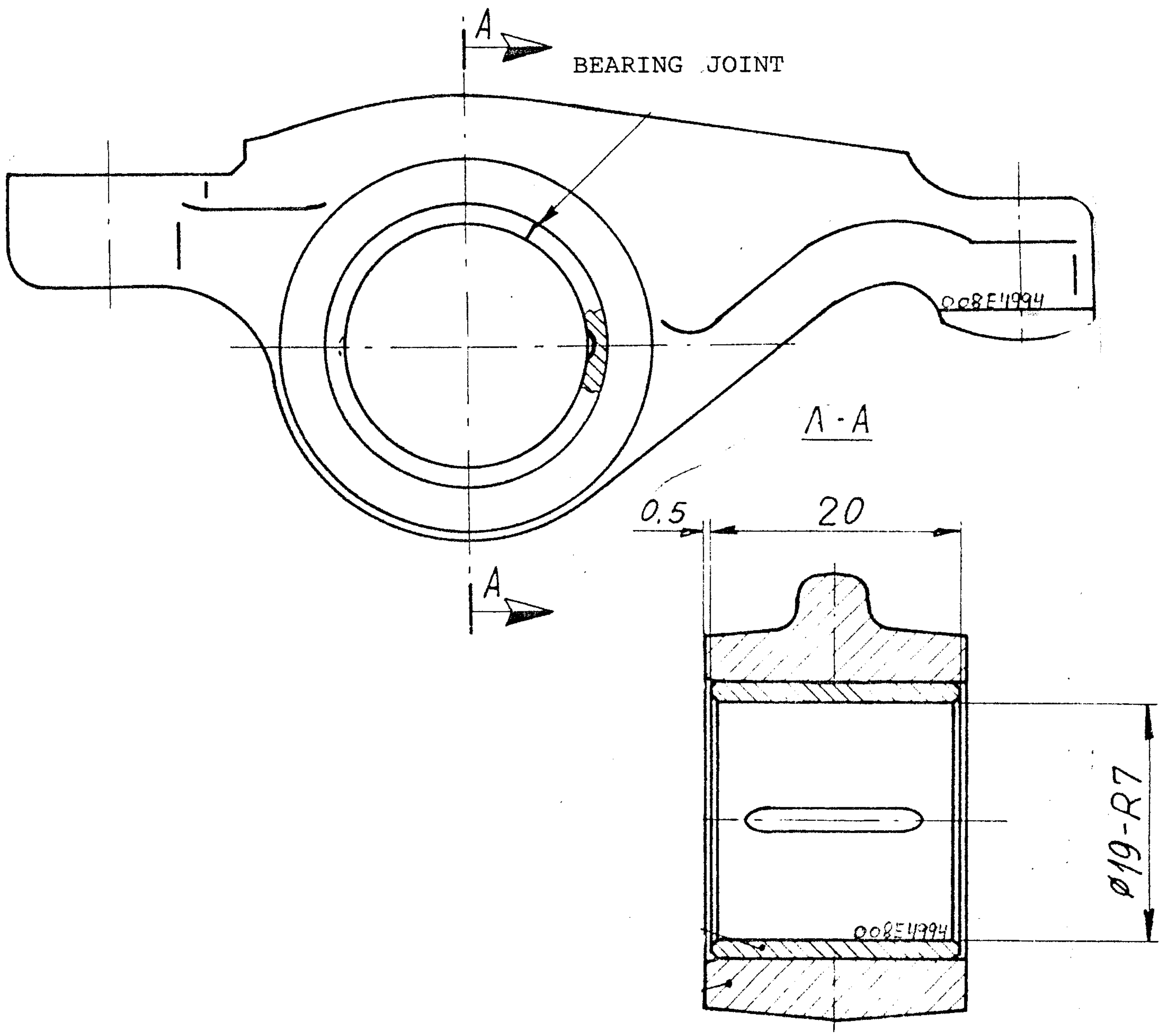
2. The lub. oil connections (pos. 49-50-51 page C 5) should be completely tight in order to secure maintenance of the lubricating oil pressure.

3. Fit the rocker arms in correct position - see indication of positions for left and right rocker arms on page C 4 (DV20). The rocker arms for DV10 (C 3) are alike.

Exchange of Bushing in Rocker Arm

1. Remove the rocker arm as mentioned on page C 5, and examine it for wear and fractures, if any.
2. Press out the defective bushing with an adequate tool.
3. Fit the new bushing as shown below. Special attention should be paid to the positions of the bearing joint and the oil grooves.
4. Calibrate the bearing bushing after the mounting, so that the tolerance 19 - R7 is observed. (18.80/18.59). This may either be carried out with a calibrating ball or with a reamer having the mentioned tolerance.
5. After the rocker arm has been fitted: measure the bearing clearance and the axial clearance with a feeler gauge.

   Bearing clearance : 0.04 - 0.06 mm
   Axial clearance 0.1 - 0.2 mm
6. Finish the fitting of the rocker arm arrangement.



	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	85967		4400.1.E	1973
DV 20	92447		4600.1.C	1973

Dismounting of Cylinder Head

1. Drain the cooling water off the engine.
2. Dismount the water passage with belonging pipes.
3. Dismount the inlet and exhaust manifolds.
4. Remove the cable drives for the decompression handle.
5. Dismount the cylinder cover.
6. Dismount the fuel pressure pipe from the fuel pump to the fuel valve. Cover all openings in the fuel system with plastic plugs or the like during the disassembling, so that every risk of impurities in the fuel system is avoided.
7. Loosen and unscrew the nuts in the cylinder head, after which the cylinder head can be removed.

Mounting of Cylinder Head

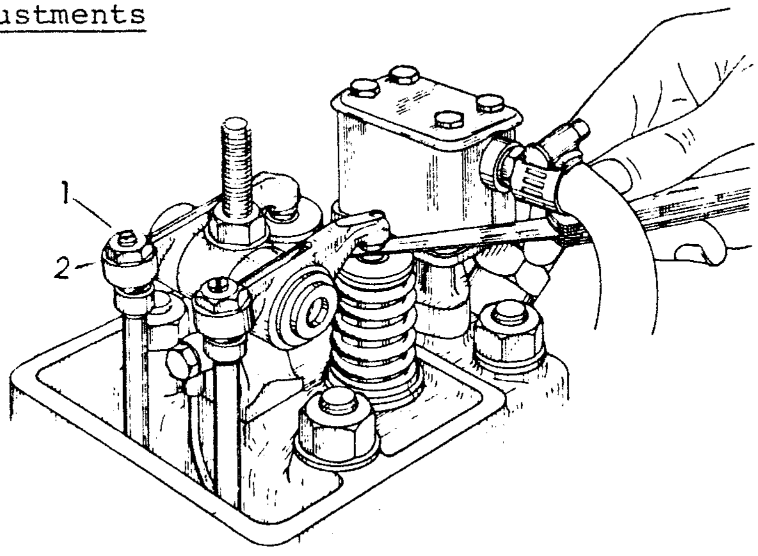
The mounting takes place in reverse order of the dismounting, while observing the following:

1. Torque of cylinder head:

DV 10	-	15-17 kgm	108.5 - 123	ft.lbf.
DV 20	-	9.5-10.5 kgm	68.7 - 75.9	ft.lbf.

2. The tightening must take place evenly and crosswise so that every bolt is tightened alike.

Valve Adjustments



The valve clearance is to be adjusted when the engine is cold and should always be made after a re-tightening of the cylinder head. Further the valve clearance should be adjusted every 3 months.

The valves are adjusted when the piston is near T.D.C. on the compression stroke.

The valve clearance is:

Inlet valve	0.25 mm	0.01 inch
Exhaust valve	0.30 mm	0.012 inch

	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	85000		4400.1.E	1973
DV 20	92000		4600.1.C	1973

Dismounting of Fuel Valves

Unscrew the fuel valves 26 screwed into the upper part of the pre-combustion chamber 24 after removal of the fuel pipes.

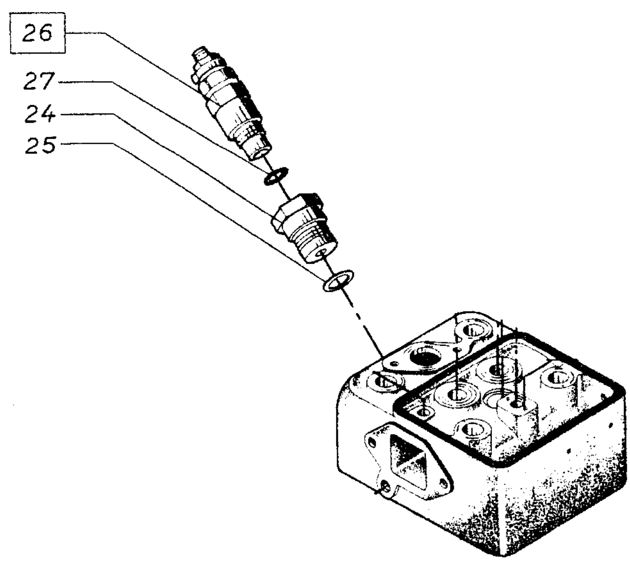
Mounting of Fuel Valves

At the mounting which takes place in reverse order, the tightening of the fuel valves must be carried out very carefully and any form of dirt and impurities must be avoided.

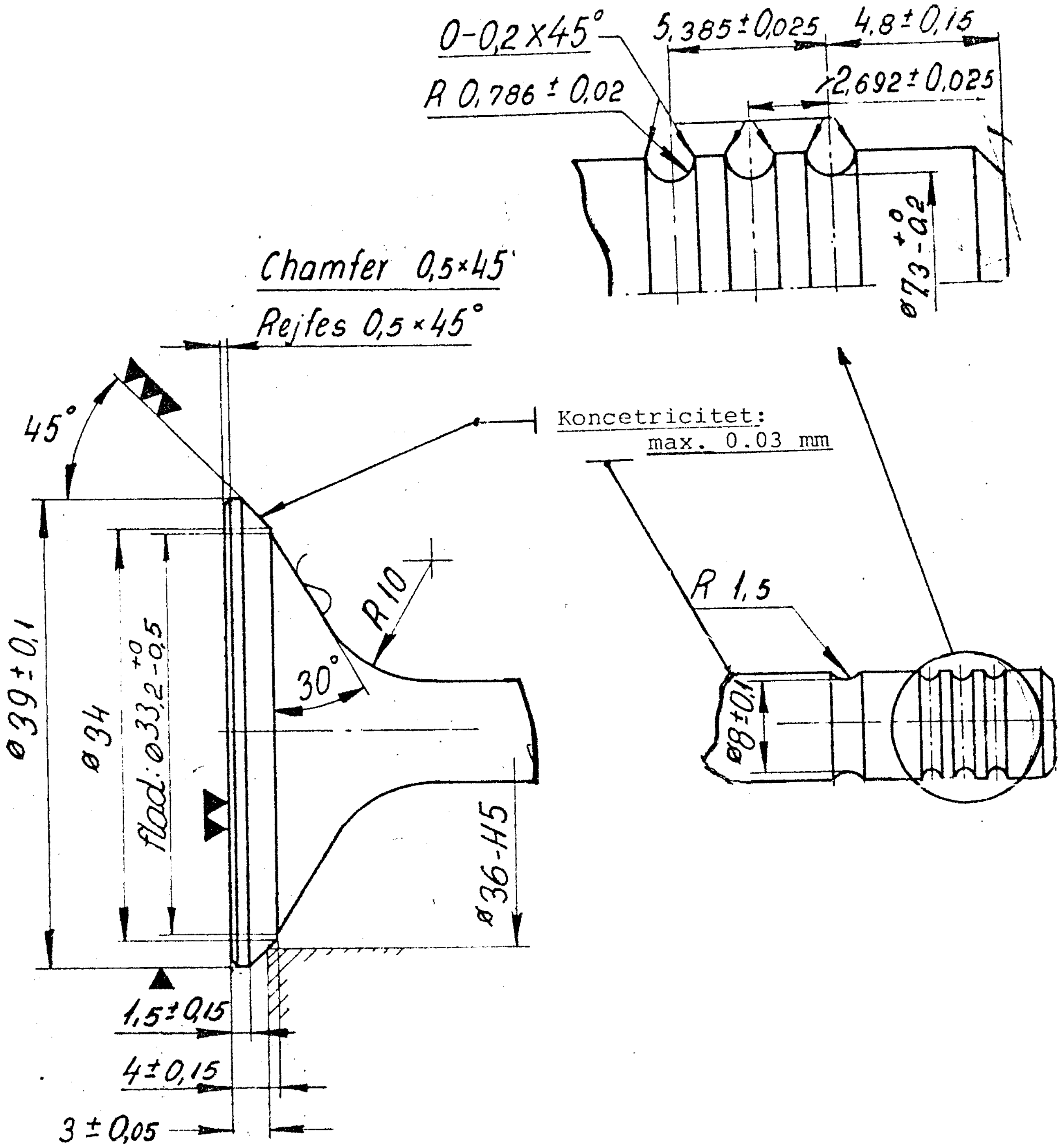
The fuel valves are normally tightened with a torque of 7-8 kgm (50.6 - 57.8 ft.lbf).

The gasket 27 between the fuel valve and the upper part of the pre-combustion chamber must be placed correctly at the mounting, i.e. the plane part upwards. This is of great importance as otherwise the nozzle easily gets too warm and cokes.

Further the gasket should be replaced by every disassembling of the fuel system when the nozzle is replaced in the nozzle holder or when a new nozzle holder is mounted.

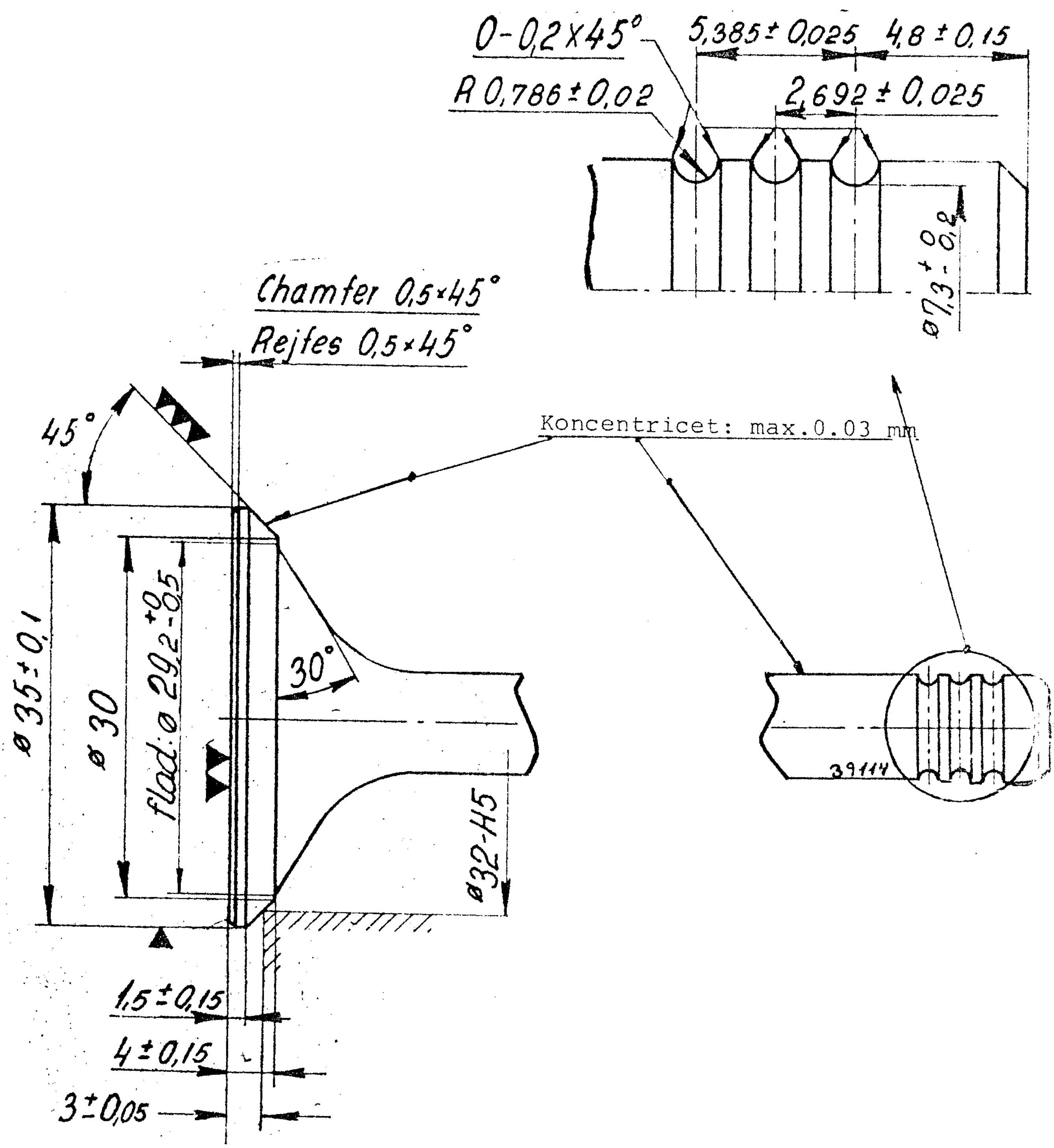


Inlet Valve - Machining Dimensions and Tolerances



The seal face of the inlet valve must max. have a breadth of 3.72 mm.

Exhaust Valve - Machining and Tolerances

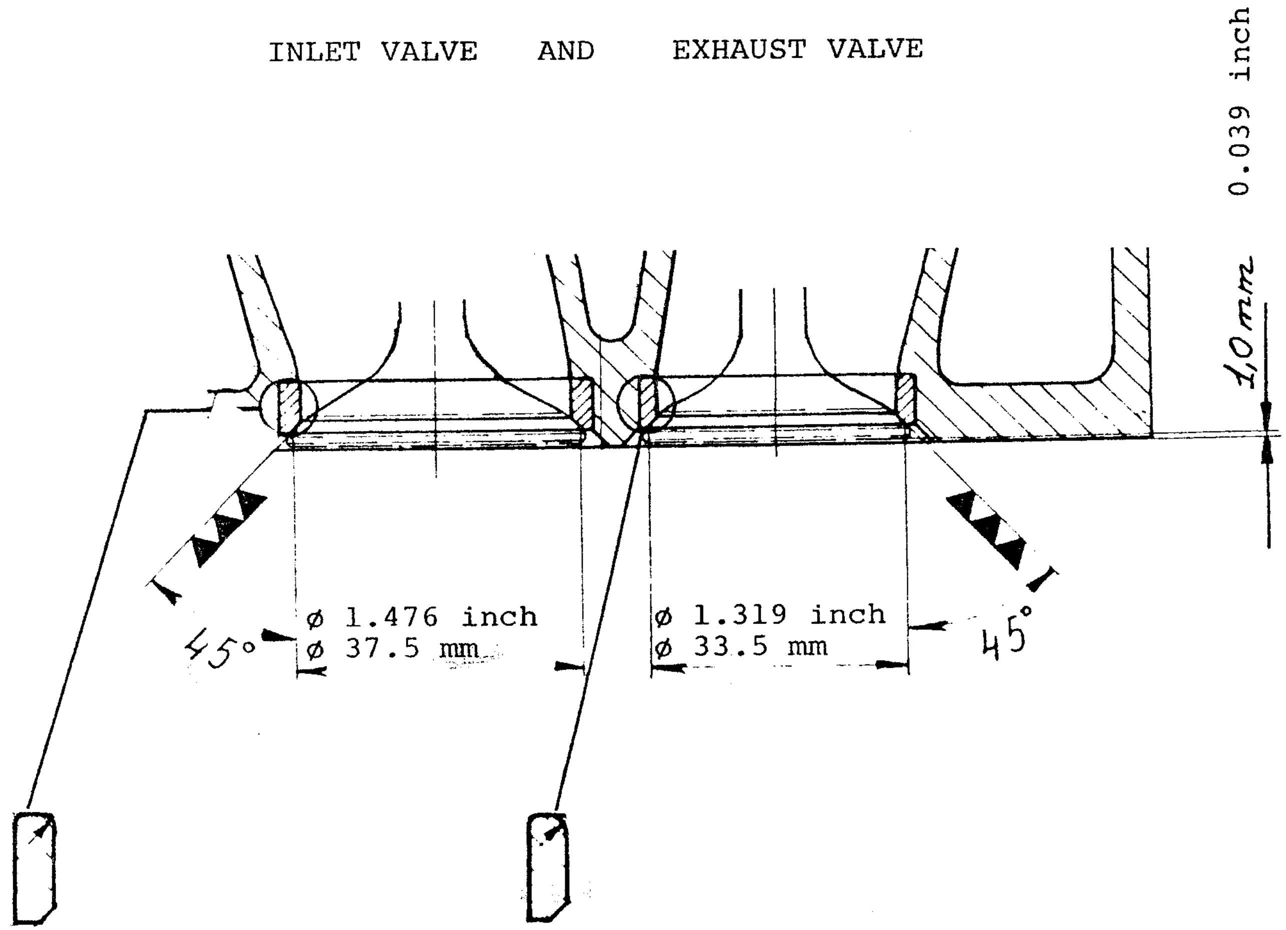


The seal face of the exhaust valve must max. have a breadth of 3.72 mm

MINIMUM REPAIR MEASURES

FOR

INLET VALVE AND EXHAUST VALVE



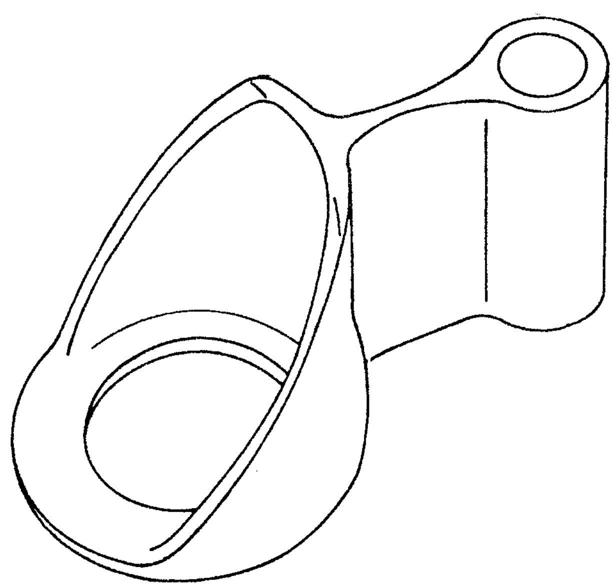
Repair or Change of Exhaust and Inlet Valves

1. Dismount the cylinder head (see page C 7).
2. Place the cylinder head on a vice bench or the like with the valve seats down.
3. Press down the spring disc with the below special tool or the like, remove the two conical retaining spring ring halves, and take off the valve springs and the valve spring guides.
4. Place the cylinder head upright and take out the valves when the O-ring on the valve stem has been removed.
5. At the fitting the valves should be fitted in the respective valve guides.

If the valves are so damaged that a re-milling with special tools and a subsequent grinding is impossible without exceeding the tolerances desired (see C 10, 11, 12) they must be changed with new ones. A re-milling with fixed guide should always be made when the valve does not operate satisfactorily.

After replacement of seat and valve or only of valve, you must grind seat and valve against each other with abrasive compound in order to obtain complete tightness. It is a condition for the engine's compression being in order that this work is carried out very carefully.

Grinding of valves takes place as described on next page.



Grinding takes place as follows

1. Place the cylinder head upside down and block it up so that the valves can be turned freely by means of a rubber sucking disc.

2. Spread abrasive compound on valve and seat, place the valve against the seat, and grind these against each other.

3. When grinding, turn the valve by means of the rubber sucking dics in various directions while pressing towards the seat. Lift the valve frequently during the grinding, and spread the compound over the whole seat.

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 be smeared.

5. Smear a thin coat of oil on the valve and the seat before refitment.

Measures for New Valves

Valve stem diameter	8.972-8.987 mm (0.35323-0.35382 inch)
Valve guide bore	9.050-0.062 mm (0.35630-0.35677 inch)
Clearance between valve stem and valve guide	0.063-0.090 mm (0.0025-0.0035 inch)

The valve stems are chromium-plated. The chromium-plating is only a few thousandth mm thick, and consequently the valve stems must in no circumstances be ground.

Change of Valve Guides

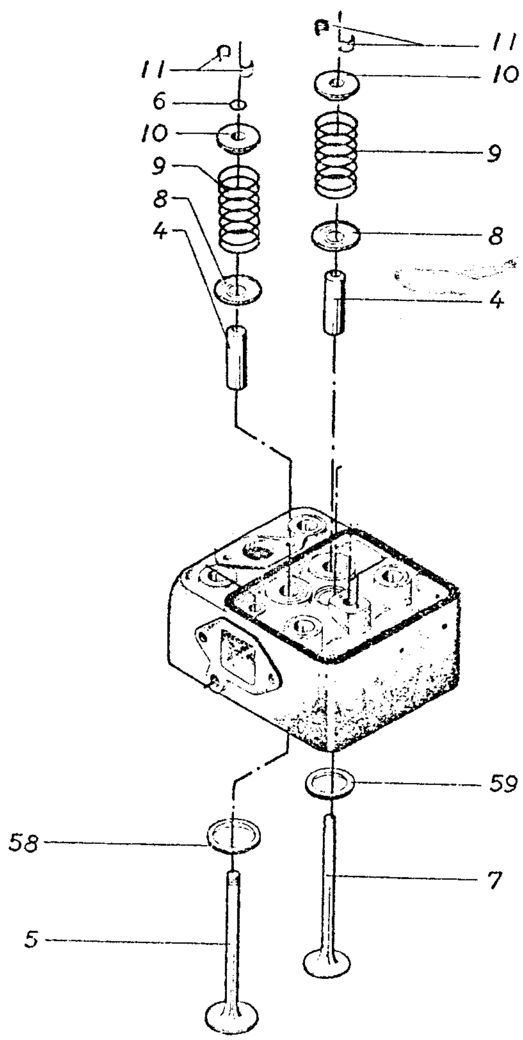
The valve guides 4 are exchangeable and pressed down in the cylinder head from above. If by warm engine, the clearance between valve guide and valve stem exceeds 0.1 mm, the valve (0.0039" guide must be changed. This takes place as follows:

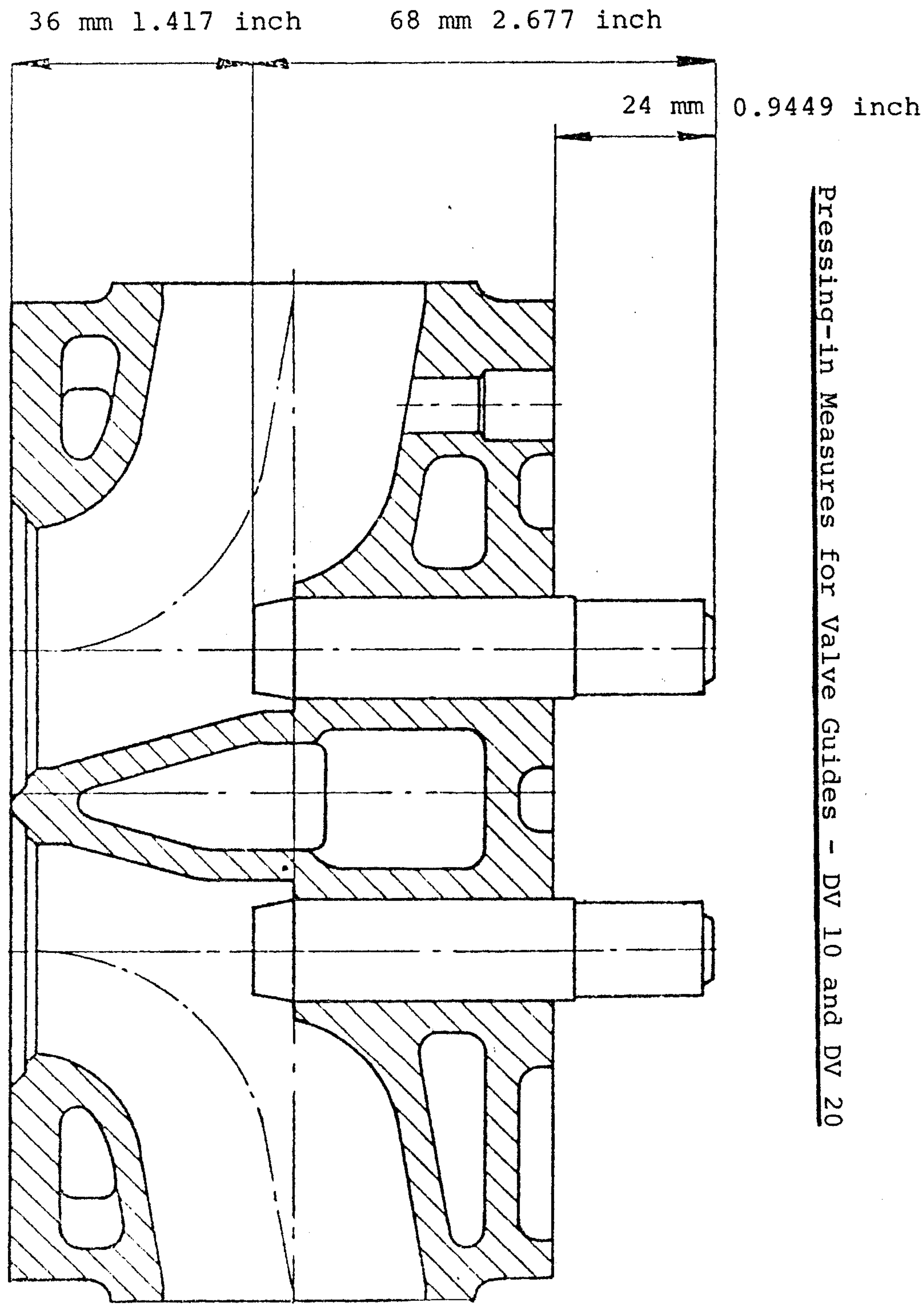
1. Dismount the cylinder head and the valves in accordance with the instructions.

2. Press the valve guide out below or above of the cylinder head.

3. New guides are pressed down from above in accordance with the measures and tolerances of the preceding page. Ream the bore of the valve guides with a reamer 9 H 8. This is done to remove any upsettings from the fitting.

4. Then check the tolerance between valve stem and valve guide.





Pressing-in Measures for Valve Guides - DV 10 and DV 20

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85182		4400.1.E	1973
DV20	92015		4600.1.C	1973

Changing of Valve Seats

When milling and grinding the valve, the measures indicated on pages C 10, C 11 and C 18 must not be exceeded.

The exchangeable valve seat rings 58 and 59 on page C 9 can be changed as follows:

1. Remove the valve guides 4 as indicated on the preceding page.
2. Stick a thin punch into the valve guide hole of the cylinder head and push out the valve seat rings by striking on the small edge of the ring which sticks out of the materials of the cylinder head.

You can also take out the valve seat ring by means of a bent chisel (crowbar principle) and a piece of lead plate. This takes place as follows:

1. Place the lead plate as protection between the cylinder head and the centre of rotation of the chisel.
2. Stick one end of the chisel under the valve seat ring and knock it out.

By the last-mentioned method you save taking out the valve guides, but you must use a lead plate (as intermediate layer) as otherwise you risk damaging the cylinder head.

Mounting of Valve Seat Rings

Before mounting the valve seats clean the bores in the cylinder head thoroughly and then check them for correct roundness and measuring tolerances.

This check should be carried out, if you want to fit new valve seats.

Measures for Bores for Valve Seats

Inlet valve : 41H6 (+ 0, + 0.025)
Exhaust valve: 36H6 (+ 0, + 0.025)
Eccentricity : max. 0.01

Before the fitting check whether there is any cracks in the cylinder head.

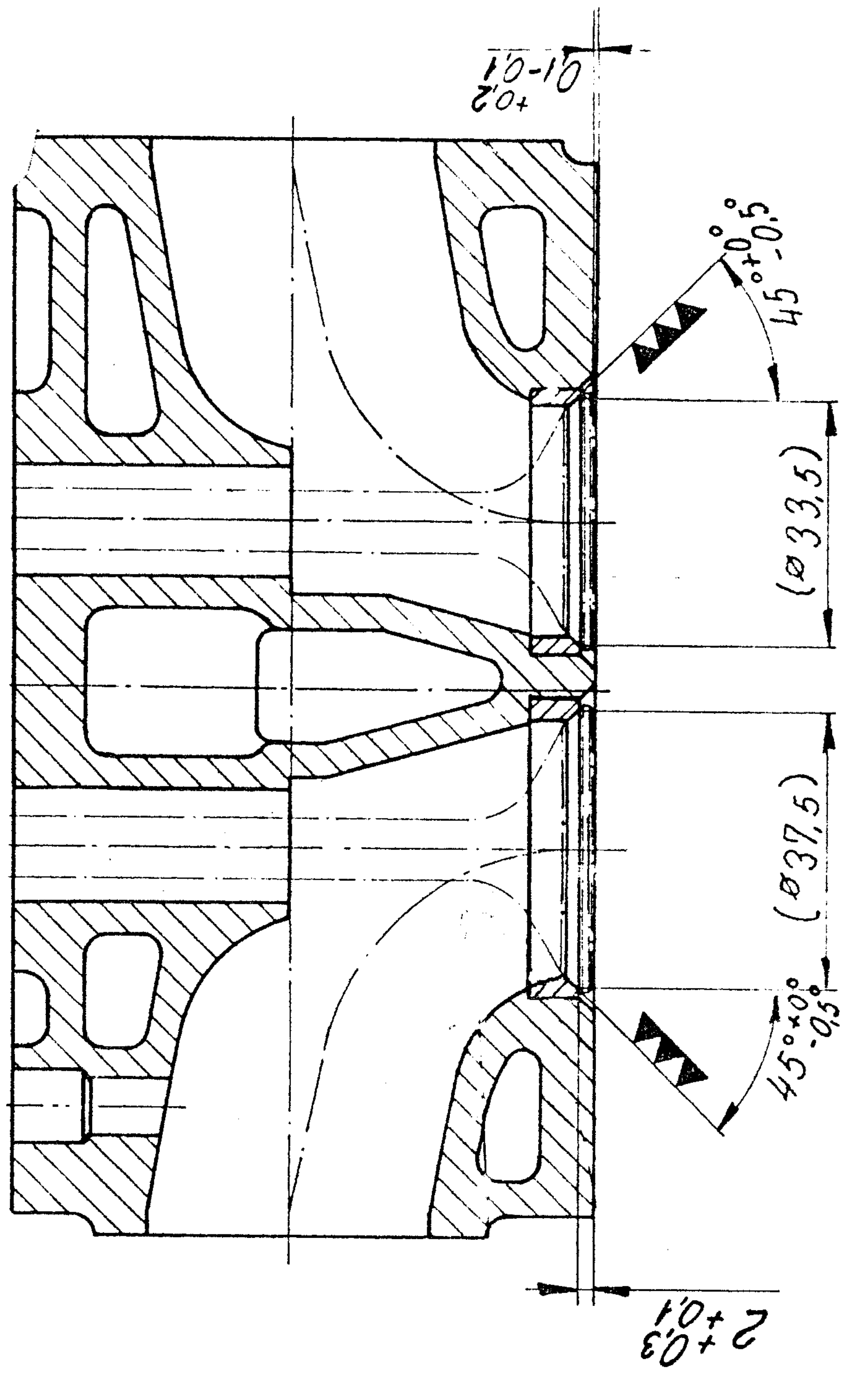
Heat the cylinder head in boiling water to about 100°C (212°F). At the same time cool down the valve seat rings by means of CO^2 or liquid nitrogen.

At the fitting of the valve seat rings the temperature difference (cylinder head - valve seat rings) should be 220°-250°C (430°-480°F).

The valve seat rings MUST NOT be knocked into the cylinder head.

After the fitting true up the valve seats so that the indicated tolerances on the pages C 10, C 11 and C 18 are observed.

Machining and Mounting Dimensions for Inlet and Exhaust Valve Seat



permissible breadth of se 1.7 - 2.3 mm

Cylinder Head Gasket

The cylinder head gasket is made from "Victorcore 200" which consists of rubber asbestos plate with moulded-in metal reinforcement of tinned steel and a fire ring.

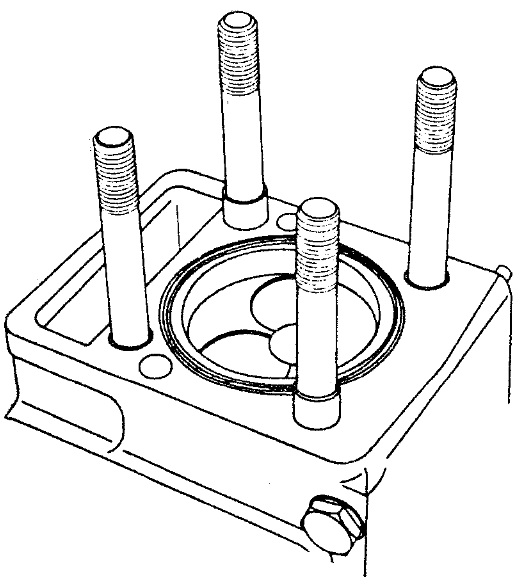
When exchanging the cylinder head gasket the grooves in the cylinder head must be completely clean in order to obtain tightness. The grooves can be cleaned out by means of a scraper. When fitting the new cylinder head gasket the side marked "top side" should turn up towards the cylinder head.

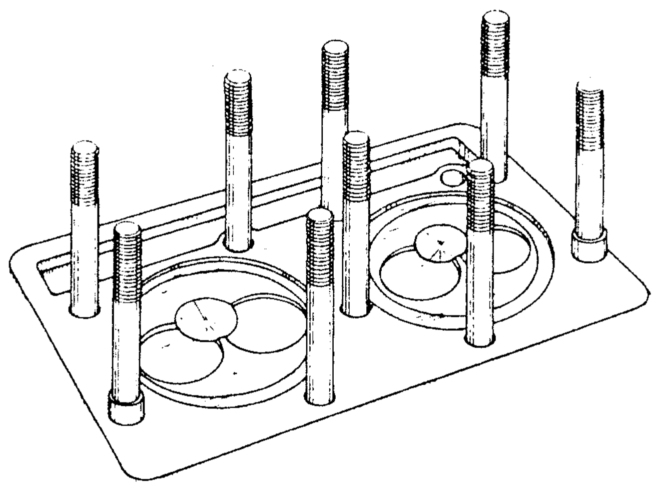
If the studs of the cylinder head gasket have been removed, it is important that they are fitted correctly, i.e. that the studs with guides are fitted as shown on the drawings below.

When the cylinder head gasket has been removed several times, the metal round the studs may have risen which can be checked by means of a straight edge.

If the metal has risen it must be planed.

As all types of gaskets will "settle" in the course of the first operating hours, it is necessary to make a tightening-up.





Tighten the cylinder head gasket to correct torque after about 25 operating hours. At the same time it is recommended to tighten the other gaskets of the engine.

Tighten up when the engine is warm.

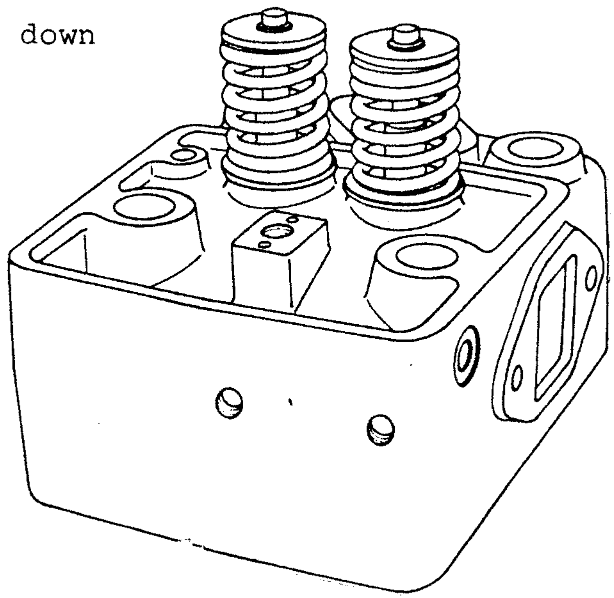
Mounting of Valve Springs

C O R R E C T

Dampener coil down
is correct

W R O N G

Dampener coil up
is incorrect



When mounting the valve springs you must take care that they are placed correctly - which can be seen from the above drawing.

The above only applies to the following engine numbers:

	From eng. No.	To eng. No.	From parts list No.	To parts list No.
DV10	85.000	200582	-	021D0002
DV20	92.000	94404	-	022D0002

After the mentioned engine numbers the valve springs can be fitted arbitrarily.

Adjustment of Decompression Lever

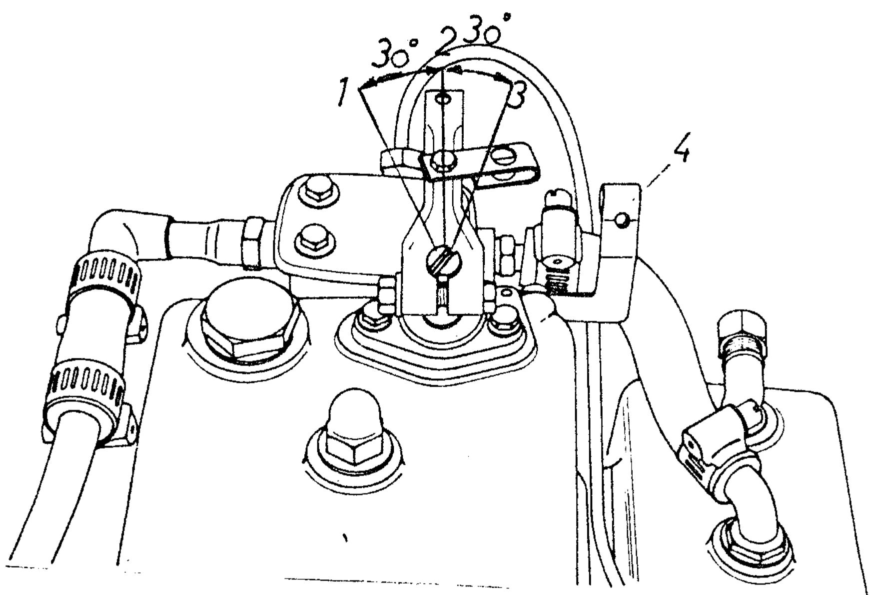
The decompression lever which is shown on the below drawing can be adjusted as follows:

1. Turn the fly-wheel so that the exhaust valve closes.

2. Turn the shaft for decompression lever clockwise until it just touches rocker arm of the exhaust valve.

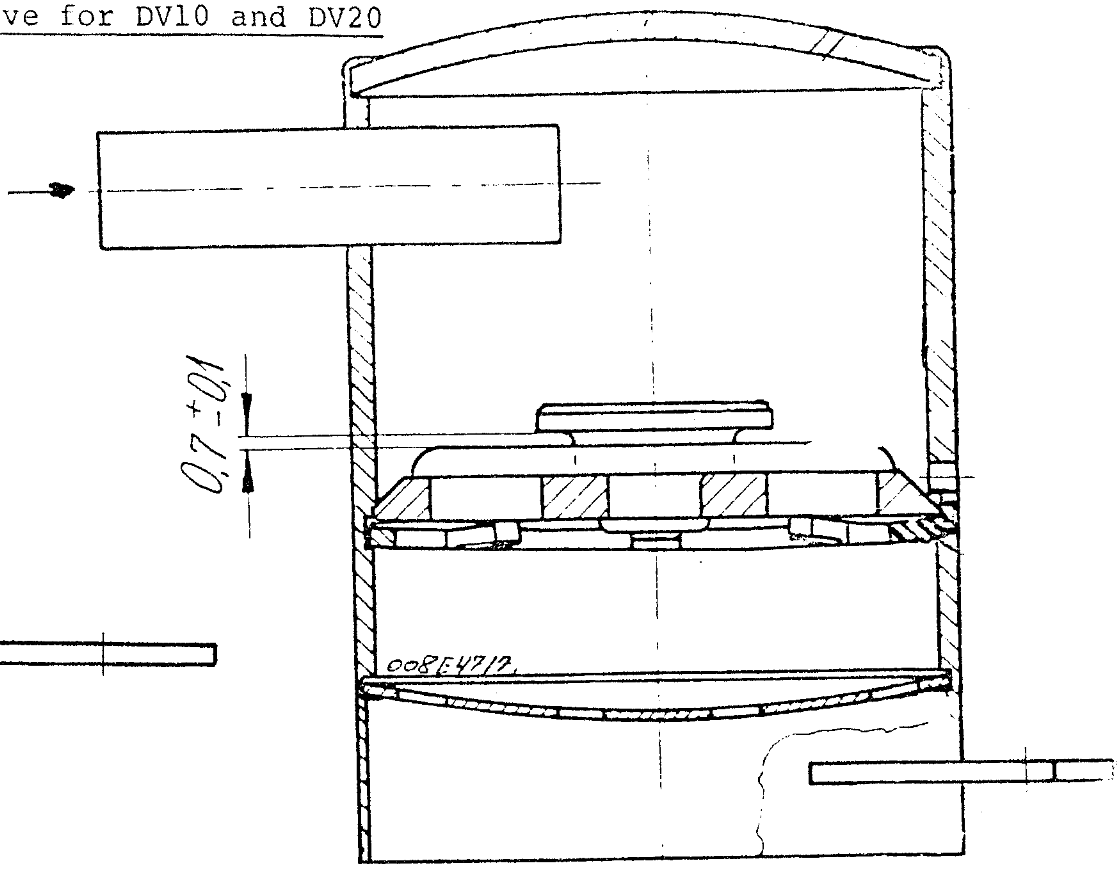
3. With the shaft in this position you must mount the lever so that it is perpendicular to the longitudinal axis of the engine.

4. Tighten the lever with a torque of 0.9 - 1.0 kgm (6.5 - 7.23 ft.lbf.).

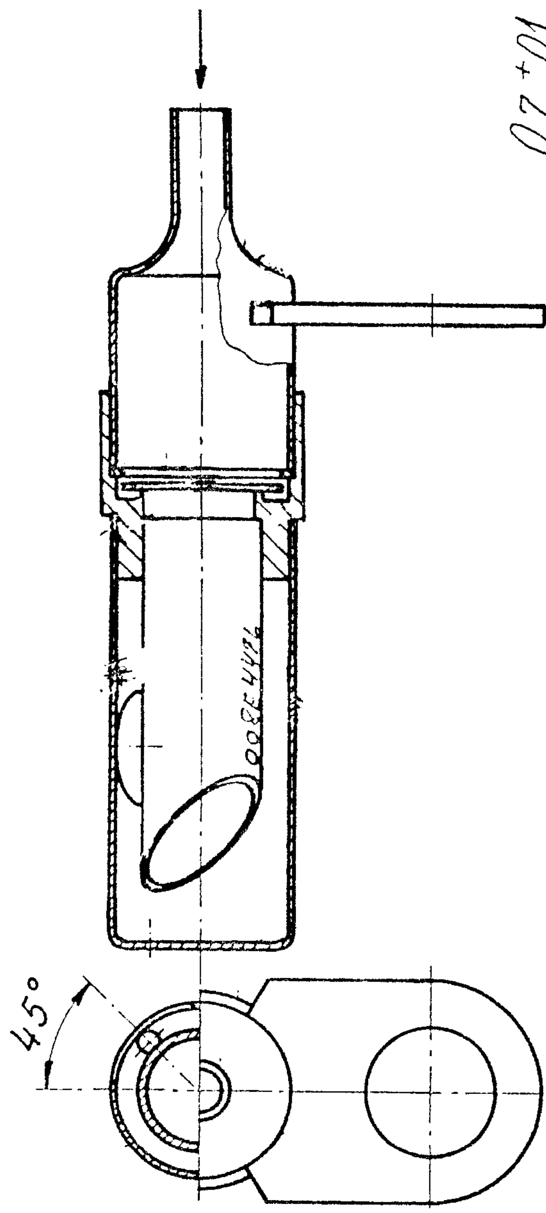


1. Rest position
2. Adjusting position
3. Position when decompressing
4. Holder for decompression lever cable

Vacuum Valve for DV10 and DV20



Vacuum valve for DV20 (2:1)



Vacuum valve for DV10 (1:1)

The fitting of the vacuum valve for DV20 has been changed, as now hose and connecti pipe are used. The change has been made in order to obtain better tightness in the connections of the vacuum valve.

If the new vacuum valve is used on old engines the connection pipe (sp.p.No. 000E42 should be used.

Fit the connection pipe in the hole in the suction manifold and secure it with Readit 5850.

When fitting the hose connection observe that this is carried out without any bends on the hose.

Surfacing of Cylinder Head

A surfacing may be necessary on old engines or on engines having been overheated.

This surfacing must be made if a hollowness of max. ____ mm of the sealing surface of the cylinder head can be measured.

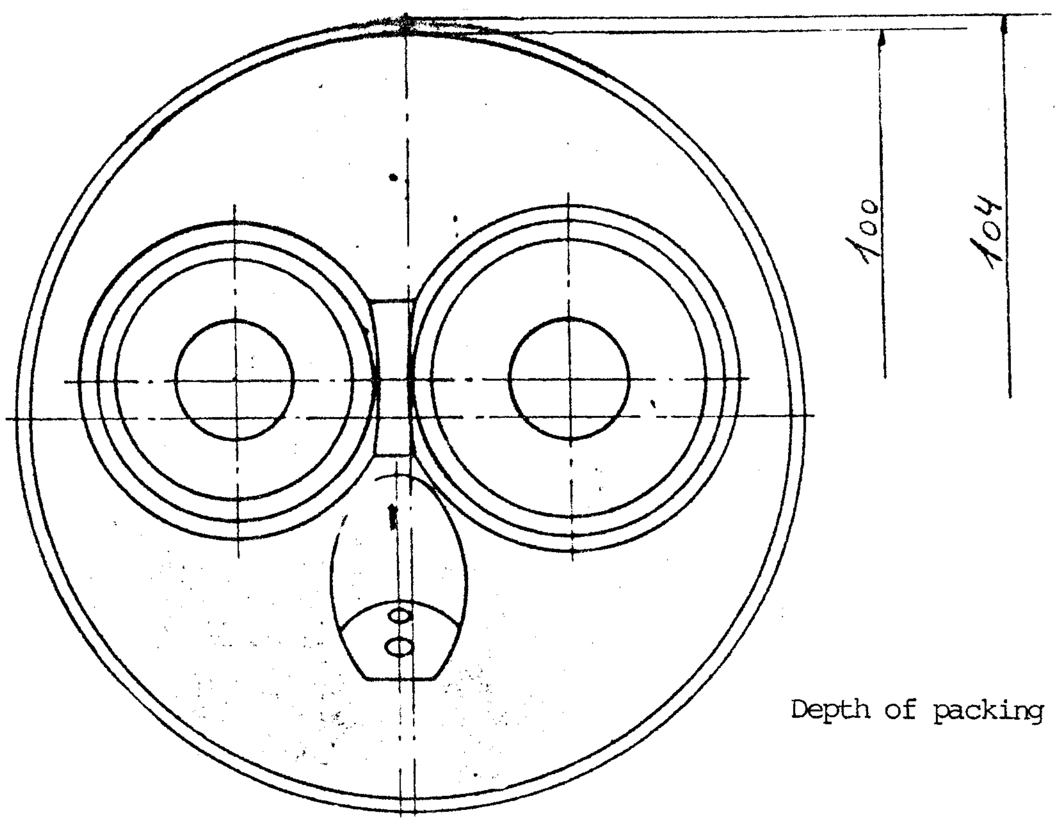
The test measurement is made 90 degr. displaced around each cylinder and is carried out with a straightedge and a feeler gauge.

When surfacing, the measures on page C 18 must be observed.

After the surfacing has been carried out, cut up the packing grooves in the cylinder head according to the dimensional sketch below and for the following engines:

	From eng. No.	To eng. No.	From type No.	To type No.
DV10	85.000	203812	102-1	021D0007
DV20	92.000			

Packing Grooves



Depth of packing grooves: 0.3 mm

Precombustion Chamber

For the DV engines the precombustion chamber consists of two parts, a top part and a bottom part. The top part is removable and screwed into the cylinder head and can be screwed off when the fuel valve has been removed. The bottom part is formed by the cylinder head and cannot be removed.

When fitting the top part of the precombustion chamber in the cylinder head, the torque must be 24 - 25 kgm (173.5 - 180.8 ft.lbf.)

Compression gauging

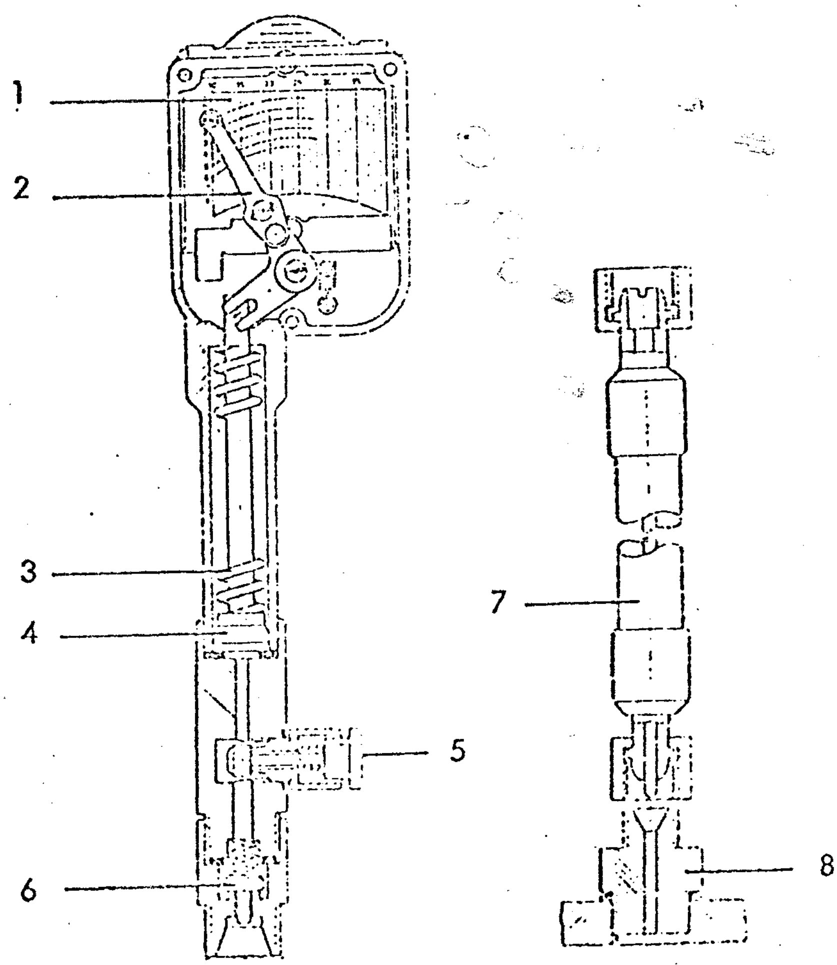
The compression gauging gives a picture of the general conditions of the engine.

As the compression gauging takes place at a low RPM, the compression shown will not correspond with the actual conditions of the engine. Furthermore, throttle loss in the compression gauge will result in small values on the compression card, but our experience shows that:

1. By a new engine the compression should be between 27 - 29 kg/cm^2. (383 - 412 PSI).
2. By compressions below 25 kg/cm^2 the engine cannot start or (355 PS is very difficult to get started.

Remedy the low compression and the resulting starting problems by changing either cylinder liners, piston rings, or inlet and exhaust valves.

See instruction on next page.



MotoMeter compression gauge

The MotoMeter compression pressure gauge consists of 4 principal parts:

1. A unit containing scriber (2) with piston (4), valve and handle. On one side of this the return valve (5) is placed and at the end a non-return valve (6) which prevents the pressure from escaping the cylinder which is being gauged.

2. Fit the high pressure hose (7) on the gauge unit.

3. Intermediate piece (8).

4. Connecting piece. Together with your compression gauge you receive two connecting pieces which fit all BUKH engines. The piece marked A on the hexagon fits the types DV10, DV20, G105, 4K105, and 6K105. The piece marked on the key fits 2G105 and 3G105.

Operation Instruction

1. Fit a new card in the compression gauge. Check that the scriber is in starting position.

2. Fit the high pressure hose (7) and the intermediate piece (8) on the gauge unit.

3. Drive the engine up on normal operating temperature.

4. Stop the engine and close the fuel supply.

5. Remove the nozzle holder.

6. Fit the connecting piece in the engine's precombustion chamber top part where the fuel nozzle is normally fitted.

7. The gauge unit with the high pressure hose and the intermediate piece can now be screwed on the connecting piece.

8. Turn the engine by means of the electric start or the hand start until the pressure in the compression chamber in the gauge unit stops increasing.

9. Press the return valve (5). The scriber must go back to 0.

10. Drive the card in the scriber a position forward by pulling the pin under the handle on the back of the gauge.

11. Remove the connecting piece.

Repeat the points 5 to 11 for each cylinder.

Section D

Flywheel

Contents

	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	85000	89156	020D1501	1973
DV 20	92000	93637	020D1501	1973

Dismounting of flywheel

1. Loosen the bolts 8 and 12 (page D3) and the bolts 10, 12, and 13 (page D5).

2. Turn the dynastarter/alternator downwards, after which the V-belt can be removed.

3. Unscrew the six unbraco bolts 19 which hold the flywheel 18 on to the cranshaft and pull the flywheel, which weighs about 30 kg, off the crankshaft stud.

Mounting of flywheel

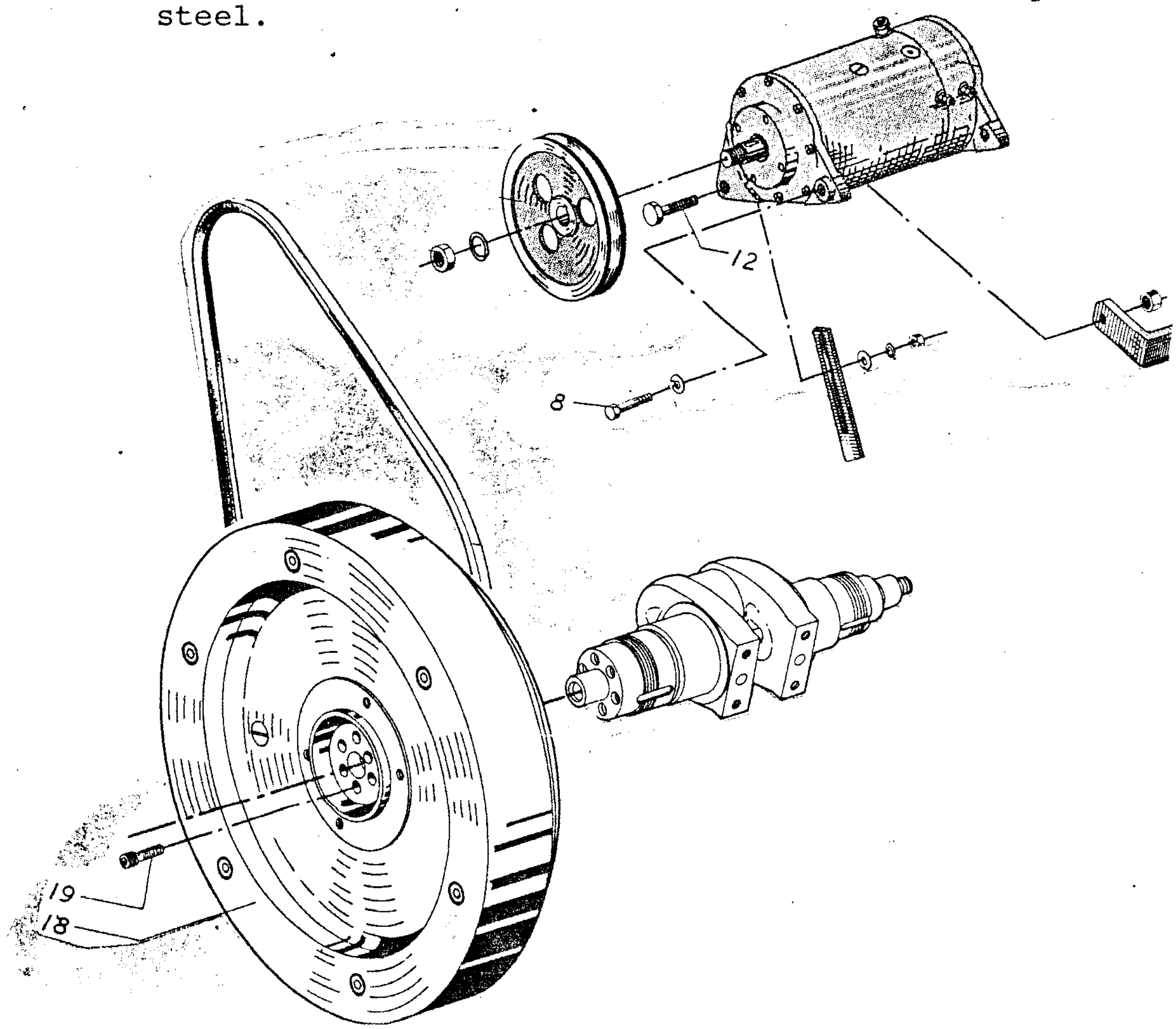
The mounting takes place in reverse order of the dismounting as the following is observed:

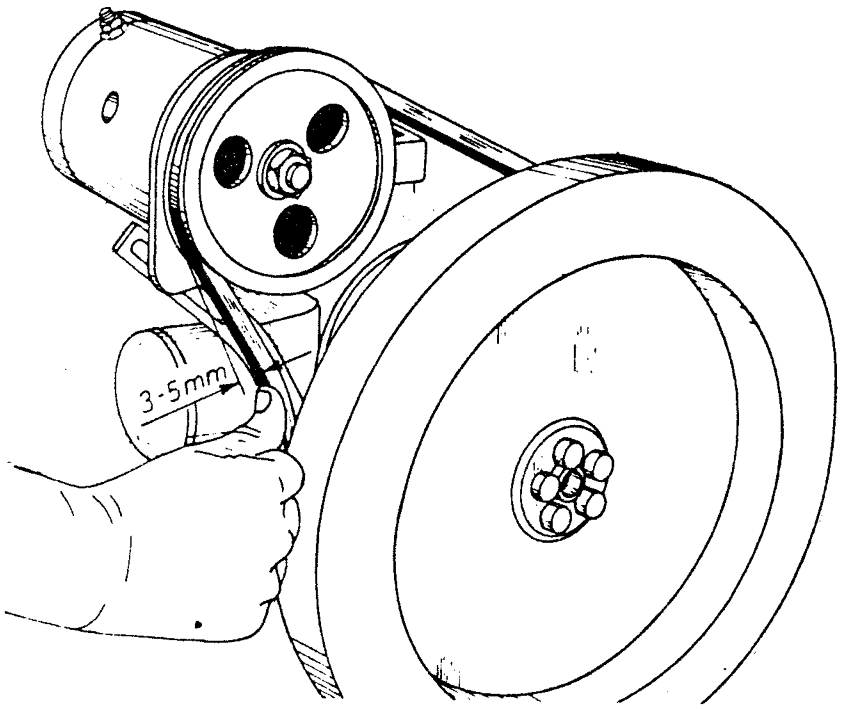
1. Tighten the unbraco bolts 19 crosswise with a torque of 8 - 8.5 kgm (58 - 61.5 ft.lbf.) after they have been greased with some Lock-tite.

2. The correct tightening of the V-belt allows a movement of 3 - 5 mm (0.1181 - 0.1969 inch.) (see page D 4).

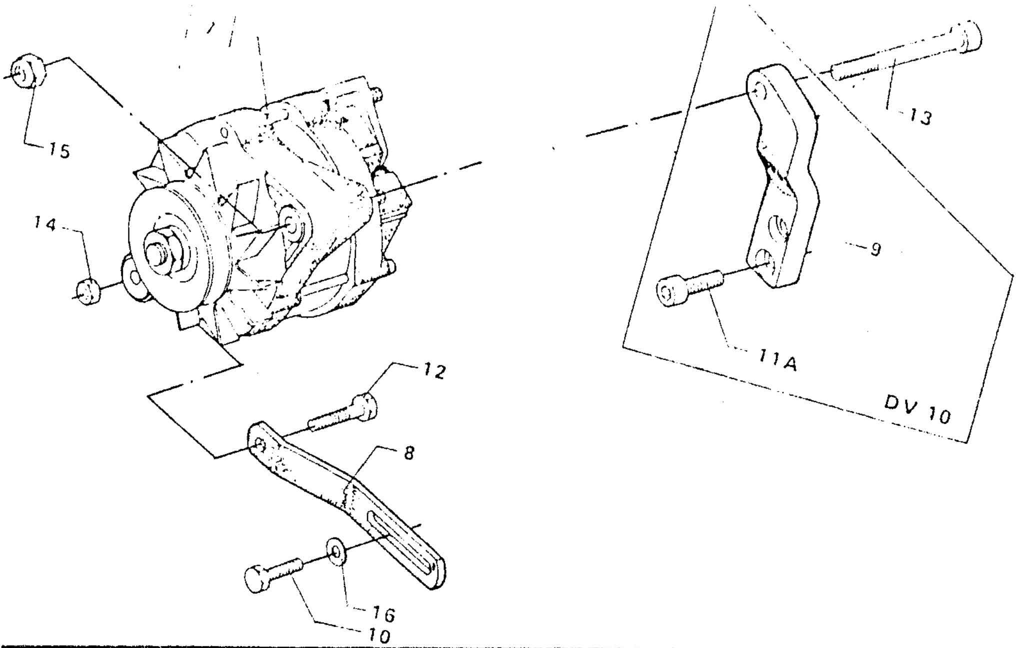
3. Tighten the bolt 8 with a torque of 4 - 4.5 kgm (28.9 - 32.5) and the bolt 12 with a torque of 2 - 2.3 (14.5 - 16.6). The bolt thread has to be greased with oil.

4. It is important that the unbraco bolts belonging to the flywheel are used as these are made from special steel.





Adjustment of V-belt



	From eng. No.	To eng. No.	Parts list No.	Year
DV10	89156		020D1501	1974
DV20	93637		020D1501	1974

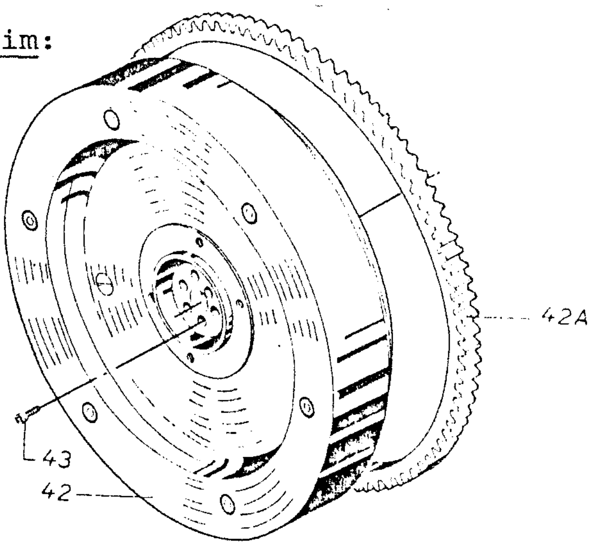
From the above engine Nos. the flywheel has been altered because the electrical system of the engine has been altered.

The flywheel is now provided with a shrinked on gear rim with which the starter mesh in the starting moment.

Further the flywheel in the new execution is provided with a V-belt pulley on the front end for drive of the alternator.

For mounting and dismounting the same directions are valid as previously.

Replacement of gear rim:



1. Dismount the flywheel (page D 3).
2. Saw with a hack-saw as far into the gear rim as possible without damaging the flywheel.
3. Split the gear rim in the sawn slot with a chisel.
4. Clean the recess on the flywheel.
5. Warm up the new gear rim gradually to about 225°C (dark blue colour), after which it is mounted. When mounting, you have to make sure that the gear rim lies true against the recess and that the chamfered edge faces the starter motor.

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 front main bearing lining.

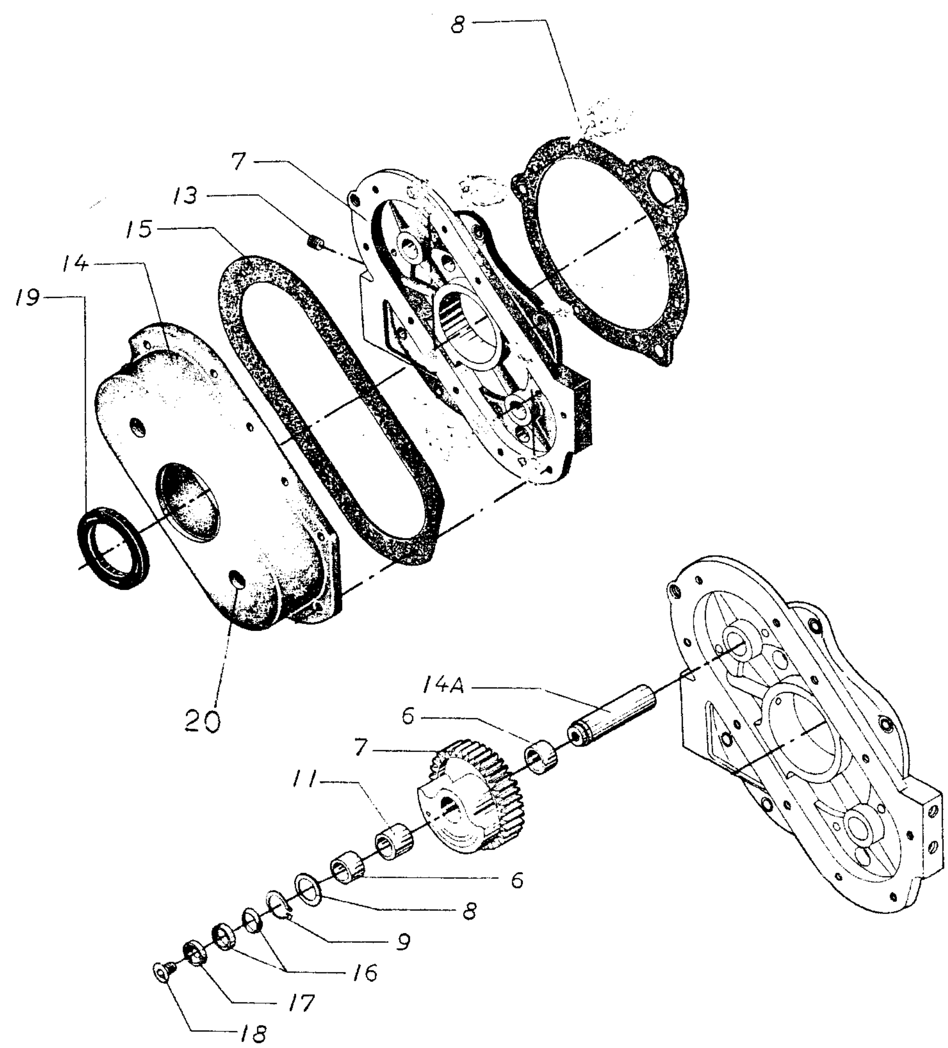
Pressed into the front end cover there are the axle journals 14a carrying the counterweights 7 which cause the fine balance of the engine. The counterweights are covered by a guard 14 made from iron plate for DV10 and cast for DV20.

For DV10 the guard 14 is without the the holes 20 and the unbraco screw 18 as well as the collars 16 and 17. When dismounting the counterweights for DV10 dismount at first the guard 14 and follow the instructions from point 4 below.

Dismounting of counterweights

1. Dismount the flywheel (see page D 3).
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 page G.4.

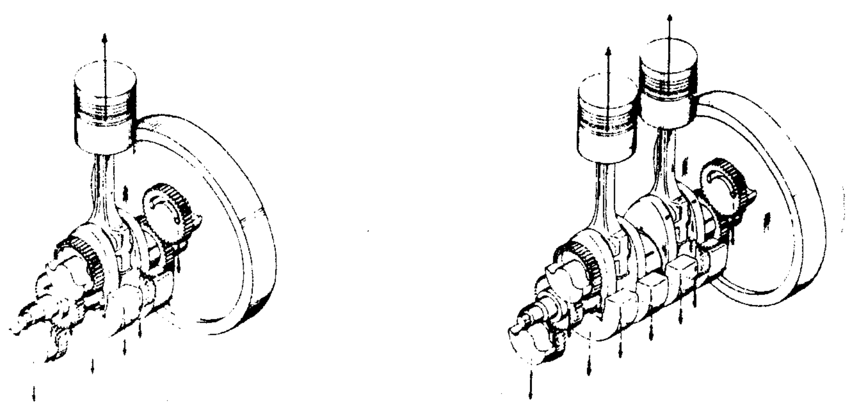


Mounting of Counterweights

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85000		021D0101	1973
DV20	92000		022D0101	1973

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

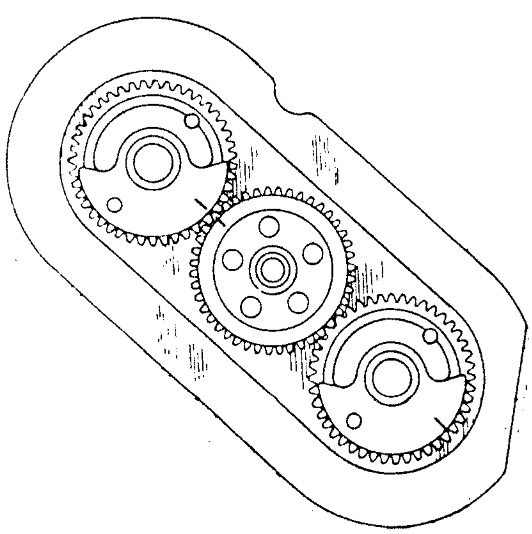
1. The piston(s) has/have to be in the T.D.C. position, and the counterweights are to be refitted with the heavy part downwards so that this part is horizontal. It is recommended to turn the counterweight one or two teeth to each side in order to find the exact position. To-day there does not exist any marking of the counterweights.



Mounting of counterweights

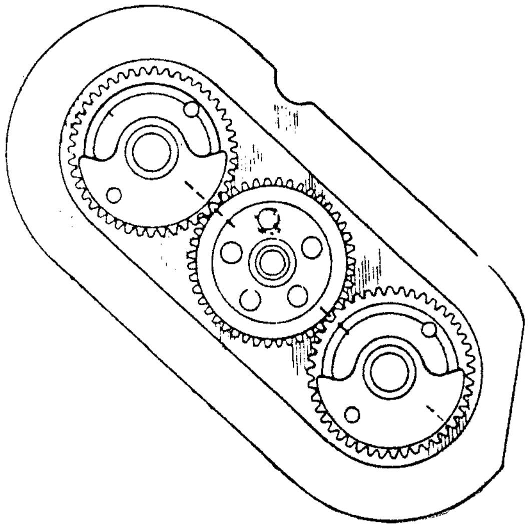
2. On old engine types there have been two different markings for the mounting. The mounting can be made as indicated under 1.

Old Marking



On old engine types mount the counterweight so that the marked tooth on the crankshaft gear-wheel is facing the mark on the counterweight.

New Marking



On new engine types mount the counterweight so that a tooth with one mark is facing a tooth space with one mark, and a tooth with two marks is facing a tooth space with one mark and a tooth space with two marks, respectively.

After the fitting adjust the axial clearance at 0.1 - 0.4 mm. This is done by displacing the shaft for the counterweights axially. After the adjustment, check that there is connection through the lubricating oil channels.

The following applies to DV20 engines: Mount the cover pos. 14 page E 3 before the thrust washer pos. 17 and the Allen screw pos. 18 page E3. Apply lock-tite on the thread of the Allen screw pos. 18 and tighten this with a torque of 2.5 kpm.

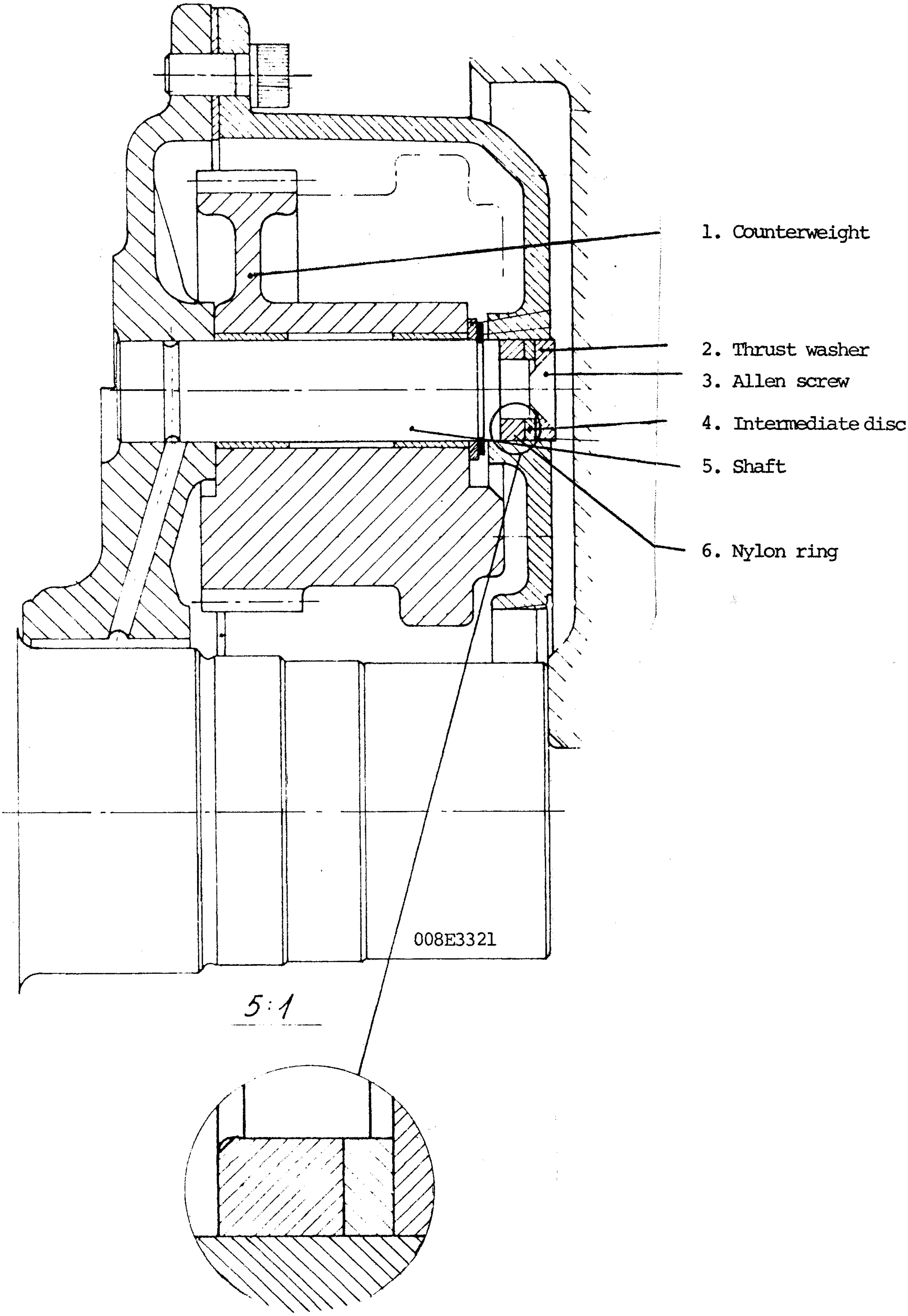
Tightening of Shafts for Counterweights

	From eng. No.	To eng. No.	Type No.	Year
DV20	96233		022D0007	1976

As from the above engine number, we have introduced another sort of tightening as indicated on page E 6. The tightening itself is made with a nylon ring which is spanned against the sides of the holes in the cover. Note especially the fitting of the nylon ring with the chamfering turned towards the shaft. See the enlargement. Carry out the mounting as mentioned above.

Note: If you want to change the old tightening method into the one stated here, it is necessary to replace at the same time the shafts for the rotating weights.

ARRANGEMENT OF COUNTERWEIGHT

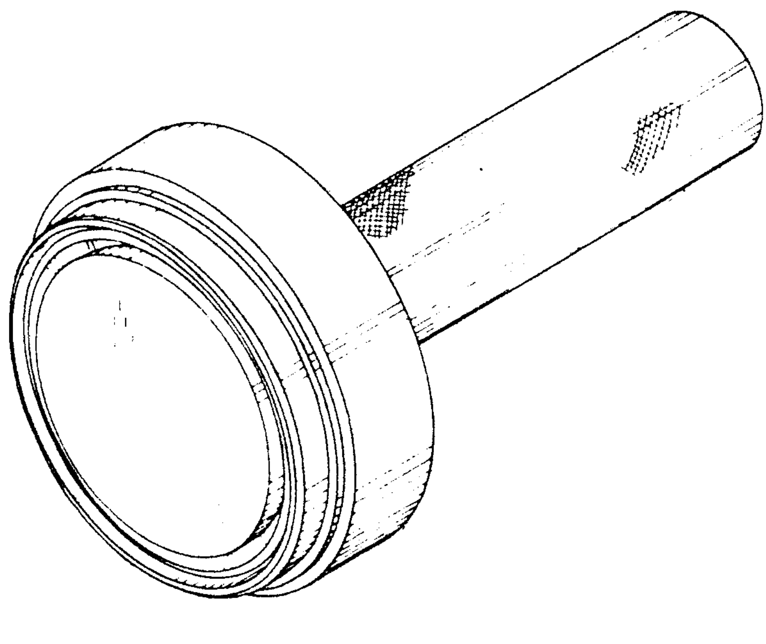


Replacement of oil seal ring in guard

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 (see section D page 3).
2. Dismount guard for counterweights.
3. Dismount counterweights (see page E 3).
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 with raised hand start on 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 kgm (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 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, see page E 6.

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

Section F

Raised Hand Start

CONTENTS

Raised Hand Start on Front Edge

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85000		4402.4.A	1973
DV20	92000		4402.1.D	1973

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85000		4402.2.A	1973
DV20	92000		4602.B	1973

Raised hand start on the front edge is standard on DV10 and DV20, 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 correct tightness.

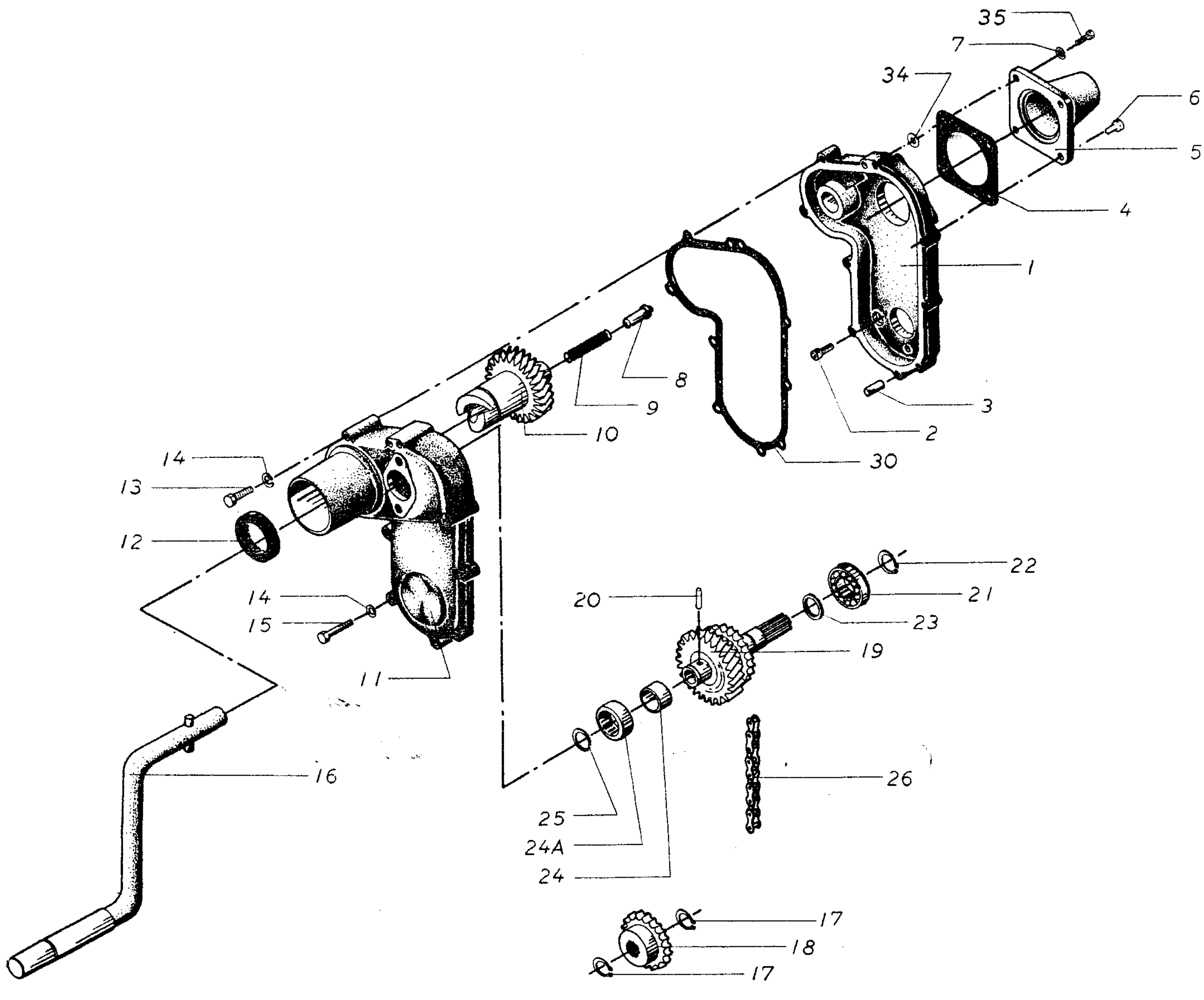
However, if noise from the chain box should occur, this may be due to wear and tear on the chain.

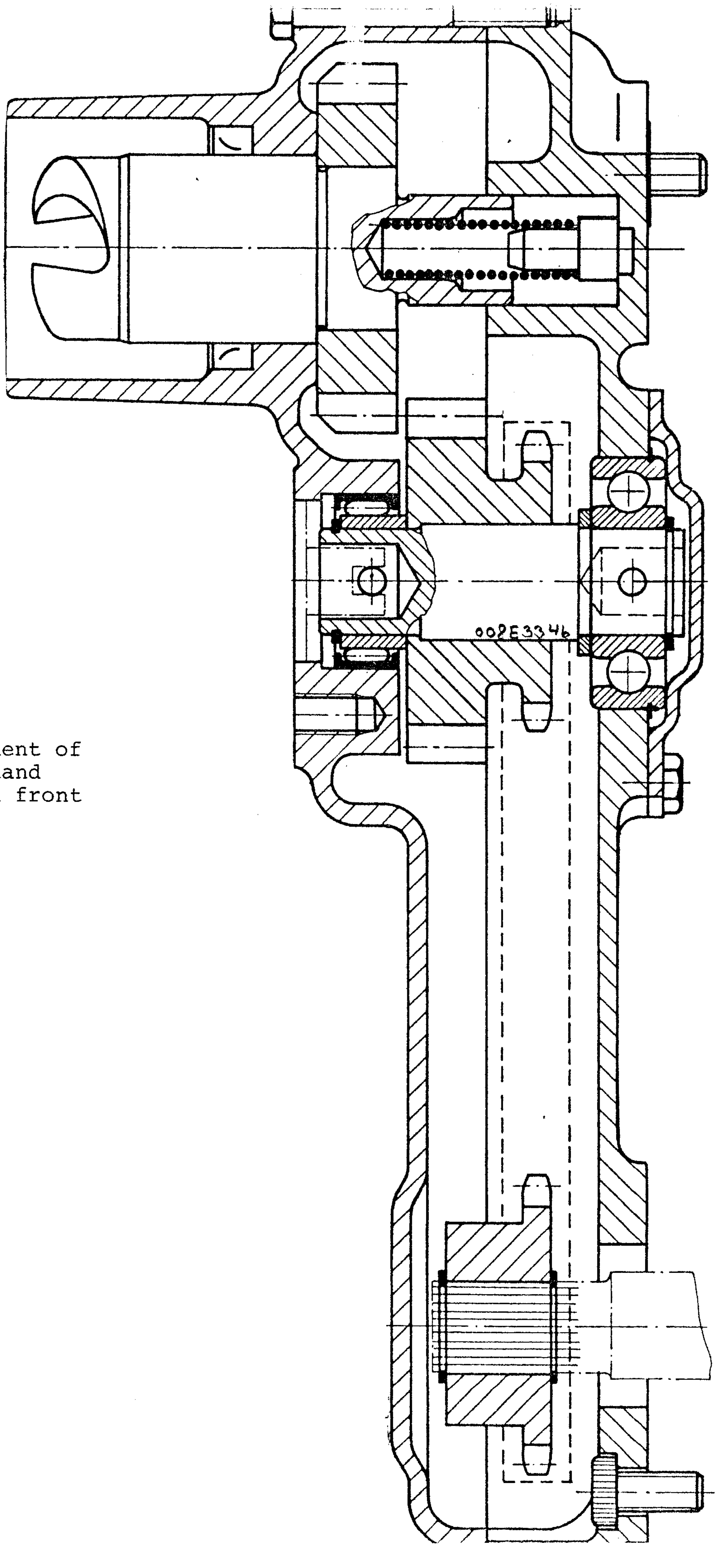
The normal length of the chain is <u>438 mm</u> and must max. have a increase of the length to <u>440 mm</u>. This corresponds to a center distance between the gear-wheels of <u>133 mm</u> and <u>134 mm</u> respectively.

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 ring of 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 kgm (6.5 - 7.23 ft.lbf.).



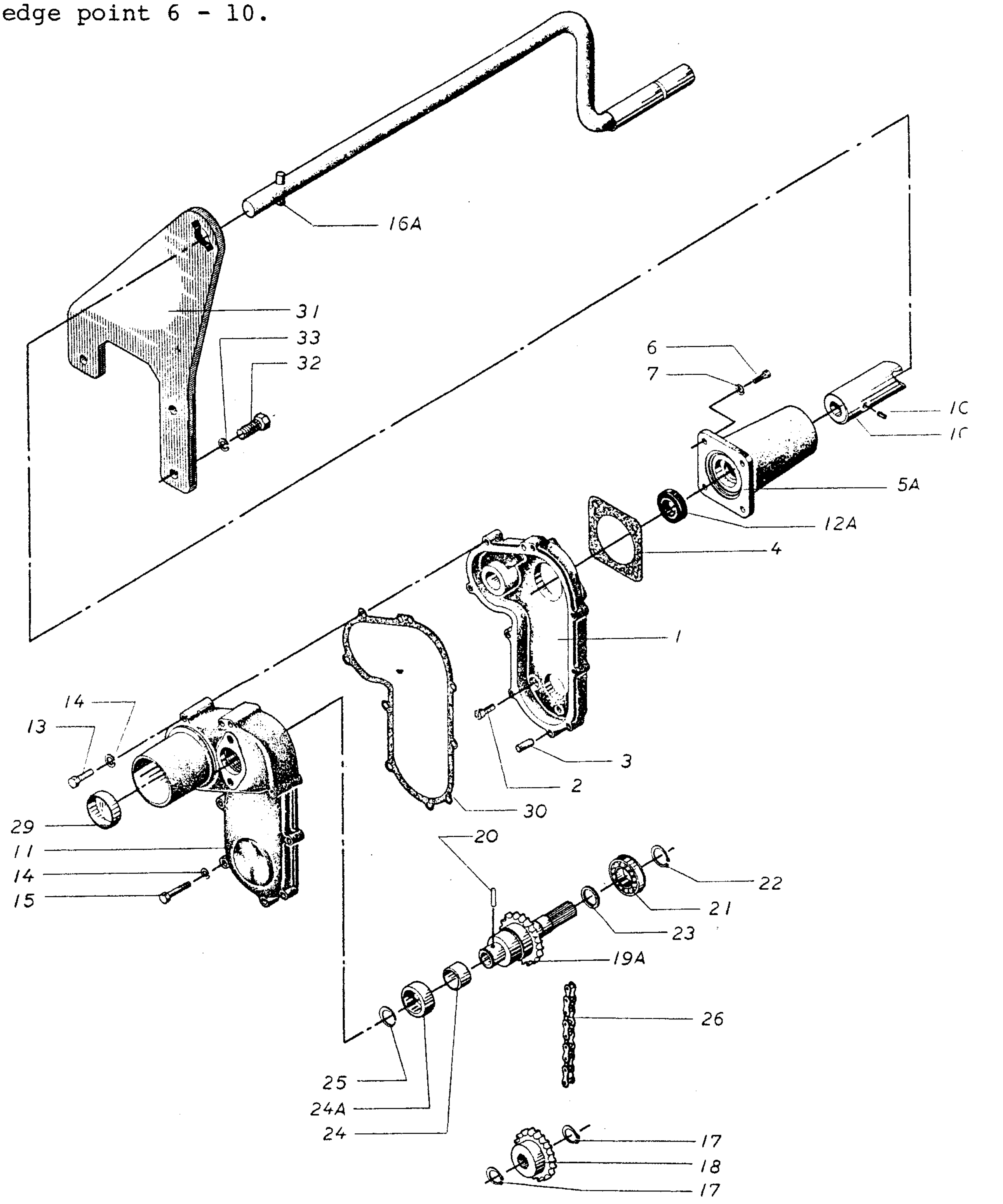


Arrangement of raised hand start on front edge

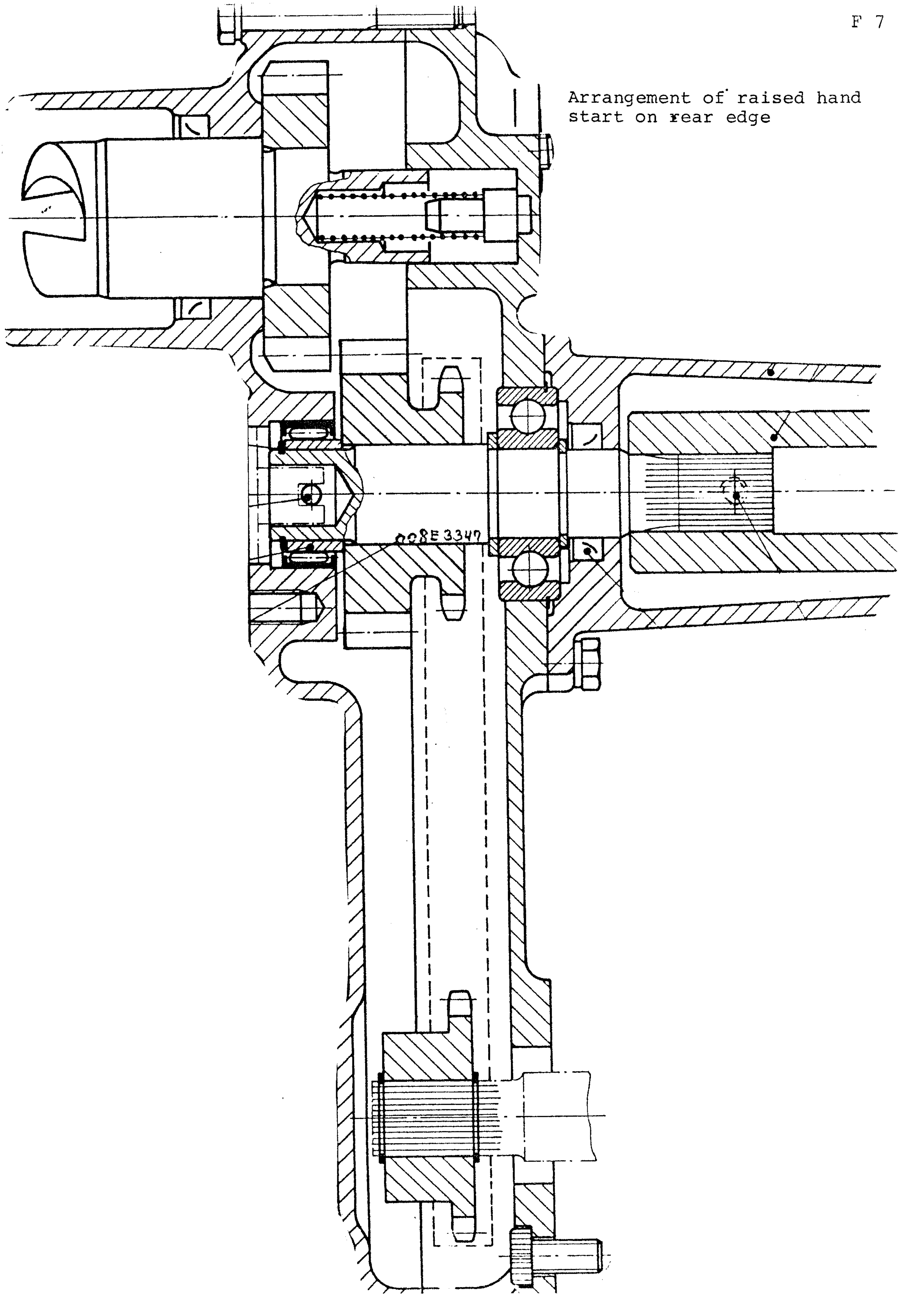
Dismounting of Raised Hand Start on Rear Edge

1. Remove the handle, 16 A.
2. Dismount the cooling water pump when the water has been drained off the engine and inlet and exhaust pipes have been removed.
3. Dismount the bolts 13 and pull off front chain box half 11.
4. Dismount the outer ring of the needle 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



Section G

Rear End Cover

CONTENTS

	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	85967		4400.1.E	1973
DV 20	92447		4600.1.C	1973

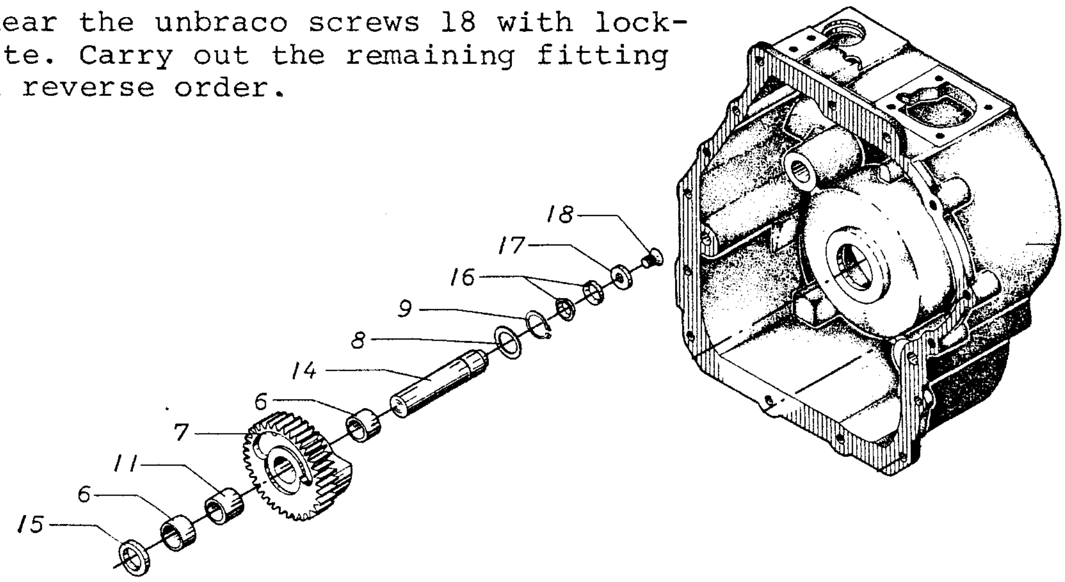
The rear end cover of the engine is made from cast iron. The built in fuel pump is placed on the top side of the rear end cover. Further the revolution control is incorporated in the cover. Besides the injection timing control, which is built on in continuation of the camshaft, is placed in the rear 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 fuel filter to fuel pump and from fuel pump to fuel valves. Remove 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 locktite. Carry out the remaining fitting in reverse order.



Removal of Rear Counterweights

1. Remove rear end cover.

2. Remove the seeger-ring 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.

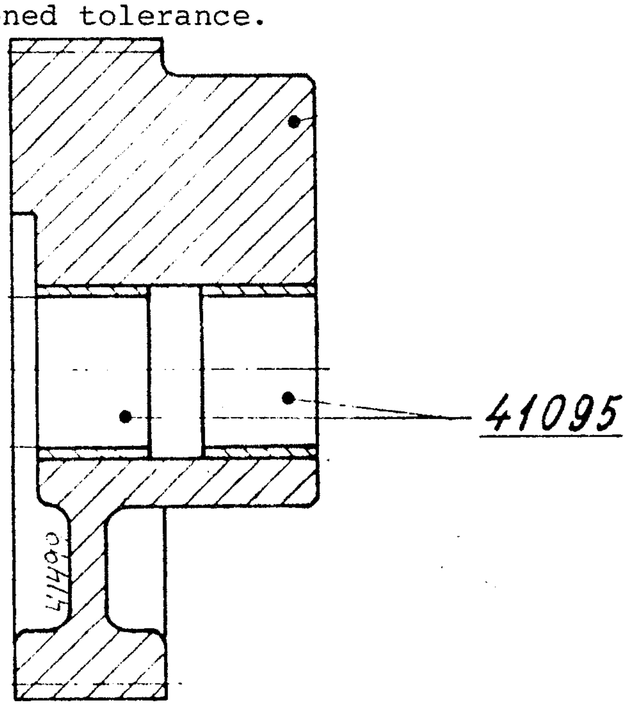
Exchange as follows:

1. Remove the counterweight.

2. Press out the bearings No. 41095 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 H7 (20.000 - 20.021). 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 E 4 and E 5.

Tightening of Shafts for Rotating Weights

	From eng. No.	To eng. No.	Type No.	Year
DV10	203612		021D0007	1976
DV20	96233		022D0007	1976

From the above engine numbers a new form of tightening has been introduced, as stated on pages E 6 and G 4. The tightening in itself is carried out by means of a nylon ring which is to be fitted towards the surfaces in the cover. Especially note the fitting of the nylon ring with the chamfering facing the shaft. See the enlargement. Carry out the fitting as mentioned above.

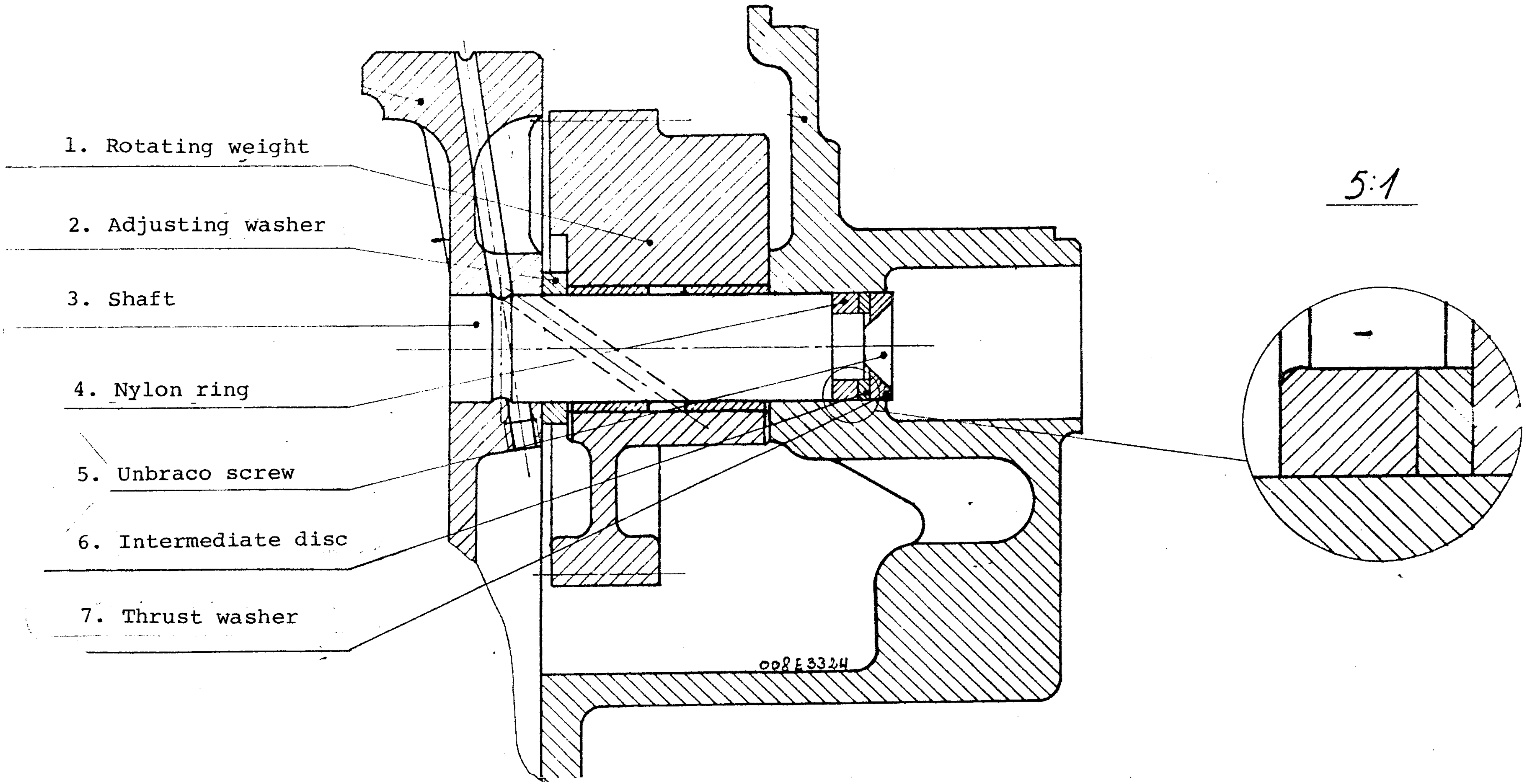
NOTE! If you want the old method of tightening changed into the one stated here it is necessary at the same time to exchange the shafts for the rotating weights.

	From eng. No.	To eng. No.	Type No.	Year
DV10	85000	203612	021D0007	1976
DV20	92000	96233	022D0007	1976

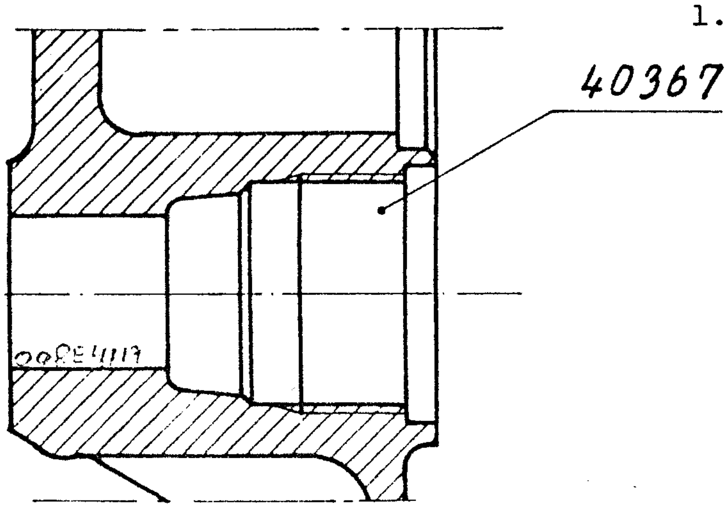
For engines with serial numbers within those mentioned above it will be possible to prevent lubricating oil leakages by fitting seal rings in the rear end cover.

The necessary procedure is stated on page G 7.

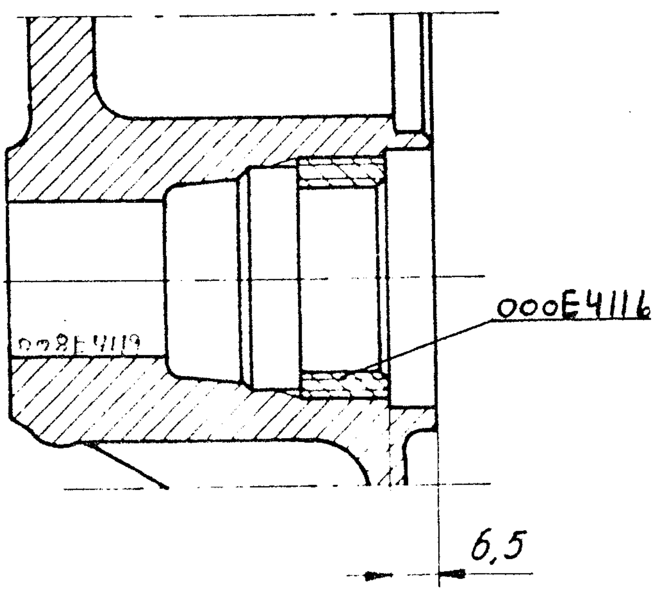
Arrangement of Rotating Weights



Tightening of Pipe Plugs in Rear End Cover

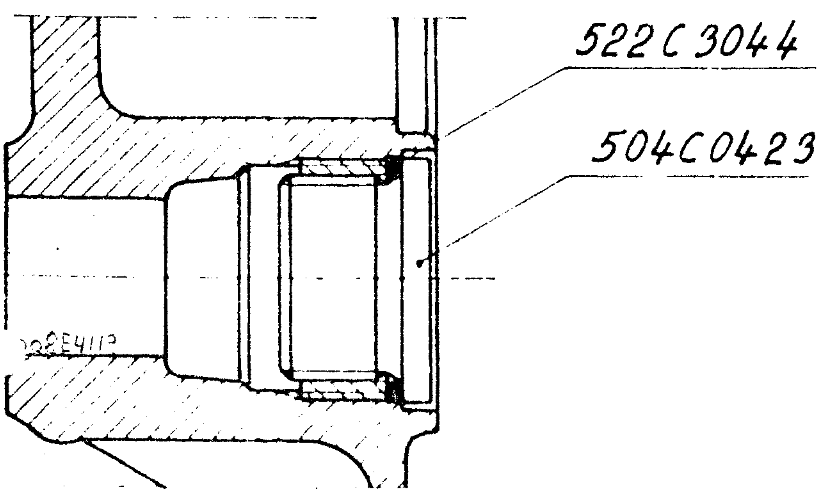


1. Remove gear (see page R)
Remove old pipe plugs (tool: 17 mm allen top). Cut up the thread with a 1" WRG threaded pin and clean thoroughly with a fat-soluble liquid - the thread must be meticulously clean.



2. Smear READIT 5850 on the threaded piece No. 000E4116 on the external thread and fit it by means of the tool No. 008E4224. The threaded piece must be tightened the whole way down.

The sealing surface should be trued to a depth of 6.5 mm with tool No. 008E4223.



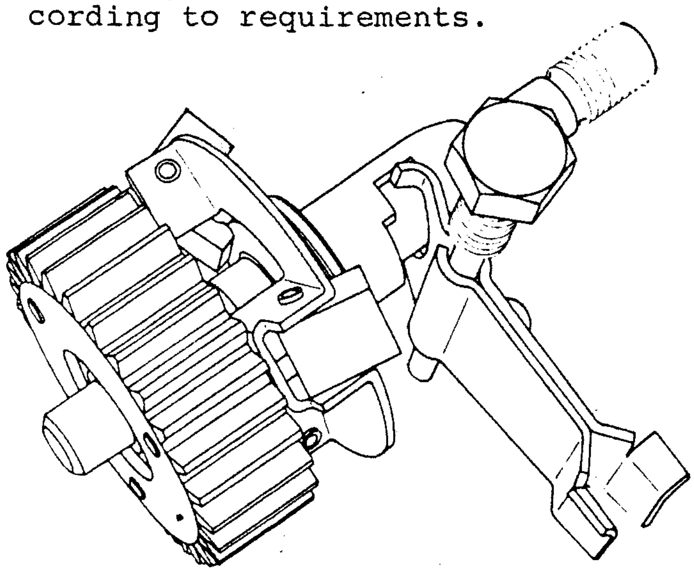
3.
Cut up the inside thread with a 3/4% WRG treaded pin. Fit the copper ring No. 522C3044 and the unbraco screw No. 504C0423 and tighten them.

	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	85967		4400.1.E	1973
DV 20	92447		4600.1.C	1973

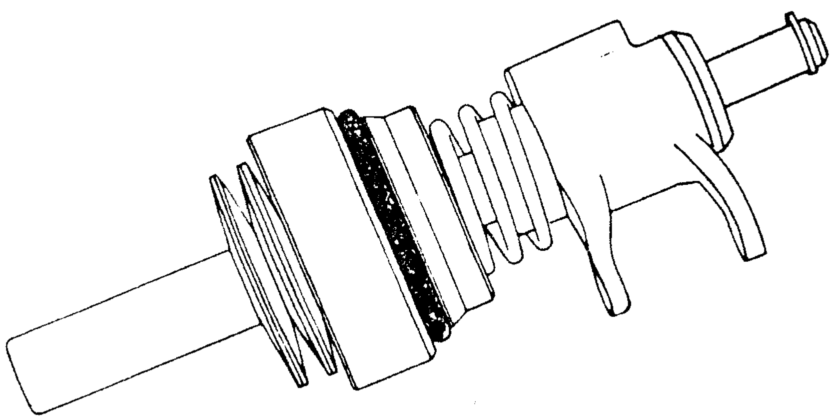
Governor system

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.



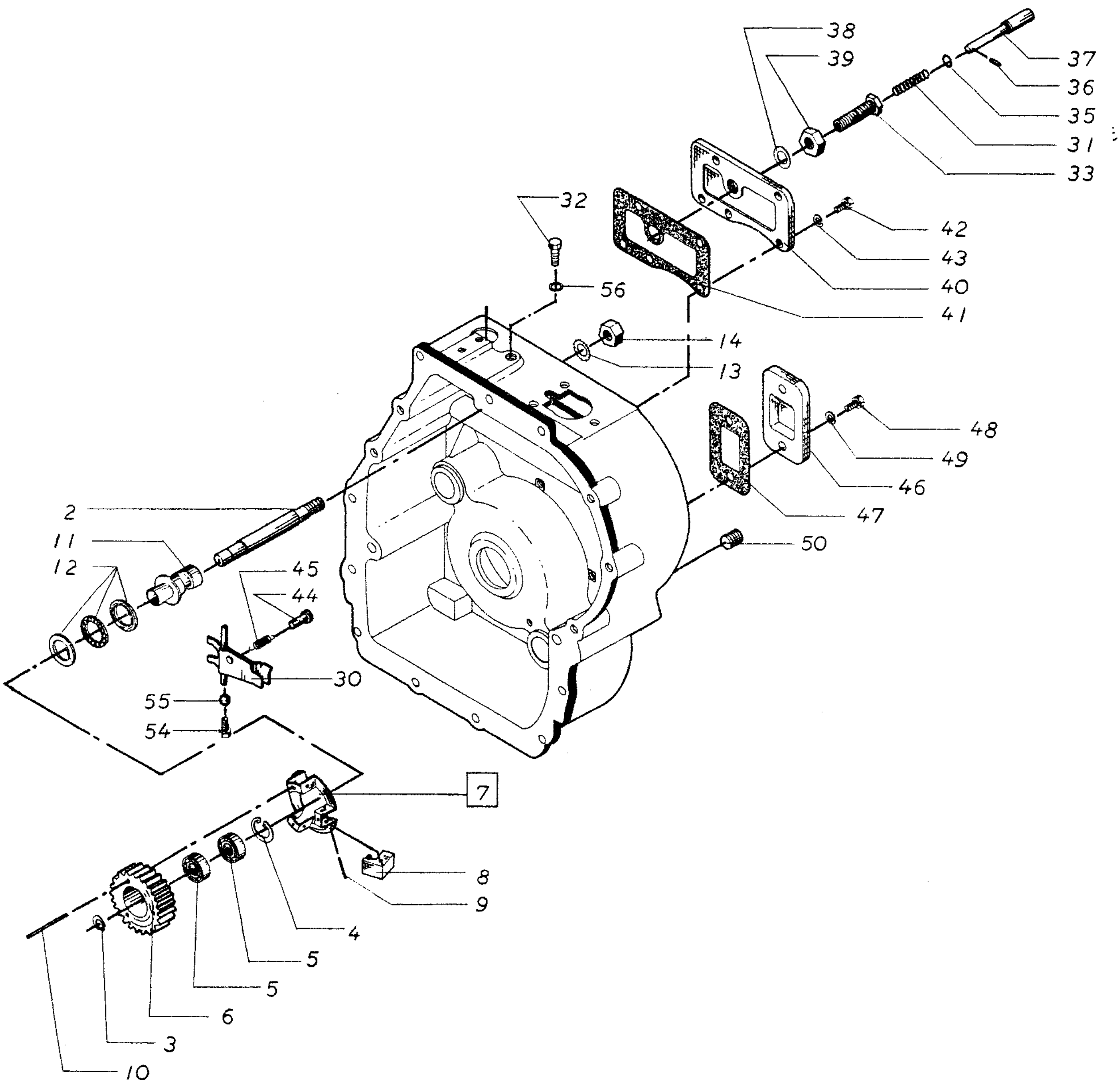
Centrifugal governor



Manual governor

Dismounting of Centrifugal Governor

1. Dismount rear end cover (see page G 3)
2. Remove the seeger-ring 3 and pull off the gear-wheel 6 with the centrifugal governor 7.
3. Remove the seeger-ring 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.



Fitting 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 - 7.5 kgm (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 the adjusting screw 54 with lock-tite 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 G 9. 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.

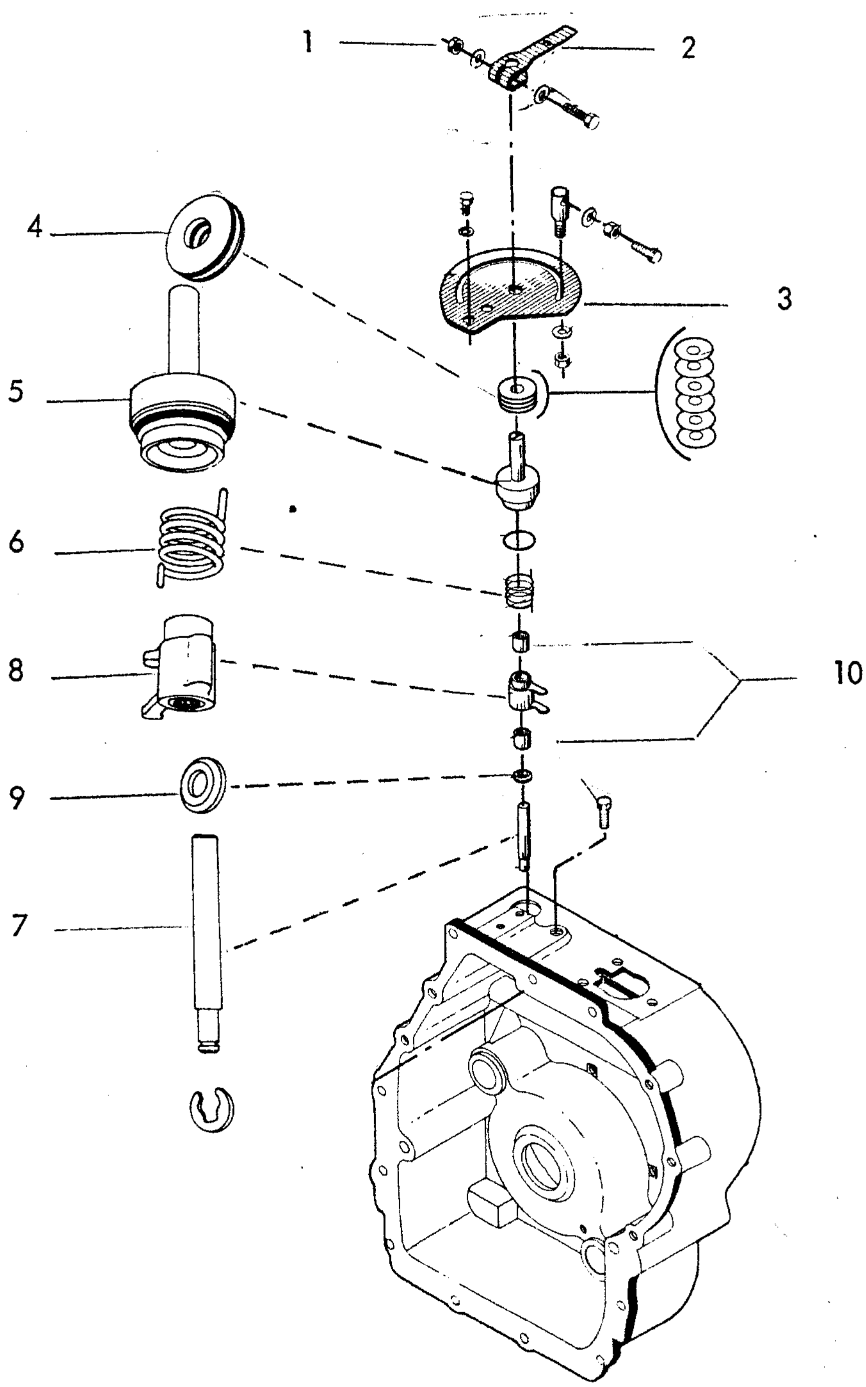
5. Fit the gear-wheel ball bearings 5 in the gear-wheel and lock them with the seeger-ring 4.

6. Fit the gear-wheel 6 on the shaft and fit the seeger-ring. The arm of the centrifugal blocks must lie true against the thrust bearing as shown on page G 9 .

7. Fit the end cover.

Dismounting of Manual Governor

1. Dismount the rear end cover (see page G 3).
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 disk 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 needle 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 G 9) 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 3 different executions depending on which maximum revolutions that are required on the engine.

   Thickness of spring 2.0 mm (0.0787 inch) .. 1500 r.p.m.

   Thickness of spring 2.2 mm (0.0866 inch) .. 1800 r.p.m.

   Thickness of spring 2.4 mm (0.0945 inch) .. 2500-3000 r.p..
5. Mount the shaft so that the spring wire catches in the hole in the bottom of the shaft.
6. Mount the disk springs.
7. Place the regulating quadrant and tighten it with a torque of 2 - 2.3 kgm (14.5 - 16.6 ft.lbf).
8. Mount the governor arm and tighten it with a torque of 0.9 - 1.0 kgm (6.5 - 7.23 ft.lbf).

	From eng. No.	To eng. No.	Type	Year
DV10	205241	-	021D0007	1978
DV20	99661	-	022D0007	1978

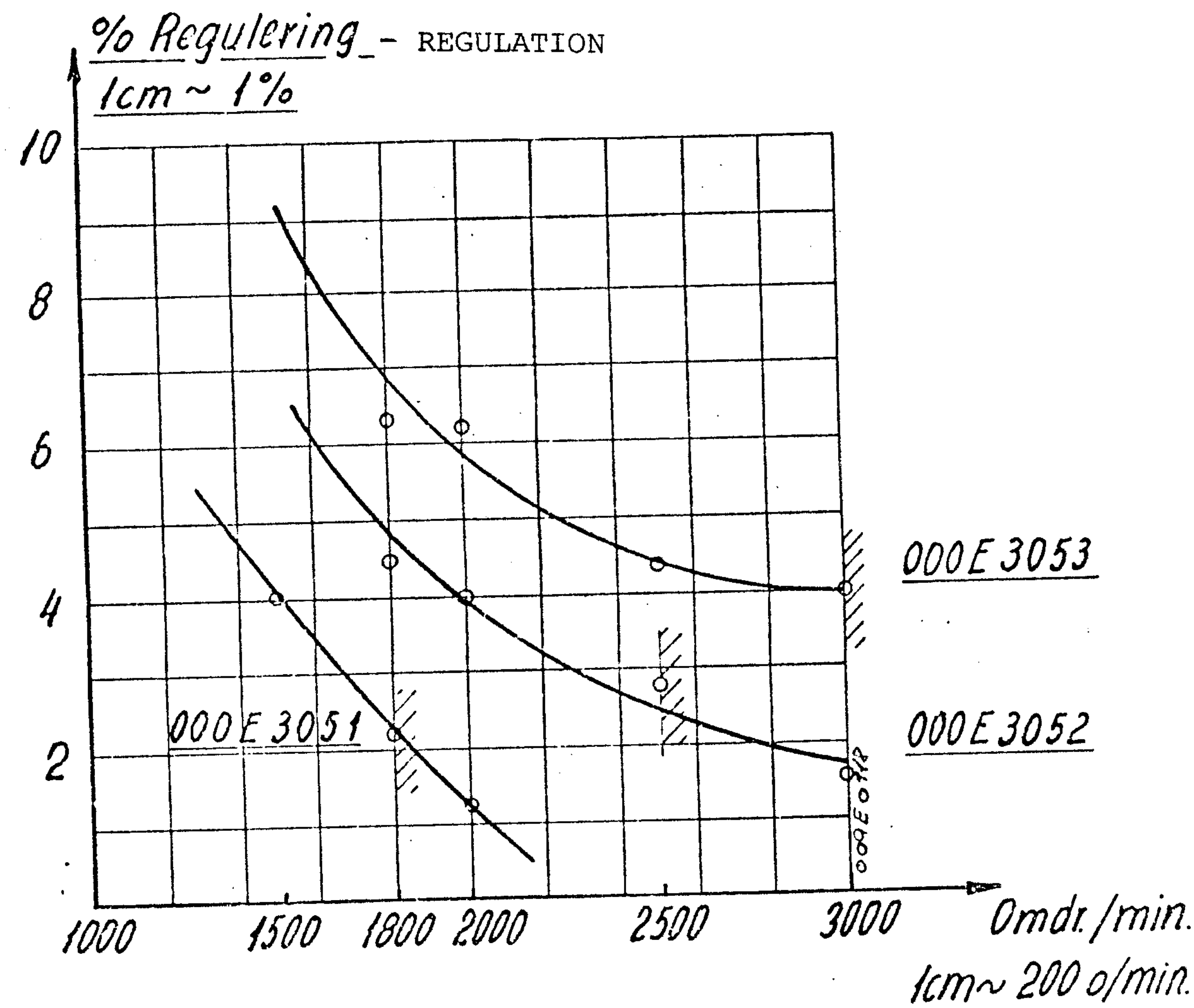
From the above engine numbers a change of the shaft for manual governor (pos. 5 page G 11) has been made.

The change has been made in order to improve the friction and tightening conditions.

The shaft has been prepared for fitting of a conical ring of plastics (hostaform).

The new shaft and ring of plastics can direct replace earlier executions.

Characteristic for Governor Spring



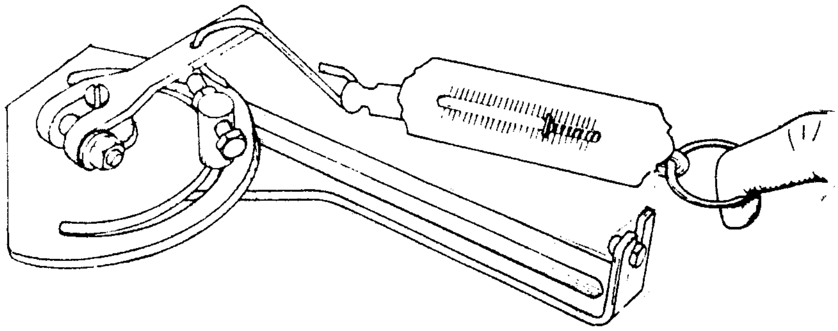
o/min = r.p.m.

The below-mentioned can be used when choosing spring:

Drawing No.	Wire Dia.	1500 rpm	1800 rpm	2000 rpm	2500 rpm	3000 rpm
000E3051	2.0	x				
000E3052	2.2		x	x		
000E3053	2.5				x	x

Use drawing No. 000E3053 for marine engine

Adjustment of Governor System



1. Adjust the tightness of the governor arm by altering the number of disk springs below the 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 kg (13.2 lb) at direct control and 4.5 kg (9.9 lb) at remote control.

2. Start the engine and regulate it down to idling, 900-1200 r.p.m.

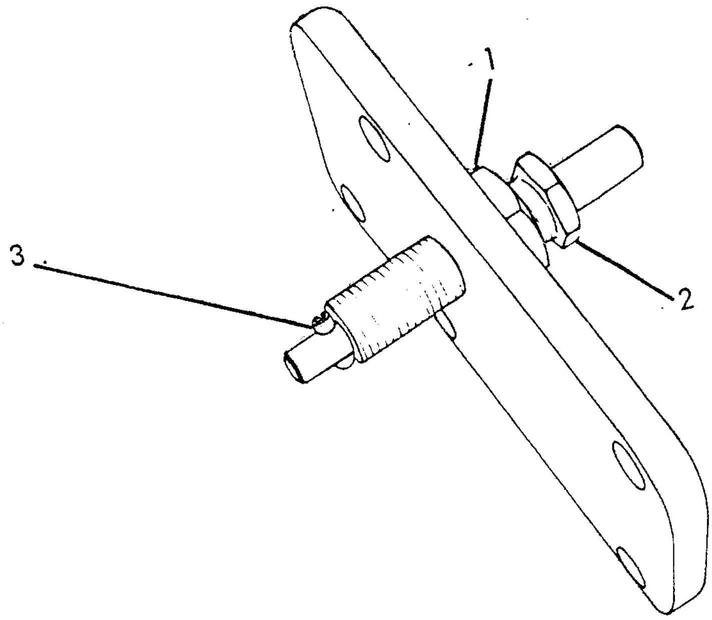
   Loosen the nut on the governor arm and turn the governor arm towards the stop for idling, and tighten with a torque of 0.9 - 1.0 kgm (6.5 - 7.23 ft.lbf).

3. Turn the governor handle to the right until the engine runs 3150 r.p.m. idle.

4. Loosen the counter nut on the regulating screw and adjust the regulating 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



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 headles screw 2 4-5 threads from the counter nut 1.
2. Start the engine and load it with 10 and 20 HP respectively at 3000 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 1/4 turn back before the counter nut is tightened.

This applies to engines up to and including DV10 No. 89156 and DV20 No. 93687.

For engines after these numbers stop magnet is used (page 8).

Section H

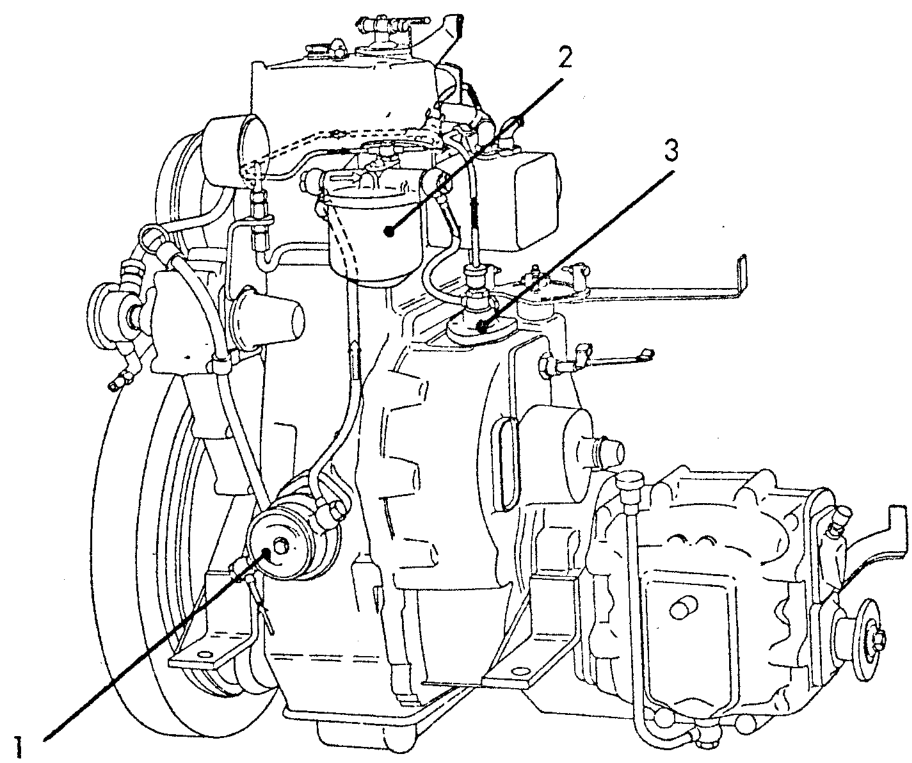
Fuel System

Contents

The fuel system

The fuel is common gas oil contained in a fuel tank from where it is drawn by the lift pump which pumps it through the fuel filter 2 to the fuel pump 3. The fuel pump passes the fuel on to respective cylinders with a pressure of 150 kg/cm^2 through the fuel valve which is placed on the right side of the cylinder head.

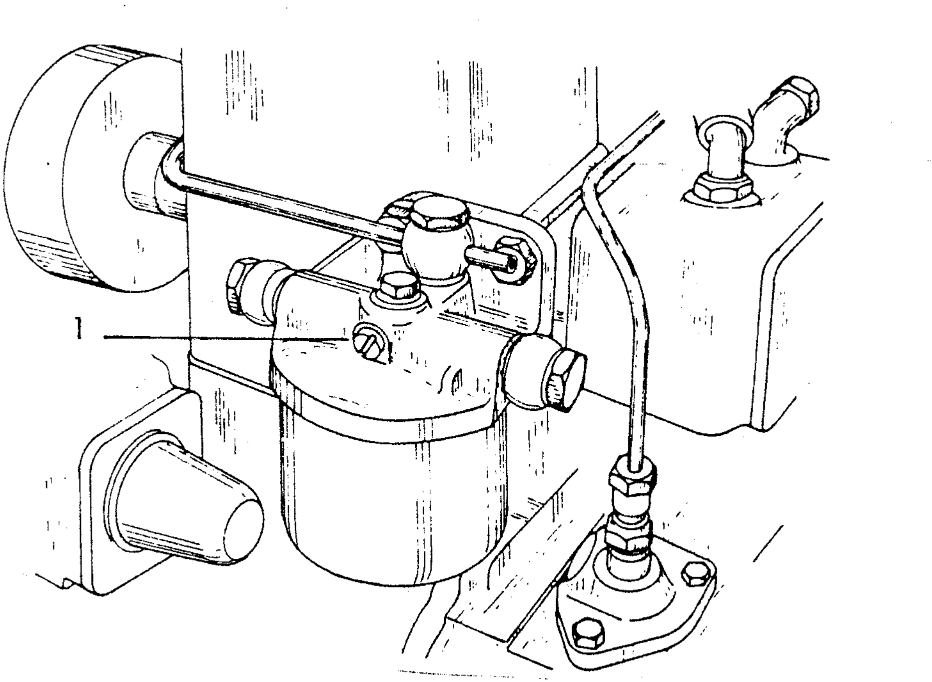
By means of the handle of the lift pump it is possible to pump pressure to the fuel system while the engine is stopped (used for bleeding of the fuel system).

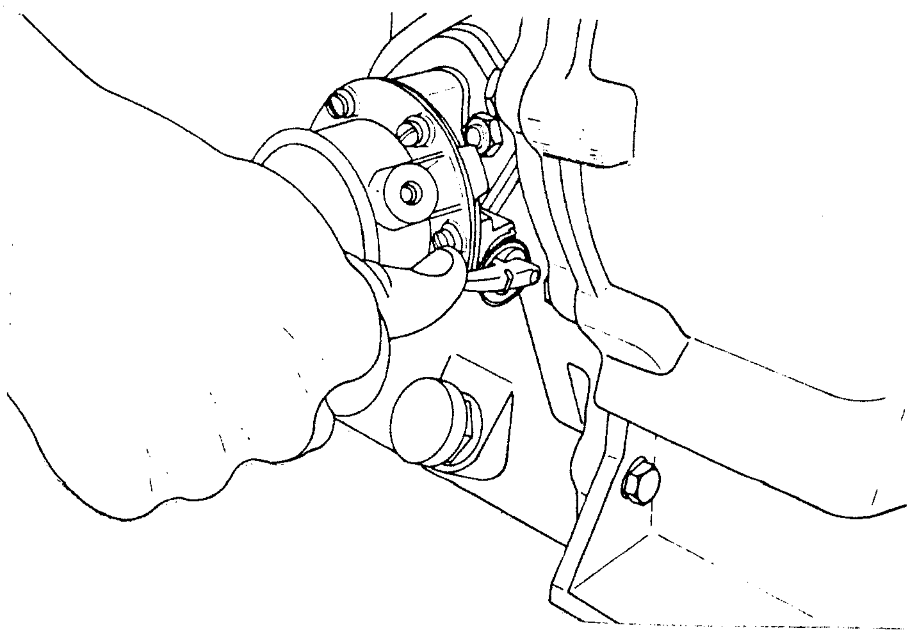


Bleeding of the Fuel System

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

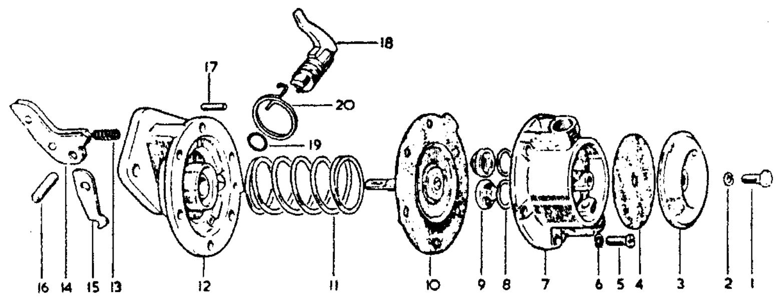
1. Loosen the slotted screw 1 on the fuel filter.
2. Pump with the handle on the fuel lift pump until the fuel flow is without air bubbles at the slotted screw. Then tighten the slotted screw.
3. Loosen the fuel pipe union nut on the fuel valve. Turn the engine by means of the handle or the starter. 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.





	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	85000	205011	4400.1.E	1973
DV 20	92000	99100	4600.1.C	1973

The fuel lift pump is a diaphragm pump of AC-Delco make type 7971291 which is driven by the camshaft or manually by means of the handle (used for bleeding of the fuel system).



The fuel pump can be dismantled as shown on the drawing, but in cases where more parts than for instance the valves or the diaphragm must be replaced it will often pay to mount a new pump as these are very cheap to purchase.

Dismounting and Mounting of the Fuel Lift Pump

1. Dismount the inlet and exhaust pipe of the pump.
2. Unscrew the bolt marked 1.
3. Unscrew the bolts marked 5 and dismount the pump cover marked 7.
4. Dismount the valves marked 9 by removing the three burrs holding these.
5. Dismount the spring marked 20 and pull out the pin marked 17. Dismount the hand pump arm marked 18.
6. Knock out the pin marked 16 and dismount the pump arm marked 14 and the connecting rod marked 15.
7. Now dismount the diaphragm marked 10 and the spring marked 11.

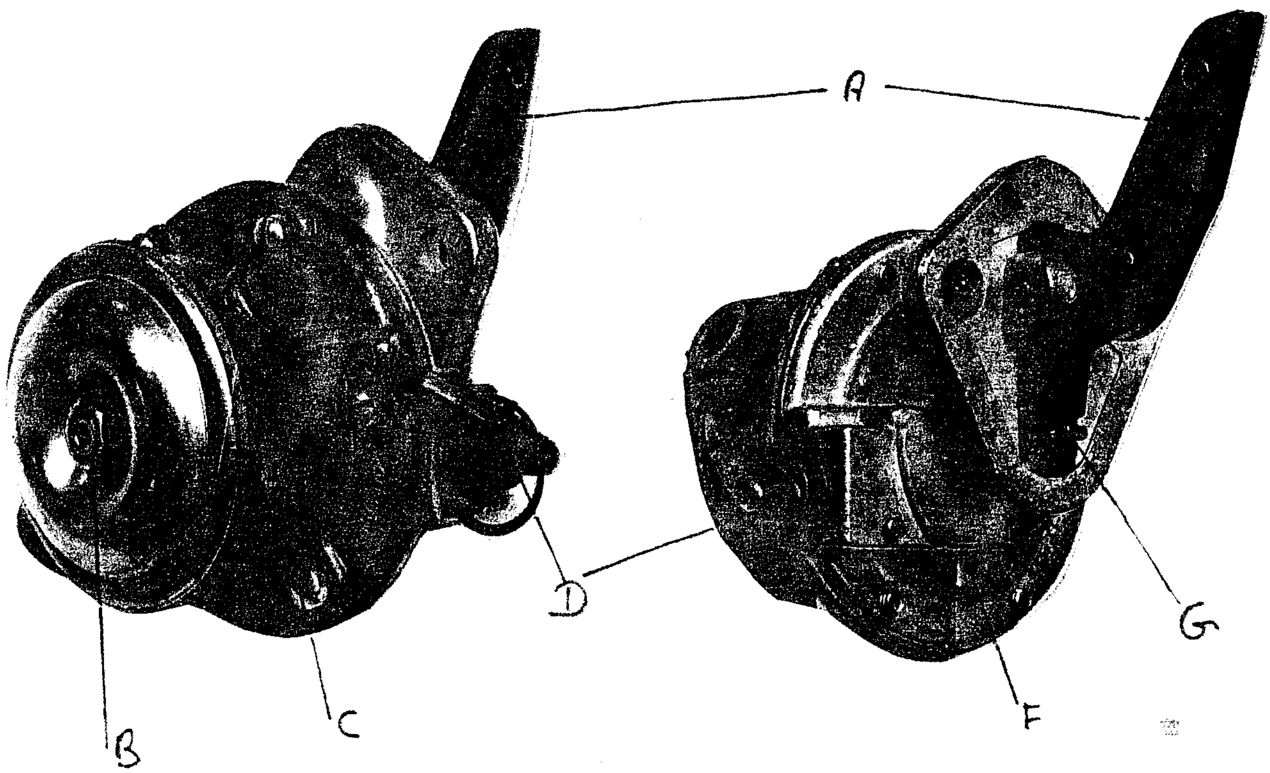
The mounting takes place in reverse order and observe that at mounting of new valves the valve flap at the socket marked N must face the diaphragm. Turn the other valve opposite. Lock the valves with three burrs.

Repair of Fuel Lift Pump Type AC-DELCO

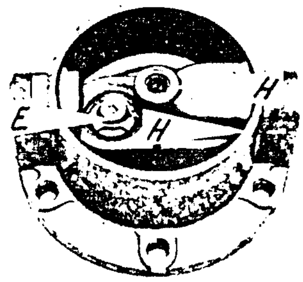
Asthe fuel lift pump type AC-DELCO previously used has been replaced by type S.E.V.-Marchall, the repair instructions are indicated for the AC-DELCO type.

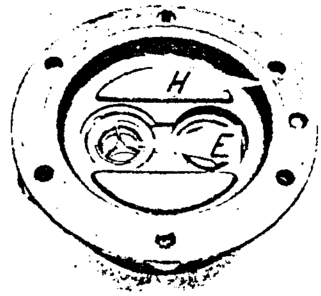
"

Remedy of Leaks



1. Remove the fuel lift pump from the engine as mentioned on page H 3.
2. Actuate the arm for manual operation (D) of the fuel lift pump. This should make the pull rod (G) move outwards. If the pull rod does not move or is only moving sideways put the lift pump aside for dismantling and repair.
3. The lift pumps the manual function of which are in order should be placed in a clamping tool which holds the pump arm.
4. Remove the cover by loosening the screw in the middle (B).
5. Remove the valve section by loosening the 6 slotted screws (C). If there are noticed flaws which prevent tightening, discard the lift pump, otherwise proceed with point.





6. Smear the sealing surfaces (H) of the valve section with liquid jointing. E.g. permatex or curil.

   The application must be carried out very carefully so that only the necessary quantity of jointing material is applied and pollution of the valves (E) is avoided.

7. Refit the valve section and cover.

8. Plug the drain hole (F) at the bottom of the pump with a plug rivet No. 520D4260.

9. The sealing surfaces of the inlet and pressure studs of the fuel lift pump should be smoothed before fitting on the engine.

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	205012		10-37	1977
DV20	99101		20-41	1977

From the above engine numbers a new fuel lift pump of make S.E.V. Marchal type 70 BA has been introduced.

This fuel lift pump is shown on page H10.

Technical Data of the Fuel Lift Pump

Suction Line

Max. length	:	3500 mm
Max. suction head	:	300 mm
Suction hose, min. inside diameter	:	⌀6 mm

Pressure Pipe

Max. length	:	640 mm
Max. height	:	300 mm
Pressure pipe, min. inside diameter	:	⌀6 mm

Counter Pressure

At 60 l/H	:	0.070 kg/cm (0.69 Pa)

As to price, efficiency and life, this pump is designed as compact and simple as possible. If great repairs should prove necessary, the fuel pump must be replaced. Small repairs of filter, diaphragm and springs may, however, be carried out by means of a repair kit.

Disassembly of Fuel Lift Pump

As stated on page H 10 this type of pump is fitted with a built-in suction filter. This filter has been fitted to protect the diaphragm, inlet and pressure valve of the fuel lift pump against impurities in the fuel.

Cleaning of Suction Filter

Loosen the two slotted screws fixing the pump cover.

BE CAREFUL!! The spring may jump up.

Now the filter can be removed to be cleaned, perhaps exchanged.

Refit in reverse order. Do not forget to fit the spring correctly as shown on the sectional drawing.

Exchange of Diaphragm

In case of failure of the delivery function of the fuel lift pump, the cause may either be due to a choked suction filter or a defective diaphragm.

Exchange Diaphragm as follows:

1. Remove the inlet and outlet pipes of the fuel lift pump.

2. Dismantle pump housing and valve housing by loosening the six slotted screws.

3. Now the diaphragm can be removed to be examined and perhaps exchanged.

4. While the diaphragm is removed, check the rubber sleeve, which tightens round the pump shaft, to see if it is defective.

Before the fuel lift pump is assembled, examine all sealing surfaces for any unevennesses.

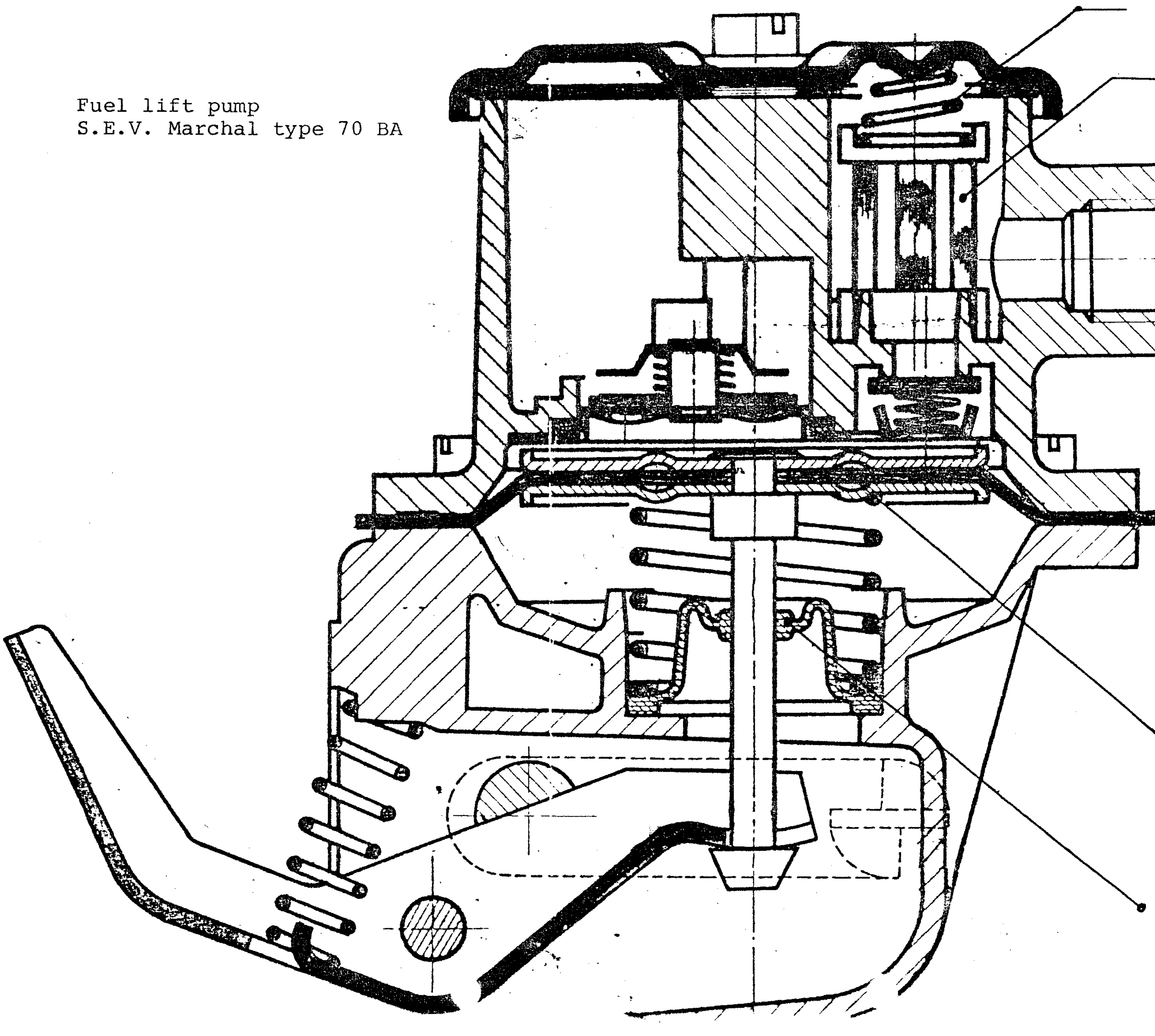
Refit the fuel lift pump in reverse order and bleed the fuel system.

Please note that the vent hole in the throttle screw of the fuel lift pumps must be bored to 1.5 mm.

If it has been necessary to remove the fuel lift pump from the engine an original gasket must be used between engine block and fuel lift pump when fitting.
Gasket: Duroid - 0.4 mm.

The S.E.V. Marchall fuel lift pump cannot be used in substitution of the fuel lift pump A.C. Delco.

Fuel lift pump
S.E.V. Marchal type 70 BA



Fuel Filter

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85000	89156	4400.1.E	1973
DV20	92000	93637	4600.1.C	1973

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	200.007	-	10-23	
DV20	93.888	-	20-22	

Within the above engine numbers a replaceable fuel filter element is used.

This filter element is made from special paper and cannot be cleaned. The filter element does not stand water and has to be protected against this, e.g. by fitting a water separator.

Fuel Filter Element: BOSCH No. 04500 15014

The purpose of the fuel filter is to remove dirt from the fuel when it comes into the fuel pumps. It is of great importance that the fuel is cleaned thoroughly as dirty oil will damage both fuel pumps as well as nozzles in a short time.

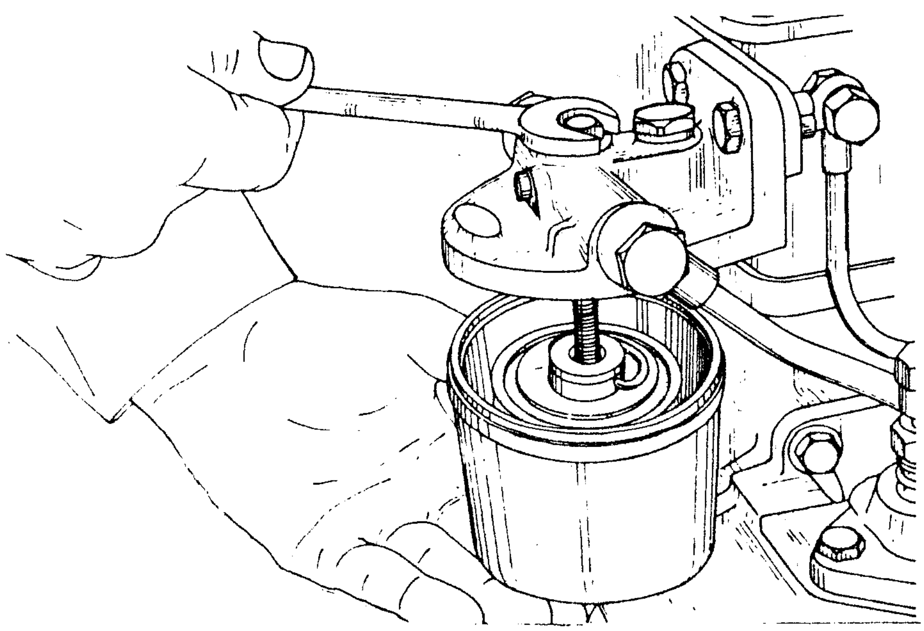
Exchange of Fuel Filter Element

1. Remove the filter house by loosening the centre bolt (see fig.).

2. Remove the filter insert and exchange it.

3. Clean the filter house and fit new insert. Remember to fit the gasket correctly.

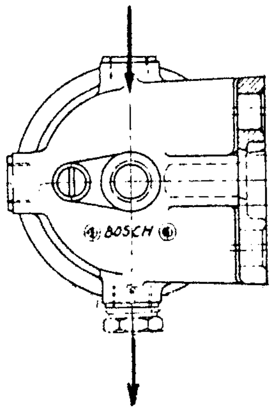
When the filter has been replaced vent the fuel system.



	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	89156	200006	021D0601	1974
DV 20	93637	93887	021D0601	1974

BOSCH type FJ/DB 1 W 4/101

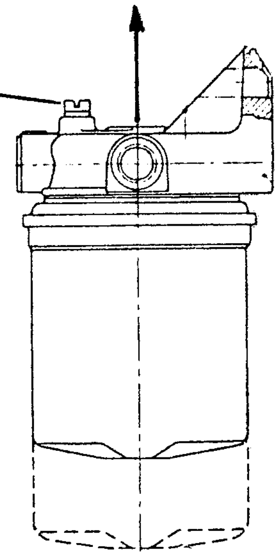
Inlet from lift pump



Return pipe to tank

Outlet to fuel pump

Bleeder screw



From the above engine Nos. the fuel filter has been altered to a throw-away filter.

As shown on the above drawing the outlet from the filter to the fuel pump is now from the top of the filter whereas the return pipe goes from the side of the filter cover.

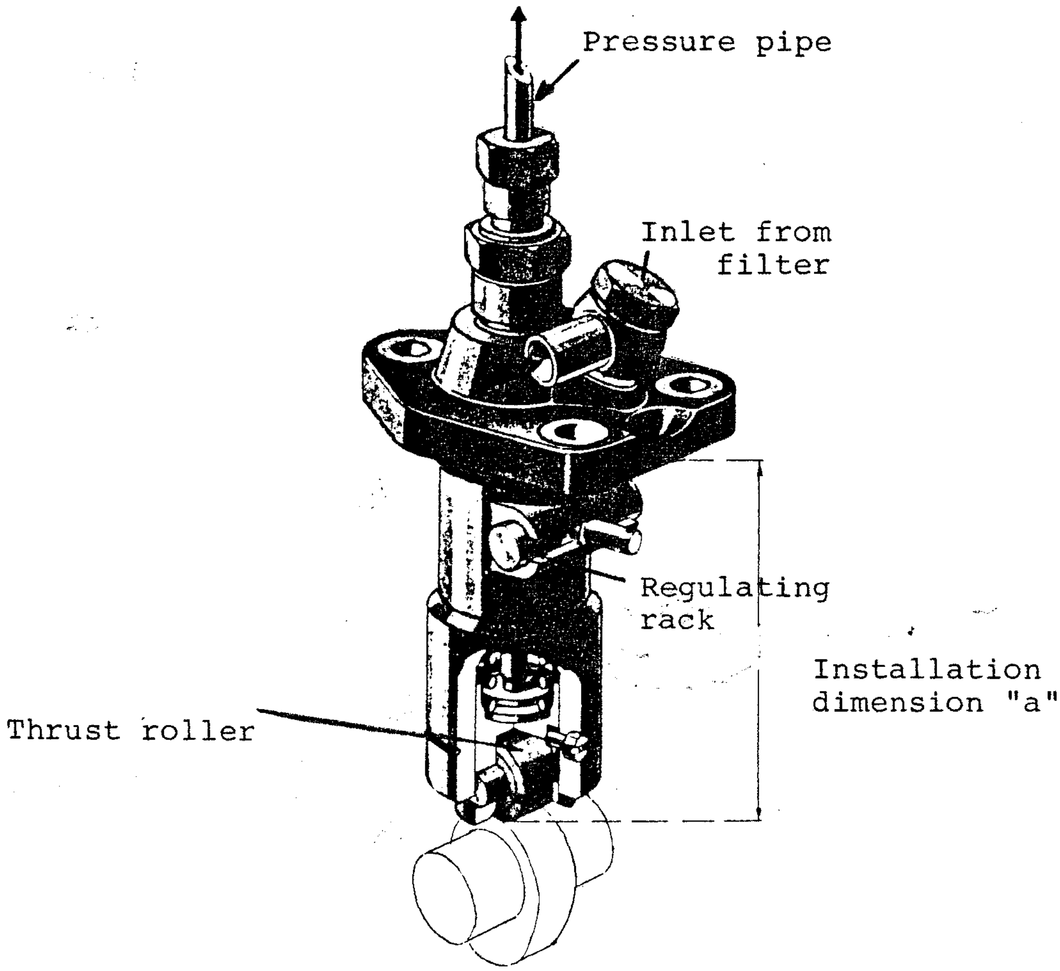
Replace the fuel filter every 300 working hours or once a year.

After replacement of the filter the fuel system must be bleeded

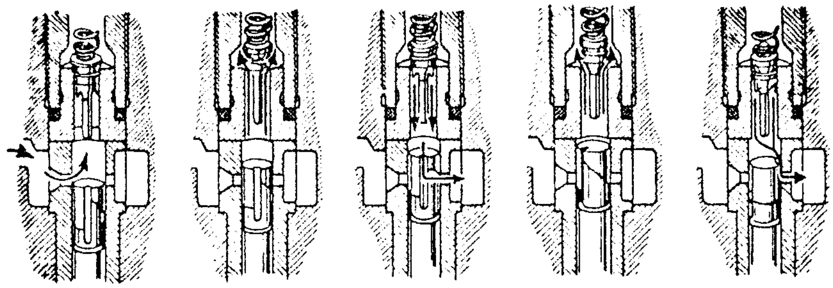
Fuel Pump

	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	85000	205011	4400.1.E	1973
DV 20	92000	99100	4600.1.C	1973

Type: Bosch PFR 1 K 70/8 for DV10



The fuel pump is a single-acting piston pump activated by the fuel cam of the camshaft through a roller guide. A spring built into the pump housing secures that the pump piston and the spring are constantly pressed against the fuel cam.



a. b c d e

The principle of the function of the fuel pump is shown on fig. a - e and is as follows:

Fig. a When the pump piston on the way towards the bottom has uncovered the upper edge of the inlet hole the fuel is led into the pump lining in the direction shown.

Fig. b As soon as the pump piston has passed the upper edge of the inlet hole during the subsequent upward stroke the fuel is under pressure, and when this pressure is equal to the injection pressure (nozzle pressure) the fuel is injected into the precombustion chamber through the fuel valve.

Fig. c The volume of the injected fuel is adjusted by turning the pump piston as the position of its cut-off edge determines when the suction and pressure side of the pump get into touch with each other, by which the injection ceases.

Fig. d Shows the position of the pump piston when the volume of the injected fuel is maximum.

Fig. e Shows when the volume is zero.

Turning of the pump piston is effected by a regulating bushing which at the lower end forms a fork round the lower milled end of the pump piston (the tab) and which is provided with a toothed rim at the top engaged with a rack guided by the governor of the engine.

If the fuel pump is considered to be in disorder according to the section about "Irregularities in operation" dismantle and examine it and follow the description and remedy of the defects mentioned in the section.

Further it can be examined whether the pump piston and the pump cylinder are tight in proportion to each other. This is done by lowering the pump vertically into Bosch test oil 01 61v1 so that the regulating rod is submerged. Then set 1.5 - 2.0 ato to the pump through its inlet socket.

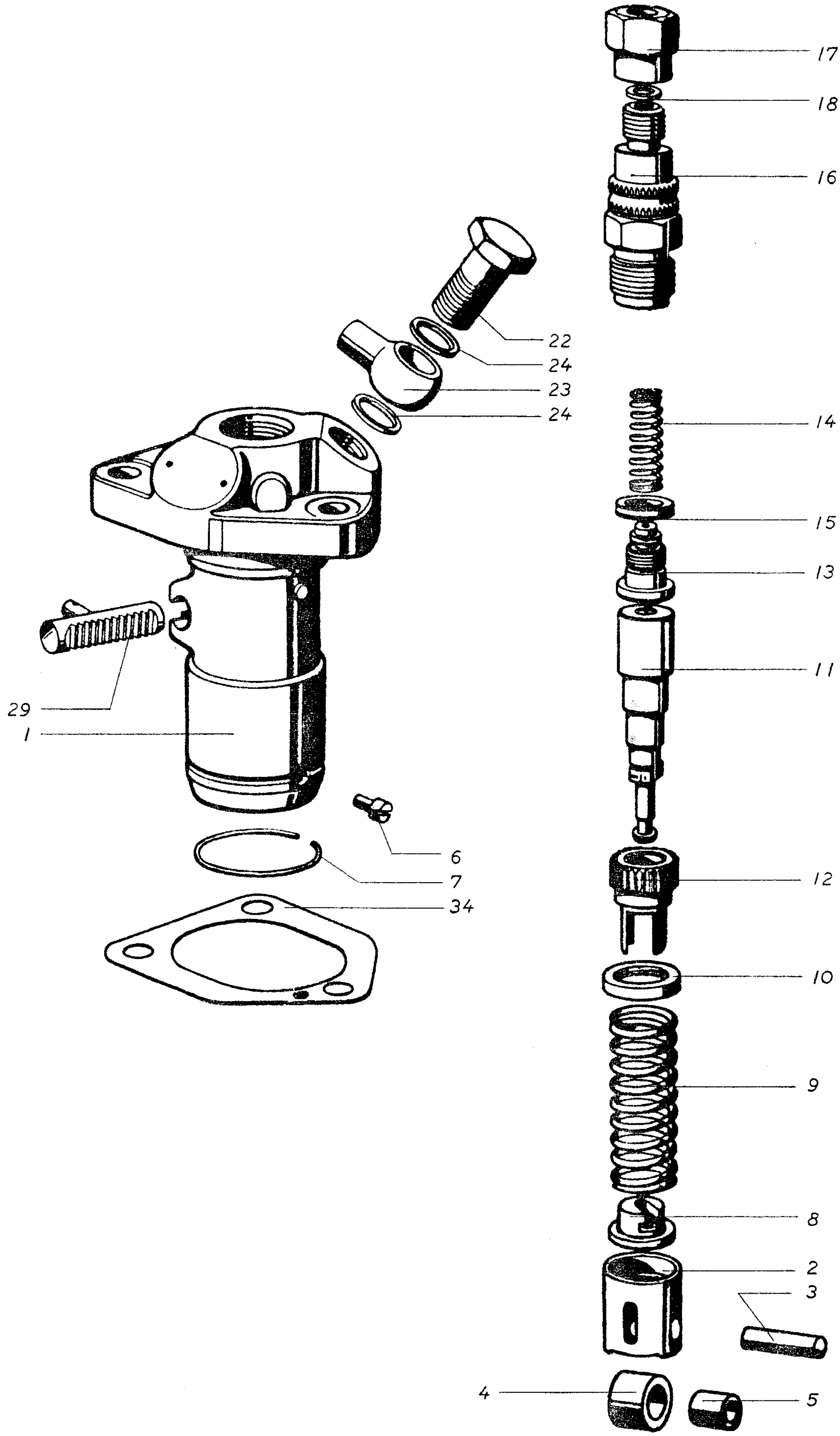
If the pump is tight between the pump piston and the pump cylinder there will not be air bubbles in the oil within 20 - 25 seconds.

Dismounting of the Fuel Pump

1. Remove the fuel pressure pipe from the pump to the fuel valve and the inlet pipe from the fuel filter.
2. Remove the set screws in the tightening flange of the fuel pump.
3. Take out the fuel pump.

Dismantling of the Fuel Pump

1. Unscrew the pressure valve holder 16 (see drawing next page).
2. Take out the spring 14 and the pressure valve 13.
3. Remove the spring lock 7.
4. Press the roller guide 4 into the pump housing and remove the guide pin 6 that is loosely inserted.
5. Then remove the guide bushing 2, the spring guide 8, the spring 9, the ring 10, the regulating bushing 12, the pump piston 11, and the toothed quadrant 29.
6. Push the pump cylinder and the pressure valve seat out of the pump housing 1 above. For this purpose use a piece of hard wood or the like as punch.


17
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5

Assembling of the Pump

When assembling the fuel pump observe the greatest cleanliness, and all parts must be cleaned carefully in pure fuel.

Furthermore, the pump must be assembled according to the marks on the various pump parts.

1. Put the pump cylinder down into the pump housing from above so that the milled slot on the outer side of the cylinder fits over the small guide pin driven in through the back of the pump housing.
2. Mount in succession: The pressure valve seat, the packing ring, the pressure valve, the valve spring, and the pressure valve holder.
3. Place the regulating rack in the pump housing with the line division to the indicator side.
4. Put the regulating bushing into the pump housing so that the marked tooth on the rack quadrant fits into the tooth space marked on the regulating rack.
5. Place the upper spring holder and the plunger spring in the pump housing.
6. Place the lower spring holder on the pump piston and put the piston into the pump cylinder so that the piston tab marked with a line fits into the groove in the regulating bushing also marked with a line.
7. Place the guide bushing in the pump housing. Press the bushing into the pump housing and thrust a split pin in through the small hole at the bottom of the pump housing so that the guide bushing is kept in its place.
8. Place the spring lock.

Capacity of the Fuel Pump

(measure with special equipment .... Bosch EFEP 255)

The newest pumps give the highest amount of fuel. The amount of fuel cannot be adjusted, and therefore, the pump must be replaced or repaired if the required values cannot be kept.

r.p.m.	position	amount of fuel cm^3/100 strokes
1000	6	1.0 - 2.2
1000	12	5.4 - 6.8
1000	18	8.8 - 10.6
200	9	2.0 - 3.4

Fuel Pump Type BRYCE

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	205012	-	10-37	1977
DV20	99381	-	20-41	1977

Another type of fuel pump, type BRYCE, has been introduced from the above engine numbers to replace the BOSCH fuel pump.

BRYCE type FAOAR - 070E0631 is used for DV10.

BRYCE type FAOBR - 070E0632 is used for DV20.

Design E is used for both types of pump.

The BRYCE fuel lift pumps can direct replace the BOSCH pumps when the fuel pipe between fuel filter and fuel pump has been replaced.

The fuel pumps are shown in exploded view on page H 22 for DV10 and on page H 23 for DV20.

Disassembly of Fuel Pumps

The disassembling procedure is the same for the fuel pumps for both DV10 and DV20.

When disassembling, repairing and reassembling of the fuel equipment the following should be taken note of:

1. Absolute cleanliness is necessary.
2. Only use clean fuel and non-fluffy cloths for the cleaning.
3. Always change the gaskets when reassembling the fuel pumps.
4. Do not use violence when disassembling and assembling.
5. Keep each pump unit apart (DV20).

Remove the fuel pump from the engine and wash the fuel pump. Empty the fuel pump of fuel, if any.

Disassembly of the Roller Section

1. Remove the fuse wire (4) and see to it that it is not overloaded when doing so.
2. Press roller and roller guide into the fuel pump and remove guide pin (20). The guide pin may lodge and then it has to be disengaged. E.g. use fuel to dissolve the pin and knock carefully at the pump housing in order to loosen it.

3. Remove the thrust roller section (10, 17, 18 and 19) together with the adjusting washers (21), the lower spring disc (9) and the pump piston (2).

   THE PUMP PISTON MUST BE HANDLED WITH CARE

   Remove the spring (8) and the control sleeve (6). At the same time remove the upper spring disc (7). Then remove the regulating rod (5). Remove the cover lid (22), however, do not try to remove the guide pins (3) at this stage.

Disassembly of the Pressure Valve Section

1. Remove the house for the delivery valve (16) - (wrench opening 19 mm). Remove the delivery valve (11, 12 and 13) and the gaskets (14-15).

2. Then remove the pump cylinder by turning the pump housing upside down.

3. Knock the guide pins (3) out of the pump housing by means of a 5 mm punch.

Examination of the Fuel Pumps

A pump unit must be replaced if it shows signs of:

a. Wear and tear or scratches on the sloping screw line of the piston.

b. Wear and tear or scratches on the piston head.

c. Scattered scratches, wear and tear or "dead" zones.

d. The piston sticking in the cylinder.

The pump piston must be able to slide in the cylinder unaided.

A delivery valve unit must be replaced, if it shows signs:

a. That the valves are "sticking" in the seat.

b. That the relief ring is scratched.

c. That there is radial play in the valve.

The upper plane surface of the pump cylinder and the two plane surfaces of the delivery valve seat can be slightly polished in order to remove any marks.

A thrust roller unit must be replaced, if it shows signs of:

a. Seizings, push-ups or oxidations.

Checking of the Control Sleeve

a. Check the mobility of the control sleeves in the pump housing.

b. Check the function og the regulating rod.

Reassembly of Fuel Pumps

The fuel pumps are assembled in the reverse order of the disassembling and the following should be observed:

a. Fit the pump cylinder (2) in the housing (1) so that the groove for the guide pin (3) is opposite the hole.

b. Fit the guide pin (3) and the cover lid (22).

c. When the delivery valve has been assembled (11-15) in the housing (16) the groove in the seat should be opposite the groove in the pump cylinder.

d. Screw the delivery valve carefully into the housing until the O-ring tightens. Then tighten with a torque of 41 Nm (4.2 kg/cm^2).

e. Make sure that shims (21) are not exchanged by mistake or lost.

f. Fit the regulating rod (5) and check that it is fitted in accordance with page H 24 , and that it is mobile.

Finish the assembling of the fuel pump and check and test it.

Testing of BRYCE Fuel Pumps

Having been disassembled and perhaps repaired the fuel pumps must be tested. This should be carried out at a test bench.

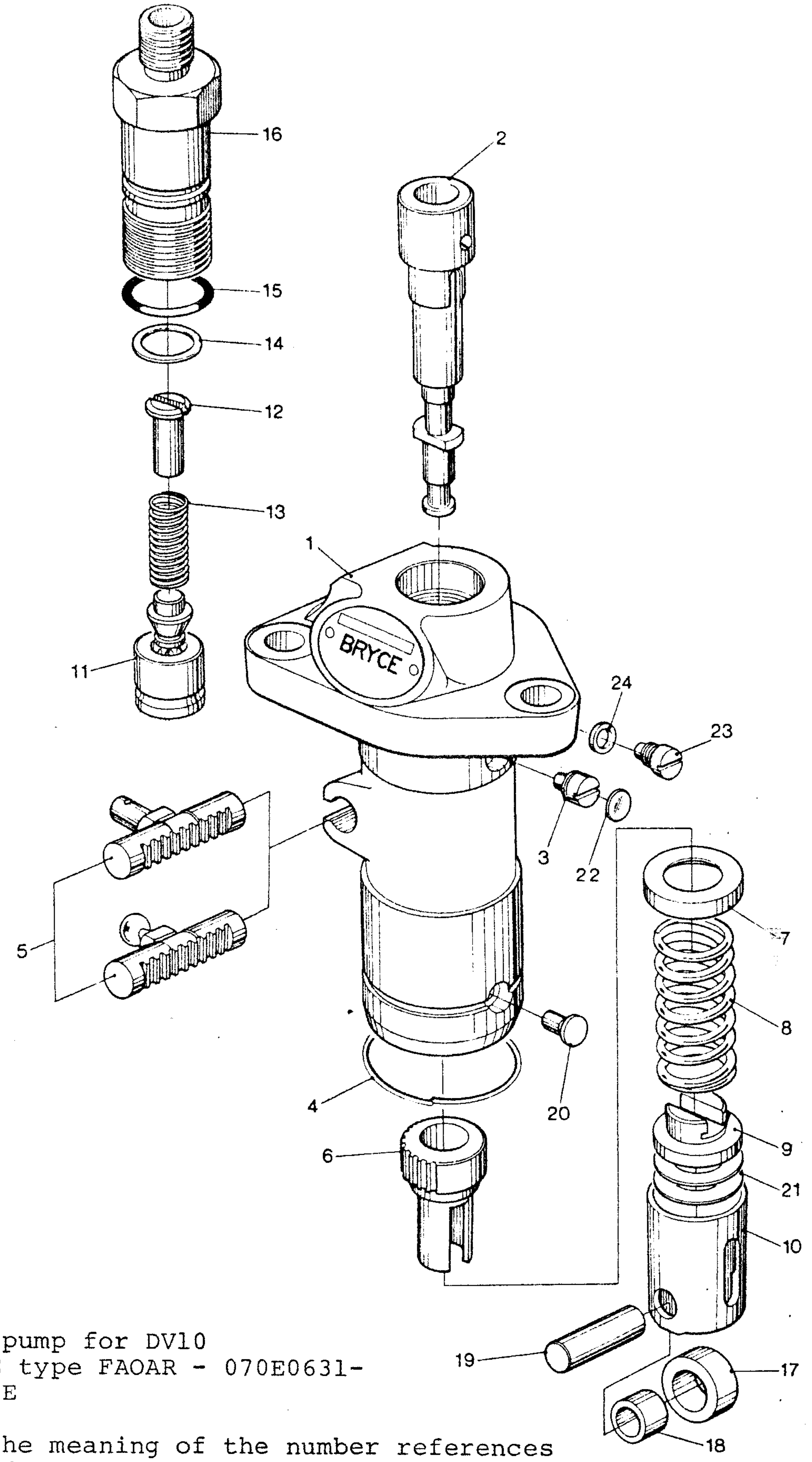
When making the test the following should be used:

BRYCE test valve No.:	BDN 12SD12
Opening pressure:	175 atm
Fuel pressure pipe:	6x2x500 mm (Dxdxl)

The fuel pump should be adjusted with the regulating hose 7 mm from the mechanical stop.

Revolutions of the cam shaft: 1500 o/m

The injected quantity : 27 - 29 mm^3/stroke



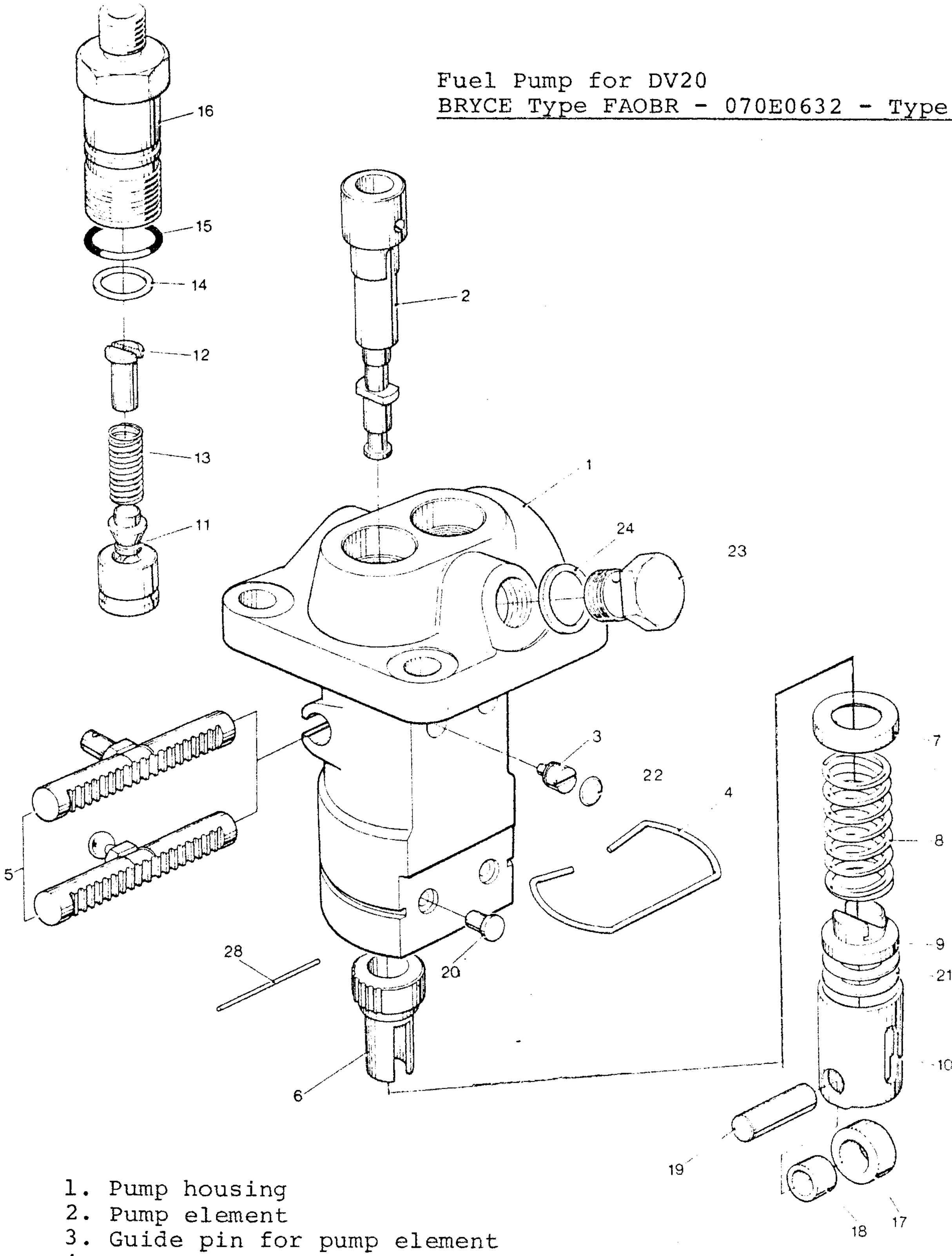
Fuel pump for DV10
BRYCE type FAOAR - 070E0631-
type E

For the meaning of the number references we refer to page . However, except the meaning for No.

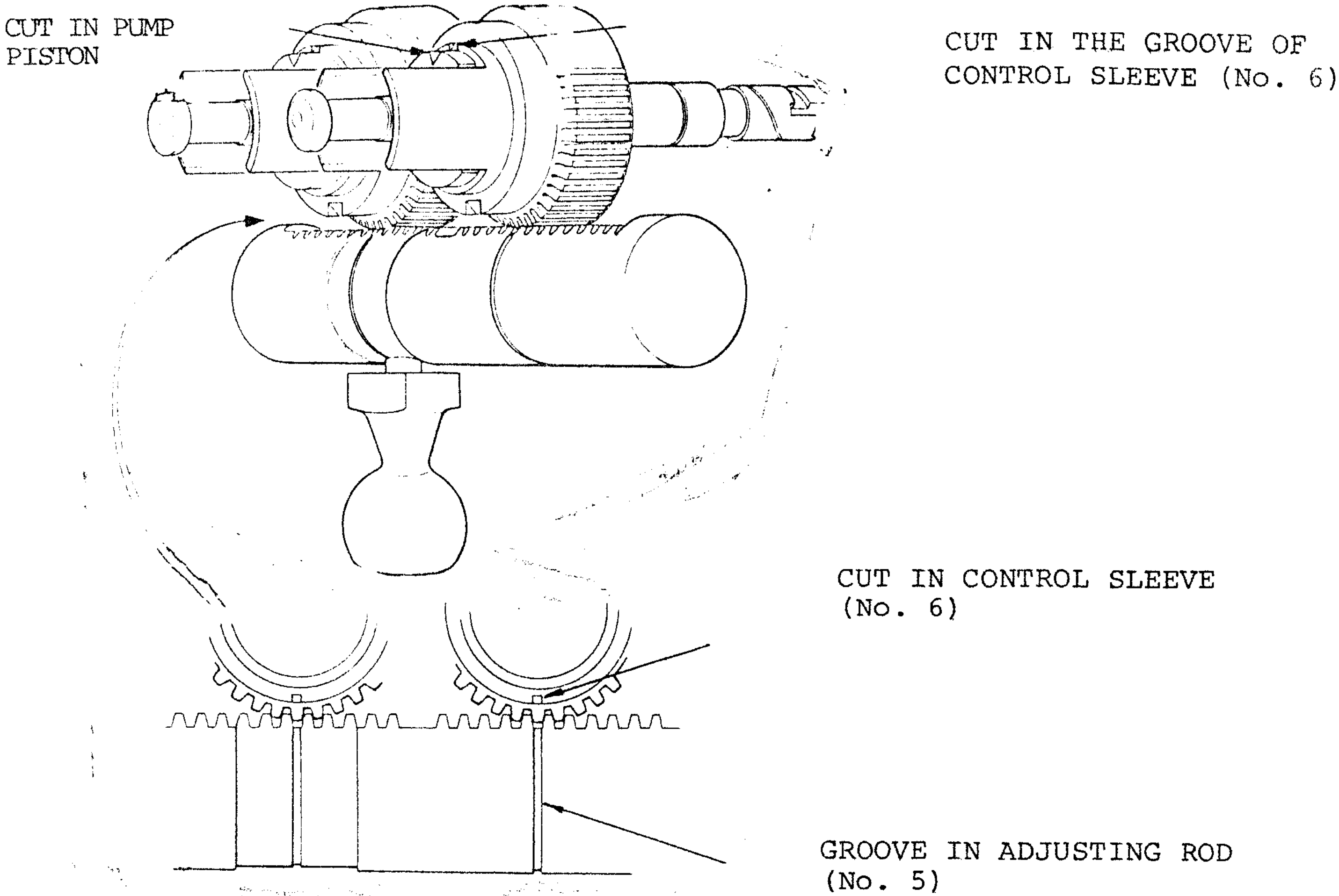
23: Guide bolt

24: Gasket

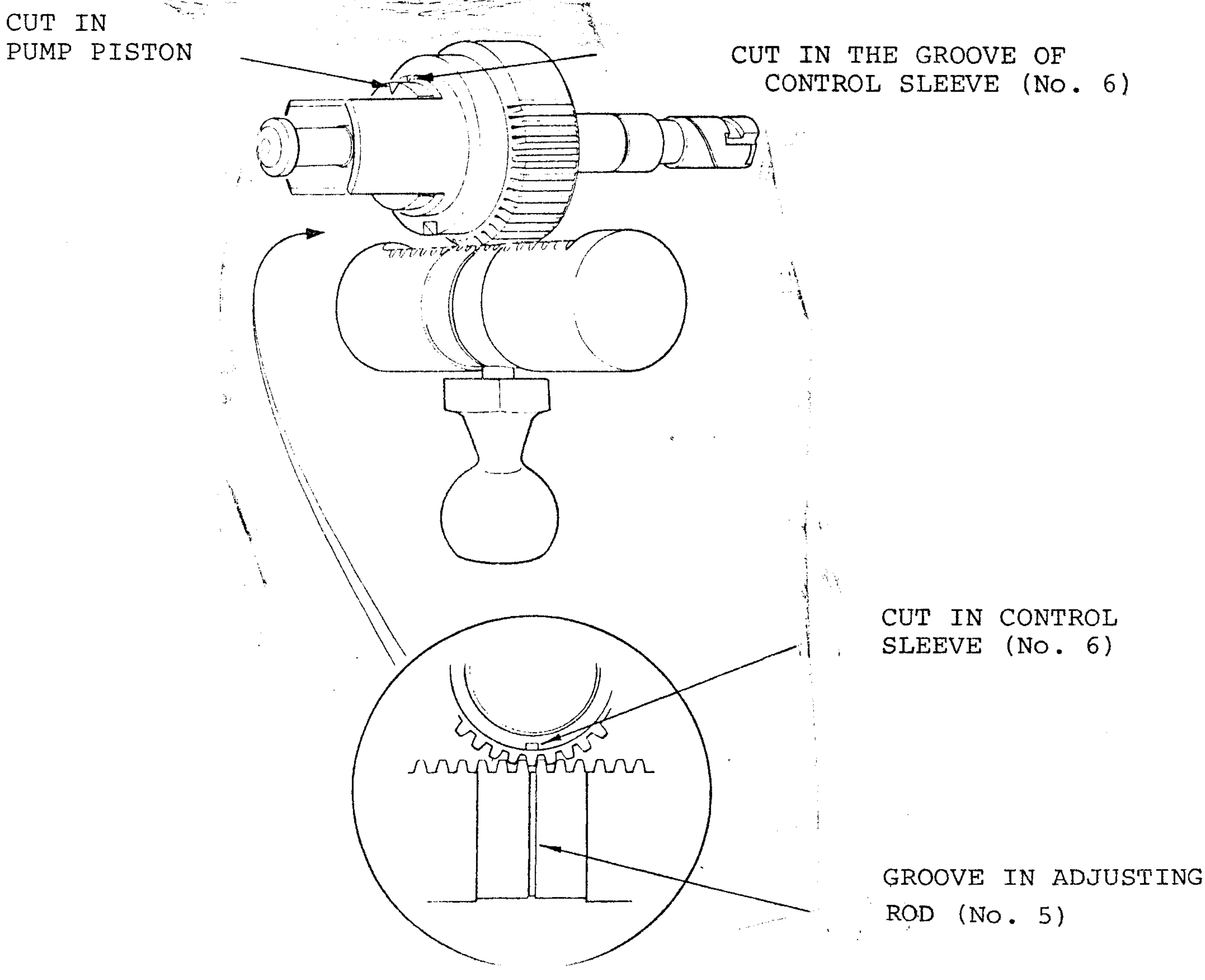
Fuel Pump for DV20
BRYCE Type FAOBR - 070E0632 - Type E



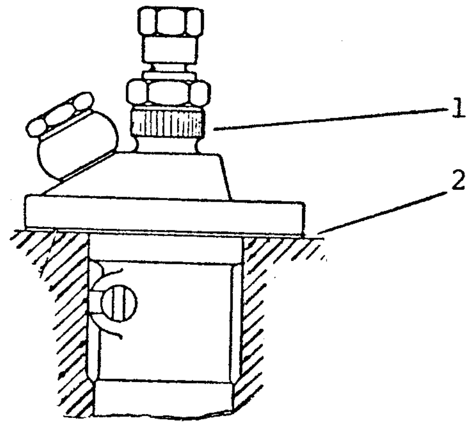
1. Pump housing
2. Pump element
3. Guide pin for pump element
4. Fuse wire
5. Regulating rod
6. Control sleeve
7. Upper spring disc
8. Spring for pump element
9. Lower spring disc
10. Housing for driver
11. Delivery valve
12. spring guide
13. Delivery valve spring
14. High pressure seal
15. Seal - O-ring
16. Housing for delivery valve
17. Thrust roller
18. Bush for thrust roller
19. Journal for thrust roller
20. Guide pin
21. Adjusting washer
22. Cover lid
23. Vent screw
24. Gasket
28. Safety wire



MESH FOR CONTROL SLEEVE AND ADJUSTING ROD



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 piston top. 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 direct 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. Mark these positions on the flywheel opposite the fixed point 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).

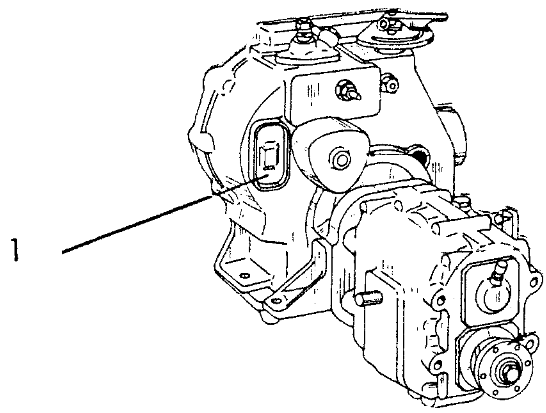
11. Set the throttle control on full output.

12. Actuate the sphygmomanometer and let down the piston 1.766 mm in the cylinder (at 3000 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.

For DV10 engines before No. 85889 and for DV20 engines before No. 92420 adjust the injection timing on the fuel cam of the camshaft. This is done as follows:

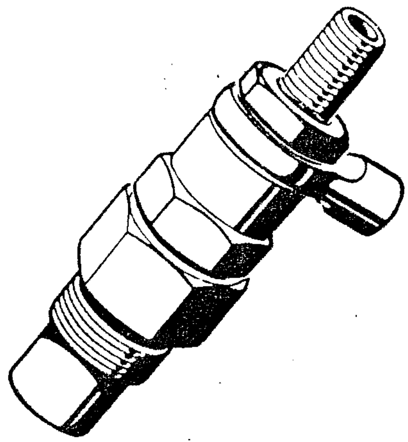
1. Dismount the cylinder head or dismount a valve spring while the piston is in top position so that the valve "steps" on the piston top.
2. Mount the sphygmomanometer as indicated on the previous page.
3. Mount the dial indicator.
4. Set the piston in the top dead centre in the working stroke and set the dial indicator in 0 position.
5. Set the throttle control on full output.



6. Lower the piston 1.76 mm (applies at 3000 r.p.m.).
7. Dismount the cover 1 and loosen the bolts of the fuel cam with a special key.
8. Actuate the sphygmomanometer and turn the fuel cam until the indicator on the sphygmomanometer stands still.

Fuel Valve

	From eng. No.	To eng. No.	Parts List No.	Year
DV 10	85000		4400.1.E	1973
DV 20	92000		4600.1.C	1973



The fuel valve consists of injection nozzle and nozzle holder.

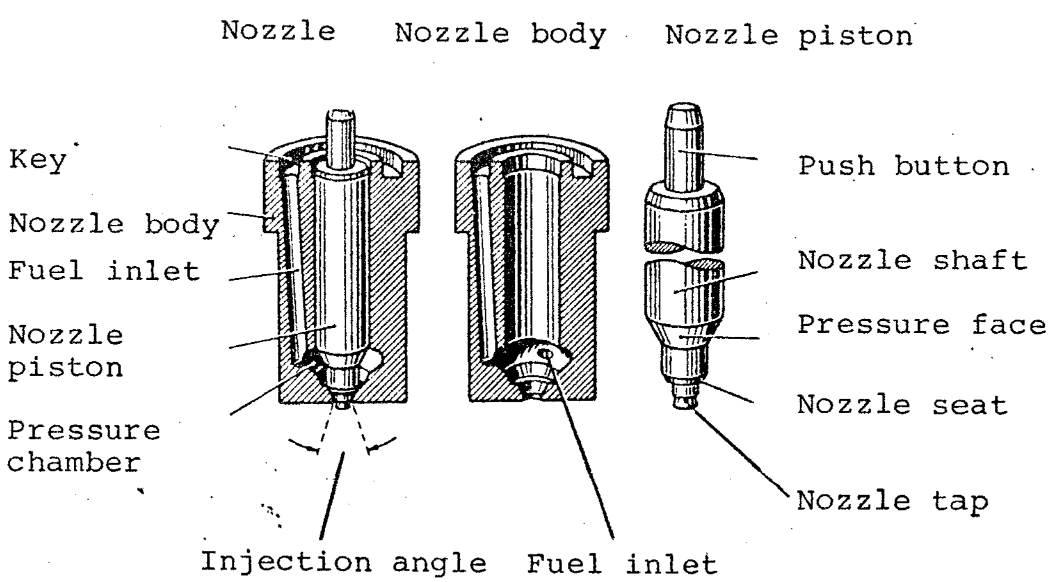
Injection nozzle: make Bosch, type DNO SD 2110
opening pressure: 150 +/- 10 kg/cm^2

Nozzle holder: make Bosch, type 55 SD 20/4

The function of the fuel valve

The nozzle is guided by the fuel pressure. The pressure produced by the fuel pump works on the pressure face of the nozzle piston and raises the nozzle pin from its seat when the power from below is greater than the power working from above from the pressure spring in the nozzle holder. Then the fuel is injected into the precombustion chamber through the nozzle hole.

As mentioned before pintle nozzles are used on BUKH diesel engines. The main components of the pintle nozzle are shown on the drawing below.



When working with fuel valves and their nozzles observe the greatest cleanliness, and all parts must be washed and cleaned carefully with pure petrol at the dismantling.

Dismounting and Dismantling of the Fuel Valve

1. Dismount the inlet pipe and return oil pipe of the fuel valve.
2. Unscrew the fuel valve from the upper part of the precombustion chamber.
3. Dismount the upper part 1 of the nozzle holder (see next page).
4. Remove cautiously the adjusting washers 6, the valve guide 5, the pressure spring 3, and the pressure spindle 2.
5. Further remove the intermediate washer 26 and the nozzle 27 placed in the lower part of the nozzle holder 25.

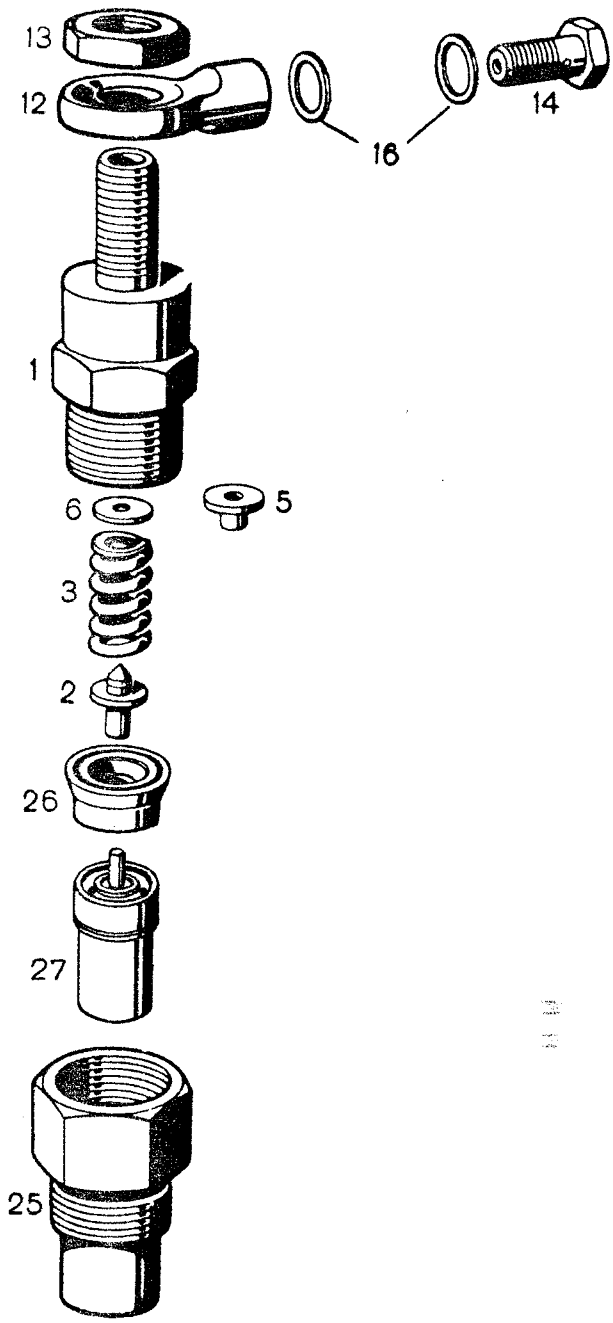
Assembling takes place in reverse order.

If there are irregularities on the fuel valves according to the section about "Irregularities in Operation" dismantle these and observe the following when repairing:

1. Show cleanliness.
2. Do not grind the needle valve in the nozzle.
3. Replace the needle valve and nozzle body at the same time as these are patched together.
4. Replace always nozzle body and its needle valve if the needle valve is knocked in, has rough needle seat, or damaged nozzle tap.

   Replace also the nozzle and its needle valve if the seat of the nozzle body is knocked in, if the seat has a heavy coast of coke, and in case of burns round the nozzle hole. Examine this with a light magnifier.

   Furthermore, replace the nozzle and its needle if the slide test and the results from the testing with the nozzle tester are not satisfactory (see page H [illegible]).



1 - Upper part of nozzle holder
2 - Pressure spindle with spring guide
3 - Pressure spring
5 - Spring guide
6 - Intermediate washer for adjustment of opening pressure
12 - Fuel connection for return oil
13 - Clasp nut
25 - Lower part of nozzle holder
26 - Intermediate washer for the nozzle
27 - Nozzle

Adjustment of Opening Pressure

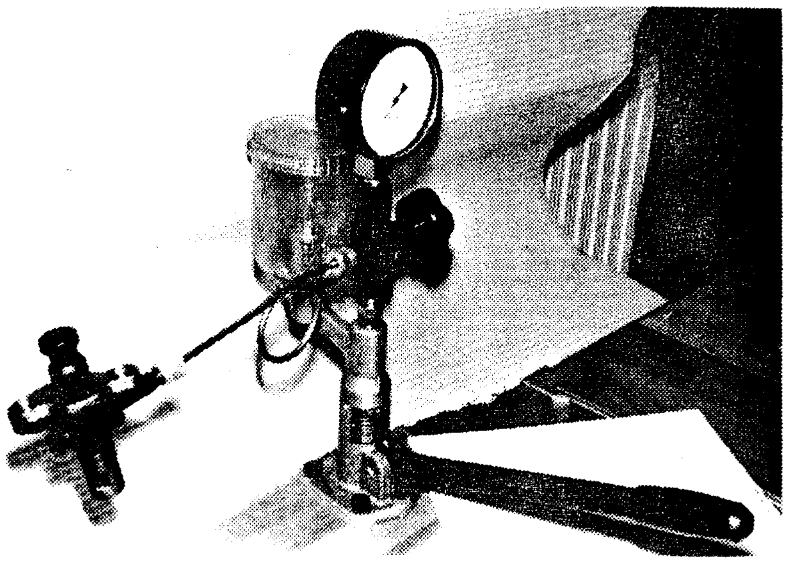
If the opening pressure of the fuel valve must be altered according to the test page H34 this is done as follows:

Remove the nozzle holder 1 page H30 carefully and intermediate washers 6 may be inserted or removed.

Intermediate washers of 0.1 mm give a variation in the opening pressure of approximately 10 atm.

There are intermediate washers of the sizes 0.1 - 0.2 - 0.5, and 1.0 mm.

The opening pressure must lie on 150 +/- 10 kg/cm^2.



Nozzle tester

Operating Instructions for Bosch Nozzle Tester

1. Cleaning of Nozzles

Before use new fuel nozzles must be cleaned completely for anti-corrosion grease by washing in pure petrol - clean used fuel nozzles of dirt and coke and wash them out in petrol - use nozzle cleaning tool EF 8486 B. Then dip the nozzle piston in pure filtered diesel fuel and insert it in the nozzle body.

Nozzle piston and nozzle body are patched together and must not be mixed up.

2. Preliminary Testing

A. Examination of appearance - only on used nozzles.
After the cleaning examine the appearance of used nozzles.

Look after:

1. At the nozzle piston

Knocked in and rough nozzle seat.
Worn or damaged nozzle tap.

2. At the nozzle body

Knocked in or coke covered seat (examine the seat with light magnifier EFAW 25 B) on oblong injection hole at tap nozzles.

B. Slide testing

After examination of the appearance carry out the slide test on all fuel nozzles. At first dip the nozzle piston in pure diesel fuel, then insert it in the nozzle body. Hold this almost vertically by the hand and pull the piston upwards corresponding to one third of its stroke. The piston must then slide into the seat by its own weight (fig. 1).

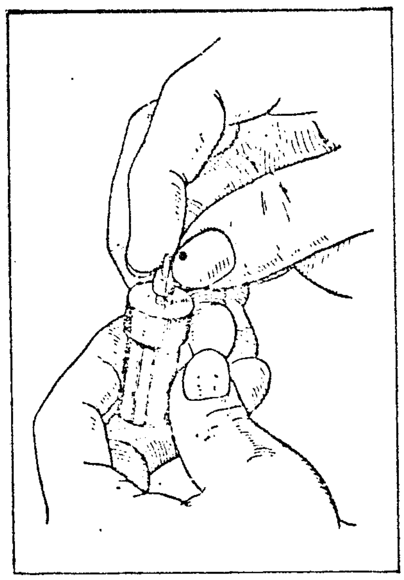


Fig. 1 Slide test

3. Testing with Nozzle Tester

Examine with nozzle tester:

a. Opening pressure
b. Tightness
c. Snarling and injection angle of the nozzle

For testing of nozzles of sizes R, S and T use tester EFEP 60 A.

As test oil use either

test oil consisting of 50% Shell Clavus Oil 17 + 50% clear kerosene

or

pure gas oil.

It is very important that the oil is completely pure.

Normally test the fuel nozzles together with their nozzle holders.

When fixing the nozzle in the holder take care that the seal faces are clean and undamaged. At first press the nozzle against the seal face of the holder, then tighten the union nut by the hand and at last with a key that fits to a necety - at holders with fitting pins the spring of the holder must first be completely slackened.

The torque moment for the union nut - measured with a torsion meter - must be

<u>nozzles size S 6 - 8 kgm</u>.

Then connect the nozzle holder with its pressure pipe to the nozzle tester. With <u>disengaged pressure gauge</u> make at first some heavy strokes with the pump - with a rate of about 6 - 8 downward movements per second - in order to examine whether the fuel nozzle is tightened too much. If the nozzle piston goes normally the nozzle must snarl with a loud whistling tone.

A. Opening Pressure

The opening pressure is stated in the operating manual for the engine in question and must be adjusted according to these specifications. In some cases the pressure indication is carved into the nozzle holder.

With engaged pressure gauge press the pump arm slowly down until the nozzle injects with a slight snarl. Read the opening pressure on the pressure gauge.

Take care: When the pressure gauge is engaged the pressure must only be increased slowly, and above all it must only be lowered slowly as the pressure gauge might otherwise be damaged.

B. Testing of Tightness

Operate the pump arm until the pressure gauge indicator is 20 ato. below the prescribed opening pressure.

The fuel nozzle is tight when no drops fall from the nozzle openings

C. Snarl Test and Injection Angle

Before these tests are carried out the pressure gauge must always be disengaged.

Nozzle Type	Snarl Test	Injection Angle
	1. Fuel nozzles	
	a. Without throttle effect	
DN R DN S DN T	These nozzles snarl without exception over the whole speed range. Lowest test speed is one downward movement of the pump arm per second. It is of no importance if there are small areas without snarl.	Independently of the test speed - however, always above the lowest test spee - the fuel nozzle must giv a well atomized regular injection. (Observe the injection angle).
	b. With throttle effect	
DN RD DN SD DN TD	Due to the special design of these nozzles the snarl tone is very soft. A test of the snarl tone is only possible at a test speed speed of 1 - 2 downward movements of the pump arm per second. When the test speed is increased the snarl tone ceases. The test oil comes then out of the nozzle with a fizzing sound. The nozzle does only snarl with a loud tone at a very fast movement of the arm - 4 - 6 strokes downwards per second.	Until the loud whistling tone has been obtained the injection must be unatomized and irregular. A split injection with tab formation is without importance in this range (snarl in the throttle stroke). An estimate of the injection formation is not possible until the pump arm moves fast (about 4 - 6 downward movements per second). The injection mus then be closed and well atomized (snarl at full stroke of the nozzle piston).

W A R N I N G

KEEP THE HANDS AWAY FROM THE ATOMIZED INJECTION

An atomized fuel injection penetrates deep into the flesh of the finger or the hand and injures the tissue. The fuel penetrating into the blood may cause blood poisoning.

Maintenance

At the tests observe the greatest cleanliness. Keep the place of work free from swarf and dirt.

Replace the test oil by new oil when it is dirty. At the same time wash out the filter insert in pure fuel or replace it by a new. After filling with new oil rinse the interior of the nozzle tester by operation of the pump arm. During this rinsing inject in the open without fuel valve mounted.

Once a month the pressure gauge must be compared to a test pressure gauge, and if necessary work out a correction table.

Section IJ

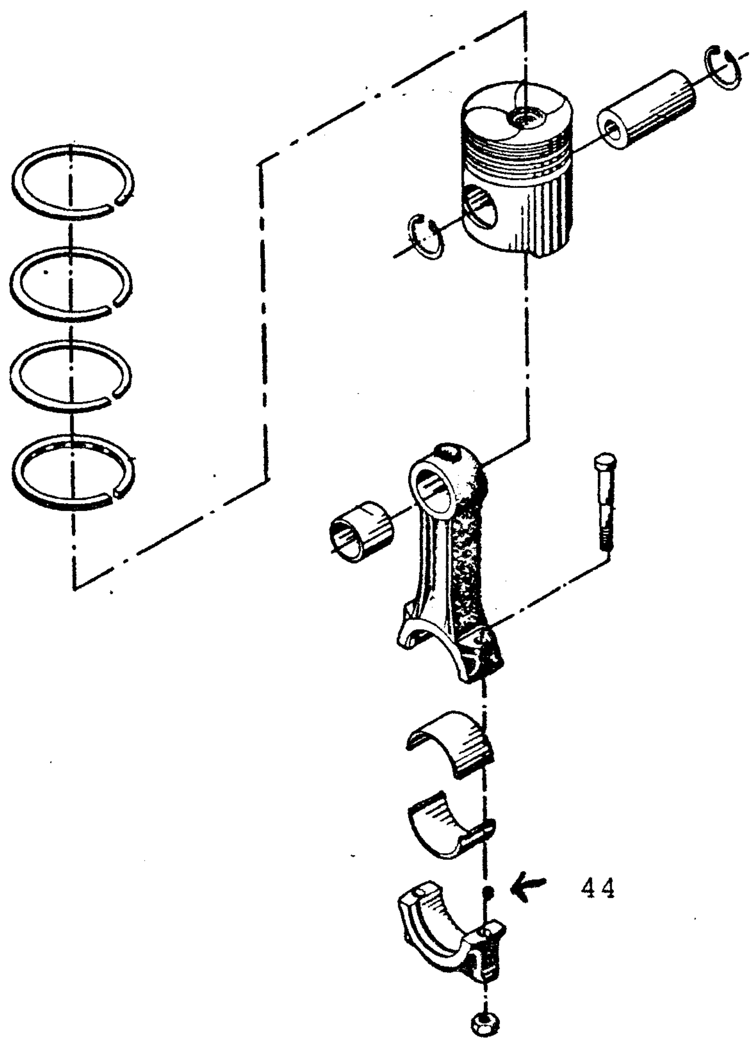
Piston, Connecting Rod, and Cylinder Liners

Contents

	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	85000	87601	4400.1.E	1973
DV 20	92000	92996	4600.1.C	1973

Dismounting of Pistons and Connecting Rods

1. Drain the cooling water and the lubricating oil off the engine.
2. Dismount the cylinder head (see section C page 7).
3. Remove with a scraper the possible wear or soot edge which is at the top of the cylinder liner.
4. Turn the engine "upside down".
5. Dismount the oil sump.
6. Unscrew the connecting rod nuts and take out the cap.
7. Place protective caps (soft plastic hose or the like) on the connecting rod bolts 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.



Change 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.

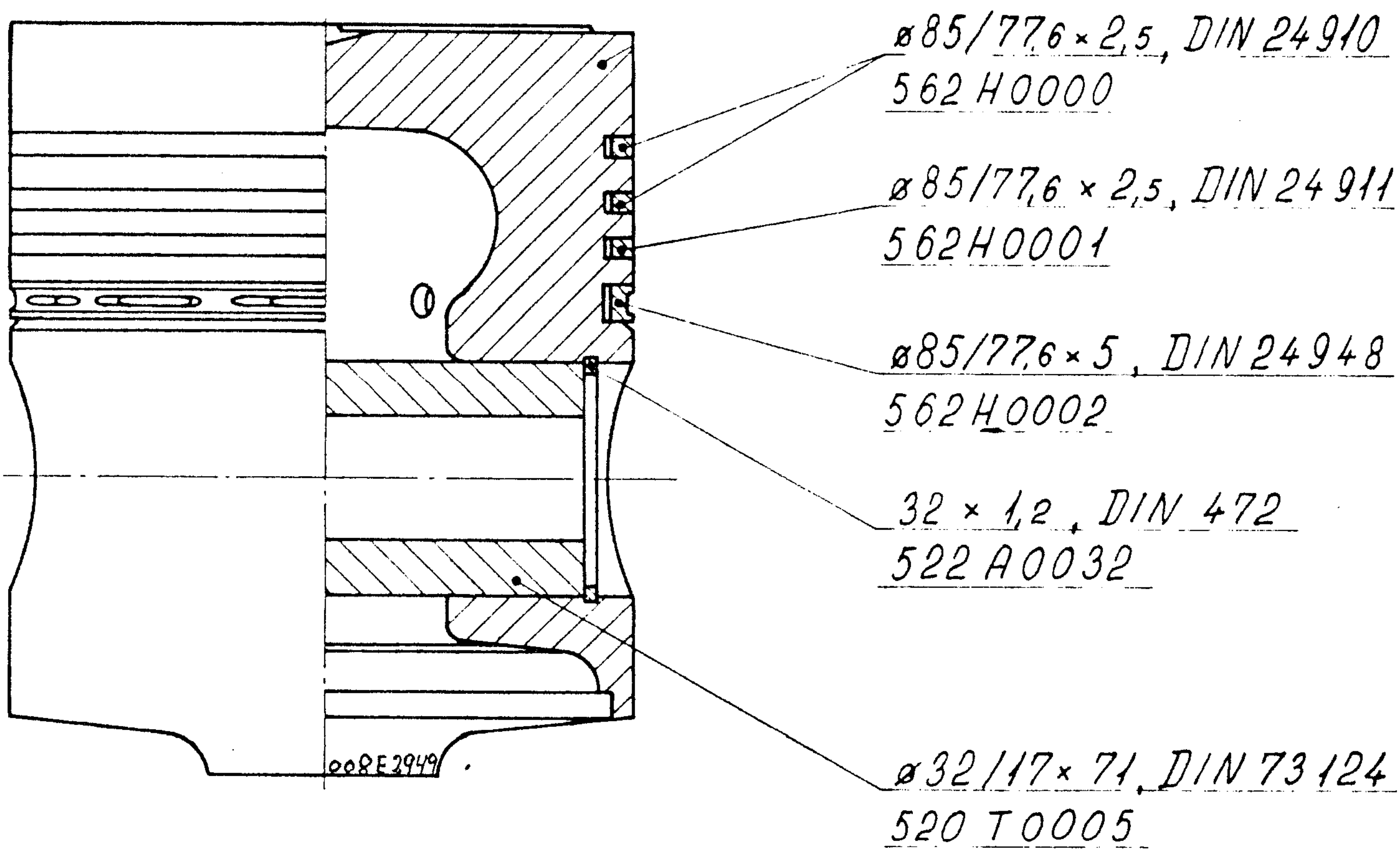
4. Place the new pistons upside down. Pour a little spirit into them and light it. The heating can also take place on a boiling plate.

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.

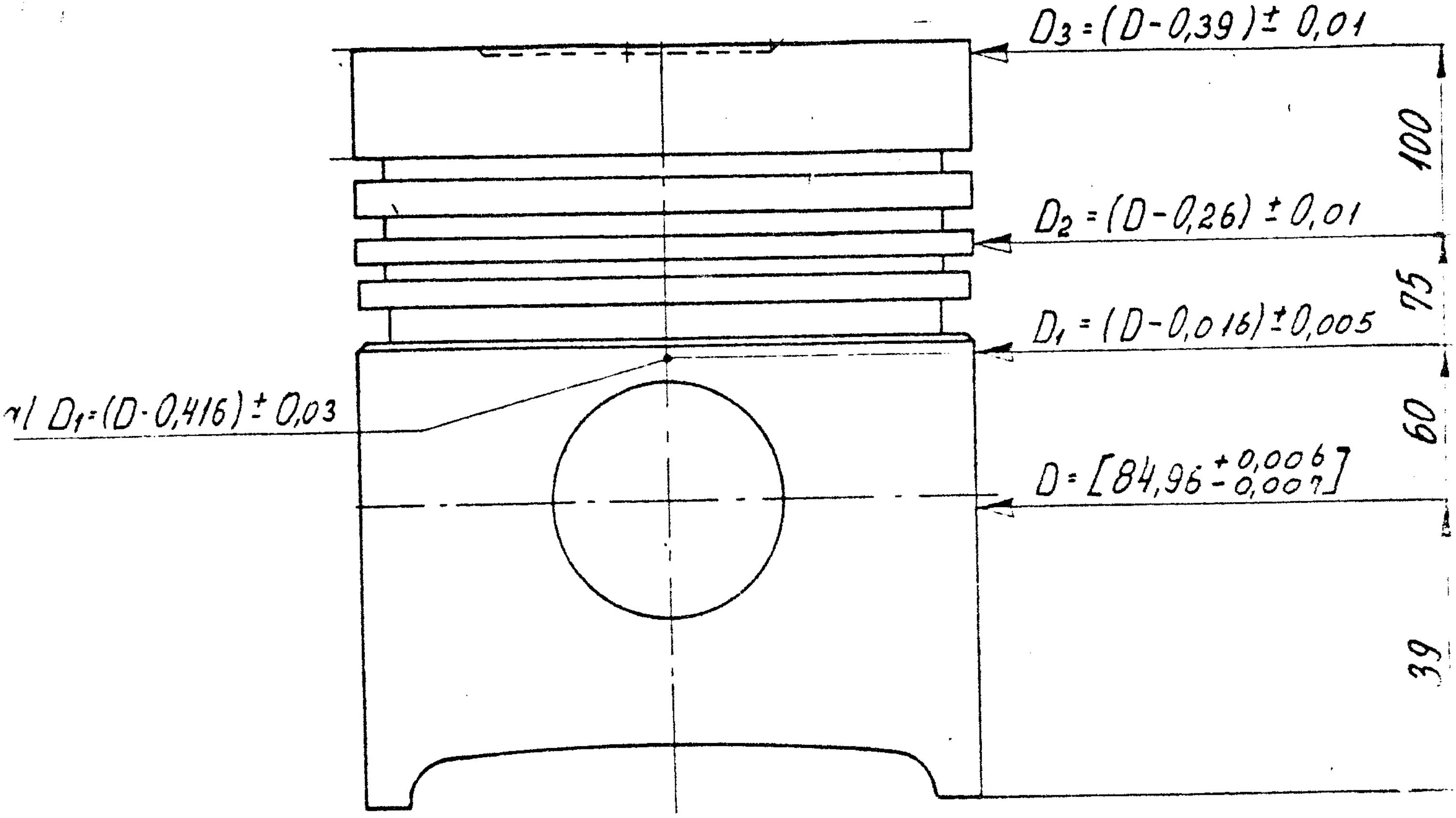
   If it is possible for you, it is recommended to cool down the piston pin first, e.g. in a deep freezer.

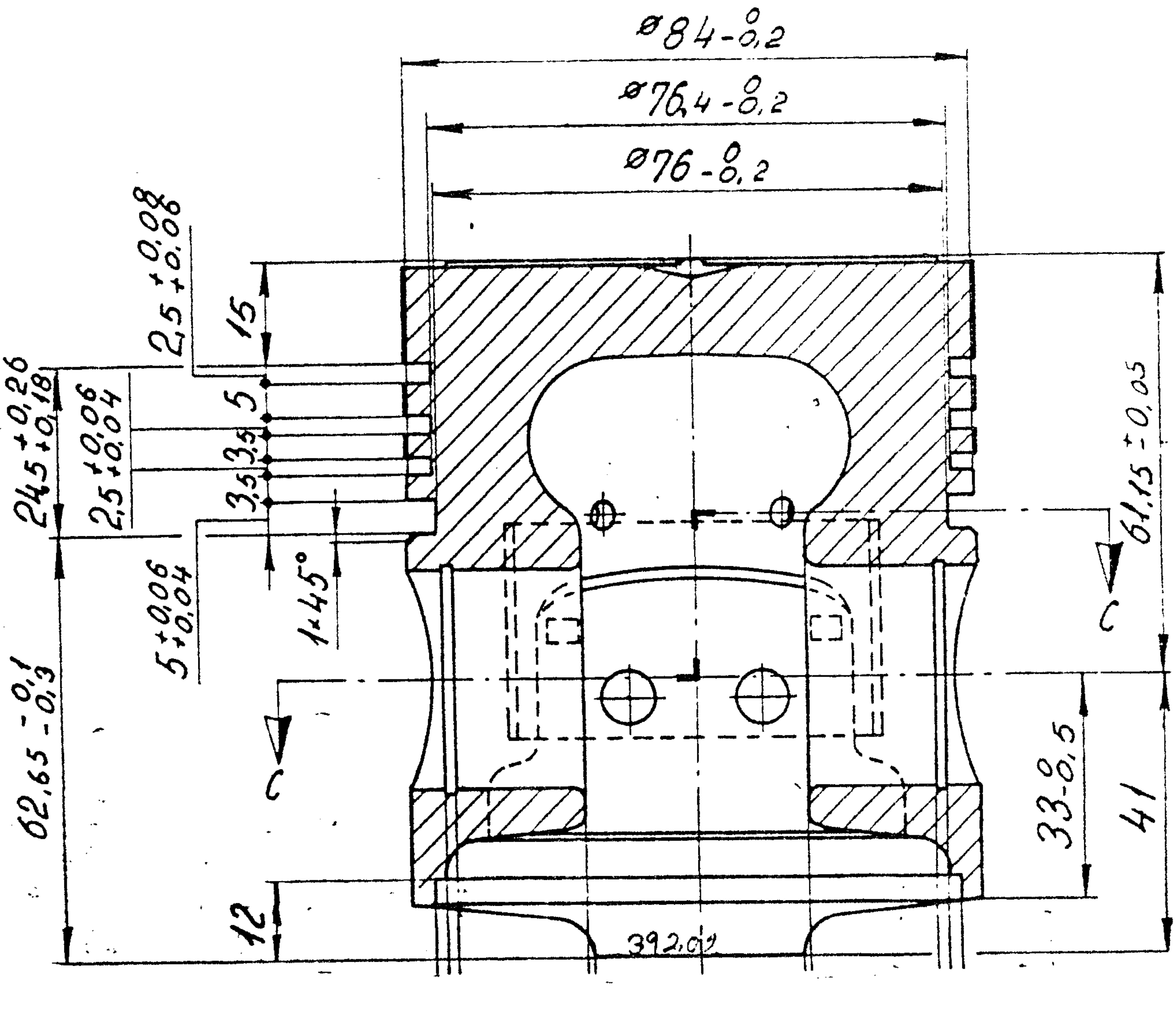
6. Then lock the piston pin with the lock ring.

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



Test Measurement of Piston DV10 - DV20





Change of Piston Rings

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

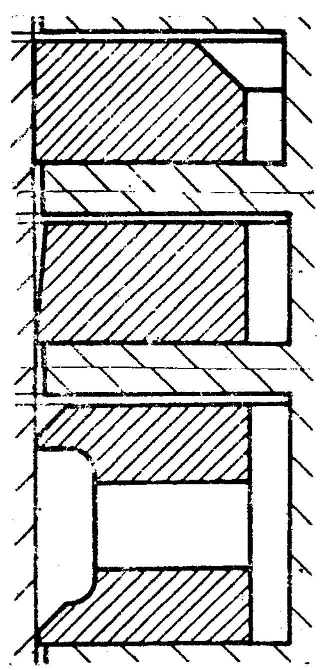
The wear of the piston rings can be seen by measuring the piston ring gap, and the piston rings must be changed when this is max. 2.0 mm (0.0787 inch).

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 takes 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 four piston rings: 3 compression rings and one oil scraper ring. The two upper compression rings are of the same type as A, the third compression is like B and the oil scraper ring is like C. (see below)



	Measures	
A	85/77.6x2.5	(3.346/3.055x0.098)
B	85/77.6x2.5	(3.346/3.055x0.098)
C	85/77.6x5.0	(3.346/3.055x0.1969)

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	87602		4400.1.E	1973
DV20	92997		4600.1.C	1973

In future engines the guidance between the connecting rod and the connecting rod cap will be changed from a fit on the connecting rod bolt to two balls in the joint surface. The connecting rod bolt is replaced by a standard cylinder screw.

When dismounting the last-mentioned type of connecting rods, you must, therefore, pay attention to the guide balls. Se page IJ 4 pos. 44 on the fig., and page IJ 8.

At the mounting you must first tighten the cap and the connecting rod loosely, then strike the cap with a few light strokes in order to secure that the guide balls fall in correctly. Then tighten the connecting rod swrews with a torque of 5 kgm (36.2 ft.lbf).

<u>Exchange of Connecting Rod</u>

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	204.812		021D0007	1977
DV20	98646		022D0007	1977

From the above engine numbers a new balanced connecting rod has been introduced for DV10 and DV20. The connecting rod is shown on page IJ 8 with the balancing weights hatched.

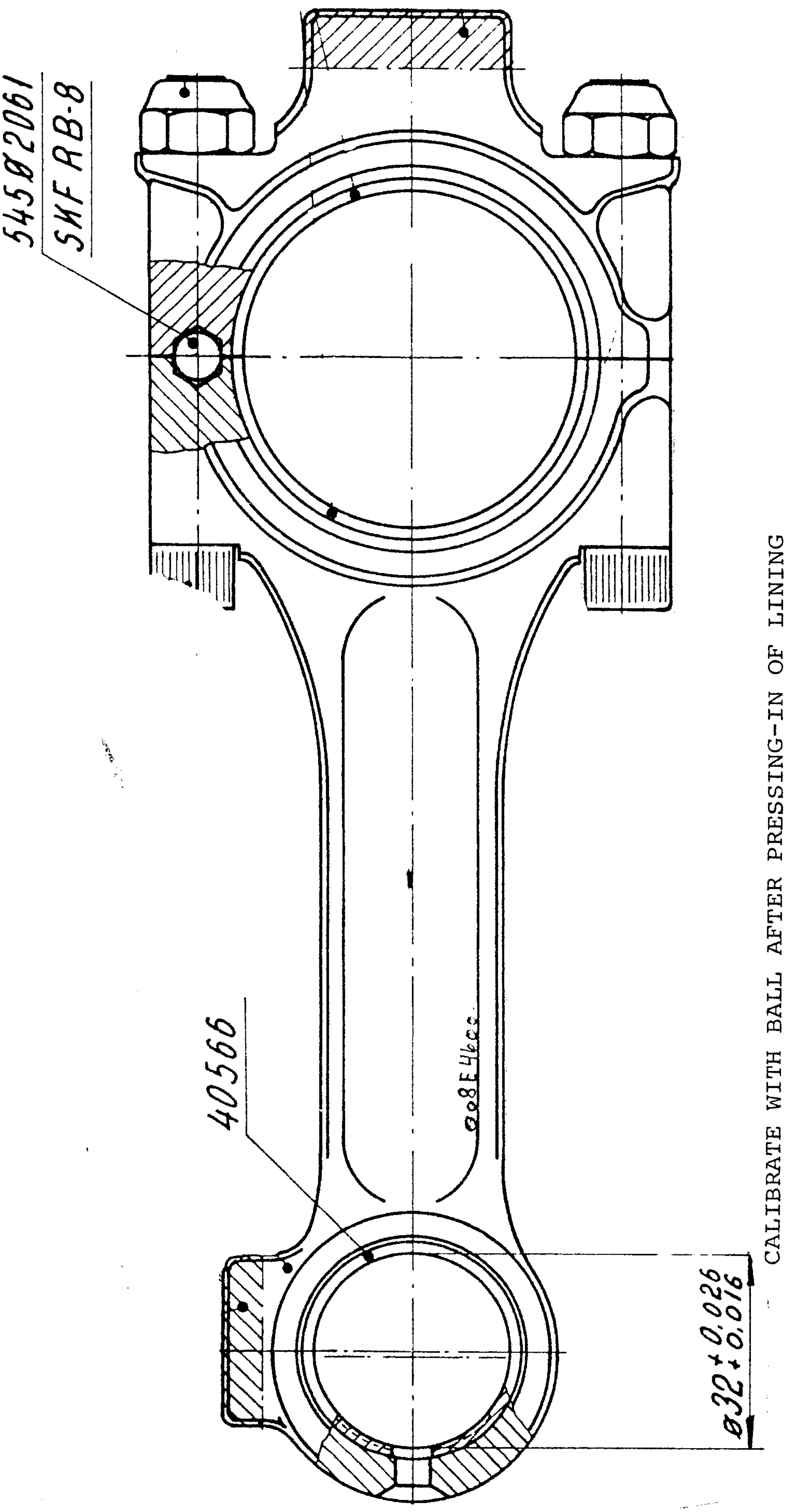
This connecting rod cannot be used on earlier delivered engines, as this would demand a special weighing-out of the crank.

Please note the guide ball 545Ø2061 which is shown mounted in the connecting rod on page IJ 8.

<u>Exchange of Piston Pin Bearing</u>

If a heavy wear of the piston pin bearing is found it may be necessary to exchange this. When exchanging it particular attention should be paid, as the bearing must be calibrated to correct roundness and clearance after the fitting. This is either done with a calibration ball or with a reamer with the clearance mentioned. Please note the clearance on page IJ 8.

Arrangement of Connecting Rod



Mounting of Pistons and Connecting Rods

1. Place a slip ring over the cylinder liner.

2. Place the crank in top position.

3. Place the "protective caps" on the connecting rod bolts.

4. Place the piston with connecting rod in the slip ring and the cylinder liner while observing that the piston ring grooves are displaced. Further you must check that the milled recess in the piston top is turned towards the fuel valve.

5. Turn the engine "upside down".

6. Remove the "protective caps".

7. Mount the cap with the journal.

8. Tighten the connecting rod bolts with a torque of 5 kgm (36.2 ft.lbf). For the connecting rod bolts you must use self-locking nylon nuts which are renewed by every disassembling of the engine.

NB : The numbers on the connecting rods must be placed as before the disassembling.

The numbers on the connecting rod and the cap must fit.

Connecting Rod Bearings

The connecting rod bearings consist of two twin bearing shells in which a thin layer of bearing metal is cast. The connecting rod bearings must be changed if they are scratched or if the "red" layer between the bearing metal and the steel liner can be seen faintly.

The connecting rod bearings can be delivered in the following undersizes: 0.3 mm (0.01181 inch) and 0.6 mm (0.02362 inch). (See section L, page 3).

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85000		4400.1.E	1973
DV20	92000		4600.1.C	1973

Cylinder Liner

The bore of the cylinder liner is 85.000-85.020 mm (3.3464-3.3472 inch). Change the cylinder liner 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 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 : Large measure less small measure divided by 3.

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

Dismounting of Cylinder Liner

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

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

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

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

Mounting of Cylinder Liner

At the top there is no gasket between cylinder liner and engine block. Therefore, the joint faces must be completely clean and without burrs. Grind with abrasive compound, if required.

The rubber rings at the bottom of the liner must be renewed by every disassembling and at the mounting <u>they must not be twisted</u>.

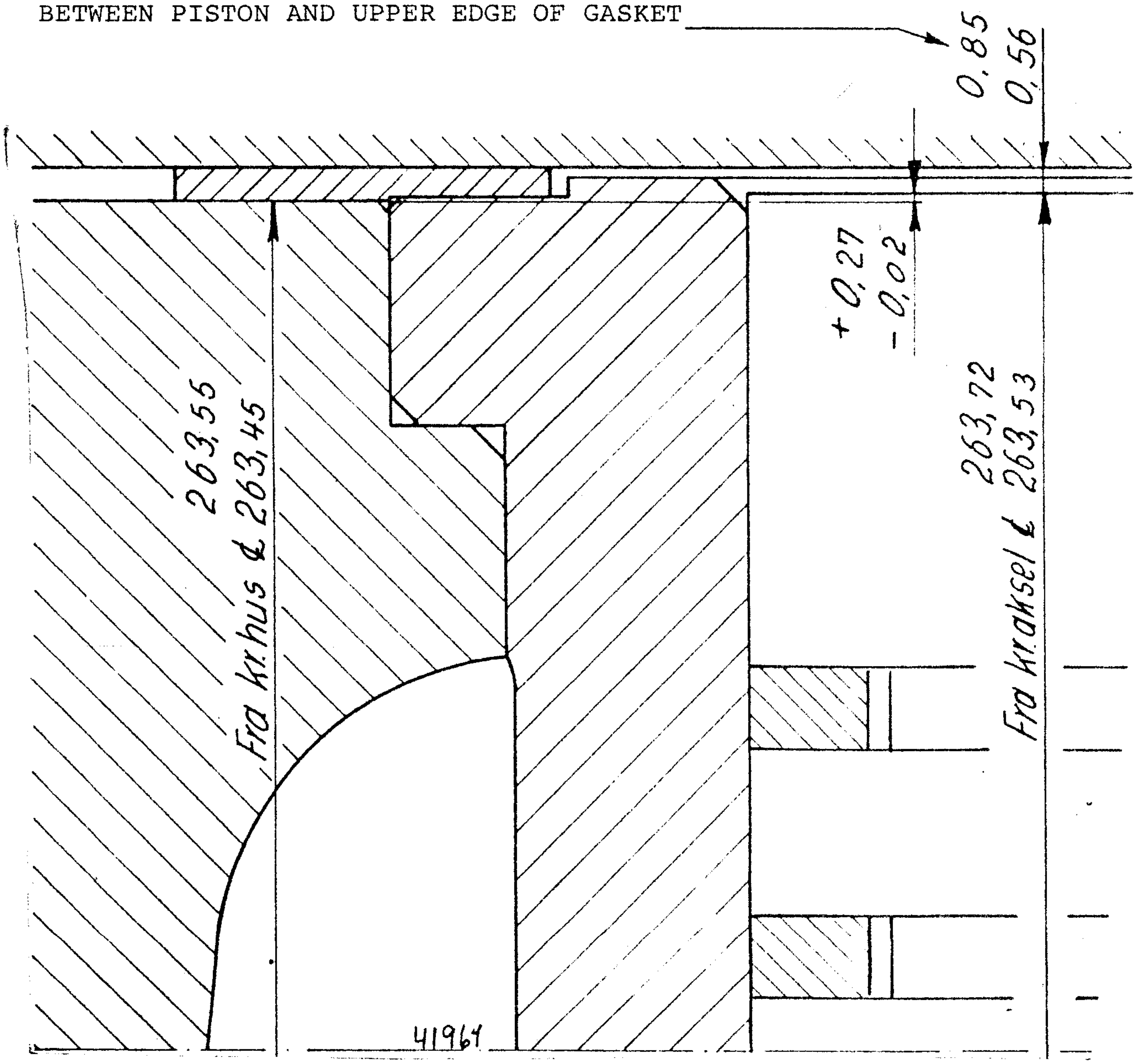
The rubber rings and the flange at the top can be supplied with a thin coat of jointing paste at the mounting.

When the above things are in order you can - by means of a wooden block - put the cylinder liner in place in the engine 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).

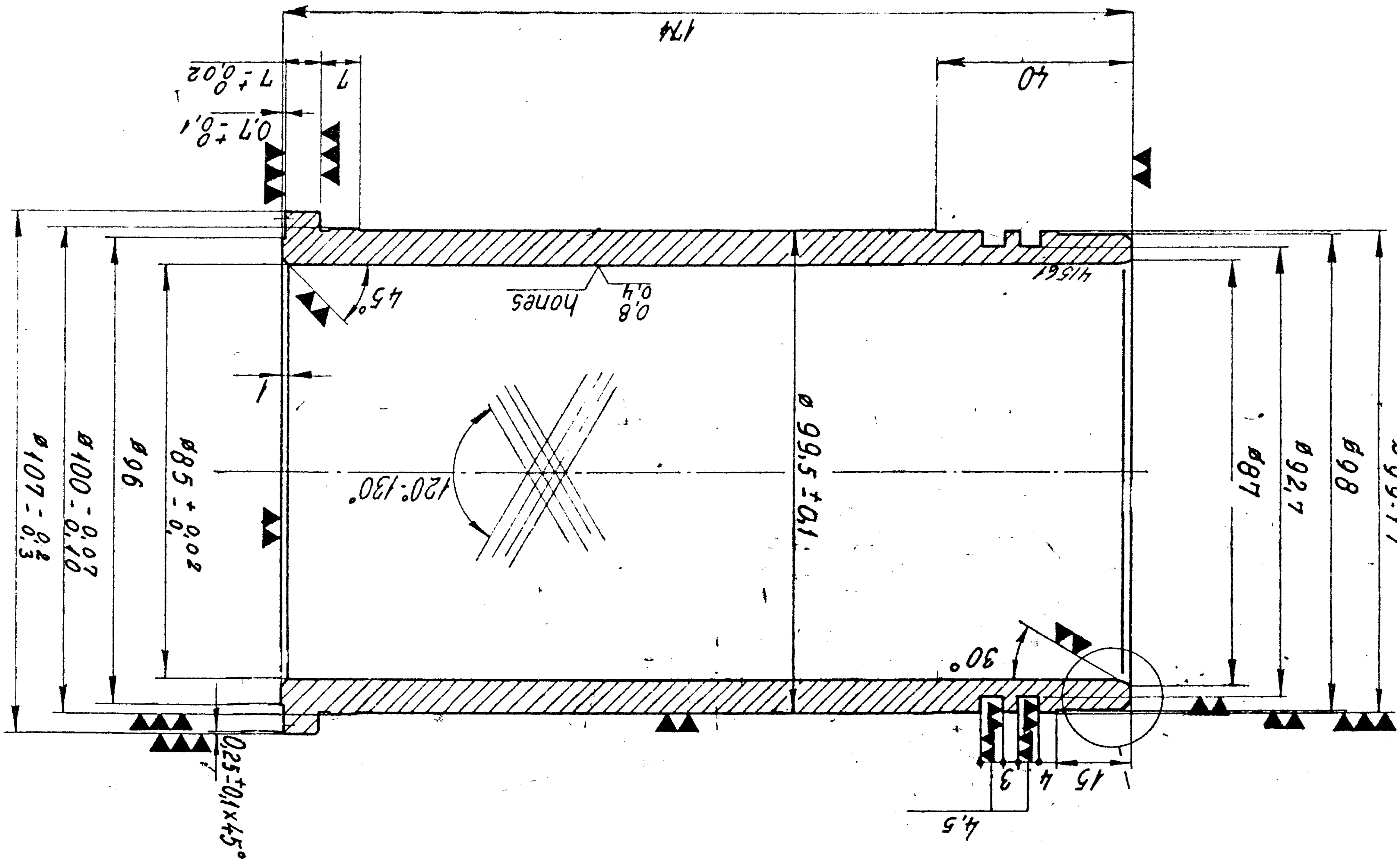
Arrangement of Cylinder Liner

WITH GASKET 1.06/1.19 COMPRESSED TO 0.83 THE DISTANCE BETWEEN PISTON AND UPPER EDGE OF GASKET



TEST MEASUREMENT OF CYLINDER LINER

DV10 - DV20



Section K

Crankcase

Contents

Crankcase

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	205012		021D0007	1977
DV20	99101		021D0007	1978

From the above engine numbers a new type of fuel lift pump has been introduced which has caused a change of the crankcase. Crankcases which are used from the above engine numbers cannot be used direct as spare part for an old engine - See information No. 7852.

Fitting of Oil Dip Stick

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	89157		D10	1974
DV20	93638		022D0002	1974

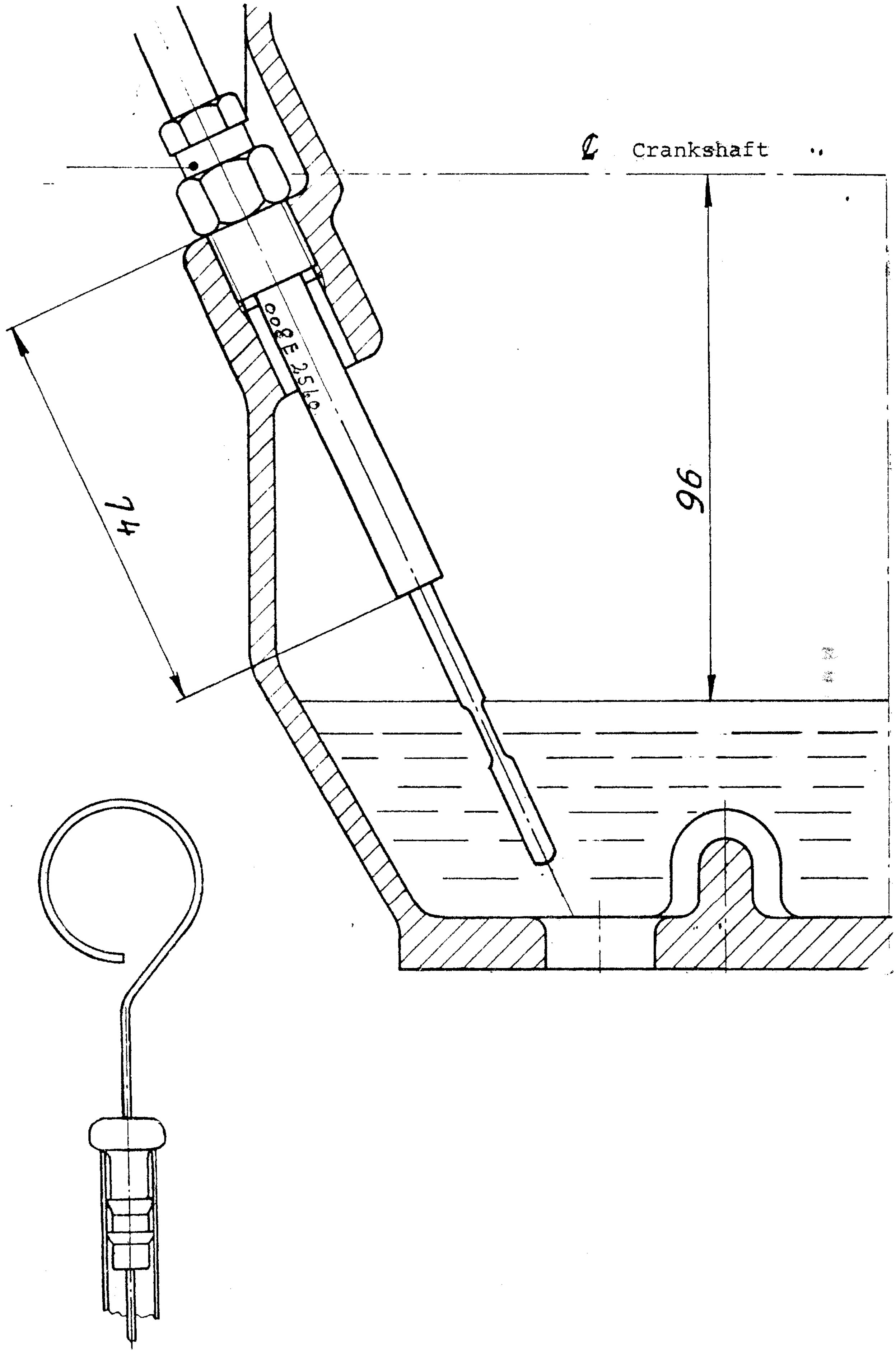
From the above engine serial numbers a change of the lubricating oil dip stick of the engine has been carried out. The new dip stick is 60 mm shorter than the old execution and consequently it cannot replace the latter.

On page K 4 the fitting of the new execution is stated.

On old executions the fitting of the pipe for the dip stick is so adapted that the dip stick indicates max. oil level when the quantity of oil filled in is correct and the engine stands on a plane floor.

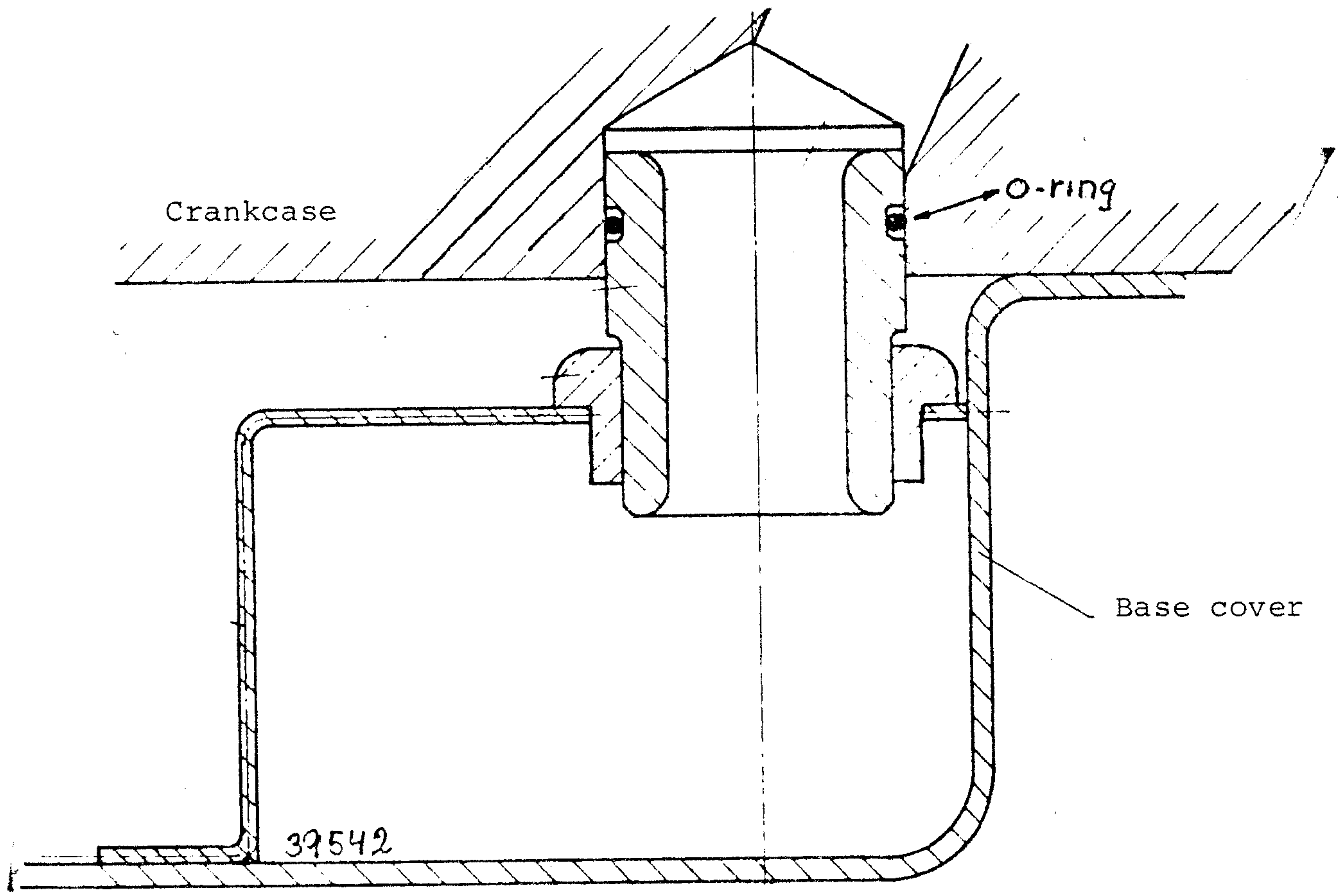
Fitting of Oil Dip Stick for DV10 and DV20

- new execution -



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.



Tightening of Lubricating Oil Grooves

It is necessary that the O-rings which are used between crankcase 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 crankcase. It may also be necessary to make the holes in the gasket bigger.

Section L

Crank Shaft, Intermediate Bearing and Rear Main Bearing Bush

Contents

Repair Dimensions of Crank Shaft

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85000		4400.1.E	1973
DV20	92000		4600.1.C	1973

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

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

The crank shaft 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 crank shaft must be:

DV10 0.18 - 0.43 mm (0.0071 - 0.0169 inch)

DV20 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")
0.3 mm undersize .... 64.687 - 64.700 mm (2.5467-2.5472")
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")
0.3 mm undersize .... 55.687 - 55.700 mm (2.1924-2.1929")
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 (DV20)

Standard .... 55.987 - 56.000 mm (2.2042-2.2047")
0.3 mm undersize .... 55.687 - 55.700 mm (2.1924-2.1929")
0.6 mm undersize .... 55.387 - 55.400 mm (2.1806-2.1811")

Connecting Rod Journals

Standard	53.987 - 54.000 mm (2.1255-2.1260")
0.3 mm undersize	53.687 - 53.700 mm (2.1137-2.1142")
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")

Exchange of Crank

	From eng. No.		Parts list No.	Year
DV10	204812		021D0007	1977
DV20	98646		021D0007	1977

In connection with the above engine numbers balanced connecting rods have been introduced which demands a special weighed-out crank (drawing No. 008E4561).

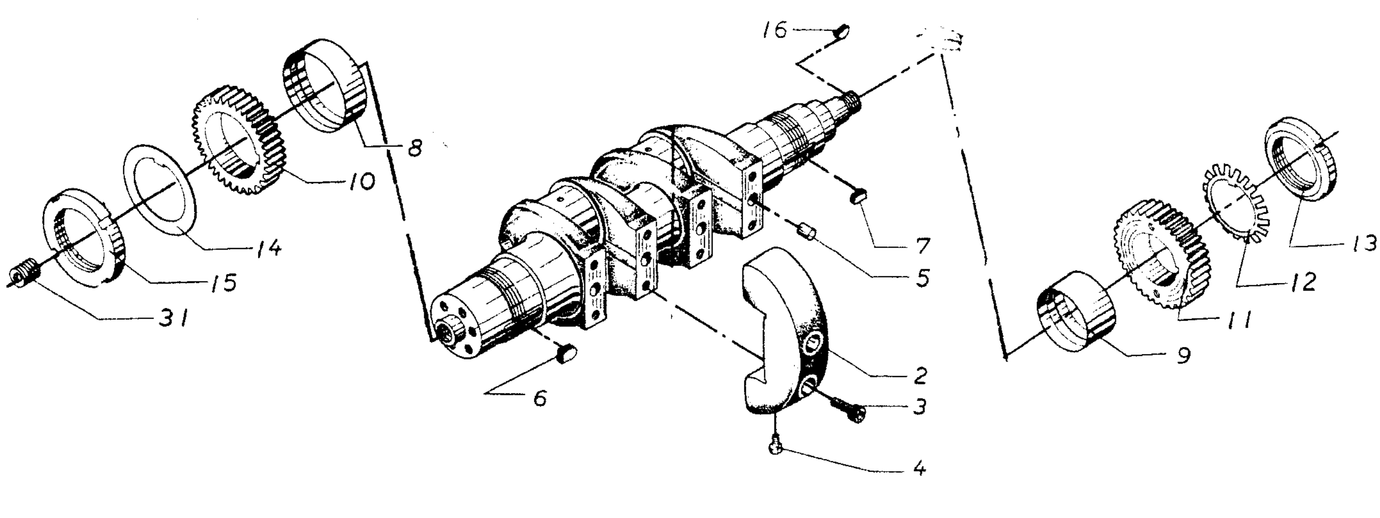
It is therefore necessary to use connected spare parts, when an exchange is found necessary.

Dismounting of Crank Shaft

1. Dismount the fly-wheel (see section D 3).
2. Dismount the gear (see section R).
3. Dismount the cylinder head (see section C page 7).
4. Dismount the pistons and the connecting rods (see section IJ 3).
5. Dismount the cooling water pump (see section O page 5).
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 page 3).
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. Special for DV 20.

    The camshaft is supplied with an intermediate bearing. For old types this bearing is loosened by screwing out the expansion bolt for the intermediate bearing about 10 mm (0.393 inch) and then driving in the expander by striking on the bolt. Then you can screw out the bolt. For the new types the intermediate bearing is loosened by screwing out the bolts fixing the intermediate bearing to the crank case (see drawing next page).
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 crank shaft.
14. Then lift out the crank shaft with intermediate bearing.

The mounting of the crank shaft takes place in reverse order, and if the engine has expansion bolt and key, the expansion bolt must be tightened with a torque of 2.4 kgm (17.35 ft.lbf). If the intermediate bearing is fixed to the crank case with screws, these must be tightened with a torque of 2.5 kgm (18.08 ft.lbf).



	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	85000		4400.1.E	1973
DV 20	92000		4600.1.C	1973

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 3).

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.

Change of Intermediate Bearing

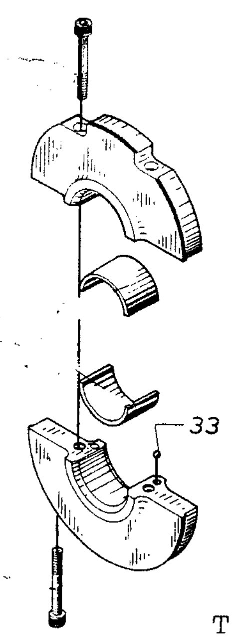
Unscrew the two unbraco screws and take out the two bearing halves. The bearing halves are assembled round two steel balls, 33.

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

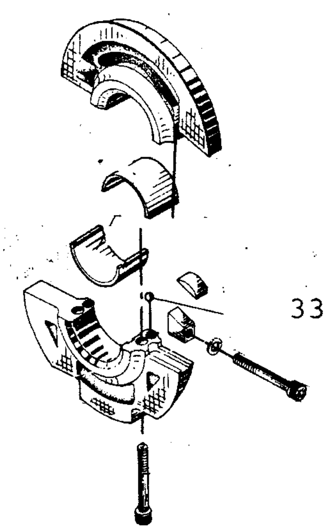
At the mounting you must tighten the bearing lightly first, then knock gently with a plastic hammer in order to secure that the guide balls are in place.

Then tighten the intermediate bearing evenly with a torque of 6.2 kgm (44.8 ft.lbf) if the bearing is supplied with key and expansion bolt, i.e. type A. If the intermediate bearing has screws , i.e. type B, it must be tightened with a torque of 5.2 - 5.8 kgm (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.



Type A



Type B

Section M

Camshaft, Complete

Contents

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85967		4400.1.E	1973
DV20	92447		4600.1.C	1973

Camshaft

The cams which are pressed into the camshaft are made of hardened steel. The cams are for the suction and exhaust valves and for the fuel pump.

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

The correct position of the camshaft must be between 0.2 - 0.5 mm (0.008 - 0.020 inch) for DV10 and DV20. The axial clearance must be adjusted with shims between rear end cover and camshaft or by displacing the camshaft bearing.

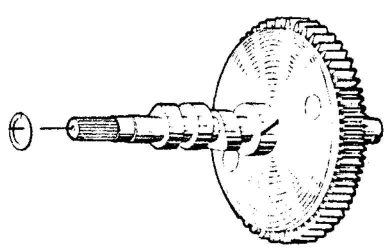
Dismounting of the Camshaft

1. Dismount the fuel pump (section H page 15).
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 page 5).
6. Dismount the lubricating oil pump (see section N page 5).
7. Dismount the raised hand starting (see section F page 4) 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 clutch (see section R page).
10. Dismount the rear end cover with counter weights (see section G pages 3 and 4).
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 crank shaft and the camshaft.

If under the dismounting some of the push rods have fallen down into the crank case, you must dismount the oil sump and grease the push rods before remounting them 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

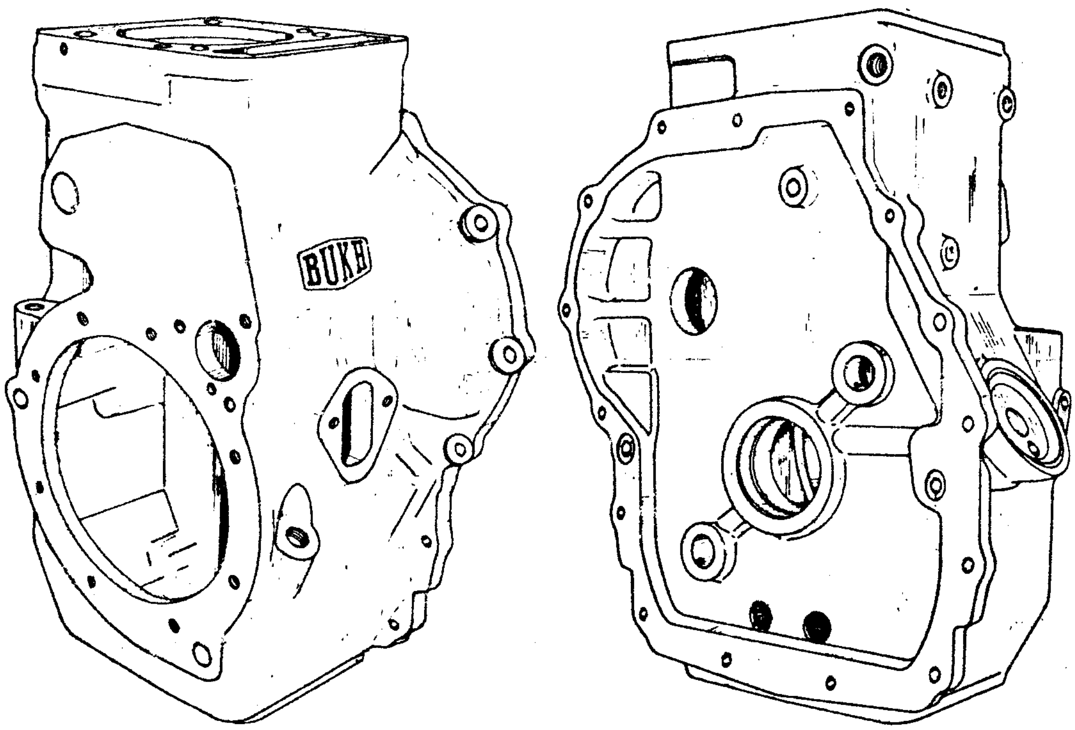
1. Dismount the camshaft (page M 3).

2. Dismount the front end cover (section E page 3).

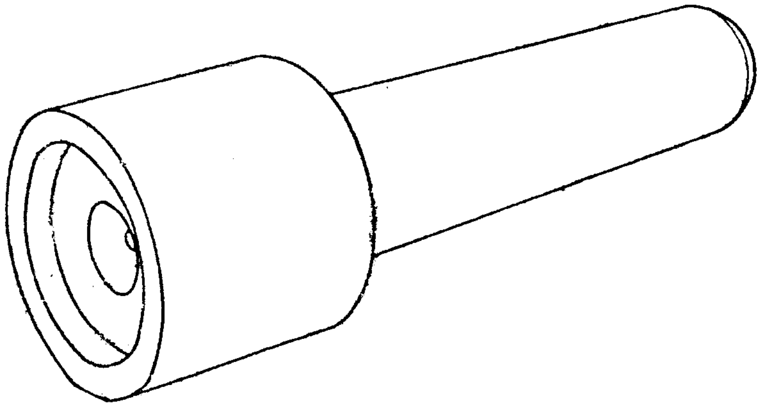
3. The bearing bushes can now be driven out by means of a suitable punch.

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

The cam shaft bearing bush has by a new engine an outer diameter of 42.000 - 42.024 mm (1.654-1.6545 inch) and an inner diameter of 20.040 - 20.053 mm (0.78890-0.7895 inch).



Placing of the bearing bush
in the crank case



Mounting punch

Check of 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 fly-wheel 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 fly-wheel until the valve has sunk 0.10 mm (0.004 inch) and mark the fly-wheel 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.

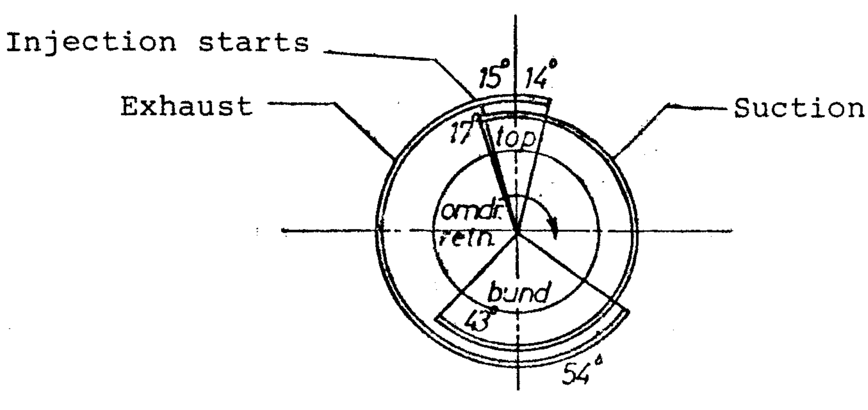
11. Adjust the clearance of the exhaust valve to 0.3 mm (0 inch) and place the dial micrometer on the valve. (spring disc).

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 Times

Suction valve	opens	17°	before	TDC	(arc measure 58 mm - 2.28")
-	- closes	43°	after	BDC	(arc measure 147 mm - 5.78")
Exhaust valve	opens	54°	before	BDC	(arc measure 184.5 mm 7.26")
-	- closes	14°	after	TDC	(arc measure 48 mm - 1.89")



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 page 9).
2. Dismount the gear (see section R page).
3. Dismount the rear end cover (see section G page 3).
4. Remove the bolts 7.
5. Dismount the driving piece 4, the springs 5, and the centrifugal weights 3.

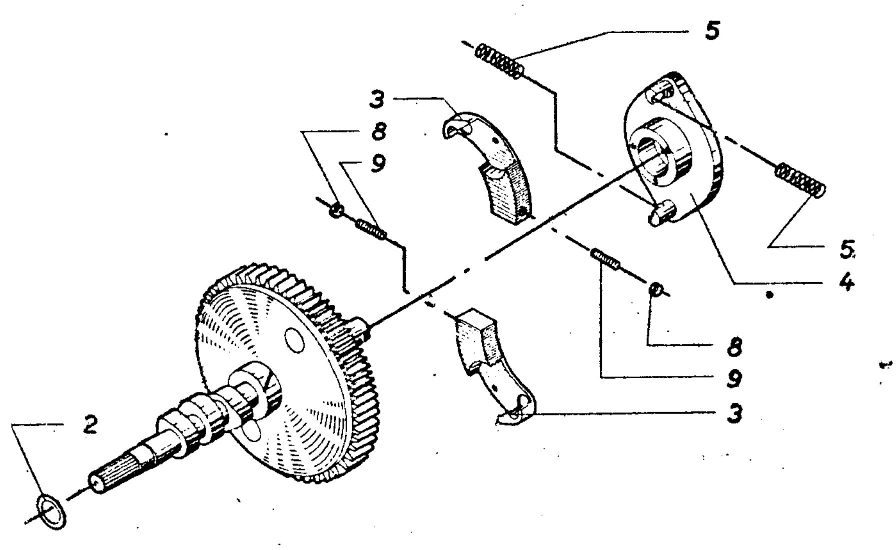
Mounting

The mounting takes place in reverse order and it must be checked that all parts operates 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 treaded 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 page 25.



Check of Injection Timer

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

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

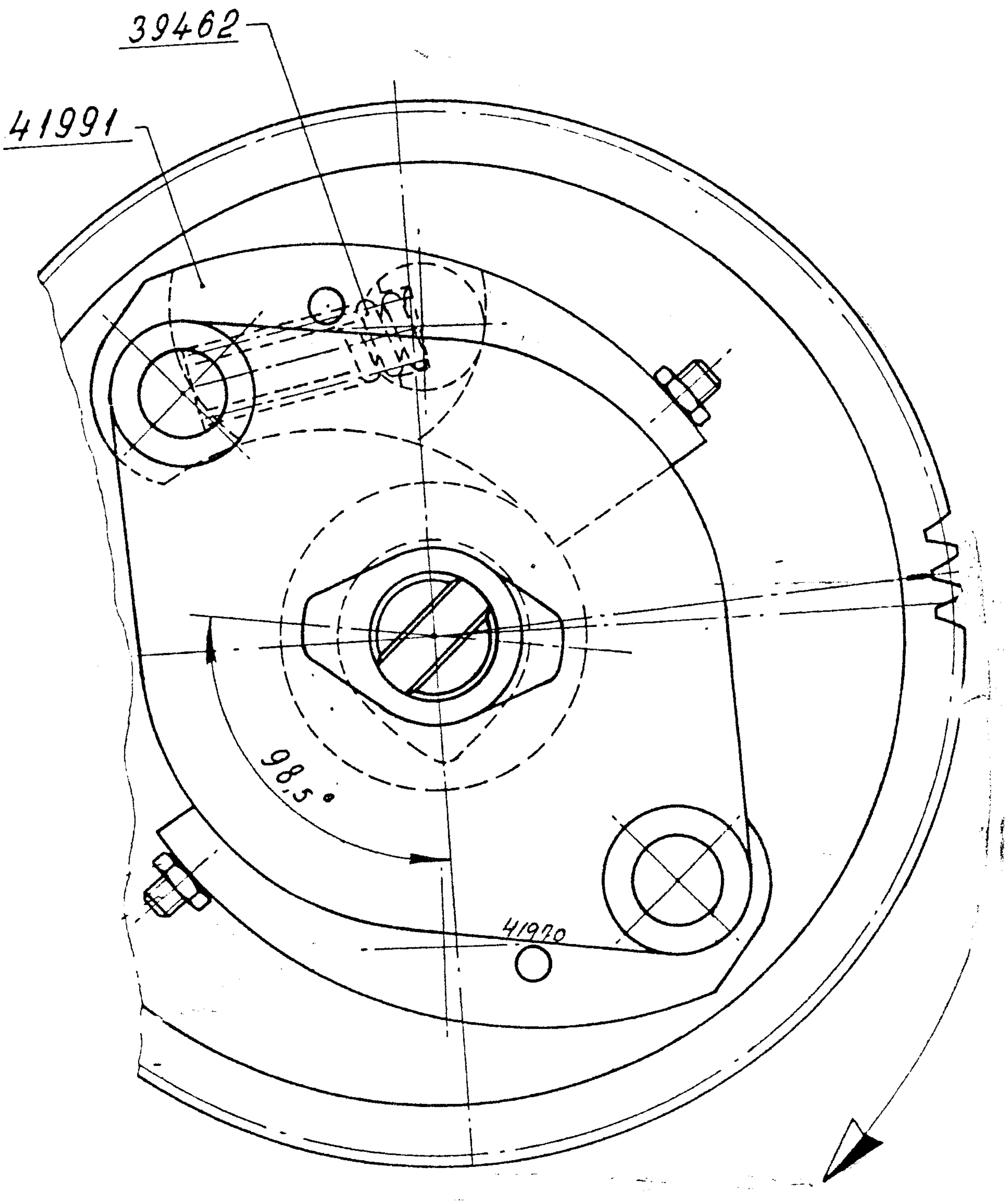
If the above torques cannot be achieved, you must change the spring force by grinding off the turns or by placing adjustment washers under the spring.

Too high torque .... grind off

Too small torque .... use adjustment washers

Arrangement of Automatic Injection Timer

Assembly drawing



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

Section N

Lubricating 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 - 4.0 kg/cm^2 at hot engine and maximum revolutions.

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

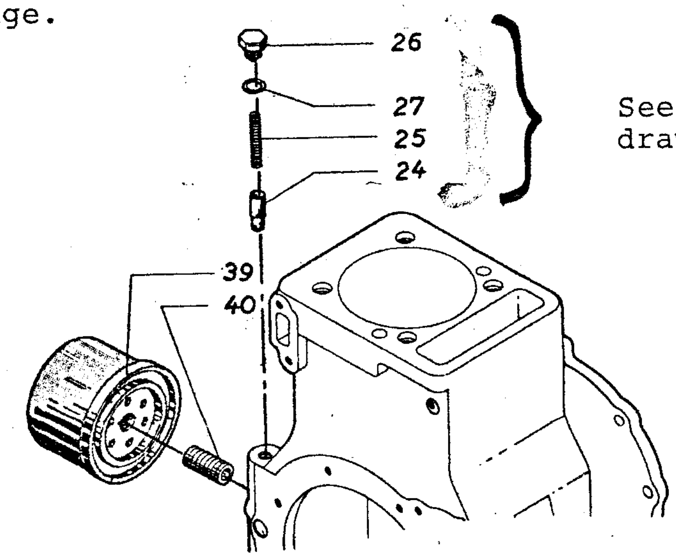
Excess-pressure Valve

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 kg/cm^2 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 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.



See arrangement drawing page N 4

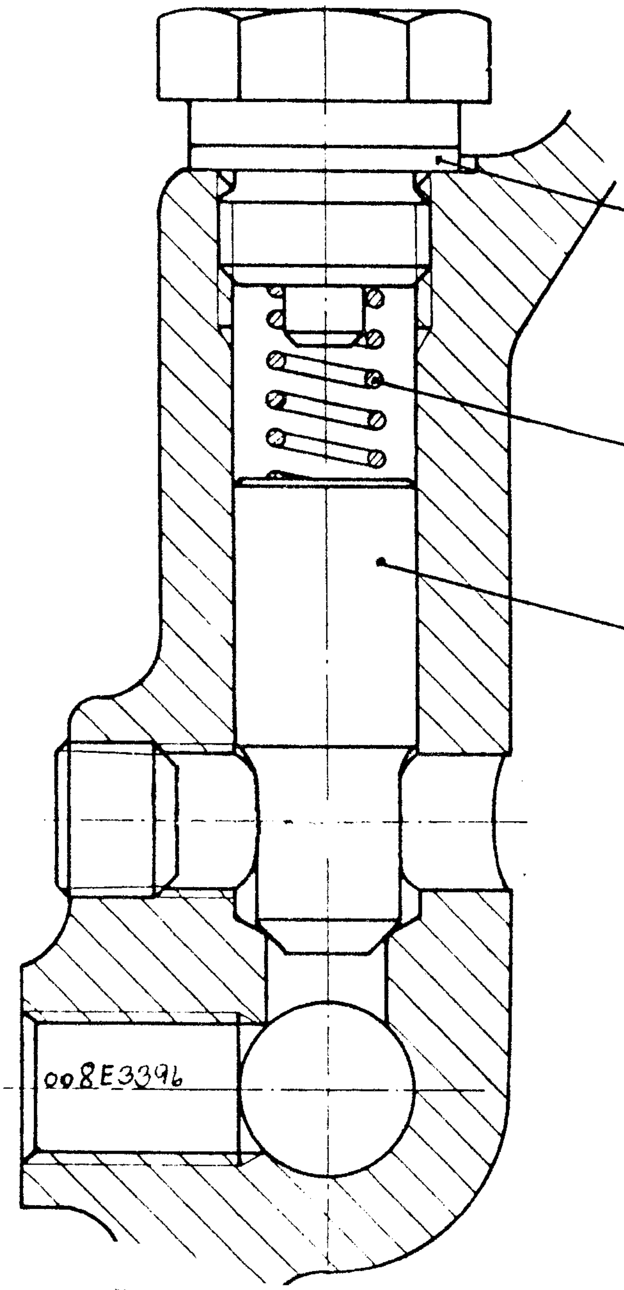
Lubricating Oil Filter

The lubricating filter 39 cannot be cleaned, but must be replaced every 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 the hand.

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

Arrangement Drawing of Lubricating Oil Reduction Valve



The above fig. Nos. show the lubricating oil reduction valve in the new execution. The improvement is that the designing of the valve has been changed. The function is still the same.

Lubricating Pump - Old Type

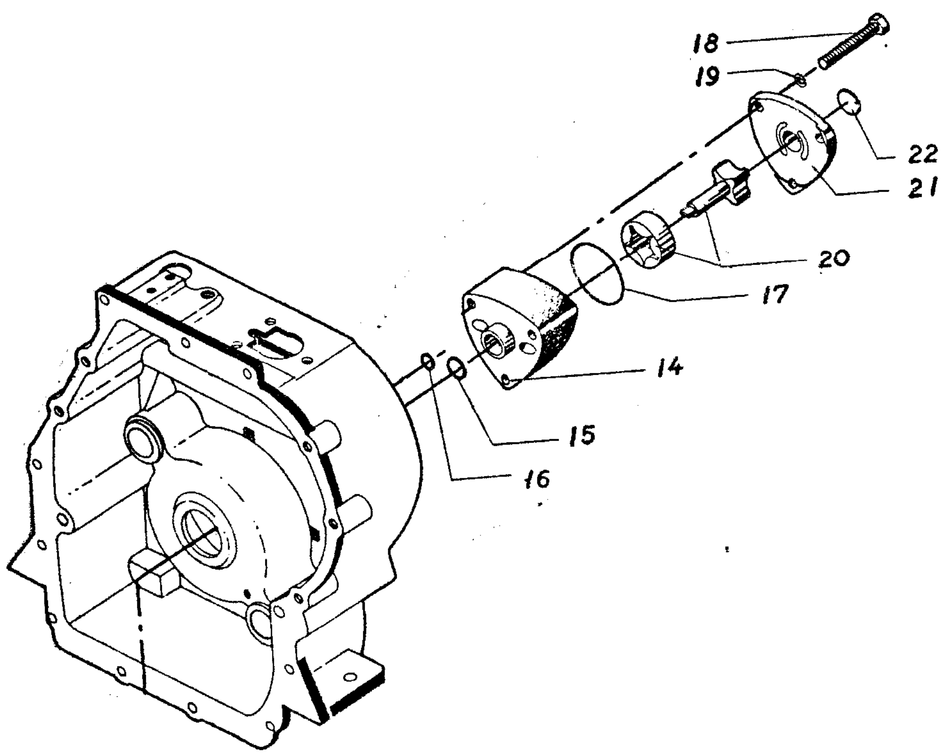
The lubricating pump make Eaton has a capacity of 10 l/min.
See page N 6 fig. 1.

Dismounting

1. Dismount the bolts 18.
2. Pull out the inner rotor 20.
3. Dismount the pump housing 14 and pull out the outer rotor 20.
4. Dismount the O-rings 15, 16, and 17.

Mounting

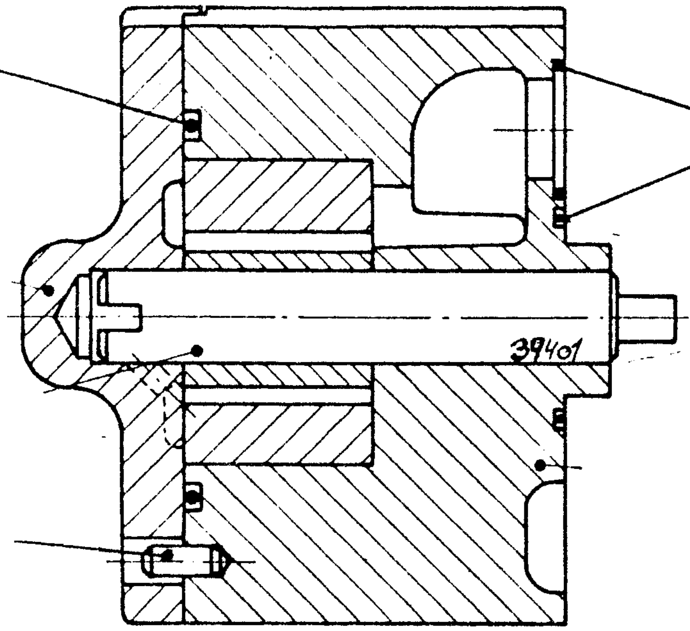
1. Examine the O-rings for wear and replace if necessary.
2. Mount the O-rings 15 and 16.
3. Assemble the outer and the inner rotor 20.
4. Mount the outer rotor in the pump housing. The tolerance between housing and rotor must be 0.05 - 0.15 mm (0.002 - 0.006 inch.).
5. Place a steel ruler across the terminal face of the housing and check the tolerance between rotor and ruler. This tolerance must be 0.025 - 0.075 mm (0.001 - 0.003 inch.).
6. Mount the O-ring 17 and the cover. Tighten the bolts with a torque of 2 - 2.3 kgm (14.5 - 16.6 ft.lb.).



Lubricating Oil Pump in Old Execution

1. O-ring

2. o-ring



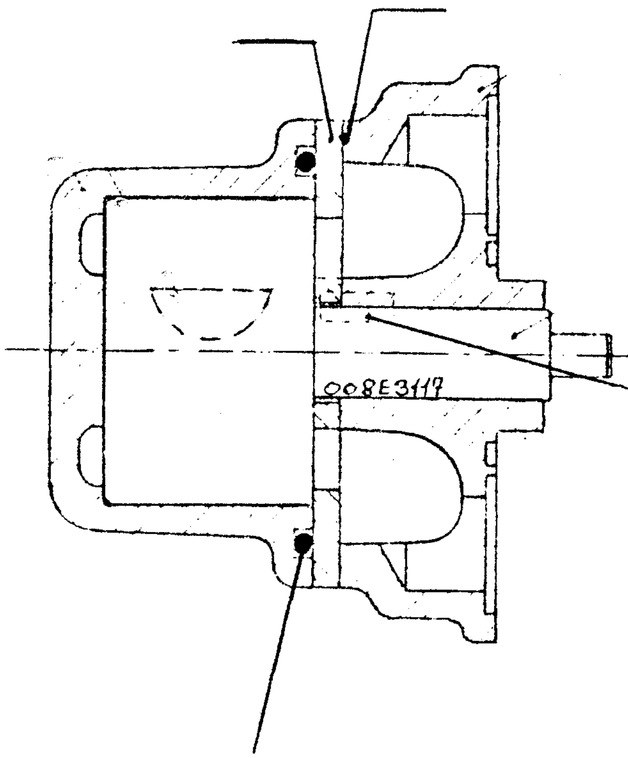
3. Guide pin

4. Fig. 1

Lubricating oil Pump in New Execution

1. Intermediate plate

2. Gasket



3. Guide pin

4. O-ring

5. Fig. 2

Lubricating Oil Pump - New Type

	From eng. No.	To eng. No.	Parts List No.	Year
DV10	203612		021D0007	1976
DV20	96233		021D0007	1976

From the above engine numbers a new type of lubricating oil pump has been introduced. The pump is shown on page N 6 fig. 2.

The capacity of the pump is the same as the one of the old execution.

Contrary to the old type of pump the new execution is used for both DV10 as well as for DV20.

As lubricating oil pump the new lubricating oil pump can direct replace previous executions.

Lubricating Oil Quality

The designations used until now, DM and DS, which are designations for the lubricating oil quality from the old API classification system are replaced by the corresponding designations CC and CD from the new API classification system.

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

Besides, quality mark "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.

In air temperatures at the engine between 5°C and 25°C viscosity SAE 20 is used.

In air temperatures at the engine above 25°C viscosity SAE 30 is used.

Section O

Cooling Water System

Contents

DV10 and DV20 are water cooled and are supplied with various cooling systems according to the use of the engines.

The cooling water is circulated through the engine by means of a Johnson rotary pump with rubber impeller.

A constant cooling water temperature is obtained by means of a thermostat placed in connection with the cooling water outlet.

Direct Cooling (Seawater Cooling
Cooling Water Pump

	From eng. No.	To eng. No.	Parts List No.	Year
DV10	85967	203811	4400.1.E	1973
DV20	92447	97548	4600.1.C	1973

Technical data:

Make .... Johnson

Type P.31.934

Capacity .... max. 11.7 l/min. for DV20
max. 7.3 l/min. for DV10

~~Counter Pressure~~.... ~~max.~~ 6 m W.C.

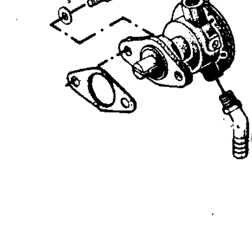
Suction (manometric) 3 m W.C.

Cam height DV10 .... 2.4 mm
- - DV20 .... 3.4 mm

Dismounting

1. Drain off the cooling water.
2. Remove the the inlet and outlet hoses of the pump.
3. Remove the bolts 22 and pull out the pump.

The mounting takes place in reverse order and the bolts 22 should be tightened with a torque of 2 - 2.3 kgm (14.5 - 16.6 ft. lbf.).



	From eng. No.	To eng. No.	Parts list No.	Year
DV10	203812		021D0007	1976
DV20	97549		021D0007	1977

From the above engine numbers a changed and improved execution of the cooling water pump has been introduced. In principle the function is the same as the one of earlier executions whereas the fitting is different.

The cooling water pump is fixed by means of a clamp - torque 1 - 1.3 kpm. See to it that the drain hole is turning downwards.

Technical Data

Make .... Johnson

Type 10-32412-1

Capacity .... 11 l/min.

Manometric delivery head .... 10 m W.C.

Cam height .... 3.4 mm

---- 0 ----

In connection with freshwater cooler (heat exchanger) it is necessary to use a special seawater pump for DV20 engines, as a larger quantity of seawater is necessary. Type 10-32412-1 is used for DV10 engines.

Technical Data - Pump for DV20

Make .... Johnson

Type .... 10-35064-1 (BUKH No. 610G0120)

Capacity .... 17 l/min.

Manometric delivery head .... 10 m W.C.

In connection with this cooling water pump exhaust bend No. 000E3890 must be used, as the manometric counter-pressure of the pump would otherwise be too high.

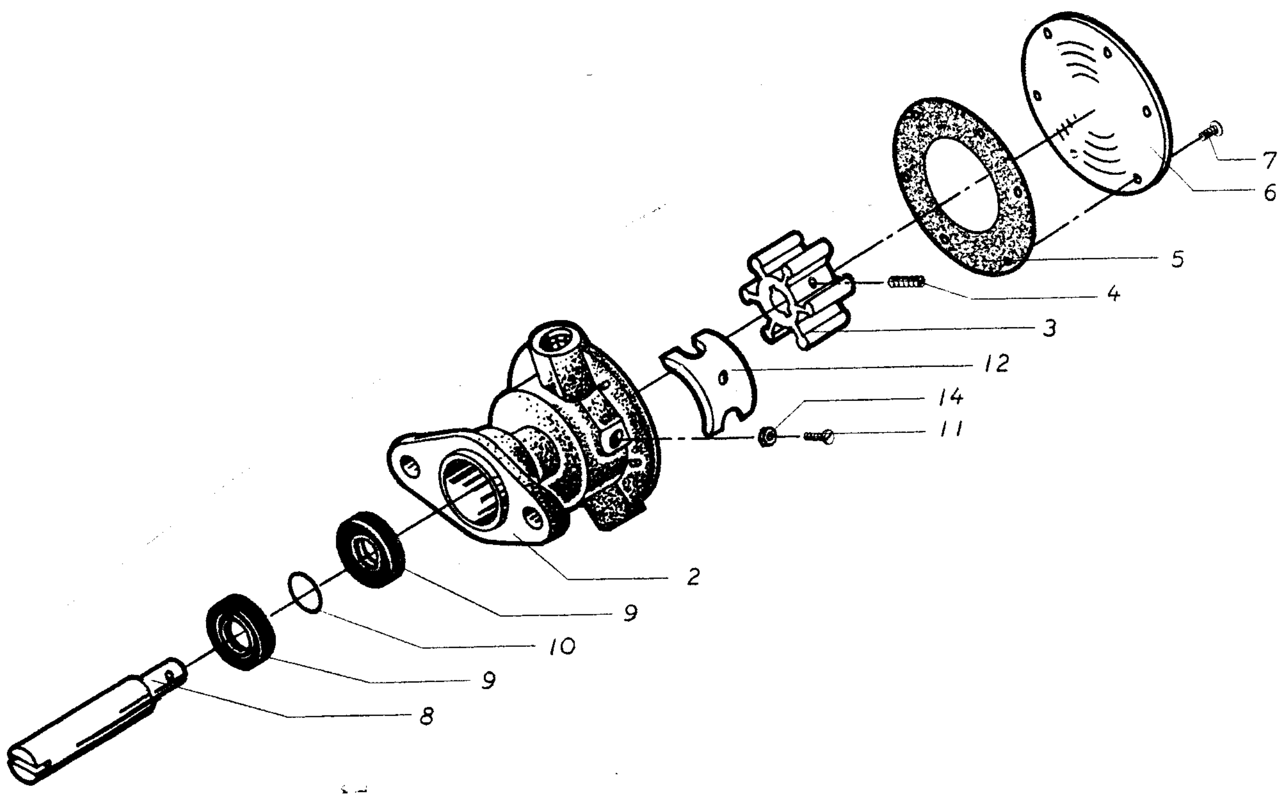
Dismantling of Cooling Water pump

1. Dismount the cooling water pump (see page O 3).
2. Unscrew the set screws 7 and remove the cover 6.
3. Pull out the rubber impeller 3 and the shaft 8 at the front of the pump housing.
4. Dismount the screw pin 4 and dismantle impeller and shaft. Examine whether the impeller is worn and replace it if necessary.
5. Examine whether the oil seal rings and the O-ring 9 and 10 are worn and replace these if necessary.

Assembling takes place in reverse order. See to it that the wings of the rubber impeller bend backward from the rotation direction at the cam.

The cam 12, which is removable when the rubber impeller is removed and the screw 11 is unscrewed, is used for adjustment of the volume of water. If the cam 12 shows signs of wear, or if it is seized on the surface it must be exchanged.

Below an exploded view of the Johnson pump type P.31.934 is shown. The other pumps are built up in the same way, and consequently the procedure is the same.



Thermostat

The thermostat is used to keep the cooling water temperature as constant as possible. The thermostat starts to open at 60°C and the normal cooling water temperature is about 70°C.

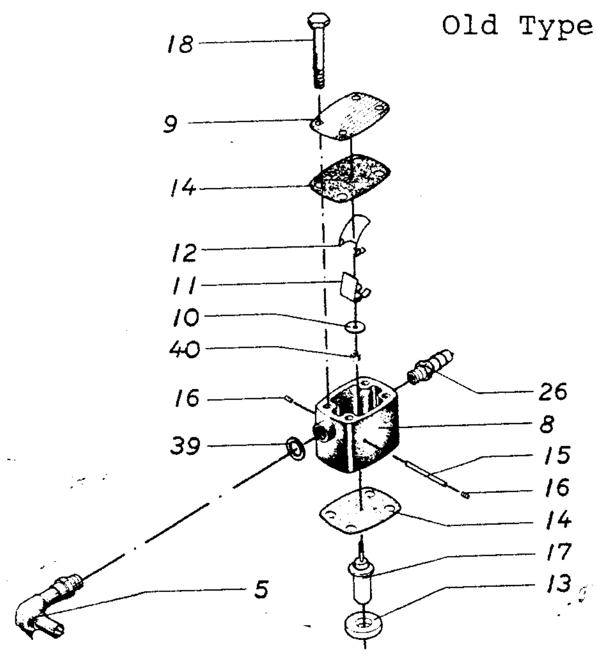
	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85967	89156	4400.1.E	1973
DV20	92447	93637	4600.1.C	1973

In connection with the above engines a thermostat of the wax type is used.

The function of the thermostat is based on the expansion of the wax at rising temperature resulting in an opening of the cooling water passage.

Dismantling and repair of the thermostat are desribed below.

Old Type



Dismounting

1. Remove the inlet and outlet hoses of the thermostat.
2. Loosen the four machine bolts 18 and lift the thermostat from the cylinder head.
3. Remove the cover 9.
4. Unscrew the connections 5 and 26.
5. Remove the pointed screws 16 and knock the shaft 15 out of the housing with a thin punch.
6. Remove the spring 12 and the valve flap 11.

7. Remove the disc valve 10.
8. Pull the thermostat body 17 with the ring 13 out of the housing from below.
9. Remove the ring from the thermostat body.

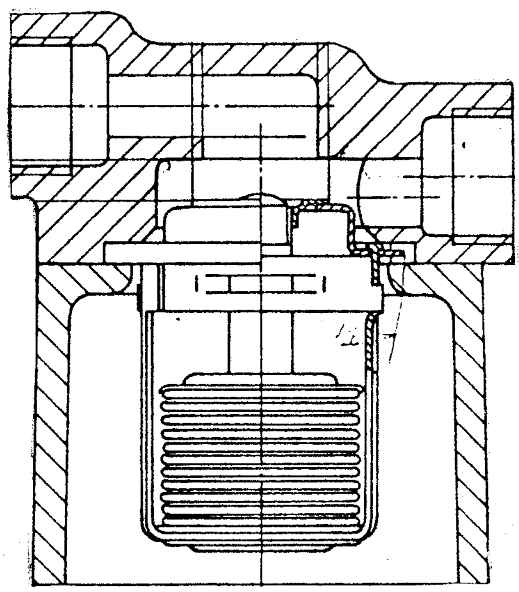
Mounting

1. Screw home the nut on the push rod of the thermostat body and fasten it with LOCTITE.
2. Mount the ring on the thermostat body and press the assembly into the housing.
3. Fit the disc valve.
4. Place the spring and the valve flap, and fit the shaft. Screw in the pointed screws.
5. Fit connections, top cover, and inlet and exhaust hoses.

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	89156		021D6301	1974
DV20	93637		022D6301	1974

From the above engine numbers the execution of the thermostat has been changed. The thermostat is made so that it will open for the cooling water passage should it develop a fault, unlike the one previously used. The function of the thermostat is now of the bellows type.

The opening temperature of the thermostat is about 60°C.



New type

It is possible to fit the new thermostat on engines with engine numbers which lie before those mentioned above.

The new thermostat housing can be mounted without changes on DV20, whereas on DV10 the pipe must be cut off, the pipe which connects the thermostat housing to the elbow immediately after the screwed connection on the thermostat housing. If necessary the hoses must be replaced by longer hoses.

For the alteration a hose nipple will be necessary.

In connection with freshwater cooling a thermostat with an opening temperature of 75°C is used.

Fitting of Double Transmitter

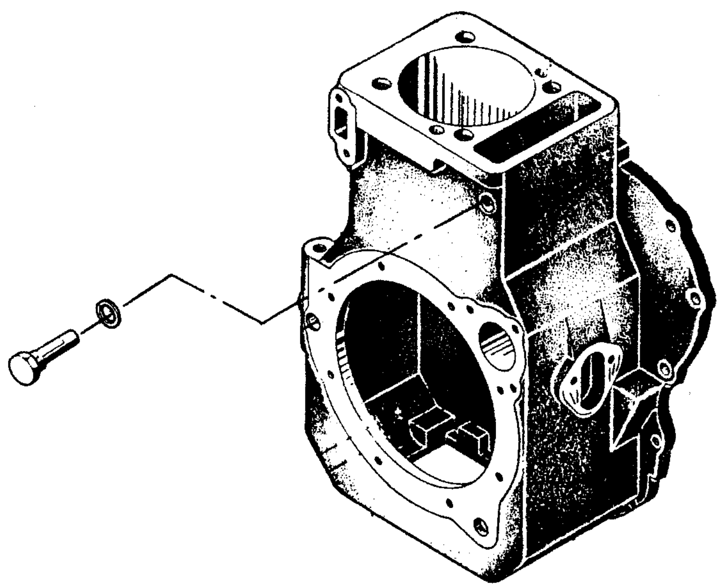
Owing to considerations of space it may not be possible to fit a double transmitter on old thermostat housings.

This can be remidied by soldering on a ring piece No. 000E4136.

Zinc Rod

The zinc rod is placed in the cooling jacket of the crank-case, see the drawing below, where it is screwed in from the front end of the engine. 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 hours. Replace the zinc rod when only half of it is left.



Indirect Cooling (Freshwater Cooling)

DV10 and DV20 engines can be supplied with two kinds of freshwater cooling, viz. cooling with heat exchanger and keel cooling.

The two cooling methods are differently built up, even though in principle the function is the same.

Heat Exchanger System

The heat exchanger system for DV20 is shown on page O 15.

DV20 Engines

Particular attention should be paid to the placing of the thermostat in connection with the exhaust manifold.

Dismantling, Cleaning and Reassembly of Heat Exchanger for DV10 and DV20

1. Turn off the seawater intake and drain off the fresh and the 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 2 x 3 nuts.

4. Now the cooling unit can be taken out and cleaned. The cooling unit is built up as a nest of pipes of nickolite. The pipes are tinned inside and outside, which - together with the bottoms of gun metal - gives an optimum protection against corrosion.

Out of consideration for the tinning of the pipes there must only be used water and a soft brush when cleaning the nest of pipes. Chemicals or steel brushes must not be used.

Exchange of Thermostat

On DV20 engines with heat exchanger the thermostat is exchanged by removing the heat exchanger first.

Follow points 1 and 2 mentioned under dismantling.

3. Remove the heat exchanger by loosening the 4 bolts securing the heat exchanger to the exhaust manifold.

4. Examine the thermostat and check its function. Exchange the gasket for the thermostat at each dismantling and reassembly.

DV10 Engines

The thermostat should be checked and perhaps exchanged as mentioned above and as it is in case of seawater-cooled engines. The thermostat is fitted as shown under keel cooling.

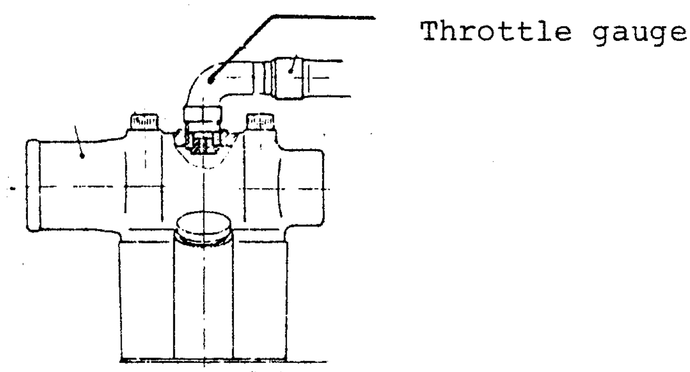
Assemble the heat exchanger in reverse order and see to it that the two O-rings are replaced after each dismantling of the heat exchanger. These O-rings tighten the nest of pipes between the seawater side and the freshwater side.

Cooling Water System for DV10 and DV20

The cooling water system is shown on page O 16 for DV10 and on page O 17 for DV20.

Functionally the systems are indentical whereas in principle they have different components in the construction.

Thermostat Housing

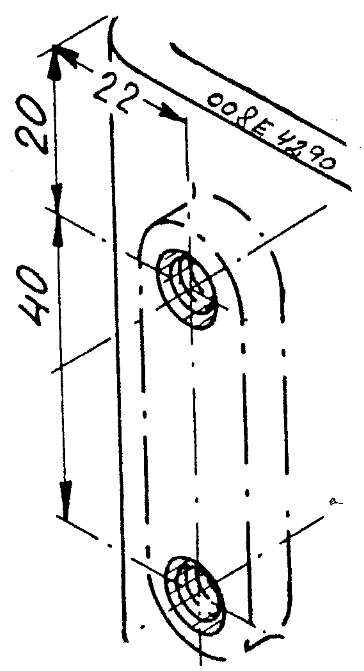


As shown on the above sketch a throttle gauge has been fitted in the cover in the venting connection. If this connection is choked the refrigerating capacity is considerably reduced owing to the increased quantity of air in the system.

Header Tank

Fit the header tank on the left, front side of the cylinder cover.

On old engines, where there is no projection, the mounting holes are to be drilled according to the dimensional sketch below.



Keel Cooling

For both DV10 and DV20 the keel cooler consists of 2 bottoms and a cooling pipe with the dimension ø28/25 x 1500 mm.

Common Components

In the two above systems the freshwater circulating pump, the thermostat, the expansion cover and the V-belt are identical.

Freshwater Circulating Pump

The circulating pump is shown on page O 14. 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 V-belt and 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 end cover of pump.

5. Press bearing shell with shaft, stuffing box and rotor out of pump housing with a punch, the diameter of which corresponds to the inner diameter of the pump housing.

6. Remove rotor from shaft by pressing the shaft out of the rotor.

   Now the stuffing box can be replaced.

If the shaft and the bearing shell show 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 pump shaft and bearing shell in the pump housing so that the locking ring is opposite the hole in the pump housing. Then fit and secure the safety wire.

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 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 flywheel, alternator and circulation 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:	AC-Delco type RC2 - 850501 Working pressure 4 p.s.i.
V-belt:	Rofan S 43 (length 1103 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.

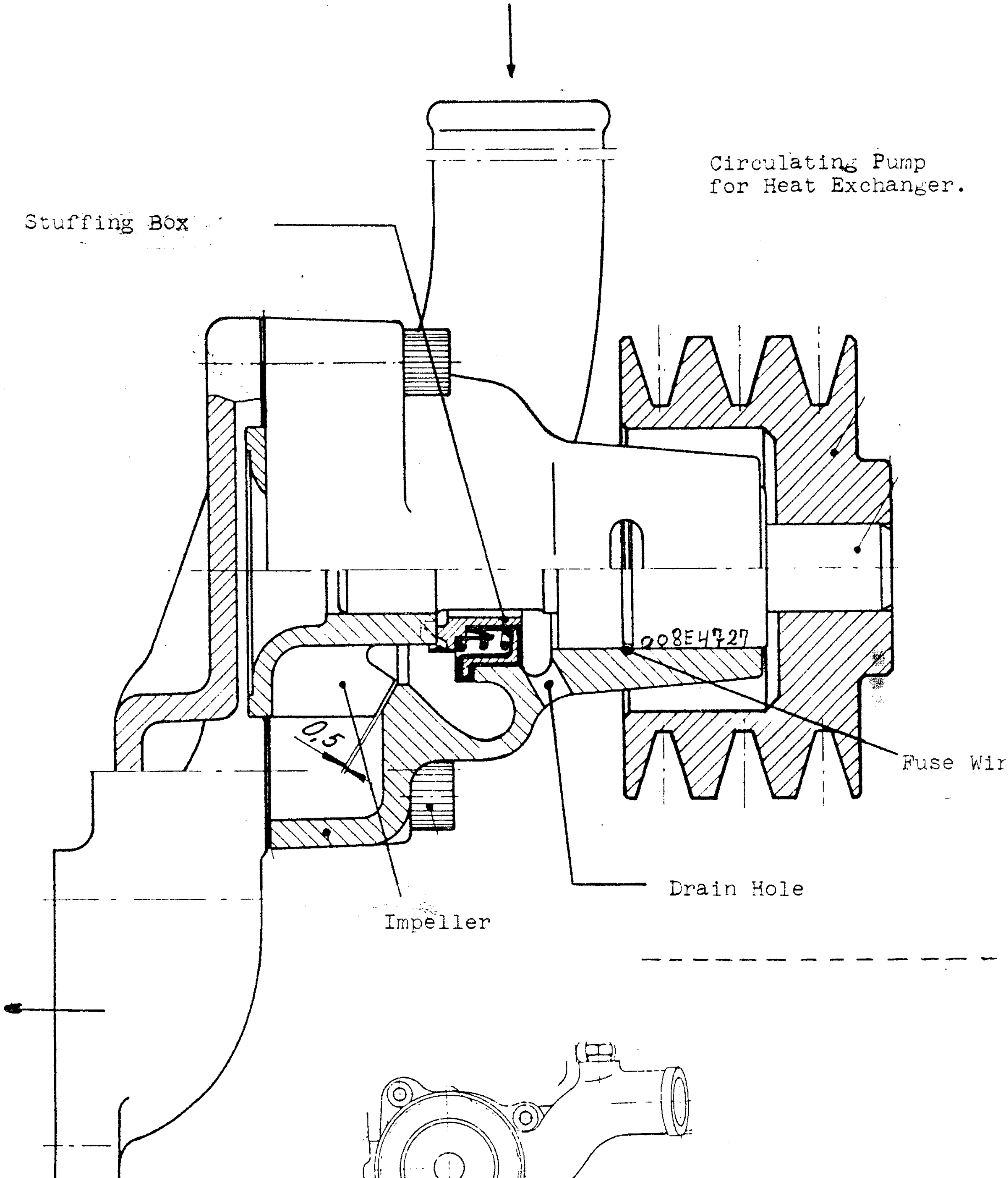
The protection against frost should be carried out considering the local conditions and in accordance with the recommendations for the used anti-freeze solution.

The contents of fresh water for engines with heat exchanger and keel cooling:

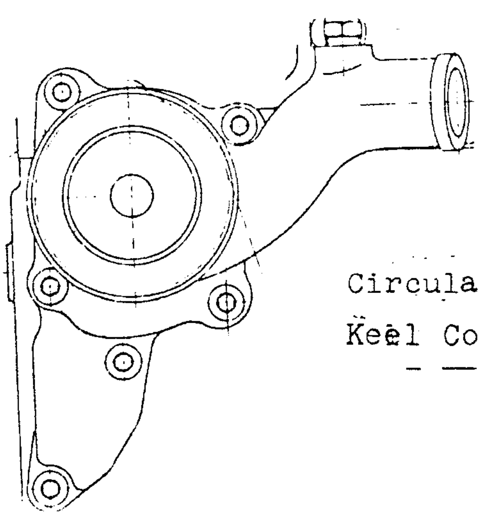
DV10: 4 litres

DV20: 6 litres

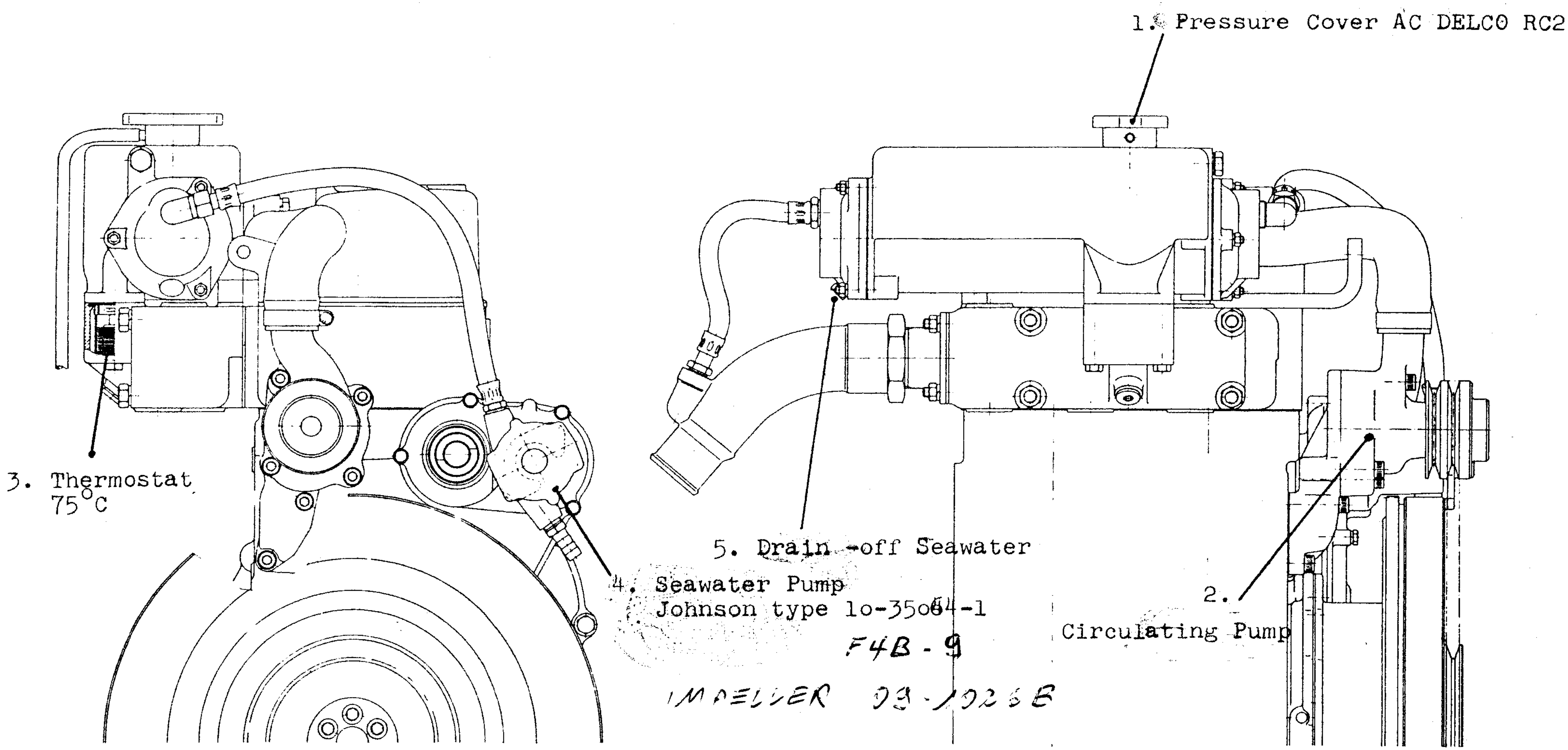
ARRANGEMENT OF CIRCULATING PUMP



Circulating Pump for Heat Exchanger.

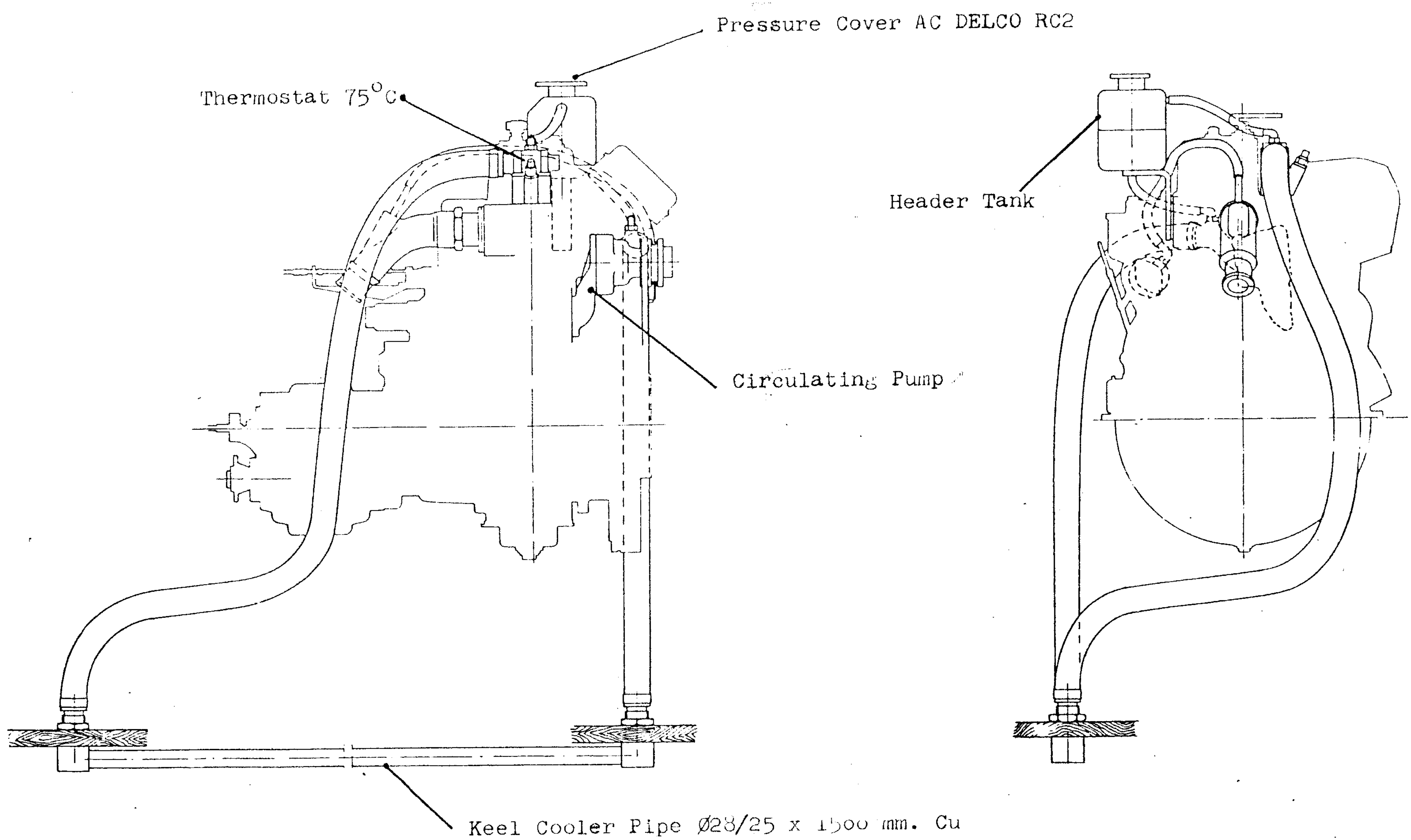


Circulating Pump for Keel Cooling

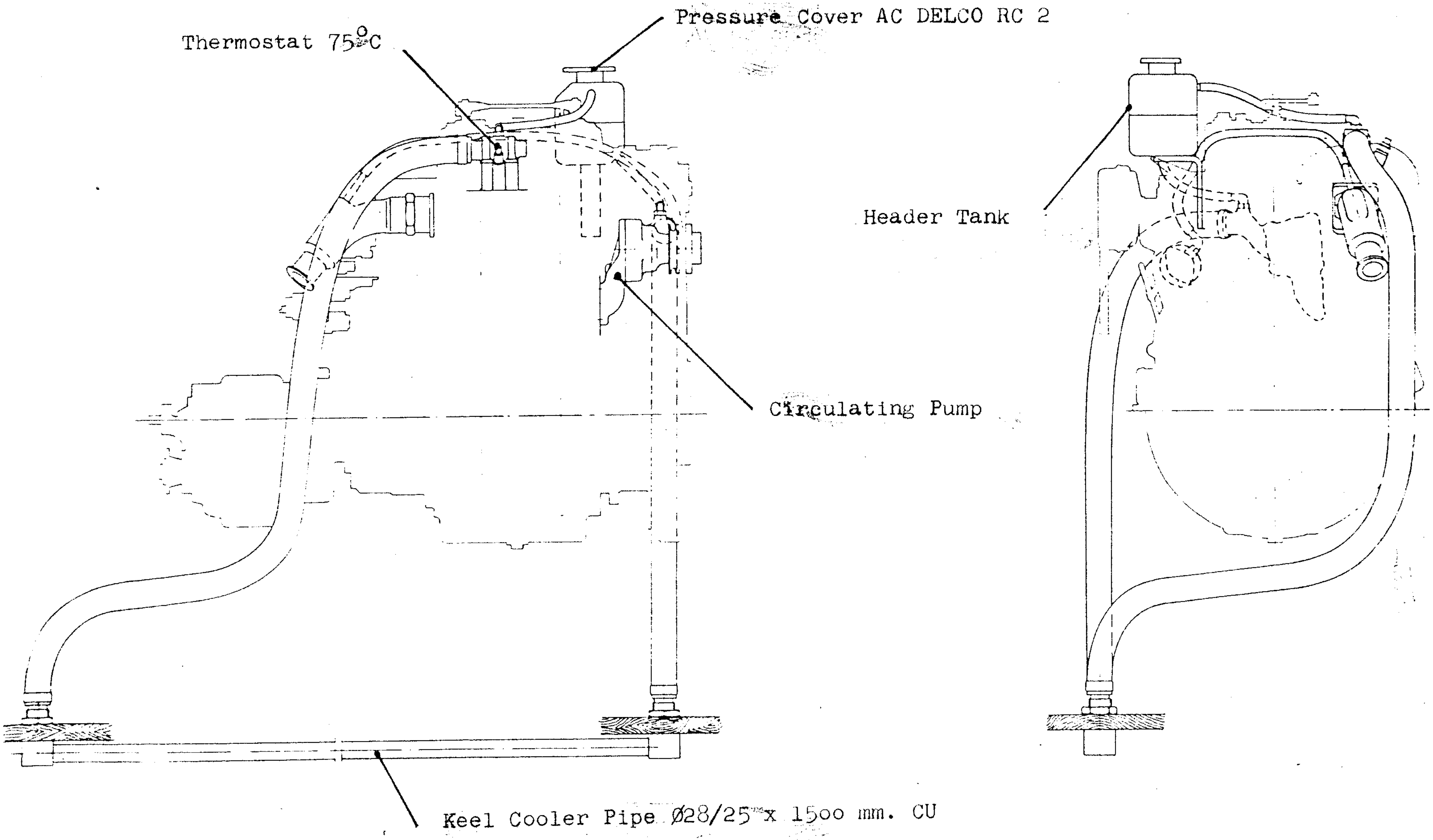


ARRANGEMENT OF HEAT EXCHANGER DV20

ARRANGEMENT OF KEEL COOLING DV10



ARRANGEMENT OF KEEL COOLING DV20



Section P

The Electrical System

Contents

This applies for engines up to and including No. 89156 for DV10 and No. 93637 for DV20. For engines after these numbers the gear rim starter is used (page P 7).

Dynastarter

The dynastarter has the following specifications:

Type .... LA/EJ 90/12/2900+1.0 R
Generator section:
    Voltage .... 14 volt
    Max. delivery .... 11 Amp

Starter section:
    Nominal voltage .... 12 volt
    Output .... 1 HP

Short circuit values:
    Torque .... 2.1 kpm
    Power consumption .... 300 A

Rotation direction seen from flywheel end .. clockwise
Weight .... 9.3 kg

Regarding inspection and testing of the dynastarter you must contact a Bosch workshop.

The following test values can be given

STARTER SECTION									
Battery		Idling			Setting load	Load		Short circuit values	
V	Ah	A	V	rpm	A	V	rpm	A	V
12	24	8-10	11-11.5	2050-2150	170	9.5-10	600-650	290-310	7.5-8.5
	135	8-10	11-12	2050-2150	180	10.5-11	700-730	345-390	9.5-10

GENERATOR SECTION						Clamping tools	
Generator voltage	without load	with load		Setting load	Brush pressure		
V	rpm	cold rpm	hot rpm	A	g		
12	2650-2750	2750-2850	2950-3050	7.5	850-1000	Bush	EFLJ 15/68
						Coupling half	EFLJ 25/64a
						V-belt pulley	EFLJ 15/50
						Pinion	EFMM 1

Supervisory Relay

The relay has the following specifications:

Type	ZAD 14 V 11 A
Charging voltage	14 volt
Max. current	11 Amp.
Short starting current	300 Amp.
Weight	0.55 kg

Regarding inspection and testing of the relay you must contact a Bosch workshop.

DIMENSIONING OF STARTER CABLES

AND

TECHNICAL DATA FOR THE ELECTRICAL SYSTEM

APPLY TO DV10 and DV20

Starter No. 612C1050
Voltage in volt 12
Battery capacity Ah 56
Short circuit current in Amp. 300

Maximum Allowable Distance on Starter Cables	
25 mm^2	2.3 m
35 mm^2	3.1 m
50 mm^2	4.4 m
70 mm^2	6.2 m
95 mm^2	8.4 m
120 mm^2	-

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	85000	89156	020D2302	1973
DV20	92000	93637	020D2302	1973

	From eng. No.	To eng. No.	Parts list No.	Year
DV10	89156		020D2302	1974
DV20	93637		020D2302	1974

When placing the battery after the above engine numbers, the voltage drop in the starter cables must be taken into consideration.

The starter cables are dimensioned according to the table below, which applies to a 56 Ah battery.

Maximum Allowable Total Length of Starter Cables	
35 mm^2	2.4 m
50 mm^2	3.6 m
70 mm^2	5.0 m
95 mm^2	6.8 m
120 mm^2	8.6 m

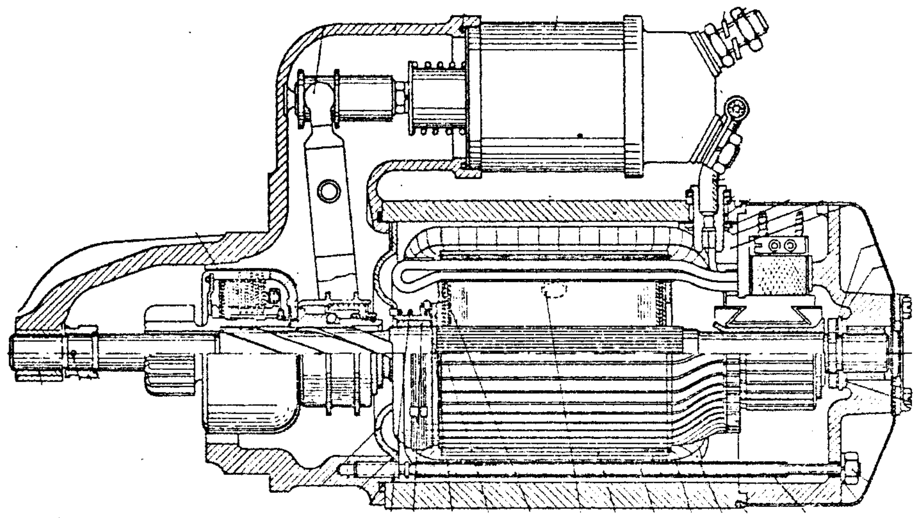
The total cable length means the length from the + pole of the starter to the + terminal of the battery plus the cable from the - terminal of the battery to frame.

<u>THE ENGINE MUST NOT BE STARTED UNTIL THE BATTERY HAS BEEN CONNECTED TO THE ALTERNATOR</u>

	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	89156		020D2302	1974
DV 20	93637		020D2302	1974

Starter motor

Make BOSCH .... type 001 315 004
Voltage .... 12 volt
Output .... 2 HP
Capacity (battery) .... 56 Ah
Max. allowable capacity .... 88 Ah



The starter motor is mounted on the left side of the engine seen from the flywheel end,and via a gear rim shrinked on the flywheel it starts the engine.

The starter motor has self-lubricating bearings, and therefore it needs no lubrication.

After every 800 - 1400 working hours remove the cover of the starter motor and replace worn brushes or defective springs.

If the commutator is dirty or oiled, clean it with a cloth wetted with petrol. Never use emery cloth.

If the surface of the commutator is rough, very scratched or burnt, the starter motor must be dismounted and the commutator turned clean.

Large repairs of the starter motor must be carried out at special workshops.

	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	89156		021D0702	1974
DV 20	93637		022D0702	1974

From the above engine numbers the manual stop of the engine has been altered to a stop magnet.

Stop magnet

Make BOSCH .... type 0330 101 024

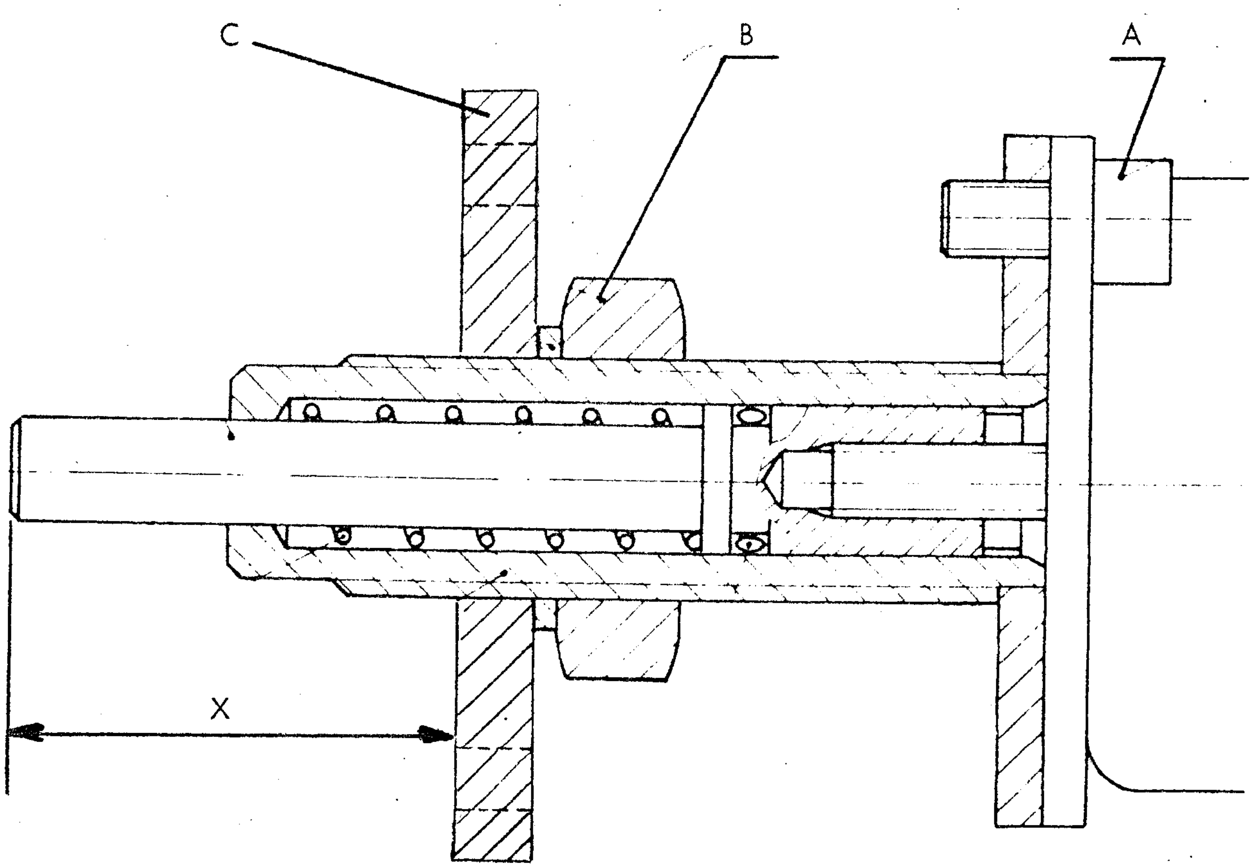
Voltage .... 12 volt

In case of defects on the stop magnet,which cannot be repaired, the stop magnet must be replaced. When mounting a new stop magnet observe the following:

1. Tighten the four fixing screws A evenly. At the slightest disalignment due to the tightening the stop magnet will not work.

2. The stop button, which is actuated by the stop magnet, determines the maximum position the fuel pump control rod. Therefore, it is necessary to check that the distance X, which is adjustable by the nut B, is the same as on the stop magnet previously used.

   This is done easiest by dismounting the stop magnet together with the cover C.



Safety Regulations

At all work on the electrical system always observe the following regulations:

1. Never touch cables and connection without stopping the engine and disconnecting the starter key first.
2. At the alternator the wires between the alternator and the governor must be disconnected.
3. At electric welding both the alternator and the battery connections must be disconnected. Further all light switches must be turned off.
4. At dismounting of the battery the frame connections must be dismounted first.

Battery

When connecting the electrical system of the engine to the battery it is of great importance to use wires with the prescribed squares (see next page).

If the wiring length of the battery is more than 0.5 m from the engine the square of the wire must be considered.

The maintenance of the battery is of great importance to secure the proper starting conditions for the engine and to secure the battery a long life.

The liquid level in the battery must be 5-7 mm above the sheet leads.

Check that the ventilation of the closing plugs is in order.

When gauging the battery with a acidometer the specific gravity must be as shown in the diagram below.

	Battery charged	Battery half charged	Battery discharged
Specific gravity 20°C	1.28	1.20	1.12

When gauging the battery you must first make sure that the liquid level is normal.

The specific gravity changes with the temperature, and so it will be valuable to know that a specific gravity of 1.27 at 25°C will rise to 1.29 at 0°C and fall at 54° C.

For the 1974 execution of the DV engines the electrical system has been altered as described on the following pages.

Generally the alterations for the electrical system are as follows:

1. The dynastarter is replaced by a gear rim starter. From this follows alteration in dimensioning of starter cables.

2. The manual stop of the engine mentioned on page G-15 is replaced by a stop magnet.

3. New wiring diagrams.

4. The wiring system of the engine is now mounted by BUKH and provided with two multiple plugs.

The new electrical system cannot be mounted on old types of engines.

Electrical System

In connection with the change-over to the 1974 model a general alteration of the electrical system and its main components was carried through.

A number of new components was introduced in replacement of the existing ones, and this resulted in a real improvement of the electrical system.

The changes were introduced from the following engines and onwards:

Eng. Type	Eng. No.	Eng. Series	Eng. List	Year
DV10	89157	11-7	D-10	1974
DV20	93638	20-21	022D0002	1974

From the above engine numbers the following components are standard parts in the new electrical system:

Charging System

This system consists of battery, alternator, voltage regulator, and perhaps ammeter, charging lamp, electric mains, cables and frame connections.

Starter System

This system consists of battery, starter motor, starting relay, switches, starting cables and frame connection.

Consumers of Current

Among consumers of current are electrical mains with multiple plugs, instruments, instrument transmitters, stop magnet and consumption take-off.

Battery

The operating conditions of the battery.

The individual parts and the changes carried out will be dealt with separately on the following pages.

Group A: Alternator

In connection with the electrical installation 2 different types of alternators and voltage relays have been used together with the engine numbers mentioned below.

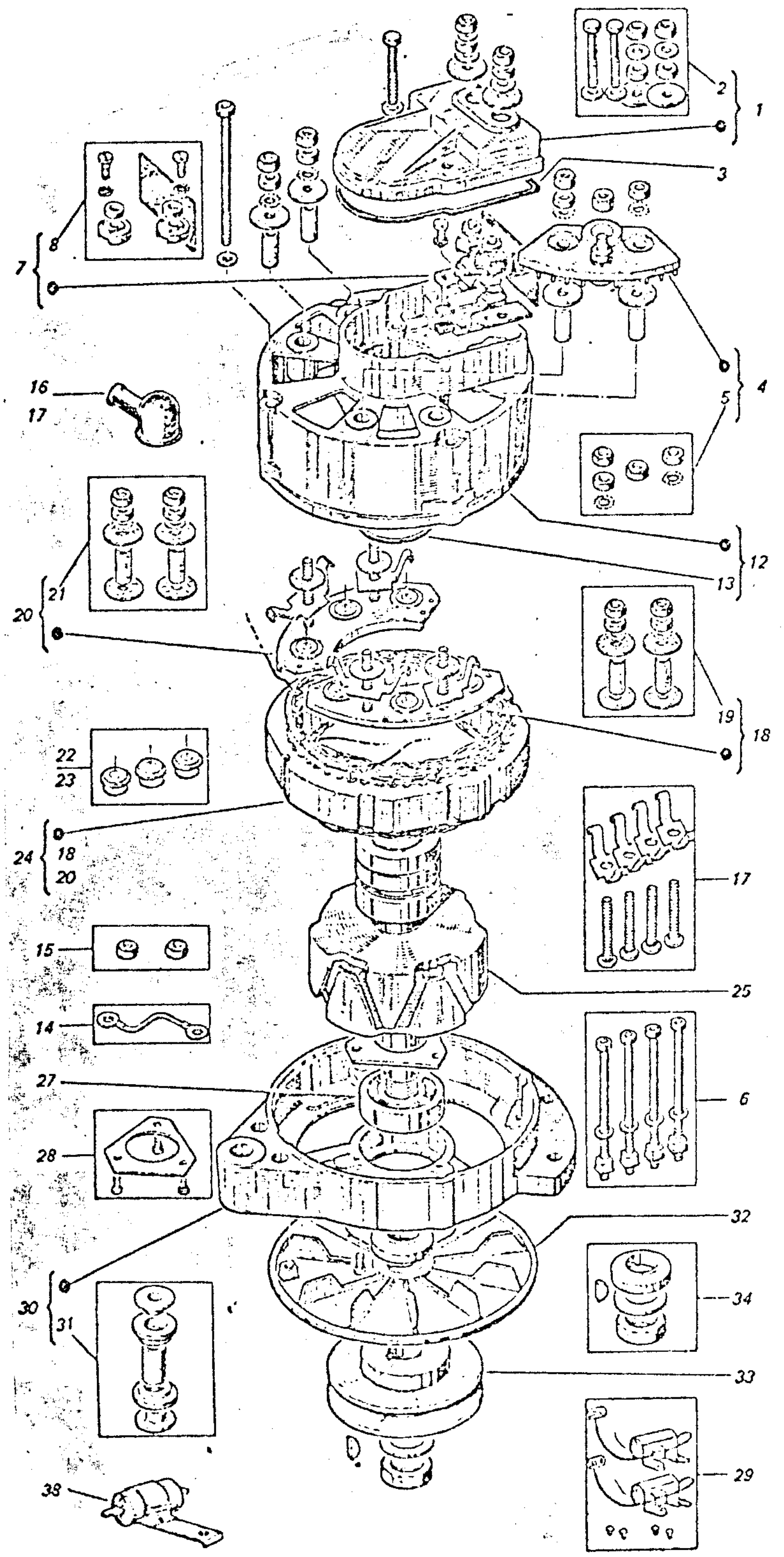
Eng. Type	Eng. No. From	To	Alternator Type	Voltage Relay Type
DV10	89157	203611	S.E.V. Marchal H. 14/30	S.E.V. Marchal F 14V
DV10	203612	-	S.E.V. Marchal 14/35A	S.E.V. Marchal T 14V
DV20	93638	96232	S.E.V. Marchal A 14/30	S.E.V. Marchal F 14V
DV20	96233	-	S.E.V. Marchal 14/35A	S.E.V. Marchal T 14V

Alternator

Make S.E.V. Marchal (Motorola) .... type A14/30
Voltage .... 14 volt
Maximum charging rate .... 38 Amp.
Output at 4000 r.p.m. on generator .... 530 Watt
Maximum revolutions .... 9000 r.p.m.

On the drawing below the alternator is shown dismantled.

Large repairs of the alternator must be carried out at special workshops.

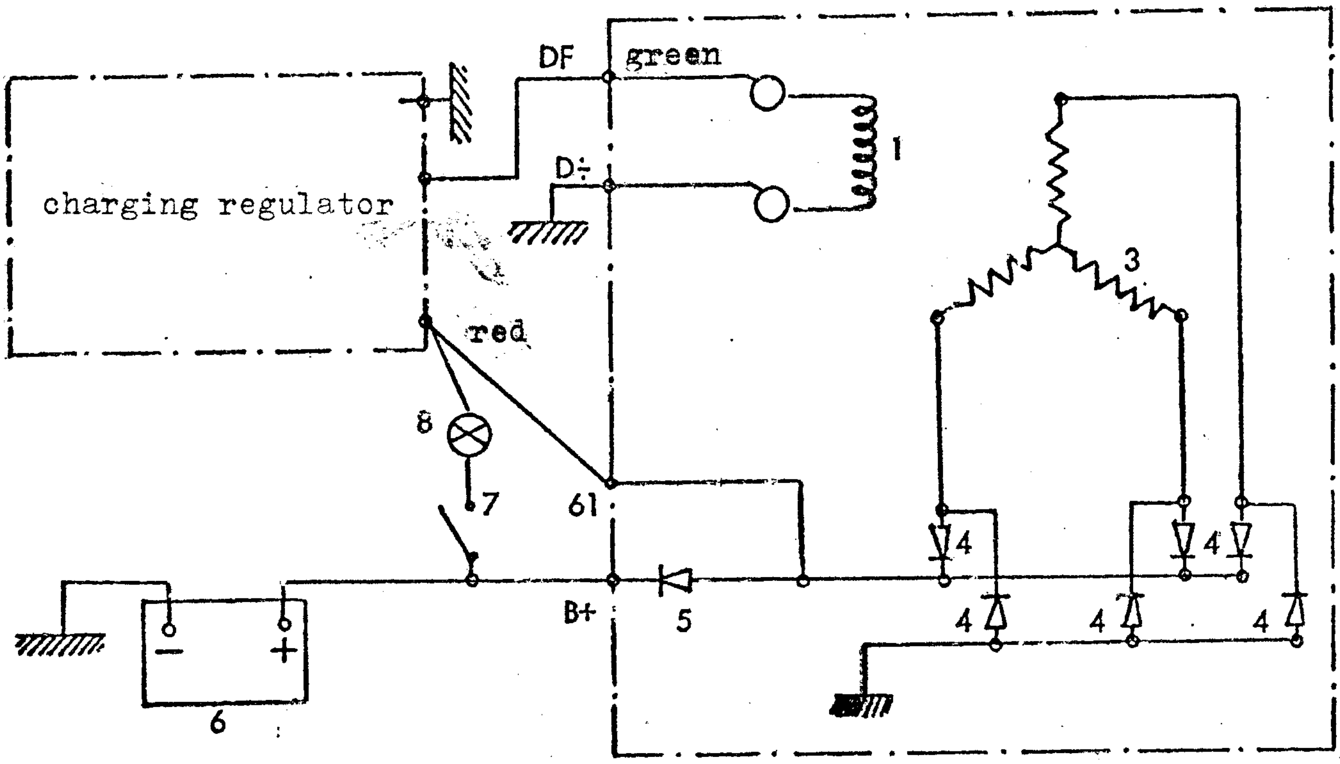


In the electrical systems for DV engines where a S.E.V. Marchal (Motorola) alternator is used the following must be carefully observed.

1. The alternator <u>must</u> always be connected to the battery during operation, otherwise the diode is blown.

2. The alternator must not operate parallel on the same battery as the dynastarter as the load is not distributed equally.

3. If it is necessary to run the engine without loading the alternator, its V-belt must be removed, for instance if the battery is being charged.



If the plant does not charge (the charging warning lamp shines) check the following:

1. Dismount the wires of the charging regulator at connection 61 (red) and DF (green).
Mount a separate wire direct between 61 and DF.
Mount a voltmeter between 61 (red) and frame.
Start the engine and let it run idle after speeding up for a short moment.
If the voltmeter indicates voltage, about 15 volt, the charging regulator is defective.
If the voltmeter does not indicate any voltage the alternator is defective.
If a lower voltage is demonstrated one of the rectifying diodes is probably defective.

2. With disconnected starter key and stopped engine

Mount a voltmeter between connection 61 (red) and frame.
The voltmeter must not show any deflection.
If any deflection is demonstrated this may be due to breakdown in the isolation diode (reverse current rectifier).

3. With connected starter key and stopped engine

Mount a voltmeter between connection 61 (red) and frame.
The voltmeter must show a deflection of 1 - 2 volt.
If the deflection is smaller this may be due to bad connection in the circuit to the starter key and the charging warning lamp.
If the deflection is larger this may be due to:

a. Breakdown in the isolation diode (the reverse current rectifier)
b. Too large resistance in the exciting circuit of the rotor.
b. Check all connections at contact rings and brushes.

4. Mount a voltmeter from B+ (the charging wire) on the alternator and direct to the + pole of the battery.

   Run the engine at high idling.
   Turn on the lamps if any to increase the current take-off. Now the voltmeter must not show larger deflection than 0.3 volt.
   If the deflection is larger check all connections at batteries and charging circuits.

5. Mount a voltmeter between the - pole of the battery (frame connection) and the - pole of the alternator (frame connection).

   Run the engine at high idling and turn on the lamps if any.

   Maximum allowable voltage drop is here 0.2 volt.

Maintenance Instructions for Motorola Alternator

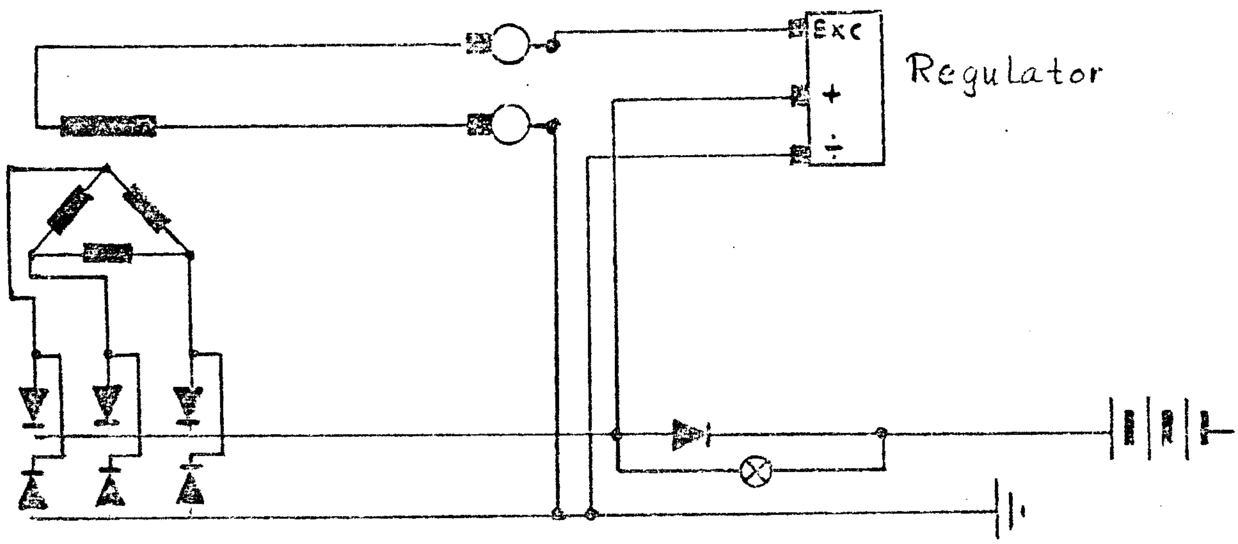
Work	Procedure	Warning
Replacement	When the battery is replaced it is important that the battery poles are connected correctly. Notice If it is necessary to operate with a battery which is completely run down or defective, disconnect and insulate the wires to the charging regulator first.	Never loosen the terminals of the battery and never open the circuit of the battery while the engine is running.
Wires	Check frequently the wire connections at the alternator.	Never loosen a wire without stopping the engine and removing one of the battery terminals first.
Help for starting		Never start with an auxiliary battery without disconnecting and insulating the wires to the charging regulator. Never use mains connection.
V-belt	Loosen all fixing bolts sufficiently. Do not force the alternator too hard outwards with tools and the like, especially not towards the stator section and the rear end piece.	

Alternator Type A 14/30

Make S.E.V. Marchal (Motorola) type	: A 14/30
Terminal voltage (B+, D-)	: 14 Volts
Max. charging current	: 38 Amp
Charging current at 3000 r.p.m. and 13.2 V	: 30 Amp
Max. output	: 530 W
Max. r.p.m.	: 15000 r.p.m.
Voltage relay type	: F 14V
Voltage control at 25° C	: 14V $\pm$ 0.2

The characteristic features of this type of alternator are the excitation via brushes and slip rings, the separately fitted mechanical voltage relay and the outside fitted red part diode bridge.

The schematic structure of the generator is shown below.

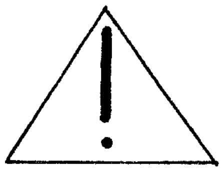


Fault Localization

Required Tools

1 voltmeter)
1 ohmmeter) can be replaced by a multimeter
1 12 V test lamp)
1 combination wrench 10 mm

1 screwdriver
1 electric wire
6°, 100 mm long



IMPORTANT

1. Never connect excitation to earth (frame)

2. Never disconnect the battery when the alternator is operating (the diesel engine is running).

Checking and Testing of Alternator and Voltage Relay

If charging problems occur, it will be necessary to check the following points before exchanges and repairs are carried out:

1. Condition of battery (see under the section for battery).

2. a. Tension of belt for alternator (should max. be able to deflect 1.5 - 2 cm by a light pressure of one finger).

   b. Charging light (should shine bright red when the engine is stopped and the ignition connected).

   c. Connections in the multiple plug should be firm and clean.

   d. Connections on battery and engine should be good and clean.

Accelerate the engine for one moment in order to ascertain whether the defect has been remedied.

If the problem is still present check the voltage relay first, then the alternator.

Voltage Relay

If overcharging occurs, showing itself by boiling of the battery, the reason is a defective voltage relay which must be replaced.

If overcharging does not occur, check the voltage relay as follows:

Checking of Voltage Relay

1. Disconnect connection to the voltage relay direct on it and isolate it adequately.

2. Connect the B+ terminal of the alternator direct with the DF terminal of the alternator. Thus direct excitation is obtained.

3. Start the engine and regulate so that the alternator runs about 3500 r.p.m. (r.p.m. on the engine).

4. Read the voltage over the B+ terminal and the D- terminal of the alternator by means of a voltmeter. If the voltage exceeds 12 V (24 V) the alternator is all right, and the voltage relay defective and must be exchanged.

However, if the voltage is under 12 V (24 V) the alternator has to be measured.

Checking of Alternator

Examination of Insulating Diode Bridge

If the diode bridge is fitted with 2 pcs. of insulating diodes, both diodes must be checked.

1. Measure the connecting direction of the diode by means of a ohmmeter or a 12 V test lamp.
2. Connect the ohmmeter or the test lamp between the B+ and the D- terminals. There must only be connection in one direction. If the opposite is the case (to be measured by turning the connections) change the insulating diode bridge.

Exciting Circuit

Examination of Rotor Windings and Brush Holder

There are two types:

Two-pole insulated type

One-pole insulated type

Two-pole Insulated Type

Measure with an ohmmeter on the terminals to the rotor windings the DF+ and the negative terminal.

One-pole Insulated Type

This system is normally used on BUKH engines.

Carry out the measuring between the DF+ terminal and frame.

The ohmmeter must indicate:

Between 2 and 10 ohm for 14 V alternator.

Between 6 and 30 ohm for 28 V alternator.

If the readings are within the above range the rotor windings and the brush holder are all right.

If lower resistance is measured, the rotor is defective and should consequently be replaced.

If there is not measured any connection, it will be necessary to check the rotor windings separately.

Loosen the end cover and the terminal DF. Remove the brush holder. Observe that the brushes are not damaged. Measure direct on the two cast rings with an ohmmeter or a test lamp.

If connection cannot be measured (extremely high resistance) the rotor is defective.

If connection is in fact measured, the brush holder is defective and has to be exchanged.

Checking of Rectifier Diodes

Remove the red diode bridge. Measure with an ohmmeter or a test lamp the diodes in the connecting direction. The measuring is carried out between the + side of each diode and the complete output terminal for the diodes.

The measurings are carried out both on the positive as well as on the negative diode bridge.

If there is only connection in one direction the rectifier diodes are all right.

The stator must then be replaced as this is defective.

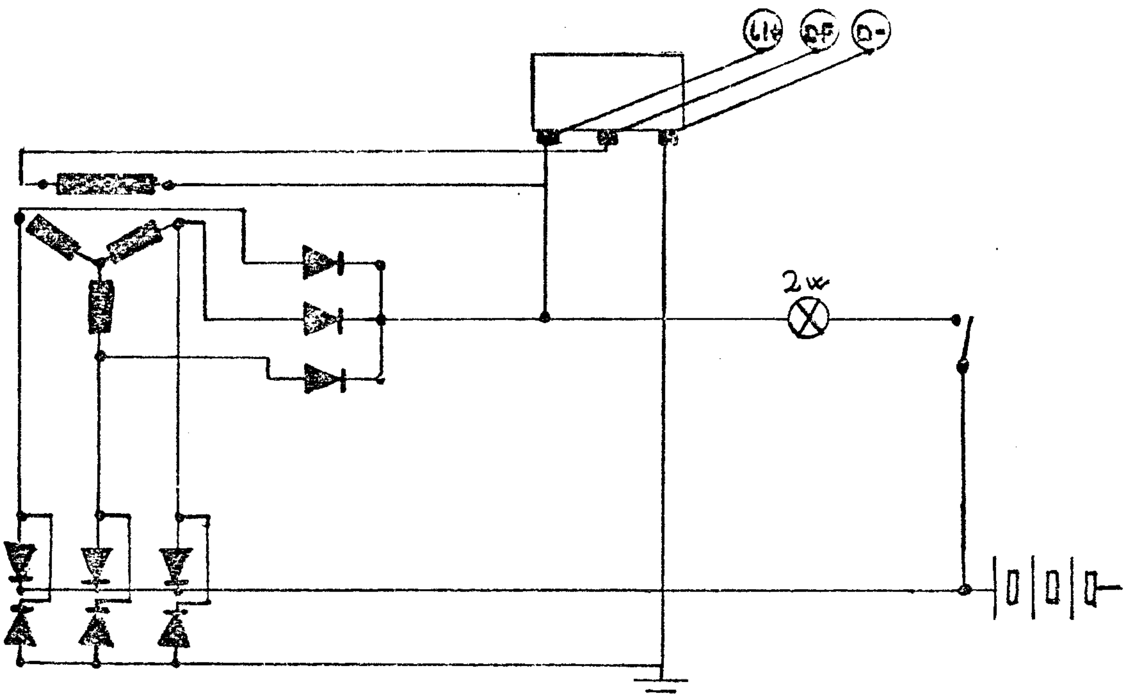
If there is connection in either direction or disconnection in the diode bridge, this must be exchanged.

Alternator Type 14/35 A

Make S.E.V. Marchal (Motorola) type	14/35 A
Terminal voltage (B+, D-)	14 V
Max. charging current	38 amp
Min. charging current (3000 r.p.m.)	27 amp
Max. output	530 W
Max. r.p.m.	15000 r.p.m.
Voltage relay type	T14V
Voltage control at 25° C and 4000 r.p.m.	14 V ± 0.2

The characteristic features of this type of alternator are the excitation via three diodes and the integrated electronic voltage relay.

The structure of the alternator is schematically shown below:



Fault Localization of Alternator

Fault localization of this type of alternator is mainly carried out as mentioned under alternator A14/30. The same range of tools is used.

This alternator differs in some respects from type A14/30:

Checking and Testing of Alternator and Voltage Relay

The preliminary checking and testing should be carried out as described under alternator type A14/30.

Voltage Relay - Type T14V

Check the voltage relay as described under alternator, type A14/30.

Alternator Type 14/35 A

The measurings should be carried out as described alternator, type A14/30.

Checking of Rotor Windings

Carry out the measurings with an ohmmeter between the DF terminal of the alternator and the frame.

The ohmmeter is to indicate:

Between 3 and 15 ohm for 14 V alternators.

If the readings are within this range, the rotor windings are all right.

If the resistance is under 3 ohm or if the resistance is 0 ohm, the rotor windings are defective and must be exchanged.

NOTE: This type of alternator is not fitted with carbon and brush holders.

Checking of Magnetizing (Trio) Diodes

The alternator is excited via 3 small diodes connected direct to the 61+ terminal of the voltage relay.

Check the diodes as follows:

Check the diode connection:

Remove nuts and washers from B+ and D- terminals. Now the plastic cap can be easily loosened.

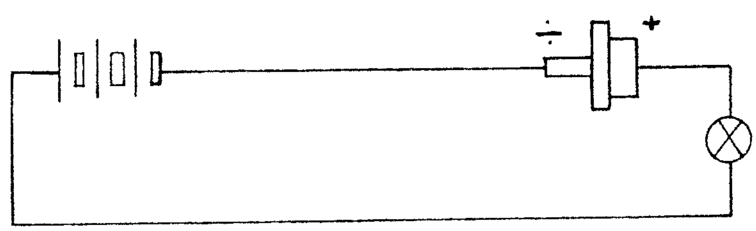
Remove the three nuts and washers securing the stator connections. Bend the three stator wires from the trio diodes and keep them in upright position.

Measure the connection between 61+ and the common centre of the diodes with an ohmmeter or a 12V test lamp.

The connection must be good (no resistance). If it is not, replace the diode set.

Checking of Trio Diodes

Measure each of the three diodes in the connecting direction with an ohmmeter or a 12V test lamp. (See fig.).



The measuring is carried out between the common base point (+) and the threaded rod (-) of the diode.

If there is connection/disconnection in both directions in one diode or in all the diodes, replace the diode set.

Checking of Rectifier Diodes

Open the metal sheets with a screwdriver. The metal sheets are assembled round the mounting screws (threaded rods) of the stator wires.

Measure connection/disconnection in both directions for each diode with a test lamp (12 V) or an ohmmeter.

The measuring of the individual diode is carried out between the frame and the bent metal sheet.

If there is connection in one direction and disconnection in the other one, the diode is good.

If the opposite is the case with one of the diodes, the diode set should be replaced.

Removal of Diode Set

Remove nuts and washers of the 61+ terminal. Then remove the metal sheet carefully (black wire) under the B+ terminal.

Remove the diode set by removing the 61+ terminal carefully from the housing.

Reassembly of Alternator

Assemble the alternator in reverse order paying special attention to the following:

When fitting the 61+ terminal, this must not turn when the nut is tightened.

Please note that the frame connection of the diode bridge is to be fitted correctly under the B+ terminal, and the wire to be secured in its guide.

Place the plastic cap correctly for tightening of the B+ and D- terminals.

Fitting of Voltage Regulator

Hold the auxiliary terminal on ther 61+ terminal while tightening the wiring connections.

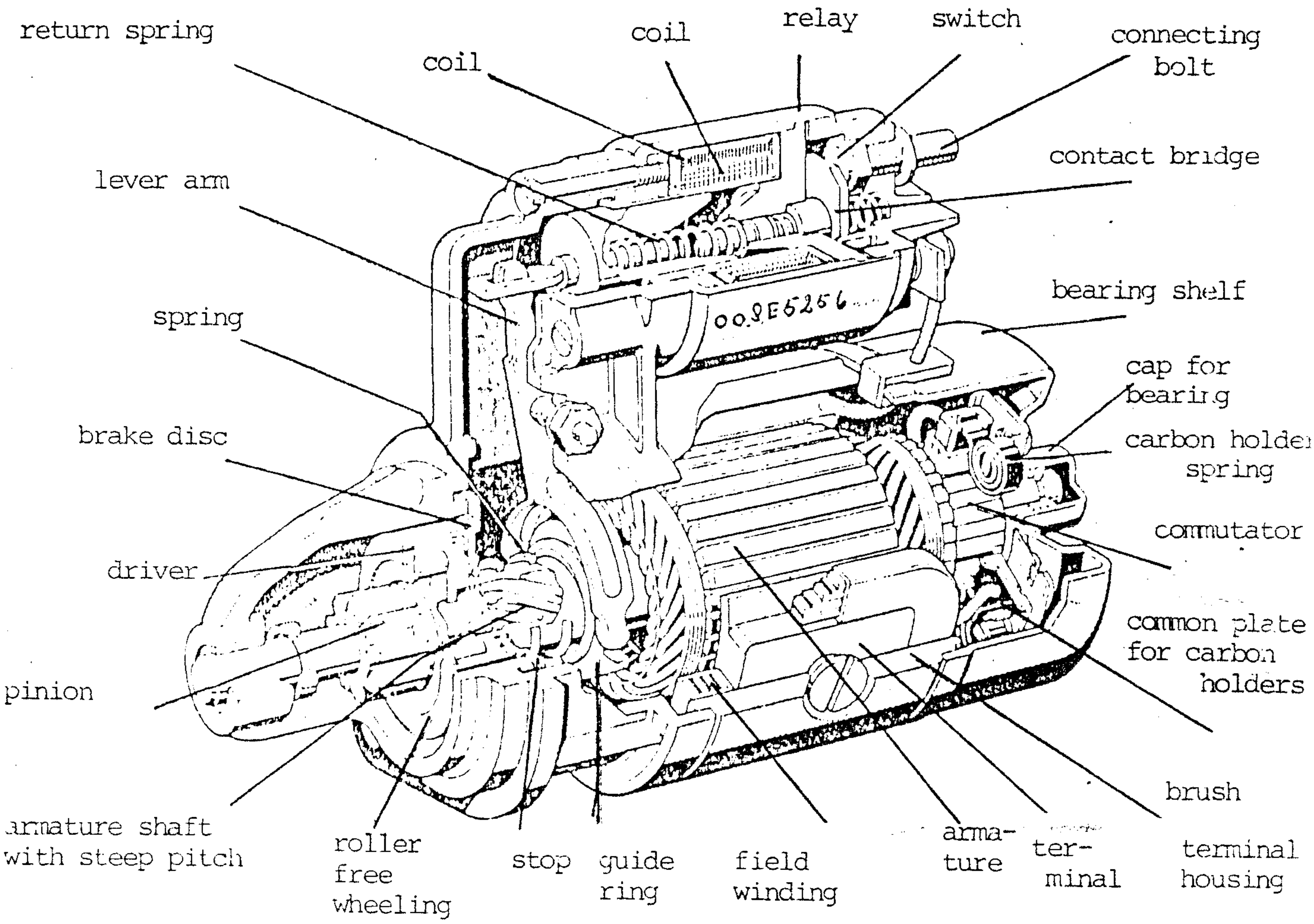
AVOID SHORT CIRCUIT BETWEEN THE WIRING CONNECTIONS OF THE 61+ TERMINAL AND THE FRAME

Checking at Starting-Up

Connect all wiring connections and measure with an ohmmeter the voltage between the B+ and D- terminals.

The voltage is to be measured to 12 and 15 volts at 20° C and max. r.p.m.

Large repairs and/or exchanges on the alternator should be avoided. Instead we recommend to exchange the alternator for a renovated one which can be ordered from BUKH.



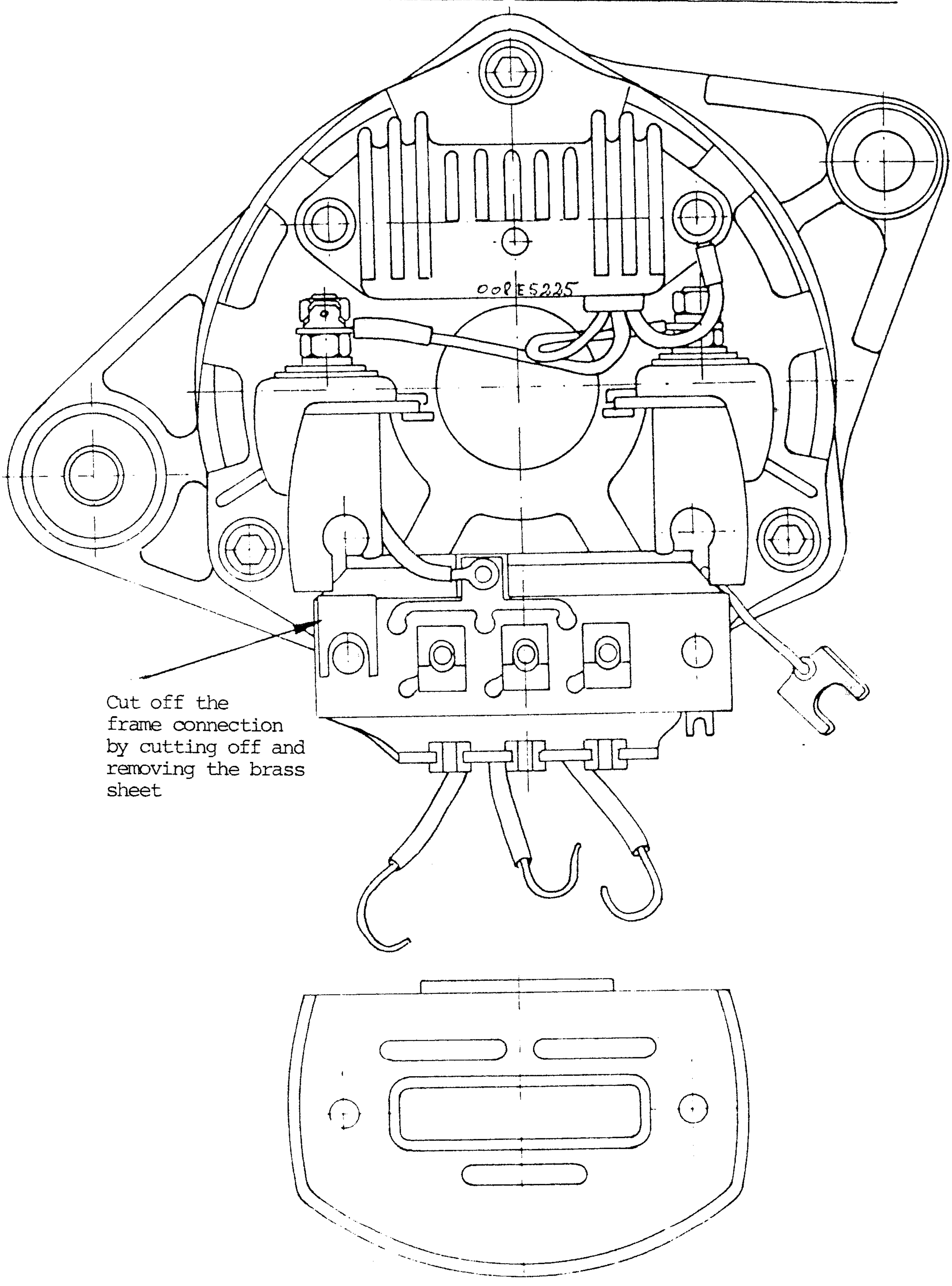
Relay

1. Remove the bakelite cap of the relay.
2. Cut off the frame connection of the coil and solder it with a 250 mm black wire 1.5 mm^2 (550D0013).
3. Imbed the non-insulated piece in silicone rubber.
4. Put the wire through the hole in the cap.
5. Refit the cap and tighten the hole with silicone rubber.
6. Fit the cable terminal ø8 (551A2208) and connect it with the negative terminal, see below.

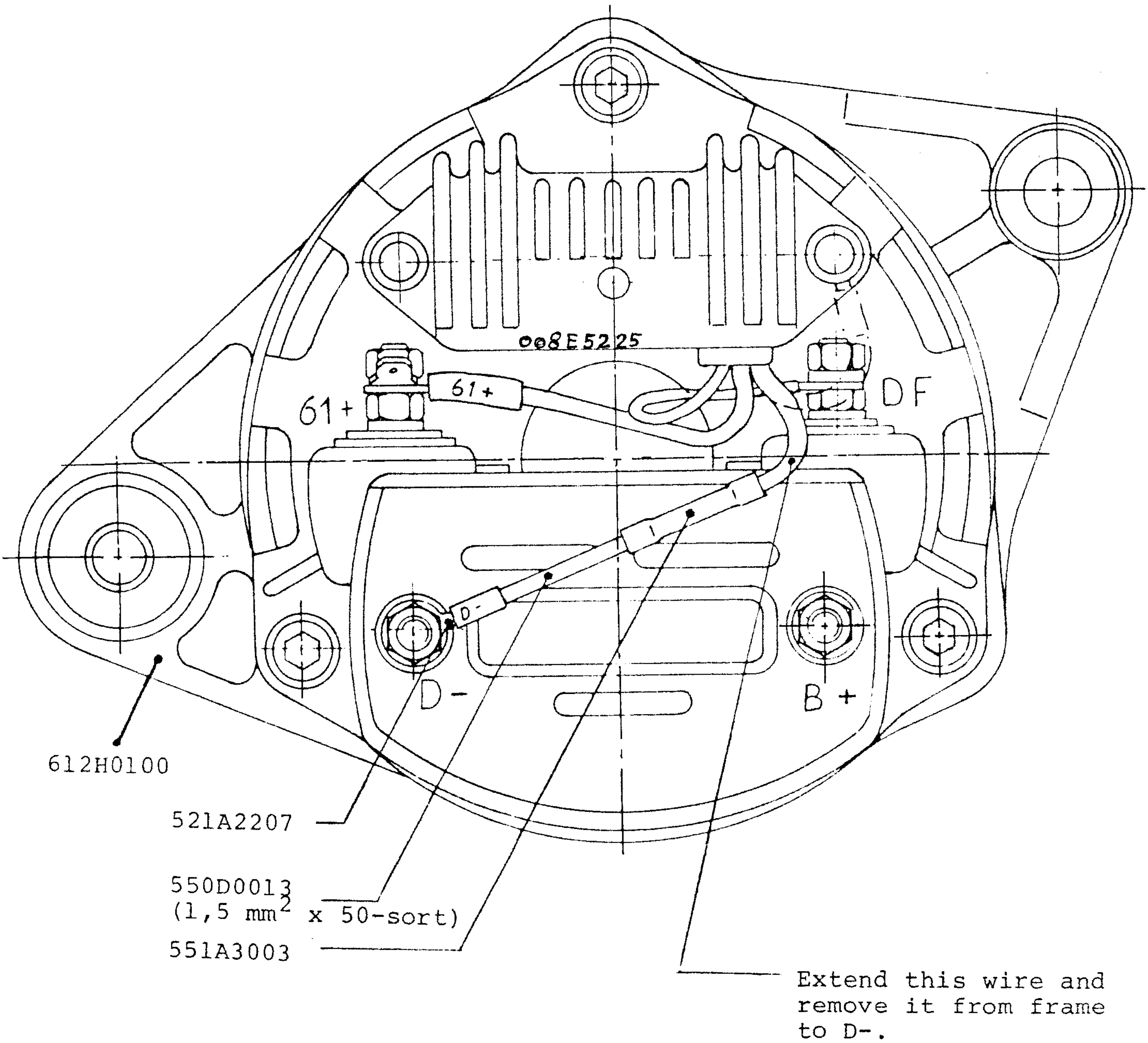
Starter Motor

1. Remove the bearing shelf.
2. Isolate the common plate of the carbon holders from the bearing shelf with a 0.5 mm fibre board (562C5050).
3. Isolate the screws securing the cap of the bearing to the bearing shelf (M4) from this with nylon bushes (000E5292).
4. Isolate the stay bolts from the carbon holder plate with nylon bushes (000E5291).
5. Pass the negative terminal through the terminal housing. The negative terminal consists of one M6 screw (502D2316), 2 nylon bushes (000E5291), 1 washer 522C1219) and 2 nuts (510A0207).
6. Connect the negative terminal internally with the common plate for the carbon holders by means of a 45 mm black wire, 6 mm^2 (550D0039) which is fitted with two cable terminals (551A0014) and insulated with shrink hose (550S0403). Unsolder a carbon wire and fit it with a cable terminal (551A0014). Connect the two wires to the plate by means of a M5 screw (502D2258).

Change of Alternator into Two-wire Execution

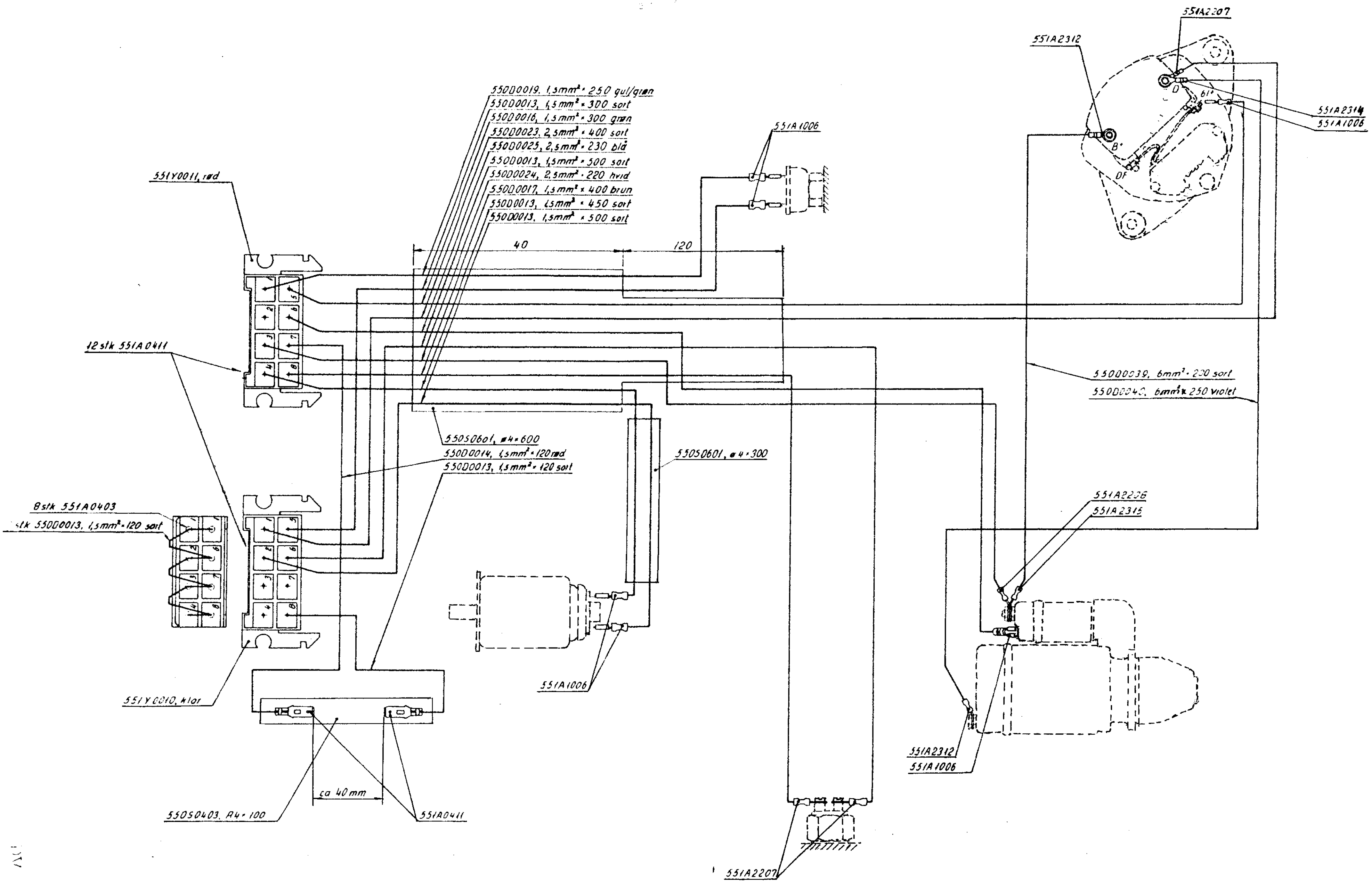


Change of Alternator into Two-wire Execution

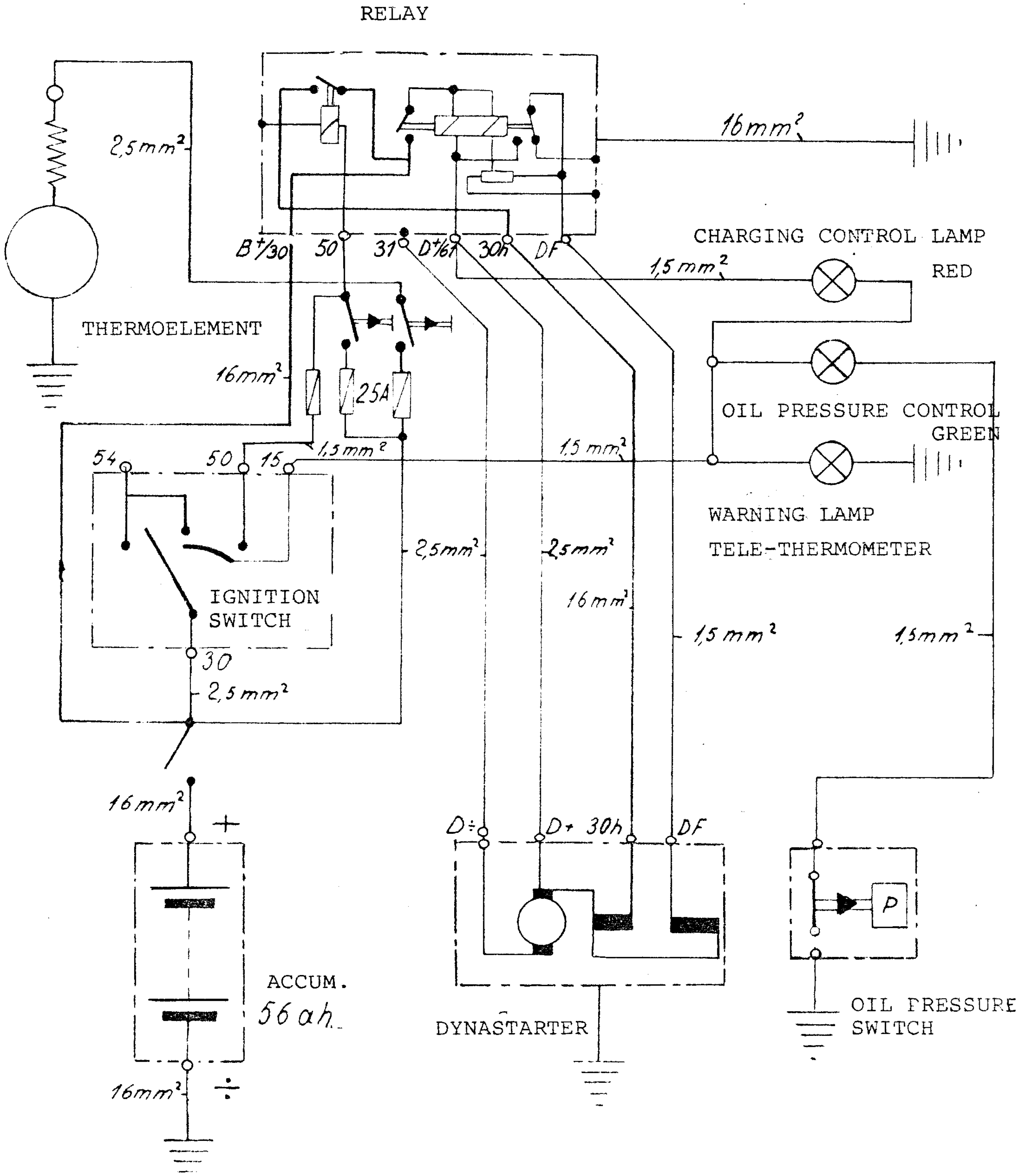


If the alternator is to be changed into 2-wire execution this should be carried out with the alternator dismantled from the engine.

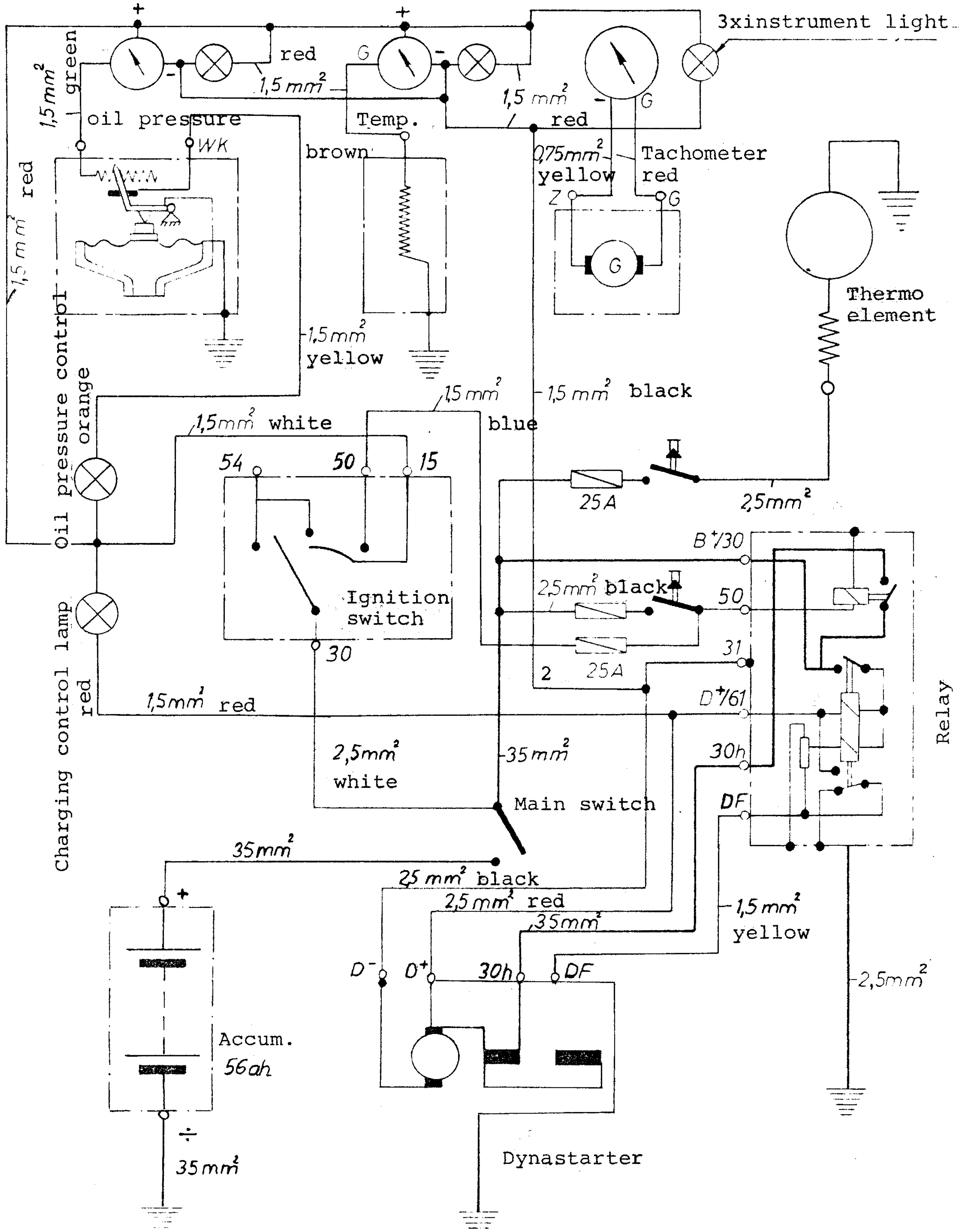
It is also necessary to change the other components of the mains network in accordance with the diagram on page



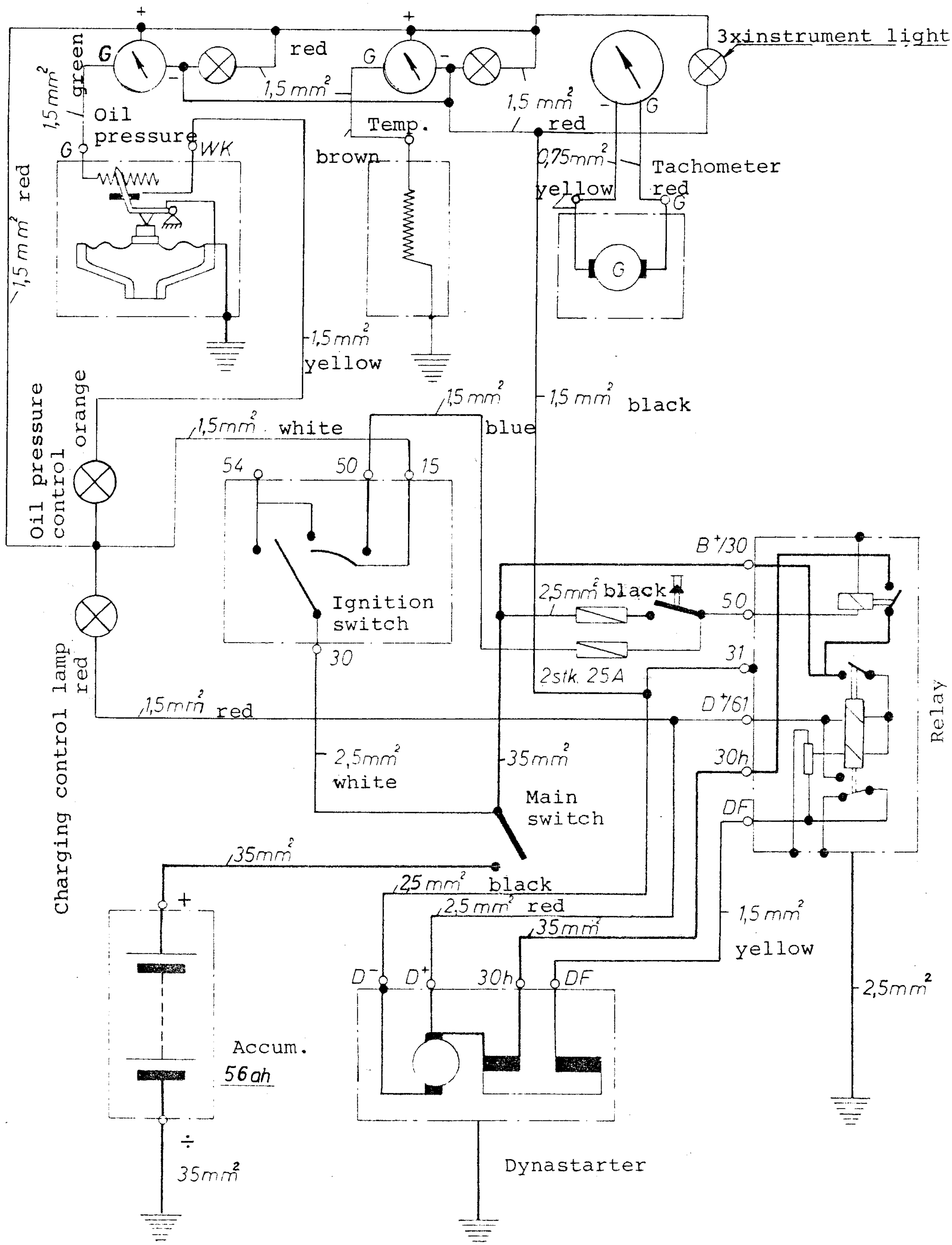
551A2207
551A2312
551A2314
551A1006
55000019, 1,5mm² × 250 gul/grøn
55000013, 1,5mm² × 300 sort
55000016, 1,5mm² × 300 grøn
55000023, 2,5mm² × 400 sort
55000025, 2,5mm² × 230 blå
55000013, 1,5mm² × 500 sort
55000024, 2,5mm² × 220 hvid
55000017, 1,5mm² × 400 brun
55000013, 1,5mm² × 450 sort
55000013, 1,5mm² × 500 sort
551A1006
551Y0011, rød
40
120
12 stk 551A0411
55000039, 6mm² × 220 sort
55000040, 6mm² × 250 violet
55050601, ø4 × 600
55000014, 1,5mm² × 120 rød
55000013, 1,5mm² × 120 sort
55050601, ø4 × 300
8 stk 551A0403
stk 55000013, 1,5mm² × 120 sort
551A2226
551A2315
551A1006
551Y0010, klar
ca 40 mm
55050403, R4 × 100
551A0411
551A2312
551A1006
551A2207



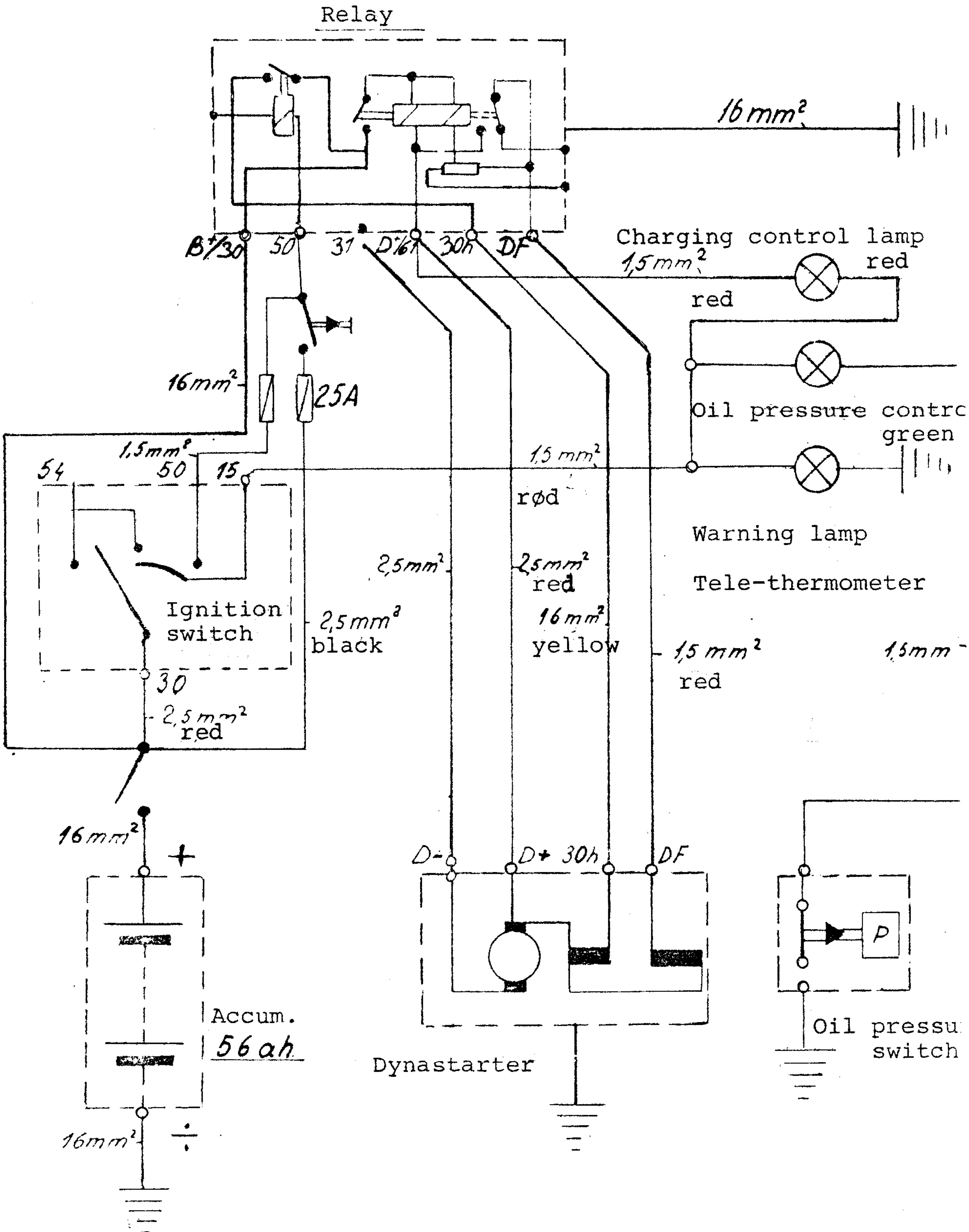
Wiring diagram for dynastarter with thermostart and instrument panel.



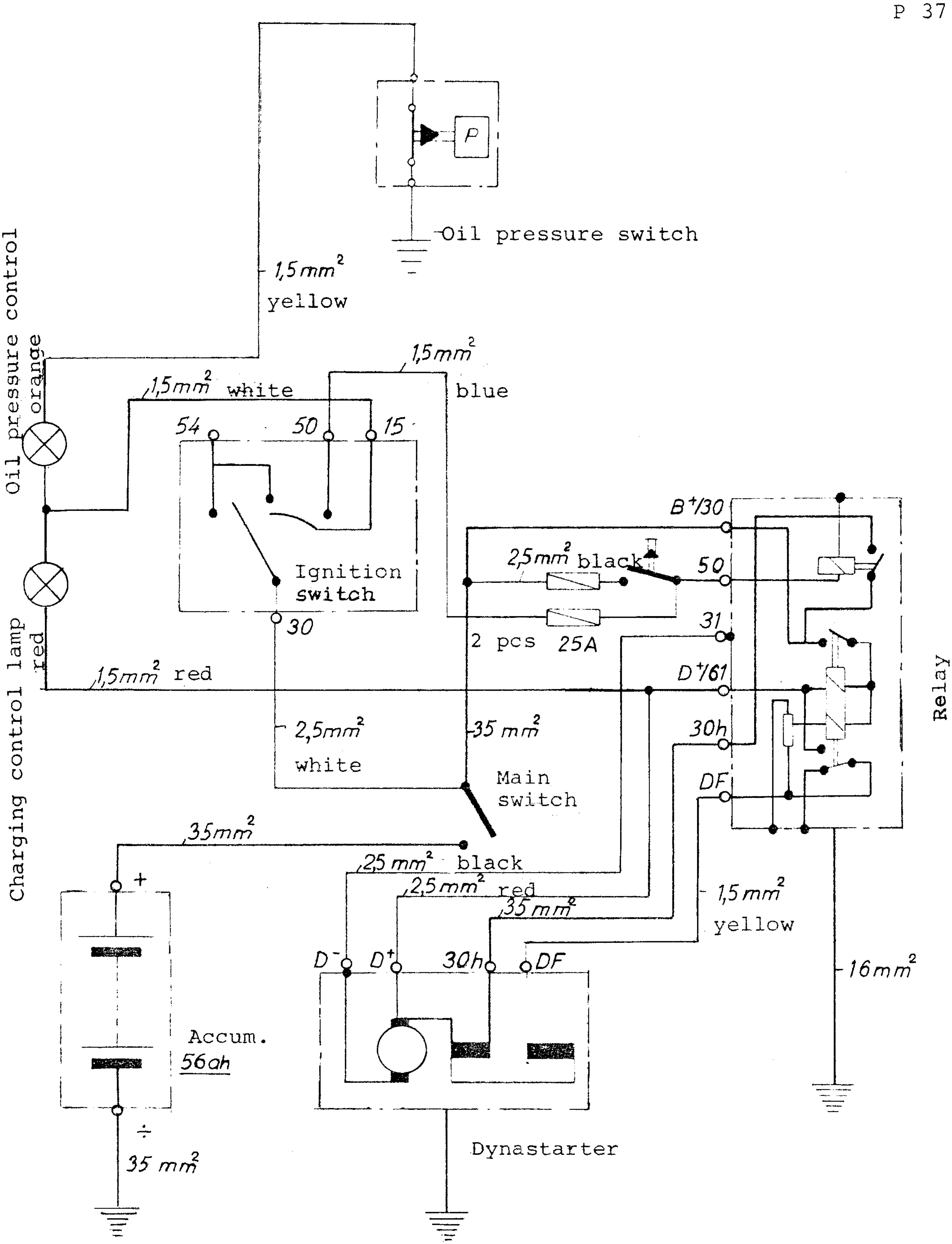
Wiring diagram for dynastarter with thermostart plus operating and instrument panel.



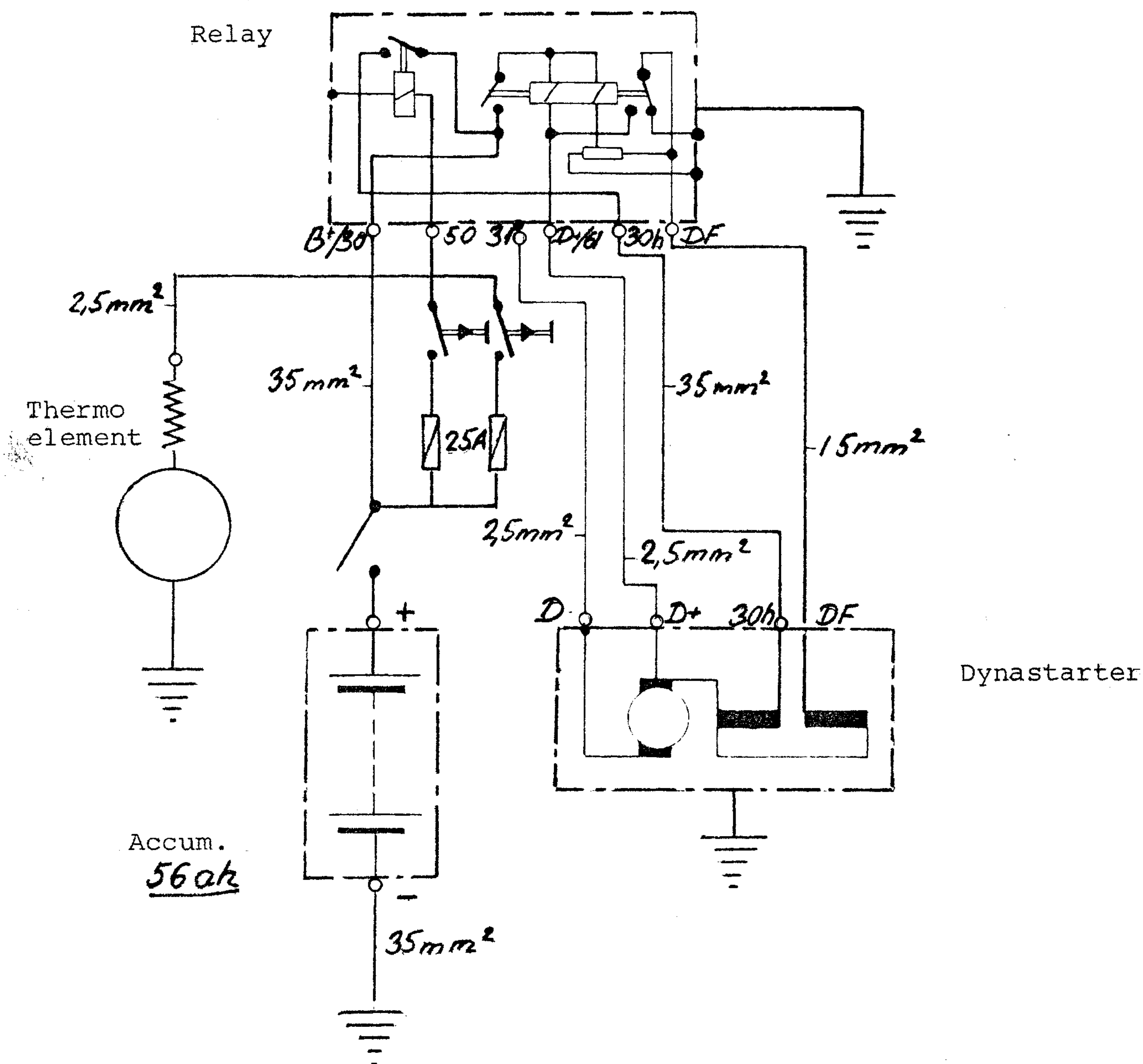
Wiring diagram for dynastarter with operating and instrument panel.



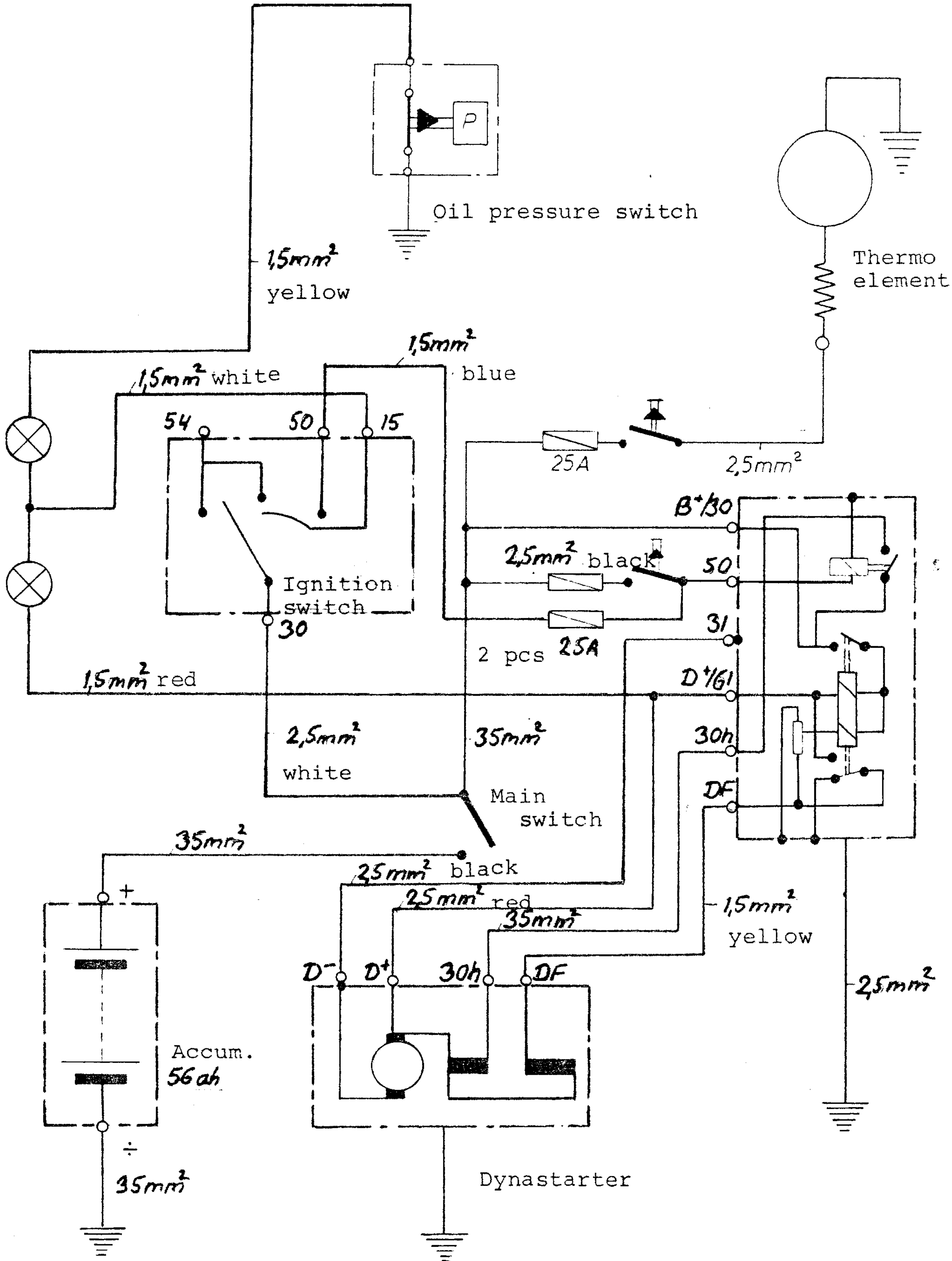
Wiring diagram for dynastarter with instrument panel



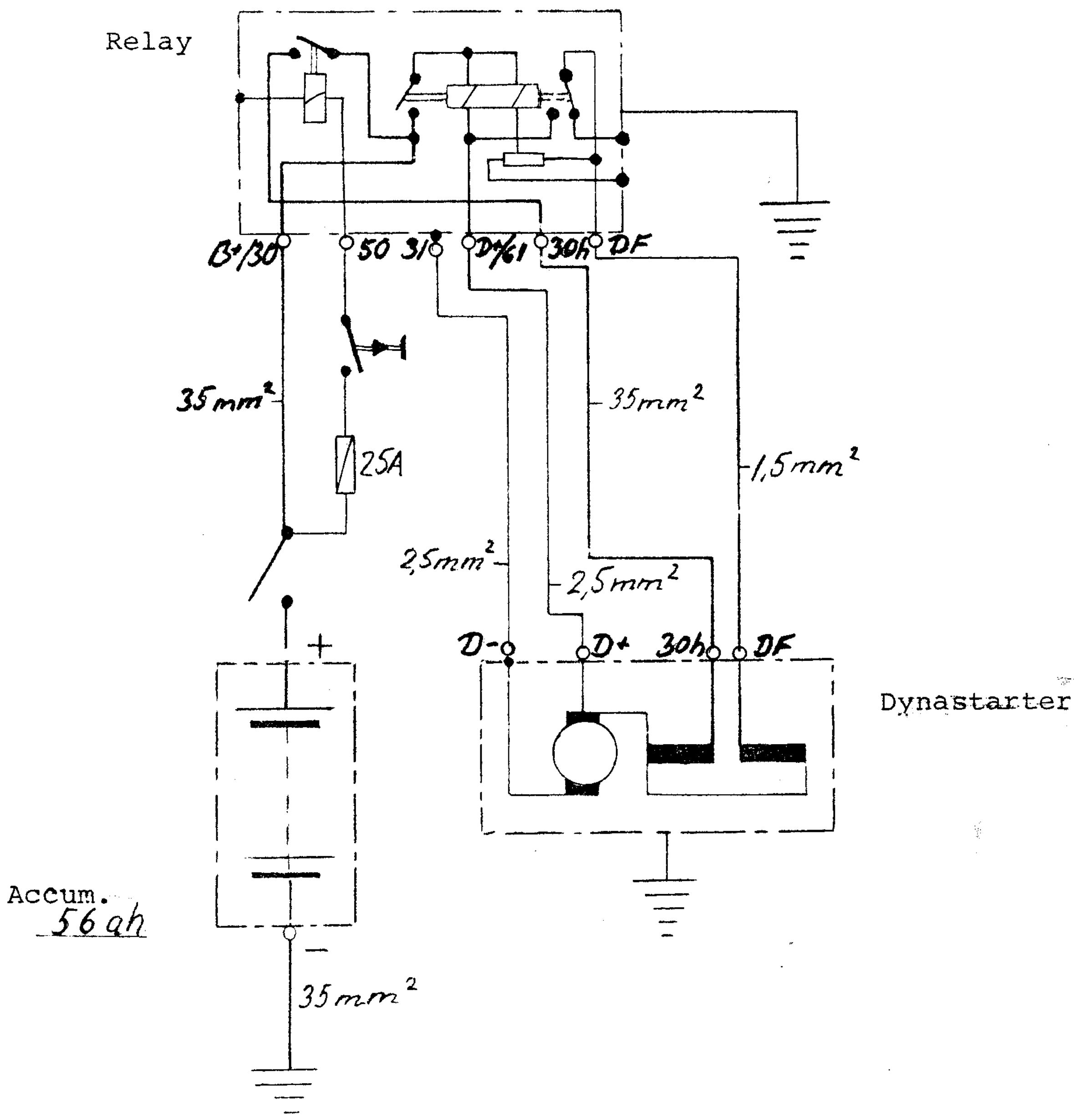
Wiring diagram for dynastarter with operating panel



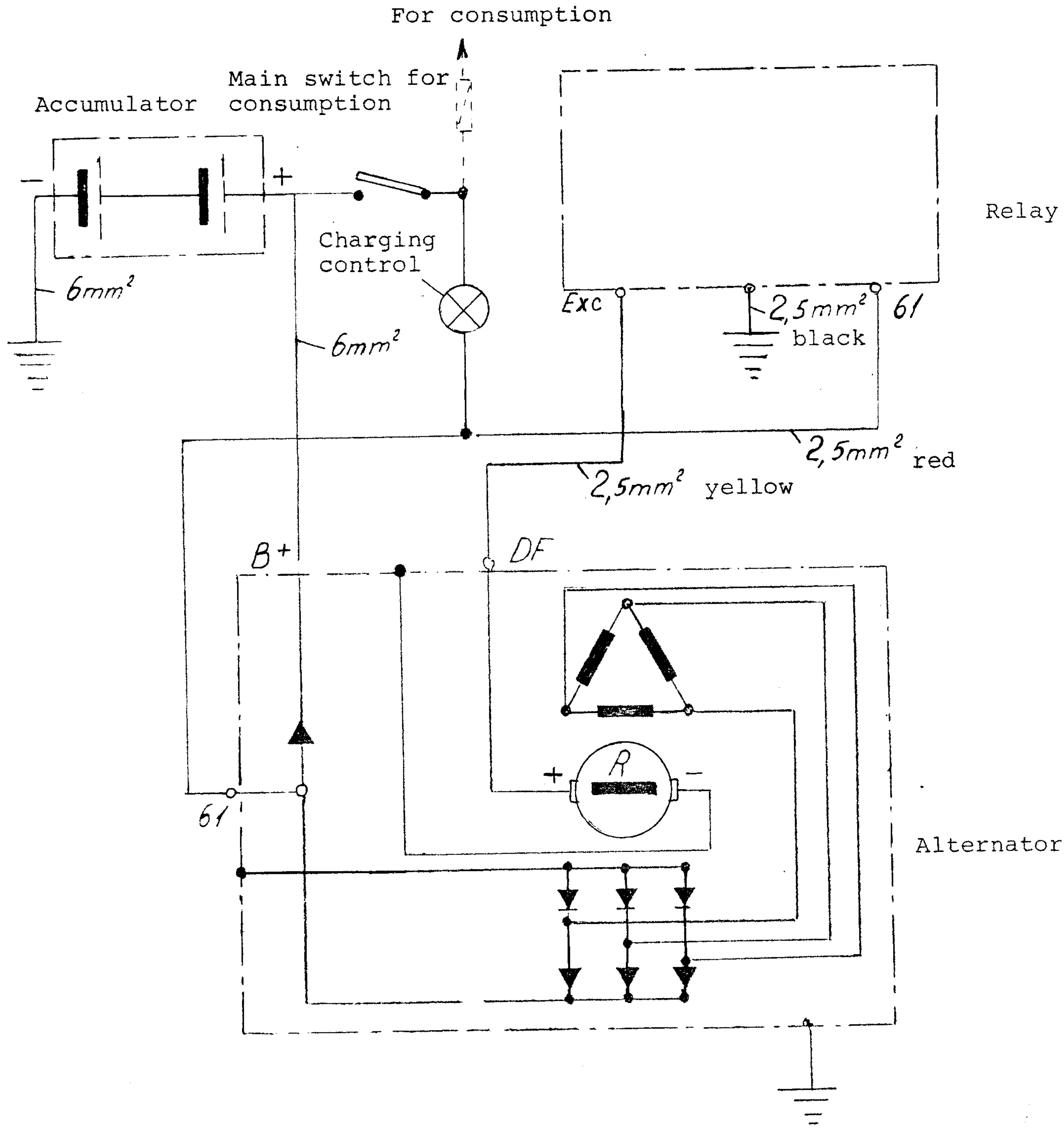
Wiring diagram for dynastarter with thermostart



Wiring diagram for dynastarter with thermostart and operating panel

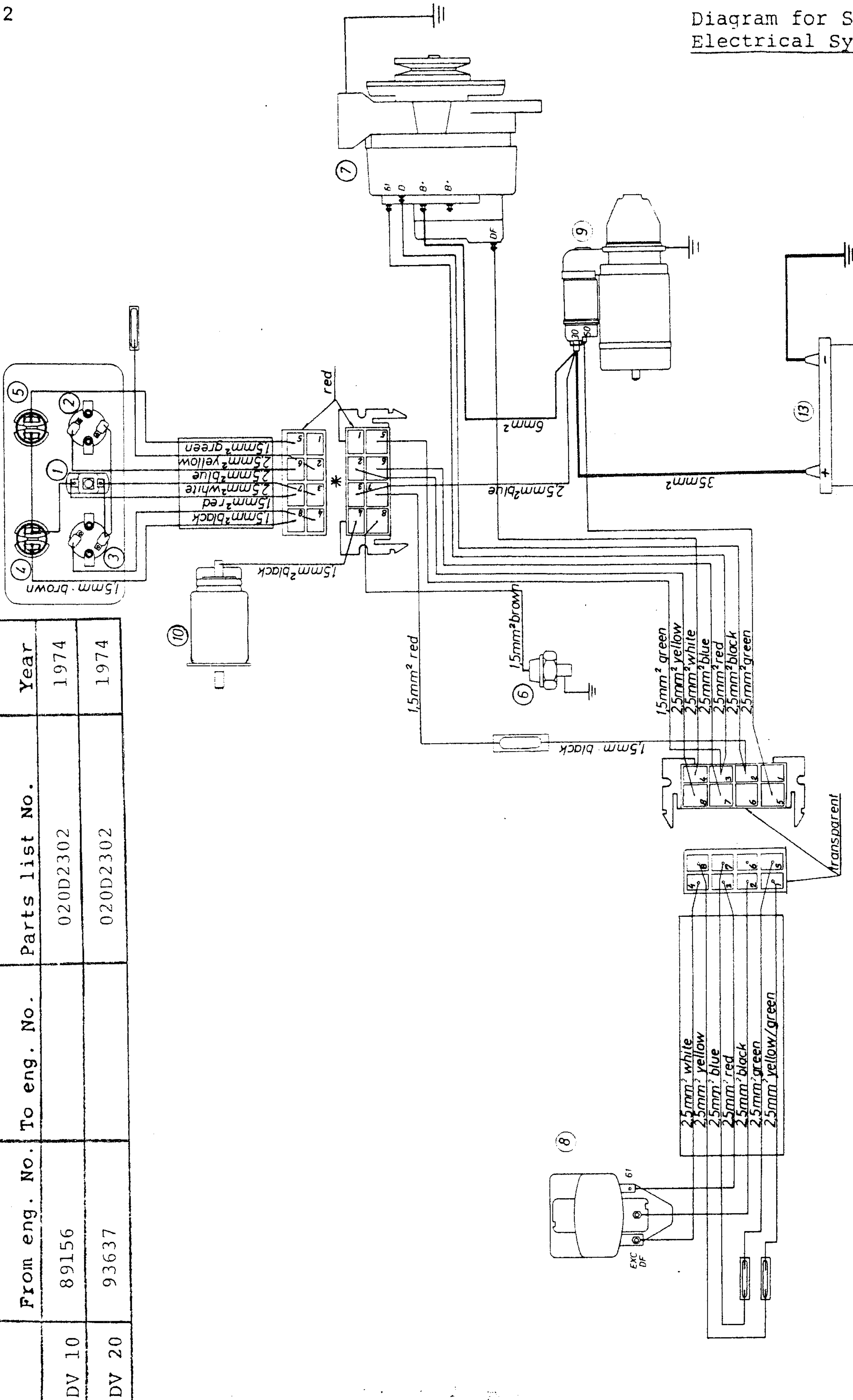


Wiring diagram for dynastarter



Wiring diagram for alternator

Diagram for Standard Electrical System



	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	89156		020D2302	1974
DV 20	93637		020D2302	1974

	From eng. No.	To eng. No.	Parts list No.	Year
DV 10	89156	203611	020D2302	1974
DV 20	93637	96232	020D2302	1974

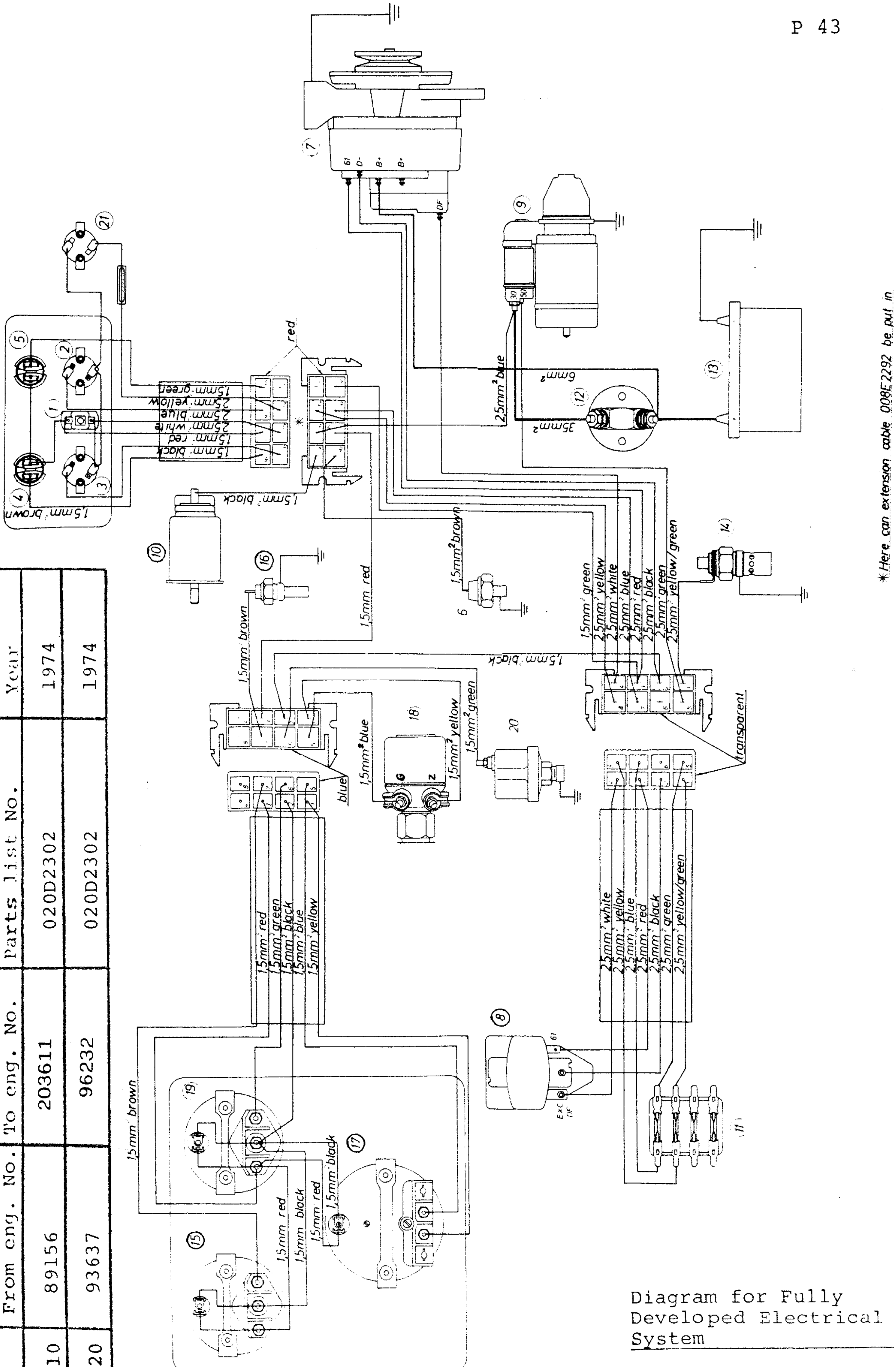


Diagram for Fully Developed Electrical System

Explanation to the Wiring Diagrams Pages P42 and P43

1 Switch for warning lamps and instrument illumination

2 Start button

3 Stop button

4 Warning lamp for oil pressure

5 Warning lamp for charging current

6 Oil pressure switch

7 Charging generator

8 Charging relay

9 Gear rim starter

10 Stop magnet

11 Fuse box

12 Main switch

13 Battery

14 Thermostart

15 Cooling water thermometer

16 Transmitter for cooling water thermometer

17 Tachometer

18 Transmitter for tachometer

19 Oil pressure gauge

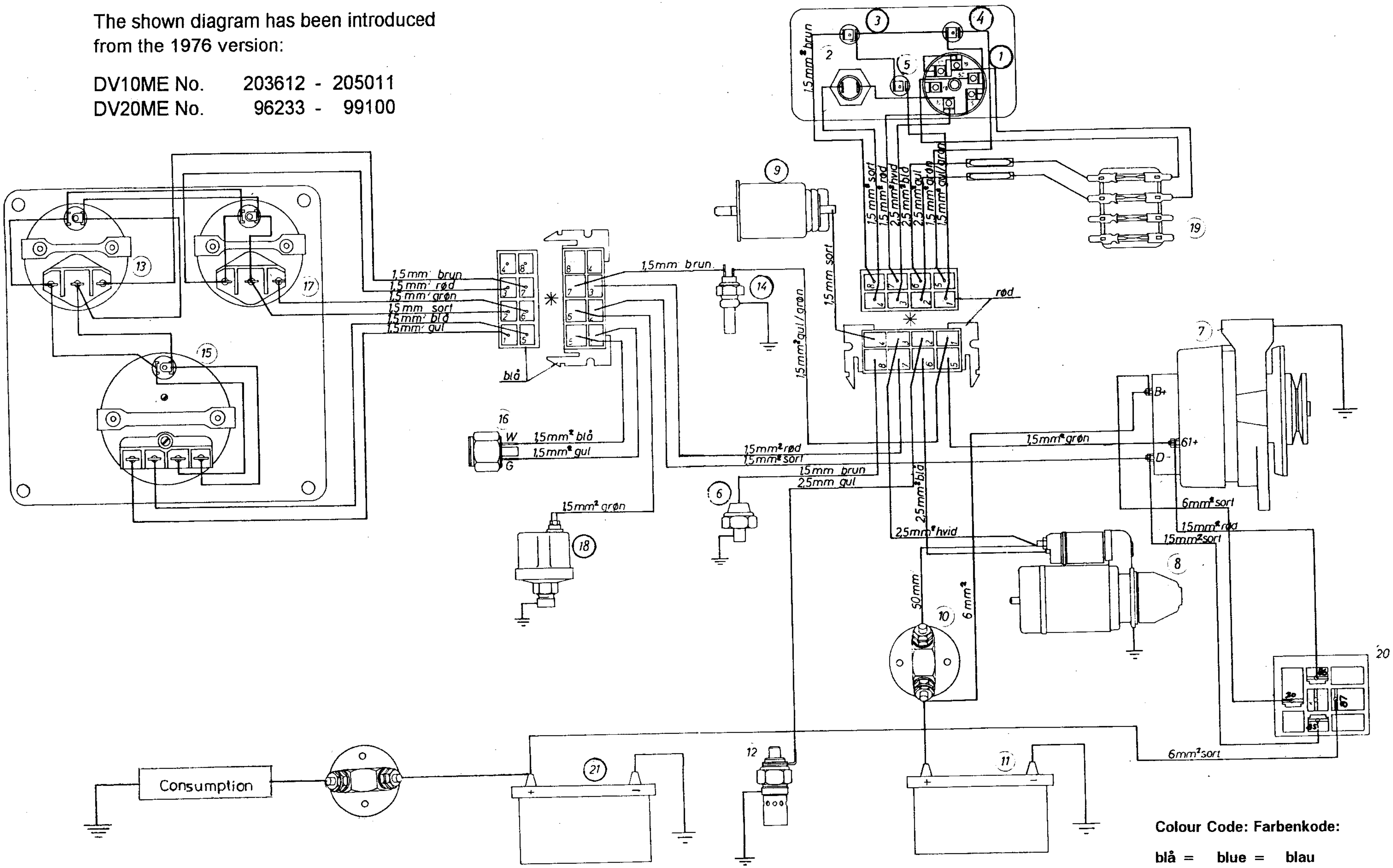
20 Transmitter for oil pressure gauge

21 Switch for thermostart

22 Isolated cable ends for use at development of installation

The shown diagram has been introduced from the 1976 version:

DV10ME No.	203612 -	205011
DV20ME No.	96233 -	99100



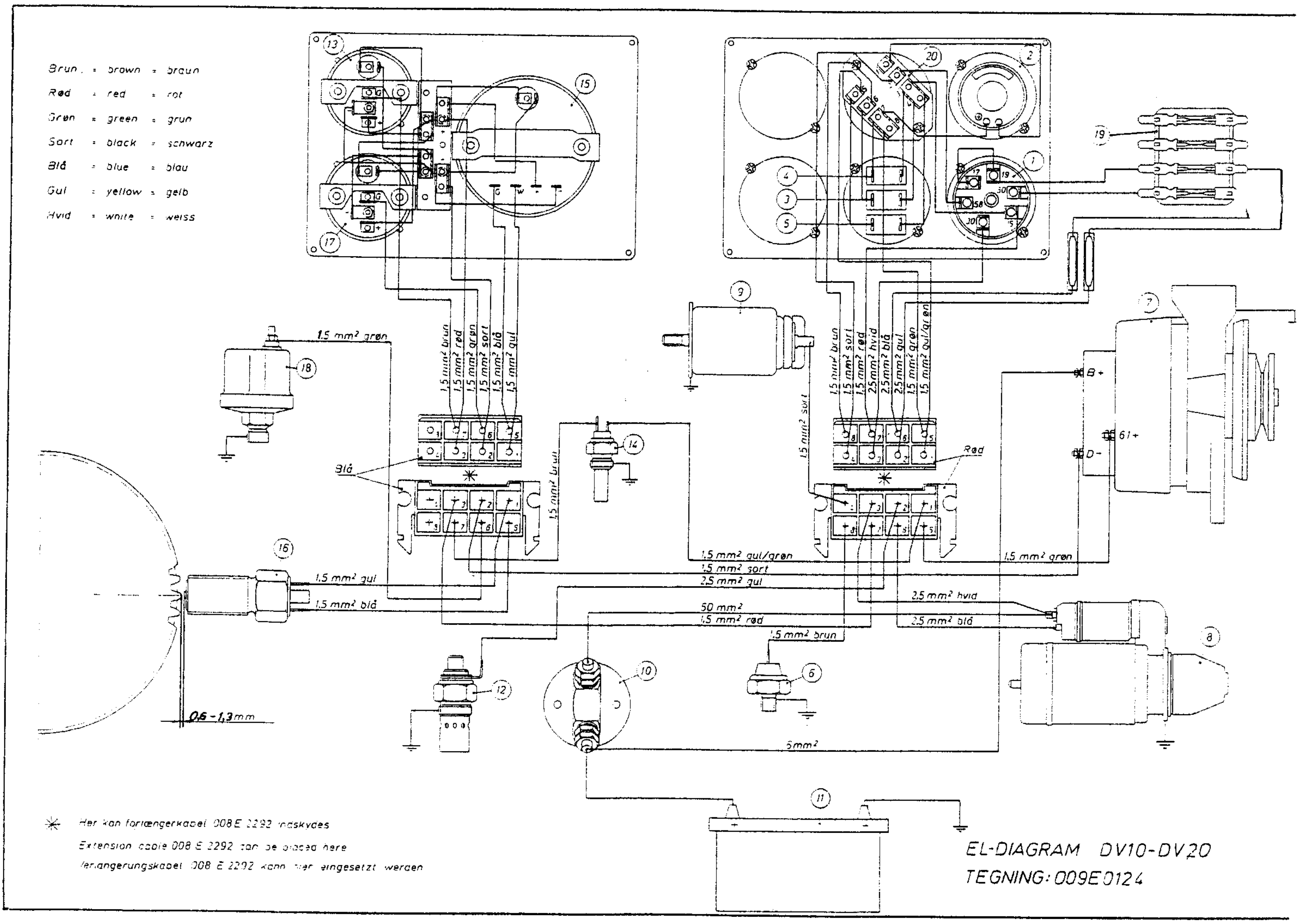
Colour Code: Farbenkode:

blå =	blue =	blau
brun =	brown	braun
grøn =	green =	grün
gul =	yellow	gelb
hvid =	white =	weiss
rød =	red =	rot
sort =	black =	schwarz

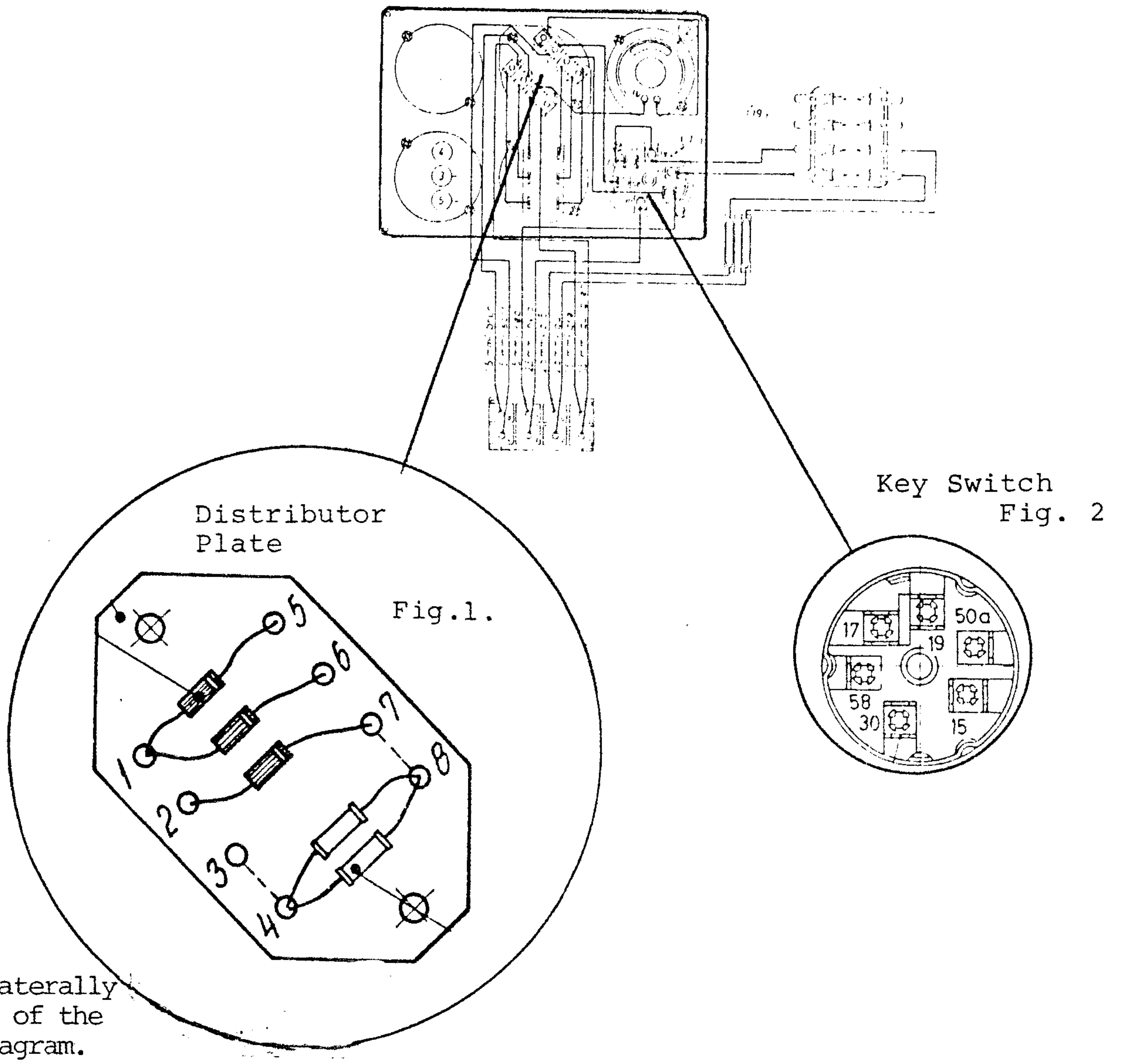
*Extension cable can be placed here.

The shown diagram has been introduced from the 1976 version:

DV10ME No. 205012 -
DV20ME No. 99101 -



Standard Operating Panel with Warning Lamps, Key Switch and Acoustic Alarm



Stated laterally reversed of the above diagram.

Three diodes (type IN4002 - BUKH No. 552A2102) are fitted on the distributor plate. Of these three diodes the two upper ones see to it that the lamp with alarm is alight and that the connection for this lamp is connected with the acoustic alarm at the same time. The bottom diode is inserted so that it actuates the acoustic alarm, if the key is left in pos. 58 in the key switch, where the stop solenoid is actuated.

If defects should occur on the diodes, e.g. internal burning-out, the acoustic alarm will not function and/or the warning lamp for both cooling water and oil pressure will light up at the same time.

Further the distributor plate is fitted with 2 pcs. of 270 ohm resistances (BUKH No. 552A2027) out of consideration for the excitation of the alternator which demands two Watts. In previous executions of operating panels this demand was satisfied by using a charging lamp of 2 W, whereas the type used now is of 0.5 W and thus makes the insertion of resistances necessary.

Section R

Marine Reduction Gear

ZF - BW6

Contents

BW6

MARINE REVERSING GEAR

ISA - ZF BW-6

Technical characteristics

Max. allowable input torque:

Gear ratios:

FORWARD	REVERSE	GASOLINE ENGINE	DIESEL ENGINE
2	1.76	16 Kg x m	12 Kg x m
2.5	2.77	13 Kg x m	10 Kg x m

The numbers figured are referred to forward gear rotation up to a max. rate of 4.500 rpm. A higher rpm rate could be obtained, but in such case consult our Technical Department.

As for reverse gear rotation, the total turning torque can only be obtained for a short time.

Input rotation sense:

Anticlockwise, looking towards the flywheel.

Power flow:

In forward is through ground helical teeth spur-gear sets, whereas in reverse gear, power is transmitted by chain.

Change-over:

By Z.F. cone clutch.

Operating conditions:

An engine coupling elastic disc between the engine and the gearbox has been provided in order to avoid the transmission of torsional vibrations. This torsional elasticity must be adapted to the complete propeller unit.

As a rule, the suitable election must be accomplished by the engine manufacturer.

The change-over can only be accomplished when the engine is idling, or in any case max. 900-1.200 rpm. We recommend in changing-over to stop shortly in the selector lever idling position in order to allow the engine revolutions to go down. In any case, it should be suitable to fit a combined control shift-accelerator in order to obtain these results.

The gearbox includes two safety systems, consisting the first one in two conveniently adjusted stop pieces located in the shifter-yoke avoiding this way any damage when changing-over at any speed, and consisting the second one in two pairs of Belleville spring washers fitted each pair at the ends of the lower shaft, disconnecting the gearbox as soon as an eventual overcharge equivalent to 40-70 Kg x m output torque occurs.

Service

Towage : No time limit with dead engine and propeller shaft in idling.

Oil capacity: Approx 0.4 litres (0.7 pints).

Oil grade : HD-engine oil SAE20 or 30 preferably as per specification MIL-L-2104 B; furthermore HD-engine oils SAE 20 or 30 according to MIL-L-2104 A, supplement 1 or DEF 2101 D (see ZF list of lubricants for ZF marine reversing gears, which can be ordered from ZF Service Stations) are also permitted.

Oil change : Once, after the 25 first operating hours, then after every 150 operating hours, or at least once a year.

Oil level control : Through the overflow plug. This control should be made very carefully as the oil excess as much as the oil shortage can abnormally overheat the gearbox. Under continuous operation conditions the temperature should not rise above 110°C in order to keep rubber seals in good condition. (For BUKH engines an oil dipstick is used).

Repairs

Disassembling: If for justified reasons the gearbox has to be disassembled, this must only be done by an expert with enough experience and practice. The first thing to do consists in cleaning carefully all the outer parts in order to avoid dirt penetrating inside the gearbox. Do not hit the gearbox with hard tools, use better a nylon hammer and wooden or aluminium pin drivers.

Once the gearbox disassembled, all the parts should be carefully cleaned and inspected one by one in order to separate those damaged or inserviceable. All the injured parts in disassembling the gearbox as washers studs, locking plugs, seals, etc. should be replaced by new ones.

To disassemble the gearbox, just remove the closing covers and the coupling flange, then the screws joining both half-casings, now you have at sight all the inner parts ready for inspection.

In reassembling the gearbox, pay special attention not to interchange the taper bearing tracks nor alter the position of the bearing complete unit and the washers with different thickness in order to avoid a new regulation.

In case of doubt, a new regulation should be necessary proceeding a. explained later on.

Reassembly

In this part, we shall explain the different assembly operations, in rational order, detailing the points needing special care.

Reassembly Operations

Pinions Axial Setting

The parts are to be placed as shown in page 10, set the variable thickness washer, pos 33, (1-1.8 mm) until 0.8-0.9 mm backlash is obtained between the gear cone and the moveable cone.

To verify this, proceed as follows: Over the output shaft place the moveable cone, needle cage, gear, bushing, pos 34, and washer, pos. 35. Secure by hand this last part, and upon the moveable cone place a comparator or other similar instrument, rotate the moveable cone until the gear stops without backlash. The displacement of the moveable cone during this operation should be 0.8-0.9 mm, if not, change the variable thickness washer, pos. 33.

For the other setting, proceed the same way. The setting (regulation) of each of both gears could not be the same, so has to be done independently of each other.

Slip Sleeve Fitting

As shown in pos. 11, the slip sleeve should be fit upon the outer shaft, helped by a special tool in order to push the springs located on the shaft and mount the part easier.

Of course, the special tool can be suppressed, manually comppressings the springs helped by some standard tool while the sleeve is being mounted.

Lapping of the Moveable Cones

Before reassembling the gearbox, is necessary to check the adjustment between the gear cones and the synchronizer ring. A good adjustment can only be possible after lapping with fine R-360½ emery powder (normally we use TETRABOR 800 grain).

Lapping has to be done in order to equalize angle differences between the synchronizer ring and the gear cone. As the lapping increases the roughness in the frictioning surfaces, prior to reassembling the gearbox it should be necessary to eliminate such roughness by running the complete unit.

Two different ways for running the gearbox:

1st. - On a testing-bed, change over 40 times at 800 rpm and 10 times at 1300 rpm after fitting an inertia-disc of 0.6 cm Kg seg^2 to the output flange.

2nd - Change-over the same as in previous case, on the boat and windmilling propeller.

Lapping Method:

Place the parts as shown in pos. 18, and smear the gear with TETRA-BOR 800 dissolved in oil, then rotate the gear 45^o at right and left sides pressing slightly with both hands, repeating this operation 4 or 6 times. Lift the gear and rotate 90^o. Repeat the same movements until the angles of both cones coinceeds.

Once finished lapping operation, clean carefully the cone in order to eliminate completely the emery powder. The best way to achieve this consists in the use of a current detergent, then oiling over the molybdene cone and frictioning the ring over the cone. Repeat this operation (oil and rotate pressing with the hand) until the oil dark turbid colour disappears.

Once reassembled the gearbox, with a speed-in and blocking the input shaft, check that the turning torque in the outer flange is 40-70 Kg x m. The same checking can be done with the parts loosed and using a special tool so designed.

Of course, once the parts lapped they should be fitted matched.

Fit Belleville washers and the cone bearing (previously heated at a temperature and during the necessary time to allow manual operation) as shown in pos. 36.

Use the same procedure in both shaft ends.

Fit, also previously heated, the separating bush, pos. 21.

The bush in the opposite shaft side needs no heat to be fitted.

By the opposite flange side (see page10), fit definitively washer and screw, tighten at 5 Kg x m approx., fastening with Loctite so the cone bearing will adjust at first in its correct position.

The bearing must overcome Belleville washers pressure until the front of inner track reaches the front of the separating-ring, pos. 34, otherwise the reassembling should be incorrect. Therefore, the tightening-screw must overcome the Belleville washers resistance and also the bearing resistance (now cooled somewhat) against the shaft. Usually, a 5 Kg x m tightening shall be enough to overcome these resistances and adjust the parts in correct position. Anyway, during the tightening screw operation, can be feeled first an elastic resistance (the compression of Belleville washers) and then a rigid resistance as soon as the bearing reaches its correct position. If in some case could be necessary the application of more than 5 Kg x m, care must be taken to be sure that previously the bearing has been correctly mounted.

Even so, the screw tightening will be readjusted again after the reassembling of the gearbox.

After being fitted the cone bearing in the input shaft (heating the same as explained above with the output shaft) couple with the chain and the shifter-yoke the two complete shafts, and mount the complete assy. over the half-casing.

Care must be take while doing this reassembly to place the four cone bearings outer tracks, not to injure the casing hitting the rollers over it.

Then, and previously impregnated with HERMETITE, couple both half-casings.

Set two bolts in order to close both half-casing, and then screw down applying to a grip-torque of 2-2.5 Kgm.

Setting (Regulation) of the Cone Bearings

Cone bearings has an initial overload of 0.08-0.11 mm. Make the regulating gauges, placing the variable thickness washers, pos. 33, between the tracks and the front of the closing cover, until an overload of 0.08-0.11 is obtained.

Introduce correctly the outer track tapping carefully in order to adjust completely this part to the conical rollers, before gauging on the cone bearing.

The closing cover front and the casing front must be impregnated with HERMETITE and then the bolts screwdown applying a grip-torque of 2-2.5 Kg x m. Do not mount still the input side lower cover.

After these operations fit the flange previously heated, taking the necessary care so the heating time and temperature be sufficient to allow the adjustments by hand without forcing the part.

Place the gearbox in a special hand press tool, and seated in its lower part only upon the cone bearing outer track, press upon the flange with a 3 or 4 ton stress. Then tight the screw (impregnated in Loctite 84) applying a grip-torque of 5 Kg x m readjusting the lower screw applying also the same grip-torque.

The reason for this apparently complicated operations is to be quite sure that both outer shaft cone bearings seats perfectly upon the parts, pos. 34, instead upon Belleville washers.

Because of the screw stress (5 Kg x m) could be sometimes insufficient to overcome the resistance of all the parts previously heated plus the resistance of Belleville washers, it is necessary to apply a supplementary stress of 3 or 4 ton, since it is very important to be sure that the cone bearings are mounted in their correct positions.

Place now the input side closing cover in the same ways as the other three.

Setting of the Shifting Yoke

The subject consists in the regulation of the shifting yoke position in order to avoid the slides pressure, pos. 33, against the slip sleeve, pos. 52, when introducing one speed.

This operation has to be made as follows:

With one speed acting (page 12), fit the screws, pos. 27, (previously smeared with Loctite) to the casing just touching the shifter yoke, this moment will be noticed since the lever starts to move back.

With a similar device and measuring the displacement over the end of the shifting yoke control lever, pos. 12 page 12, continue rotating the screw inwards until the displacement atains approx. 0.2 mm.

Proceed exactly the same with the other speed.

Place the nut, pos. 28, smeared with Loctite (grip-torque 1 Kg x m) in order to fit the screws. When tighten these nuts, avoid the rotation of the screws.

Immediately, proceed verifying as follows: With one speed acting, press slightly over the shifting lever end (length 25 cm and pressure 2 Kg approx.), and see if the flange rotates at hand too easy or too hard, if so, vary the regulation.

NOTE: Size 0.2 has been figured as guidance, valid only the final verification as explained above.

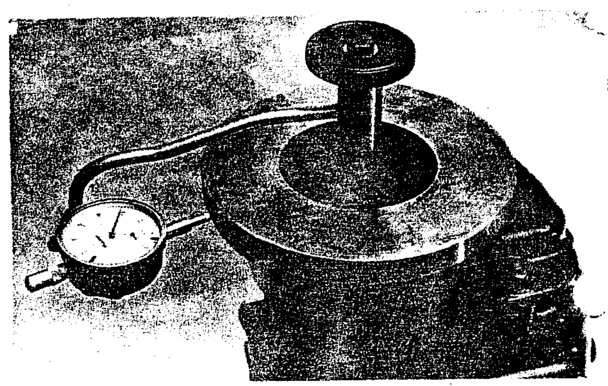
Arrangement of the gearbox in the test-bed, with the inertia-disc in the output side of the gearbox.

Once tested the gearbox, fit the venting valve with a grip-torque of 1 Kg x m. Also must be tightened the darin and filling plugs, with a grip-torque of 2-2.5 Kg.

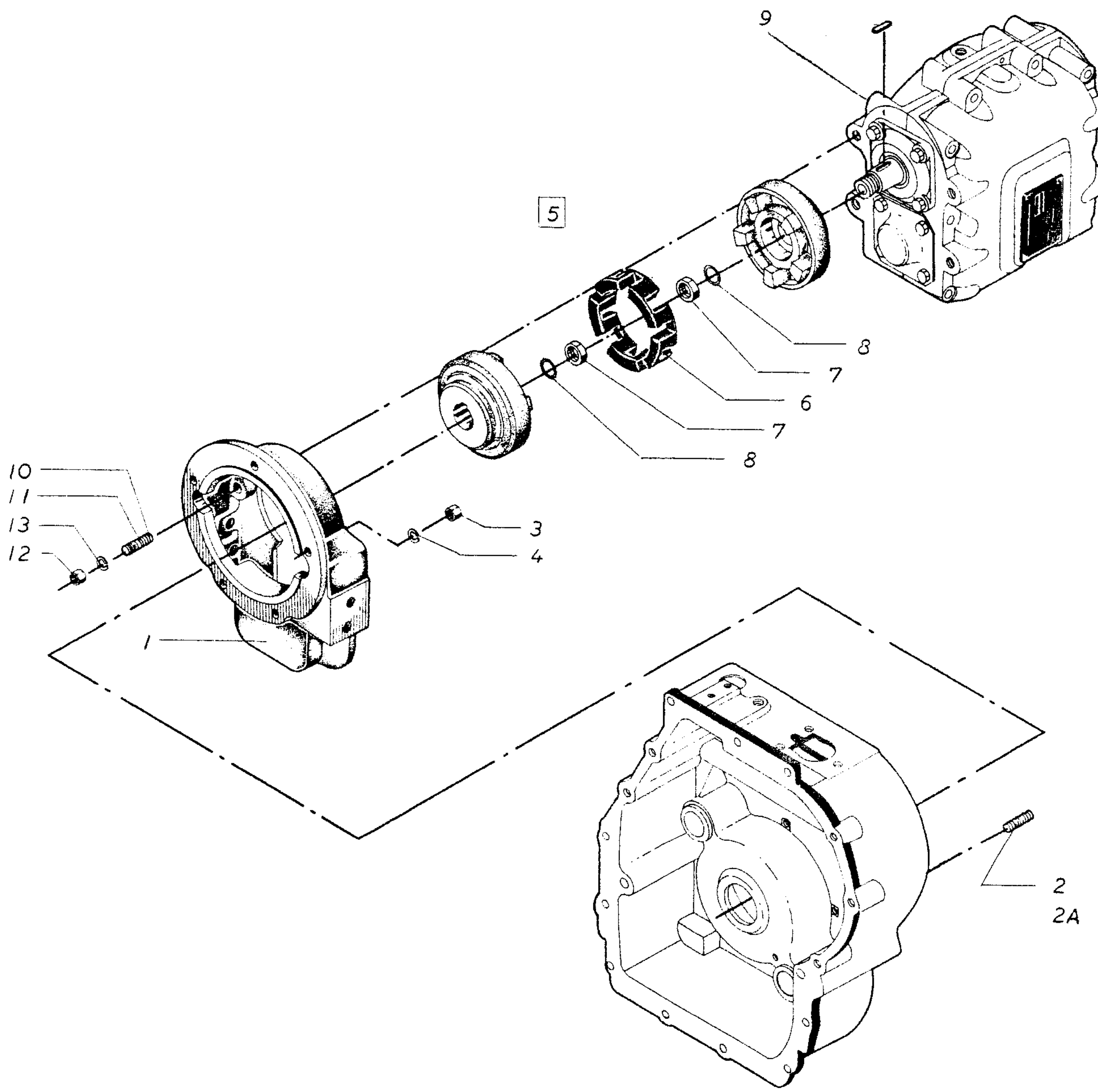
Lining up of Intermediate Housing

After assembling of the gearbox pos. 9 page 9 the intermediate housing pos. 1 page 9 must be lined up within 0.05 mm to the gearbox.

This can be done by means of a dial micrometer and a machined ring. (See picture of tool below)



Lining up tool for intermediate housing (dial micrometer not included). Order No. V 2110.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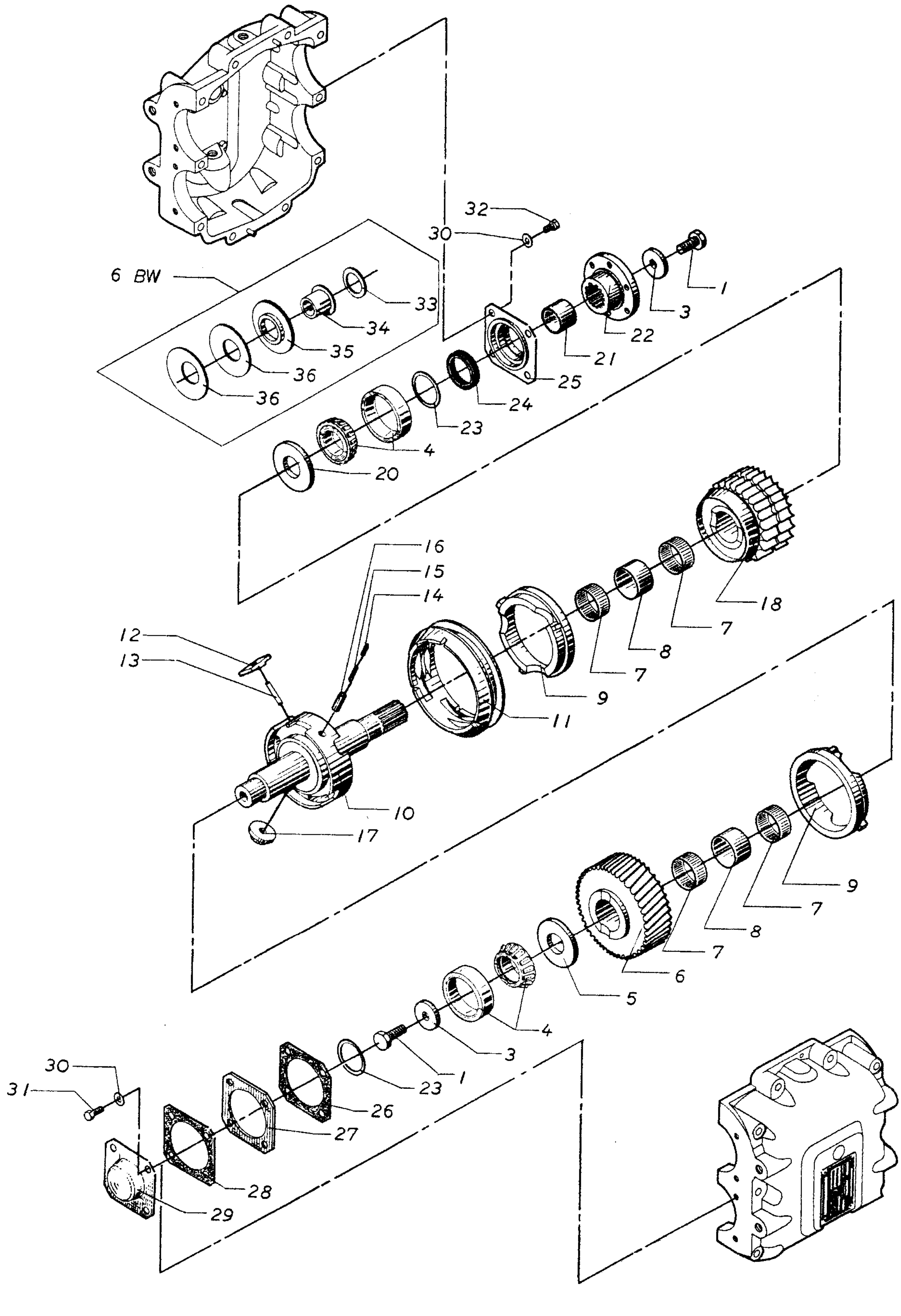
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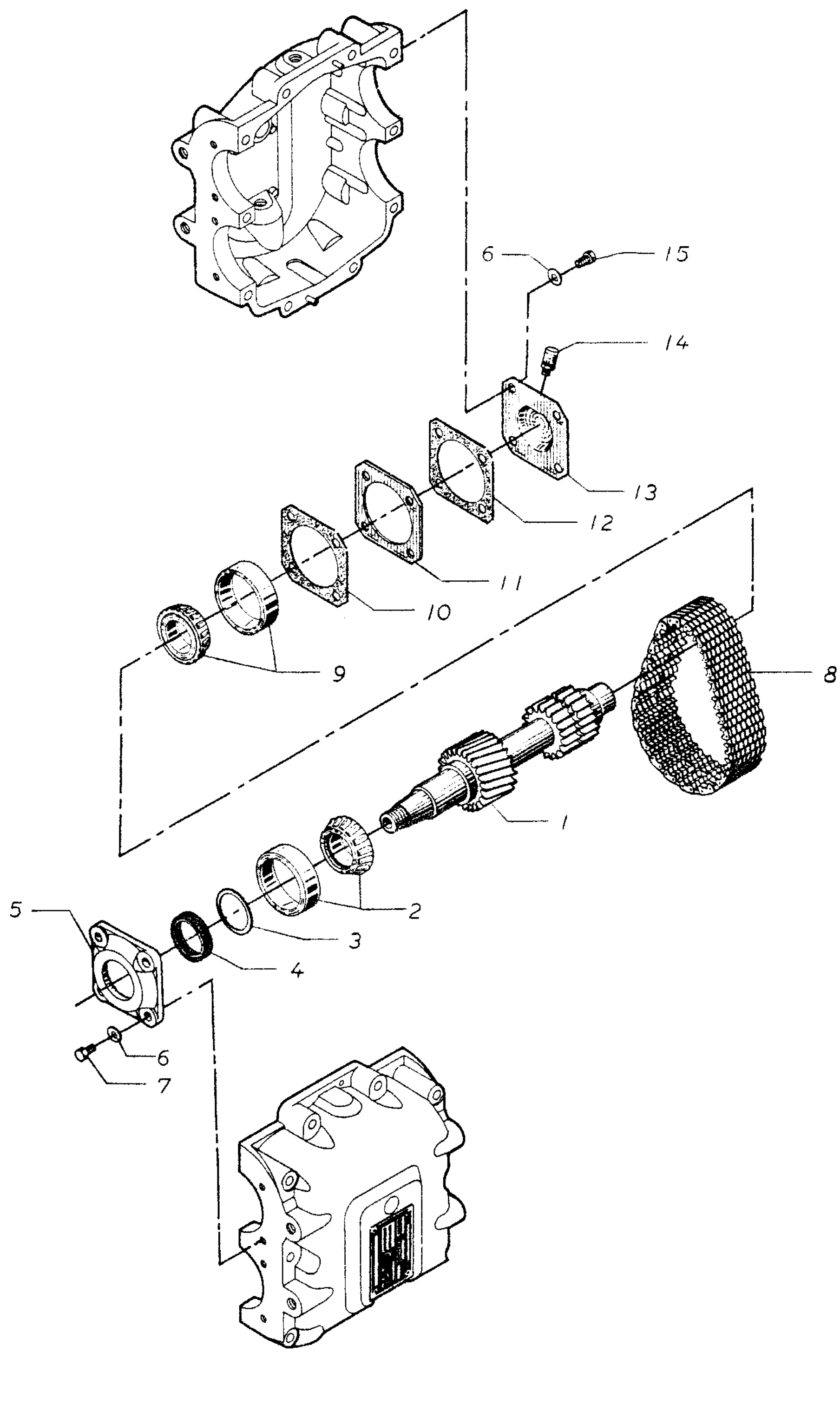
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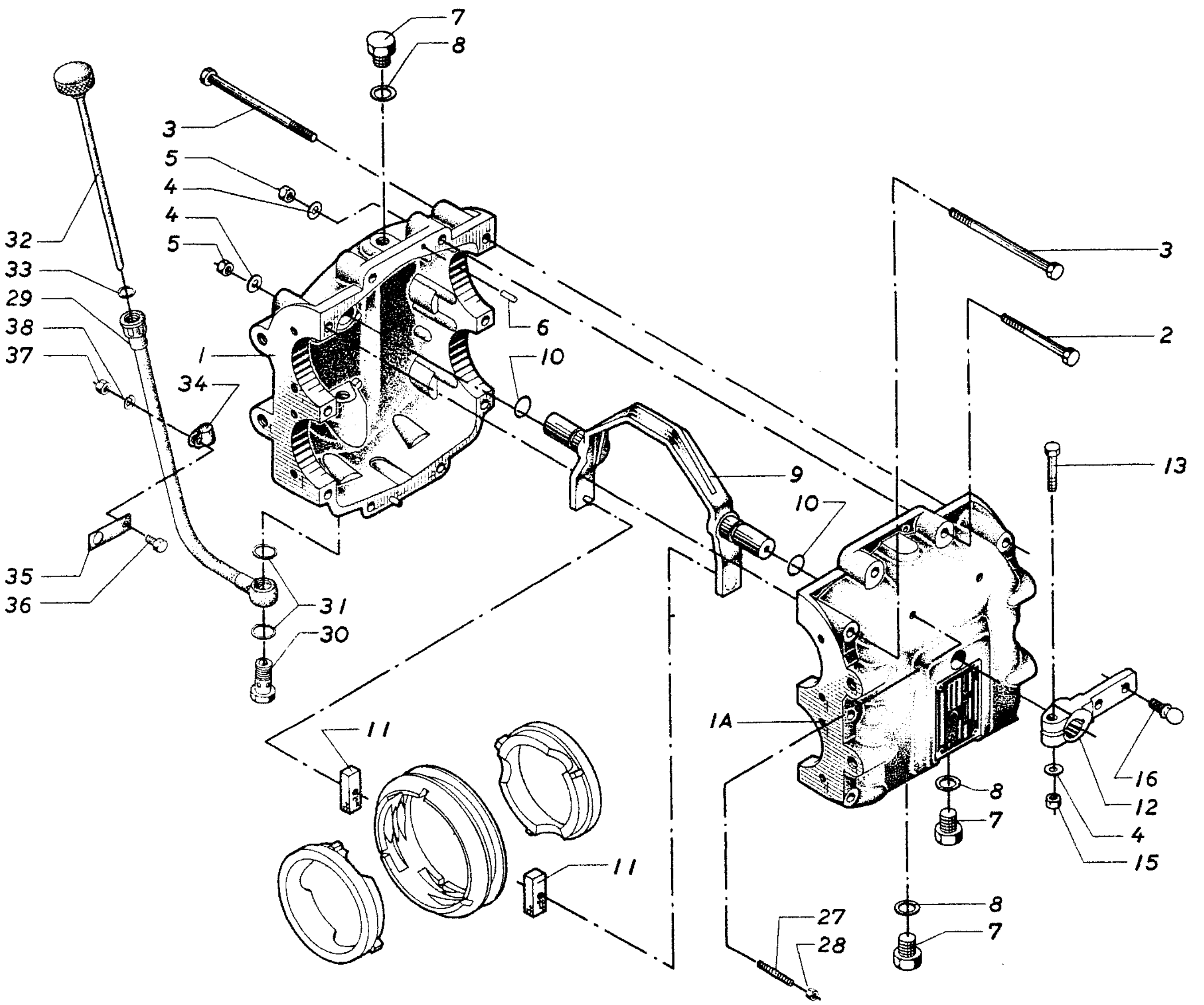
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Section R

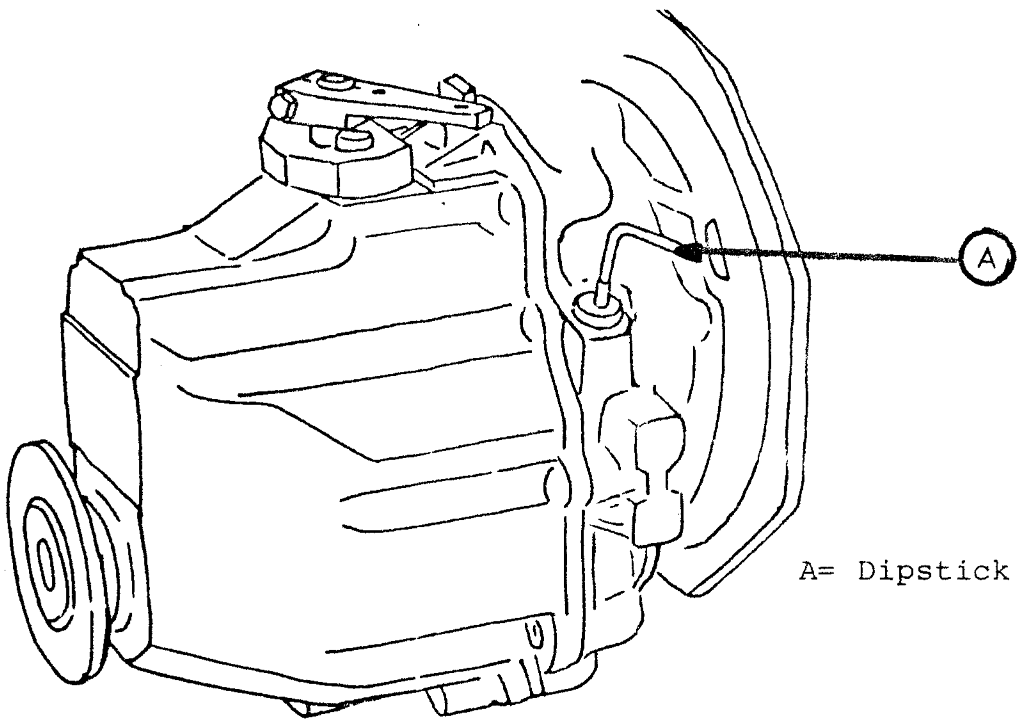
ZF GEAR - BW7

CONTENTS

Gear Ratio

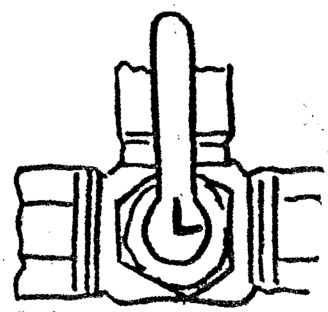
The BW7 gear is used on DV36. The reduction is 3:1 for AHEAD and 2.36:1 for REVERSE.

When using the gear on DV10/20 the reduction is 2.5:1 for AHEAD and 2.77:1 for REVERSE.



A= Dipstick

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 fitted on the engine and the three-way cock which should be set in the position shown on the sketch.

Refill fresh oil to the quantity of 1.1 litres.

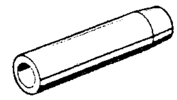
Quality of lubricating oil marked Service CC or CD with firm viscosity of SAE20, alternatively SAE30 is used. Oils covering more viscosity numbers must not be used.

R 4

Special Tools

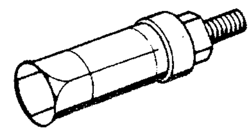
Order No. 009P3187

Mounting punch for seal ring
25 x 33 x 6 at input shaft.



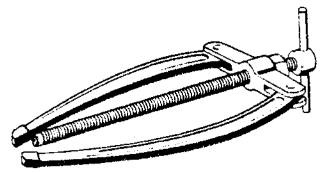
Order No. 009P3188

Internal puller for tapered
roller bearings/outer ring.



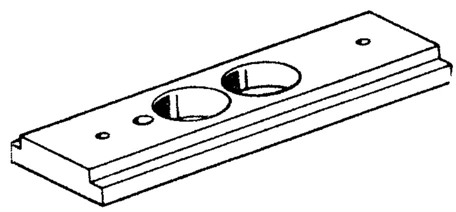
Order No. 009P3189

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



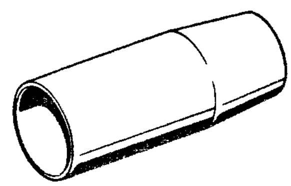
Order No. 009P3190

Measuring instrument for adjustment
of tapered roller bearings.



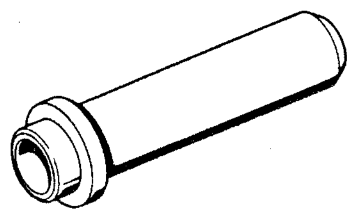
Order No. 009P3191

Protective sleeve for seal ring
25 x 33 x 6 at input shaft.



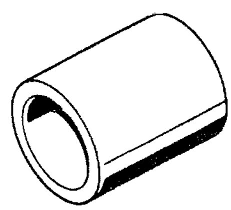
Order No. 009P3192

Mounting punch for seal ring
32 x 45 x 7 at output shaft.



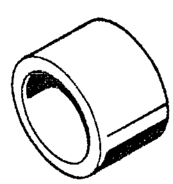
Order No. 009P3193

Bush for stiffening of disc
springs. "AHEAD".



Order No. 009P3194

Bush for stiffening of disc
springs. "ASTERN".



Adjusting Measures and Torques for BW7

Designation	Statement of dimensions	Gauge	Remarks
Axial tightening of the 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±2.4N (3.89±0.24 kp)	Depth measure Weight	L = length of loaded spring P = spring power

Adjusting Measures and Torques for BW7

Designation	Statement of dimensions	Gauge	Remarks
Testing indication for pressure spring 0732 041 008 for shift pins	L = 11.4 mm P = $46^{\pm}5$ N ($4.6^{\pm}0.5$ kp)	Depth measure Weight	L = length of loaded spring P = spring power
Torque of hexagon nut M 20 x 1.5 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 M 20 x 1.5 on output shaft on the input side	100 Nm (10 kpm)	Torque wrench	Secure after tightening
Torque of hexagon nut M 20 x 1.5 on gear-wheel bolts	50 Nm (5 kpm)	Torque wrench	Secure after having packed with liquid jointing on the contact face
Torque of M 8 screws in the halves of the gearbox	17 Nm (1.7 kpm)	Torque wrench	Add U-washers
Torque of the M8 x 25 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)	Torque wrench	————
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	$22.5^{\pm}0.5$ 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 house 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 house 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 engine and gear.

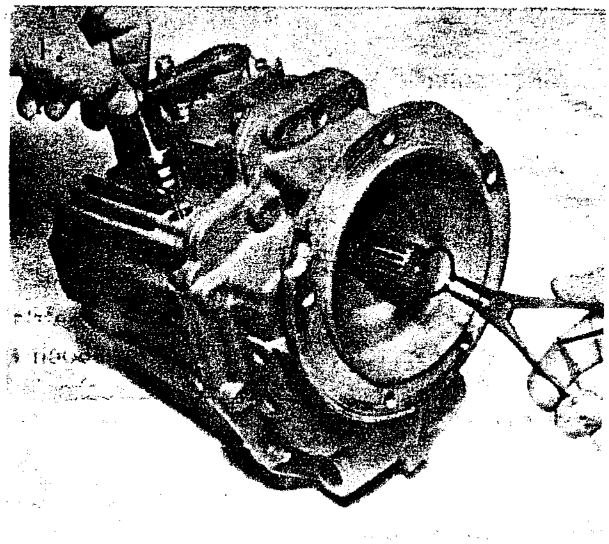
3. Lift clear the gear of the engine.

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

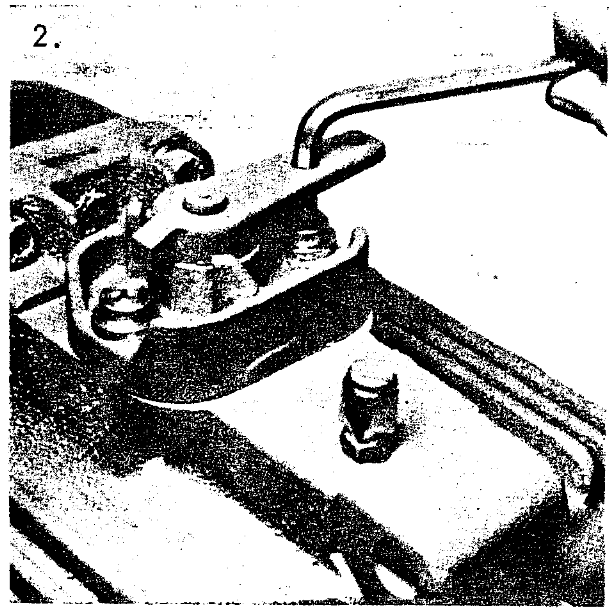
Pull out the dip stick of the house.

Remove the locking ring on the input shaft.



Remove the shifting arrangement with gasket.

2.

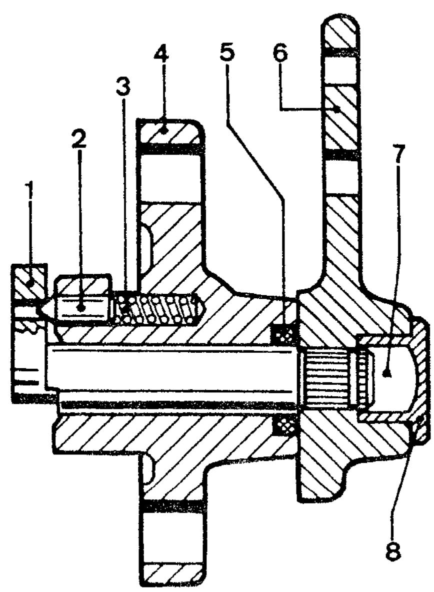


There are two different shifting levers which, however, can be built in without any problems in either cases.

3.

Press the shifting lever out of the shifter shaft and take out the O-ring 12 x 2.4 and the pin and the pressure spring.

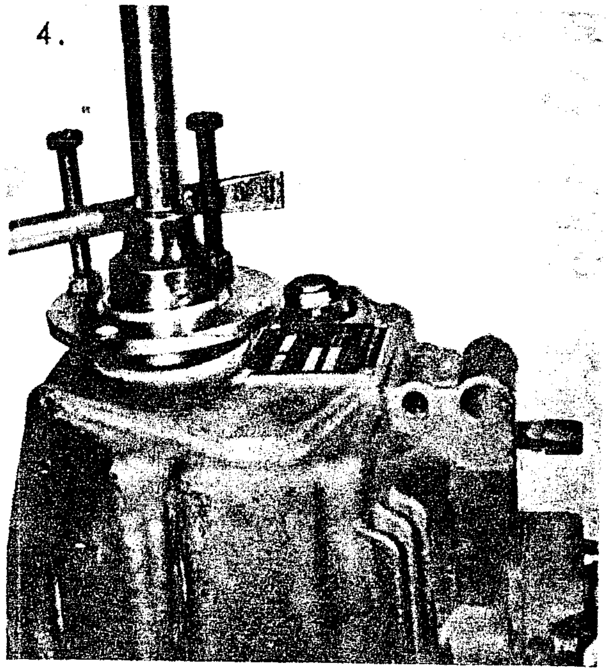
Before the shifting lever is pressed out it should be marked in proportion to the shaft out of consideration for the later assembling of the arrangement.



1 = shifter shaft
2 = pin
3 = pressure spring
4 = shifting housing
5 = O-ring
6 = shifting lever
7 = grease lubricating
8 = screw cap

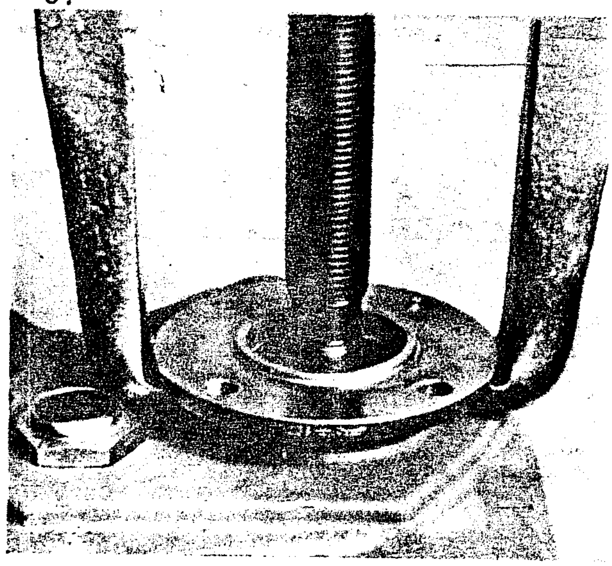
4.

Unscrew the nut of the output shaft flange



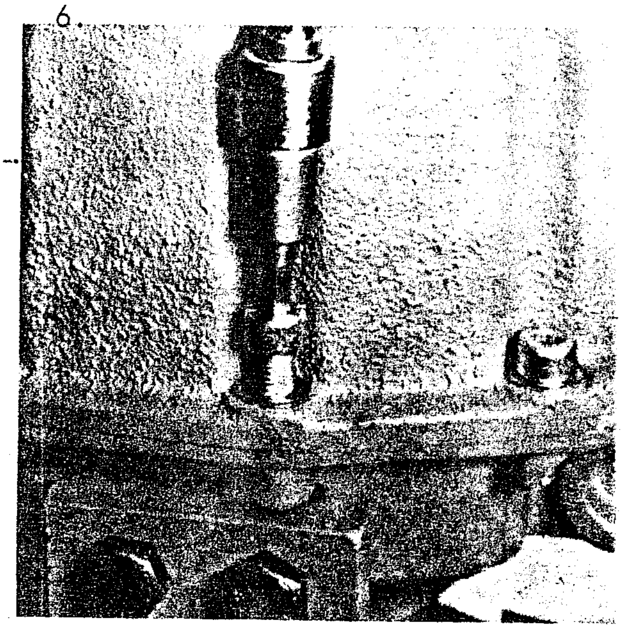
5.

Pull off the output shaft flange

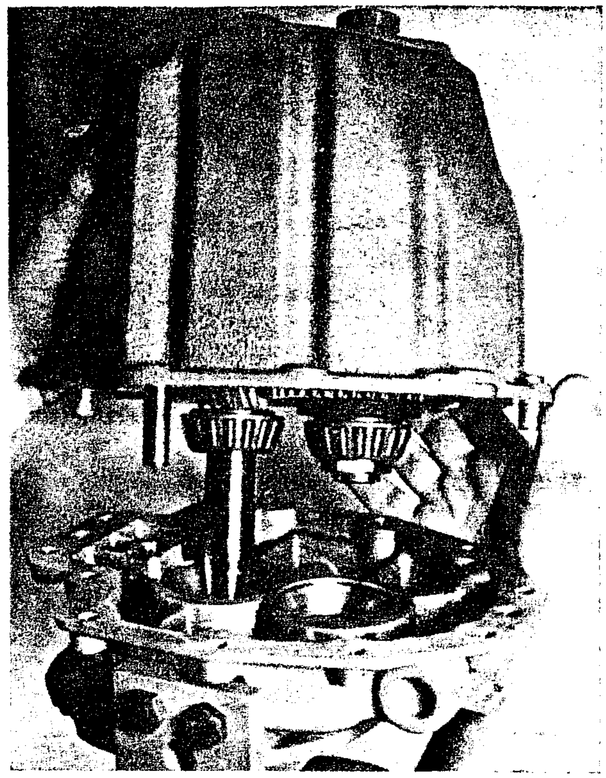


6.

Screw off the fixing screws which hold the halves of the gear-box together



7.



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.

8.

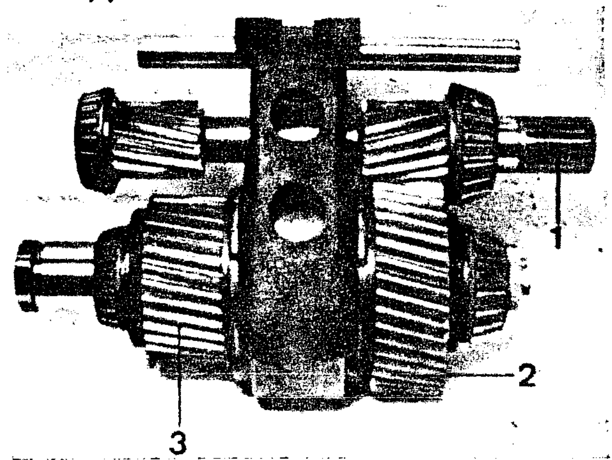
Removal of Input and Output Shaft

Take out the screws M 8 x 25 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.



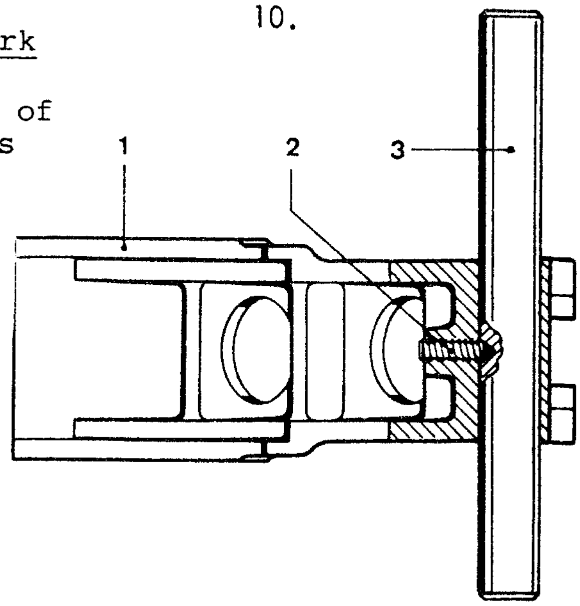
Lift the complete arrangement with input and output shafts and shifting fork out of the house.

Now the arrangement can be lifted free of each other.

1 = input shaft
2 = wheel ASTERN
3 = wheel AHEAD

Dismantling of Shifting Fork

10.

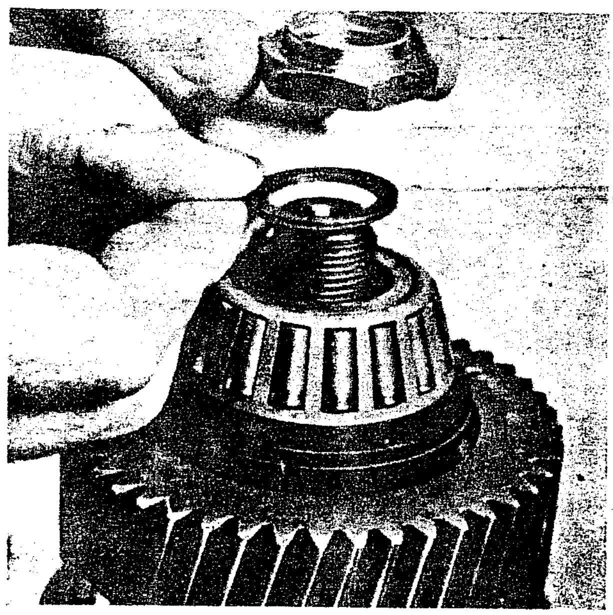


Screw out the pin M 6 x 12 of the shifting fork and press out the reversing shaft of the shifting fork.

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

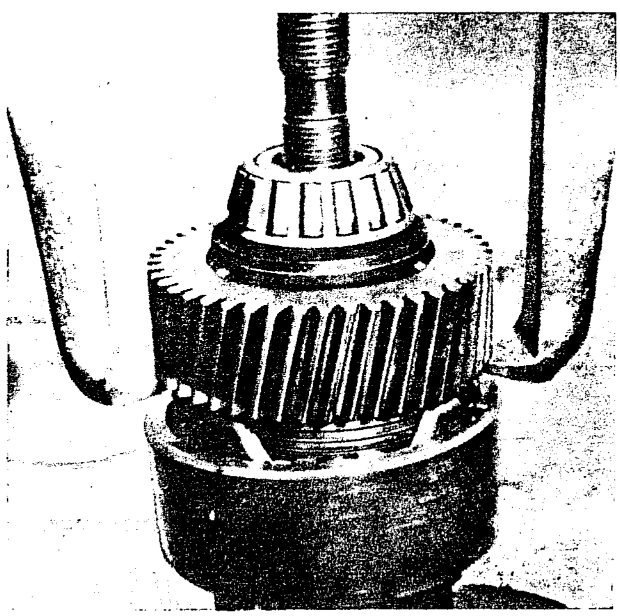
11.



Dismantling of Output Shaft

Remove nut with washer ASTERN.

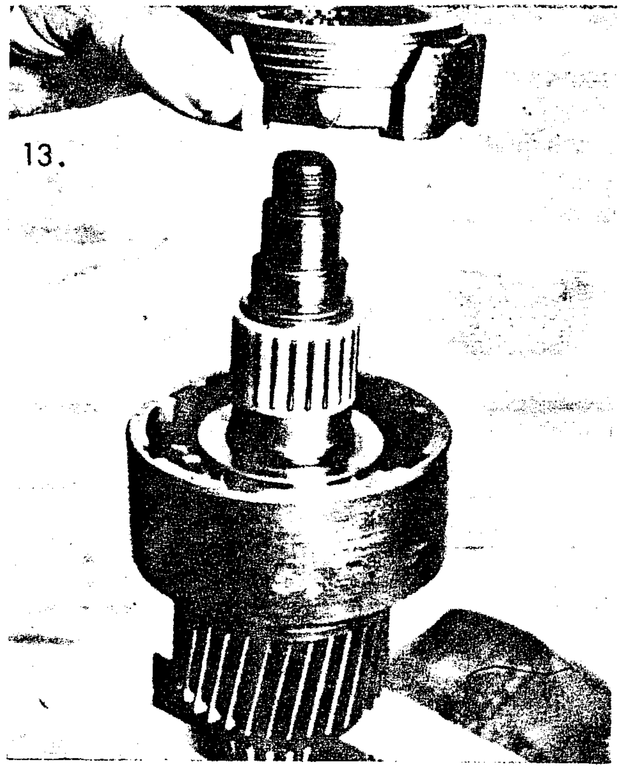
12.



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

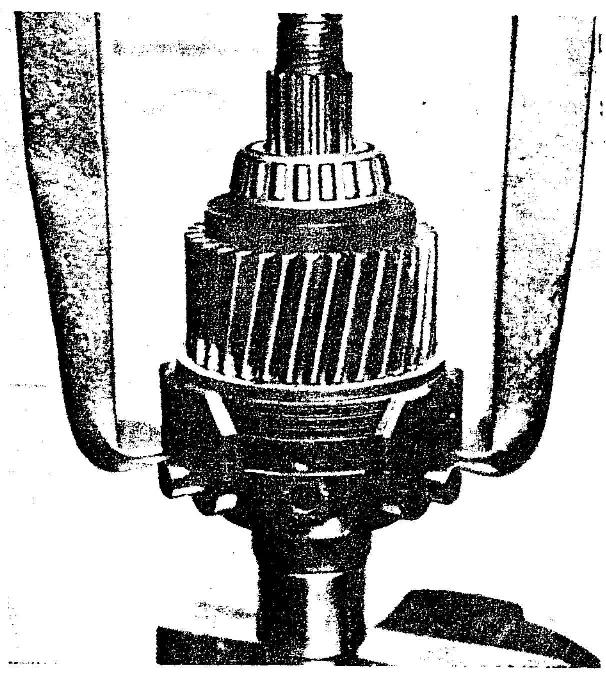
Remove thrust collar with bolts and washers together with needle bearing bushing, sliding sleeve and pressure spring.

13.



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

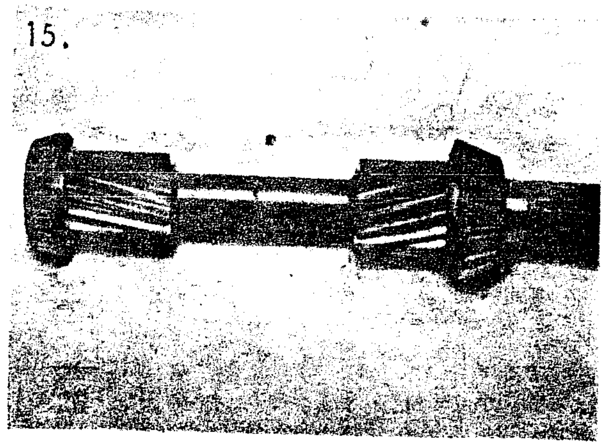
14.



Dismantling of Input Shaft

Squeeze off the tapered roller bearing inner collar.

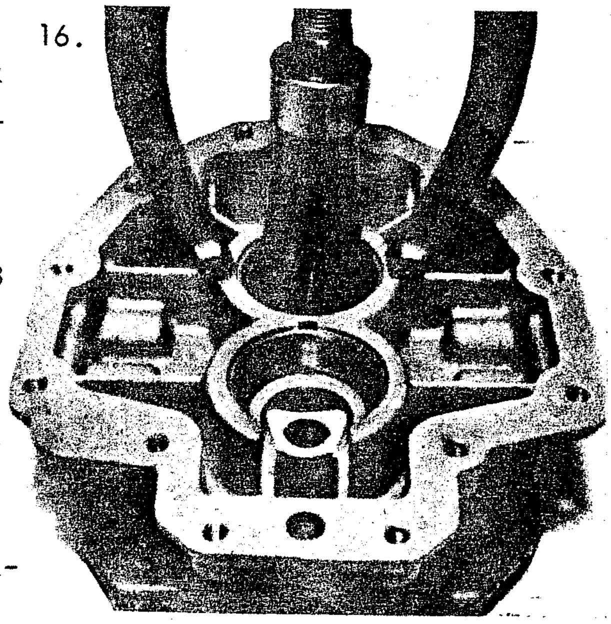
15.



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 No. 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.

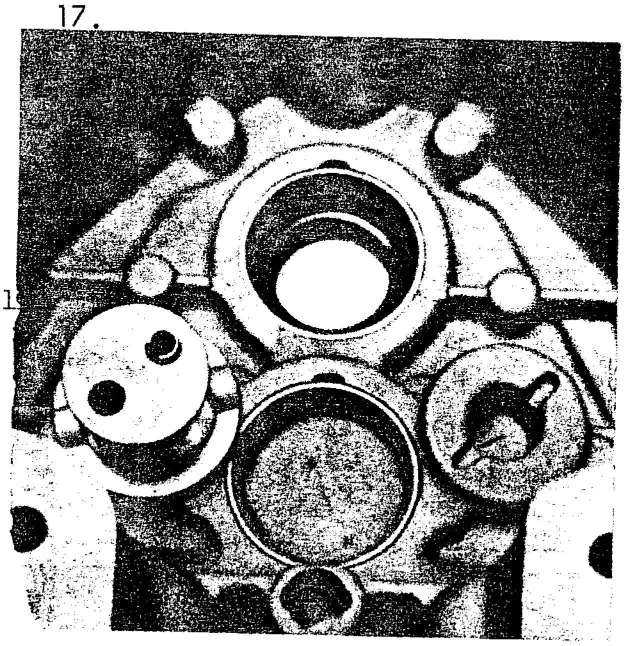


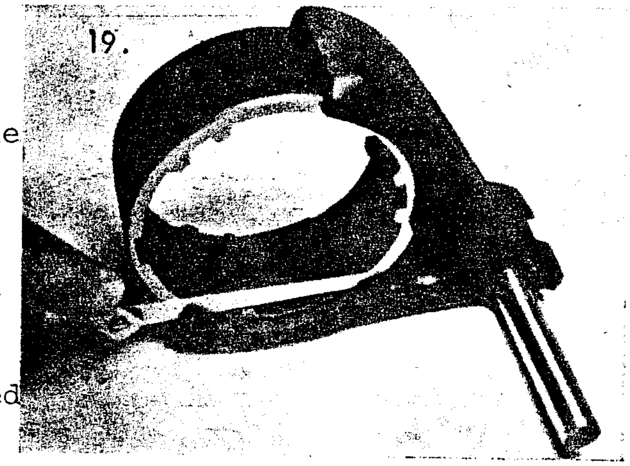
Dismantling of Upper Gearbox Half

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 house.
Remove slotted pin and washer.

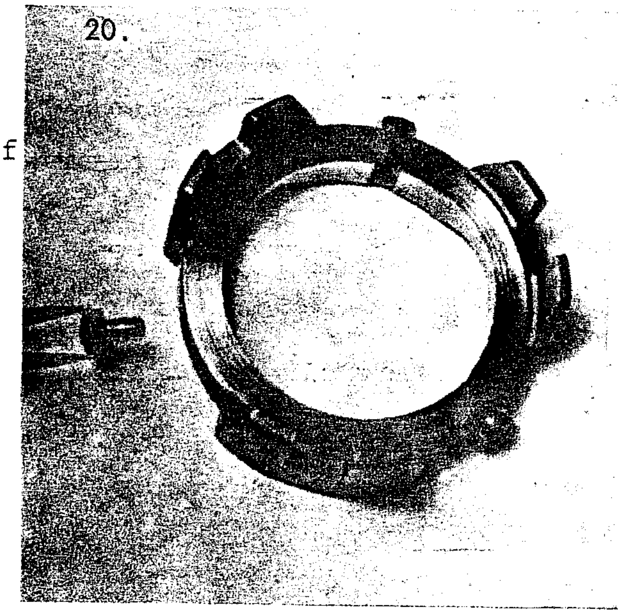
17.





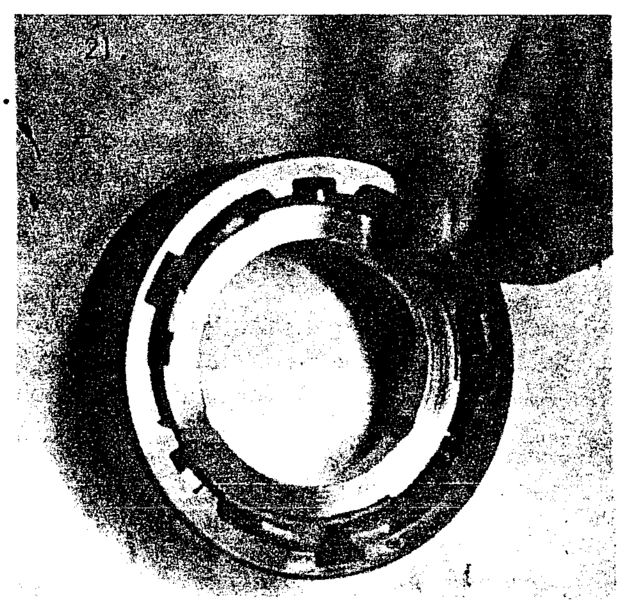
Refitment of BW7 Gear

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".



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.
"NOTE": Axial clearance inclusive of permissible wear must be max. 0.8 mm.

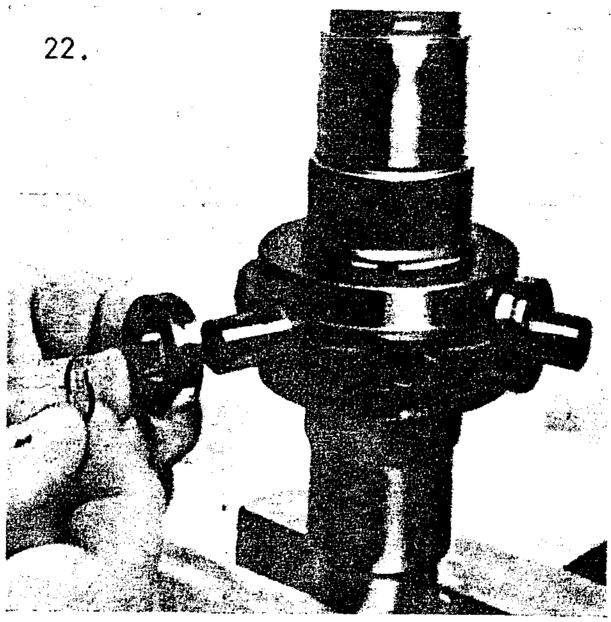
Picture 20: Insert the locking bolt in the thrust collar. The locking bolt should be able to turn easily in its bore in the thrust collar. The head of the locking bolt must adjoin the thrust collar.



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.

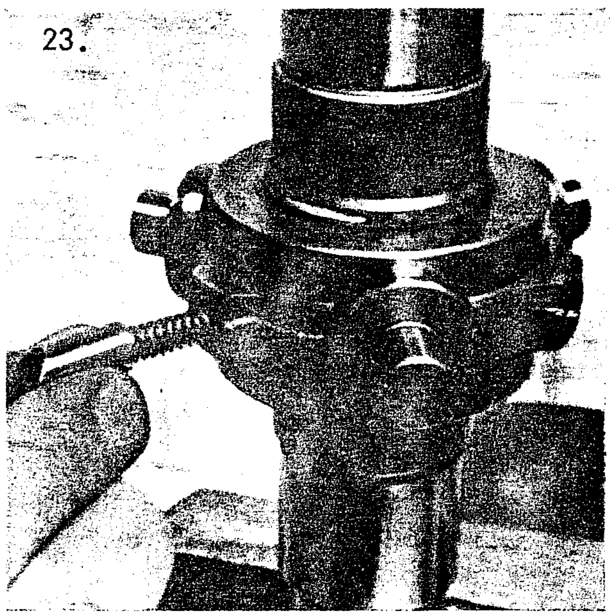
22.



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.

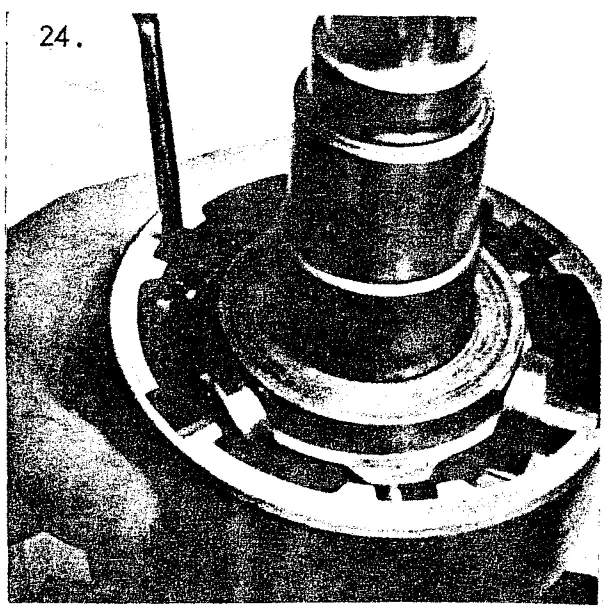
23.



Press the sliding sleeve from the bottom against the check bolts.
Press the check bolts back with a screwdriver and at the same time press the sliding sleeve upwards.

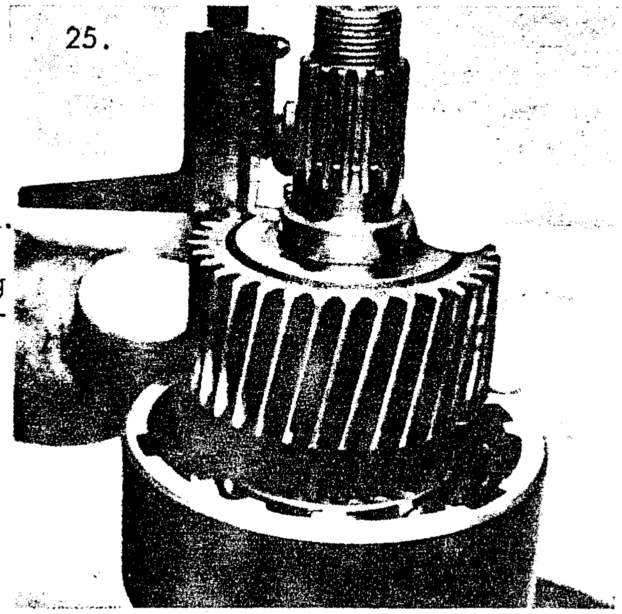
The bolts should rest in the points of rest of the sliding sleeve.

24.

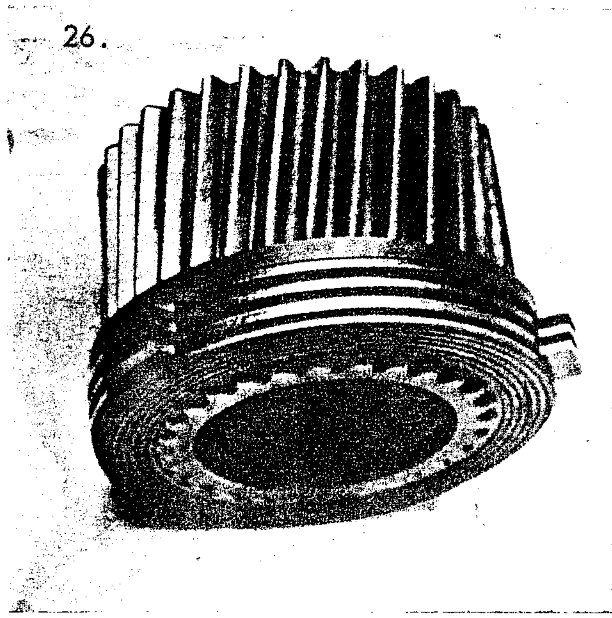


Fit needle bearing housing, wheel for "AHEAD" and washer.

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).

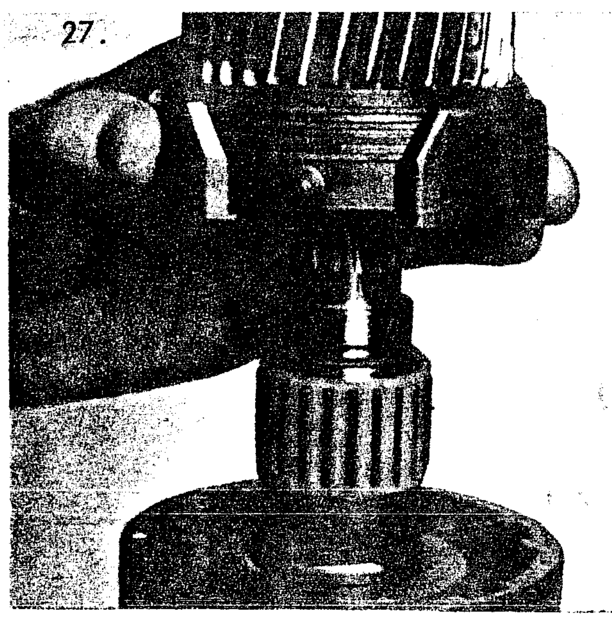

25.

First fit a washer. Then fit an inner disc and then an outer disc. Fit 4 inner and 3 outer discs in this order.

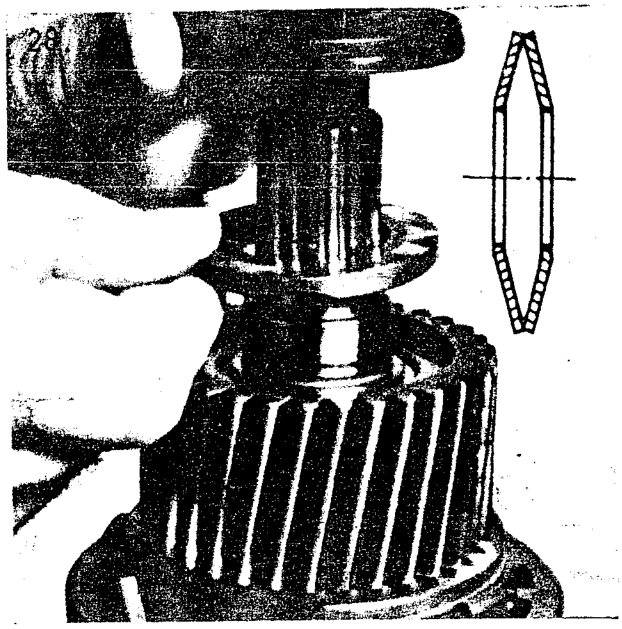

26.

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

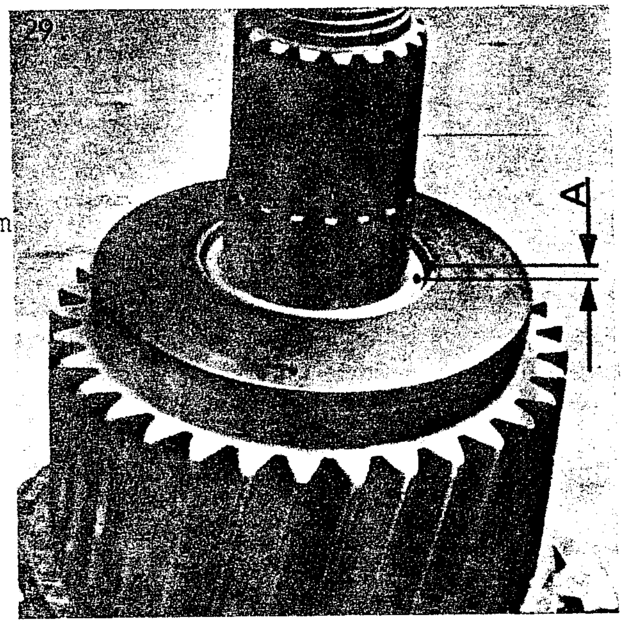
First fit the driving pins through the thrust collar and then fit the thrust collar with clutch discs and wheel for "AHEAD" over the needle case on the input shaft in the sliding sleeve.


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.

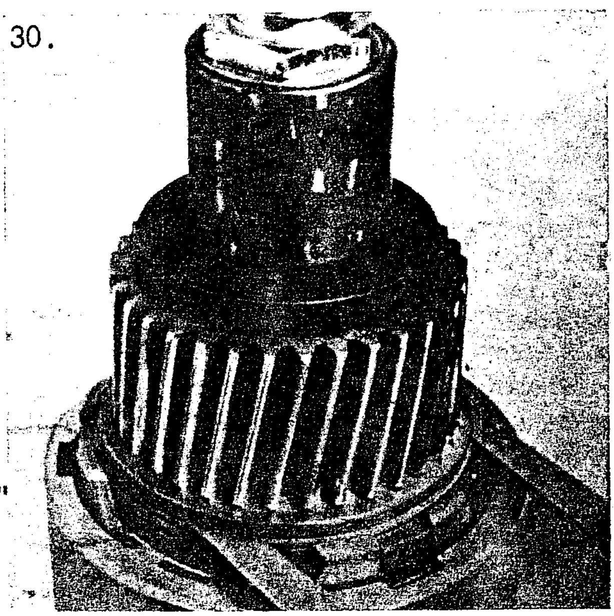


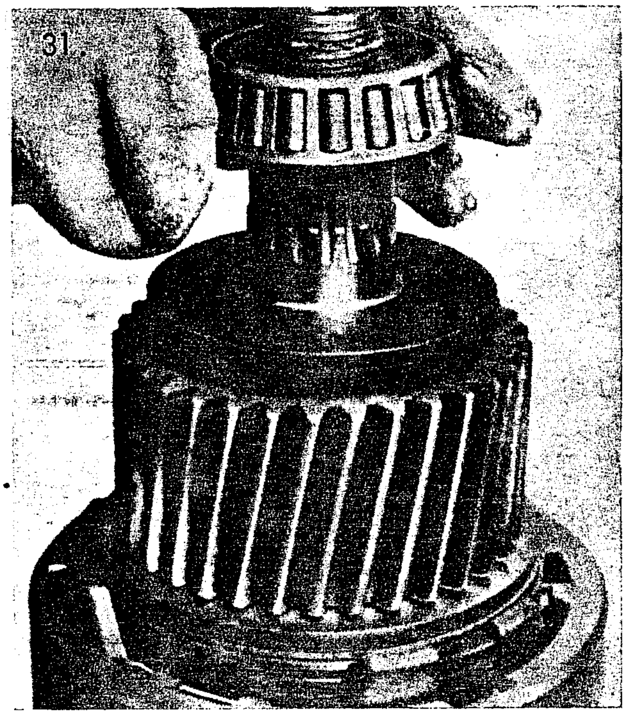
Check the tightening of the disc springs. The inside diameter of the disc springs must, when slack,in proportion to the front be min. 1.1 mm (measure A).



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.

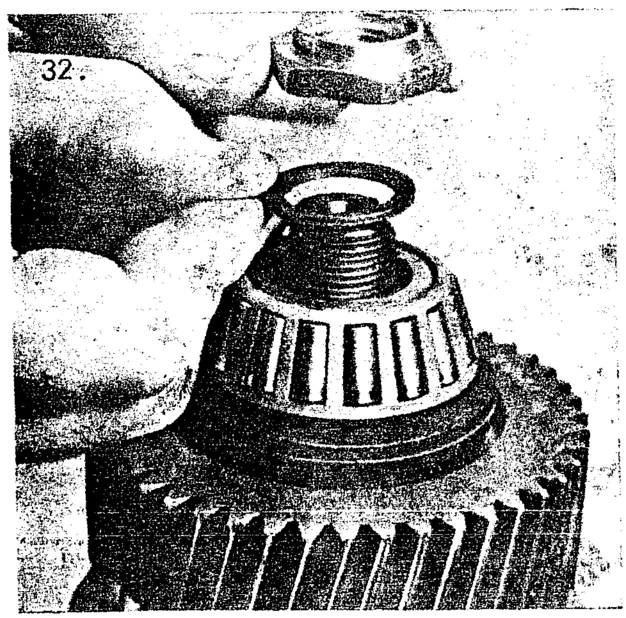
30.





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).

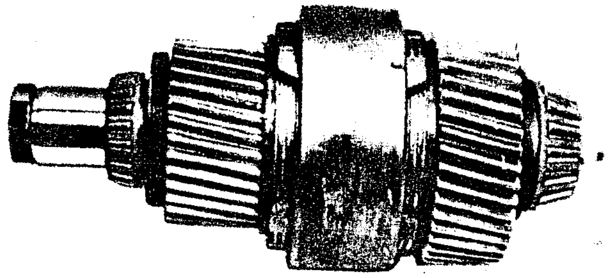


"NOTE": Fix the tapered roller bearing for "ASTERN" with supporting washer and original hexagon nut.

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

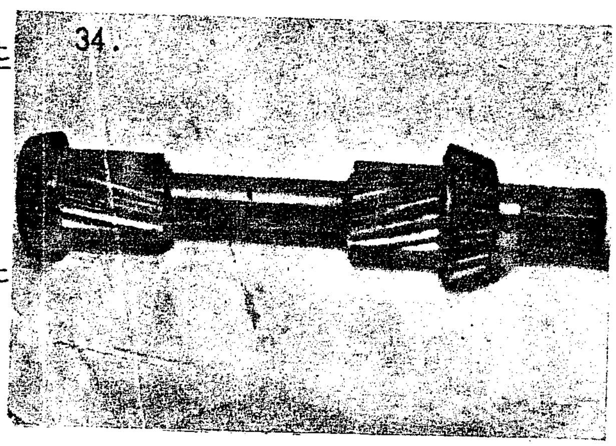
33.

The picture shows the ready-mounted output shaft.



Fitting of Input Shaft

34.

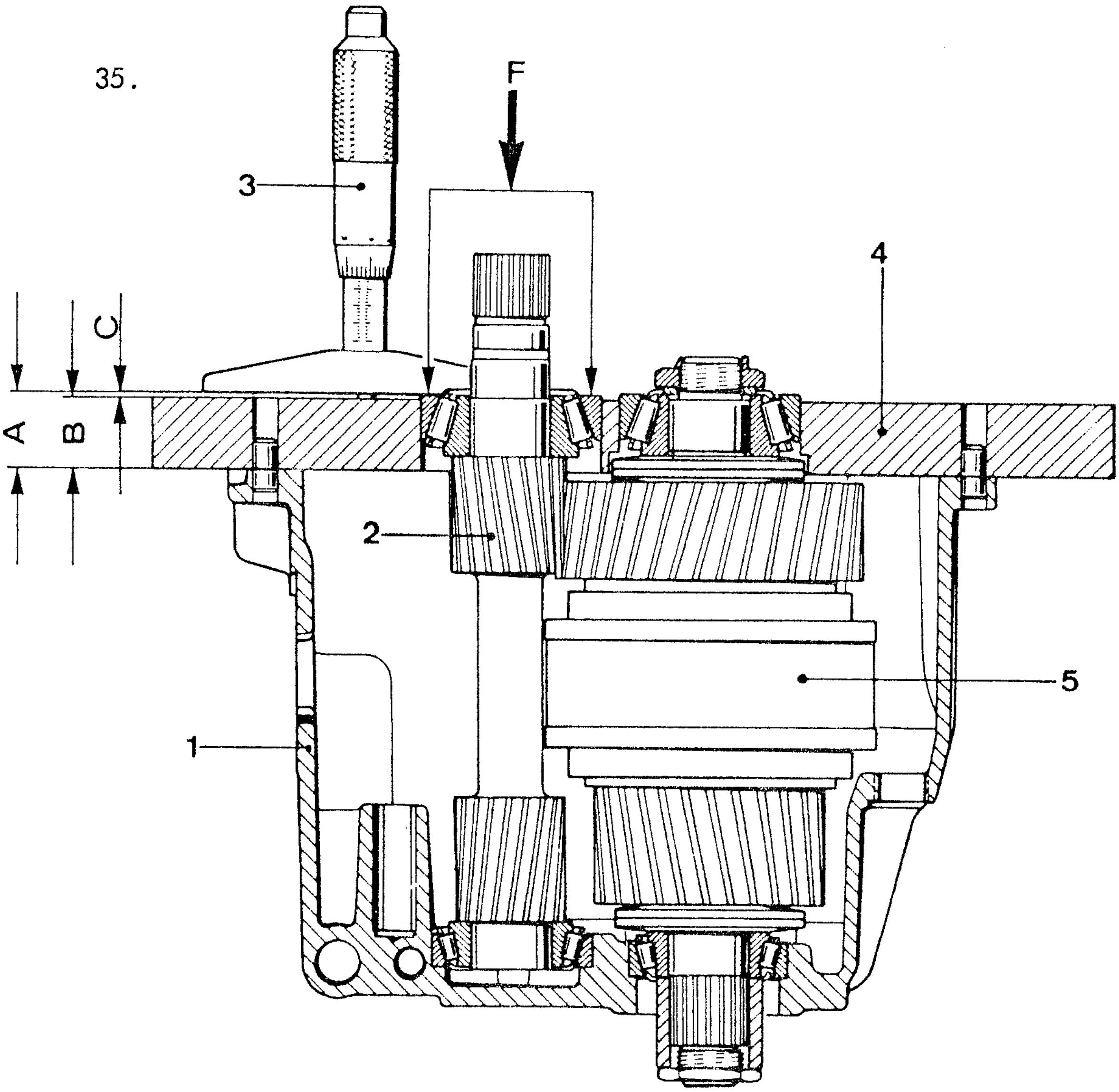


Heat the tapered roller bearing inner collars to about 85°C and fit it with the thin end of the bearings towards the shaft ends.

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

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

35.



1 = house	3 = depth micrometer	5 = output shaft
2 = input shaft	4 = measuring gauge 1 x 56 136 978	6 = 30 N (3.0 kp)

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

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

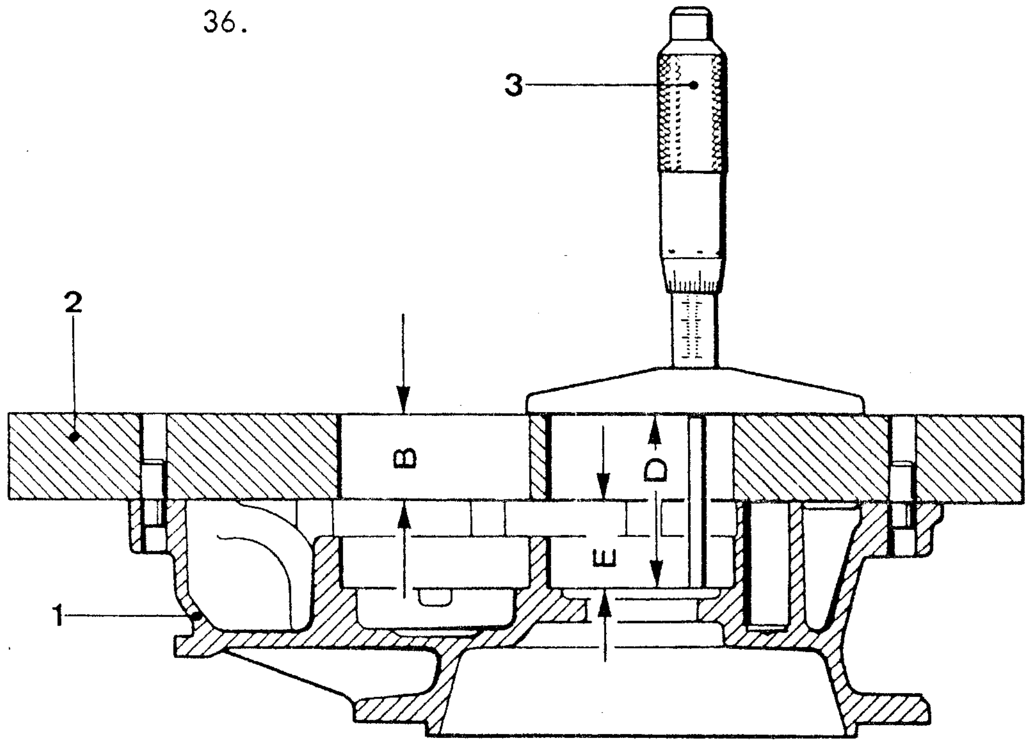
Measure the tightening as shown on the pictures 35, 36 and 37 and adjust it with adjusting washers (measure G). Measure G: measure F (difference measure) plus tightening.

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

Fit the tapered roller bearing outer collars in the measuring gauge until they fit tightly against the taper 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.

36.



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 itermediate washer G for input shaft as F plus tightening 0.03 - 0.98 mm.

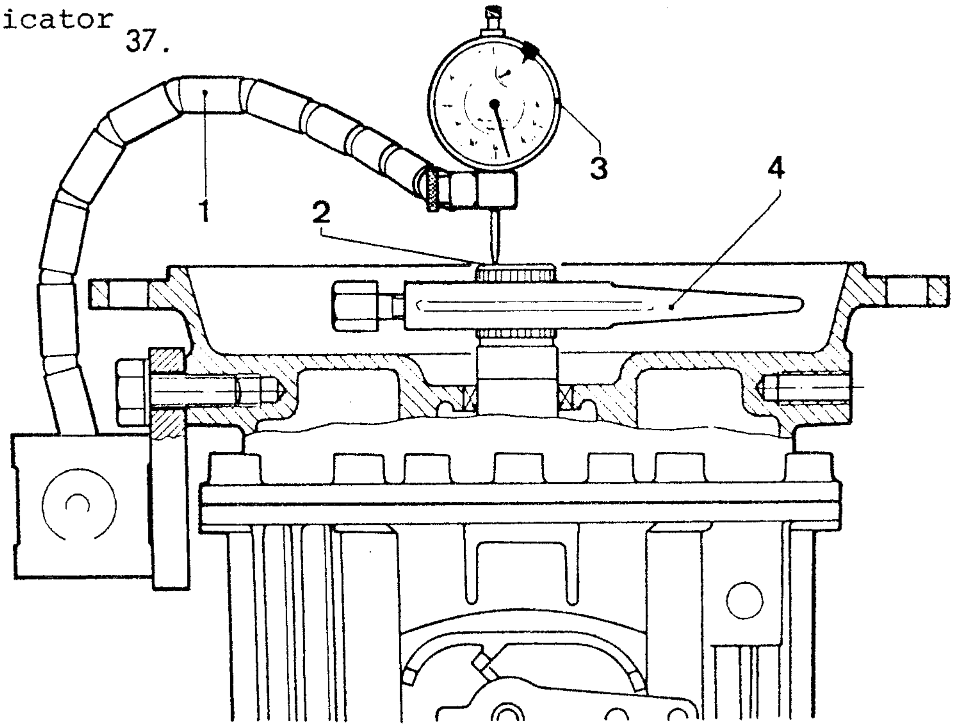
At the calculations the thickness of the liquid jointing, when compressed, should be included and an empirical value of 0.02 mm should be considered.

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 = output shaft
3 = dial indicator
4 = driving arrangement

37.



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 that 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 house 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 interm. washer	0.755 mm

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

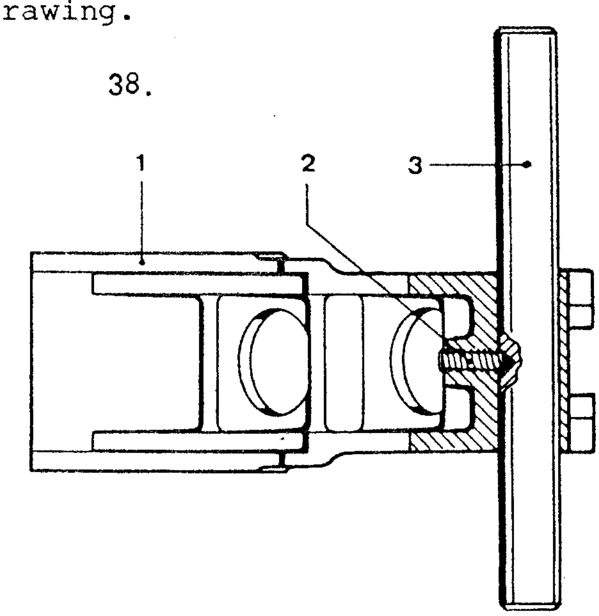
Then insert the correct intermediate washers in the bores (max. 2 washers in each bore) and fit the bearing outer collars after heating with loctite No. 601.

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.

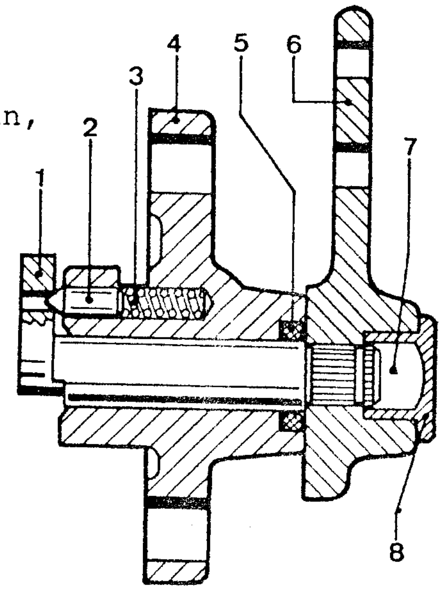
38.



1 = shifter shaft
2 = shift pin
3 = pressure spring
4 = gearbox
5 = O-ring
6 = shift control lever
7 = grease lubricating
8 = screw cap

39.

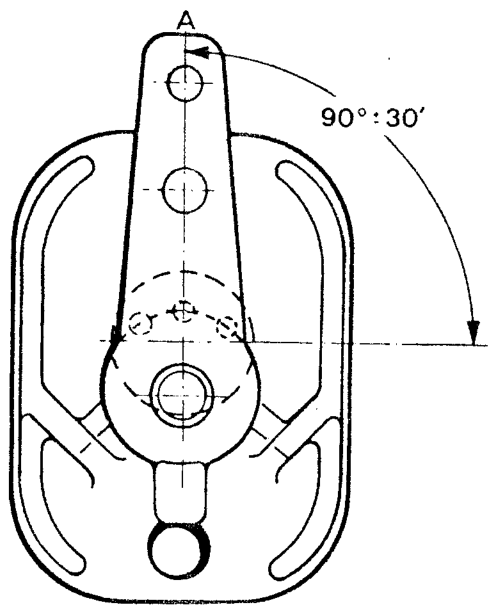
Insert pressure spring, shift pin, oiled shifter shaft and O-ring in the gearbox.



40.

Press the shift control lever on to the shifter shaft so that shift control lever is placed in neutral position at $90^{\circ} \pm 30'$ to the gear shaft length.

Fit the screw cap with grease lubricating after the pressing on.



Fitting of Bolts in Gearbox

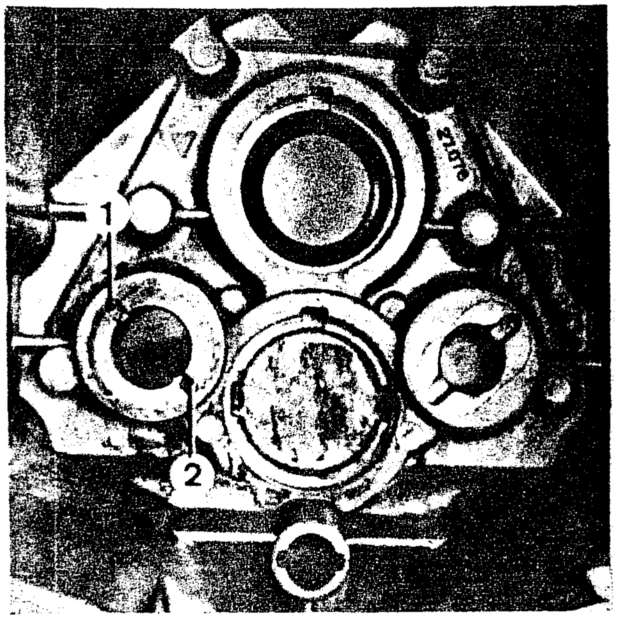
Drive in the slotted pins 4 x 16 in the bolts and fit the washers on the bolts so that the lubricating groove in them point to the wheel.

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

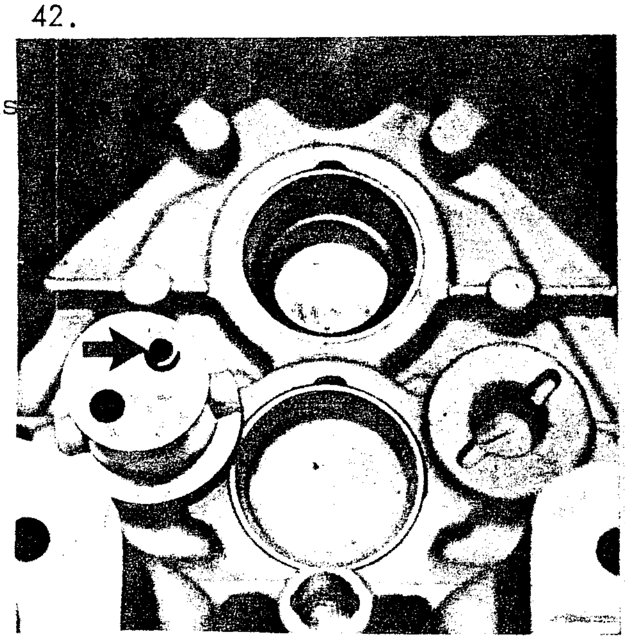
Transmission:

GLL = AHEAD
GGL = ASTERN

41.



42.



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

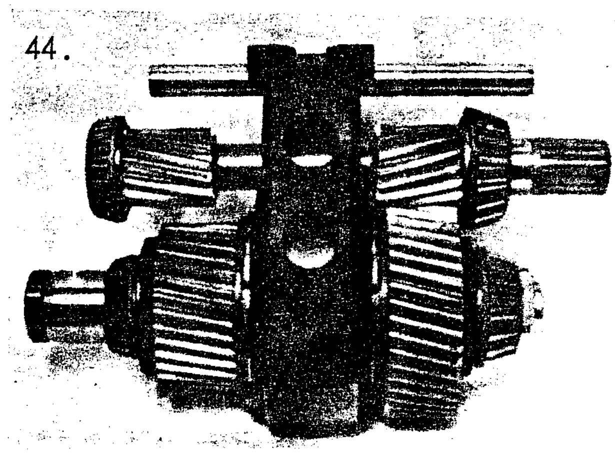
Fit the hexagon nut and tighten it with 100 Nm (10 kpm).
Fit the sleeve in the bolt bore nearest the centre of the gear (see the arrow).
Smear the hexagon nut with unhardening packing material before the fitting.

Fitting of Input and Output Shafts with Shifting Fork in Gearbox

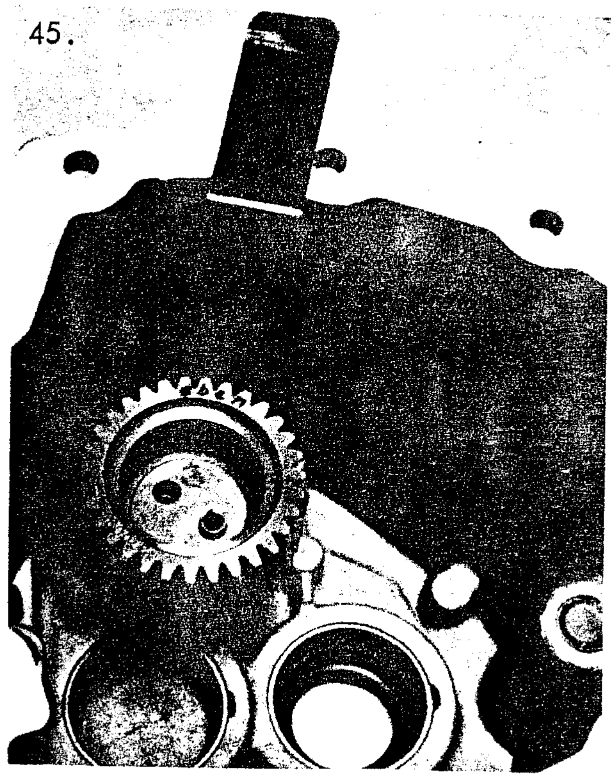
Place the shaft arrangement as shown on the picture.

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

44.



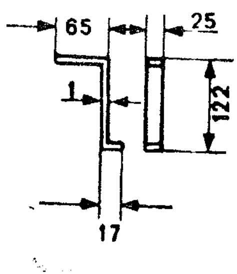
45.



Fit intermediate wheel and needle bearing.

Lift intermediate wheel with stop plate (see the illustration).

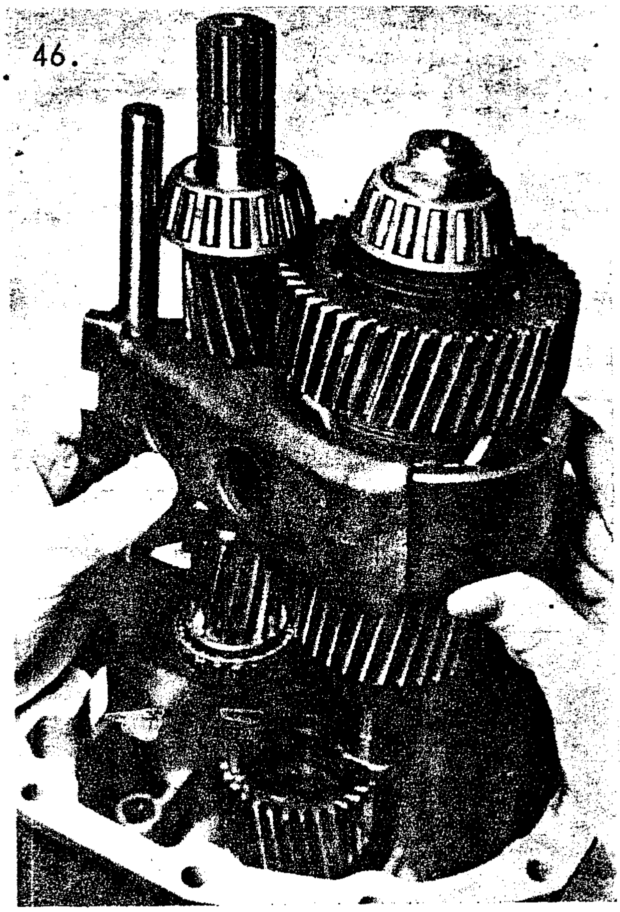
The intermediate wheel should be lifted about 25 mm,otherwise fitting is not possible.



measures in mm

Sketch of Stop Plate

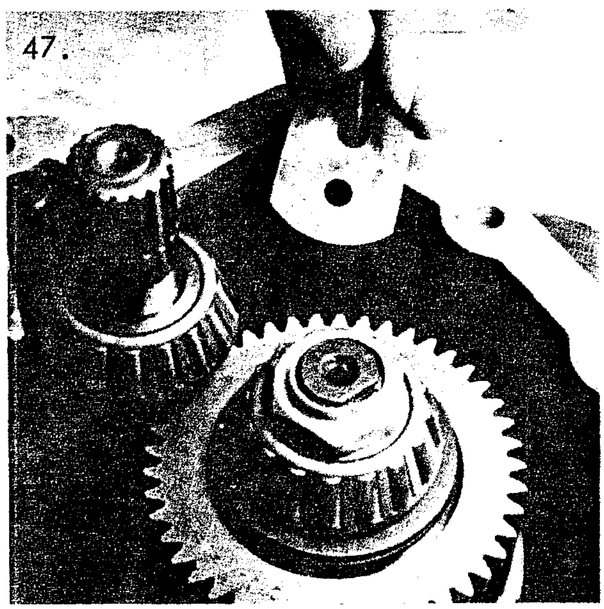
Place the house so that
the opening of it turns up.



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

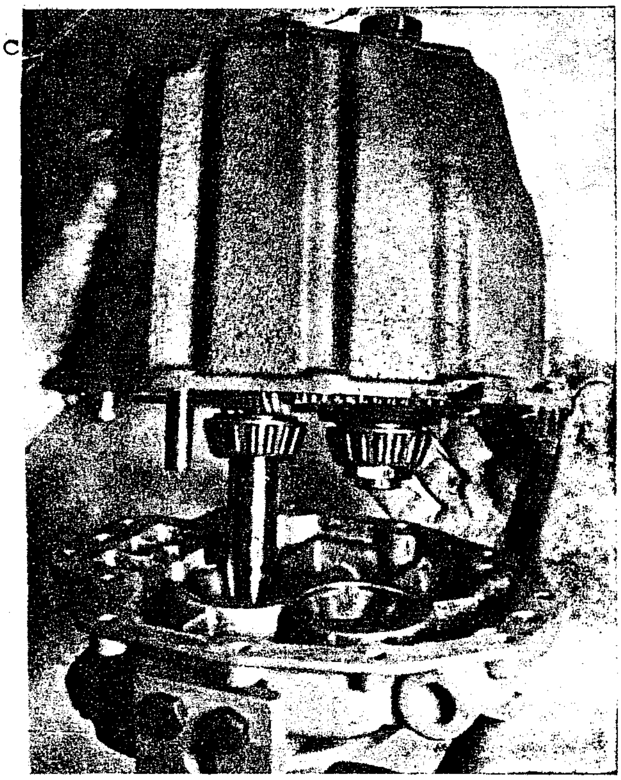
Remove the stop plate.
"NOTE": the long side of
the reversing
shaft points up-
wards to the input
side.

Fit retaining plate for
intermediate wheel and
before that smear the
screws M 8 x 25 with
loctite No. 241.



Torque 17 Nm (1.7 kpm).

48.

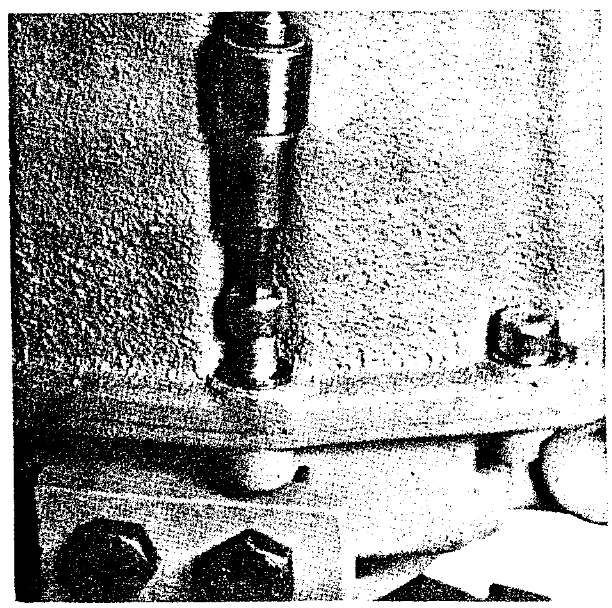


Smear the seal faces of the gear-box halves with permanently plastic liquid jointing.

Oil the bearings on the input and output shafts.

Assemble the gearbox and drive in the guide pins.

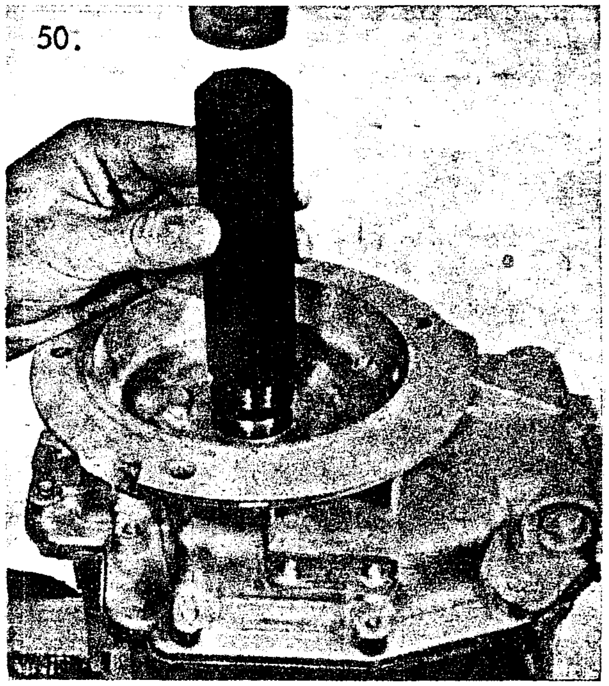
49.



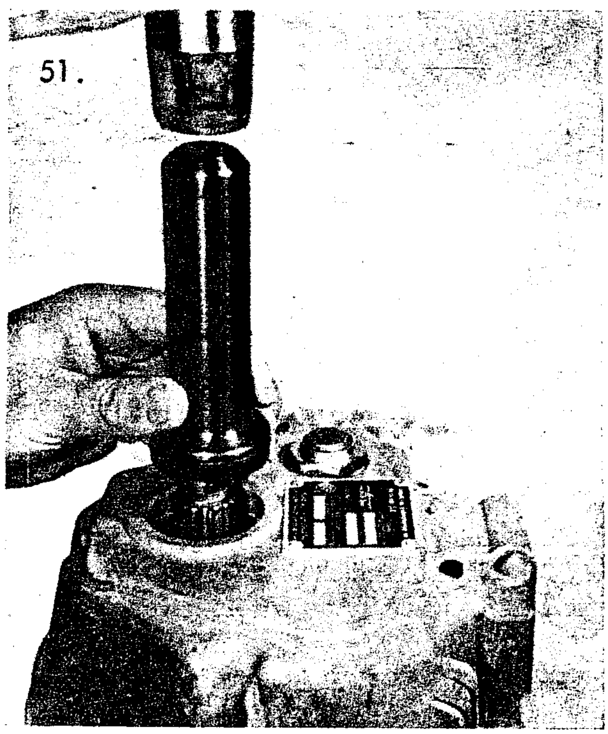
Tighten the screws M 8 x 25 with a torque of 17 Nm (1.7 kpm).

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 layer of permanently 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 house.

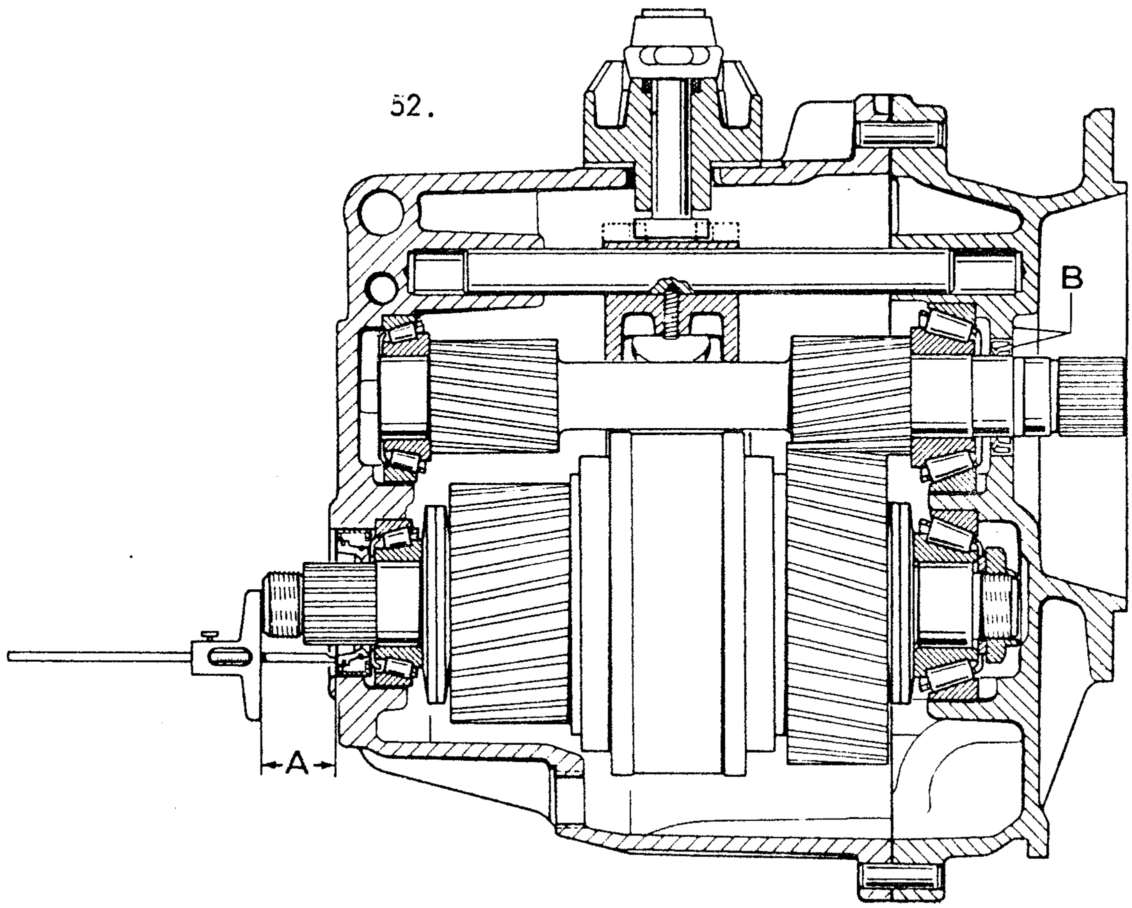


Smear the similar seal ring 32 x 45 x 7 for the output shaft in the same way as the seal ring for input shaft and fit it by means of punch No. 1 x 56 136 993 in the house so that it fits tightly against the tapered roller bearing inner collar.



Supplement to Fitting of Shaft Seal Rings

52.

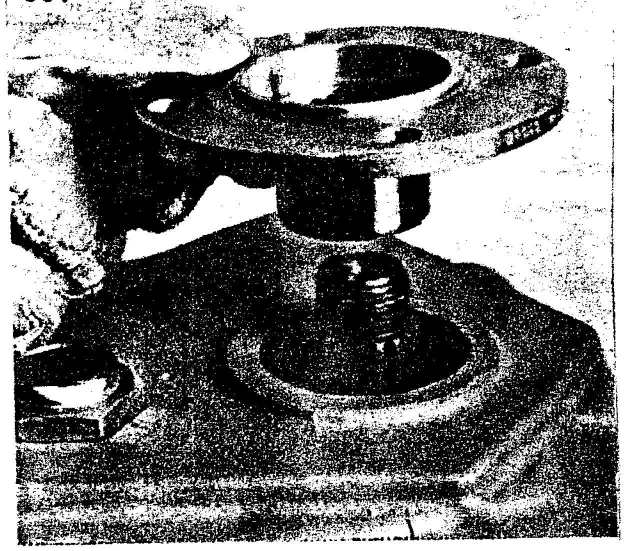


A = distance to shaft seal ring 22.5 +/- 0.5 mm.
B = shaft seal ring binding with surface of casting on lower gearbox half.

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 M 8 x 25 with washers in the gearbox. Put the gear shift lever in "neutral" (the sliding sleeve is also in "neutral" position).

Place gearbox with gasket in the opening of the house and press the shifting eccentric down into the shifting fork. In connection with this check at the same time with a light 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 gearbox because of the slots which may lead to wrong adjustments.

Adjustment can be carried out by axial displacement (angle 90° must be maintained, see picture 40).

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 should be connected (click) in both directions when the angles of engagement are as equal as possible.

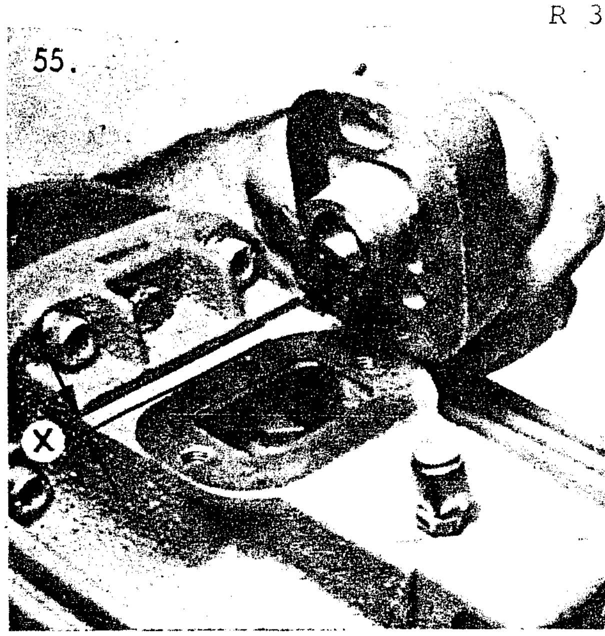
Besides, it must always be possible to turn the shift control lever 37° in either direction without much resistance.

Picture 57

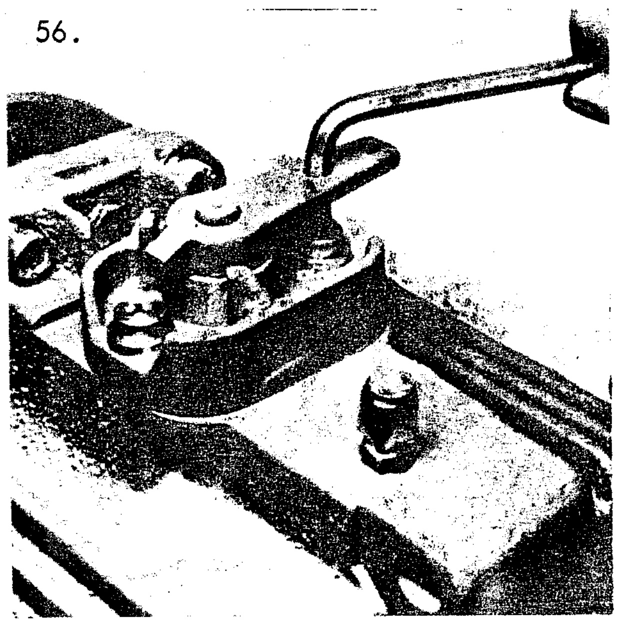
At last fit the dip stick and the locking ring at the end of the input shaft when fitted.

Fill oil in the gearbox to a quantity corresponding to the upper mark on the dip stick.

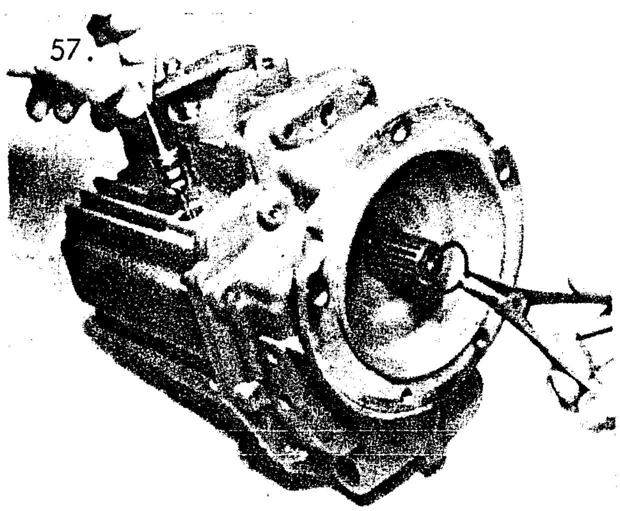
55.



56.



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 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 the quantity of 3.3 ltr. 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

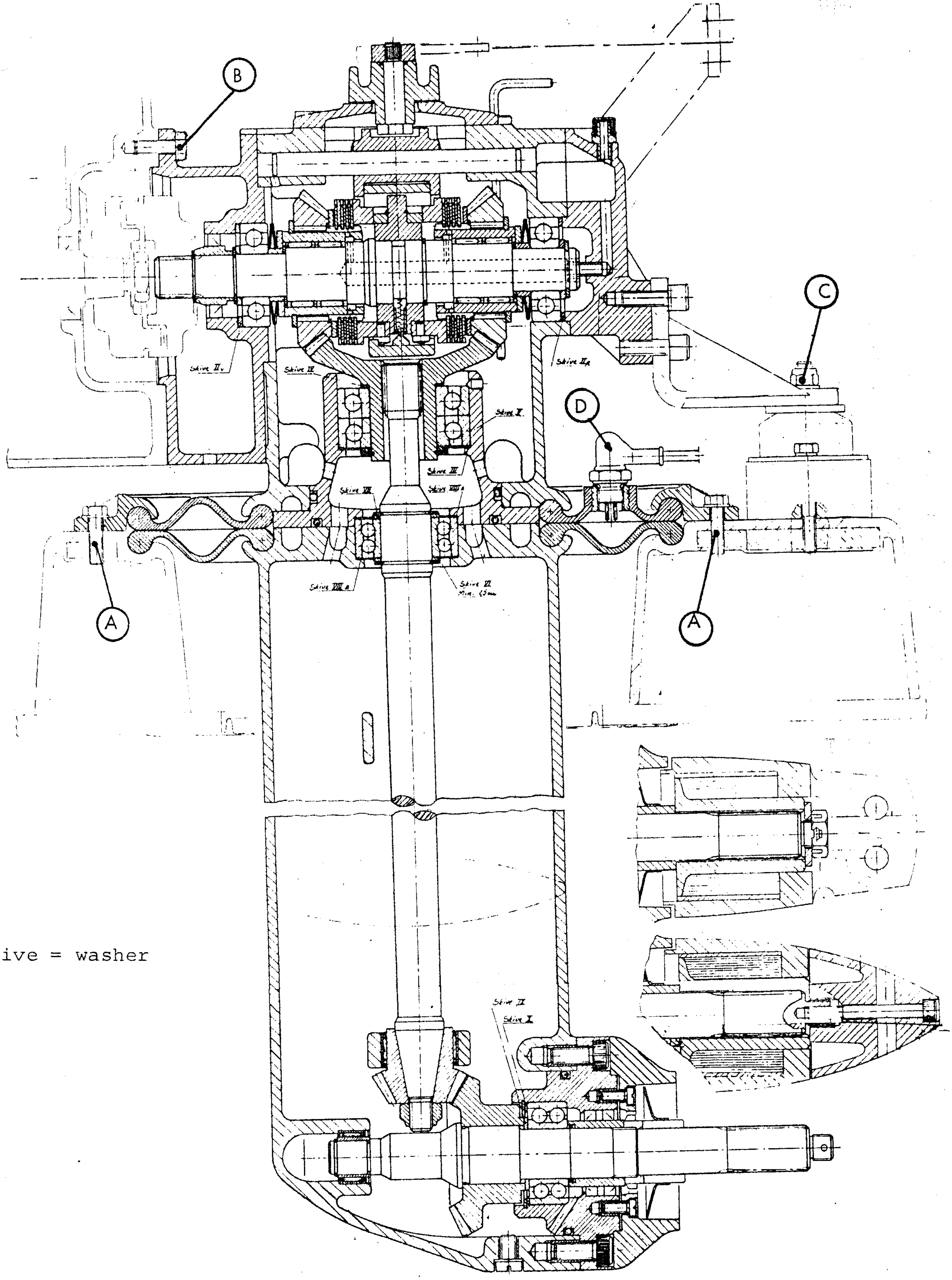
Do not grind thoroughly when careening the boat. Damage to the surface treatment should be treated as soon as possible with special BUKH paint.

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 S 4)

1. Beach the boat.
2. Loosen the bolts marked A in the flange at the double membrane.
3. Loosen the bolts B on the flange towards the engine.
4. Loosen the nut C on the sail drive holder astern (only DV10/20).
5. Loosen the sensing element D for water in the double membrane.
6. 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.



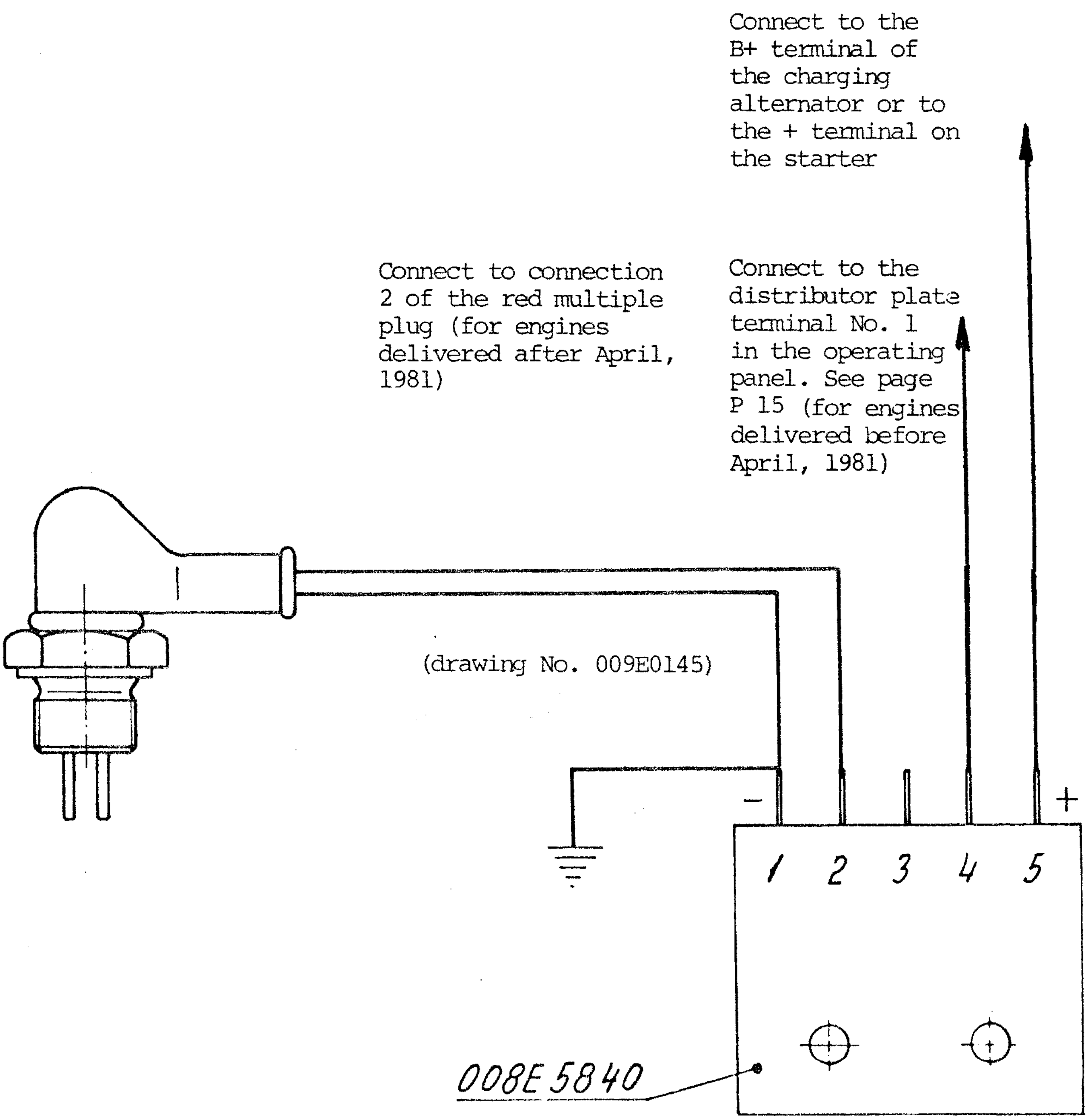
Skive = washer

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 with 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 measurings 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^{o}C when fitting the bearings in accordance with the procedure. However, the temperature must not exceed 140^{o}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 $90^{o} \pm 30'$. 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 a wrong adjustment.

   d. Shift the reversing lever in both directions and test the shifting function. In both shifting positions the pipe collar should 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^{o}. The adjustment is corrected by axial displacement of the reversing house, the angle of 90^{o} being observed.

   e. In order to test the function of both couplings 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 thickness 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 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 big 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 125Nm $\pm$ 5Nm (13 $\pm$ 0.2 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 be measured.

    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 house.

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 W1 measure is indicated on the gear-wheel.

    The intermediate washer = W measure minus the sum of V measure and W1 measure.

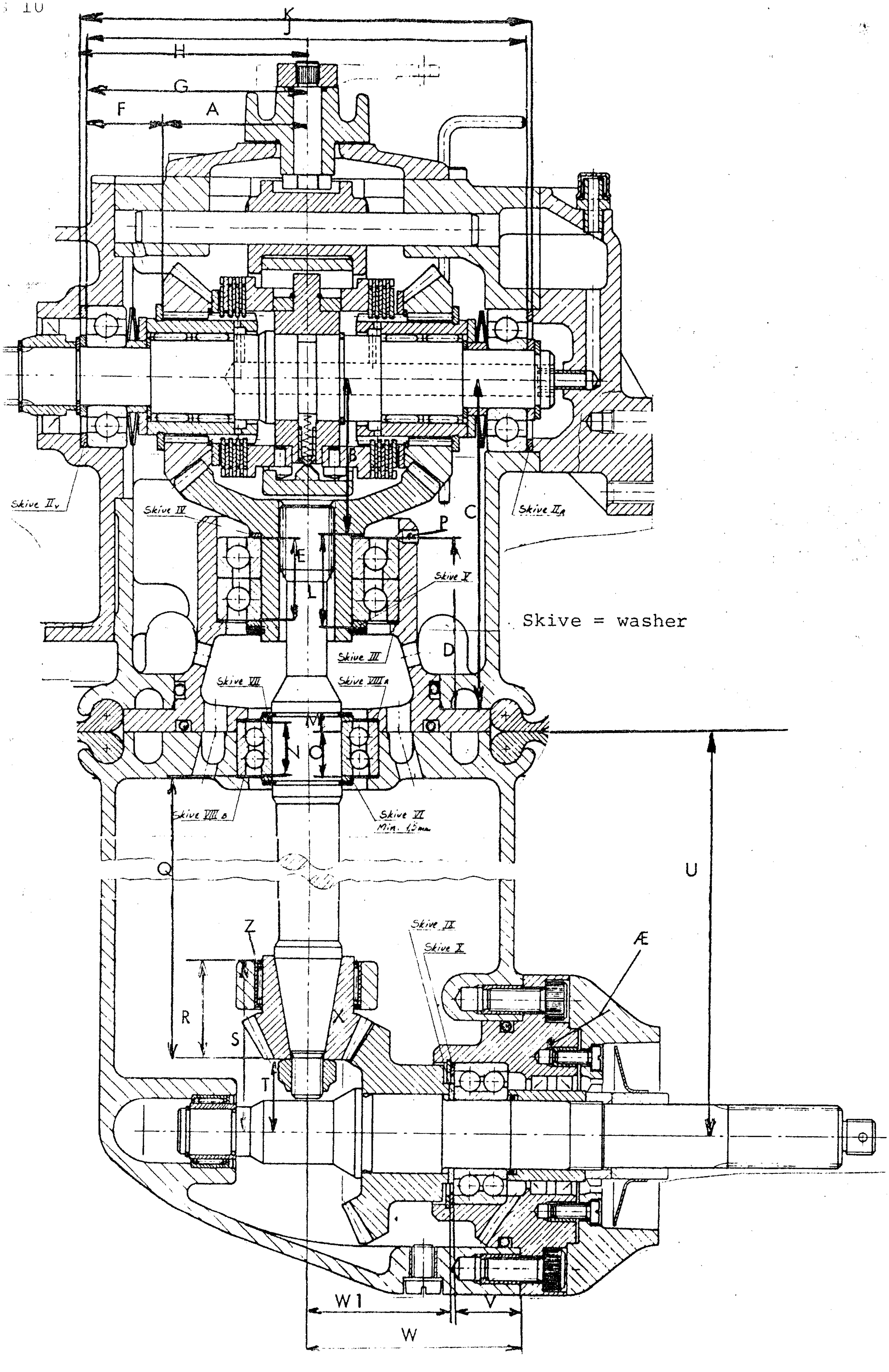
32. Fit the output shaft with gear-wheel in the cover for propeller house with seals.

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

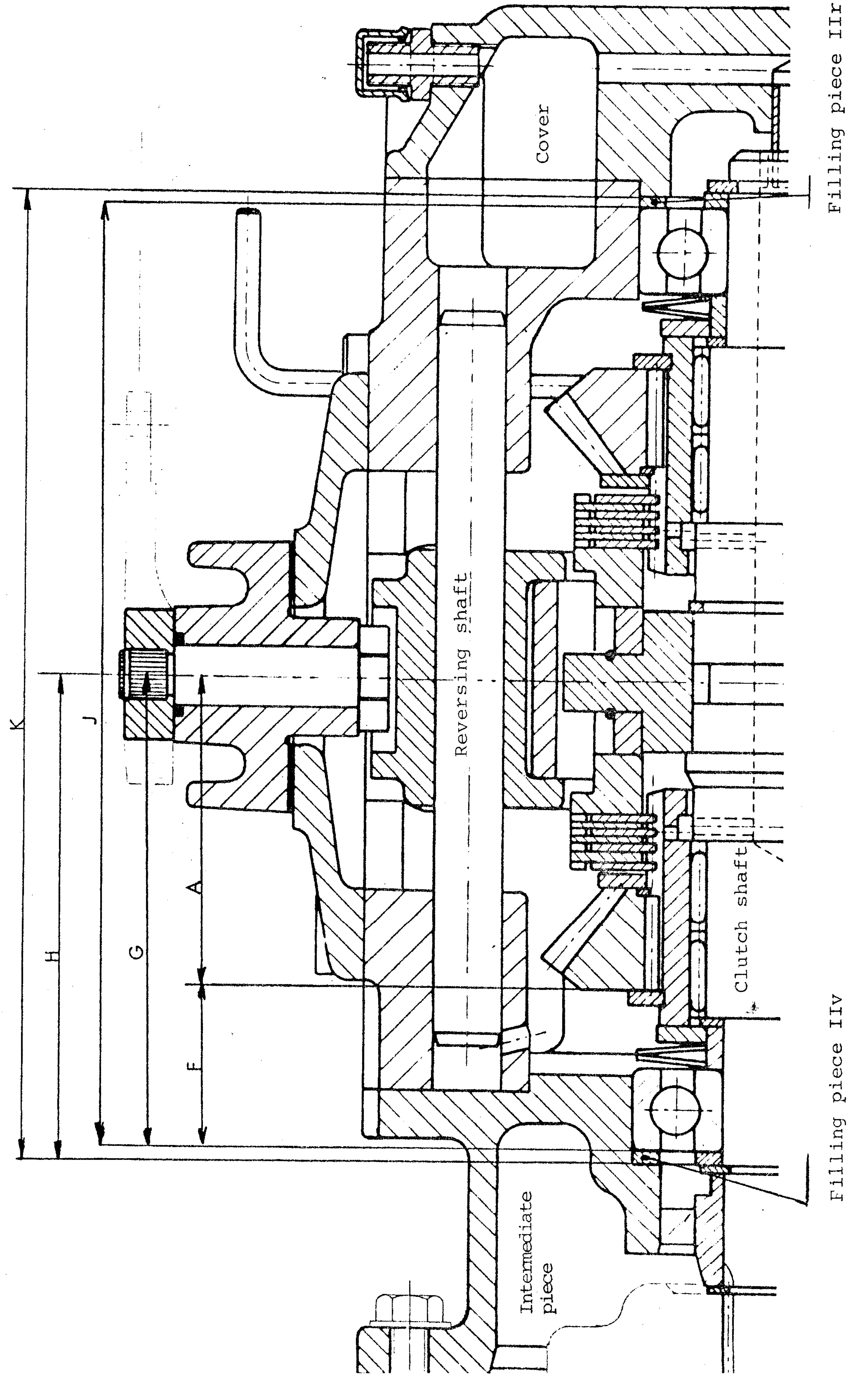
34. Check the flank clearance at the output shaft. The intermediate shaft is blocked and on the propeller shaft a lever is placed, on which should be measured at difference radius R = 40 mm. The shaft nut must be tightened.

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

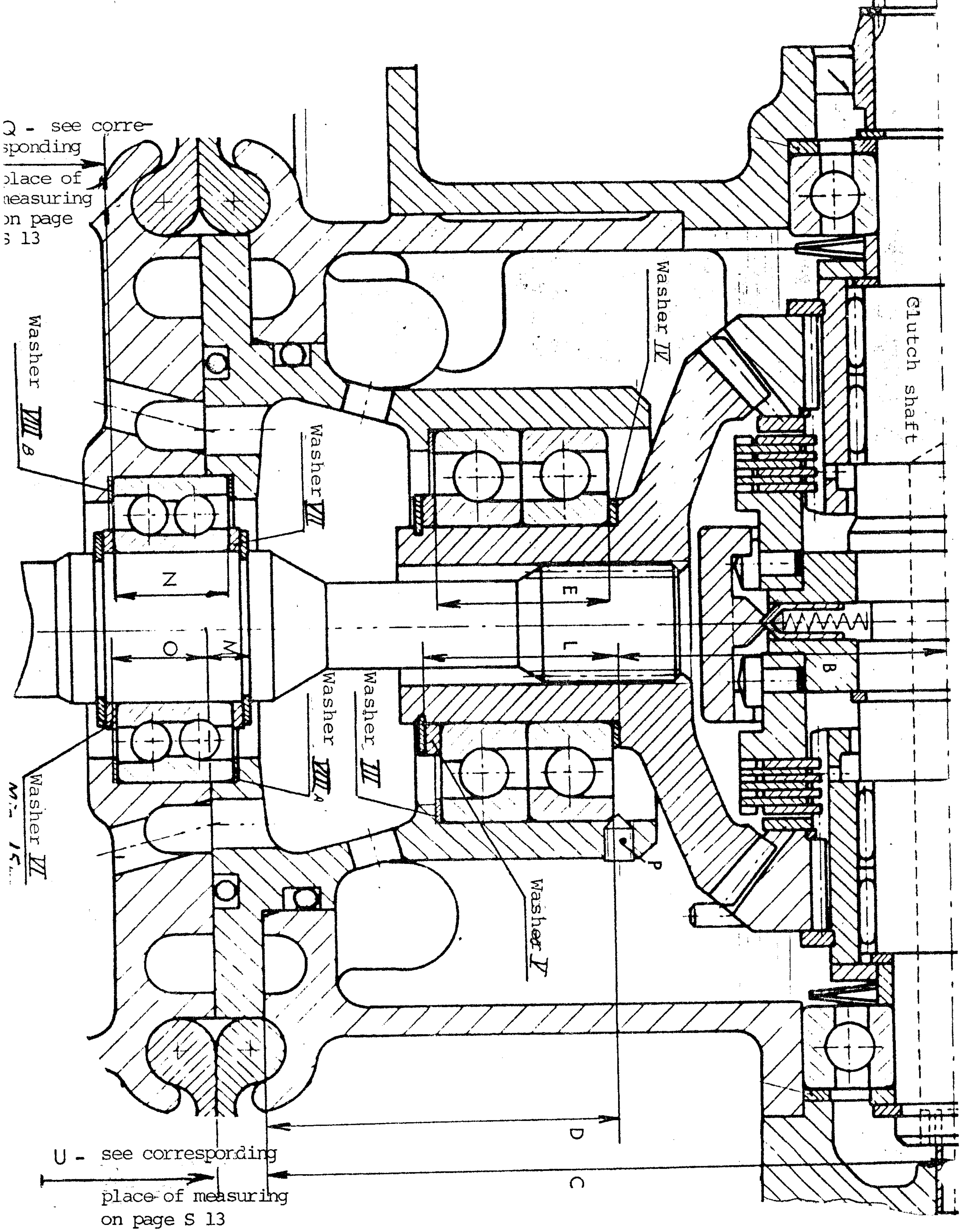
On pages S 10, 11, 12 and 13 longitudinal sections of the sail drive with places of measuring drawn in are shown, partly by a general drawing and partly by detail drawings.

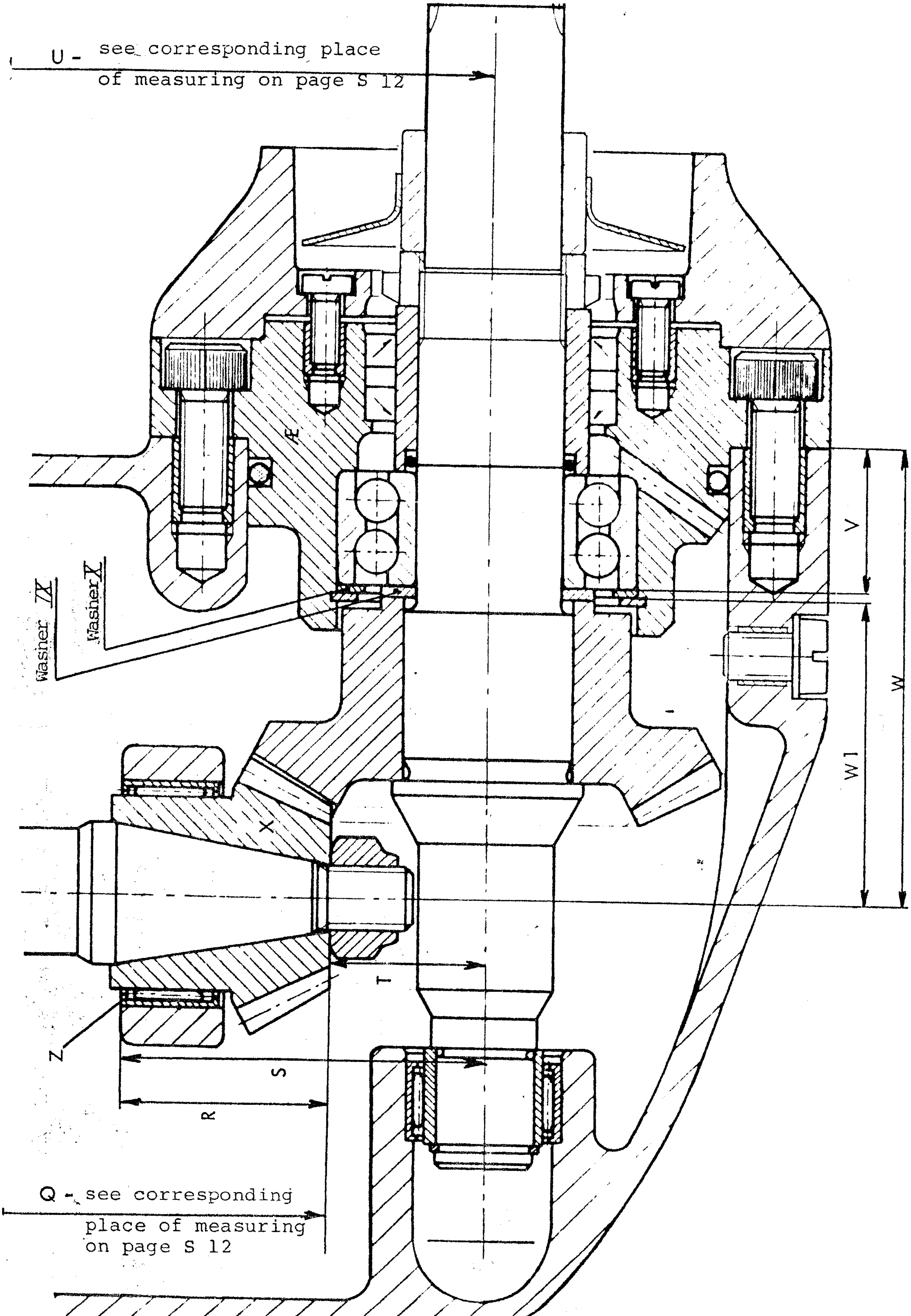


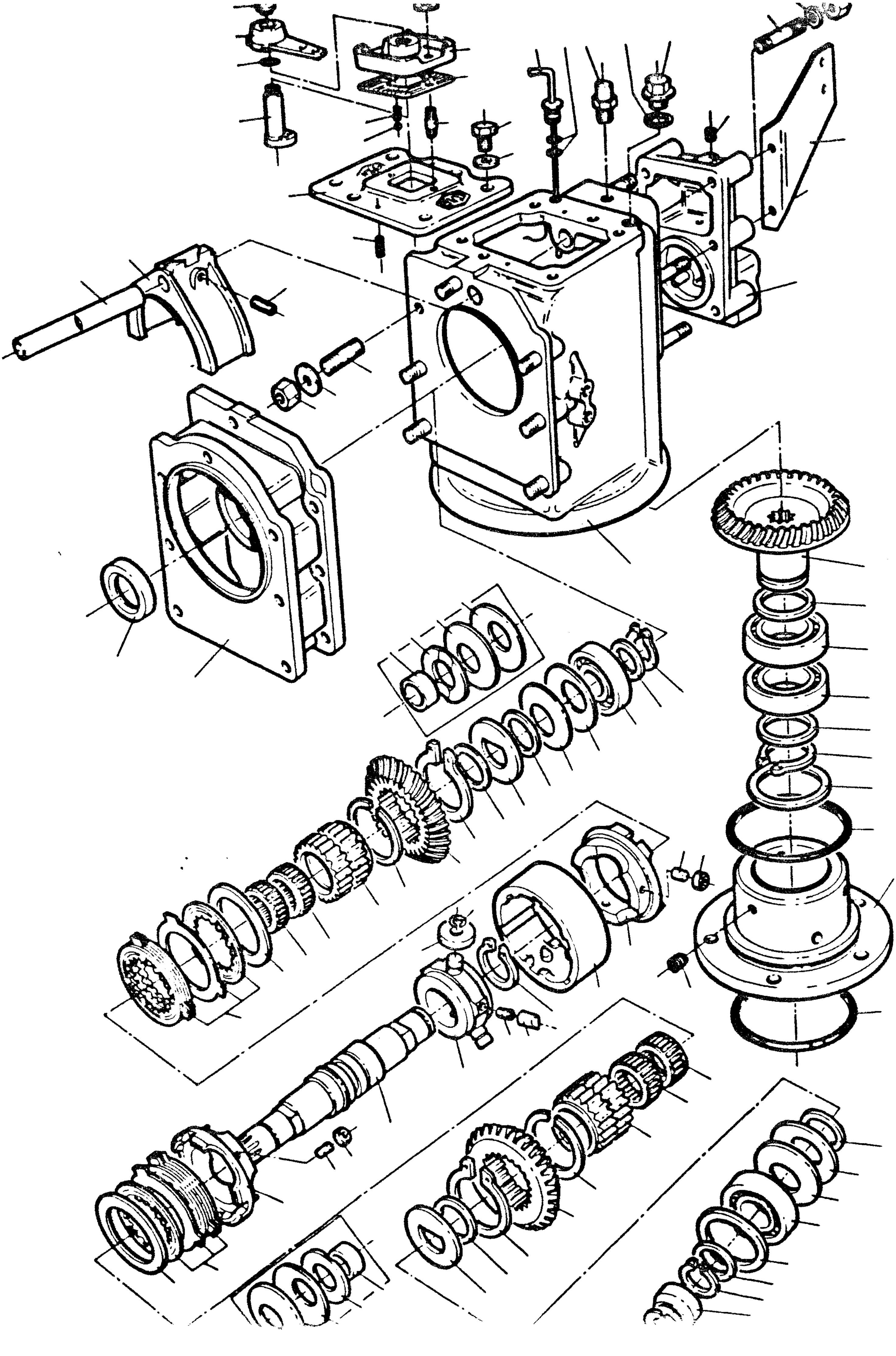
Skive = washer

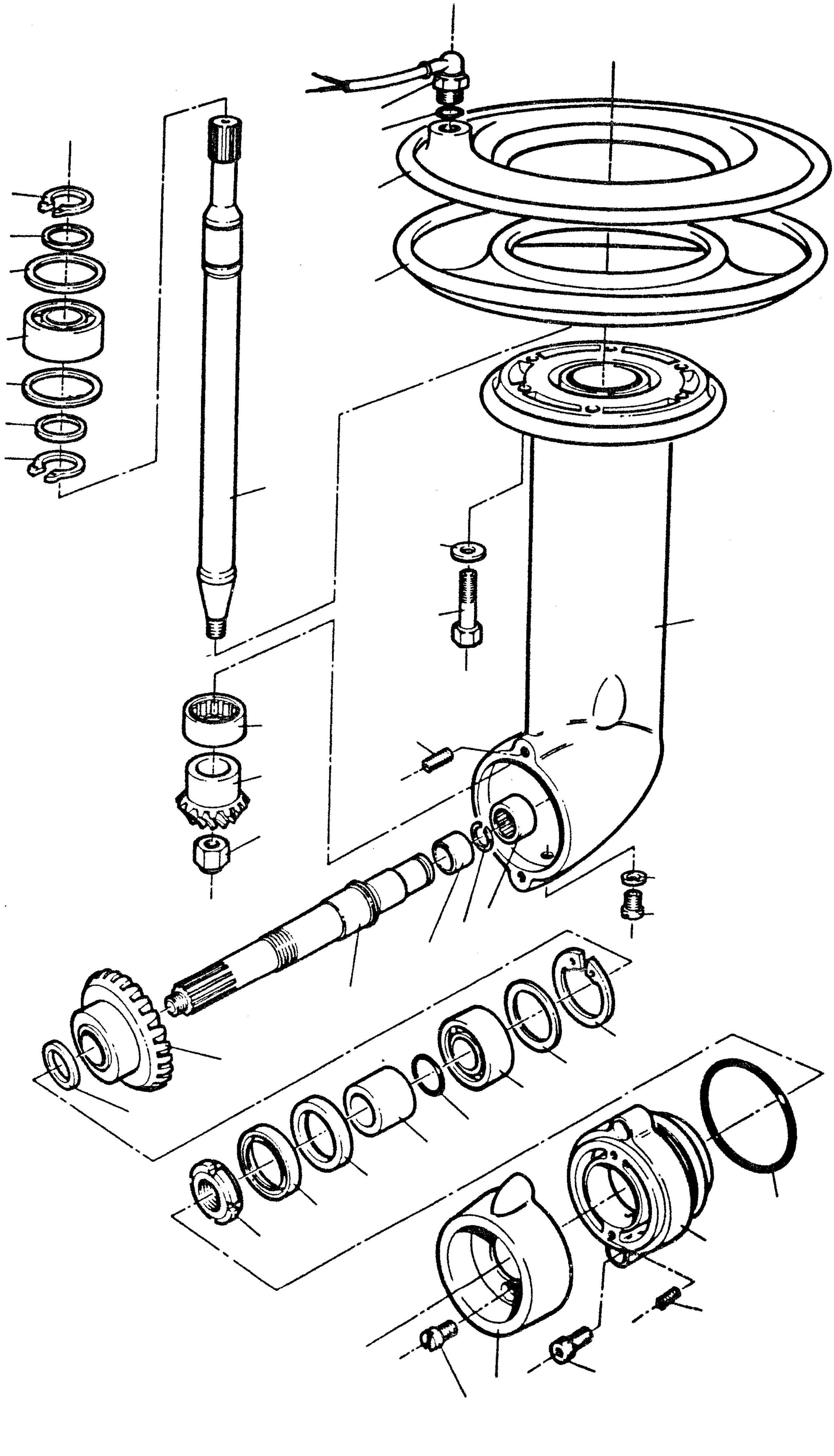

Filling piece IIr
Cover
Reversing shaft
Clutch shaft
Filling piece IIv
Intermediate piece
K
J
H
G
A
F

Intermediate Housing and Intermediate Shaft




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





Section T

Irregularities in Operation
Causes and Remedies
for
the Engine and the Electrical System

Contents

1. THE ENGINE DOES NOT START OR IS DIFFICULT TO START

No or only little compression

Inlet and exhaust valves leaking. Sticking.	Valve seats worn.
	Too small valve clearance.
	Valve springs slack or broken.
	Valves too tight in guides.
Piston rings worn or gripped.	Too low working temperature.
	Wrong or bad lubricating oil.
	Ordinary wear and tear.
Worn pistons and cylinder linings.	Too cold cooling water.
	Ordinary wear and tear.
Torn pistons and cylinder liners.	Engine has been superheated.
	Failing cooling.
	Dirty air filter.
Engine working temperature too high.	Valve seat dropped out.
	Dirty air filter.
	Dirty sea cock.
	Cracked cylinder cover.

Thermostart in disorder

Electrical system in disorder.	Fuse blown.
	Connection from fuse box above thermostart switch disconnected.
	Filament spirals in thermostart burnt through.
No fuel feed.	Air in piping from tank to thermostart.
	Ball valve leaking so that tank is emptied during standstill.

Fuel system

Fuel pump gives too small yield.	Fuel tank almost empty.
	Air or water in the system.
	Fuel lift pump defective.
	Fuel filter clogged.
Pressure valve in fuel pump sticking or worn.	Ordinary wear. Appears as small scratches on valve cone and seat.
Pressure valve sticking.	Dirt or water in the pump.
Pump piston and cylinder worn.	Dirt or water in the pump gives sudden wear.
	Ordinary wear.
Stop magnet determining maximum position of control rod in disorder.	Incorrect adjustment.
	Sticking due to incorrect tightening.
Fuel valve in disorder.	Injection pressure too low.
Needle valve in nozzle sticking.	Fuel valve opening pressure too low. Hereby combustion pressure is able to lift the nozzle piston from the seat and knock it into the the nozzle, by which it gets hot and fouled.
	High temperature on nozzle due to the engine working at full load at high working temperature and suddenly stopping the engine without previous unloading. By this the cooling water temperature is increased further and the fuel valve gets so hot that the nozzle piston seizes.
	The nozzle gets too hot because the combustion bursts out between the cylinder head and the upper part of the precombustion chamber or at the copper gasket.
Needle valve in nozzle leaking, by which fuel is hardly atomized and leaks from the nozzle.	Needle valve in nozzle worn on valve seat.
	Nozzle piston can also be worn on the stem itself. This appears by too large fuel outlet from the return pipe of the fuel valve.

2. ENGINE STARTS, BUT STOPS SHORTLY AFTER

Failing fuel supply.	Fuel tank almost empty.
	Water or air in the system.
	Fuel filter clogged.
	Piston torn due to failing cooling.
	No bleeding from fuel tank.
	Lacking air supply to the engine room.

3. ENGINE DOES NOT REACH MAXIMUM CAPACITY

Exhaust gets into the air inlet filter.	Camshaft mounted in wrong position in proportion to the crank.
	Timing gear on camshaft has turned.
Engine reaches maximum speed at 1/1 load only momentarily.	Fuel system in disorder, see page 1 "Fuel system".
	Lacking air supply to the engine room.
Engine does not reach maximum speed at 0 load.	Fuel system in disorder, see page 1 "Fuel system".
	Lacking air supply to the engine room.
	Remote control wrongly adjusted.
	Maximum position of control rod wrongly adjusted.
	Governor arm has turned on the governor spindle.
Engine looses speed after operating for some time.	Lacking bleeding of fuel tank.
	Lacking air supply to the engine room.

4. KNOCKING OPERATION OF ENGINE

Engine misfires and the speed fluctuates excessively.	Air or water in the fuel.
	Fuel filter clogged.
	Air in the fuel may come from leaks at the fuel lift pump.

5. ENGINE SPEED TOO HIGH

Governor not working properly.	Governor spindle is bent or works sluggishly.
Governor not properly adjusted.	Governor arm has turned on the governor spindle.
Engine runs too fast during idling.	Idler spring too tight.

6. ENGINE KNOCKS

Hard knocking sound at the combustions.	Incorrect adjustment of the injection time causing too early ignition.
Engine too heavy loaded or run hot.	
Knocking sound from engine.	Loose connecting rod bolts.
	Worn or burnt bearings.
	Much worn piston and cylinder liner.

7. ENGINE HAS BLACK EXHAUST SMOKE

Engine receives too little air for the combustion.	Clogged air filter.
	Lacking air supply from engine room.
Fuel valve in disorder (see page 1).	
Too little compression (see page 1).	
Engine overloaded.	

8. ENGINE HAS BLUISH EXHAUST SMOKE

Engine uses lubricating oil passing the piston into the combustion chamber.	Clogged air filter.
	Piston and oil rings worn or burnt.
	Piston and cylinder liner worn.
	Bleeder valve in disorder.

9. EXCESSIVE LUBRICATING OIL CONSUMPTION

Engine smokes bluishly and has heavy formation of soot in the exhaust pipe.	See above.
Lubricating oil drips from the engine.	Leaking gaskets.
	Lubricating oil filter leaking at the rubber ring.
	Crankshaft seal rings leaking.
	Plugs in end cover at counterweights leaking.

10. EXCESSIVE FUEL OIL CONSUMPTION

Leakages in the fuel system.	Fuel pipes or hoses leaking.
	Leakages at the fuel lift pump.
Black smoke from engine.	See above.
Lubricating oil thinned with fuel oil.	Leakages at the fuel lift pump.

11. ENGINE RUNS HOT

Strong smell of hot paint and oil.	Engine overloaded.	
	No or insufficient cooling water.	Defective cooling water pump.
		Leaking hose connections.
		Leaking drain cock.
		Clogged strainer.
Cooling water temperature too high (above 85°C).	Cylinder head gasket leaking. Combustion gets into the water chamber. This can be seen on oil in the cooling water outlet and overpressure in the cooling system.	
Too low lubricating oil pressure.	No or insufficient lubricating oil on the engine.	
	Lubricating oil too thin.	
	Lubricating oil pump defective.	
	Overpressure pipe in the lubricating oil system sticking.	
	See page 3 "Excessive lubricating oil consumption".	

12. ENGINE DOES NOT REACH NORMAL OPERATION TEMPERATURE

Too low cooling water temperature (below 50°C).	Defective thermostat. Is open all the time.
	Too low air temperature.

13. THE ELECTRICAL SYSTEM

Fault	Cause
The battery is not sufficiently charged.	Battery connections bad or loose.
	Too little liquid on the battery.
	One or more of the battery cells have broken down.
	Charging relay defective.
	Charging generator defective.
Dynastarter turns too slowly or not at all.	Flat battery.
	No or bad connection between the pole shafts of the battery and the battery cables.
	Defective battery.
	Defective starter switch.
	Defective wire connection from starter switch to dynastarter.
	Starter cables wrongly dimensioned.

14. CAUSES TO IRREGULARITIES IN THE ELECTRIC STARTER

Fault	Cause
The starter turns too slowly or not at all.	Flat battery. Smallest closing voltage for starter relay is 7.5 volt.
	No or bad connection between the pole shafts of the battery and the battery cables.
	Defective battery - one or more cells out of function.
	No or bad connection from the positive cable of the battery to the starter and from there via the relay to the switch.
	Defective starter switch.
	Worn starter carbons.
The starter turns, but the starter wheel does not get into connection with the starter rim.	Burrs on gear wheel and starter rim.
The starter turns, but stops when it meshes with the starter rim.	See above causes for "The starter turns too slowly or not at all".
The starter continues to turn after having got into connection with the starter rim, but does not turn the engine.	The disc clutch on the starter drive slips.
The starter continues to turn though the starter switch has been switched off.	Defective starter switch.
	The starter coil sticks.
The starter drive will not go out of the starter rim when the engine has been started.	Damaged starter drive or starter rim. Return spring too slack or broken.

Section V

MAINTENANCE

Contents

Section V

MAINTENANCE

Check

Check oil level in the engine for every 25 hours' operation and refill if necessary.

Check liquid level in the battery for every 25 hours operation and refill with distilled water if necessary.

Check and adjust if necessary

Check valves for every 150 hours' operation and adjust if necessary.

Check V-belt for every 150 hours' operation and adjust if necessary.

Change or clean

Change lubricating oil for every 150 hours' operation, the first time after 30 hours' operation.

Change lubricating oil filter for every 150 hours' operation.

Change or clean fuel filter for every 300 hours' operation, the filter can be cleaned 4-5 times before it has to be changed.

Change air filter for every 300 hours' operation.

Maintenance Schedule

	Every 25 h.	Every 50 h.	Every 150 h.	Every 300 h.	Every 600 h.	Every 900 h.
<u>Check</u>:						
Oil level in engine	x					
Oil level in marine gear	x					
Liquid level in battery	x					
Nozzles					x	
Dynastarter						x
<u>Change</u>:						
Lubricating oil			x			
Gear oil		x				
Lubricating oil filter			x			
Fuel filter				x		
Air filter				x		
<u>Adjust (if necessary)</u>:						
Valves			x			
Belt			x			

Storage

If the engine must stand still for a long period you can risk damages in the form of rust as well in the combustion chamber as in the cooling system.

Therefore, it is recommended to carry out the following treatment before storing the engine for a long period.

1. Let the engine run so that it reaches its normal working temperature and drain the lubricating oil off the engine and the gear.

2. Fill with anti-corrosion oil. One of the below mentioned types or another established type of corrosion oil can be used.

Anti-corrosion oil	
Shell	Ensis Engine Oil 20 W
Esso	Rust Ban 623
Texaco	Preservative Oil 30
BP	Energol Protective Oil 30
Castrol	Rustilo 652
Mobil	Avma 523
Valvoline	Tectyl 876

3. Empty the fuel tank and fill it with 1 - 2 ltr. anti-corrosion fuel. One of the types mentioned below or another established type of oil can be used.

Anti-corrosion fuel	
Shell	Ensis Engine Oil 20 W
Esso	1/3 Rust Ban 623 + 2/3 Autodiesel
Texaco	Rustproof Oil
BP	Energol CPD 33
Castrol	JSO (1:16)
Mobil	Avma 245
Valvoline	Tectyl 876

4. Start the engine and let it run for approx. 10 minutes. Then stop the engine and drain the anti-corrosion oil off the engine and the gear. Empty the fuel tank and the fuel filter.

5. Cover the inlet and exhaust openings.

6. Remove the hose connection cooling water pump - thermostat housing - crankcase. Dismount thermostat housing. Drain off the cooling water by opening the cocks. Then close the cocks again.

7. Plug the holes in the crankcase, however, not the hole where the thermostat housing has been.

8. Fill up the cooling system with one of the mentioned anti-corrosion liquids, possibly mixed with water where this is recommended. Plug the hole for thermostat housing.

Preservation liquid for cooling jacket	
Shell	Dromus Oil B
Esso	Rust Ban 392
Gulf	Cut 51 A or Solcut No. 1
Texaco	Radiatortex or Soluble Oil (2%)
BP	Soluble Oil EH or Energol SB 4
Castrol	Radiator Preservative (2%)
Mobil	Solvac 2 (½%)
Valvoline	1/3 Tectyl 810 Base + 2/3 water

<u>NOTICE</u> The cooling water pump and the bilge pump must not get into touch with the anti-corrosion liquid as the rotors are made from rubber.

Preparation for Use after Storage

Drain anti-corrosion oil off the engine if any and fill with new engine oil. Drain anti-corrosion liquid off the cooling system and mount thermostat housing and hose connections. Fill the tank with fuel.

Storage of Fuel

As fuel pumps and nozzle are manufactured with fine tolerances it is very important that the fuel oil is absolutely free from impurities. Therefore the engine is provided with a fine fuel filter which gives good protection of the fuel equipment.

Nevertheless it is recommendable to take the following precautions when storing fuel oil:

1. Storage drums must not be galvanized as the fuel in connection with possible water will resolve the galvanizing.

2. The drums must be stored clean and dry.

3. The drain plug must lie above the lowest point on the drum to avoid that settled dirt comes out with the fuel.

4. Use a fine-meshed strainer at the draining.

5. The drums must have been kept quiet for some time before the draining.