OWNER'S MANUAL

WESTERBEKE 10

WESTERBEKE 20

Marine Diesel Engines

Publication Number 19228
Issue Date October, 1976
Edition 2

OPERATOR INSTRUCTIONS

WESTERBEKE

10 hp Marine Diesel Engine – PILOT 10

20 hp Marine Diesel Engine – PILOT 20

INTRODUCTION

This manual describes the operation, adjustment and maintenance of the Westerbeke Model PILOT 10 and PILOT 20 Marine Diesel Engines and is designed to be a guide for those concerned with the operation and maintenance of these diesels.

The diesel engine closely resembles the gasoline engine inasmuch as the mechanism is essentially the same. Its cylinders are arranged above its closed crankcase, its crankshaft is one of the same general type as that of a gasoline engine; it has the same sort of valves, camshaft, pistons, connecting rods and lubricating system and reverse and reduction gear.

Therefore it follows to a great extent, that it requires the same treatment as that which any intelligent and careful operator would give to a gasoline engine and that gross negligence such as running the engine short of oil, with sludged oil, dirty filters, or with water boiling will have the same expensive consequences.

The diesel engine does differ from the gasoline engine however, in the method of handling and firing its fuel. Carburetor and ignition system are done away with and in its place is a single component – the Fuel Injection Pump – which performs the functions of both.

Speaking of the Fuel Injection Pump, it cannot be over-emphasized that clean fuel is a necessity. Water or dirt in the fuel will damage fuel injection equipment causing expensive repairs. It must be added that such repairs if caused by water or dirt are never covered by warranty.

Unremitting care and attention at the factory have resulted in an engine capable of many hundreds of hours of service. What the manufacturer cannot control however, is the treatment the product will receive in service. This part rests with you.

Whenever service parts are ordered, always give complete description and part numbers with engine model and number, as an example:

Please supply:
For Pilot 10 Marine Diesel Engine No. DV 12345.
10 of 16995 Lube Oil Filter Elements

CONTENTS:

1. Cooling water pump
2. Oil dipstick
3. Fly-wheel
4. Fuel lift pump with manual priming
5. Fuel filter
6. Water cooled exhaust manifold
7. Regulating lever
8. Bracket for remote control of regulating lever
9. Fuel pump
10. Stop button
11. Lubricating oil pump
12. Tachometer drive
13. Bracket for remote control of reversing gear
14. Reverse–reduction gear
15. Coupling flange for propeller shaft
16. Oil dipstick for reverse–reduction gear
17. Invertable engine mountings

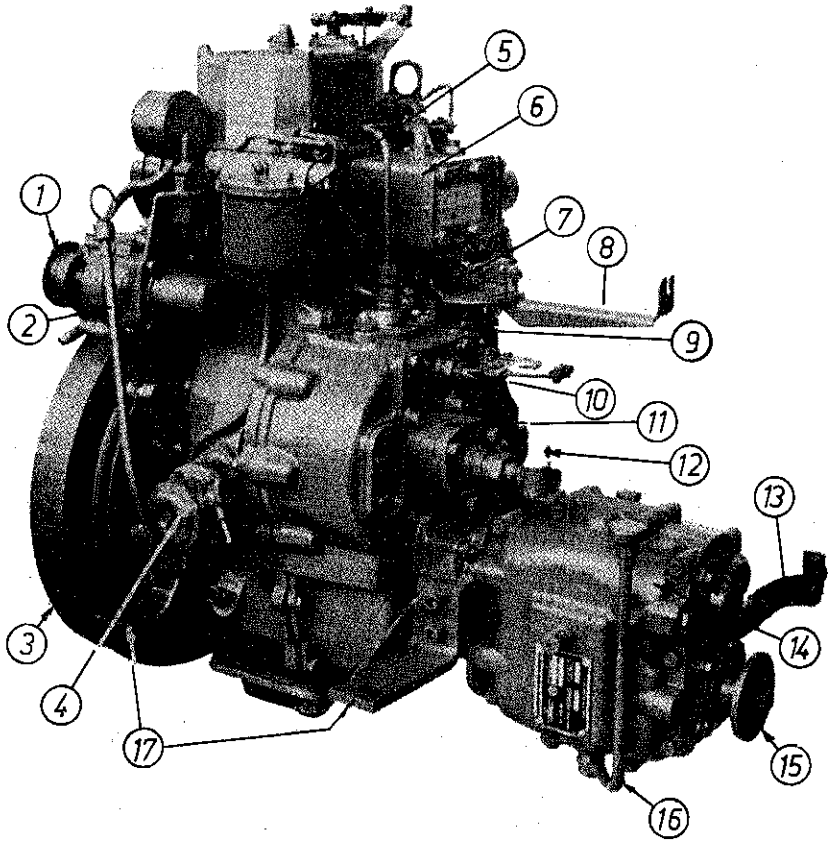

Fig. 1 Pilot 10

18. Gear lever for reverse–reduction gear
19. Lubricating oil filter
20. Oil pressure indicator
21. Oil sump
22. Decompression lever
23. Oil filling plug
24. Cooling water thermostat
26. Fuel valve
27. Air cleaner with silencer
28. Raised handstart
29. Starter/generator

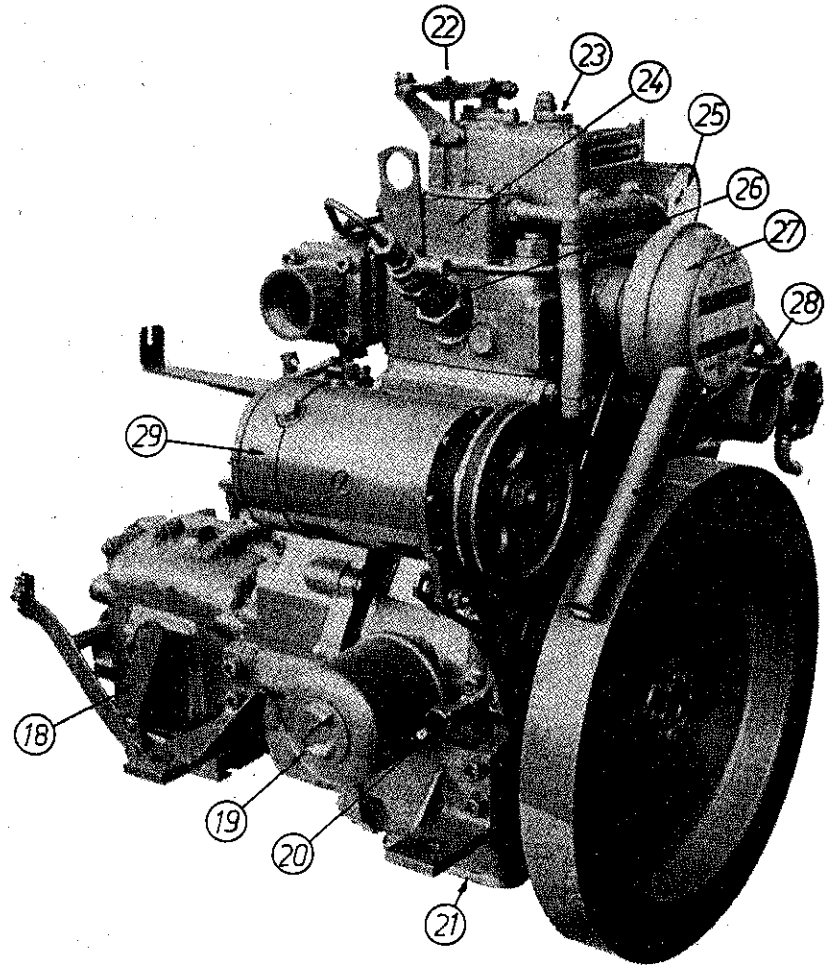

Fig. 2 Pilot 10

1. Cooling water pump
2. Oil dipstick
3. Fly-wheel
4. Fuel lift pump with manual priming
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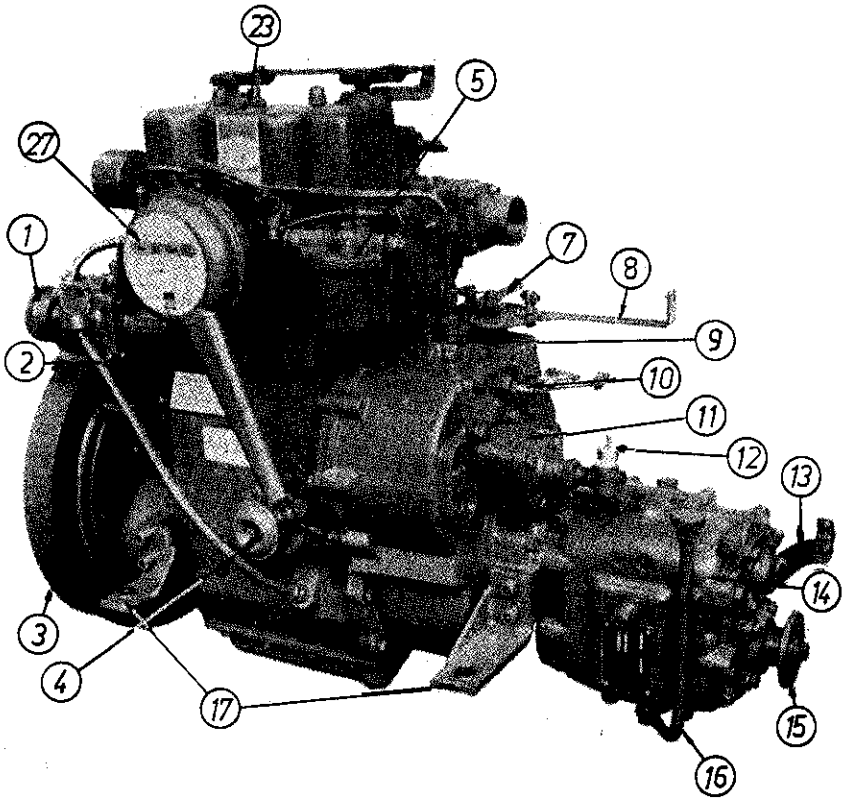


Fig. 3 Pilot 20

18. Gear lever for reverse–reduction gear
19. Lubricating oil filter
20. Oil pressure indicator
21. Oil sump
22. Decompression lever
23. Oil filling plug
24. Cooling water thermostat
26. Fuel valve
27. Air cleaner with silencer
28. Raised handstart
29. Starter/generator

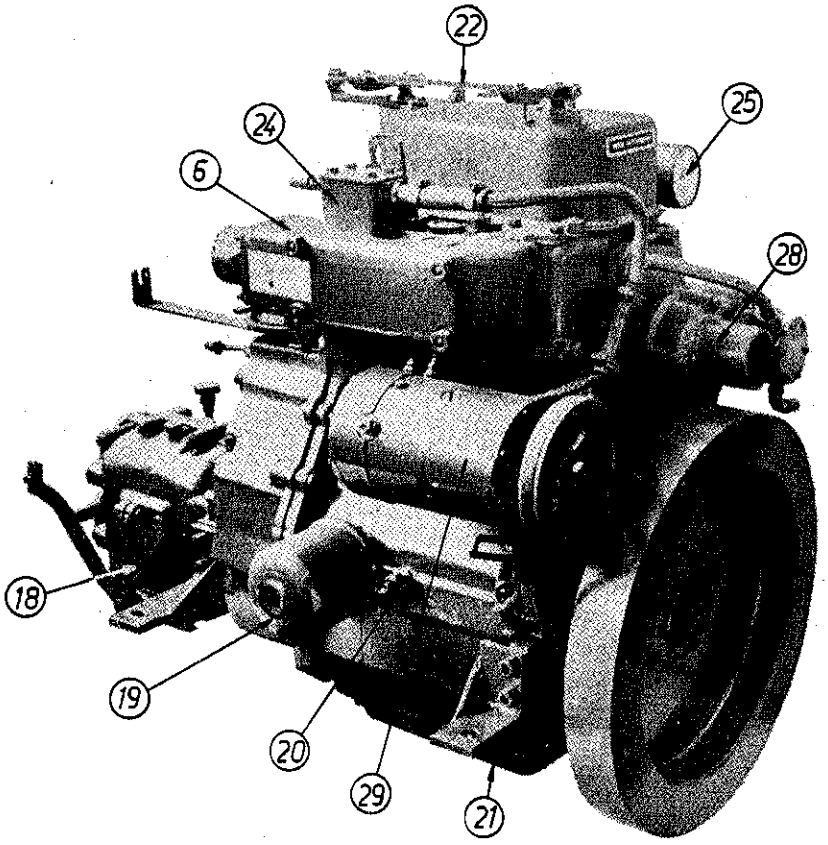


Fig. 4 Pilot 20

TECHNICAL DATA

Engine

	Pilot 10	Pilot 20
Working principle	4-stroke with pre-combustion chamber	
Number of cylinders	1	2
Cylinder diameter	85 mm (3,35")	
Stroke	85 mm (3,35")	
Cylinder volume	0,482 ltr. 29.4 in³	58.8 in³ 0,964 ltr.
Compression ratio	21.5:1	
Compression pressure at 2000–3000 r.p.m.	48 kp/sq.cm (683 p.s.i.)	
Output BHP at r.p.m.	8/2000	12,8/2000
	9/2400	16,8/2400
	10/3000	20/3000
Max. torque kgm at r.p.m.	2,5/2700	5/2700
Engine-rotation, looking forward	anti-clockwise	
Idling speed	900–1200 rpm	
Max. inclination backwards	15°	12°
sideways	25°	
Valve timings and injection point		
Fly wheel diameter	391 mm	
Inlet 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 starts (manual turn)	15° before TDC (arc measure: 51 mm (2,02"))	
Valve clearances (cold engine)	inlet 0,25 mm (0,00984")	
	exhaust 0,30 mm (0,0118")	
Weight incl. ZF-marinegear (net weight) M	135 kg (297 lb)	185 kg (408 lb)
ME	145 kg (319 lb)	195 kg (431 lb)

Fuel System

Combustion system	precombustion chamber
Injection pressure	150 kg/sq.cm (2135 p.s.i.)
Injection timing	automatic variable
Fuel lift pump	
Pressure of fuel lift pump	0,325–0,562 kg/sq.cm (4,62–7,99 p.s.i.)
Fuel filter (element)	16995
Fuel quality	No. 2 Fuel Oil is recommended because of its higher lubricant content. The use of No. 1 is permissible.

Lubricating System

Engine

Pressure lubricated, lubricating oil pump	
Lubricating oil pressure (warm engine)	2,5–3,5 kg/sq.cm (35,6–49,8 p.s.i.)
Lubricating oil pressure, minimum	1 kg/sq.cm (14,22 p.s.i.)
Lubricating oil quality	service DM or DS
Lubricating oil viscosity temp.	below +5° C (41° F): SAE 10 or SAE 5W-20
	between +5° C (41° F) and 25° C (77° F): SAE 20
	above +25° C (77° F): SAE 30
Lubricating oil capacity, incl. filter	1,75 ltr. 1.85 qts. 2.9 qts. 2,75 ltr.
Lubricating oil filter (element)	16795

ZF-marinegear

Lubricating oil quality	gear oil
Lubricating oil viscosity	SAE 20 or 30
Lubricating oil temperature	max. 110° C (230° F)
Lubricating oil capacity	0,4 ltr. (0.85 Pts)

	PILOT 10	PILOT 20
Cooling System		
Thermostat starts opening at	65° C (149° F)	
Cooling water temperature	app. 65° C (149° F)	
Type of pump (impeller)	17031	
Pump capacity	1.93 gal./min.	2.91 gal./min.
Pump back pressure	max. 6 m (19,69') W.C.	
Pump suction head (manometric)	max. 3 m (9,85') W.C.	
Electrical System		
Battery voltage	12 volt	
Battery capacity	max. 56 Ah	
Starter/generator,		
Starter/generator, temperature	max. 90° C (194° F)	
Starting output	1 BHP	
Charging output	154 Watt	
Torques		
Cylinder head bolts	15–17 kgm (108–123 ft.lb)	9,5–10,5 kgm (69–76 ft.lb)
Connecting rod bolts	4,7–5,3 kgm (34–38 ft.lb)	
Precombustion chamber	24–25 kgm (174–181 ft.lb)	
Flywheel	8–8,5 kgm (58–61,5 ft.lb)	
Counter weight	8–8,5 kgm (58–61,5 ft.lb)	
Stanchion for rocker arm	4–4,5 kgm (29–31,5 ft.lb)	
Fuel valve	6–8 kgm (43,5–58 ft.lb)	
ZF-gearbox	2–3 kgm (14,5–22 ft.lb)	

OPTIONAL EQUIPMENT AVAILABLE

NEW SEA WATER STRAINER
Water Cooled Exhaust Elbow, 1½" IPS
Alternator Kit (in addition to the standard starter/generator 12 volt 55 amp alternator and transistorized regulator
Deluxe Instrument panel, All Electric including tachometer, oil pressure and water temperature gauges with senders and wiring
Three Groove Front End Pulley
Flexible Adjustable Mounts
Flexible Coupling
Flexible exhaust hose (stainless steel 1½" x 12")
Spart Parts Kit: (including "V" belt; water pump impeller; lube oil filter element; fuel filter element; fuel line and water pump seal)

INSTALLATION

Foreword

It is not the purpose of this section to advise boatyards and engine installers on the generally well understood and well developed procedures for installation of engines. However, the following outline of general procedure is included because it is valuable in explaining the functions of each component, the reasons why, the precautions to be watched and the relationship of the installation to the operation of the engine. There are details of the installation which should have a periodic check and of which the operator should have a thorough understanding to ensure good operating conditions for the engine and correct procedure in servicing the engine.

Inspection of Shipment

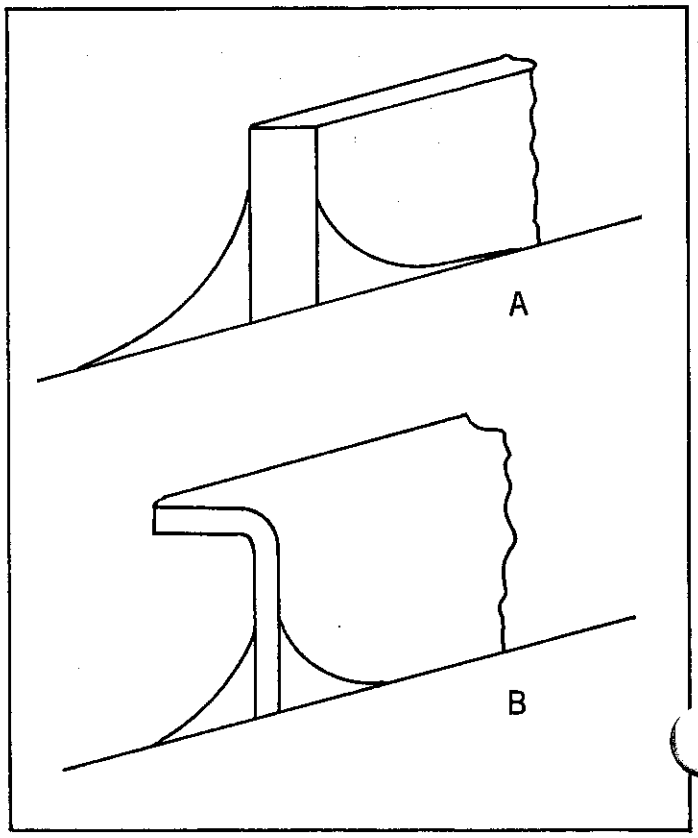
The engine is shipped from the factory mounted upon heavy skids and properly crated. Accessory equipment is shipped in a separate small box, usually packed with the engine crate. Immediately upon arrival, the shipment should be inspected for possible accidental damage in transit and for any possible shortage in parts and equipment. Before accepting any shipment from the transportation company, check with the parking list and if any shortage or damage is noted, file claim with the agent before accepting shipment, reporting same to the shipper.

Foundation for Engine

A good engine bed contributes much toward the satisfactory operation of the engine. The engine bed must be of rigid construction and neither deflect or twist when subjected to the engine weight or the position the boat may have to take under the effects of rough seas. The bed must not only support the engine firmly in the exact position but must keep the engine within one or two thousandths of an inch of this position at all times. It has to withstand the forward push of the propeller which is applied to the propeller shaft, to the thrust washer bearing in the engine and finally to the engine bolts and engine bed.

In fiberglas hulls, we recommend that similar wooden stringers as in wooden hulls be formed and fitted, then glassed to the hull securely. This allows hanger bolts to be installed firmly in wood, thus reducing noise and transmitted vibration.

The temptation to install the engine on a pair of fiberglas "angle irons" should be resisted. Such construction will allow engine vibrations to pass through to the hull. Flexible mounts require a firm foundation against which to react if they are to do their job. When possible, follow bed design "A" and avoid bed design "B".



Engine Bolts

It is recommended that 5/16 inch lag bolts (hanger bolts), preferably of bronze, be used through the engine supporting mounts. Lag screws are less preferred because their hold on the wood is weakened every time they are moved, whereas the lag bolt stays in position and the nuts on top of the lag bolts are used to tighten the engine down or are loosened to permit the engine to be moved. The bolt itself stays in position at all times as a stud and the bond between the bolt and the wood is not weakened by its removal.

Propeller Coupling

Each Westerbeke Diesel engine is fitted with a suitable coupling for connecting the propeller shaft to the engine. The coupling is very carefully machined for accurate fit. The forward end of the propeller shaft has a long, straight keyway and any burrs should be removed from this end. The coupling should be a light drive fit on the shaft and the shaft should not have to be scraped down or filed in order to get a fit. It is important that the key be properly fitted both to the shaft and the coupling.

If it seems difficult to fit the coupling over the shaft, the coupling can be expanded by heating in a pail of boiling water. The face of the propeller coupling must be exactly perpendicular to the center line or axis of the propeller shaft.

Alignment

When making the alignment between the engine and propeller shaft half couplings, take plenty of time and do not be satisfied with anything less than perfect results. The alignment is correct when the shaft can be slipped backwards and forward into the counter-bore with no interference and when a feeler gauge indicates that the flanges come together at all points. The two halves of the coupling should be parallel within 0.001 inch if possible. However, the maximum allowable tolerance must not exceed 0.001 inch per inch of coupling O.D. In making the final check for alignment, the engine half coupling should be held in one position and the alignment with the propeller half coupling checked in each of four positions 90 degrees apart. Keeping the propeller coupling in one position, the alignment should be checked by rotating the engine shaft half coupling in each of four positions 90 degrees apart.

If initial alignment is accomplished during boat construction or while the boat is still on its cradle, the coupling should be disconnected and all alignment rechecked shortly after launching.

The engine alignment should be re-checked after the boat has been in service for one to three weeks, and if necessary, the alignment re-made. It will usually be found that the engine is no longer in alignment. This is not because the work was improperly done at first, but because the boat has taken some time to take its final shape and the engine bed has probably absorbed some moisture.

NOTE: A fiberglas boat requires the same "Alignment" procedures above as wood or any other material used in boat construction.

OPERATING

Operating panel

1. Warning lamp for no charge (red)
2. Warning lamp for oil pressure (green)
3. Remote decompression control
4. Key switch with start position
5. Remote stop control

Instrument panel (additional equipment)

6. Oil pressure gauge
7. Cooling water thermometer
8. Revolution counter

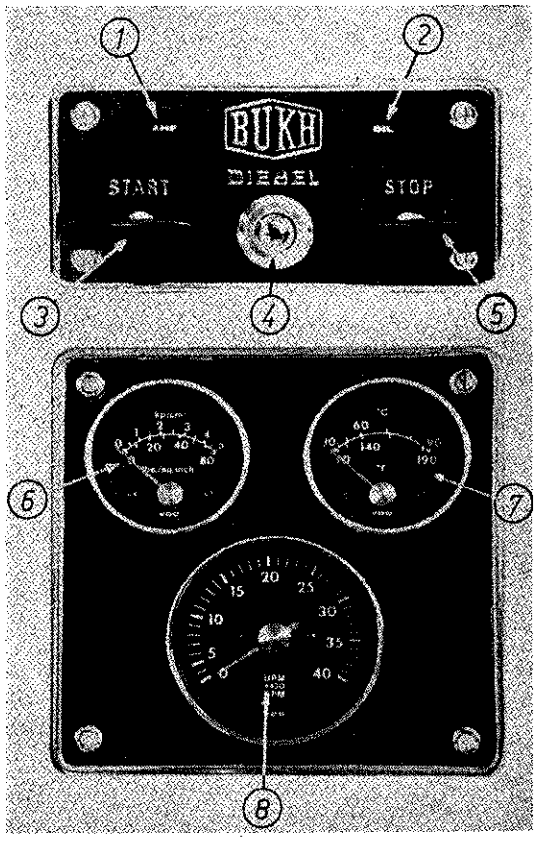


Fig. 9 Operating panel (standard) and instrument panel (additional)

RUNNING

Preparation before first Start

1. Pour lubricating oil through filling hole on top of valve cover. (Fig. 5.)
   Check that oil level is between the marks on the dipstick, placed at the left side of the engine. (Fig. 6.)
   Check oil level as mentioned below:
   a. remove and wipe dipstick
   b. reinsert dipstick in the pipe
   c. withdraw dipstick, check oil level
2. Check oil level of the reverse–reduction gear the following way: (fig. 25)
   a. remove oil filling plug completely
   b. unscrew and wipe dipstick
   c. fasten dipstick in the pipe
   d. unscrew dipstick and check oil level. The oil level must be between the marks
3. Fill the fuel tank.
4. Bleed the fuel system. This should be done if the engine has been out of operation for a long period or if the fuel tank has been emptied.
   To bleed the fuel system, proceed as follows:
   a. Loosen slotted screw on fuel filter (fig. 7).
   b. Pump by means of the priming lever of the fuel lift pump (fig. 8) until fuel flow is free from air bubbles. Retighten the slotted screw.
   c. Loosen fuel pipe connection on nozzle holder (fig. 3 item 26).
   d. Turn the engine until fuel is free from air bubbles. Retighten the pipe connection.

Before Start

1. The oil level of the engine should be checked every day or every 25 hours of running, as described in "Preparation before first start", It is not necessary to refill oil before lower mark is reached. The oil should not exceed upper mark.
2. The oil level of the marine gear should be checked every day or every 25 hours of running, as described in "Preparation before first start",
3. Check quantity of fuel and open the cock.
4. Turn on the main switch (fig. 12).

Electrical Start with remote Control and Instrument Panel

1. Put the marine gear in neutral position by means of the control handle (fig. 13). By starting a cold engine, possibly release gear (fig. 13, item 5) and put control handle into range 2 (fig. 13, item 2).
2. Pull out decompression control on the left of operation panel (fig. 9).
3. Turn key switch to position b (fig. 10).
4. Press key downwards and turn switch to position c. After some revolutions of engine, push in decompression control and the engine will start. Starter should not be activated for more than 15 seconds without pause.

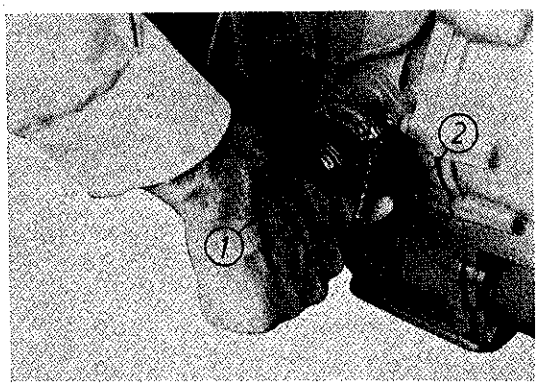


Fig. 8
1. Fuel lift pump
2. Manual priming lever

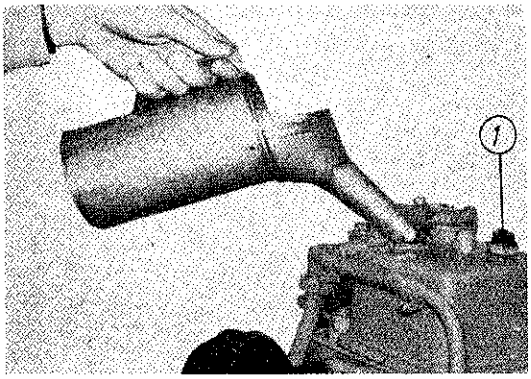


Fig. 5
1. Oil filling plug

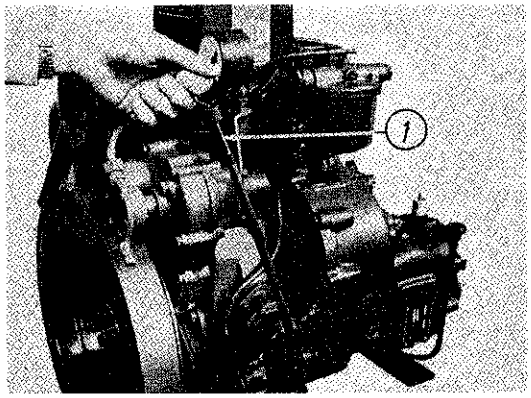


Fig. 6
1. Oil dipstick

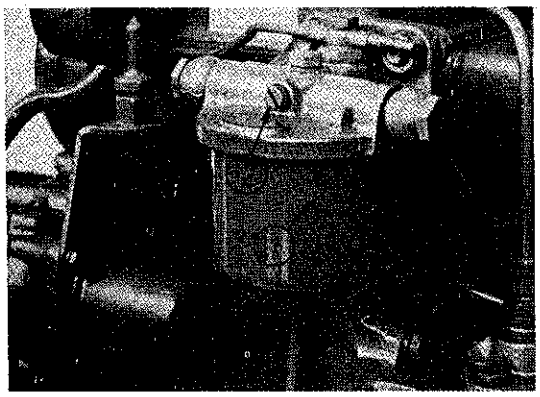


Fig. 7
1. Fuel filter
2. Slotted screw for bleeding

Hand start

1. Put the gear lever in neutral position (fig. 2 and 4, item 18).
   By starting a cold engine, turn the regulating lever a little clockwise.
2. Turn decompression lever on valve cover (fig. 11, item 2) clockwise as far as possible.
3. Engage starting handle and crank engine as quickly as possible. Release decompressor by turning lever anticlockwise while cranking and engine will start.

Cold Start

Turn key switch into position b (fig. 10).

2. Activate decompression device (fig. 9 and 11).
3. Turn key switch to position C. When engine has made some revolutions, release decompression device and the engine will start.

The engine has started

1. Once the engine has started, the revolutions per minute should be reduced to idling, 1000–1200 r.p.m.
2. Check oil pressure. Normally this is 2.5–3.5 kg/sq.cm. (35-50 lb./sq.in.). When engine is cold, the r.p.m. should be kept so low that the oil pressure does not exceed 4 kg/sq. cm. (56 lb./sq.in.). When idling a warm engine the oil pressure must not be below 1 kg/sq.cm. (15 lb./sq.in.).
3. **Engines with operating panel:** Immediately after start the oil pressure warning light should go out. Under normal operation the lamp should remain off, however, flashing when idling a very hot engine can be allowed.
   Check that charging control lamp goes out when r.p.m. exceeds idling.
4. Check frequently cooling water temperature. This should be about 65° C. (149° F).

Manoeuvring (Control lever not supplied)

1. With the control lever in central position (fig. 13, item 0), the engine is idling and the marine gear is in neutral. When the lever is moved forward in range 1 the marine gear is engaged to "Ahead" and in range 2 the gasregulation is working. When the lever is moved backwards in range 3 the marine gear is engaged to "Astern" and in range 4 the gasregulation is working.
2. **Important: Do not engage "Ahead" or "Astern" except when engine is idling.**

Stop

1. The engine is regulated down to idling and gear placed in neutral.
2. Stop control on the right side of operating panel is pulled out (fig. 9). When engine has stopped, the control handle is pressed in. The key switch is turned to position a (fig. 10).
3. If engine is to remain unused for a period, it is advisable to turn off the fuel cock and the main switch.

Running in

To secure long lifetime and high output it is recommended to let the engine run for the first 30 hours at not more than 80 % of the total output (2700 r.p.m.). Avoid slow hauling and towing. It is recommended to exchange oil in engine and gear after the first 30 hours' operation, and to check, if necessary adjust, the tension of the V-belt.

Frost precautions

To avoid damaging the engine, drain the cooling water during frosty periods. To protect the engine against damage caused by frost, proceed as follows:

1. Turn off the cock on the cooling water inlet skin fitting.
2. Open cocks on the engine and drain cooling water from exhaust manifold.
3. Start the engine and let it run for 30 seconds to remove all the water from engine and exhaust manifold. Running for that short time will cause no damage to the rotor(s) of the pump(s).

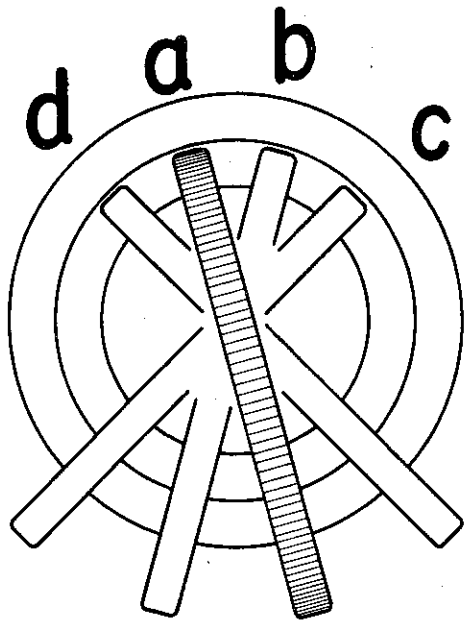


Fig. 10

d. Spare position (for supply to radio etc.)
a. OFF position, key can be inserted or removed
b. ON position, voltage on wirings
c. Starter activated. When key is released, it returns to position b

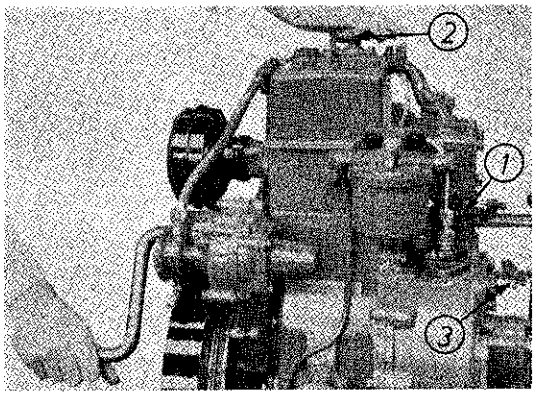


Fig. 11
1. Regulating lever
2. Decompression lever
3. Stop button

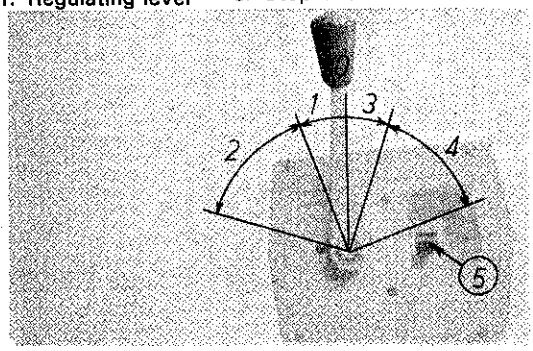


Fig. 13

0. Gear in neutral, engine idling
1. Gear in "Ahead", engine idling
2. Gear in "Ahead", engine regulation working
3. Gear in "Astern", engine idling
4. Gear in "Astern", engine regulation working
5. Gear release button (item 1 and 3)

DESCRIPTION

Crankcase: Integrally cast and equipped with wet cylinder liner to achieve easy and quick exchange when cylinder liner and piston are worn out.

Cylinder head: Integrally cast. Crankcase ventilation device is situated in cylinder head to avoid fumes.

Crank shaft: Drop-forged of chromium steel, and provided with bolted-on counter weights.

Cam shaft: Made of St. 50. The cams are made of case-hardened steel and skrunk on the shaft. The shaft is driven by the crank shaft by means of gear wheels.

Connecting rod: Drop-forged of heat treatened steel and equipped with tin-aluminium bearing and bush of bronze.

Piston: Pressure diecasts of light alloy and provided with three compression rings and one oil scraper ring.

Inlet valve: Made of chrome-silican steel and provided with seal ring on stem to avoid lubricating oil running down into the cylinder.

Exhaust valve: Made from high-alloyed chrome-molybdemum steel.

Main bearings: Large diameter tin-aluminium.

Valve cover: Cast iron and including oil filling hole and decompression device.

MAINTENANCE

Adjustments

Valves

to be adjusted when engine is cold. The clearance of the inlet valve to be 0.25 mm and that of the exhaust valve 0.3 mm (fig. 14).
Valve clearance to be checked and adjusted if necessary every 150 hours.

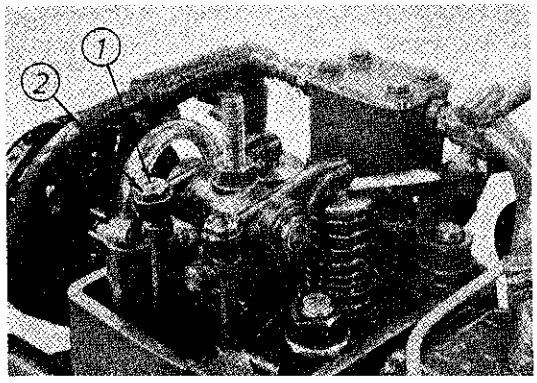


Fig. 14
1. Adjusting screw
2. Lock nut

Belt for starter-generator

to be adjusted every 150 hours by turning the dynastarter round the centres of suspension. Tensioning should be so as to allow 3–5 mm (0.125–0.190") deflection of the belt under firm thumb pressure (fig. 15).

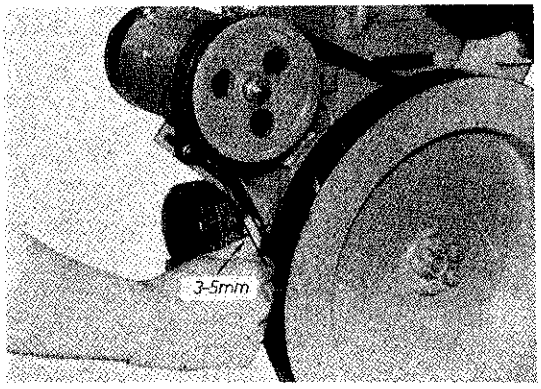


Fig. 15

Air inlet Filter

is a wire gauze filter to be rinsed in gasoline and cleaned by a blast of compressed air after 300 hours' operation.

Fuel System

The injection pump is located at the left side of the rear end cover (fig. 1 and 3, item 9).
To prevent overrunning of the engine in case of sudden disengagement of the load the injection pump is connected to a centrifugal governor allowing a max. r.p.m. of approximately 3150.

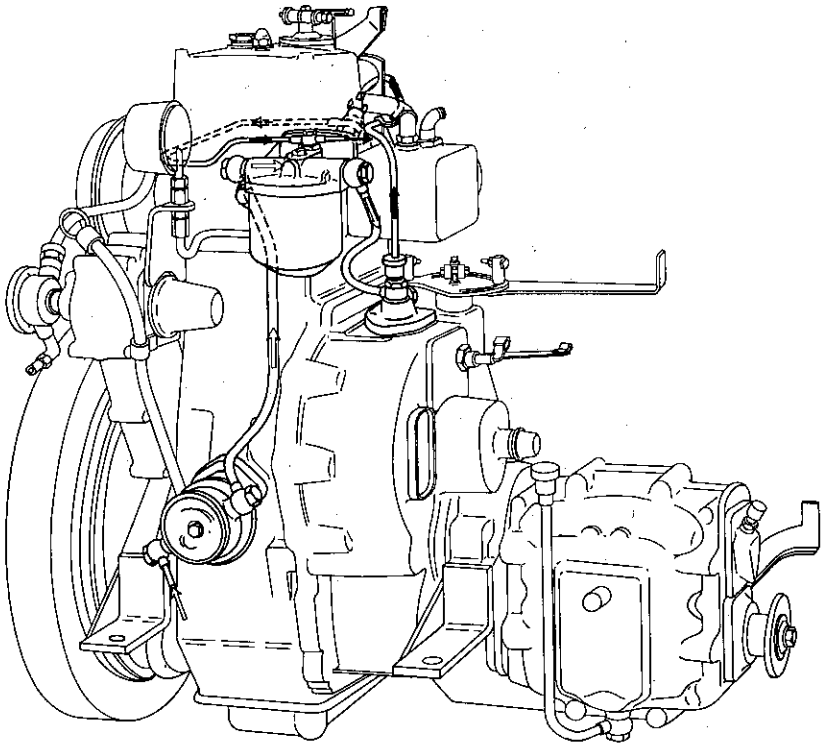


Fig. 16 Fuel passage

Fuel Filter

A fuel filter is mounted between the fuel lift pump and the injector pump. The filter element is of the paper type and should be changed every 300 hours of running. The change should be done as follows (fig. 17):

1. Loosen the centre bolt (1) and unscrew the filter cup (2).
2. Remove filter element and throw away.
3. Clean filter cup thoroughly.
4. Mount new filter element and new rubber gasket. Tighten filter cup with centre bolt.
5. Bleed fuel system as described under "Preparation before first start",

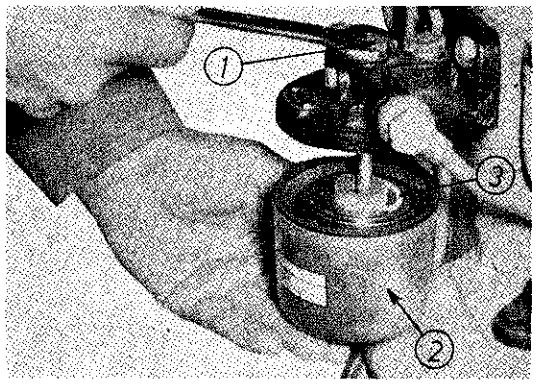


Fig. 17
1. Centre bolt
2. Filter cup
3. Filter element

Injection Nozzle

The purpose of the nozzle is to inject fuel into the cylinder. The quantity of fuel, determined by the injection pump, is delivered through the channels to the nozzle needle. When correct pressure is attained, the pintle moves upwards and fuel is sprayed into the cylinder. Both channels, nozzle hole and pintle are very carefully shaped and made to ensure correct combustion.

IMPORTANT: Adjustment and repair of the fuel system must be made by authorized dealers ONLY.

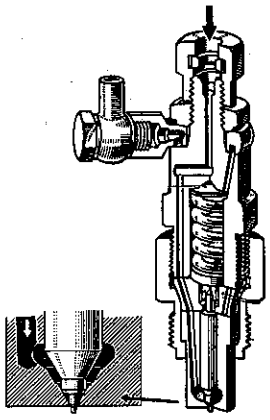


Fig. 18 Injection nozzle

Lubricating System

The engine is lubricated by a simple lubrication system. The oil passes through a strainer mounted in the sump before being sucked into the oil pump. This is a rotor type pump. From the oil pump the oil is pressed through a full-flow filter, so that it is free from impurities before forced through the drilled oil channels to the points of lubrication. To maintain sufficient lubrication in case of clogging of the filter, a spring-loaded valve will open in case of too much resistance through the filter. Thus the lubrication will take place without filtering, and therefore the oil filter should be renewed as fast as possible.

Check of Oil Level

Check the engine oil level every day
oil level must be between the two marks of the dipstick. Check the oil level in the following way (fig. 6):

1. Remove and wipe dipstick.
2. Reinsert dipstick in the pipe.
3. Withdraw dipstick, check oil level.

It is unnecessary to refill oil until the level reaches the lower mark. The oil level must not exceed the upper mark. Refill oil through the filling hole on top of the valve cover (fig. 5).

The oil capacity of the engine including filter is about 1.75 litres (1.85 qts) for Pilot 10 and 2.75 litres (2.9 qts) for Pilot 20.

Change of Oil

Change oil every 150 hours or once a year. When running-in, after 30 hours' operation. It is recommended to change the oil when engine is warm. The procedure is as follows:

1. Remove dipstick (fig. 6).
2. Insert the supplied plastic hose mounted on the hand pump into the sump, and pump up the lube oil.
3. When the sump is empty reinsert dipstick.
4. Fill fresh oil through the filling hole on valve cover.

Recommended Oils

Use oil of recommended makes.
When operating under normal conditions use oil having the following specifications:

Quality ..... Service DM
Viscosity:
Temp. below +5° C (41° F) ..... SAE 10
or SAE 5W-20
Temp. between +5° C (41° F) and +25° C (77° F) . SAE 20
Temp. above +25° C (77° F) ..... SAE 30

When operating under difficult conditions, i.e. frequent cold starting, short operation periods, very varying loads, use quality "Service DS" and the above viscosities.
Use also quality "Service DS" in case the sulphur contents of fuel oil is higher than 1 %.

Change of Lubricating Oil Filter

Lubricating oil filter cannot be cleaned, but should be changed every 150 hours or once a year. To change the filter proceed as follows (fig. 19):

1. Unscrew filter and discard it.
2. If necessary, clean gasket bearing surface of engine.
3. Screw on filter until gasket seats, tighten a further half turn.
4. Fill with oil until normal level is reached.
5. Start the engine and check that the gasket is tight.

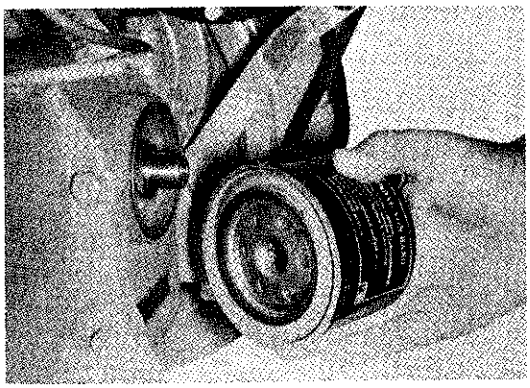


Fig. 19

Cooling System

Normally the engine is supplied with direct cooling. In order to avoid corrosion of the cooling jackets a zinc-rod has been screwed in on the right side of the rear of the crankcase. The plug marked "Z" should be dismounted for checking once or twice a year. If the zinc-rod is substantially corroded it must be replaced.
Water circulation is by means of a rotary vane pump with rubber rotor (fig. 20).

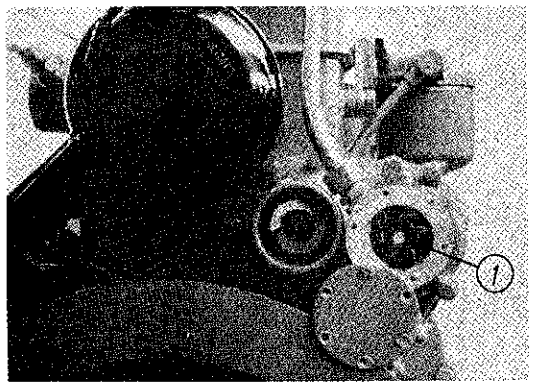


Fig. 20
1. Rubber rotor of cooling water pump

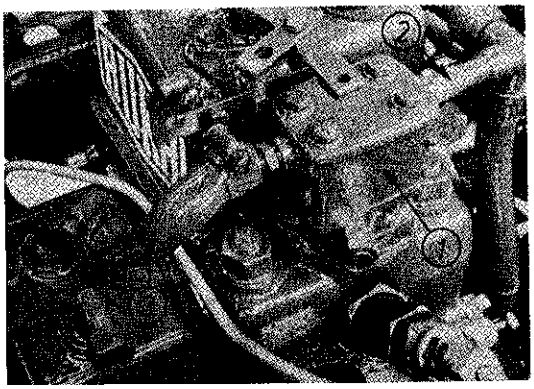


Fig. 21
1. Thermostat housing
2. Cooling water inlet
3. Cooling water outlet.

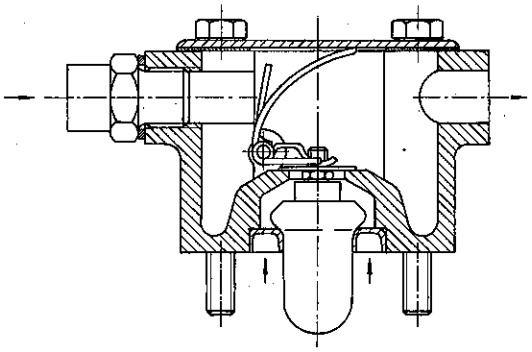


Fig. 22
Cross section of thermostat housing

The capacity of the water pump for Pilot 10 is 1.9 gal./min. (7.3 ltr./min.) and for the Pilot 20 2.9 gal./min. (11 ltr./min.) at max. r.p.m. The rubber impeller must never be run dry.

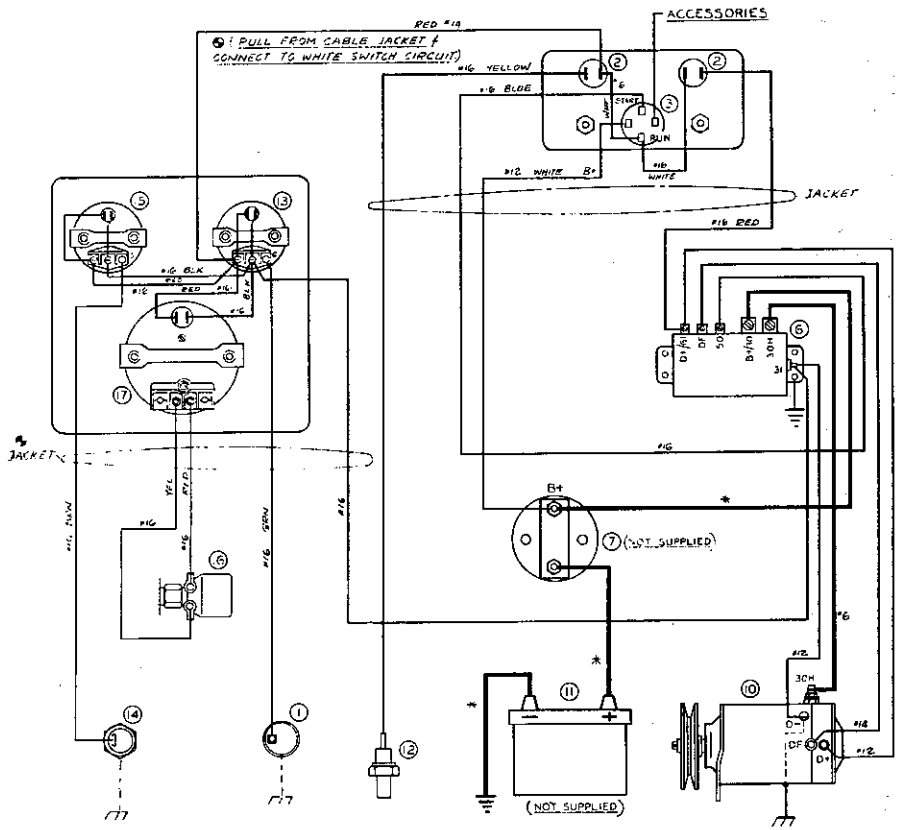
The correct engine temperature is maintained by means of a thermostat. The thermostat is placed in the thermostat housing at the right side of the cylinder head (fig. 21).
The purpose of the thermostat is to maintain a suitable and constant engine temperature. If cooling water thermometer indication is too low, a higher temperature thermostat should be fitted and vice versa. Normal cooling water temperature is about 65° C (149° F).

Electrical System (if fitted)

The engine is equipped with a 12 volt electrical unit.
A starter/generator with starter output of 1 HP (max. consumption 300 amps) and generator output of 154 W (11 amps) is mounted as standard equipment.
If a specially high charging output is required the engine may be equipped additional with a 55 amp. marine Alternator.

Fig. 23 and 24 show the electrical diagram of the engine.

Check the liquid of the battery frequently (every 25 hours or every 14 days). The liquid should be about 3/16 inch (5 mm) above the plates. If this is not the case, refill with distilled water.

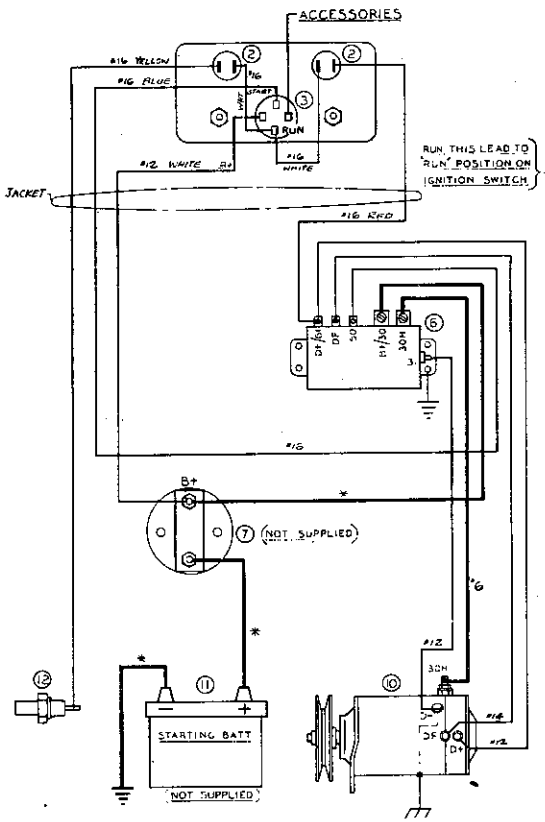


DELUXE PANEL

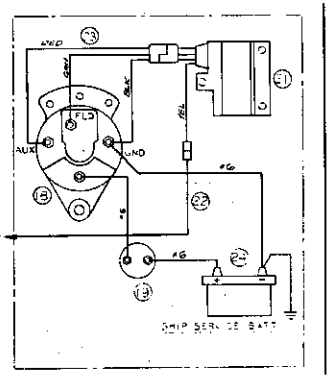
*STARTER CABLE SIZE RECOMMENDED			
FEET TOTAL LENGTH OF ADDITIONAL WIRE	VOLTAGE DROP IN CABLE FOR 300 AMPERES		
	① 3%	6%	9%
5	#4 AWG	#6 AWG	#8 AWG
10	#1 "	#4 "	#6 "
15	#2/0 "	#2 "	#4 "
20	#3/0 "	#1 "	#2 "

①3% DROP FOR CRITICAL CIRCUITS RECOMMENDED BY NFPA NO. 302.

Fig. 23



STANDARD PANEL



EXTRA ALTERNATOR - BATTERY SYSTEM.

ITEM	PART NO.	DESCRIPTION	QTY.
24		BATTERY (NOT SUPPLIED)	
23	11549	CABLE (ALT. TO REG.)	
22	11670	WIRE	
21	11550	REGULATOR	1
19		AMMETER	1
18	11546	ALTERNATOR	1
17	17215	TACHOMETER	1
16	17212	GENERATOR, TACHOMETER	1
15	17214	GUAGE, WATER TEMP.	1
14	17211	SENDER, WATER TEMP.	1
13	17215	GUAGE, OIL PRESSURE	1
12	17209	SWITCH, OIL PRESSURE	1
11		BATTERY	
10	15954	STARTER/GENERATOR	1
7		MAIN BATTERY SWITCH	1
6	15952	REGULATOR	1
			1
3	17208	KEY SWITCH	1
2	17207	BULB, WARNING LAMP	1
1	17210	SENDER, OIL PRESSURE	1

Fig. 24

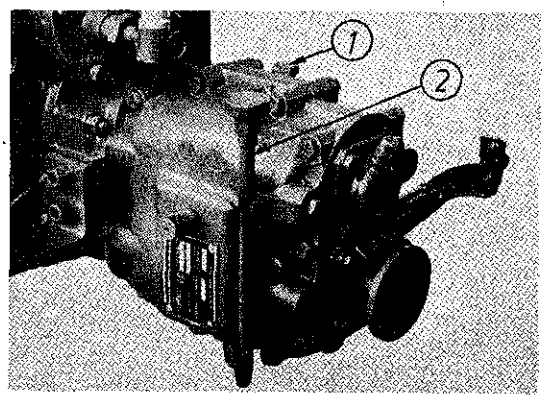


Fig. 25

1. Oil filling plug
2. Tube for oil dipstick

Marine Gear

Engines are equipped with a reverse-reduction gear driving through gear wheels and chain. The gear is 2.5:1 for AHEAD and 2.77:1 for REVERSE.

The marine gear will need no other attendance than regular check of oil and punctual exchange of oil. The oil to be exchanged after the first 30 hours' operation and then every 150 hours or once a year.

The oil to be exchanged as follows (warm engine is advisable) (fig. 25):

1. Remove filling plug (1) and oil dipstick.
2. Place the plastic tube, mounted on the hand pump, in the tube for dipstick and remove old lubricating oil.
3. Fresh oil is filled through the filler plug hole on top of the gear. 0.4 litres (.85 pts.) of gear oil SAE 90 are required.
4. Oil level is checked as described under "Preparation before first start".

NB. By checking oil level, remove filling plug, as described in "Preparation before first start".

Maintenance Table

	every 25 hrs	every 150 hrs	every 300 hrs	every 600 hrs	every 900 hrs
Check:					
Engine oil level	×				
Marine gear oil level (remove oil filling plug)	×				
Liquid level of battery	×				
Nozzles				×	
Starter-Generator					×
Change:					
Lubricating oil		×			
Gear oil		×			
Lubricating oil filter		×			
Fuel filter			×		
Clean:					
Air inlet filter			×		
Adjust (if necessary):					
Valves		×			
V-belt		×			

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

Anti-corrosion fuel	
Shell	Ensis Engine Oil 20 W
Esso	1/3 Rust Ban 623 + 2/3 Autodiesel
Texaco	Rustproof Oil
BP	Energol LM
Castrol	JSO (1:16)
Mobil	Avma 245
Valvoline	1/3 Tectyl 876 + 2/3 Autodiesel

STORAGE

If the engine is to remain out of service for a long period, it may be exposed to rusting both in the cylinder and in the cooling system.
It is recommended that the following procedure be adopted:

1. Run the engine until normal working temperature is reached and drain the lube oil from the engine and gear.
2. Fill with anti-corrosion oil. Use one of the below mentioned types or another recommended anti-corrosion oil.
3. Drain fuel tank and pour in 1–2 litres (2.2–4.3 pts.) of anti-corrosion fuel. Use one of the below mentioned types of another recommended fuel.
4. Start the engine and let it run for about 10 min. Then stop the engine and drain the anti-corrosion oil from the engine. Drain the fuel tank and fuel filter for anti-corrosion fuel.
5. Cover up the inlet and exhaust holes.
6. Remove the hose connections cooling water pump – thermostat housing – crankcase. Dismantle thermostat housing. Drain cooling water by opening the cock and opening the drain-hole in the exhaust manifold. Close cock and drain-hole.
7. Plug the holes of the crankcase but not the hole of the thermostat housing.
8. Fill up the cooling system with one of the below mentioned preservation liquids, mixed with water, if recommended. Plug the hole of the thermostat housing.

Note: The preservation liquids must not be allowed to come into contact with the rotor of cooling water pump as the rotor is made of rubber.

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 1535 (½ %)
Valvoline	1/3 Tectyl 810 Base + 2/3 water

Preparations for Use after Storage

Drain any anti-corrosion oil off the engine and pour in fresh engine oil. Drain the cooling system of preservation liquid and reinstall the thermostat housing and hose connections. Fill fuel tank.

Storage of Fuel Oil

As fuel pumps and nozzles are manufactured with very fine tolerances, it is very important that the fuel is absolutely free from impurities. Consequently the engine is equipped with a fine fuel filter providing high protection to the fuel equipment. Use a fine strainer when filling fuel tank.

MOUNTING

Engine Installation

To avoid unnecessary wear of both reverse–reduction gear and stern tube it is of vital importance that the engine installation is properly carried out. In the following you will find some good advice as to the installation.

Foundation

The engine beds must be solid. If the beds in a glass fibre boat are made of wood, the use of pine is recommended. The beds must be very solidly fixed to the hull. The measurements are stated in fig. 26 and 27.

Insulation against Noise

To avoid unnecessary noise the engine box or engine room may be lined with noise insulating materials. A lining of 3 mm barrier mat and then 1 to 2 inches of absorbsion mat have proved very effective.

The engine can be supplied with flexible rubber mounts. These are recommended for mounting in glass fibre boats.

Controls

Model Pilot 10 and Pilot 20 are ideally suited for control of the shift and throttle by a single lever type control. The control and cables should be purchased locally. The stop and decompression control cables and cable ends are supplied as loose equipment with the engine, with the necessary cable mounting hardware on the engine.

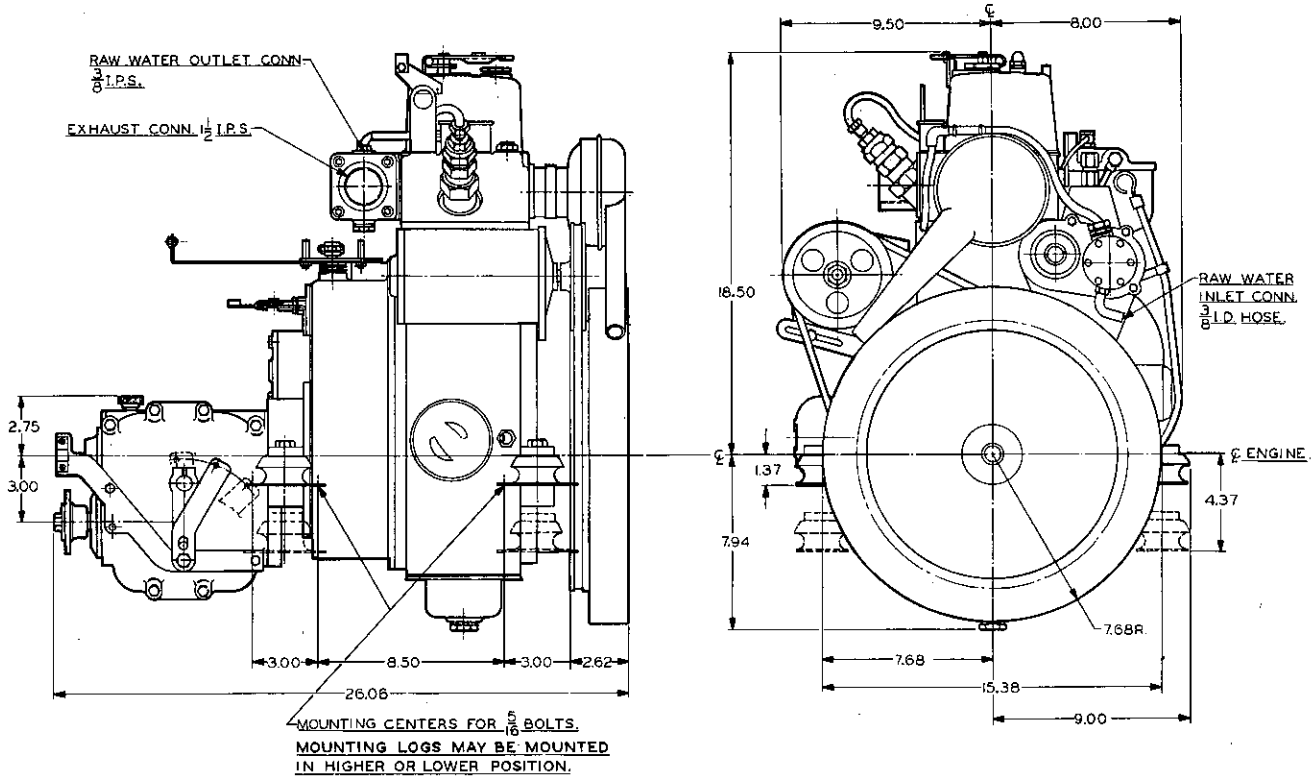


Fig. 26 Measurements of **PILOT 10**

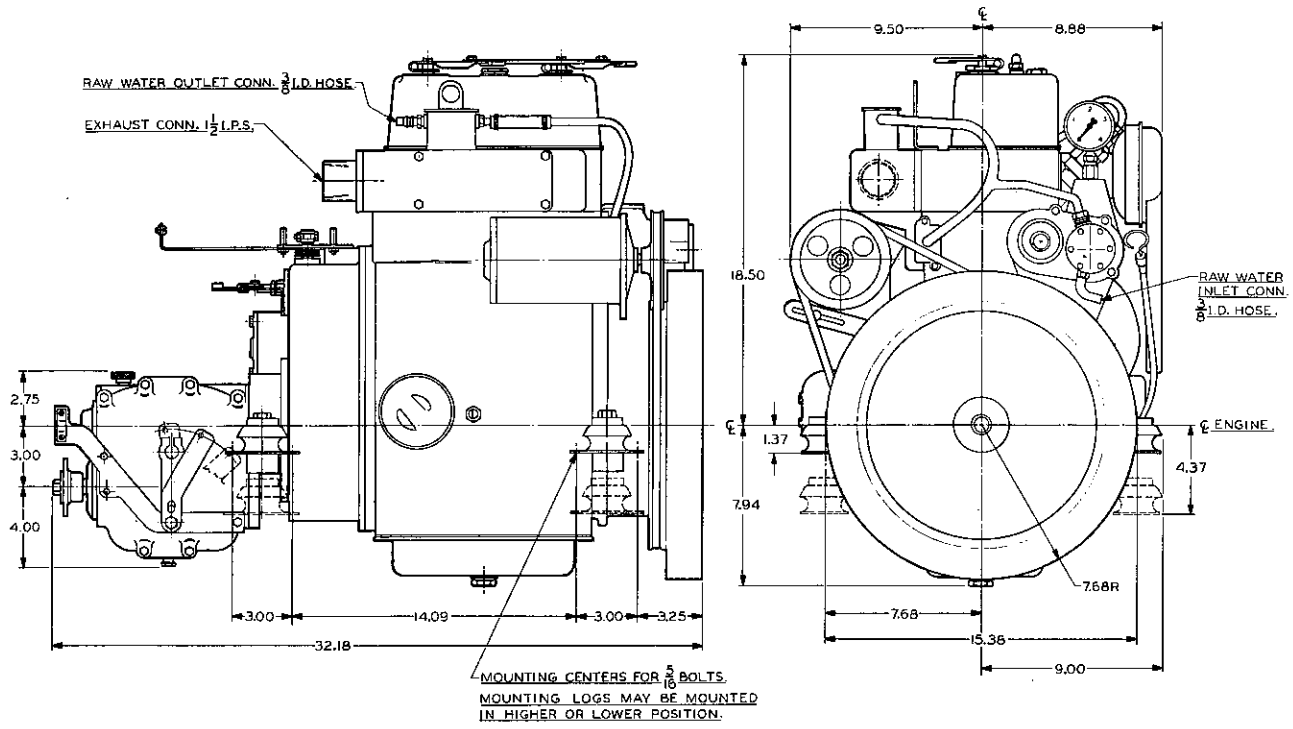


Fig. 27 Measurements of **PILOT 20**

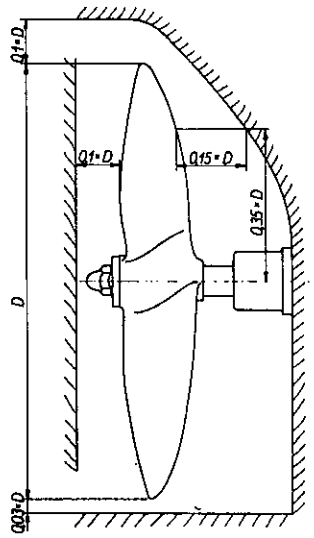


Fig. 31 Clearance of propeller (minimum)

Alignment

The gear box flange and propeller shaft flange should be carefully aligned to avoid stresses in the propeller shaft and unnecessarily heavy wear in the bearings. The alignment should be made in two stages (fig. 32).

1. **Angular alignment.** The coupling flanges are pushed towards each other until the distance is about 1 mm. Align engine and propellershaft so that the measurements "A", controlled by feeler gauge do not differ by more than 0.05 mm.
2. **Centering alignment.** The coupling flanges are manufactured with recesses, and the two parts should slip easily into oneanother.

Adjustments vertically can be made by means of metal shims under engine mounts.

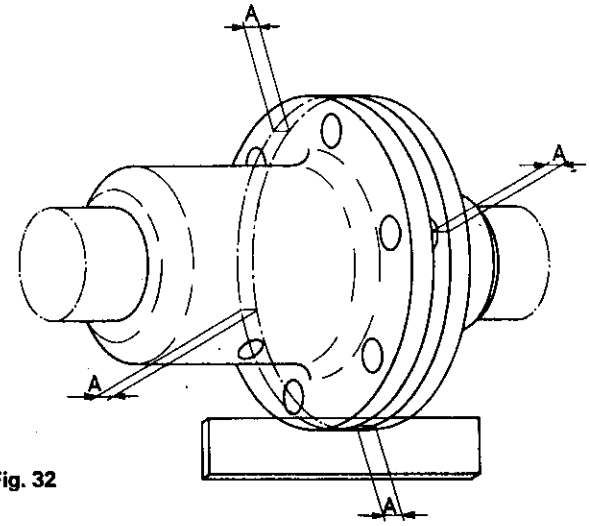


Fig. 32

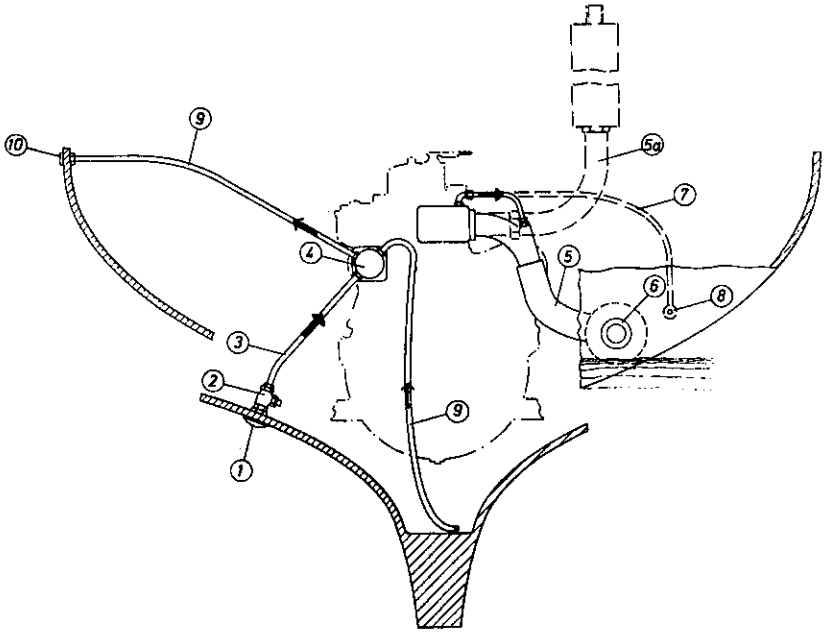


Fig. 33

Installation of Cooling Water System

1. Strainer
2. Stop cock
3. Cooling water pipe
4. Cooling water pump and bilge pump (if fitted)
5. Water-cooled exhaust pipe

5a. Dry exhaust system

6. Hull connection for water-cooled exhaust pipe
7. Water outlet pipe by dry exhaust
8. Hull connection
9. Pipe for bilge pump
10. Hull connection

IMPORTANT: The top af bilge pump pipe (9) must be approx. 12 in. (30 cm.) above water line.

Installation of Fuel System

1. Fuel tank
2. Filler hole plug
3. Plastic hose
4. Hose clip
5. Tank venting
6. Feeding pipe
7. Fuel pipe (plastic)
8. Swivel union
9. Fuel lift pump
10. Pipe for return oil, automatic bleeding

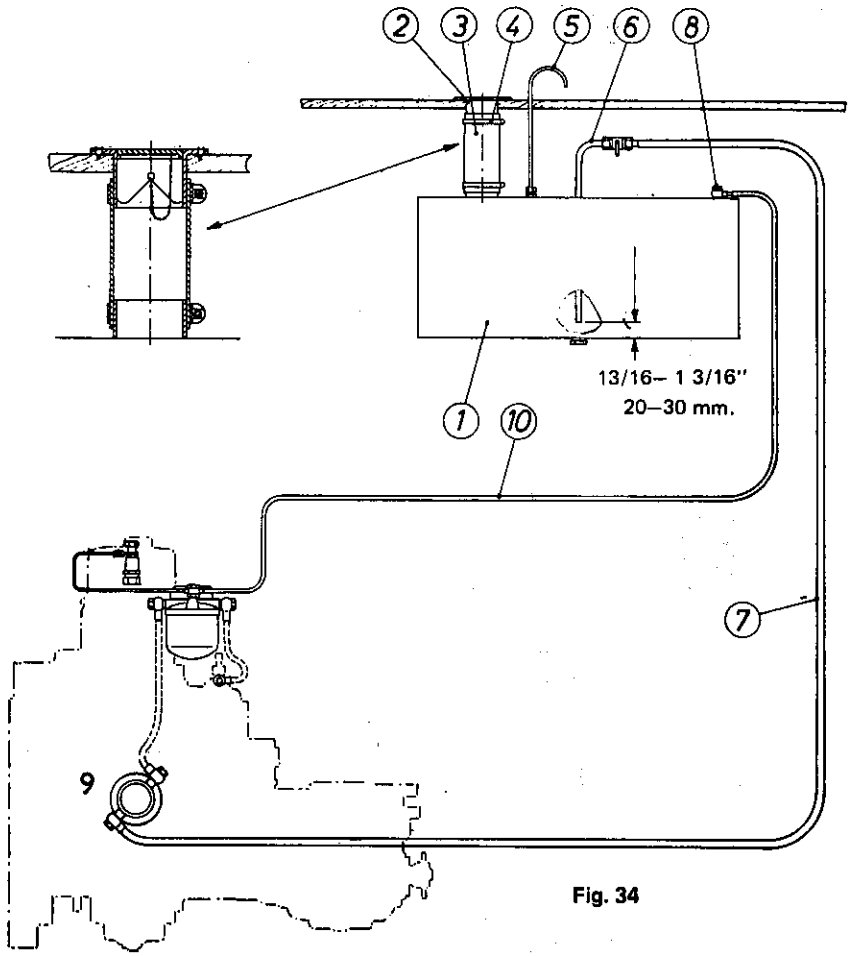


Fig. 34

EXHAUST SYSTEMS

Dry Exhaust

1. Water cooled exhaust manifold
2. Discharge for cooling water
3. Hull connection
4. Flange for exhaust manifold
5. Exhaust pipe
6. Silencer

This type of exhaust is particularly used in boats for commercial purposes with fixed mounts.

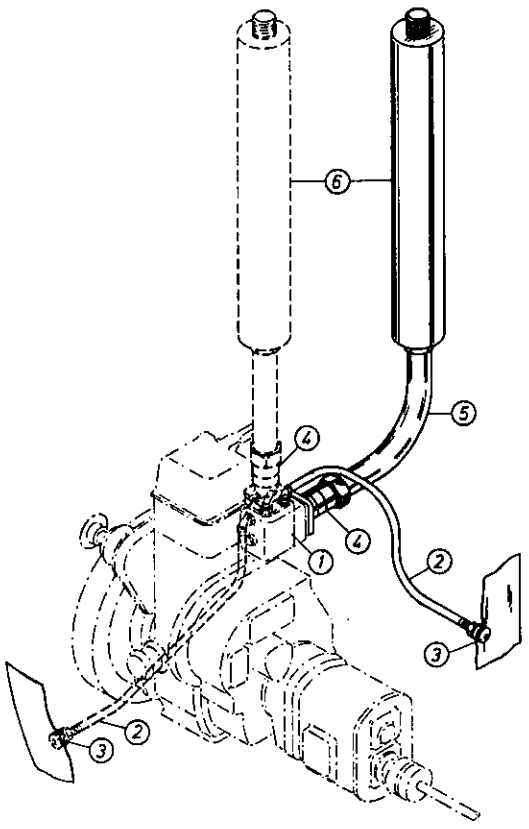


Fig. 35

Water cooled Exhaust

1. Water cooled exhaust manifold
2. Cooling water inlet from thermostat
3. Exhaust bend with water injection
4. Hose clip
5. Rubber exhaust hose
6. Pipe connection
7. Rubber silencer
8. Hull connection

To be used in cases where the exhaust manifold is sufficiently above the water line to ensure sufficient draining of the hose (5).

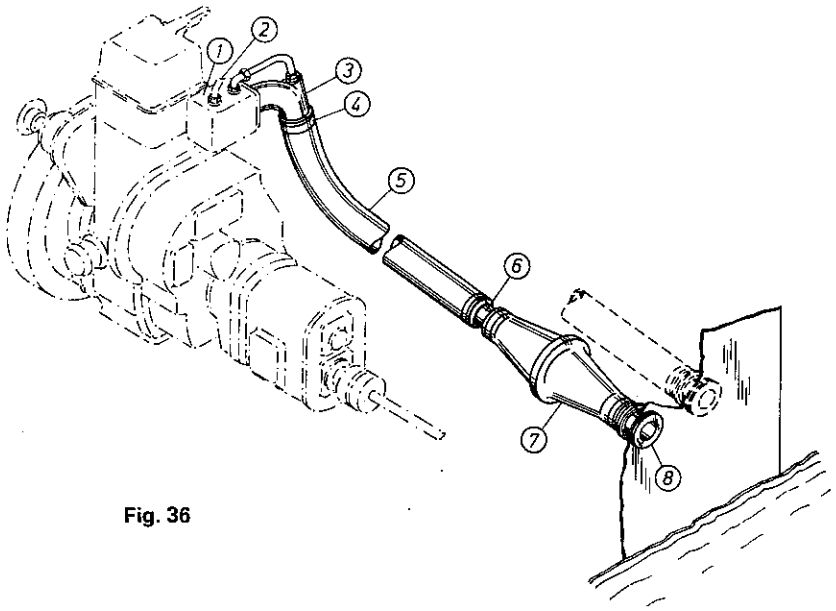


Fig. 36

"Water-lock" System

1. Water cooled exhaust manifold
2. Cooling water inlet from thermostat
3. Exhaust bend
4. Hose clip
5. Rubber hose
6. "Water lock" tank
7. Pipe bend
8. Pipe connection
9. Rubber silencer
10. Hull connection
11. Vent pipe

A: max. 800 mm (31.5 in.)
B: min. 100 mm (4 in.)
C: min. 50 mm (2 in.)
D: min. 5°

Use this system when the exhaust manifold is below the water line. The top of the bend (2) must be above water line. The measurements "A", "B", "C" and "D" must be accepted. – The vent pipe (11) must be mounted in a way that no water can stay in it.

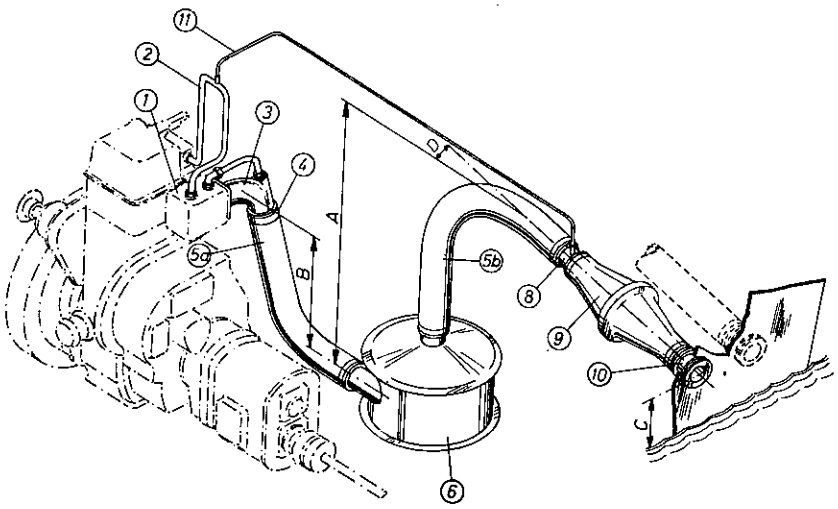


Fig. 37

GALVANIC CORROSION

To avoid corrosion of the propeller due to galvanic action it is advisable to mount sacrificial zincs on the outside of the hull. To obtain a high degree of protection, electrical contact between sacrificial zinc (anode) and propeller (cathode) must be established. This is made by mounting sacrificial zinc and making electrical connections as shown in principle in fig. 38.

In connection with the Pilot 10 and 20 engines a sacrificial zinc of the type BERA 2B is recommended. Do not mount the zinc along the edge of the stern, as this may cause cavitation of the propeller due to eddying. Do not paint the sacrificial zinc as this will prevent the zinc from corroding.

The sacrificial zinc must be checked every time the boat is ashore, or at least twice a year. If the corrosion is very heavy, mount larger anodes, e.g. two BERA 2B or one BERA 10B. If there is no corrosion, check the electrical connection.

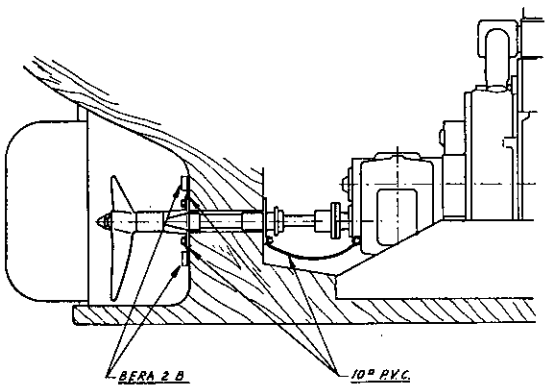


Fig. 38

IRREGULAR OPERATION – CAUSES, AND REMEDIES

1. The Engine does not start

Symptom:	Cause:	Remedy:
Insufficient or very little compression	Inlet and/or exhaust valves leaking	Grind or replace the valves; mill the seats
–	Inlet and exhaust valves sticking	Grease valve stems with $^2/_3$ gas oil and $^1/_3$ lubricating oil, if necessary clean the valves
–	Insufficient rocker arm clearance	Adjust to 0.25 mm inlet and 0.3 mm exhaust when engine is cold
–	Piston rings stuck in grooves, or are worn	Replace piston rings
–	Valve springs broken or weak	Replace springs
Insufficient or no pressure from fuel pump	Air in fuel system	Bleed
Thermo-start out of order	No fuel	Fill up
–	Electric supply out of order	Check and/or replace switch and connections

2. The Engine starts, but stops soon after

The engine starts, but stops soon after	Air in fuel system	Bleed
–	Fuel filter choked	Replace filter element
	Fuel tank empty	Fill tank and bleed the system

3. The Engine does not reach maximum output

Symptom:	Cause:	Remedy:
No or insufficient compression		See "Engine does not start"
The engine attains maximum capacity momentarily only	Fuel supply closed	Check fuel system thoroughly
The engine r.p.m. is reduced considerably when loaded	Governor incorrectly adjusted or something in the system works sluggishly	Adjust the governor. Check governor system and correct the error
Smell of heat	Insufficient cooling water	Stop engine, check cooling water pump
Hot engine	Damaged cylinder liner or bearings	Check bearings, piston, and cylinder, if necessary replace them

4. Engine-r.p.m. are not steady

Fuel valve out of order	Air in fuel system	Bleed the system, see "Engine does not start"

5. The Engine knocks

Mechanical defects	Loose connecting rod bolts	Check the connecting rod bolts closely, if cracked or defective replace them Tighten the nuts
–	Loose fly wheel	Tighten the bolts
–	Worn piston and cylinder liner	Replace them

6. The Engine smokes

Symptom:	Cause:	Remedy:
Black smoke	Air inlet filter choked	Clean filter
–	Insufficient compression	See "The Engine does not start"
–	Overload	Reduce the load on engine, the engine must never be overloaded
Blue smoke	The lube oil passes piston and oil rings and penetrates into precombustion chamber	Replace oil rings and possibly the piston rings

7. Excessive Consumption of Fuel Oil

Engine runs hot	Engine overloaded	Reduce load (never overload engine)
Insufficient compression		See "Engine does not start"
Fuel leaks from fuel system	Leaky fuel pipes	Repair or replace
Engine smokes	Thermostart out of order	Replace

8. Excessive Consumption of Lubricating Oil

Lubricating oil penetrates into combustion chamber	Worn oil and piston rings	Replace oil rings and piston rings too, if required
–	Piston and cylinder liner highly worn	Replace
Lubricating oil leaks out of crankshaft bearings	Worn oil seal rings	Replace

9. The Engine runs hot

Cause:	Symptom:	Remedy:
Strong smell of heat	No cooling water	Stop engine and check cooling water pump
Too high cooling water temperature	Insufficient cooling water owing to a defective cooling water pump or choked strainer or a defective thermostat	Repair the defect
Too low a cooling water temperature	Thermostat out of order	Repair
Insufficient lubricating oil pressure	Lube oil filter choked	Replace filter element
–	Defective lube oil pump	Repair pump
–	Leaky lube oil pressure pipe	Repair or replace pipe
–	Lube oil overflow valve out of order	Repair valve

WESTERBEKE

MARINE ENGINE PRODUCTS

SERVICE BULLETIN #99

ISSUED: November 15, 1977

SUBJECT: Hot Water Heater Connections

MODEL: Westerbeke 10 & 20

DISTR: Distributors, Engine Shipments

The Westerbeke 10 and 20 Marine Diesels are raw water cooled and thermostatly controlled by a 140°F thermostat. This is the maximum operating temperature for salt water, and no attempts are to be made to alter the engine's bypass system or its thermostat for the purpose of obtaining greater heat from a hot water heater.

To properly connect a hot water heater to these engines proceed as follows:

1. Remove water temperature sender from thermostat housing (if supplied) and install nipple, tee fitting, and bushings as shown on drawing supplied on back side of this bulletin.

2. Relocate sender (if supplied) into tee fitting as shown. Because of special metric threads on this sender, a special bushing, P.N. 23305 - included with engine, must be installed before this connection can be made.

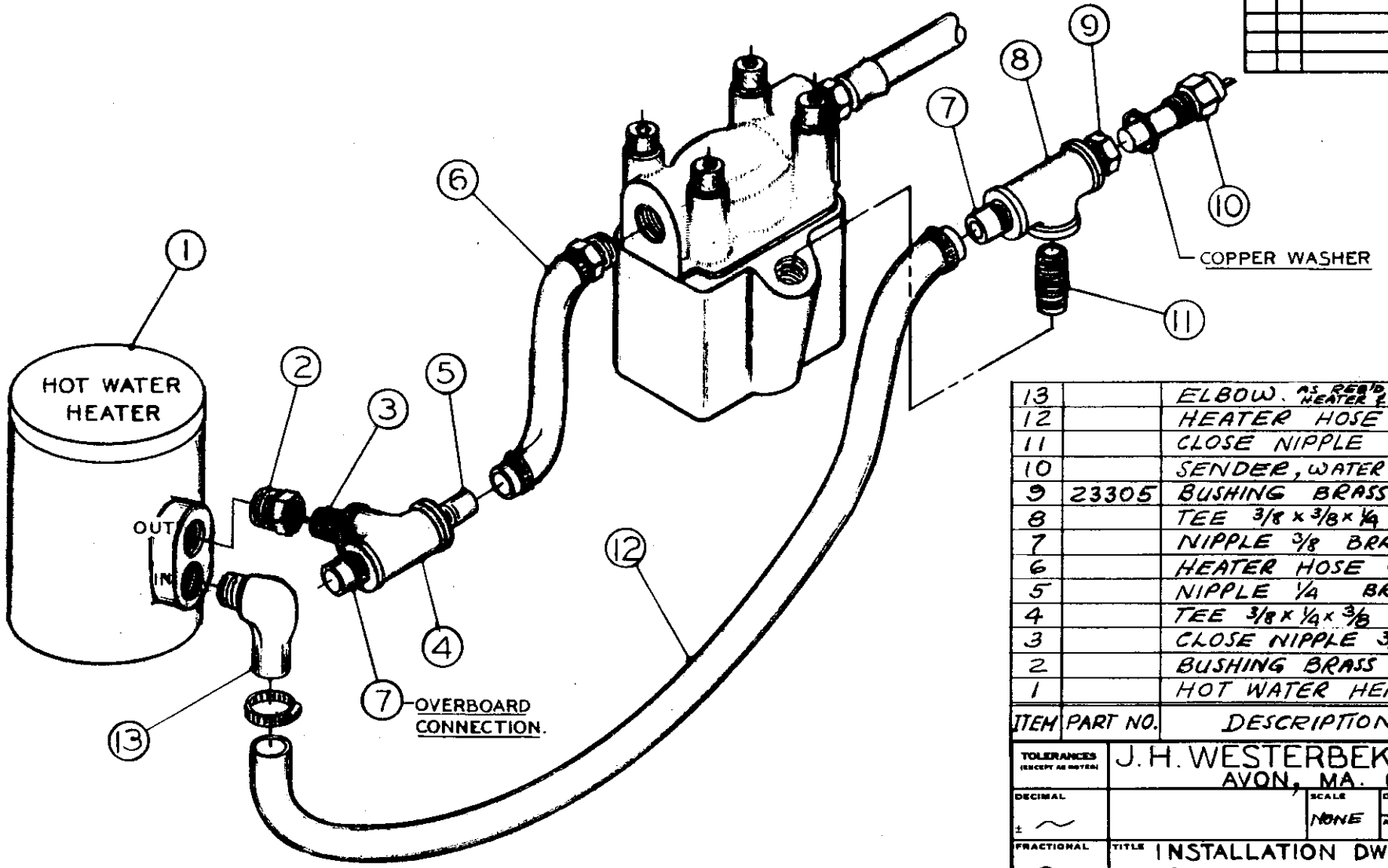
3. Connect 5/8" I.D. heater hose from tee fitting to hot water heater inlet connection. On most heaters it is the lowest of the IN and OUT raw water connecting points. Be sure to check this in your heater installation instructions.

4. Install a tee fitting into the heater's outlet connection with the branch of the tee being connected as shown on drawing.

5. Connect 1/2" I.D. heater hose from thermostat's bypass connection to this tee as shown on drawing. The opposite end of this tee fitting is the overboard connection.

A properly installed 6 gallon heater to the Westerbeke 20 will produce 140° hot water in approximately one hour from the time engine is started and running at a moderate load.

DATE	BY	REVISION RECORD	AUTH.	DR.	CK.



ITEM	PART NO.	DESCRIPTION	QTY
13		ELBOW. AS REQ'D TO FIT HEATER & 5/8 I.D. HOSE	1
12		HEATER HOSE 5/8 I.D.	AS REQ'D
11		CLOSE NIPPLE BRASS 1/4	1
10		SENDER, WATER TEMPT.	1
9	23305	BUSHING BRASS	1
8		TEE 3/8 x 3/8 x 1/4 BRASS	1
7		NIPPLE 3/8 BRASS	2
6		HEATER HOSE 1/2 I.D.	AS REQ'D
5		NIPPLE 1/4 BRASS	1
4		TEE 3/8 x 1/4 x 3/8 BRASS	1
3		CLOSE NIPPLE 3/8 BRASS	1
2		BUSHING BRASS AS REQ'D	1
1		HOT WATER HEATER	1

TOLERANCES (EXCEPT AS NOTED)

DECIMAL ± ~

FRACTIONAL ± ~

ANGULAR ± ~

J. H. WESTERBEKE CORP.
AVON, MA. 02322

SCALE NONE

DRAWN BY R. Strahle

APPROVED BY

TITLE INSTALLATION DWG., WESTERBEKE 10 & 20 HOT WATER HEATER

DATE 10-26-77

DRAWING NUMBER 23306

OVERHAUL INSTRUCTIONS

The following sections contain detailed information relating to the proper operating characteristics of the major components and systems in Pilot 10 and Pilot 20 diesel engines. Included are disassembly, rework and reassembly instructions for the guidance of suitably equipped and staffed marine engine service and rebuilding facilities. The necessary procedures should be undertaken only by such facilities.

Additional operating characteristics are included in the Operators Section (B) of this manual.

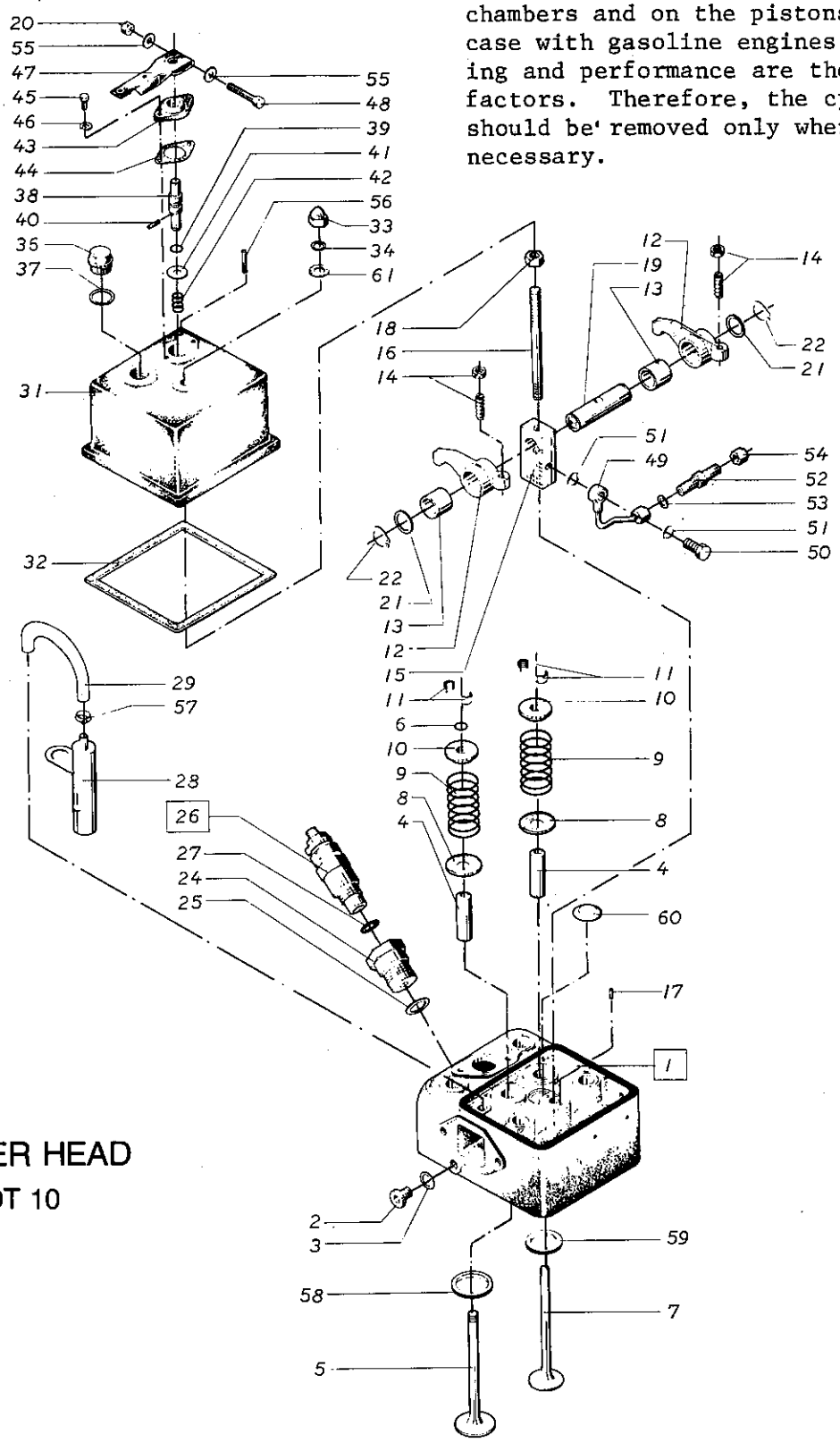
Any replacements should be made only with genuine Westerbeke parts.

CYLINDER HEAD

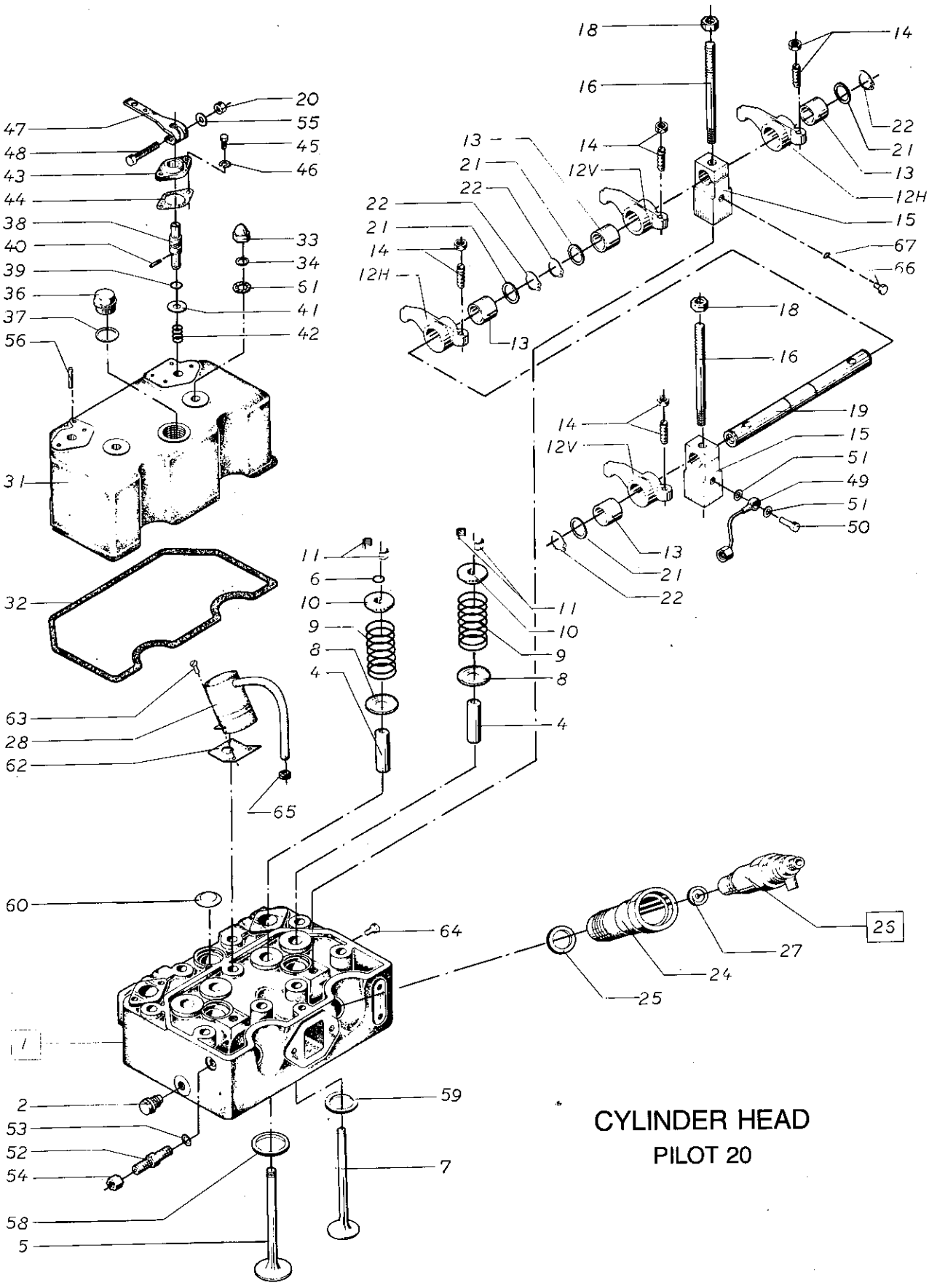
ENGINE	SERIAL NO.	CYL. HEAD	YEAR
Pilot 10	85967 & up	4400.1.E	1973
Pilot 20	92447 & up	4600.1.C	1973

IMPORTANT:

The number of operating hours has no bearing on when to overhaul the cylinder head on either the Pilot 10 or Pilot 20 series diesel engines. This is because carbon, beyond a superficial coating, does not form or accumulate in the combustion chambers and on the pistons, as is the case with gasoline engines. Ease of starting and performance are the determining factors. Therefore, the cylinder head should be removed only when absolutely necessary.



CYLINDER HEAD
PILOT 10



CYLINDER HEAD

PILOT 20

REMOVING THE CYLINDER HEAD

1. Drain all water from the engine.
2. Disconnect the water piping at top of engine.
3. Remove intake and exhaust manifold.
4. Remove cable for decompression lever.
5. Remove cylinder head cover.
6. Remove the fuel pressure pipe. Take precautions so no dirt will get into the fuel injection system.
7. Remove cylinder head nuts. Now the cylinder head can be lifted off.

Replacing the cylinder head is accomplished in reverse sequence. The cylinder head bolts should be tightened with the following torques:

Pilot 10 15 - 17 kgm (108-123 lbs.)
Pilot 20 9.5 - 10.5 kgm (69-76 lbs.)

The nuts are to be tightened alternately, in steps, to achieve uniform tension.

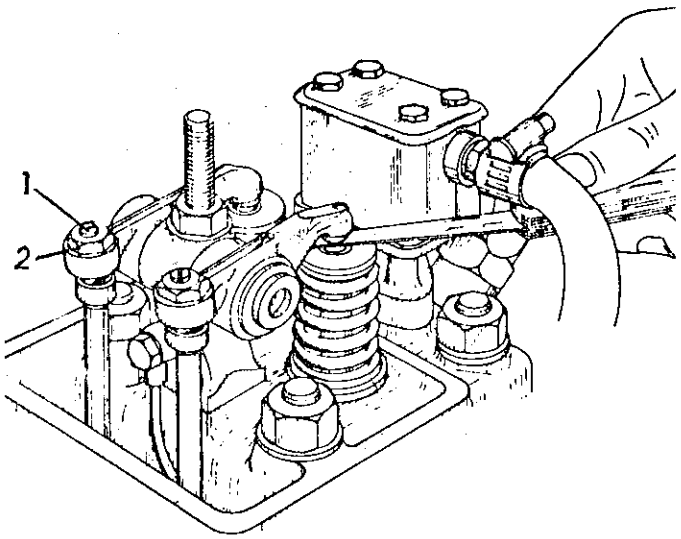
REPLACING ROCKER ARM AND SHAFT

1. Remove decompression lever cables.
2. Remove cylinder head cover.
3. Remove stop ring (22), see illustration opposite or on page C1.
4. Remove spacer rings (21). Now rocker arm can be pulled off.
5. Unscrew nut (18).
6. Unscrew banjo bolt (50), and remove rocker arm bracket (15). Now the rocker arm shaft (19) can be replaced.

Reassembly is accomplished in reverse sequence.

NOTE: Replacement of bushing (13) should be avoided unless absolutely necessary. It is machined to very close tolerances for mating fit with rocker arm bore.

ADJUSTING VALVE CLEARANCE



ADJUSTING VALVE CLEARANCE (cont'd)

Setting valve clearance has to be done with a cold engine and only after the cylinder head bolts have been tightened with the proper torque. It is recommended that the valve clearance and torque be re-checked every 100 Hrs. of operation.

Valve clearance is to be adjusted when the piston is near top dead center on the compression stroke.

Clearance for intake valve - 0.25 mm (.010")
Clearance for exhaust valve - 0.30 mm (.012")

ENGINE	SERIAL NO.	VALVE	YEAR
Pilot 10	85000 & up	4400.1.E	1973
Pilot 20	92000 & up	4600.1.C	1973

Removal:

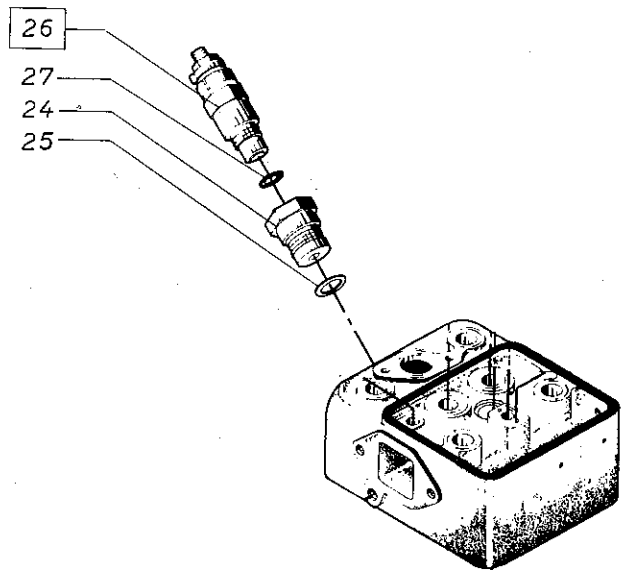
The fuel injection holder assembly (26), below, can be removed from the pre-combustion chamber (24) after the fuel pressure pipe is removed.

Replacement:

Precautions should be taken so that no dirt gets into the system. The fuel injection holder assembly is to be tightened

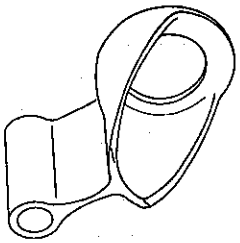
The heat transfer washer (27) must be reassembled in the right position. It is very important that the flat surface of the washer is turned towards the injection nozzle.

This washer should be replaced whenever the injection nozzle assembly is removed from the pre-combustion chamber.



INTAKE AND EXHAUST VALVES

Removal:

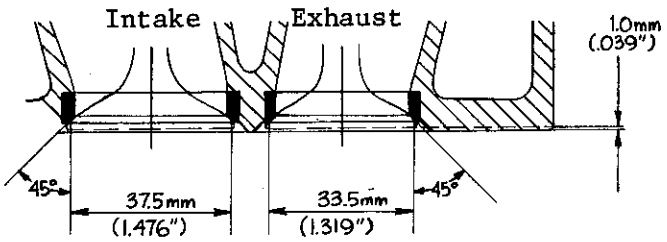


1. Remove cylinder head (page C3).
2. Place the cylinder head on a workbench with the valve seats facing down.
3. With the special tool (right), depress the spring cap (10), illustration lower right, and the springs (9) and remove the two half conical collars (11). Remove spring caps, springs, and spring plates (8) as well as any rubber seals. The valves can now be removed when the cylinder head is placed on its side.

Inspection:

If the wear of the valve seats is so extensive that regrinding or recutting of the valve seats is not possible within the tolerances given below, the valve seats will have to be replaced.

It is of great importance that contact between valves and seats is the best possible. When grinding in valves, make certain that no signs of pitting are left on the seats. Take care that excessive grinding of the seat is avoided.



REGRINDING MEASUREMENTS

Lapping in:

1. The cylinder head is placed on a workbench with valve seats facing up. Make sure that the valve stems have free movement underneath.
2. The orthodox manner of using grinding compound and a lapping holder may be used if the wear on the valve seats or the valve surface is not excessive. It is important that the compound is spread over the whole area, and that the valve is indexed in various positions during the lapping operation.
3. The valve and the valve seat will have to be thoroughly cleaned after the lapping process. Make sure, by careful inspection, that the surface has been lapped evenly. Prepare for this by making pencil marks on seats at 90° points, or coating seats with Prussian Blue. As the valve is indexed in its seat during lapping, the pencil marks or Prussian Blue should disappear uniformly.
4. Before reassembly, add #10 oil to the valve seat.

DIMENSIONS for new values:

Valve stem diameter:

8.972-8.987 mm (.3532"-.3538")

Valve guide diameter:

9.050-9.062 mm (.3563"-.3568")

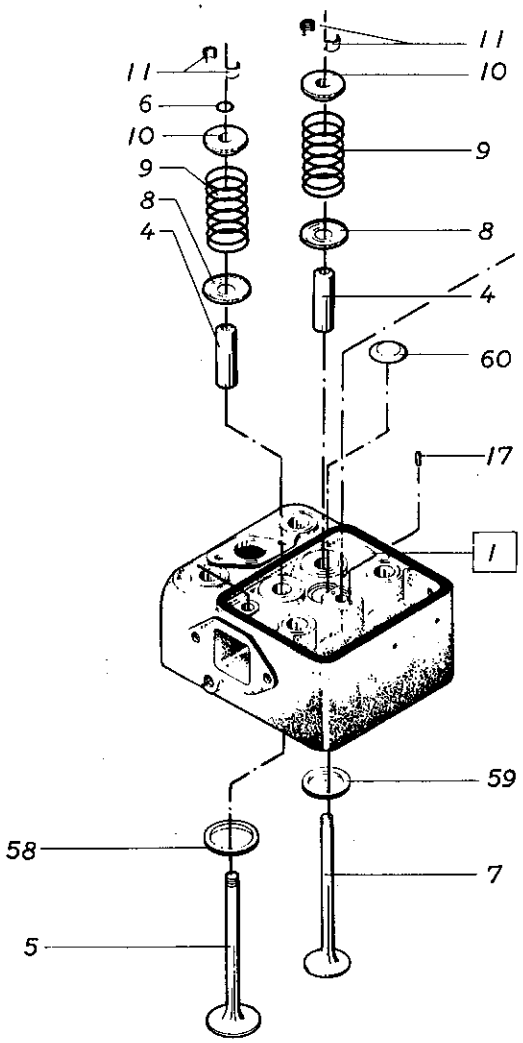
Clearance between valve stem and guide:

0.063-0.090 mm (.0025"-.0035")

Please note: The valve stems are chrome plated and should not be ground.

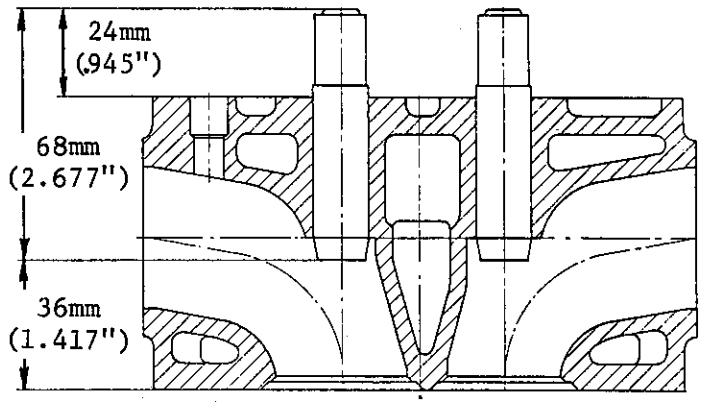
REPLACING VALVE GUIDES

The valve guides (4) are pressed into the cylinder head from the top, and replaceable. If the total clearance between the valve guide and the valve stem exceeds 0.1 mm (.0039") with warm engine, the valve guide has to be replaced.



REPLACING VALVE GUIDES (Cont'd)

1. Remove cylinder head and valves.
2. Using a suitable tool, press the guide out of the cylinder head from the top.
3. Using the same tool, press in the new valve guide from the top according to the dimensions given on preceeding page.
4. Make sure the valve stem moves freely in the new valve guide.



Dimensions for replacing valve guides

REPLACING VALVE SEATS

ENGINE	SERIAL NO.	GUIDE	YEAR
Pilot 10	85182 & up	4400.1.E	1973
Pilot 20	92015 & up	4600.1.C	1973

When grinding or lapping the valve seat, the dimensions on opposite page must not be exceeded.

If necessary to replace the valve seats, use the following procedure:

1. Remove the valve guide (4).
2. Place a brass rod in the valve guide bore and knock the valve seat out.

The top of the cylinder must be heated to approx. 100°C (212°F) before installing a new valve seat. This can be done by means of hot water or a welding torch. After making sure that the right temperature has been reached, the new valve seat may be inserted. No lubrication should be used when pressing in the insert. To make the job easier, it is advisable to shrink the valve seat ring by exposing to CO^2 under pressure or to dry ice.

PRECOMBUSTION CHAMBER

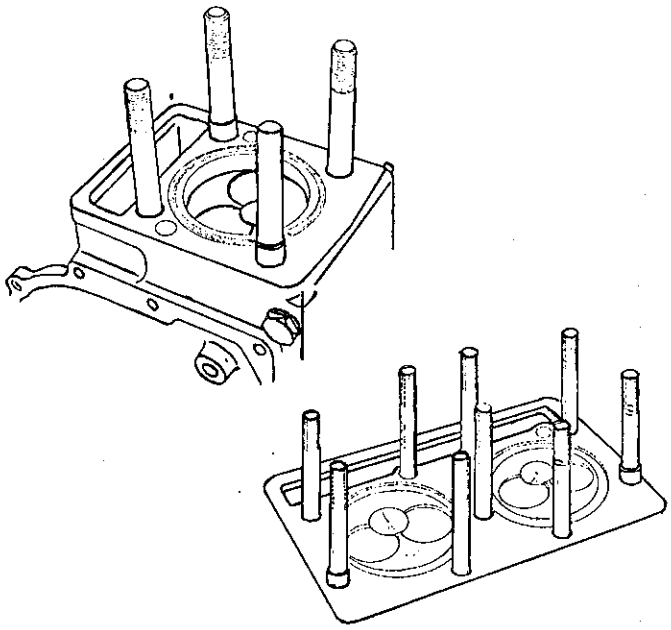
The precombustion chamber is made out of two parts. The top part is removable. After the fuel injection holder assembly is removed, the top part of the precombustion chamber can be unscrewed. The lower part of the precombustion chamber is machined into the cylinder head.

When reassembling the top part of the precombustion chamber, the torque should be 24-25 kgm (173.6-180.8 lbs.)

CYLINDER HEAD GASKET

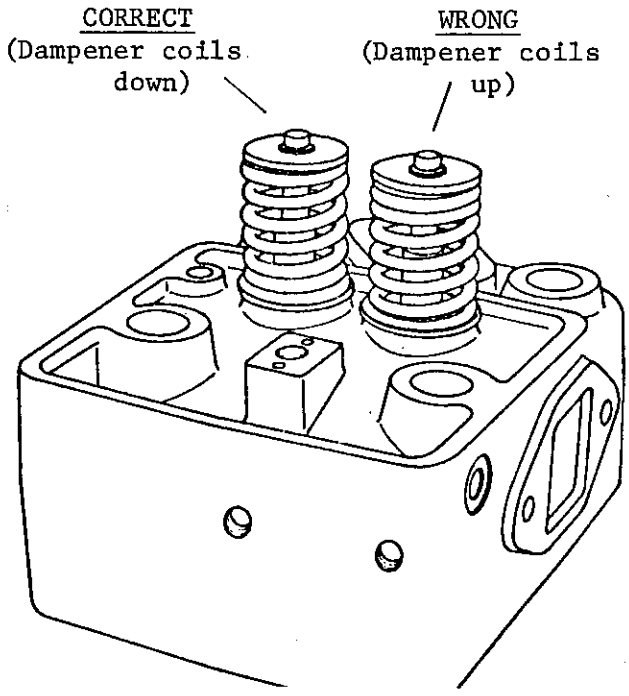
The cylinder head gasket is made from "Victorcore 200", which consists of rubber asbestos, moulded into sheet steel. Before replacing the cylinder head it is extremely important to make sure that the surfaces of the cylinder block and cylinder head are perfectly clean.

With the underside of the cylinder head perfectly clean, the gasket placed in position on the surface and the nuts tightened down.



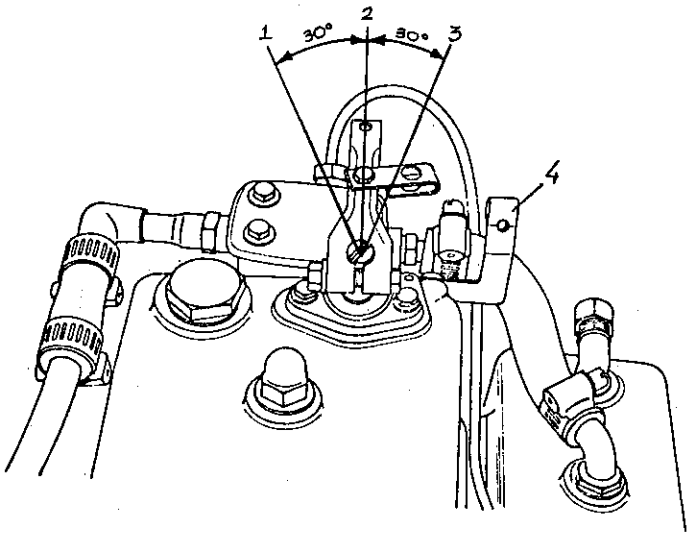
REASSEMBLING VALVE SPRINGS

It is most important that the valve springs are reassembled in the correct position as shown above.



ADJUSTING DECOMPRESSION LEVER

1. Turn the engine, using the fly-wheel, until the exhaust valve is closed.
2. Turn the decompression lever shaft (with slotted head) clock-wise until it touches the exhaust valve rocker arm.
3. With the decompresssion shaft held in this psoition, locate the arm at a 90° angle.
4. Tighten the decompression lever arm on the shaft with a torque of 0.9 - 1.0 kgm (20 - 22 lbs.).



1. Static position (controlled by cable adjustment).
2. Adjusting position.
3. Position when decompressing.
4. Clamp for decompression lever cable.

COMPRESSION TEST

Testing the compression will indicate the tightness of valve seating, wear of piston rings, etc. and should be a part of any troubleshooting when looking for a possible cause of hard starting.

The compression test has to be made at a low r.p.m. in order for compression value on the meter to reflect real conditions. By experience the following values should indicate:

1. For a new engine the compression value should show between 27 and 29 kg/cm^2 (384 and 412 p.s.i.).
2. With a compression value below 25 kg/cm^2 (355.5 p.s.i.), the engine will not start easily and the cause for the trouble should be found.

A low compression value indicates that the engine has to be disassembled for inspection of valves, valve seats, cylinder liners, and/or piston rings.

FLYWHEEL

REMOVAL

1. Loosen bolts (8) and (12) on the dyna-starter (diagram below).
2. Dyna-starter can be pushed downwards so the V-belt can be removed.
3. Remove six bolts (19). The fly-wheel can then be removed from the stud.

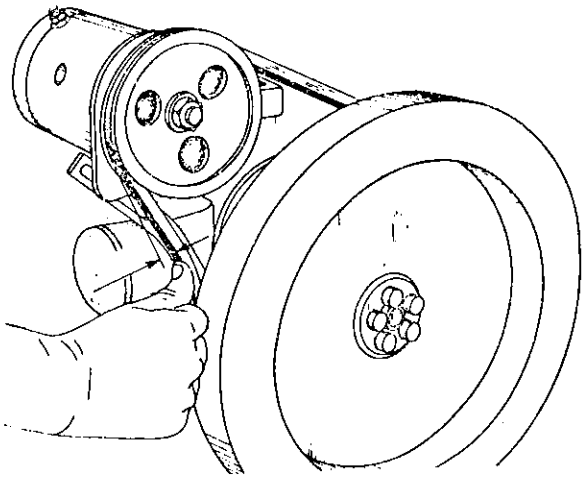
REASSEMBLY

Reassembling the fly-wheel is accomplished in reverse sequence.

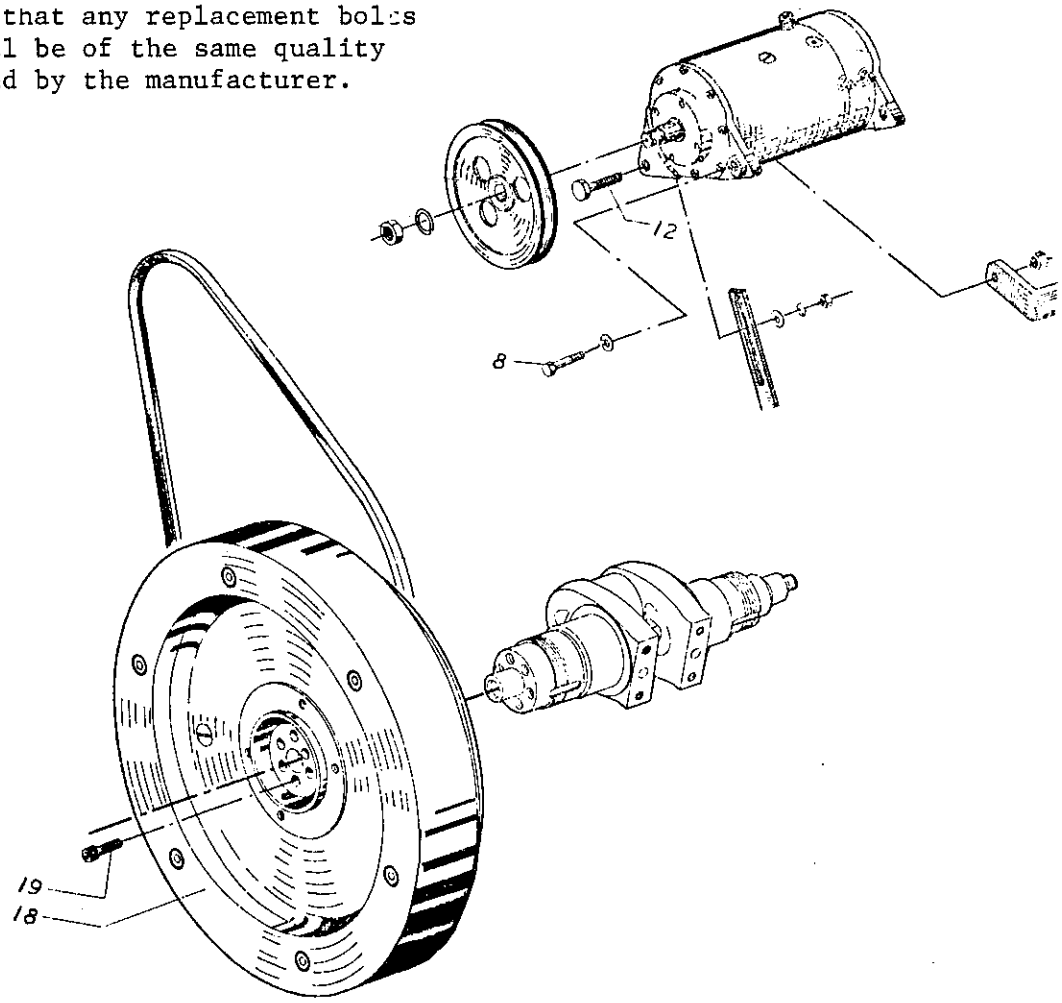
Note:

1. The six bolts (19) holding the fly-wheel have to be tightened with a torque of 8 - 8.5 kgm (58-61.5 lbs.). It is recommended that Locktite be applied to the bolts.
2. The V-belt should be tightened properly (diagram at right). Correct adjustment will allow a movement of 3 - 5 mm (.12" - .2").
3. The bolt (8) should be tightened to a torque of 4 - 4.5 kgm (29-32.5lbs.). For bolt (12) apply a torque of 2 - 2.3 kgm (14.5-16.6 lbs.).

It is important that any replacement bolts for the fly-wheel be of the same quality as those supplied by the manufacturer.



V BELT TENSION



YOUR NOTES

FRONT END COVER

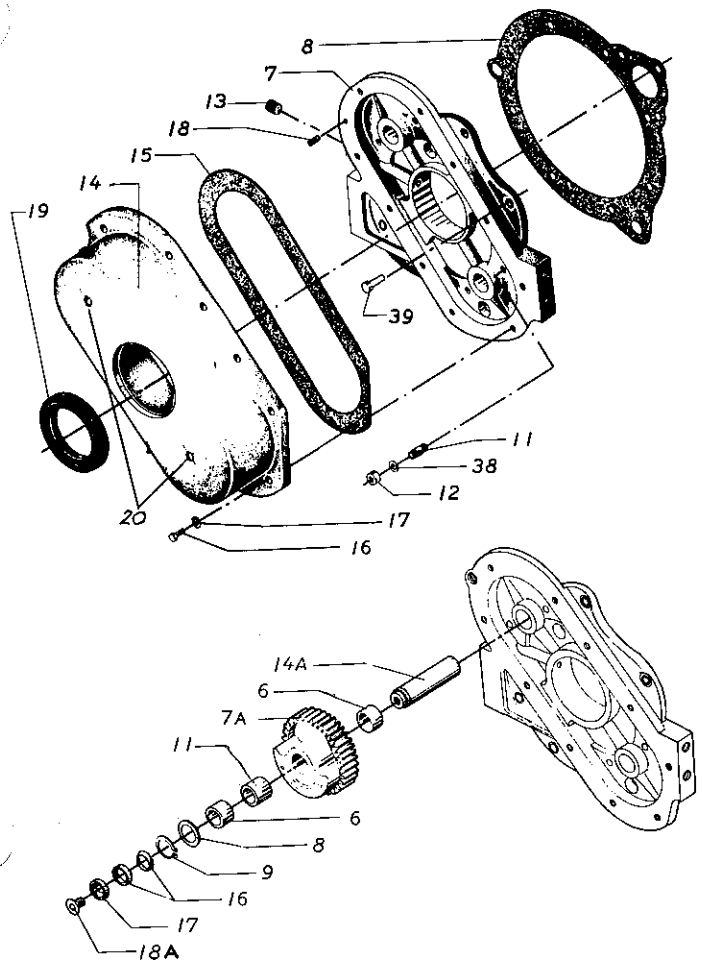
The front end plate (7) is made from cast iron and includes the front end main bearing.

Pressed into the front end plate are the shafts (14A) carrying the counter balance weights (7A). Note that the outer cover is different on the Pilot 20. It supports in holes (20), the lock screw (18) as well as collars (16) and (17). For Pilot 10 remove the outer cover (14) first to remove counter weights, then proceed at step 4 (below).

REMOVING COUNTERWEIGHTS

1. Remove fly-wheel (Section D).
2. Remove screw (18) and washer (17) in outer cover (14).
3. Remove outer cover (14).
4. Remove snap ring (9), washer (8), and then adjustment washers.
5. The counter weights can now be removed.

It is recommended that the bushing in the counter weights should not be replaced unless absolutely necessary. It is made to critical tolerances.

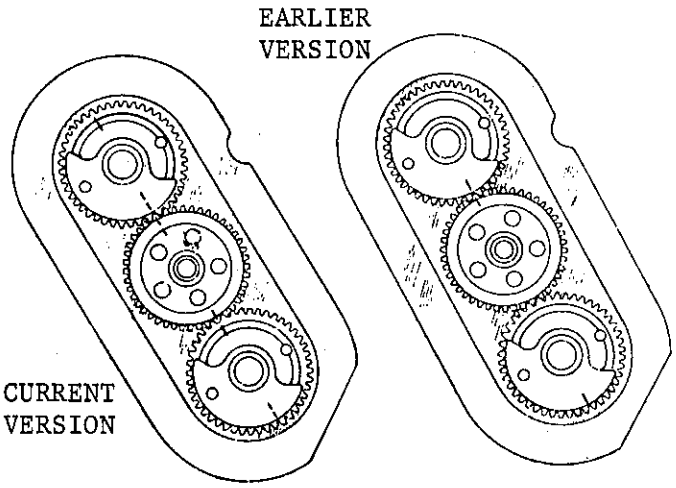


REASSEMBLING COUNTERWEIGHTS

Both versions of earlier design engines in the Pilot series had index marks on the counterweights and driving gear. These had to be properly aligned during assembly. Current design engines do not have index marks. Whether or not any index marks are found on counterweights being assembled, use the following procedure.

1. Rotate the crankshaft, bringing the piston or pistons to top dead center position.
2. Engage counterweight gears with driving gear, making sure that the center of the weighted portion is downward.

The end play on the counter weights should be from 0.1 to 0.4 mm (.004" - .016") and should be adjusted by spacer washers.



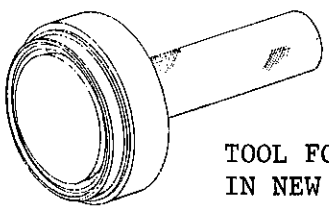
MARKS ON COUNTERWEIGHTS AND CRANK GEAR

REPLACING OIL SEAL IN OUTER COVER

If the surface of the oil seal in the outer cover exceeds 0.5 mm (.02") the oil seal has to be replaced.

1. Remove the fly-wheel (Section D).
2. Remove the outer cover and remove the damaged oil seal.
3. Press in the new oil seal with the tool shown below.

The oil seal is to be installed with the "open lip" toward the engine.



TOOL FOR PRESSING IN NEW OIL SEAL

REPLACING FRONT END COVER

1. Remove the fly-wheel (Section D).
2. Remove outer cover.
3. Remove counter weights (see preceeding page).
4. Unlock the lock plate and remove the crankshaft gear nut.
5. Remove the hand start assembly (Section 4).
6. Remove all screws on the end plate and pull plate off.

Reassembly of the front end plate is done in reverse sequence. Torque on the front end cover screws should be 2 - 2.3 kgm. (4.4 - 5.1 lbs.).

REPLACING SHAFTS FOR COUNTER WEIGHTS

New shafts having a diameter of 19.939-19.960 mm (.785" - .786") can be replaced by removing the front end plate, then the shafts can be pressed out.

When replacing the shafts, note that the oil passage has to line up with the end plate.

REPLACING FRONT END BEARING

The front end bearing, if worn or damaged, can be replaced by the following procedure:

1. Remove front end plate.
2. Now the front end main bearing can be pressed out with a suitable tool.
3. The new front end main bearing (oil slightly on the outside) may now be pressed in with a suitable tool. The outer end of the main bearing is to be in line with the machined surface of the front end plate.

The oil passage in the main bearing should be positioned to match the end plate.

HAND STARTER

Hand starter in front (flywheel side):

ENGINE	SERIAL NO.	STARTER NO.	YEAR
Pilot 10	85000 & up	4402.4.A	1973
Pilot 20	92000 & up	4402.1.D	1973

Hand starter in rear (optional):

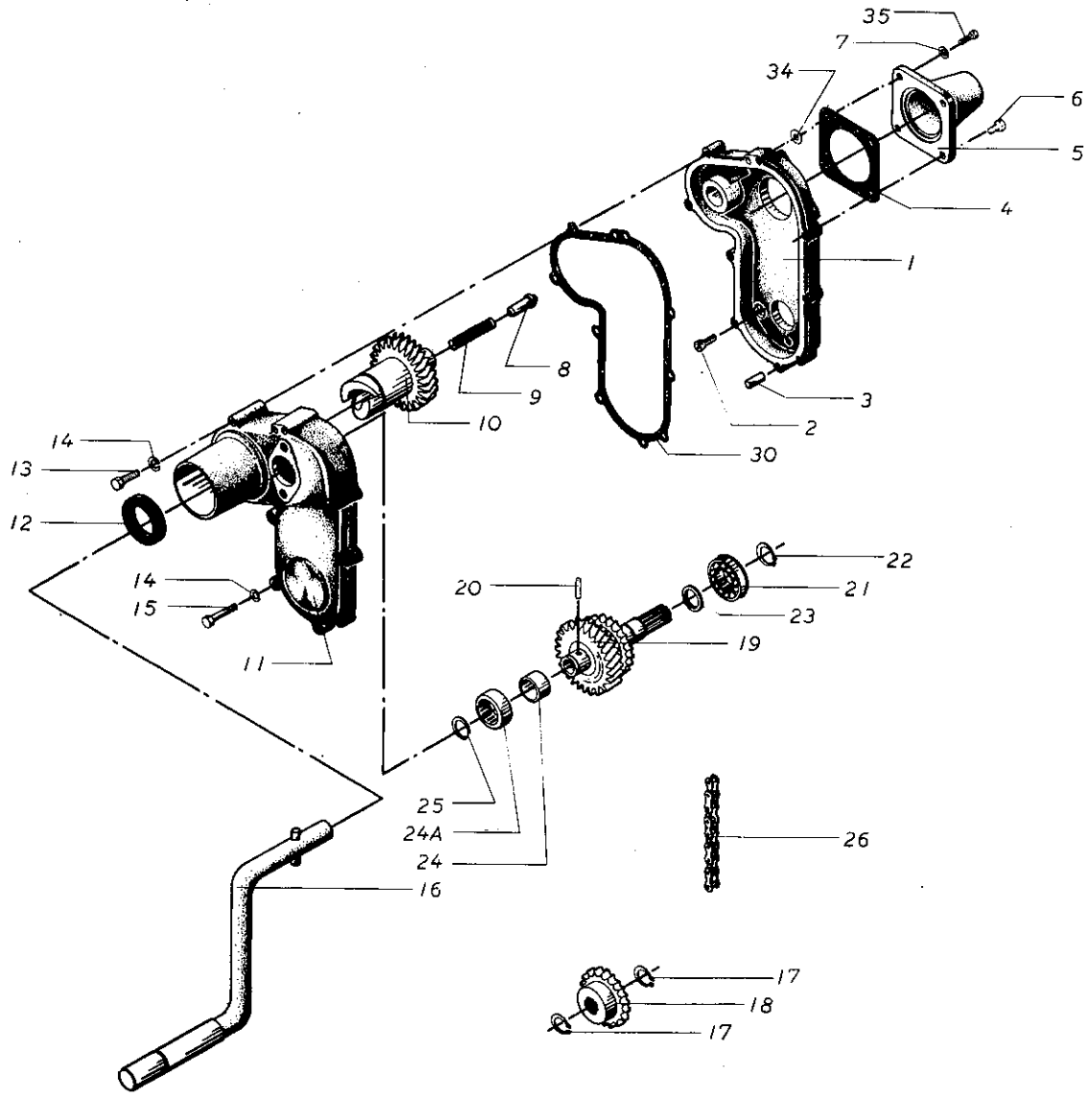
ENGINE	SERIAL NO.	STARTER NO.	YEAR
Pilot 10	85000 & up	4402.2.A	1973
Pilot 20	92000 & up	4602.2.B	1973

REMOVING HAND STARTER

1. Remove starting handle (16).
2. Remove cooling water pump as well as connections to and from the cooling water pump. Drain the water out of the engine.
3. Remove the bolts (13). The front cover of the gear case can now be removed.
4. Remove gear (10). Snap ring (25) and gear assembly (19) may be removed. The outer ring (24A) for needle bearing (24) must be pressed out if replacement is necessary.
5. Remove end cover (5).
6. Remove snap ring (22) as well as snap rings (17).
7. Using a plastic hammer knock off the chain gear (19) and bearing (21).
8. Remove chain (26).
9. If any wear can be noticed on the needle bearing inner ring, this has to be replaced.

Reassembling the hand starter is accomplished in reverse sequence.

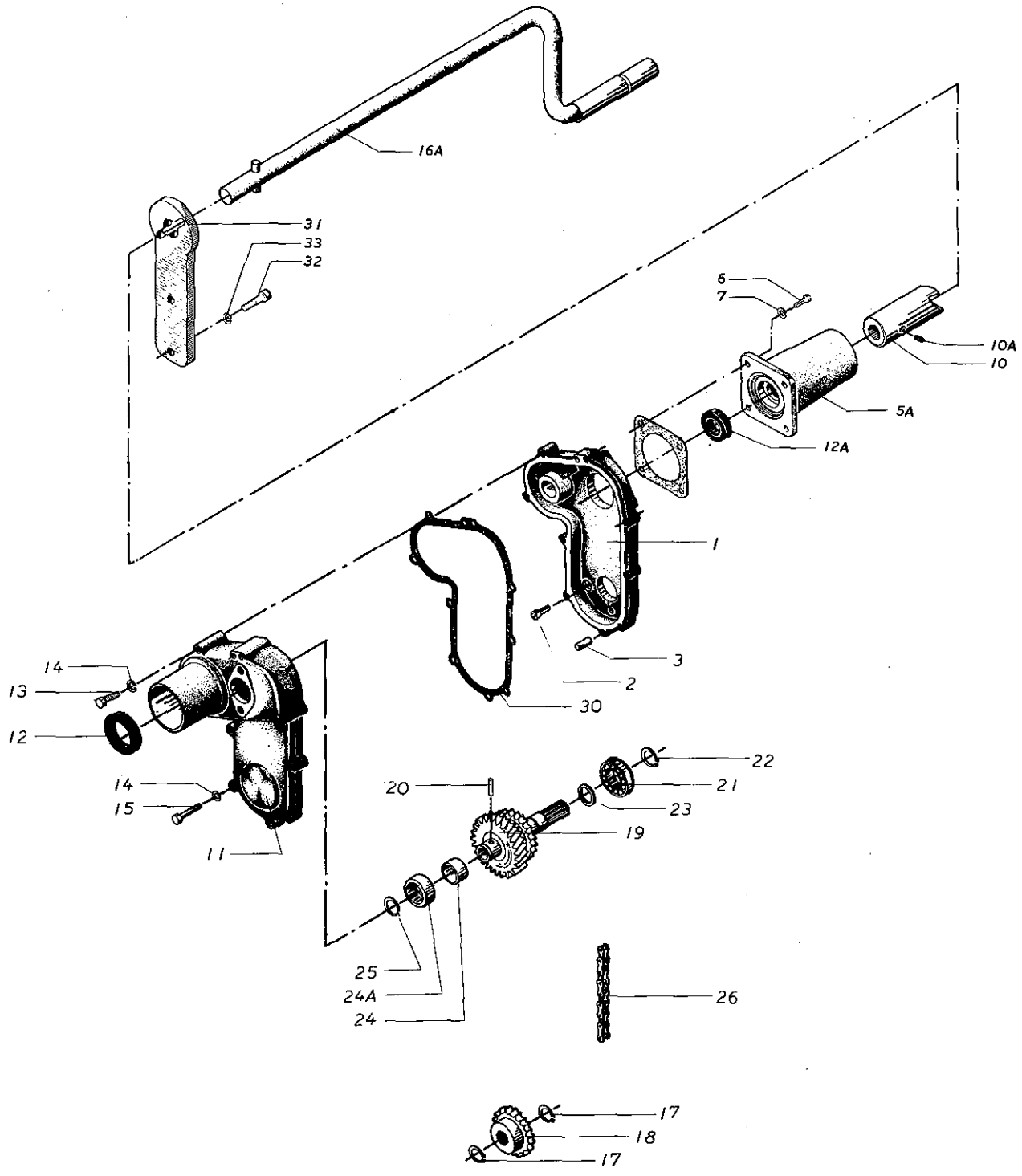
The bolts for the two halves should be tightened with a torque of 0.9 - 1.0 kgm. (7.2 lbs.)



REMOVING REAR END HAND STARTER

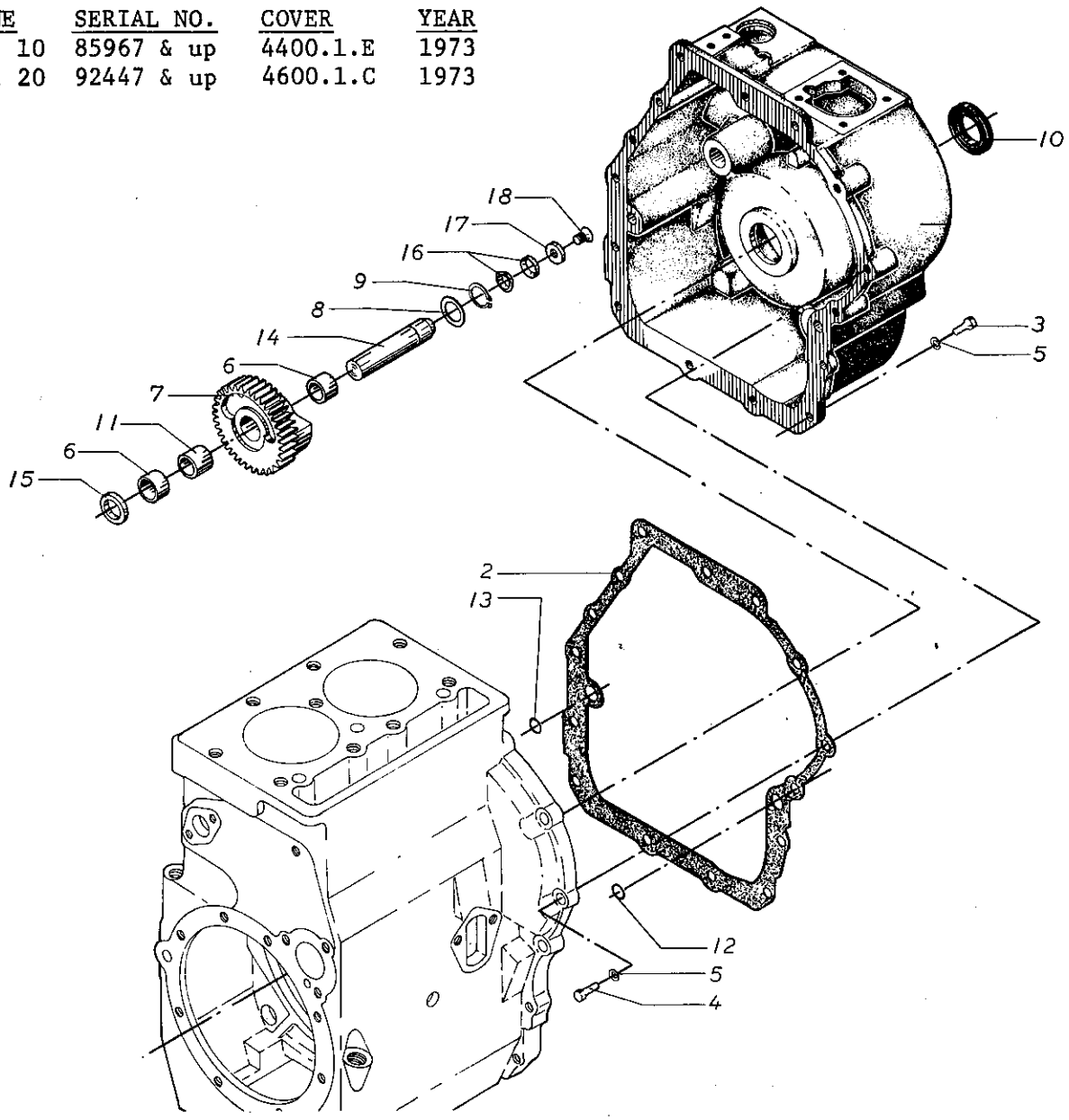
1. Remove starting handle (16A).
2. Remove cooling water pump and connections after the water has been drained from the engine.
3. Remove bolts (13) and front end cover (11).
4. Remove the snap ring (25).
5. Turn the engine until screw (10A) is visible through the hole in cover (5A).
6. Loosen screw (10A). Take out starting claw (10).

From this point proceed as indicated for front end hand starter, steps 6 through 10, preceeding page.



REAR END COVER

ENGINE	SERIAL NO.	COVER	YEAR
Pilot 10	85967 & up	4400.1.E	1973
Pilot 20	92447 & up	4600.1.C	1973



REMOVING THE COVER

1. Remove transmission (section R).
2. Remove external controls mounted on cover.
3. Remove fuel pipe from fuel lift pump to injection pump. Remove fuel pressure pipe.
4. Remove the two plugs (not shown) in end of cover.
5. Remove bolts (18) and washers (16 & 17).
6. Remove lubrication pump (section N).
7. Remove bolts (3 & 4). End cover can now be removed.

Reassembly is accomplished in reverse sequence. Add Lock-Tite to plugs before replacing in cover and fit new gasket (2).

REMOVING COUNTERWEIGHTS

1. Remove rear end cover.
2. Remove snap ring (9) and support washer (6) on shaft for counter weights.
3. Remove washer (8) and adjusting shims

REASSEMBLING

Reassembly is accomplished in reverse sequence. However, make sure that the timing of the gears are made in accordance with instruction given under section E.

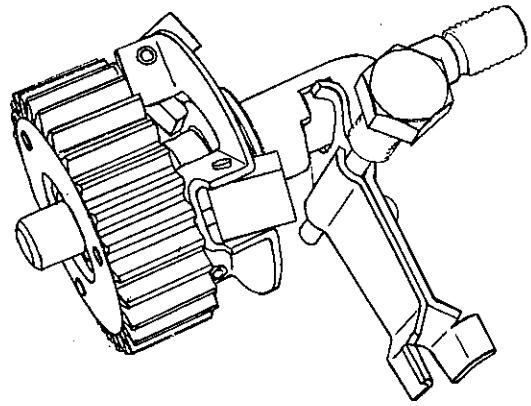
End play should be adjusted with shims to obtain a clearance of 0.1 - 0.4 mm (.004" - .015").

THE GOVERNOR SYSTEM

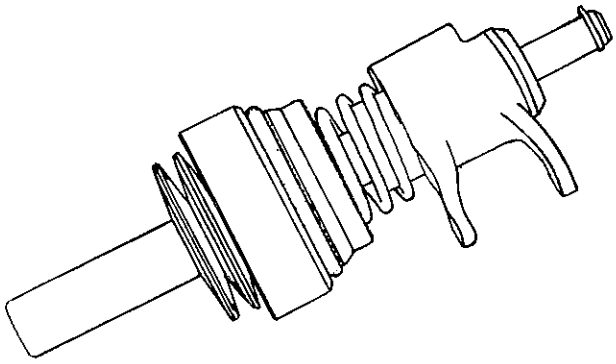
ENGINE	SERIAL NO.	GOVERNOR	YEAR
Pilot 10	85967 & up	4400.1.E	1973
Pilot 20	92447 & up	4600.1.C	1973

The governor system comprises:

1. The centrifugal governor which will keep the rpm of the engine at a constant speed despite the changes in load.
2. The manual governor which will set the engine speed at the desired rpm.



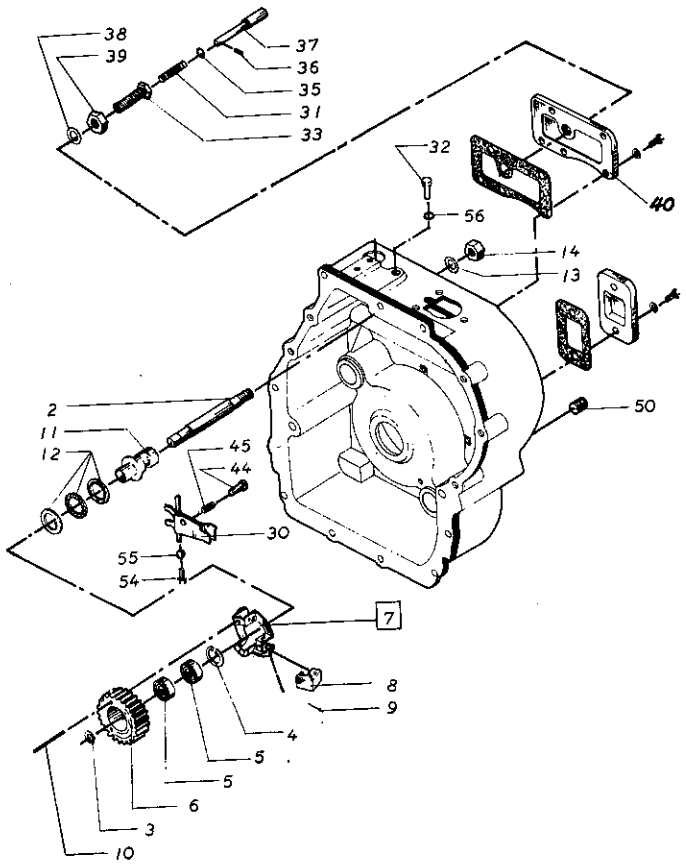
CENTRIFUGAL GOVERNOR



MANUAL GOVERNOR

REMOVING THE CENTRIFUGAL GOVERNOR
(See diagram - next column.)

1. Remove rear end cover assembly (previous page).
2. Remove end cover (40).
3. Remove snap-ring (3) the gear (6). The governor (7) may be pulled off.
4. Remove snap-ring (4). Now bearings (5) may be pressed out of the gear.
5. Remove screw (32) and take out spring (45).
6. Lift the governor arm (30), allowing the shaft to disengage, then pull out governor arm.
7. Remove sleeve (11) together with bearing (12).
8. The governor shaft (2) may be taken out after removal of locknut and washer (13), (14).

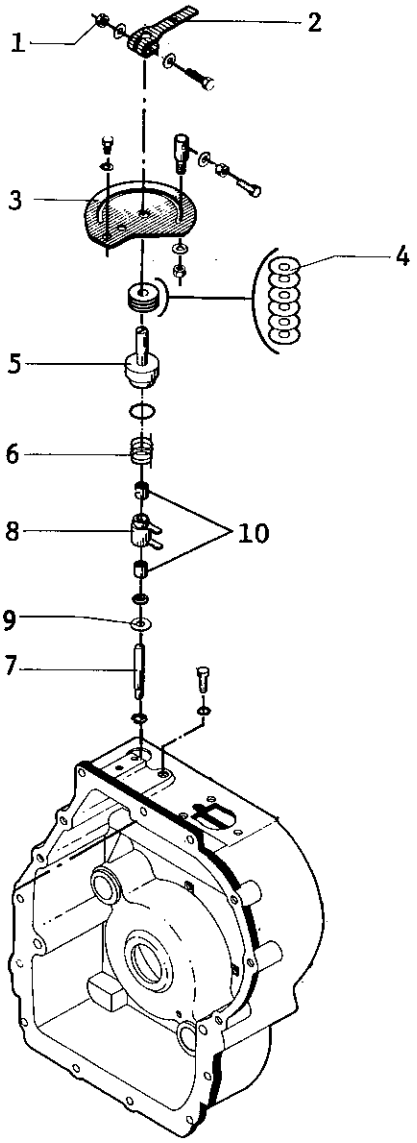


REASSEMBLING THE CENTRIFUGAL GOVERNOR

1. Place the governor shaft (2) in its position in the rear end cover and tighten nut (14) with a torque of 5-5.5 kgm. (32-40 lbs).
2. Assemble (12) to sleeve (11). Now mount the assembly on the governor shaft.
3. Reassemble governor arm (30) by first placing the top part of the shaft in the cover, then putting the shaft's lower part in position. The governor arm's two legs will now engage sleeve (11) as shown in illustration at left. Now mount spring (45) between the governor arm and the bolt. This bolt to be reinserted in the end cover through the hole covered by plate (40). Tighten screw (32) in the end cover.
4. Reassemble bearings (5) into the gear and install snap-ring (4).
5. Reassemble gear (6) on its shaft and install snap-ring (3). The arm for the centrifugal weights should touch the bearing as shown in illustration at left.
6. Reassemble end cover (40).

REMOVING THE MANUAL GOVERNOR

1. Remove end cover assembly.
2. Loosen nut (1) and pull off governor arm (2).
3. Remove rod screws (3) so the segment, the teller springs (4) and shaft (5) can be removed.
4. Remove spring (6).
5. Pull up shaft (7). Then remove the governor arm (8) and the thrust washer (9).
6. Needle bearing (10) should now be pressed out of the governor arm.



REASSEMBLING THE MANUAL GOVERNOR

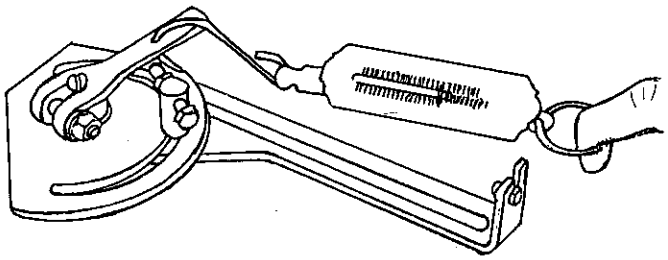
1. Reassemble the two needle bearings (10) into the governor arm (8). Make sure that the bearings are in line.
2. Mount governor arm and thrust washer (9) in position. The broken surface should be toward the governor arm. The two legs on the governor arm should be mounted against the sleeve of the centrifugal governor.
3. Assemble the shaft (7) through the governor arm. Move the assembly and thrust washer (9) into position in the end cover.
4. Reassemble the governor spring (6). Make sure the spring is in its position in the hole in the governor arm. The governor spring can be supplied in 3 different versions, depending on desired maximum rpm.

HEIGHT	DESIRED MAXIMUM
2.0 mm (.078")	1500 rpm
2.2 mm (.087")	1800 rpm
2.4 mm (.094")	2500-3000 rpm

5. When reassembling the shaft, make sure that the spring is engaging the hole in the bottom of the shaft.
6. Reassemble the teller springs (4).
7. Reassemble the governor segment and tighten the screws with a torque of 2-2.3 kgm (14.5-16.6 lbs.)
8. Reassemble the governor arm and tighten the nut with a torque of 0.9-1.0 kgm (7.23 lbs.).

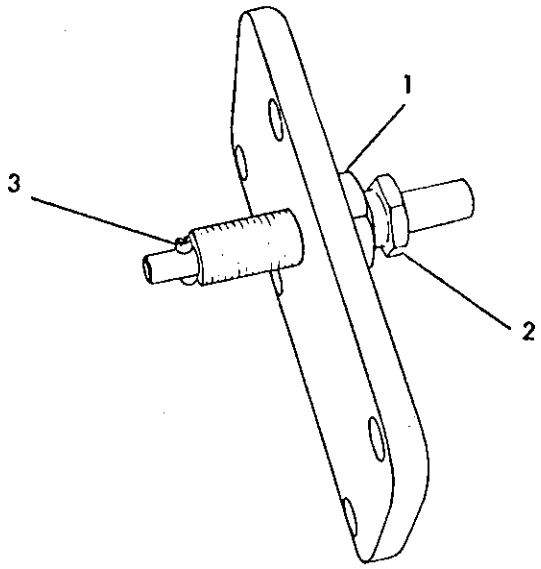
GOVERNOR ARM ADJUSTMENT
(next page)

ADJUSTMENT OF GOVERNOR ARM



1. The tightness of the governor arm may be adjusted by changing the number of teller springs (4).
   It is important that the tightness of the arm is adjusted to suit remote or direct operation.
   If remote controls are used set the adjustment to 4.5 kg (9.9 lbs.). This overcomes friction in the cables as well as the remote control box. For direct operation, set adjustment with a torque of 6 kg. (13 lbs.).
2. Start the engine and adjust the idling regulating screw to obtain an idling speed of 800-900 rpm. Make sure the governor arm is touching the adjusting screw. Tighten the nut with a torque of 0.9-1.0 kgm. (2-2.2 lbs.).
3. Turn the governor arm clock-wise and adjust the full speed screw until the engine runs 3150 rpm unloaded.

DISASSEMBLING/ADJUSTMENT OF STOP ROD



DISASSEMBLING

1. Slacken lock nut (1).
2. Unscrew Adjusting Nut (2) and remove from the end cover.
3. Remove lock pin (3). The stop rod and the spring can now be removed.

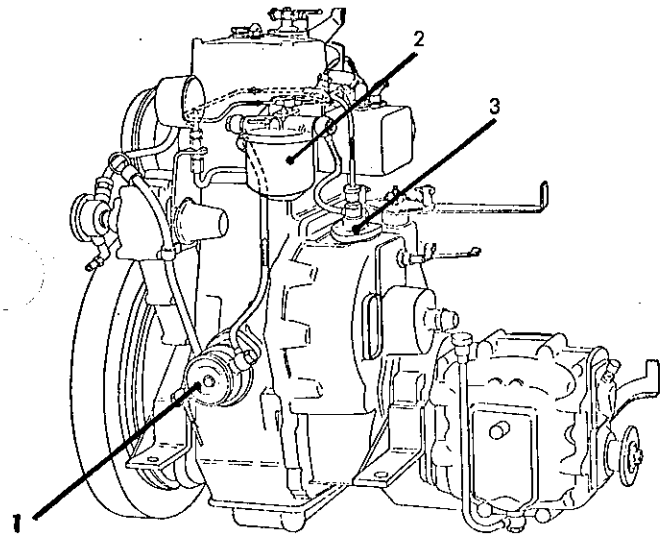
ADJUSTMENT FOR MAXIMUM FUEL SETTING

1. Start the engine and run up to 3150 rpm - unloaded.
   This adjustment is made by setting the governor arm full speed screw (step 10 - 1st column).
2. Slacken the lock nut (1).
   For increased fuel delivery turn adjustment nut (2) counter - clock-wise. For less delivery, turn (2) clock-wise.
   If the engine is not removed from the boat (for adjustment on a test bench) maximum fuel delivery should be adjusted to control smoke level with engine under load.
3. Tighten lock nut.

FUEL SYSTEM

The fuel recommended for use in both Slot series engines is #2 Diesel, similar in quality to BS-2869, Class A. During operation, the fuel flows from the tank, through fuel lift pump (1), through filter element (2) to the fuel injection pump (3). This pump will inject the fuel through the high pressure pipe at 150 kg/cm^2 (2133 psi) and into each cylinder through the nozzle holder assembly.

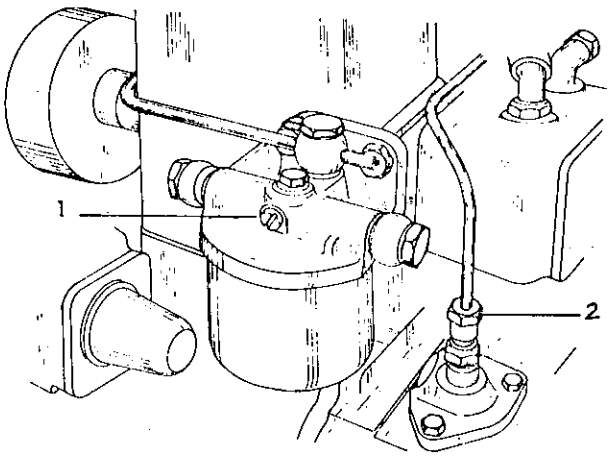
It is possible to feed the fuel mechanically to the fuel injection pump by means of a hand operated lever mounted on the lift pump (1). The main purpose of the hand priming lever is to bleed the low pressure circuit of the fuel system.

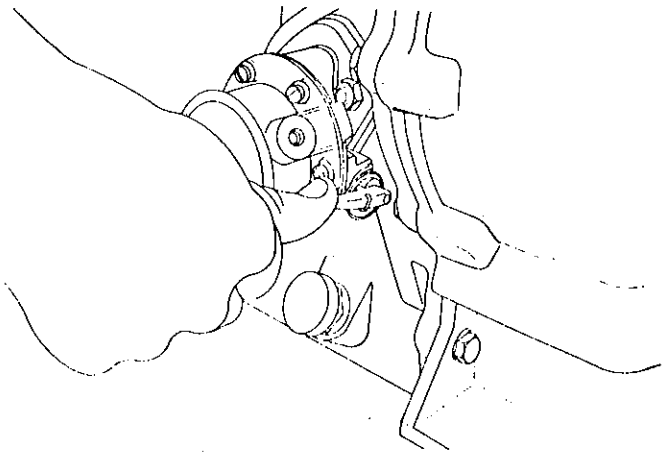


BLEEDING THE FUEL SYSTEM

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

1. Slack bleeding screw (1) on the fuel filter assembly.
2. With the hand lever on the fuel lift pump (bottom illustration), pump the fuel until a continuous stream, without air, is obtained. Tighten screw (1).
3. Slack the nut (2) holding the high pressure pipe to the nozzle holder assembly. Turn the engine by the hand crank or by the dyna start until a continuous stream of fuel, without air, is obtained. Retighten the nut.





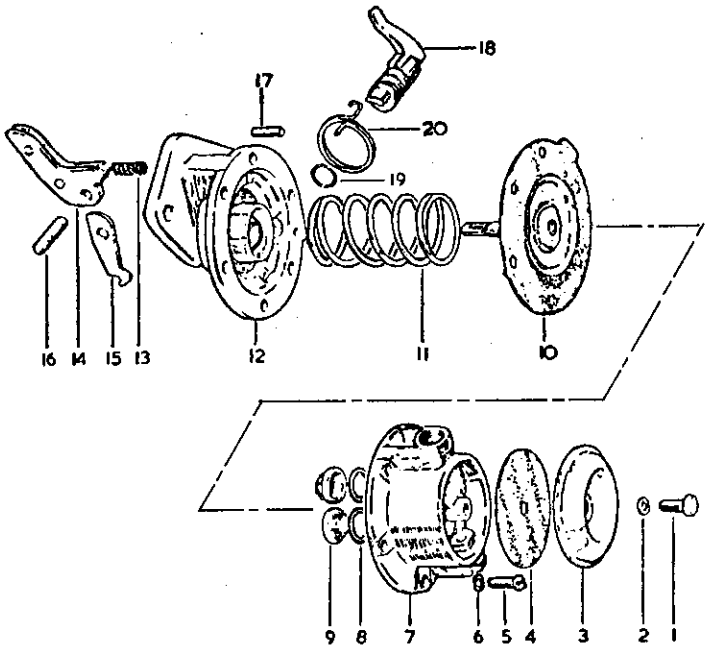
FUEL LIFT PUMP

ENGINE	SERIAL NO.	PUMP NO.	YEAR
Pilot 10	85000 & up	4400.1.E	1973
Pilot 20	92000 & up	4600.1.C	1973

The fuel lift pump is a diaphragm type, specification No. AC-Delco 7971291, activated by the engine cam shaft.

DISASSEMBLING THE FUEL LIFT PUMP

1. Disconnect fuel lines, both sides.
2. Remove screw (1).
3. Remove screws (5) and pump cover (7).
4. Remove valves (9) by removing the 3 fins.
5. Remove spring (20). Pull out pin (17). Remove hand lever (18).
6. Press out pin (16). Pump arm (14), with connecter (15) may be removed.
7. Diaphragm (10) and spring (11) can now be removed.



Reassembling is accomplished in reverse sequence. Notice that, when reassembling the valves, one valve must be turned with the flat side against the mark N. The other valve should be reassembled in the opposite direction.

ENGINE	SERIAL NO.	FILTER NO.	YEAR
Pilot 10	85000 & up	4400.1.E	1973
Pilot 20	92000 & up	4600.1.C	1973

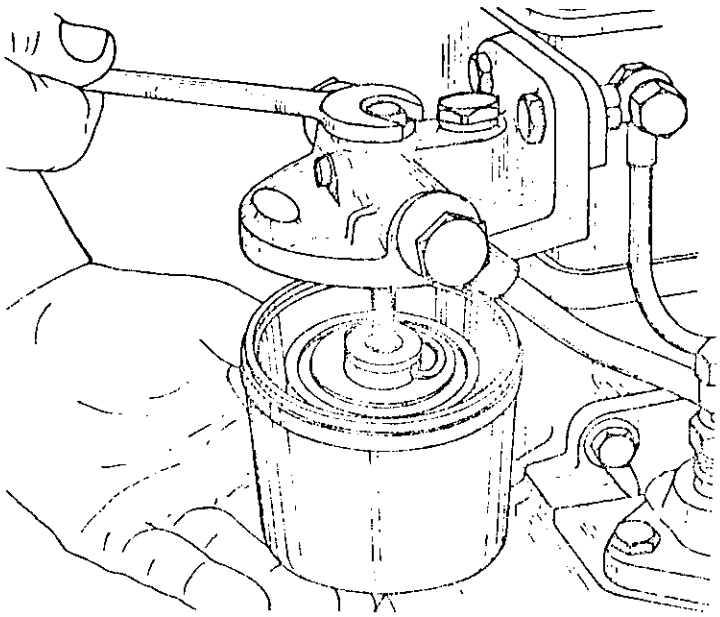
The purpose of the fuel filter is to clean out dirt and particles before the fuel is transferred to the fuel injection system.

It is most important that the fuel is cleaned properly otherwise severe damage can be done to both the fuel injection pump and the nozzle. It is also recommended that a water separating filter be installed between fuel supply and fuel lift pump.

REMOVING THE FILTER

1. Remove the center bolt (see below) by turning counterclockwise.
2. Remove filter element and replace with a new element.
3. Cleaning the used filter element and reusing is not recommended, except as an emergency measure when a replacement filter is not available, in which case the filter assembly should be thoroughly cleaned with gasoline.

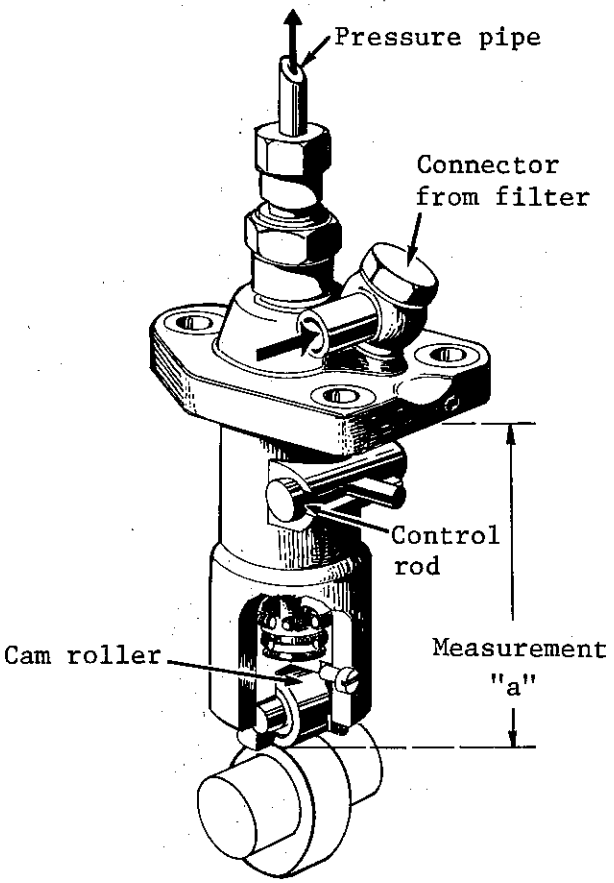
It is necessary to bleed the system after replacing the filter element.



FUEL INJECTION PUMP

ENGINE	SERIAL NO.	PUMP NO.	YEAR
Pilot 10*	85000 & up	4400.1.E	1973
Pilot 20	92000 & up	4600.1.C	1973

* Pump type is BOSCH PFR 1 K 70/8.



Note:
The fuel injection pump is a single activated piston pump driven from the cam shaft.
If any service is needed on the fuel injection pump itself, please call on an authorized workshop capable of making necessary tests and repairs.

TEST PLAN FOR FUEL SETTING

The fuel setting code is given in cm^3 (cu. in.) pr. 100 strokes. To measure correct delivery it is recommended to use BOSCH tool EFEP 255. This tool is a mm scale to be mounted at the end of the control rod.

The delivery indicated is for Pilot 10. For Pilot 20, multiply by 2.

RPM (test bench)	SCALE on tool EFEP 255	DELIVERY per 100 strokes cm^3	cu. in.
1000	6	1.0 - 2.2	.006-.134
1000	12	5.4 - 6.8	.33 -.415
1000	18	8.8 -10.6	.537-.647
200	9	2.0 - 3.4	.122-.207

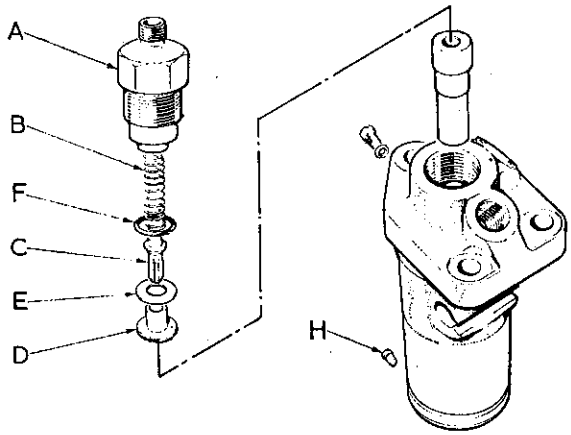
ADJUSTMENT OF SPILL POINT

The fuel injection pump is adjusted by the factory, and normally no adjustment of the timing should be necessary. If any adjustments are made, please bear in mind that if the timing is set ahead of the specification given, the compression pressure will increase. The result is increased load on all bearings, as well as increased noise level.

Late timing of the injection pump results in a difficult start, increased exhaust temperature, as well as reduced economy and horsepower.

Setting of the timing is done as follows:

1. Remove the valve cover. Remove one valve spring after making sure that the piston is in top dead center and on the compression stroke. The valve will then slip down on the piston top when the spring is removed.
2. Remove the pressure pipe.



3. Remove the top nipple (A) on the fuel injection pump. Then remove the delivery valve spring (B) & delivery valve (C).
4. Reassemble the top nipple (1) without valve needle and spring.
5. Mount the pressure pipe on nipple so that the free end of the pressure pipe is visible (nut recessed).
6. Mount a dial indicator at the top of the valve stem.
7. Adjust the dial indicator to zero with the piston in absolute top dead center.
8. Set governor arm at full speed position.
9. Set pressure on the fuel injection pump by using the lever on the fuel lift pump.
10. By moving the flywheel counter-clockwise, the correct setting of the spill point will occur when the dial indicator shows a drop of 1.85 mm (.073") and when drops of fuel appear at the free end of the pressure pipe. When

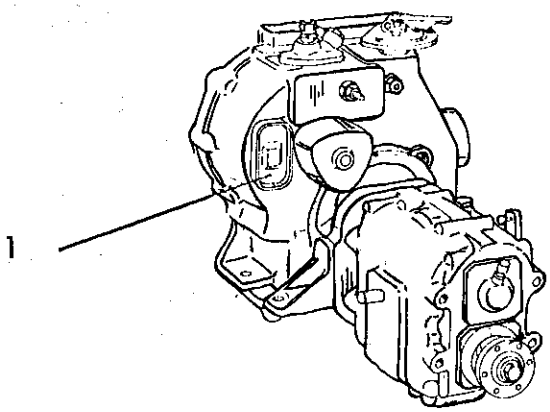
ADJUSTMENT OF SPILL POINT (cont.)

turning the flywheel further these drops of fuel should increase. Continue turning clockwise. When the indicator again shows 1.85 mm (.073") the stream of fuel should stop immediately.

11. If the spill point is not adjusted precisely, special washers have to be mounted between the flange of the fuel injection pump and the rear end cover housing.
12. After the spill point has been checked thoroughly, remove the pressure pipe and nipple (A). Reassemble the delivery valve and delivery spring. Then reassemble the pressure pipe and nipple.

Note:
For Pilot 10 with serial number lower than 85889 and Pilot 20 with serial number lower than 92420, the spill point is to be adjusted as follows:

1. Follow step 1 thru 10 (starting preceeding page).
2. Remove cover (1) at rear of the end cover.
3. With a special "T" wrench, the cam is to be adjusted to the same specifications as in step 10.



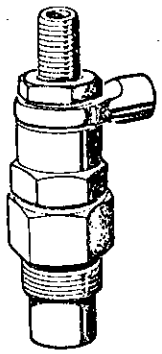
NOZZLE HOLDER ASSEMBLY

ENGINE	SERIAL NO.	HOLDER NO.	YEAR
Pilot 10	85000 & up	4400.1.E	1973
Pilot 20	92000 & up	4600.1.C	1973

The nozzle holder assembly consists of:

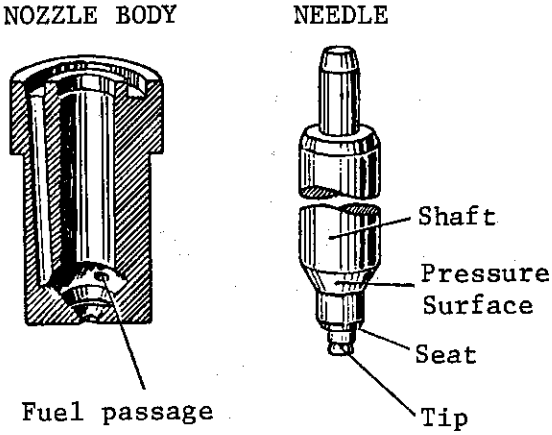
Nozzle holder	Nozzle
Bosch type	Bosch type
55 SD 20/4	DNO SD 2110

Nozzle opening pressure is 150 +/- 10 kg/cm^2 (2133 +/- 142 psi)

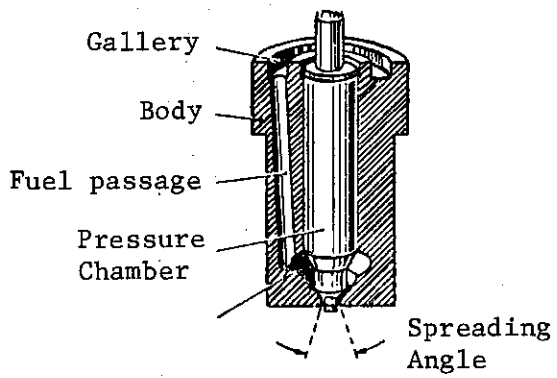


IMPORTANT

All work carried out on fuel injection equipment should be done carefully, because any foreign matter or water entering the system will cause serious damage!



COMPLETE ASSEMBLY



DISASSEMBLING HOLDER ASSEMBLY

(See diagram - opposite page.)

1. Remove high pressure pipe and return fuel nipple.
2. Remove the nozzle holder from precombustion chamber.
3. Remove the body (1).
4. Remove adjusting washers (6), guide (5), spring (3), and spindle (2).
5. Remove the spacer (26) and the fuel injection nozzle (27).

Reassembling is accomplished in reverse sequence. Also refer to page H5 for details on pressure setting.

IMPORTANT

It is vital to the proper functioning of the nozzle holder that the surface on body (1) and the spacer (26) is completely free of scratches or abrasions.

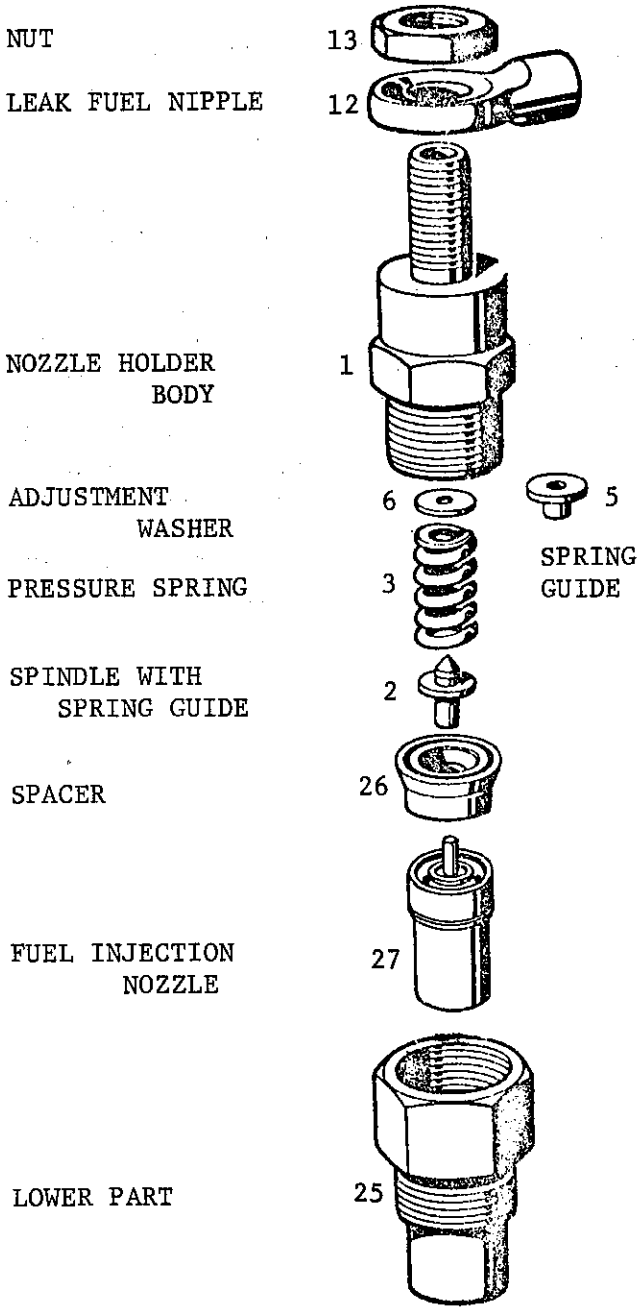
If any leakage can be observed when teasting the nozzle holder, the surfaces can be improved by lapping body (1) and spacer (26) against an absolutely flat ground, cast iron surface, using grinding compound.

ADJUSTMENT OF OPENING PRESSURE

If the opening pressure shows need for adjustment, proceed as follows:

1. Remove holder body (1).
2. Add or remove adjustment washers to obtain an opening pressure of 150 +/- 10 kg/cm^2 (2133 +/- 142 psi).

In addition to the one main washer, there are one or more adjustment shims, about 0.1 mm (.004") thick, each of which will vary the opening pressure about 10 atmospheres (147 psi). Other adjustment washers (shims) are obtainable in thicknesses of 0.2, 0.5 and 1.0 mm (.008, .02 and .09").



CLEANING THE NOZZLE

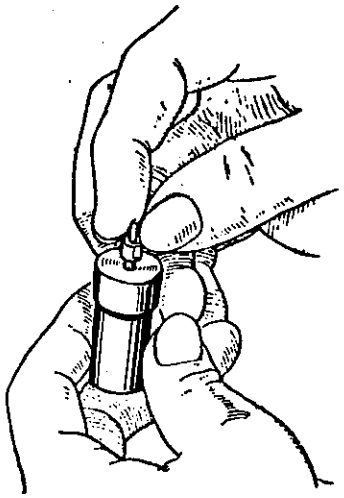
When replacing a worn out nozzle, the new nozzle has to be absolutely clean and free of preservative oil which has been added by the manufacturer. New nozzles, as well as reconditioned nozzles, should be cleaned out in gasoline. For cleaning a used nozzle, use Tool Set EF 8486 B. After cleaning, dip the nozzle needle in diesel fuel before assembling.

The nozzle and needle are supplied in matched sets. Never interchange needles, and nozzles during assembly or overhaul.

INSPECTING THE NOZZLE

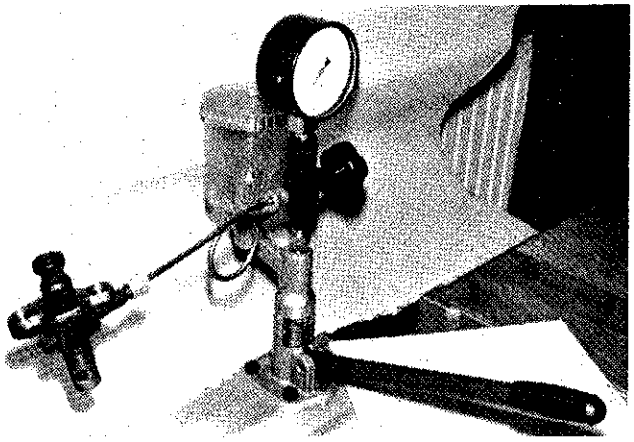
Look for the following in used nozzles:
Broken or damaged needle tip.
Scored seats, or deep scratches on sides of needle surface.
Look inside the nozzle body, using a magnifying glass or recommended Bosch Tool-EFAW 25 B. Inspect the seat for scoring and for carbon which has to be removed.

MAKING THE GLIDE TEST



After examining the external appearance of the nozzle, the following test should be carried out:
The needle should be dipped in diesel fuel and lightly inserted in the nozzle body. As soon as the needle has entered its bore it should drop into its seat easily, without any resistance.
The final test for making sure that the needle is functioning properly is to pull the needle up one third of its total length then release it. The needle should drop onto the seat in the body by its own weight.

SETTING THE NOZZLE



With the nozzle setting equipment (as shown above) it is possible to test:

a) Opening pressure
b) Tightness against leaks
c) Nozzle popping and spray pattern

Use Shell Clavus Oil 17 plus 50% clear petroleum or clean diesel fuel as testing oil.

After reassembly of the nozzle holder assembly it is of great importance that the correct torque is used.

For the nozzle holder assembly of Pilot series engines the correct torque is 6 to 8 kpm. (43.4 to 57.9 ft. lbs.)

After the nozzle holder assembly is re-assembled with the correct torque, connect the nozzle holder to the fuel pressure pipe of the nozzle setting equipment.

In order to clean out and activate the nozzle, turn off the gauge (it can otherwise be damaged). Pump the testing oil several times using a speed of approximately 6-8 strokes/second to examine the needle's free movement in its body. If the needle is moving and not bent a sharp popping should be heard.

OPENING PRESSURE - The opening pressure for the Pilot series engines is 150 +/- 10 kg/cm^2 (2133 +/- 142 psi).

To determine that opening pressure meets specifications:

1. Turn on indicating gauge.
2. Press pump handle down slowly until the nozzle is popping.
3. Reading the pressure gage should show proper figure.

TIGHTNESS - Press the pump arm until the indicator shows approximately 20 atmospheres (294 psi) under the prescribed opening pressure.

The nozzle is tight if no drips can be seen.

SNARL AND SHOOT - Before this test is made the gauge has to be turned off.

The type of nozzle used in the Pilot Series engines is Bosch DN 0 SD 2110 a so-called drossel nozzle. This nozzle will pop as soon as pressure is applied. The fastest testing speed on the pump handle is 1 stroke/second. It is not important if - at certain times - no pop is heard.

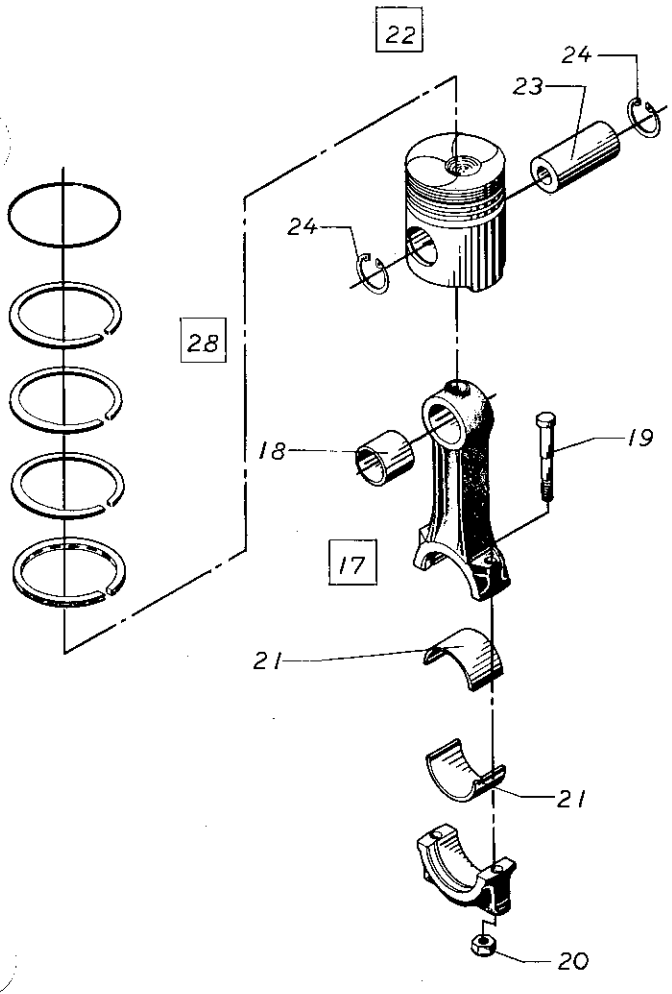
The main characteristic to be observed is spraying angle. To be correct, oil should be ejected at equal angles to the axis of the nozzle and the spray pattern should be consistently the same every time the pump handle of the nozzle testing equipment is activated.

PISTONS, CONNECTING ROD & CYLINDER LINERS

ENGINE	SERIAL NO.	PISTON/ROD	YEAR
Pilot 10	85000 & up	4400.1.E	1973
Pilot 20	92000 & up	4600.1.C	1973

REMOVING PISTONS AND CONNECTING RODS

1. Completely drain the cooling water and lubricating oil.
2. Remove cylinder head (section C).
3. Remove carbon ridge from top edge of cylinder liner.
4. Turn the engine upside down.
5. Remove oil sump.
6. Remove connecting rod bolts and rod cap.
7. Protect the crankshaft bearing surface by mounting a plastic hose or other protection on the connecting rod bolts.
8. Turn engine to top dead center. Piston and connecting rod may now be removed from the cylinder liner.



NOTE:
Future production of Pilot series engines will have two balls placed between the connecting rod and cap in order to align the bearing halves. The present connecting rod bolt will then be replaced by a standard cylindrical bolt.
Upon removal of the connecting rods on future engines, please observe the alignment balls.
When reassembling the cap to the connecting rod it is important that the balls are in the right position. Then tighten the bolts with a torque of 5 kgm. (36.2 lbs.).

REASSEMBLING PISTON AND CONNECTING ROD

1. An alignment cone is placed on the top of the cylinder sleeve.
2. Set the crankshaft in top dead center position.
3. Cover the connecting rod bolts by means of a plastic hood or similar protection.
4. The piston, with connecting rod, is dropped into the cone and cylinder sleeve. Make sure that the machined area of the piston is turned towards the nozzle holder and pre-combustion chamber.
   NOTE: Stagger the piston ring caps every 90° before installing.
5. Turn the engine upside down.
6. Remove the protection from the connecting rod bolts.
7. Reassemble the connecting rod cap and bottom-half of the bearing shell. The connecting rod bolts should be tightened with a torque of 5 kgm. (36.2 lbs.). Please note that the nuts for the connecting rod bolts have nylon locks. These nuts have to be replaced by new nuts. Each time this type of nut is unscrewed its locking efficiency is destroyed.

Be sure that the identification numbers on the connecting rod and the connecting rod cap are on the same side.

CONNECTING ROD BEARING

The connecting rod bearing consists of one top half and one bottom half bearing shell. It has to be replaced if any scratches can be observed or if the bearing surface has been worn through.

If it should be necessary to grind the crank shaft, the following under-size bearing shells can be obtained: 0.3 and 0.6 mm (.012" and .024"). See section L.

REPLACEMENT OF PISTON RINGS

The ring gap in a new engine is 0.3-0.45 mm (.012"-.018"). If the gap exceeds 2 mm (.079") the piston rings have to be replaced.

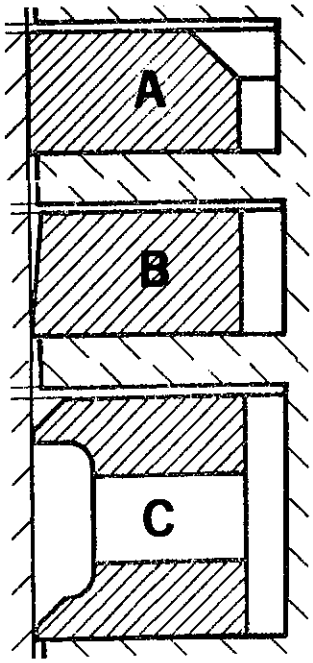
Proceed as follows:

1. Remove the piston, preceeding page.
2. Remove the piston rings, preferably using special pliers designed for such work.
3. Fit the rings to the piston in correct order. The rings should be arranged so that the gaps are equally spaced every 90° around the piston and not in line with one another.
4. When fitting new rings to a used piston, clean out the piston ring grooves. The piston should be carefully examined for bruising of the ring grooves and to insure that the rings move smoothly in their grooves. In addition the piston skirt should be examined and if there is any scoring the piston must not be used again.

NOTE: If there are carbon ridges on the top of the cylinder bore they should be removed with a scraper before the piston and connecting rod are removed. When fitting new rings to a used cylinder liner the ring gap should be checked at the bottom of the cylinder bore.

The Pilot series engines have 4 piston rings, 3 compression rings, and 1 oil scraper ring. The two top piston rings are of the type as shown at (A) below. The third compression ring is as shown at (B) and the oil scraper ring at (C).

PISTON RING DETAIL



RING O.D.

85mm (3.35")

RING I.D.

77.6mm (3.05")

RING THICKNESS

A- 2.5mm (.098")

B- 2.5mm (.098")

C- 5.0mm (.197")

REPLACEMENT OF PISTONS

If it is necessary to replace the piston proceed as follows:

1. Remove piston and connecting rod, preceeding page.
2. Remove the circlip on one side.
3. Knock out the piston pin by means of a brass rod, using a plastic hammer.
4. Assemble the connecting rod to the piston and insert the piston pin. To make this job easier, warm the piston itself in water to a temperature of approx. 100° C. (212° F). The piston pin can then easily be pushed into position.
5. Reinstall the circlip.

NOTE: The piston must be reassembled in the correct position. The small end bushing should not be removed unless absolutely necessary, as it has been precisely matched to the assembly at the factory.

CYLINDER LINER

ENGINE	SERIAL NO.	LINER	YEAR
Pilot 10	85000 & up	4400.1.E	1973
Pilot 20	92000 & up	4600.1.C	1973

The cylinder liner in Pilot series engines has a bore diameter of 85.000 - 85.020 mm (3.346" - 3.347"). It should be replaced if wear at any point on the bore surface exceeds 0.3 mm (.012"). The liner should be inspected carefully at different elevations and at various points around the bore surface, using inside micrometers, to determine that wear does not exceed the above limits.

REMOVING THE CYLINDER LINER

1. Remove cylinder head (section C).
2. Disconnect connecting rod and remove piston, preceeding page.
3. Remove the liner using a suitable liner removing tool or turn the engine upside down and knock out the cylinder liner by using a piece of wood and a hammer.

FITTING A NEW LINER

Between the cylinder liner and the engine block there is no gasket. The surface has to be absolutely clean and without any scratches.

Fit the rubber sealing rings in the grooves provided. New rings must always be used after a liner is removed. Place the liner in position and press home ensuring that the rubber rings remain in their grooves. Pressing-home can be done by tapping in, using a piece of wood and a hammer. After the new liner has been fitted check the distance of the liner above the engine block. This distance has to be 0.10 - 0.20 mm (.004" - .008").

CRANKSHAFT and BEARINGS

ENGINE	SERIAL NO.	CRANKSHAFT	YEAR
Pilot 10	85000 & up	4400.1.E	1973
Pilot 20	92000 & up	4600.1.C	1973

The crank shaft is made out of heat treated, drop forged steel, and it is possible to re-grind the crank shaft to undersize dimensions without any additional heat treating.

The crank shaft has to be re-ground if scored or out-of-round or by more than 0.05 mm (.002").

The allowable end play of the crankshaft is as follows:

Pilot 10 0.18 - 0.43 mm (.007" - .017")
Pilot 20 0.25 - 0.40 mm (.010" - .016")

CRANKSHAFT MEASUREMENTS

Front main bearing journal

Standard size:
64.987 - 65.000 mm (2.5585"- 2.5590")
0.3mm (.012") undersize:
64.687 - 64.700 mm (2.5467" - 2.5472")
0.6 mm (.024") undersize:
64.387 - 64.400 mm (2.5349" - 2.5354")
Play between front end and main bearing:
0.032 - 0.089 mm (.0012" - .0035")

Rear main bearing journal

Standard size:
55.987 - 56.000 mm (2.2042" - 2.2047")
0.3 mm (.012") undersize:
55.687 - 55.700 mm (2.1924" - 2.1929")
0.6 mm (.024") undersize:
55.387 - 55.400 mm (2.1806" - 2.1811")
Play between main and main bearing:
0.029 - 0.086 mm (.0011" - .0033")

Intermediate bearing journal (Pilot 20 only)

Standard size:
55.987 - 56.000 mm (2.2042" - 2.2047")
0.3 mm (.012") undersize:
55.687 - 55.700 mm (2.1924" - 2.1929")
0.6 mm (.024") undersize:
55.387 - 55.400 mm (2.1806" - 2.1811")

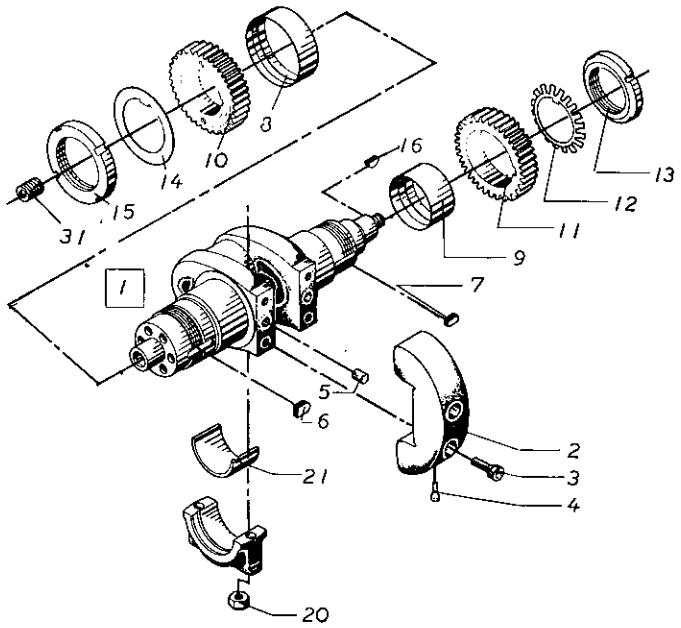
Connecting rod

Standard size:
53.987 - 54.000 mm (2.1255" - 2.1260")
0.3 mm (.012") undersize:
53.687 - 53.700 mm (2.1137" - 2.1142")
0.6 mm (.024") undersize:
53.387 - 53.400 mm (2.1018" - 2.1024")
Play between connecting rod and rod bearing:
0.028 - 0.068 mm (.0011" - .0027")

REMOVING THE CRANKSHAFT

1. Remove fly-wheel (section D).
2. Remove transmission (section R).
3. Remove cylinder head (section C).
4. Remove pistons and connecting rods (section K).
5. Remove cooling water pump (section O).
6. Remove lubricating pump (section N).
7. Remove hand start (section F).
8. Remove front end cover with counter weights (section E).
9. Remove end cover assembly (section G).
10. Remove cam shaft (section M).
11. Special - for Pilot 20. The intermediate bearing has to be loosened by unscrewing the expansion bolt approximately 10 mm (.394"). The bolt and expander will come loose by knocking carefully on the bolt. This proceedure is correct for early versions of Pilot 20. On later versions the intermediate bearing is assembled differently (see illustration below).
12. Loosen lock washer and remove nuts, (13 and 15).
13. Gears (10 and 11) are to be pulled off the crank shaft.
14. The crank shaft and the intermediate bearing can now be taken out of the crankcase.

Reassembling of the crank shaft is accomplished in reverse sequence. If the engine is mounted with expansion bolts these have to be tightened with a torque of 2.4 kgm. (16.6 lbs.). If the intermediate bearing is mounted on the cylinder block with screws, tighten with a torque of 2.5 kgm. (18 lbs.).



REAR MAIN AND INTERMEDIATE BEARINGS

ENGINE	SERIAL NO.	BEARING	YEAR
Pilot 10	85000 & up	4400.1.E	1973
Pilot 20	92000 & up	4600.1.C	1973

When the crank shaft is removed per instructions on the preceeding page, the rear main bearing can be replaced in the same way as described for the front main bearing (section E).

The intermediate bearing can now easily be replaced. It consits of 2 shells and the marking should be noted. The bearings are precisely machined by the manufacturer and must under no circumstances be touched by any tool.

Replace the intermediate bearing if any wear is shown or the surface is scored or gouged.

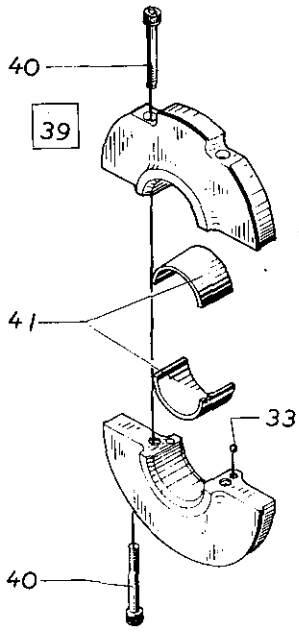
REPLACING THE INTERMEDIATE BEARING

Remove the two securing screws and the two shells will come free. The two intermediate bearing halfs are aligned by means of steel balls (33).

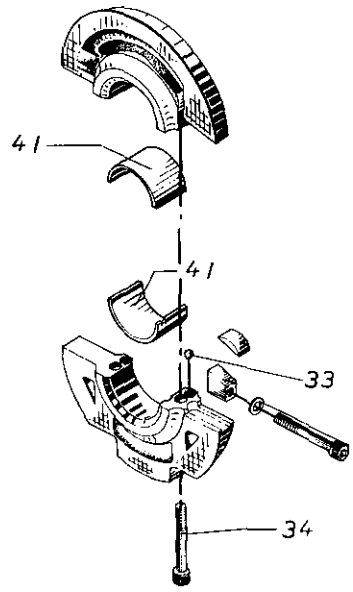
When reassembling be extremely cautious that the intermediate bearing half containing the lubrication hole is carefully aligned with the hole in the top half of the holder.

When reassembling, secure the screws loosely in order to first make sure that the balls are fitted into the right position. Thereafter the intermediate bearing parts are tightened up with a torque of 6.2 kgm (13.7 lbs.). This applies to the intermediate bearing type A (see below).

If the engine is mounted with screws, engine should have intermediate bearing type B. The screws of the bearing should be tightened with a torque of 5.2 - 5.8 kgm (11.5 - 12.8 lbs.). Check the oil canals before the final assembly into the cylinder block.



TYPE A



TYPE B

CAMSHAFT

The cam shaft is situated on the side of the cylinder block and operates the rocker shaft assembly by means of tappets and push rods.

The camshaft is driven from the front of the crankshaft by means of gears.

Identification marks for correct timing have to be strictly observed.

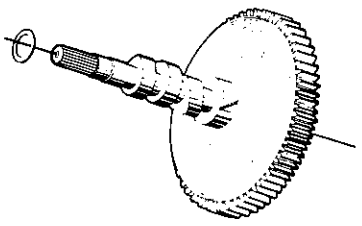
The end play of the camshaft is for both models in the Pilot series - between 0.2 - 0.5 mm (.008" - .019").

ENGINE	SERIAL NO.	SHAFT NO.	YEAR
Pilot 10	85967 & up	4400.1.E	1973
Pilot 20	92447 & up	4600.1.C	1973

REMOVING CAMSHAFT

1. Remove fuel injection pump.
2. Remove fuel lift pump.
3. Remove valve cover.
4. Remove push rods.
5. Remove cooling water pump (section O).
6. Remove lubrication pump (section N).
7. Remove hand start (section F) as well as lock ring at the end of the camshaft.
8. Remove lock ring behind the gear for hand start.
9. Remove transmission with coupling (section R).
10. Remove rear ended cover with counter weights (section G).
11. Remove the camshaft.

Reassembling is made in reverse sequence by observing the gear timing.

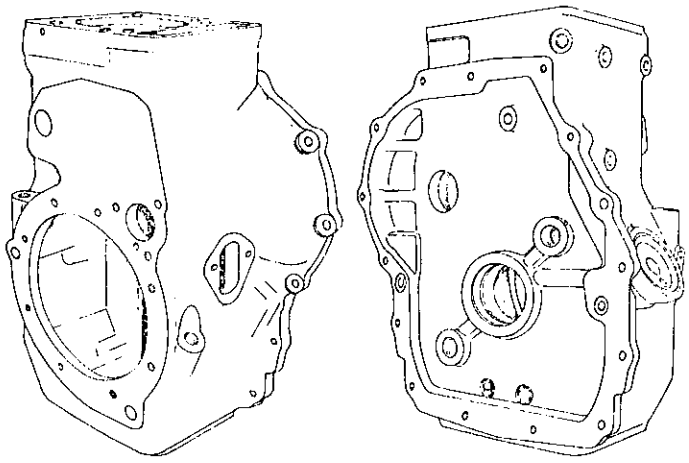


REPLACING
FRONT END BEARING

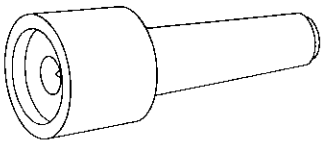
1. Remove camshaft (section M).
2. Remove front end cover (section E).
3. Remove front end bearing for camshaft by using a suitable tool.

Reassembling is made in reverse sequence and the bearing (bushing) is pressed into the cylinder block by means of the tool shown in next column.

The outer diameter of a new bushing is 42.000 - 42.024 mm (1.653" - 1.654") and the inner diameter is 20.040 - 20.053 mm (.7889" - .7894").



CAMSHAFT FRONT END BEARING



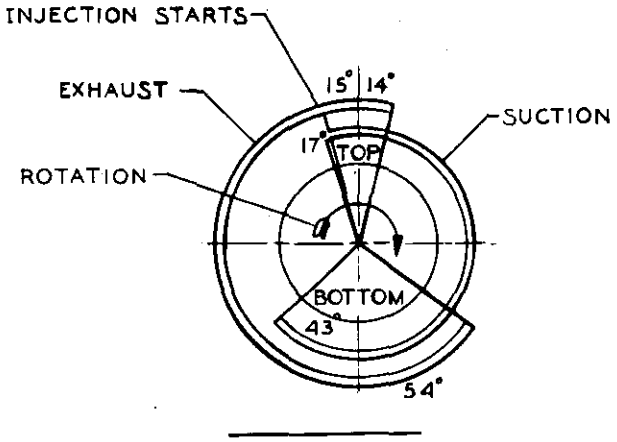
TOOL FOR PRESSING IN CAMSHAFT BEARING

CHECKING CAMSHAFT

1. Remove valve cover.
2. Remove rocker arm for inlet valve.
3. Remove spring for inlet valve.
4. Drop the inlet valve carefully down to the cylinder top.
5. Turn the engine to top dead centre.
6. Mount dial indicator on the top of the cylinder block. The indicator touching the valve stem top.
7. By means of the indicator measure top dead centre exactly and adjust the indicator to zero.
8. Mark the fly-wheel against a similar mark on the cylinder block.
9. Turn the fly-wheel clockwise until the valve has moved 0.10 mm (.004") the fly-wheel again to be marked.
10. By turning the fly-wheel anti-clockwise repeat the same procedure. The top dead centre is now to be checked and marked between the two identification marks on the fly-wheel.
11. The exhaust valve play against the rocker arm is adjusted to zero mm, and the indicator is now to be mounted touching the exhaust valve rocker arm.
12. The timing is now to be checked using the following diagram. Normally it should only be necessary to check on the exhaust valve diagram, and if the timing is not in accordance with the diagram the camshaft should be replaced.

VALVE TIMING

VALVE ACTION		MEASUREMENT ON FLYWHEEL mm	In.
Inlet opens	17° before TDC	58	2.28
Inlet closes	43° after BDC	147	5.79
Exhaust opens	54° before BDC	184.5	7.26
Exhaust closes	14° after TDC	48	1.89



AUTOMATIC ADVANCE

The automatic advance will assure correct injection timing in accordance with the r.p.m. of the engine.

The automatic advance is mounted on the camshaft as shown below.

DISASSEMBLY

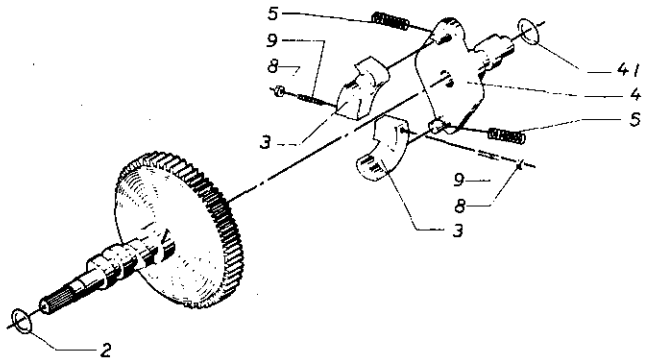
1. Remove fuel injection pump.
2. Remove transmission (section R).
3. Remove end cover (section G).
4. Remove bolts (7).
5. It is now possible to remove the holding plate (4), springs (5) and the weights (3).

Reassembling the automatic advance is done in reverse sequence. It is important that all parts are moving freely.

The springs (5) have a length of approx. 40.5 mm (1.59"). If they don't meet this measurement, they have to be replaced.

Screw (9) to be adjusted in order to allow a gap to the inner surface of the timing gear of 11 mm (.433"). The screw to be locked with the nut (8).

After reassembling the automatic advance, check on the timing in accordance with section H.



CHECKING AUTOMATIC ADVANCE

Using a torque wrench, check to see that the counterweights start moving with a torque of 0.9 kgm (1.9 lbs.).

When the screws (9) have been adjusted, the counter weights will start moving at a torque of 3.5 kgm (7.7 lbs.).

If the above torques cannot be achieved, the spring tension has to be changed as follows:

Too high torque....Shorter springs.
Too small torque...Use adjustment washers.

LUBRICATING SYSTEM

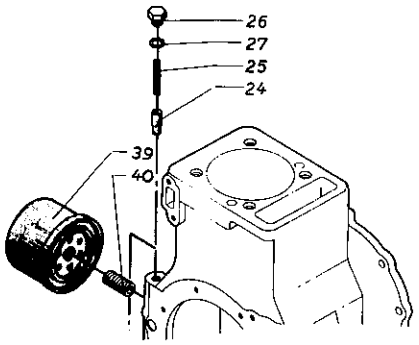
Lubrication is accomplished by a pressure type system. The lubricating pump, driven from the end of the camshaft, passes oil from the filter in the oil sump through the filter element mounted outside on the cylinder block to the various points where lubrication is needed. A pressure relief valve maintains the correct pressure at normal operating temperatures. Pressure should be between 2.5 and 3.5 kg/cm^2 (35.5 and 49.7 psi).

Replacement of lubricating oil should take place every 150 hours of operation.

LUBRICATING PRESSURE RELIEF VALVE

Valve is shown below. It can be adjusted by changing tension on spring (25). Oil pressure under normal operating temperature must not be lower than 1 kg/cm^2 (14.2 psi). If oil pressure is too high, possibly after replacing spring (25), adjustment can be made by mounting an extra copper seal (27) underneath cap.

Oil pressure relief valve can be removed by loosening cap (26) which provides access to spring (25) and piston (24). Oil pressure should always be adjusted using an oil pressure gauge.



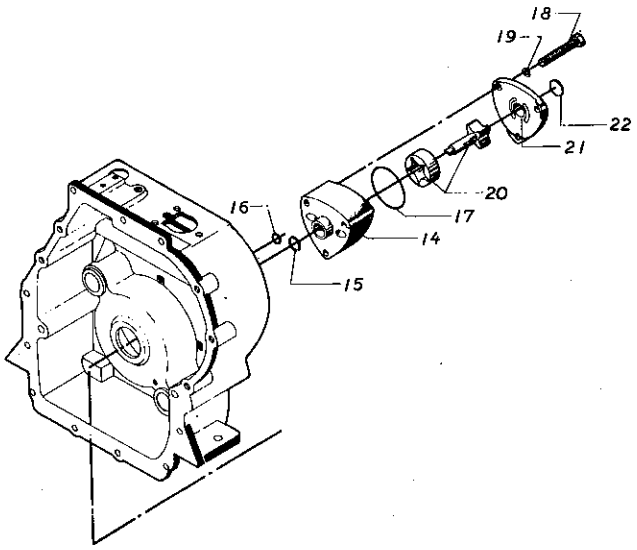
LUBRICATING FILTER

Lubricating filter (39) cannot be cleaned and must be replaced every 150 operating hours, or at least once a year. When replacing a filter element, make sure that the sealing surface against the engine is clean.

DISASSEMBLING OIL PUMP

Caution: Before removing or disassembling pump, put a scribe mark on edge of rear pump plate, and on pump body as well, to assure reassembly in the same position. If plate is improperly oriented, low oil pressure will result.

1. Remove bolt (18).
2. Pull out rotor (20).
3. Remove pump house body (14). Outer rotor (20) may then be removed.
4. Remove "O" rings (15, 16 & 17).



REASSEMBLING OIL PUMP

1. Check "O" rings for wear and replace if necessary.
2. Reassemble "O" rings 15 and 16.
3. Replace outer rotor (20) in pump house body (14). Clearance between body and rotor should be 0.05 to 0.15 mm (.002" to .006").
4. With steel rule, check play between the pump house body and rotor. Play should be between 0.025 and 0.075 mm (.001" and .003").
5. Reassemble "O" ring (17) and cover. Bolts are to be tightened with torque of 2 to 2.3 kgm (14.5-16.6 lbs.).

RECOMMENDED LUBRICATING OILS

The various oil companies' prescribed products to be used for lubrication of Pilot 10 and Pilot 20 can be seen at right.

For the service description are mentioned the descriptions DM and DS from the old API classification system and the corresponding descriptions CC and CD from the new API classification system.

At air temperatures at the engine below + 5°C (41°F) viscosity SAE 10 must be used.

At air temperatures at the engine between + 5°C (41°F) and + 25°C (77°F) viscosity SAE 20 must be used.

At air temperatures over + 25°C (77°F) viscosity SAE 30 must be used.

Some of the viscosities include a "W". This indicates that the viscosity of the oil in question is constant at variable temperatures of the engine.

Normally, a lubricating oil quality marked "Service CC" must be used, but for operation under hard working conditions such as frequent cold starting, short time operation, and very variable load, quality marked "Service CD" must be used.

Further, quality marked "Service CD" must be used if the sulphur content of the fuel is higher than 1%.

When the lubricating oil is changed the lubricating oil filters must be replaced.

The lubricating oil capacity of the engine, including the filter, is 1.75 litres (3.7 pints) for Pilot 10 and 2.75 litres (5.8 pints) for Pilot 20.

The oil capacity of the gear is 0.4 litres (.85 pints).

Lubricating oil and gear oil must be changed every 150 working hours, or at least once a year.

RECOMMENDED ENGINE OIL

MAKE & TYPE	VISCOSITY	SERV. DESCR. OLD	NEW
BP			
BP ENERGOL HD	SAE 10W/20W/30	DM	SC&CC
BP VANELLUS	SAE 10W/20W/30	DM	SC&CC
BP VANELLUS C3	SAE 10W/20W/30	DS	SD&CD
CASTROL			
CASTROL 210 M	SAE 20	DM	CC
CASTROL 215 M	SAE 30	DM	CC
CASTROL 10W/20W/20	and 30	DM	CC
DEUSOL CRML	SAE 10W/30	DM	CC
DEUSOL CRI/CRB	10/20 and 30	DM	CC
CASTROL 215 MX	SAE 30	DS	CD
CASTROL 215 MXD	SAE 30	DS	CD
CASTROL 215 MX SUPER	SAE 30	DS	CD
CASTROL CRD	10/20 and 30	DS	CD
DEUSOL CRD	10/20 and 30	DS	CD
GULF			
GULF VERITAS HD V6	SAE 20/20W	DM	CC
GULF VERITAS HD V9	SAE 30	DM	CC
GULF VERITAS SD	SAD 20/20W	DS	CD
GULF VERITAS DS	SAE 30	DS	CD
GULFLUBE	HD SAE 10W	DM	CC
GULF SUPER DUTY	SAE 10W	DS	CD
SHELL			
SHELL ROTELLA SX	SAE 20W/30	DM	CC
SHELL RIMULA CT	SAE 10W/30	DS	CD
TEXACO			
HAVOLINE		DM	CC
URSA EXTRA DUTY		DM	CC
URSA LA-3		DS	CD
VALVOLINE			
VALVOLINE SUPER HPO-HDM		DM	CC
VALVOLINE SUPER 1000 Series 3		DS	CD
ESSO			
ESSOLUBE D-3 10W/20W and 30		Combined	
ESSOLUBE D-3HP 10W/20W and 30		Combined	

RECOMMENDED GEAR OIL

MAKE	TYPE
BP	BP GEAR OIL SAE 90
CASTROL	MULTIGRADE ST 90
GULF	PREMIUM TRANSMISSION 90
	MULTI PURPOSE 90
SHELL	DENTAX 90
TEXACO	TUBAN 90
VALVOLINE	TRANSMISSION OIL TRA No. 1 and 2 SAE 90
	TRANSMISSION OIL X-18 SAE 80/90
ESSO	ESSO GEAR OIL GX 80/90

COOLING SYSTEM

The Pilot 10 and Pilot 20 are built for raw water cooling, however, as optional equipment, various cooling arrangements can be supplied.

The cooling water pump is of the Johnson impeller type.

A constant water temperature is achieved by means of a thermostat mounted at the top of the exhaust manifold.

COOLING WATER PUMP

ENGINE	SERIAL NO.	PUMP NO.	YEAR
Pilot 10	85967 & up	4400.1.E	1973
Pilot 20	92447 & up	4600.1.C	1973

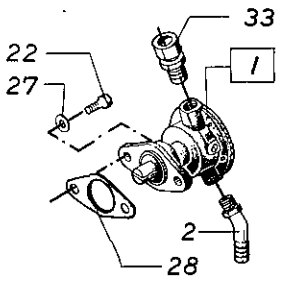
SPECIFICATIONS

manufacturer	Johnson
type	P. 31.934
capacity	max. 11.7 l/min.
pressure	max. 6 m WC
suction (by manometer)	3 m WC

REMOVING COOLING WATER PUMP

1. Drain the cooling water.
2. Remove hoses.
3. Remove bolts (22). The cooling water pump may now be pulled out.

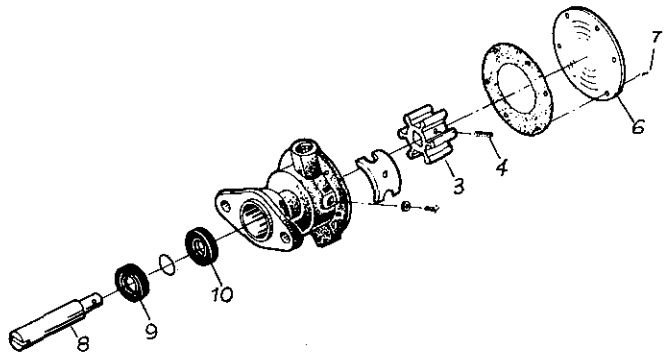
Reassembling in reverse sequence. The bolts (22) to be tightened with a torque of 2 - 2.3 kgm (14.5-16.6 lbs.).



DISASSEMBLING COOLING WATER PUMP

1. Remove cooling water pump (see above).
2. Remove screws (7) and cover (6). Diagram - next column, top.
3. Pull impeller (3) and shaft (8) out of the cooling water pump body.
4. Remove screw (4). Impeller and shaft will disengage. Inspect the impeller for wear and replace if necessary.
5. Inspect oil seals (9) and seal (10) for wear and replace if necessary.

Reassembling should be done in reverse sequence. Make sure that the impeller blades are bent in the opposite direction of pump rotation.



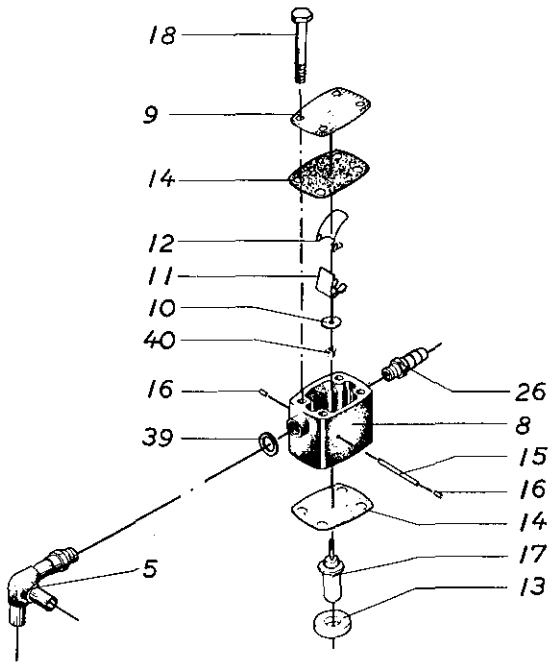
THERMOSTAT

The function of the thermostat is to keep the engine at the desired working temperature.

The thermostat starts to open at 65°C (149°F). Working temperature is approx. 70°C (158°F).

REMOVING THERMOSTAT

1. Remove tubes to and from the thermostat housing.
2. Remove screws (18). See below.
3. Remove cover (9).
4. Remove nipples (5 & 26).
5. Remove screws (16) so the shaft (15) may be knocked out of the housing, using a thin punch.
6. Remove spring (12) and spring plate (11).
7. Remove valve (10).
8. Thermostat body (17) with ring (13) can now be pulled out of the thermostat house body from underneath.
9. Remove ring from thermostat body.

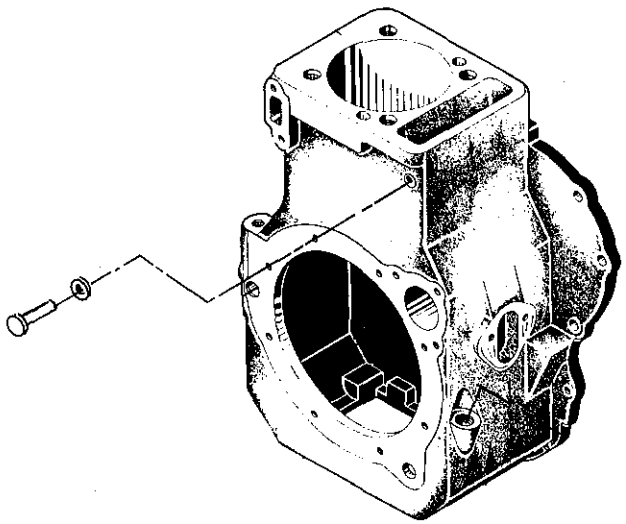


REASSEMBLING THERMOSTAT

1. Screw nut on thermostat body into its position and secure with Lock-tite.
2. Replace the ring on thermostat body then press assembly into the housing.
3. Replace the valve.
4. Replace the spring, valve plate and shaft in the indicated sequence. Replace screws (16).
5. Replace gasket, top plate (19) and tube tubes.

GALVANIC CORROSION

The galvanic zinc anode is mounted at the front end of the cylinder block and should be inspected at the end of the first month after engine has been put into operation and later at approx. 25 hour intervals of operation. When the galvanic zinc anode is reduced to half length, it should be replaced.



ELECTRICAL SYSTEM

For wiring diagrams and other data pertaining to Pilot 10 and Pilot 20 models, please refer to the Operators Section (B), pages 4, 12 and 13.

YOUR NOTES

TRANSMISSION

TYPE ZF MODELS BWS & BW6

IMPORTANT NOTES:

1. When checking the transmission oil in Pilot series engines, loosen the oil cap to vent the transmission and prevent an air lock. If this procedure is not followed, either a wrong reading or no reading will result.
2. Soft tools such as nylon hammers and aluminum or bronze bars should be used exclusively for any repairs on ZF transmissions.
3. The transmission described herein has a gear ratio of 2:1 for forward and 2:1 for reverse.
4. Transmission oil should be changed each 150 operating hours or once a year, whichever is first.

OIL CHANGE PROCEDURE

1. Remove plug and dip stick.
2. The oil should be pumped out, using a plastic-hose and hand operated pump such as supplied in the standard tool kit.
3. New oil is to be added through the plug at the top of the transmission. Oil capacity is 0.4 liter (.85 pints). Type-transmission oil SAE 90.

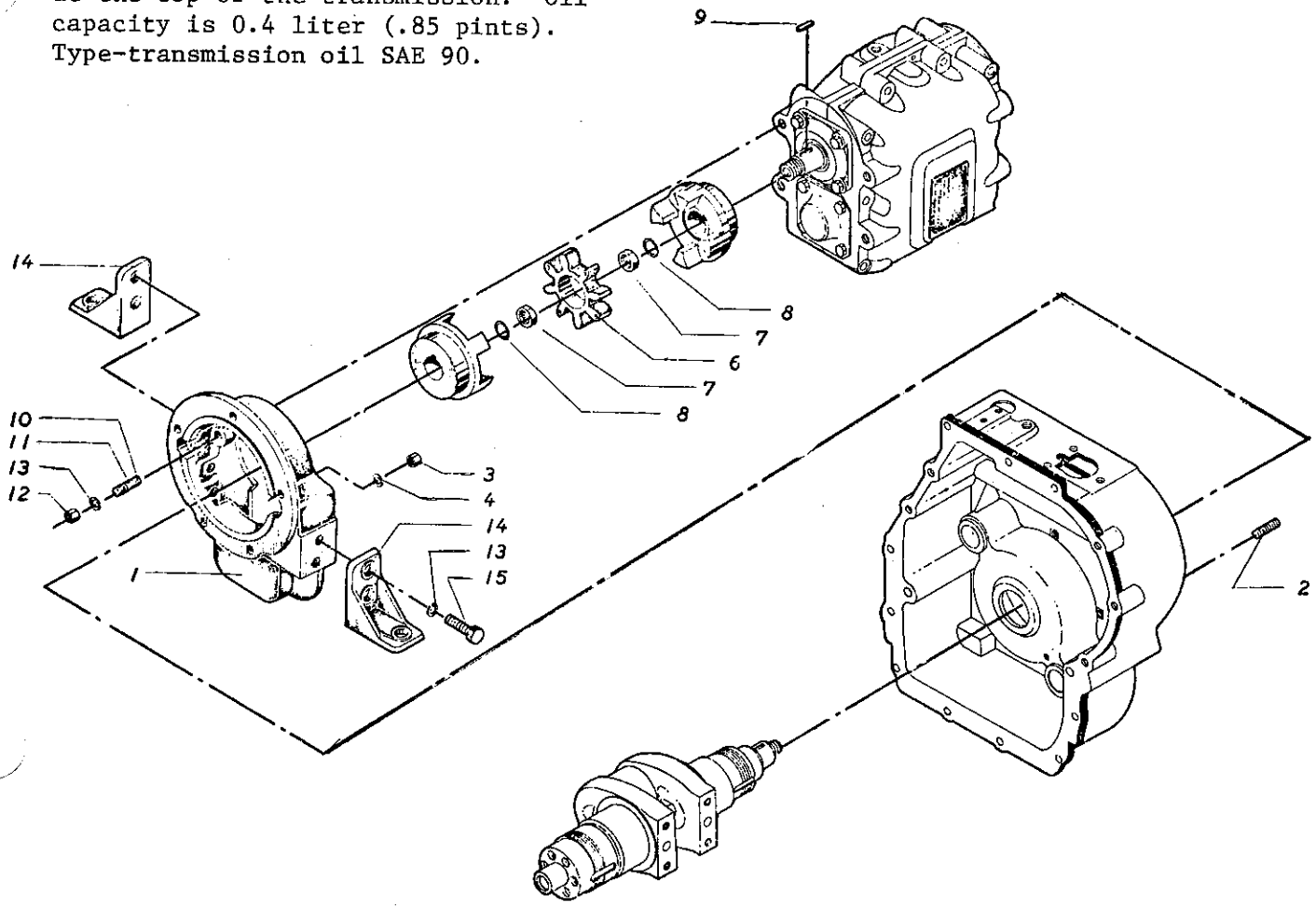
REMOVING THE TRANSMISSION AND INTERMEDIATE HOUSING

1. Put transmission lever into "neutral".
2. Remove the bolts at the flange.
3. Remove the bolts in the intermediate housing (1), see below.
4. Remove the engine brackets (14) from intermediate housing.
5. Remove transmission and intermediate housing from engine.
6. Dismantle the coupling half from the transmission.

Reassembling is accomplished in reverse sequence. The coupling half nut should be tightened with a torque of 13-14 kgm (94-100 lbs.).after applying a thin layer of lock-tite.

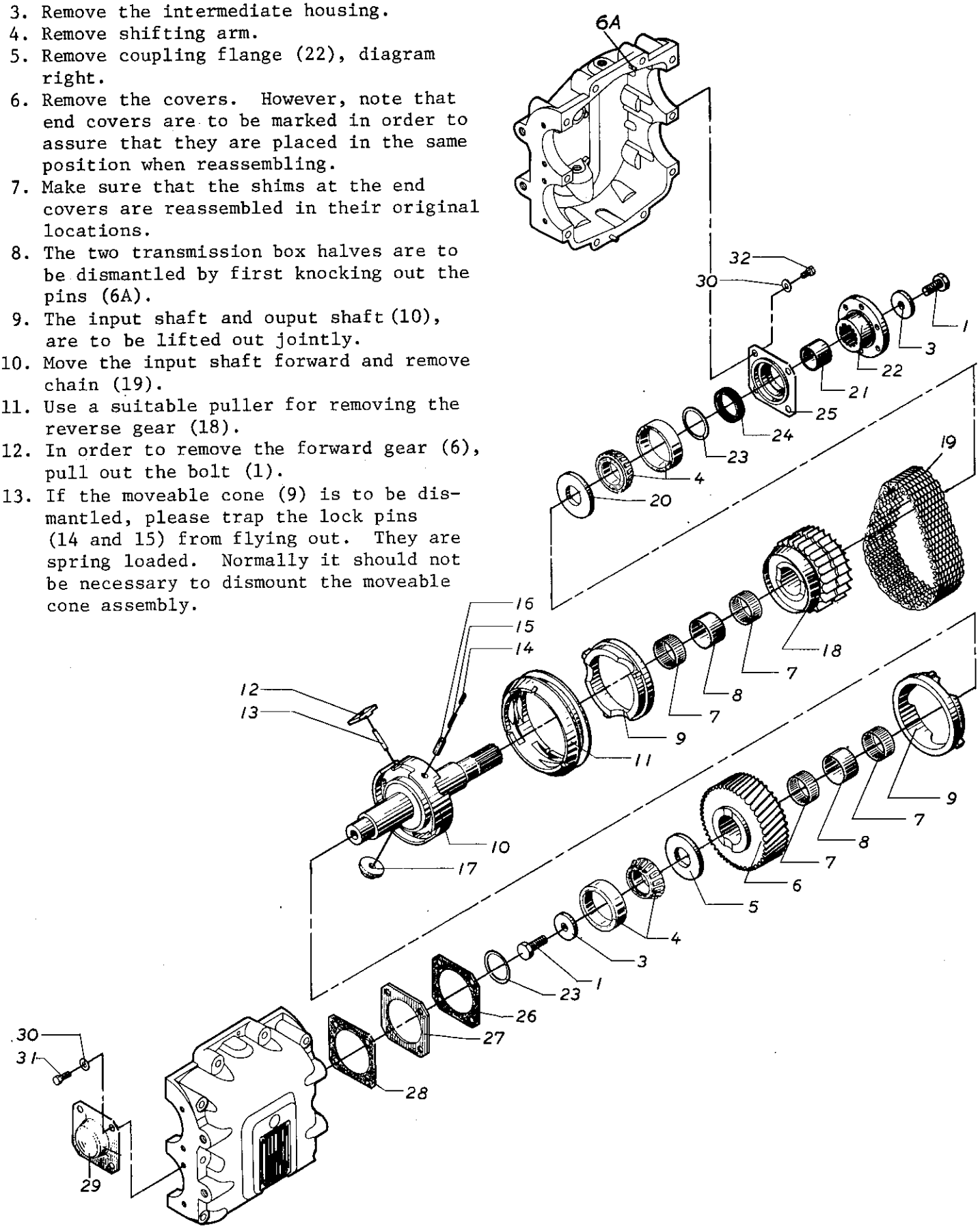
NOTE:

The two adjusting screws for transmission coupling placed behind the oil filling plug are not to be touched. If the adjusting screws should be touched by accident, proper adjustment is accomplished by testing the shifting lever. It should have a slight movement, when put in Ahead or Reverse.



DISASSEMBLING THE TRANSMISSION

1. Remove the transmission from the engine (see previous page).
2. Remove the coupling half.
3. Remove the intermediate housing.
4. Remove shifting arm.
5. Remove coupling flange (22), diagram right.
6. Remove the covers. However, note that end covers are to be marked in order to assure that they are placed in the same position when reassembling.
7. Make sure that the shims at the end covers are reassembled in their original locations.
8. The two transmission box halves are to be dismantled by first knocking out the pins (6A).
9. The input shaft and ouput shaft (10), are to be lifted out jointly.
10. Move the input shaft forward and remove chain (19).
11. Use a suitable puller for removing the reverse gear (18).
12. In order to remove the forward gear (6), pull out the bolt (1).
13. If the moveable cone (9) is to be dismantled, please trap the lock pins (14 and 15) from flying out. They are spring loaded. Normally it should not be necessary to dismount the moveable cone assembly.

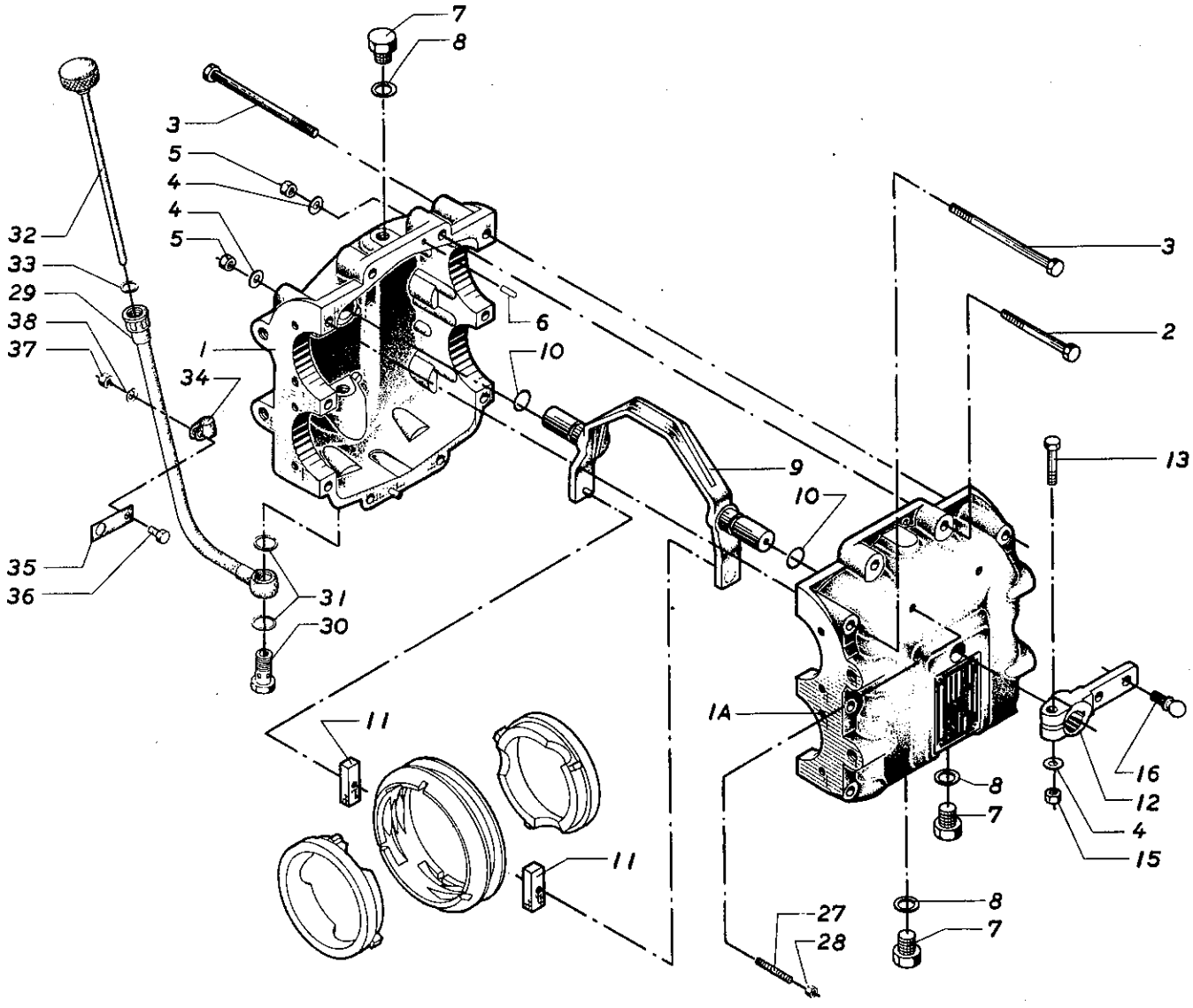


REASSEMBLING THE TRANSMISSION

1. Proceed in reverse sequence to that of disassembly, but note that screw (1) previous page is to be secured with Lock-Tite. Make sure that the two support washers are in the right position before the screw (1) is tightened.
2. The coupling fork (9), illustration below, is to be assembled with the other components in the transmission box-half containing the adjusting screws for the torque coupling.
3. Before assembling the transmission box halves, please apply a thin layer of liquid gasket. The end covers on the input shaft side are to be secured loosely at first. Thereafter, assemble the cover on the ouput shaft. However, this one must not be tightened until the coupling half is mounted and tightened to the correct torque. The lock screw for the coupling half should be secured with Lock-Tite.
4. The two transmission box halves are to be tightened with a torque of 2.5 - 3.0 kgm (18-22 lbs.).
5. The nut for coupling half on the engine side is to be tightened with a torque of 13 - 14 kgm (94-100 lbs.). after applying Lock-Tite.

HOT BEARINGS

If excessive temperature can be felt at the end covers after assembly, 80 - 90°C (175° - 190°F) remove the end covers or the cover in question, and replace adding a gasket 0.05 - 0.10 mm (.002" - .004") thick.



YOUR NOTES

PARTS LIST

NOTE

The Westerbeke policy is one of continuous improvement, and accordingly, the company reserves the right to alter specifications, weights and dimensions without prior notice.

In compiling this Parts List, every care has been taken, but specifications and details must not be regarded as binding.

Please, if you have a suggestion regarding this book, or feel there is an error, send a written note to the attention of Publications Department.

NOTES ON USING THIS PARTS LIST

1. Unit of issue for all linear commodities is inches (not feet or yards).

2. Start looking in the contents -- if you cannot find any item, check miscellaneous page.

3. Be careful to note which pages are for the Pilot 10 or 20 only, and which are common to both.

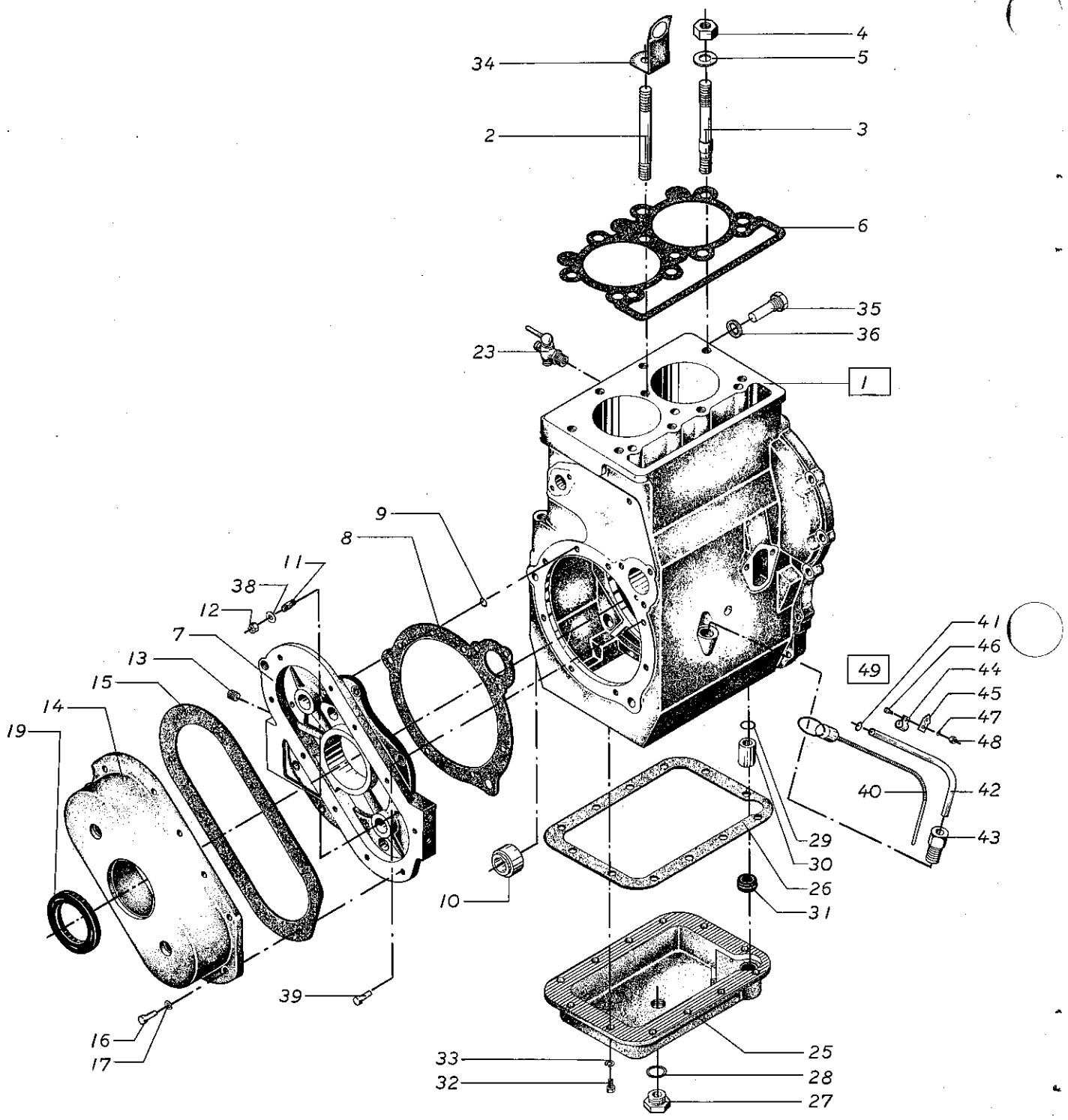
4. Parts are common to both Pilot 10 and 20 unless indicated as P10 or P20 in the "remarks" column.

5. The five digit numbers in the "remarks" column refer to engine serial numbers. Numbers beginning with "8" refer to the Pilot 10; those beginning with "9" refer to the Pilot 20. Example: "to 8----" means "Pilot 10 engines previous to serial number 8----".

6. Example: If "remarks" has a serial number beginning with an "8" but does not have a "P10", then the part applies to all P20 engines as well as the given P10 engines. If there is a "P10" given, then the part applies to P10 engines only, and only those in the series indicated.

TABLE OF CONTENTS

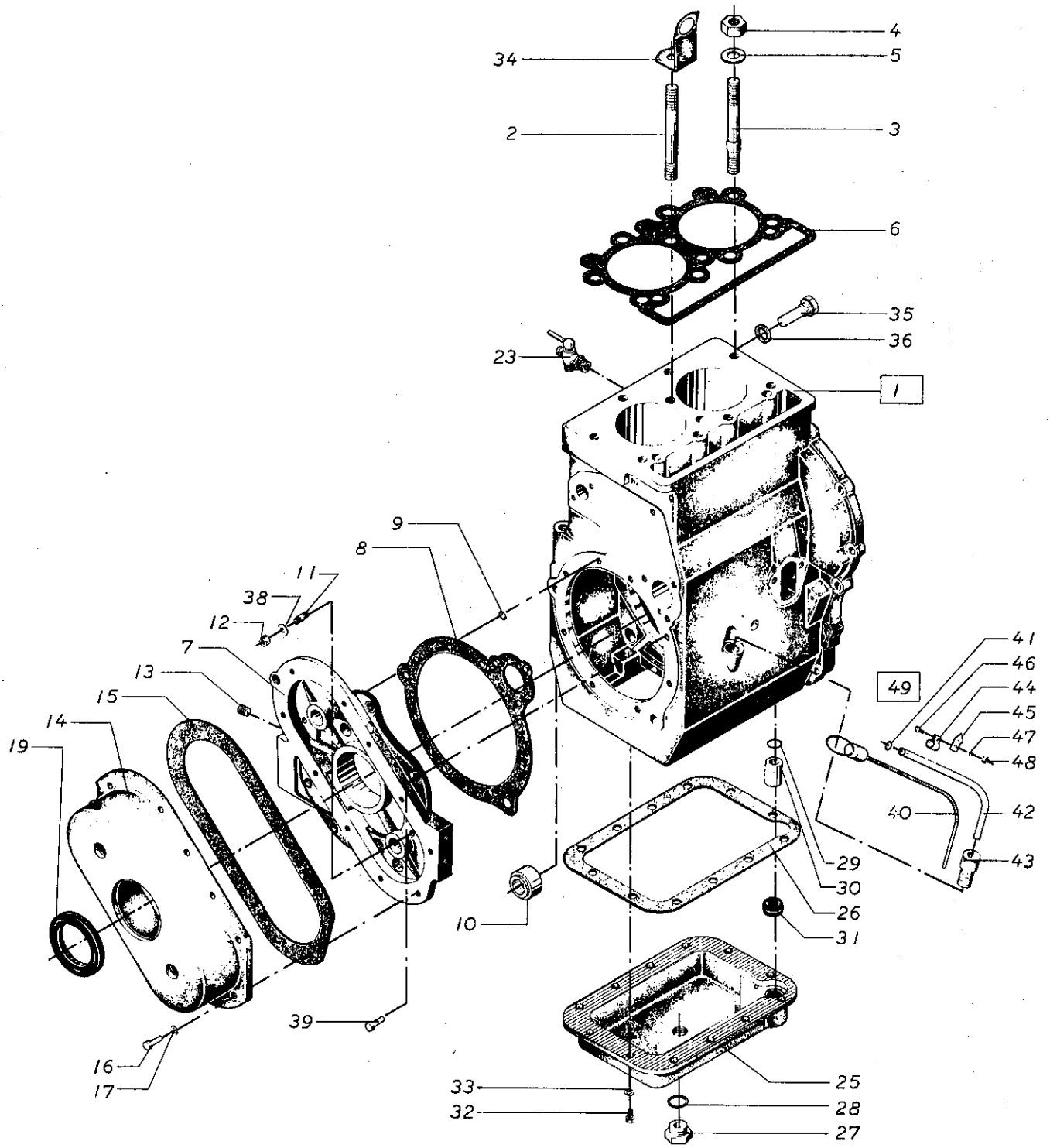
WESTERBEKE 10 & 20: CYLINDER BLOCK - FRONT COVER



WESTERBEKE 10 & 20: CYLINDER BLOCK - FRONT COVER

REF	PN	NAME	REMARKS	QUAN
1-1	18774	CRANKCASE	P10 - FROM 85967	1
1-2	16797	CRANKCASE	P10 - TO 85963	1
1-3	18777	CRANKCASE	P20 - TO 92446	1
1-4	18779	CRANKCASE	P20 - FROM 92447	1
2-1	16805	STUD	P10 - CYLINDER HEAD	2
2-2	18730	STUD	P20 - CYLINDER HEAD	7
3-1	16806	STUD	P10 - WITH GUIDE RING	2
3-2	18731	STUD	P20 - WITH GUIDE RING	2
4-1	16792	NUT	P10 - CYLINDER HEAD STUD	4
4-2	17194	NUT	P20 - CYLINDER HEAD STUD	9
5	18854	WASHER	P20 - CYLINDER HEAD STUD	7
6-1	16841	GASKET	P10 - CYLINDER HEAD	1
6-2	18729	GASKET	P20 - CYLINDER HEAD	1
7-1	18720	PLATE	P10 - FRONT END - TO 85121	1
7-2	16809	PLATE	FRONT - 85122 TO 85963 & 92000 TO 92446	1
7-3	18778	PLATE	P20 - FRONT END - FROM 92447	1
7-4	18775	PLATE	P10 - FRONT END - FROM 85967	1
8	16810	GASKET	FRONT END TO CRANKCASE	1
9	17174	RING		1
10	16902	BEARING	CAMSHAFT	1
11	16903	STUD		4
12	17195	NUT		4
13	17173	SETSCREW		1
14-1	16908	COVER	P10 - FRONT END	1
14-2	18673	COVER	P20 - FRONT END	1
15	16909	GASKET	FRONT END COVER TO PLATE	1
16-1	18806	SETSCREW	P10	10
16-2	18817	SETSCREW	P20	10
18	16910	PIN	P10	2
19	16870	SEAL	FRONT END	1
23	16922	PETCOCK	WATER DRAIN	1
24	17200	RING	PETCOCK SEALING	1
25-1	16916	SUMP	P10	1
25-2	18771	SUMP	P20	1
26-1	16921	GASKET	P10 - SUMP TO CRANKCASE	1
26-2	18732	GASKET	P20 - SUMP TO CRANKCASE	1
27	16919	PLUG	SUMP DRAIN	1
28	16920	RING	SUMP DRAIN PLUG SEALING	1
29	16904	RING	SEALING	1
30	16917	TUBE	SUCTION	1
31	16918	FITTING	OIL PREFILTER	1
32-1	16789	SCREW	P10 - SUMP TO CRANKCASE	8
32-2	17196	SCREW	P20 - SUMP TO CRANKCASE	12
34-1	17082	EYE	P10 - LIFTING	1
34-2	18636	EYE	P20 - LIFTING	1
35	17083	ZINC		1
36	16794	GASKET	ZINC SEALING	1
37	18855	WASHER	P10 - CYLINDER HEAD STUD	2
39	17196	SETSCREW		4
40-1	18752	DIPSTICK	TO 86321 & 92596	1
40-2	18709	DIPSTICK	FROM 86322 & 92597	1

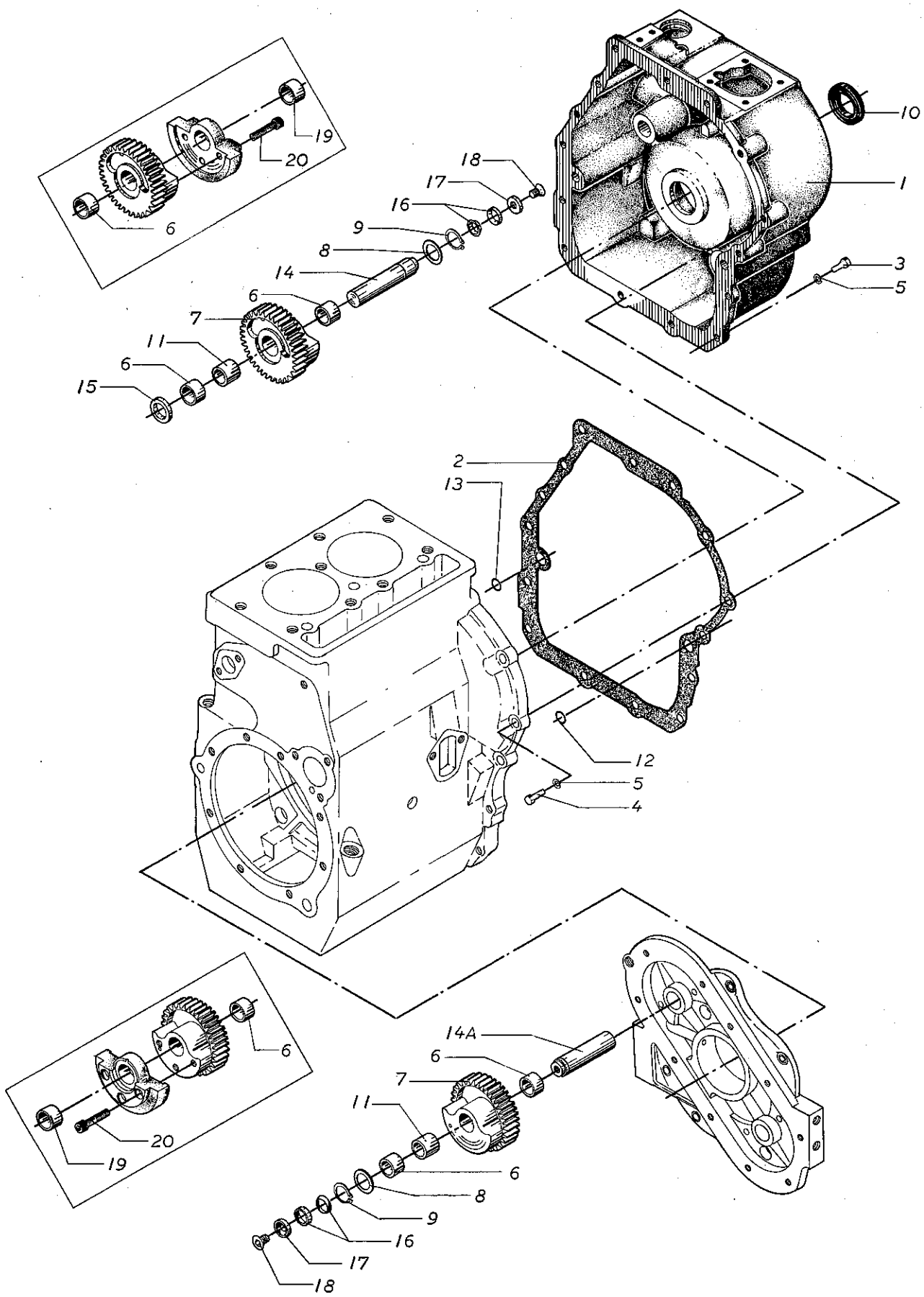
WESTERBEKE 10 & 20: CYLINDER BLOCK - FRONT COVER



WESTERBEKE 10 & 20: CYLINDER BLOCK - FRONT COVER

RFF	PN	NAME	REMARKS	QUAN
41	18955	ORING		1
42-1	18645	TUBE	DIPSTICK - TO 86321 & 92596	1
42-2	18708	TUBE	DIPSTICK - FROM 86322 & 92597	1
43	17049	FITTING	DIPSTICK TUBE	1
44	18886	CLIP		1
45-1	18653	STRAP		1
45-2	18711	STRAP	P20 - FROM 92597	1
49-1	18773	ASSEMBLY	DIPSTICK - TO 86321 & 92596	1
49-2	18770	ASSEMBLY	P20 - DIPSTICK - FROM 92597	1
49-3	18776	ASSEMBLY	P10 - DIPSTICK - FROM 86322	1

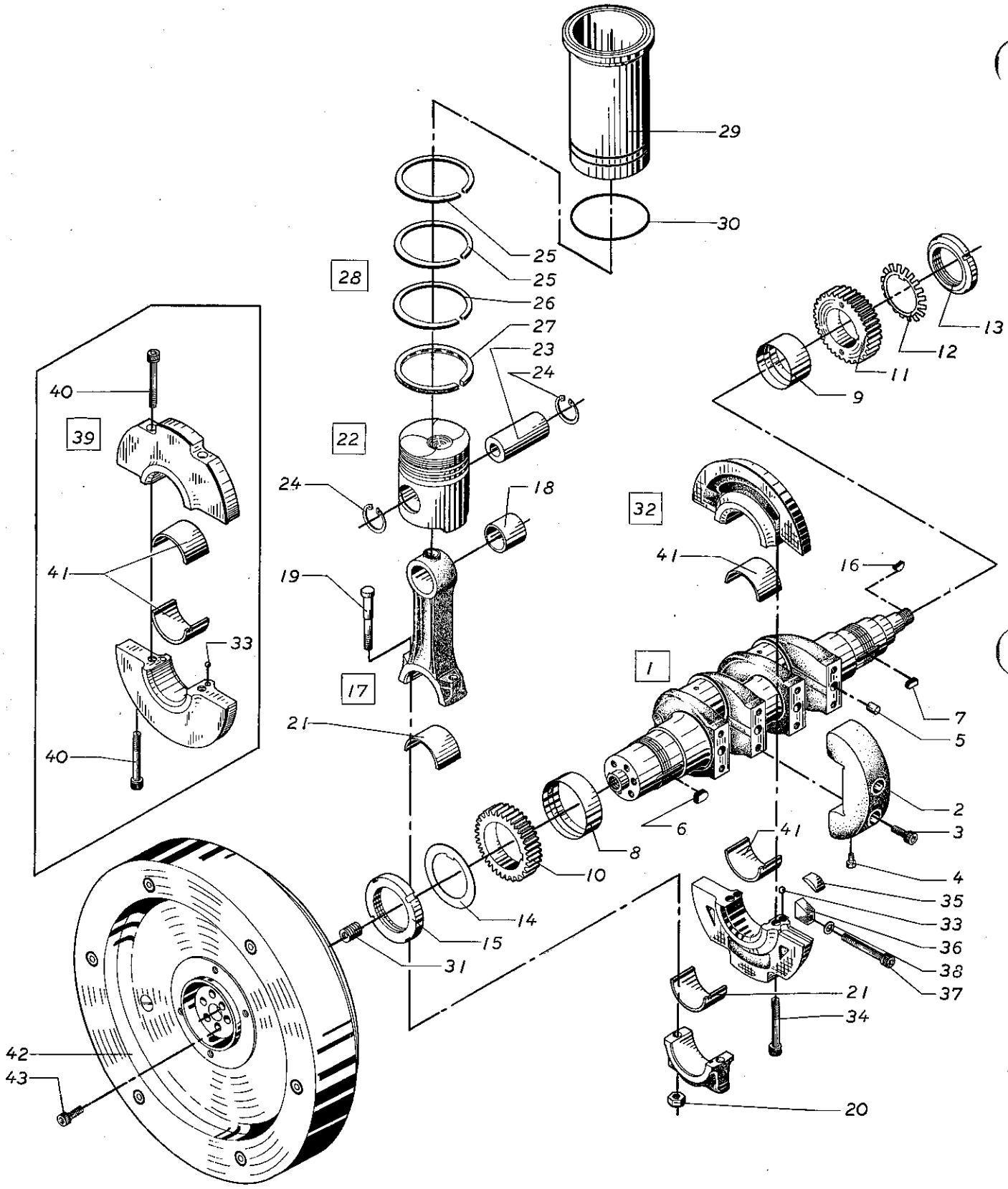
WESTERBEKE 10 & 20: REAR HOUSING - COUNTERWEIGHTS



WESTERBEKE 10 & 20: REAR HOUSING - COUNTERWEIGHTS

REF	PN	NAME	REMARKS	QUAN
1-1	16911	COVER	P10 - REAR - TO 85963	1
1-2	18671	COVER	P10 - REAR - FROM 85967	1
1-3	18640	COVER	P20 - REAR - FROM 92447	1
2	16912	GASKET	REAR,COVER	1
3	17196	SETSCREW		5
3-44	17176	SETSCREW		5
4	17172	SETSCREW		10
6-1	16906	BEARING	TO 85963 & 92446	8
6-2	18681	BEARING	FROM 85967 & 92447	8
7-1	16905	WEIGHT	P10	4
7-2	18785	WEIGHT	P20	4
8	16907	WASHER	TO 85963 & 92446	4
9-1	16907	CIRCLIP	FROM 85967 & 92447	4
9-2	16793	CIRCLIP	FROM 85967 & 92447	2
10	16871	SEAL		1
11-1	18691	SPACER	P10 - FROM 85967	4
11-2	18692	SPACER	P20	4
12	16979	RING		1
13	17174	RING		1
14-1	18634	SHAFT	P10 - TO 85963	2
14-2	18670	SHAFT	P10 - FROM 85967	2
14-3	18665	SHAFT	P20	2
15	18666	SPACER	FROM 85967	2
16	18849	RINGKEY	FROM 85967	2
17	18667	THRUSTWASHER	FROM 85967	2
18	18818	SCREW	COUNTERSUNK - FROM 85967	2
19	18664	BEARING	P20 - CENTRIFUGAL - TO 92446	4
20	18819	SCREW	P20 - TO 92446	12
21-1	18635	SHAFT	P10	2
21-2	18663	SHAFT	P20	2

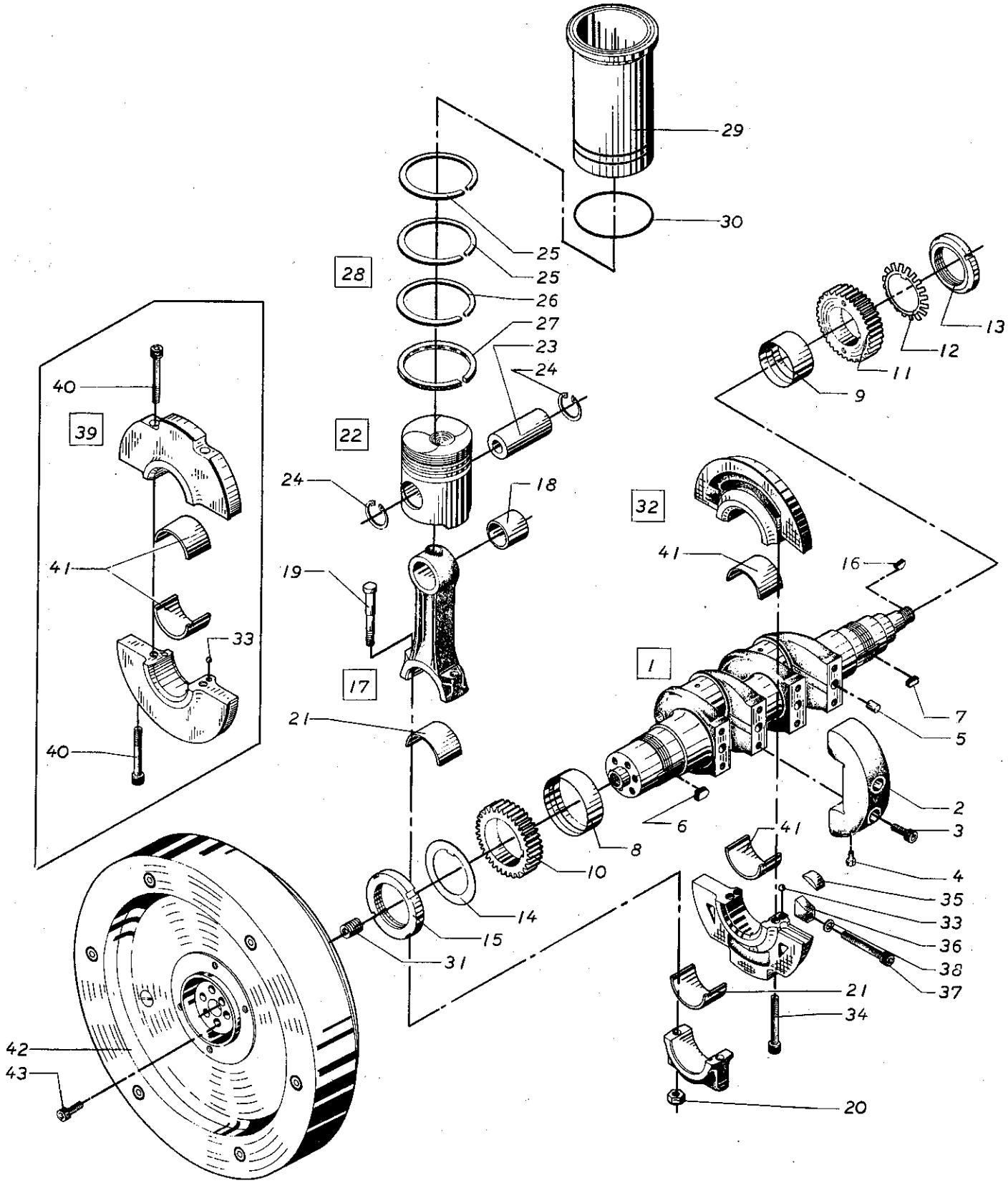
WESTERBEKE 10 & 20: CRANKSHAFT - ROD - PISTON



WESTERBEKE 10 & 20: CRANKSHAFT - ROD - PISTON

REF	PN	NAME	REMARKS	QUAN
1-1	16820	CRANKSHAFT	P10 - COMPLETE	1
1-2	18784	CRANKSHAFT	P20 - COMPLETE	1
2	16901	COUNTERWEIGHT		2
3	17169	SCREW		4
4	18803	SETSCREW		4
5	16897	PIN	TO 85121 & 92014	2
6	16899	KEY	FRONT	1
7	16900	KEY	REAR	1
8-1	16798	LINER	MAIN BEARING - FRONT - STD	1
8-2	16799	LINER	MAIN BEARING - FRONT - 0.3 MM U/S	1
8-3	16800	LINER	MAIN BEARING - FRONT - 0.6 MM U/S	1
9-1	16803	LINER	MAIN BEARING - REAR - STD	1
9-2	16802	LINER	MAIN BEARING - REAR - 0.3 MM U/S	1
9-3	16801	LINER	MAIN BEARING - REAR - 0.6 MM U/S	1
10-1	16942	GEAR	P10 - FRONT	1
10-2	18699	GEAR	P20 - FRONT	1
11-1	16822	GEAR	P10 - REAR	1
11-2	18701	GEAR	P20 - REAR	1
12	17151	PLATE	LOCKING	1
13	17152	LOCKNUT		1
14	16825	PLATE	LOCKING	1
15	16824	LOCKNUT		1
16	17179	KEY	WOODRUFF	1
17	16827	ROD	CONNECTING	1
18	16826	BUSHING	CONNECTING ROD	1
19	16829	BOLT	CONNECTING ROD	2
20	16788	NUT	CONNECTING ROD BOLT	2
21-1	16830	BEARING	CONNECTING ROD - STD	1
21-2	16831	BEARING	CONNECTING ROD - 0.3 MM U/S	1
21-3	16832	BEARING	CONNECTING ROD - 0.6 MM U/S	1
22	16834	PISTON	COMPLETE WITH PIN AND RINGS	1
23	16838	PISTON PIN		1
24	16839	CIRCLIP		2
25	16835	RING	PISTON	2
26	16836	RING	TAPER FACE - COMPRESSION	1
27	16837	RING	SCRAPING	1
28	17139	RING SET		1
29	16840	LINER	CYLINDER	1
30	16844	O RING	CYLINDER LINER	2
31	16898	SCREW	LOCKING - TO 85438 & 92034	1
32	18786	HUB	P20 - BEARING - INTERMEDIATE - TO 92446	1
33	18885	BALL	P20	2
34	18823	SCREW	P20 - CYLINDRIC - TO 92446	2
35	18650	SHOE	P20 - PRESSURE - TO 92446	1
36	18722	KEY	P20 - WOODRUFF - TO 92446	1
37	18820	SCREW	P20 - CYLINDRIC - TO 92446	1
38	18901	GASKET	P20 - TO 92446	1

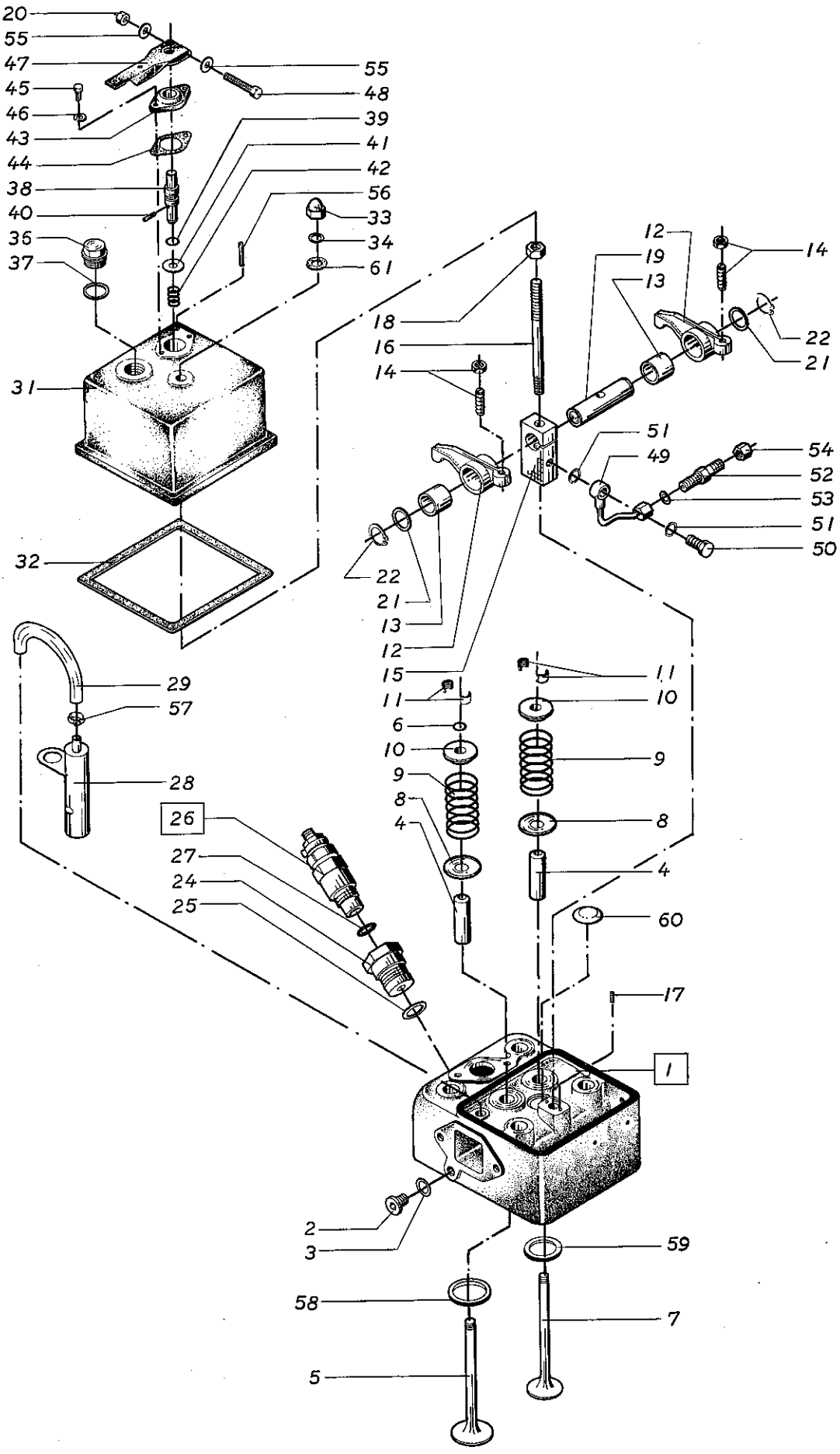
WESTERBEKE 10 & 20: CRANKSHAFT - ROD - PISTON



WESTERBEKE 10 & 20: CRANKSHAFT - ROD - PISTON

REF	PN	NAME	REMARKS	QUAN
39	18787	HUB	P20 - BRNG - INTERMEDIATE - FROM 92447	1
40	18822	SCREW	P20 - CYLINDRIC - FROM 92447	4
41-1	18721	LINER	P20 - INTERMEDIATE	1
41-2	18712	LINER	P20 - INTERMEDIATE - 0.3 MM U/S	1
41-3	18713	LINER	P20 - INTERMEDIATE - 0.6 MM U/S	1
42	16823	FLYWHEEL		1
43	17169	SCREW	FLYWHEEL TO CRANKSHAFT	6
44	17198	SCREW		1
45	18680	PULLEY	VBELT - FRONT	1
46	16923	COVER	FROM 85071 TO 85966 & TO 92946	1

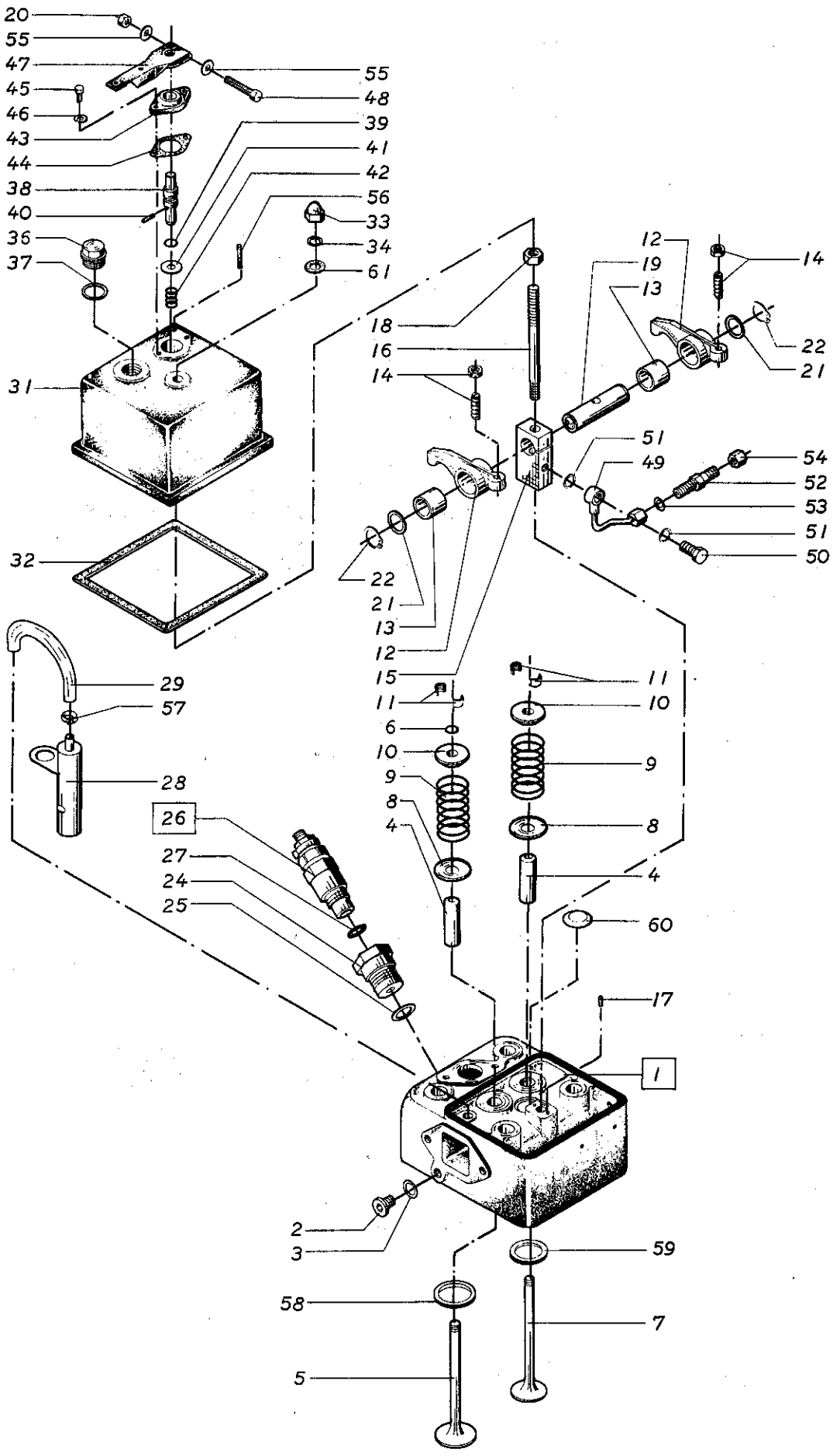
WESTERBEKE 10: CYLINDER HEAD - VALVES



WESTERBEKE 10: CYLINDER HEAD - VALVES

REF	PN	NAME	REMARKS	QUAN
1-1	18719	HEAD	CYLINDER - TO 85121	1
1-2	16845	HEAD	CYLINDER - FROM 85122	1
2	16926	PLUG	TO 85181	1
3	17202	SEAL		1
4	16853	GUIDE	VALVE	2
5	16851	VALVE	INLET	1
6	17153	O RING		1
7	16852	VALVE	EXHAUST	1
8	16927	DISC	SPRING RETAINING	2
9	16855	SPRING	VALVE	2
10	16854	DISC	SPRING RETAINING	2
11	16859	RING	CONICAL RETAINING	4
12-1	18782	ROCKER	TO 85121	2
12-2	16846	ROCKER	FROM 85122	2
12-3	18967	ASSEMBLY	ROCKER ARM	AR
13	16847	BUSHING		2
14-1	16850	SCREW	ADJUSTING - WITH NUT - TO 85121	2
14-2	18780	SCREW	ADJUSTING - WITH NUT - FROM 85122	2
15-1	16848	BRACKET	ROCKER ARM - TO 85121	1
15-2	18693	BRACKET	ROCKER ARM - FROM 85122	1
16	16858	STUD		1
17	16828	PIN		2
18	17189	NUT		1
19	16849	SHAFT	ROCKER	1
20	18836	NUT		1
21	16928	WASHER		2
22	18851	CIRCLIP		2
24	16862	CHAMBER	PRECOMBUSTION - UPPER	1
25	16861	GASKET		1
26	16768	INJECTOR	COMPLETE	1
27	16769	GASKET		1
28	16929	VALVE	VENTING	1
29	16930	LINE	PLASTIC	1
31	16857	COVER	CYLINDER HEAD	1
32	16866	GASKET	CYLINDER HEAD COVER	1
33	18838	NUT		1
34	17155	SEAL		1
36	16919	PLUG		1
37	16920	SEAL		1
38-1	18737	SHAFT	DECOMPRESSION HANDLE - TO 85529	1
38-2	16843	SHAFT	DECOMPRESSION HANDLE - FROM 85530	1
39	16934	SEAL		1
40-1	16935	PIN	TO 85529	1
40-2	18848	PIN	FROM 85530	1
41	17155	WASHER		1
42	17148	SPRING	DECOMPRESSION HANDLE	1
43	16937	FLANGE	DECOMPRESSION HANDLE	1
44	16938	GASKET		1
45	16939	SETSCREW		2
47	16821	HANDLE		1
48	16960	SETSCREW		1
49	16987	LINE	OIL	1
50	16988	BOLT	BANJO	1

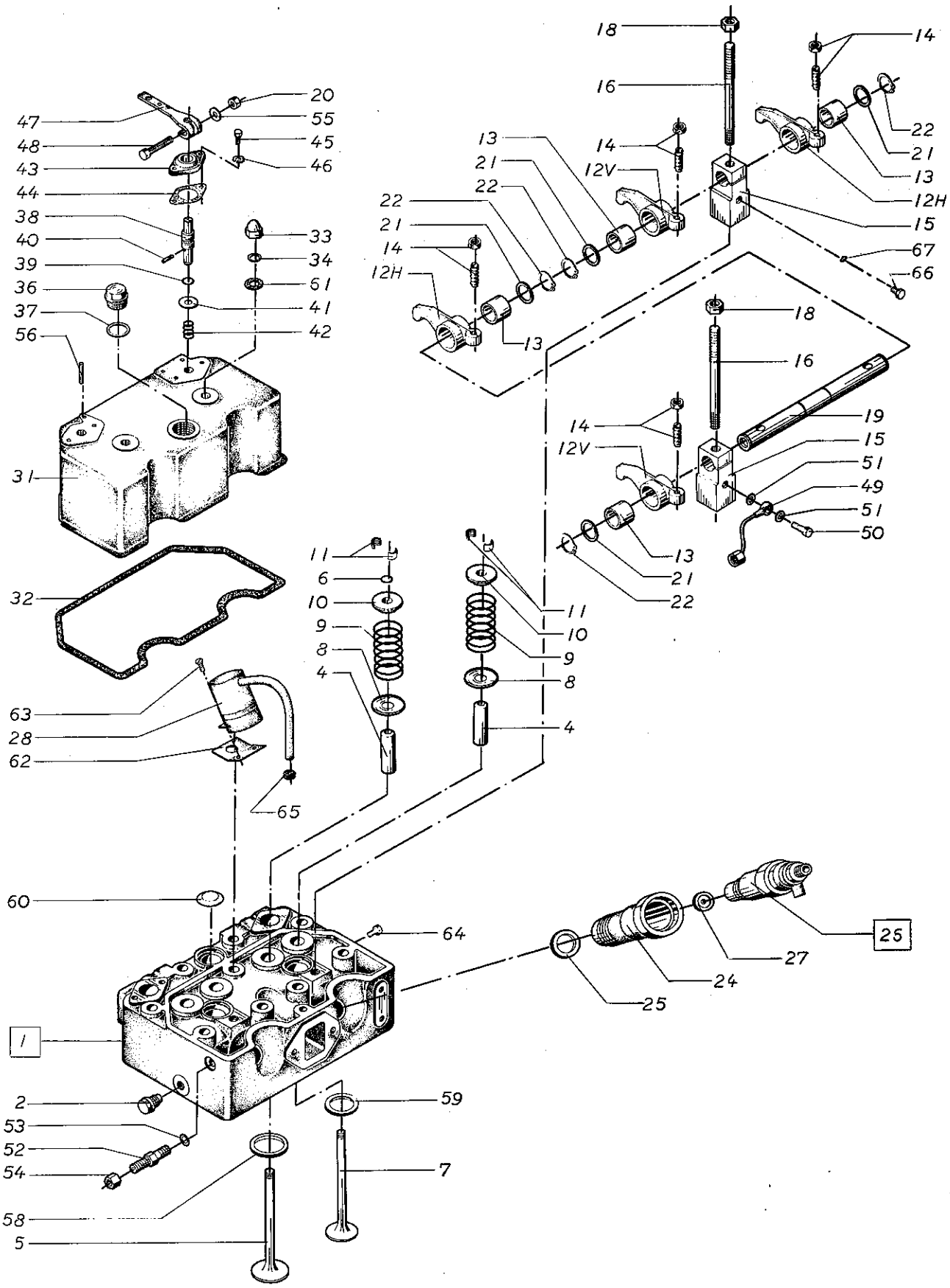
WESTERBEKE 10: CYLINDER HEAD - VALVES



WESTERBEKE 10: CYLINDER HEAD - VALVES

REF	PN	NAME	REMARKS	QUAN
51	16989	WASHER	BANJO	2
52	18718	NIPPLE	HEX	1
53	16990	SEAL		3
54	17161	NUT		1
55	16764	WASHER		2
56	18847	PIN	CYLINDRIC	1
58	18660	SEAT	VALVE - INLET - FROM 85182	1
59	18661	SEAT	VALVE - EXHAUST - FROM 85182	1
60	18642	DISC	EXPANSION - FROM 85122	1
61	18717	GASKET		1

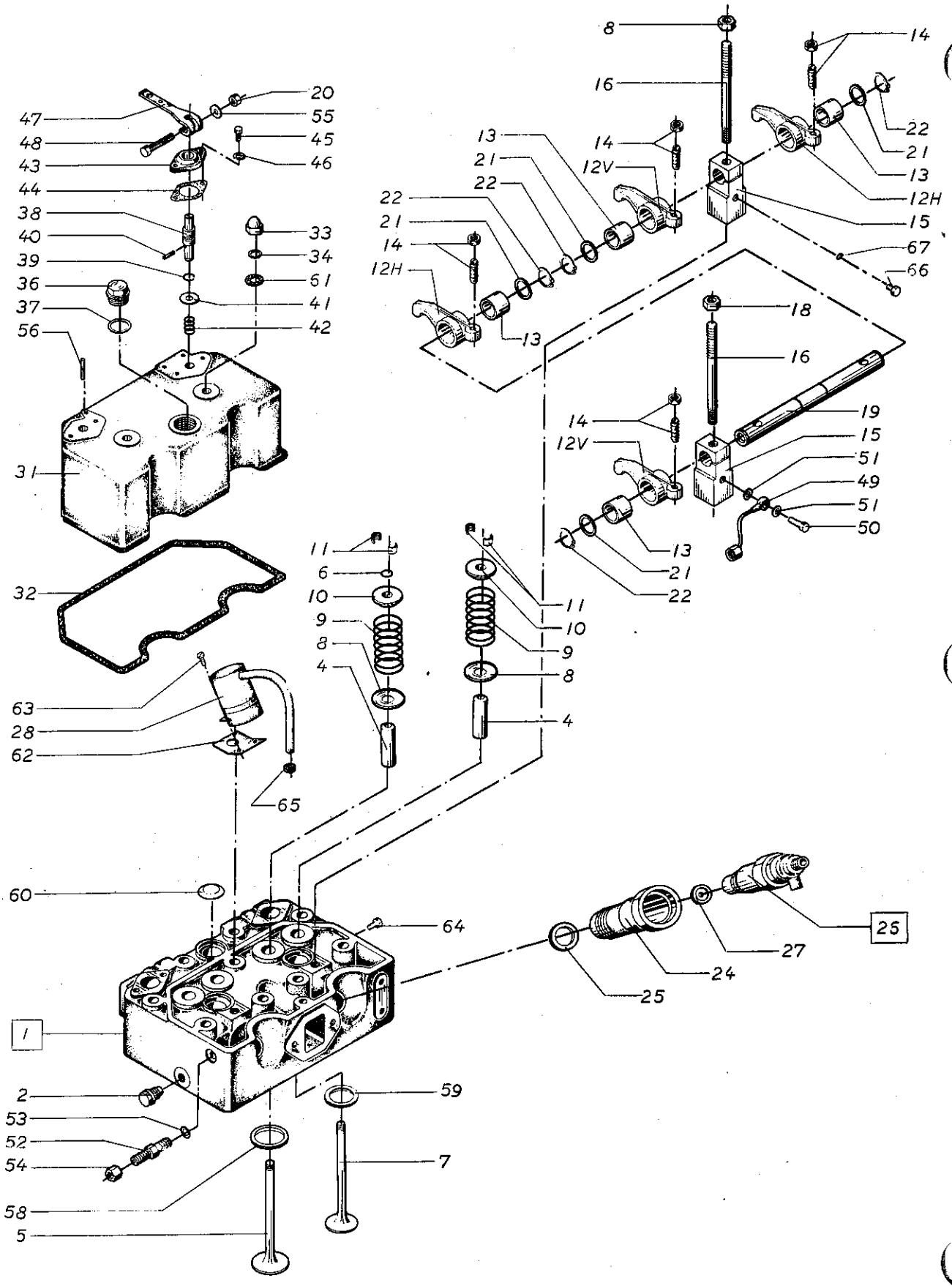
WESTERBEKE 20: CYLINDER HEAD - VALVES



WESTERBEKE 20: CYLINDER HEAD - VALVES

REF	PN	NAME	REMARKS	QUAN
1-1	18793	HEAD	CYLINDER - TO 92446	1
1-2	18794	HEAD	CYLINDER - FROM 92447	1
2	16926	PLUG	TO 92035	1
4	16853	GUIDE	VALVE	4
5	16851	VALVE	INLET	2
6	17153	O RING		2
7	16852	VALVE	EXHAUST	2
8	16927	DISC	SPRING RETAINING	4
9	16855	SPRING	VALVE	4
10	16854	DISC	SPRING RETAINING	4
11	16859	RING	CONICAL RETAINING	8
12-1	18897	ROCKER	RIGHT - TO 92006	2
12-2	18790	ROCKER	RIGHT - FROM 92007	2
12-3	18968	ASSEMBLY	ROCKER ARM	AR
13	18637	BUSHING		4
14-1	16850	SCREW	ADJUSTING - WITH NUT - TO 92006	4
14-2	18780	SCREW	ADJUSTING - WITH NUT - FROM 92007	4
15-1	16848	BRACKET	ROCKER ARM - TO 92006	2
15-2	18693	BRACKET	ROCKER ARM - FROM 92007	2
16	16858	STUD		2
17-1	18808	ROCKER	LEFT - TO 92006	2
17-2	18791	ROCKER	LEFT - FROM 92007	2
18	17189	NUT		2
19	18792	SHAFT	ROCKER	1
20	18836	NUT		2
21	16928	WASHER		4
22	18851	CIRCLIP		4
24	18727	CHAMBER	PRECOMBUSTION - UPPER	2
25	16861	GASKET		2
26	16768	INJECTOR	COMPLETE	2
27	16769	GASKET		2
28	18763	VALVE	VENTING	1
31-1	18742	COVER	CYLINDER HEAD - TO 92446	1
31-2	18695	COVER	CYLINDER HEAD - FROM 92447	1
32-1	18728	GASKET	CYLINDER HEAD COVER - TO 92446	1
32-2	18696	GASKET	CYLINDER HEAD COVER - FROM 92447	1
33	18838	NUT		2
34	17155	SEAL		2
36	16919	PLUG		1
37	16920	SEAL		1
38	16843	SHAFT	DECOMPRESSION HANDLE	2
39	16934	SEAL		2
40	18848	PIN		2
41	17155	WASHER		2
42	17148	SPRING	DECOMPRESSION HANDLE	2
43	16937	FLANGE	DECOMPRESSION HANDLE	2
44	16938	GASKET		2
45	16939	SETSCREW		4
47	16821	HANDLE		2
48	16960	SETSCREW		2
49	16987	LINE	OIL	1
50	16988	BOLT	BANJO	1
51	16989	WASHER	BANJO BOLT	2
52	18718	NIPPLE	HEX	1
53	16990	SEAL		3

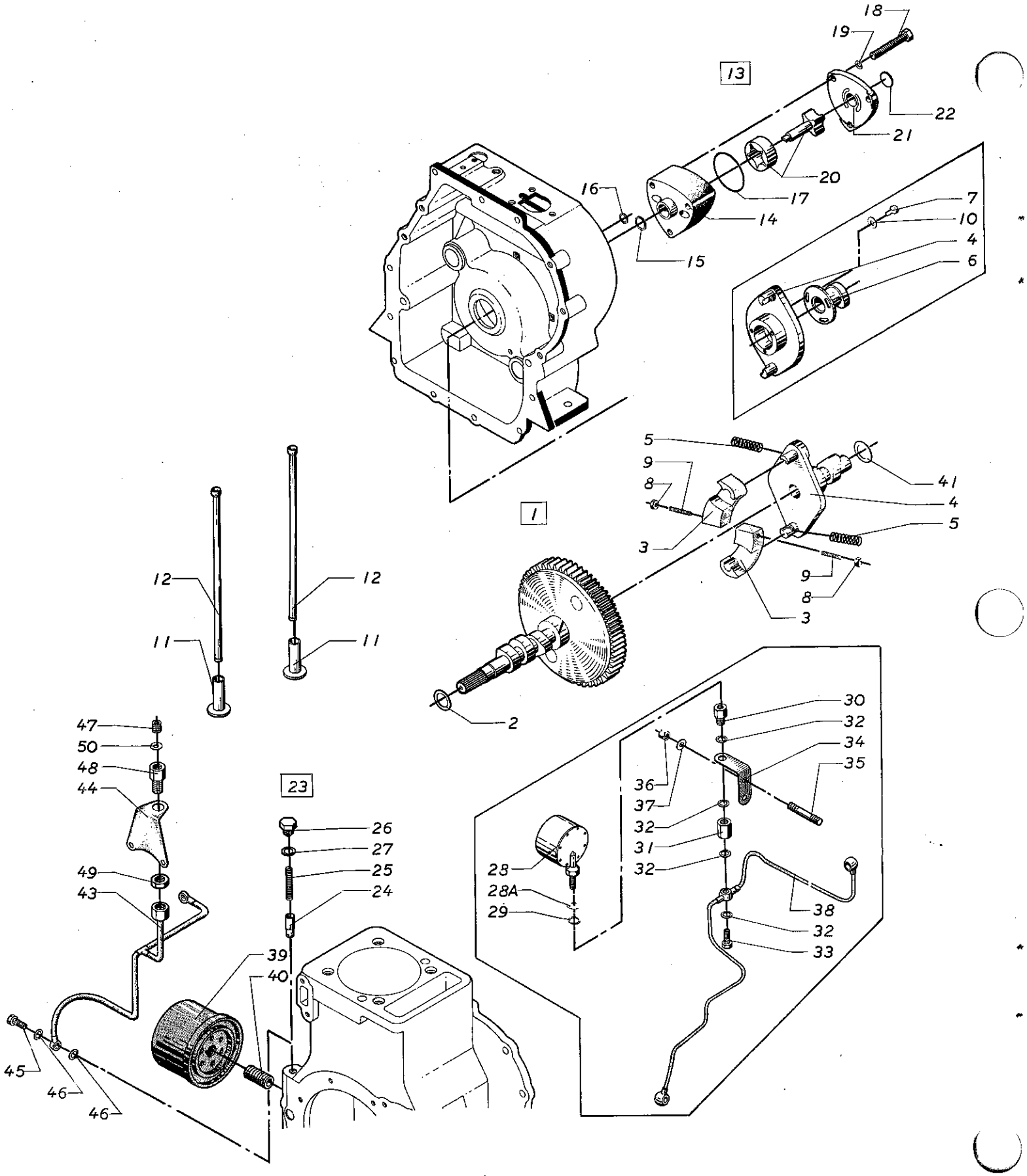
WESTERBEKE 20: CYLINDER HEAD - VALVES



WESTERBEKE 20: CYLINDER HEAD - VALVES

REF	PN	NAME	REMARKS	QUAN
54	17161	NUT		1
55	16764	WASHER		4
56	18847	PIN	CYLINDRIC	1
58	18660	SEAT	VALVE - INLET - FROM 92015	2
59	18661	SEAT	VALVE - EXHAUST - FROM 92015	2
60	18738	DISC	EXPANSION - FROM 92007	5
61	18717	GASKET		2
62	18690	BRACKET	VENTING VALVE	1
63	18825	SCREW		2
64	18834	SCREW		1
65	18899	SEAL		1
66	18832	SCREW		1
67	16989	GASKET		1

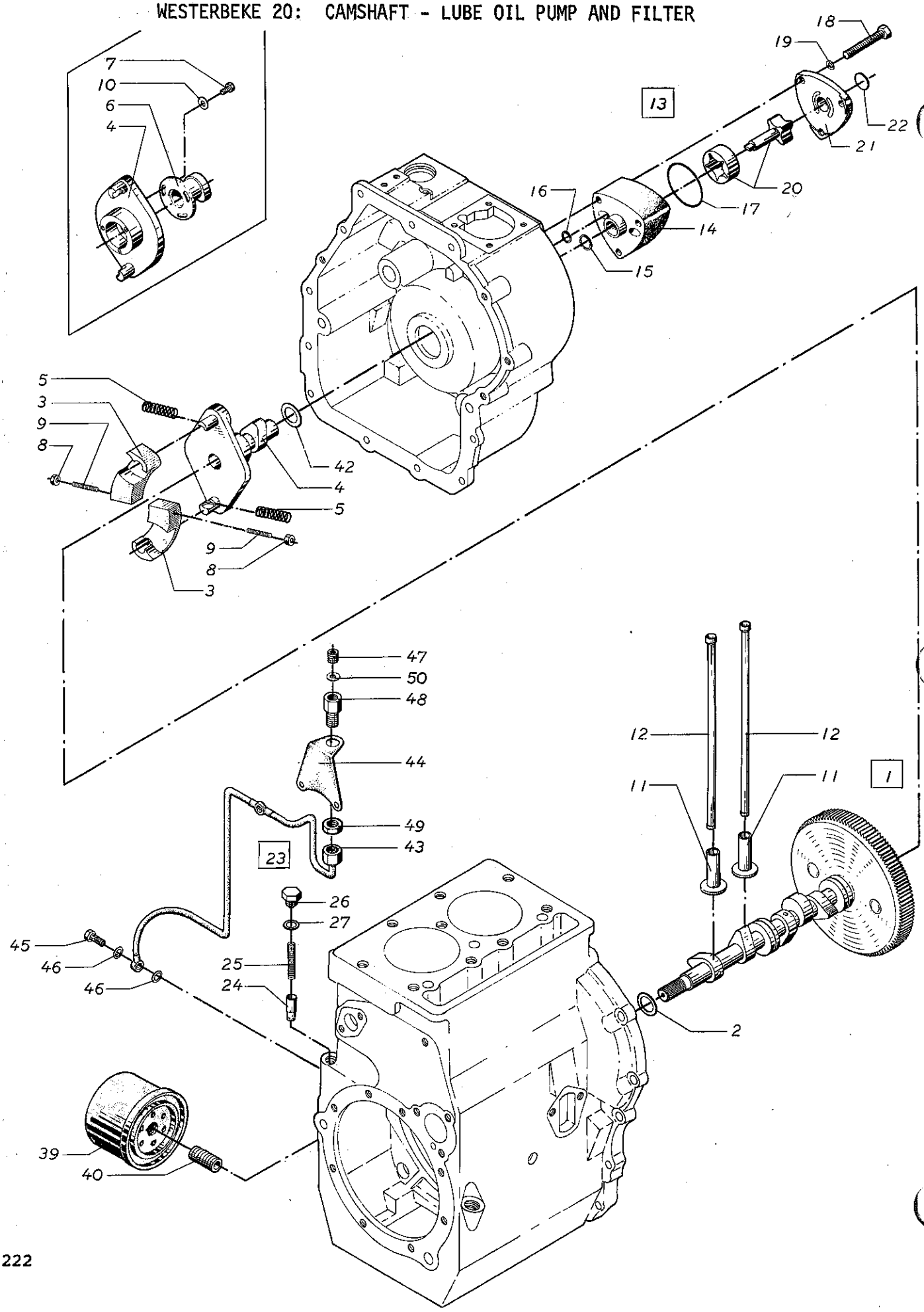
WESTERBEKE 10: CAMSHAFT - LUBE OIL PUMP AND FILTER



WESTERBEKE 10: CAMSHAFT - LUBE OIL PUMP AND FILTER

REF	PN	NAME	REMARKS	QUAN
1-1	18747	CAMSHAFT	TO 85963	1
1-2	16807	CAMSHAFT	FROM 85964	1
2	16971	RING	SPACING	1
3	16972	WEIGHT		2
4-1	16973	DRIVE	TO 85963	1
4-2	18783	DRIVE	FROM 85964	1
5	16974	SPRING		2
6	16975	CAM	FUEL OIL - WITH TIMING DEVICE - TO 85963	1
7	16976	SCREW	TO 85963	3
8	17175	NUT		2
9	16977	PIN	THREADED	2
10	18853	WASHER	SPRING - TO 85963	3
11-1	16808	GUIDE	PUSHROD - TO 85121	2
11-2	18658	GUIDE	PUSHROD - FROM 85122	2
12-1	16856	PUSHROD	COMPLETE - TO 85121	2
12-2	18659	PUSHROD	COMPLETE - FROM 85122	2
13	16868	PUMP	OIL - COMPLETE	1
14	16813	HOUSING	OIL PUMP	1
15	16978	SEAL		1
16	16979	SEAL		2
17	16980	SEAL		1
18	18912	SCREW		3
19	18863	GASKET		1
20	16982	SHAFT	WITH ROTOR	1
21	16814	COVER		1
22	17171	DISC	EXPANSION	1
23	16983	VALVE	OVERFLOW - COMPLETE	1
24	16865	PISTON		1
25	16864	SPRING		1
26	16863	PLUG		1
27	17202	GASKET		1
28	17149	GAUGE	OIL PRESSURE	1
29	17202	GASKET	TO 85121	1
30	17024	NIPPLE	TO 85121	1
31	17023	NUT	TO 85121	1
32	16990	GASKET	TO 85121	6
33	17022	BOLT	BANJO - TO 85121	2
34	17025	BRACKET	TO 85121	1
35	17026	STUD	TO 85121	2
36	17195	NUT	TO 85121	2
37	16959	WASHER	SPRING - TO 85121	2
38	16991	LINE	OIL - TO 85121	1
39	11951	FILTER	LUBE OIL	1
40	16984	NIPPLE		1
41	18674	SPACER		1
43	18753	LINE	OIL - ROCKER ARM - FROM 85122	1
44	18652	BRACKET	FROM 85122	1
45	17022	BOLT	BANJO - FROM 85122	1
46	16990	GASKET	FROM 85122	2
47	18833	SCREW	LOCKING - FROM 85122	1
48	18714	NIPPLE	FROM 85122	1
49	18772	LOCKNUT	FROM 85122	1
50	18863	GASKET	FROM 85122	1

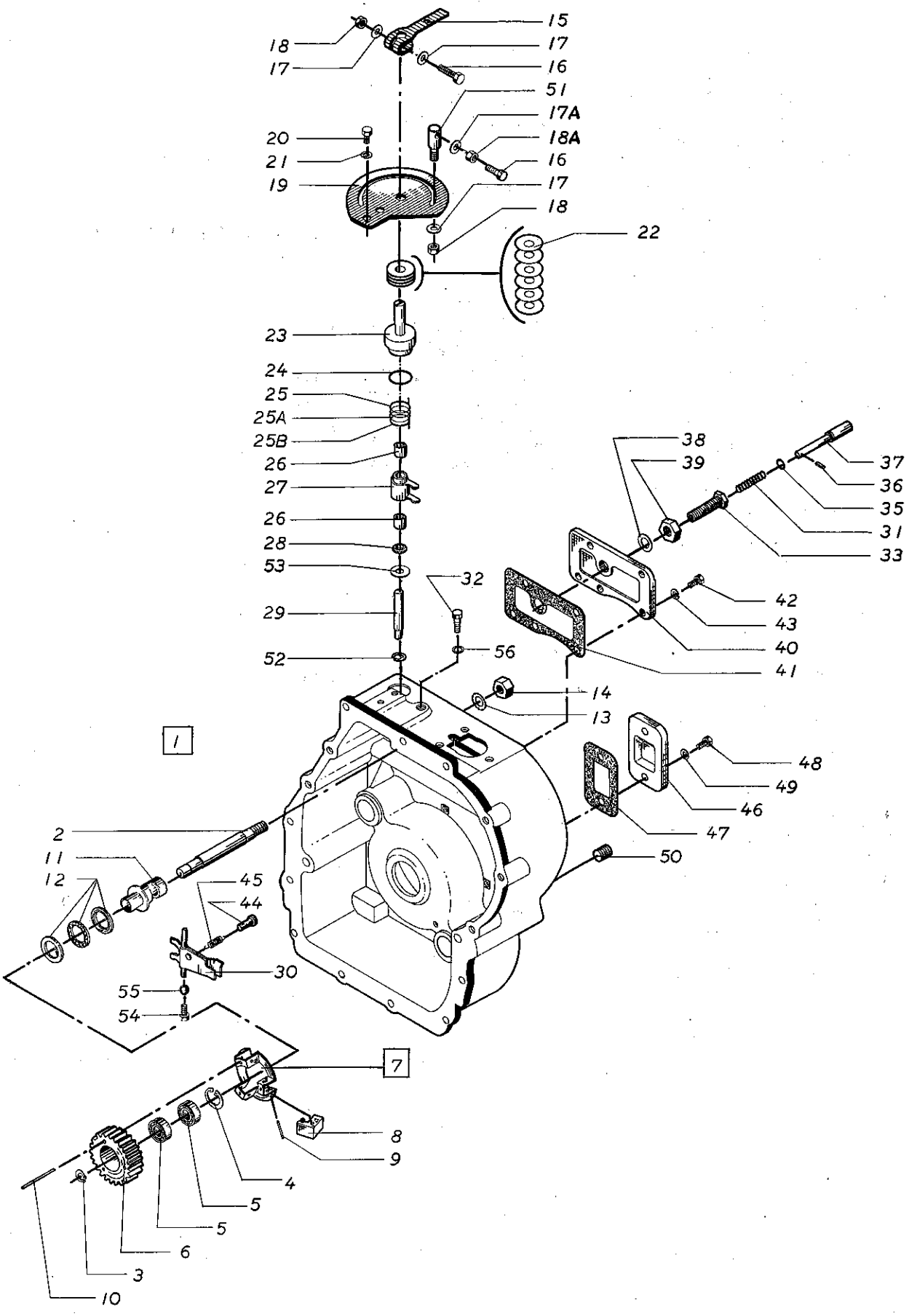
WESTERBEKE 20: CAMSHAFT - LUBE OIL PUMP AND FILTER



WESTERBEKE 20: CAMSHAFT - LUBE OIL PUMP AND FILTER

REF	PN	NAME	REMARKS	QUAN
1-1	18639	CAMSHAFT	TO 92446	1
2	16971	RING	SPACING	1
3	16972	WEIGHT		2
4-1	16973	DRIVE	TO 92446	1
4-2	18783	DRIVE	FROM 92447	1
5	16974	SPRING		2
6	18741	CAM	FUEL OIL - WITH TIMING DEVICE - TO 92446	1
7	16976	SCREW	TO 92446	3
8	17175	NUT		2
9	16977	PIN	THREADED	2
10	18853	WASHER	SPRING - TO 92446	3
10-2	18796	CAMSHAFT	FROM 92447	1
11-1	16808	GUIDE	PUSHROD - ALTERNATE	4
11-2	18658	GUIDE	PUSHROD - ALTERNATE	4
12-1	16856	PUSHROD	COMPLETE - ALTERNATE	4
12-2	18659	PUSHROD	COMPLETE - ALTERNATE	4
13	18797	PUMP	OIL - COMPLETE	1
14	18723	HOUSING	OIL PUMP	1
15	16978	SEAL		1
16	16979	SEAL		2
17	16980	SEAL		1
18	18812	SCREW		3
20	18764	SHAFT	WITH ROTOR	1
21	16814	COVER		1
22	17171	DISC	EXPANSION	1
23	16983	VALVE	OVERFLOW - COMPLETE	1
24	16865	PISTON		1
25	16864	SPRING		1
26	16863	PLUG		1
27	17202	GASKET		1
39	16795	FILTER	LUBE OIL	1
40	16984	NIPPLE		1
42	18869	WASHER	FROM 92447	1
43	18754	LINE	OIL - ROCKER ARM	1
44	18652	BRACKET		1
45	17022	BOLT	BANJO	1
46	16990	GASKET		2
47	18833	SCREW	LOCKING	1
48	18714	NIPPLE		1
49	18772	LOCKNUT		1
50	18863	GASKET		1

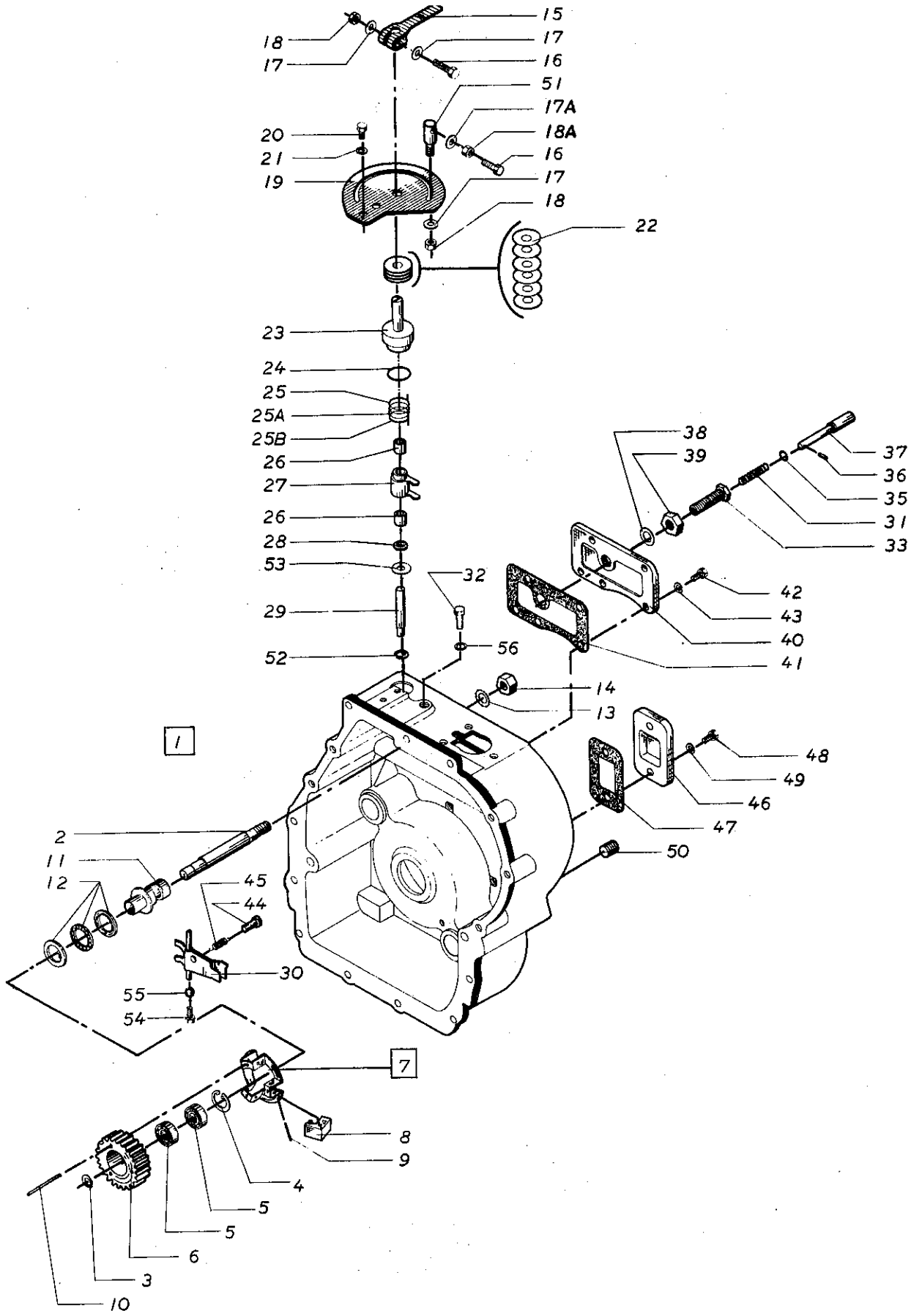
WESTERBEKE 10 & 20: GOVERNOR



WESTERBEKE 10 & 20: GOVERNOR

REF	PN	NAME	REMARKS	QUAN
1-1	16872	GOVERNOR	P10 - COMPLETE	1
1-2	18795	GOVERNOR	P20 - COMPLETE	1
2-1	16833	SHAFT	P10	1
2-2	18734	SHAFT	P20	1
3	17160	CIRCLIP		1
4	17159	CIRCLIP		1
5	17158	BALLBEARING		2
6-1	16815	GEAR	P10	1
6-2	18700	GEAR	P20	1
7	18781	HUB	COMPLETE	1
8	16874	WEIGHT		3
9	16875	JOURNAL		3
10	16949	STUD		3
11	16950	COLLAR		1
12	16951	BALLBEARING		1
14	17194	NUT		1
15	16821	HANDLE	REGULATING	1
16	16960	SETSCREW		2
17	18852	WASHER		2
18	17191	NUT		2
19-1	16957	PLATE	ADJUSTING - FROM 85122 & 92007	1
19-2	18743	PLATE	ADJUSTING - TO 85121 & 92006	1
20	17196	SETSCREW		2
22	16961	SPRING		6
23	16955	SHAFT		1
24	16956	SEAL		1
25	16817	SPRING	2000-3000 RPM	1
26	16952	BUSHING	TO 87602 & 92997	2
27-1	16816	GOVERNOR	TO 87602 & 92997	1
27-2	18961	GOVERNOR	FROM 87603 & 92997	1
28	16954	COLLAR	THRUST - TO 87602 & 92997	1
29	16953	SHAFT		1
30	16962	ARM	FUEL INJECTION PUMP	1
31	17150	SPRING		1
32	16963	SCREW		1
33	18970	SCREW		1
35	17154	SEAL		1
36	16966	PIN		1
37-1	16965	PIN	P10	1
37-2	18648	PIN	P20	1
38	18895	GASKET		1
39	18894	NUT		1
40-1	18969	COVER		1
40-2	18896	ASSEMBLY	COVER	1
41	16968	GASKET		1
42	18893	SETSCREW		5
44-1	16969	BOLT	P10	1
44-2	18735	BOLT	P20	1
43	16970	SPRING		1
46	16913	COVER	P10 - TO 85963	1
47	16914	GASKET	P10 - TO 85963	1
48	16789	SETSCREW	P10 - TO 85963	2
50	16915	SCREW		3

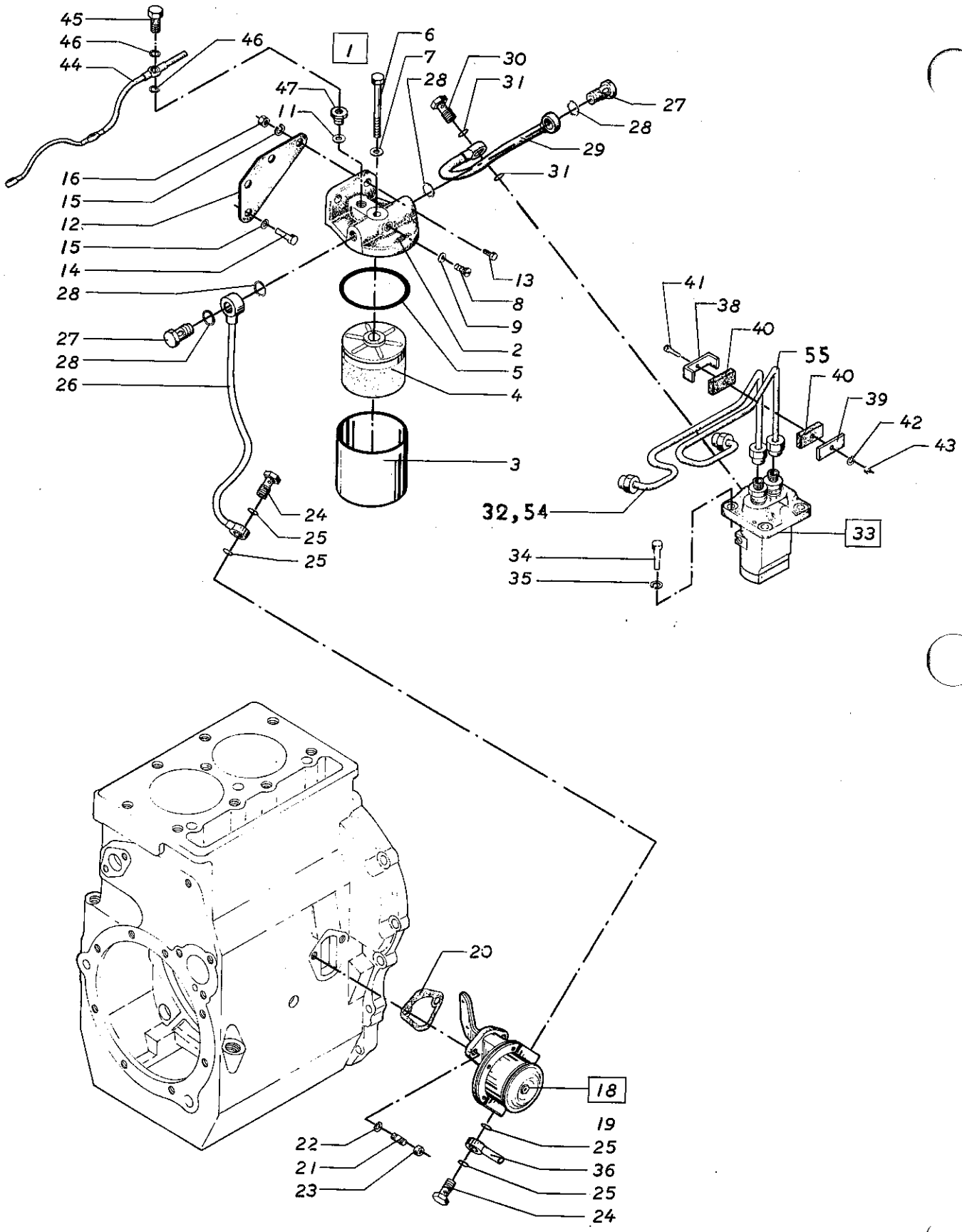
WESTERBEKE 10 & 20: GOVERNOR



WESTERBEKE 10 & 20: GOVERNOR

REF	PN	NAME	REMARKS	QUAN
51	16958	PIN		2
52	18867	LOCKRING		1
53	18860	WASHER	TO 87602 & 92997	1
54	18686	SCREW	ADJUSTING	1
55	18884	BALL	STEEL	1
56	16990	GASKET		1
57	16764	WASHER		2
58	18836	NUT		2
59	16818	SPRING	1500-1800 RPM	1
60	16819	SPRING	1800-2500 RPM	1

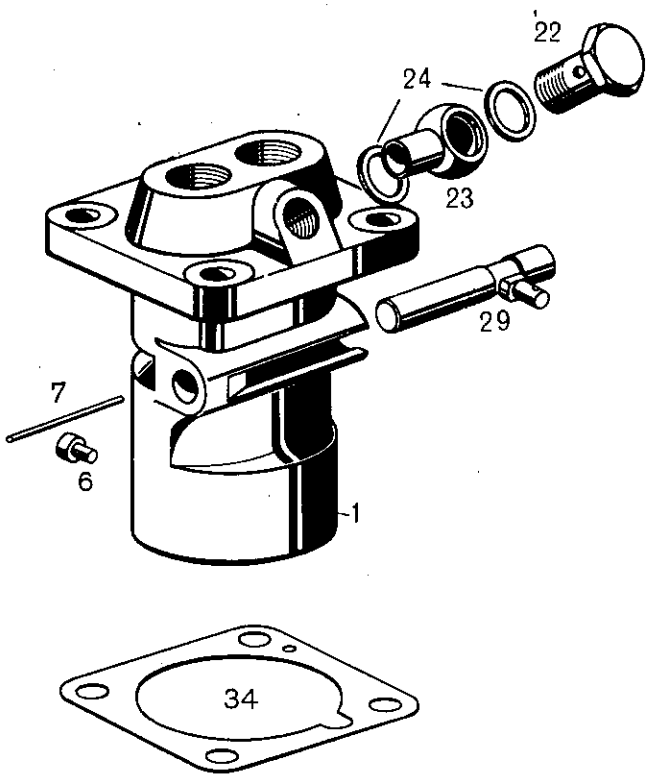
WESTERBEKE 10 & 20: FUEL SYSTEM

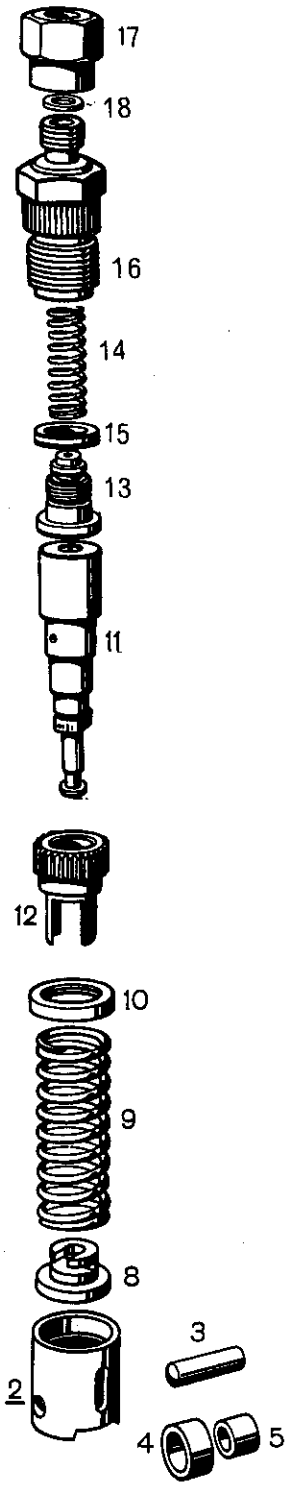


WESTERBEKE 10 & 20: FUEL SYSTEM

REF	PN	NAME	REMARKS	QUAN
1	16867	FILTER	FUEL - COMPLETE	1
2	16993	COVER		1
3	16994	CUP		1
4	16995	ELEMENT		1
5	17181	GASKET		1
6	16996	BOLT		1
7	16989	GASKET		1
8	16997	SCREW	AIR BLEED	1
9	17184	GASKET		1
11	17202	GASKET		1
12-1	16946	BRACKET	P10	1
12-2	18655	BRACKET	P20-CARTRIDGE TYPE FILTER	1
12-3	20656	BRACKET	P20-SPIN ON TYPE FILTER	1
13	17180	SCREW		2
14	17192	SCREW		2
16	17189	NUT		2
18	16774	PUMP	FUEL LIFT - COMPLETE	1
19	16775	KIT	REPAIR	AR
20	17204	GASKET		1
21	16765	STUD		2
23	17195	NUT		2
24	16772	BOLT	BANJO	2
25	16773	GASKET		4
26-1	16985	LINE	P10 - FUEL LIFT PUMP TO FILTER	1
26-2	18759	LINE	P20 - FUEL LIFT PUMP TO FILTER	1
27	16767	BOLT	BANJO	2
28	17202	GASKET		4
29-1	16986	LINE	P10 - FILTER TO FUEL INJECTION PUMP	1
29-2	18755	LINE	P20 - FILTER TO FUEL INJECTION PUMP	1
30	16784	BOLT	BANJO	1
31	16766	GASKET		2
32	16812	LINE	P10 - FUEL - HIGH PRESSURE	1
33-1	18908	PUMP	P10 - FUEL INJECTION - COMPLETE	1
33-2	18910	PUMP	P20 - FUEL INJECTION - COMPLETE	1
34	17196	SCREW		4
36	16998	BANJO		1
38	18683	CLAMP	P20	2
39	18684	PLATE	P20 - COUNTER	2
40	18685	DAMPER	P20 - RUBBER	4
41	18801	BOLT	P20	2
43	18839	NUT	P20	2
44-1	18757	LINE	P10 - RETURN - FUEL VALVE FILTER	1
44-2	18765	LINE	P20 - RETURN - FUEL VALVE FILTER	1
45	16988	BOLT	BANJO	1
46	16989	GASKET		2
47	18672	SCREW	THROTTLE	1
48	18870	TUBE	P10 - RUBBER	1
49	18651	BRACKET	P10	1
50	18682	SADDLE	P10	1
51	17093	SCREW	P10	1
53	18835	NUT	P10	1
54	18656	LINE	P20 - FUEL - HIGH PRESSURE - CYL I	1
55	18657	LINE	P20 - FUEL - HIGH PRESSURE - CYL II	1

WESTERBEKE 10 & 20: FUEL INJECTION PUMP

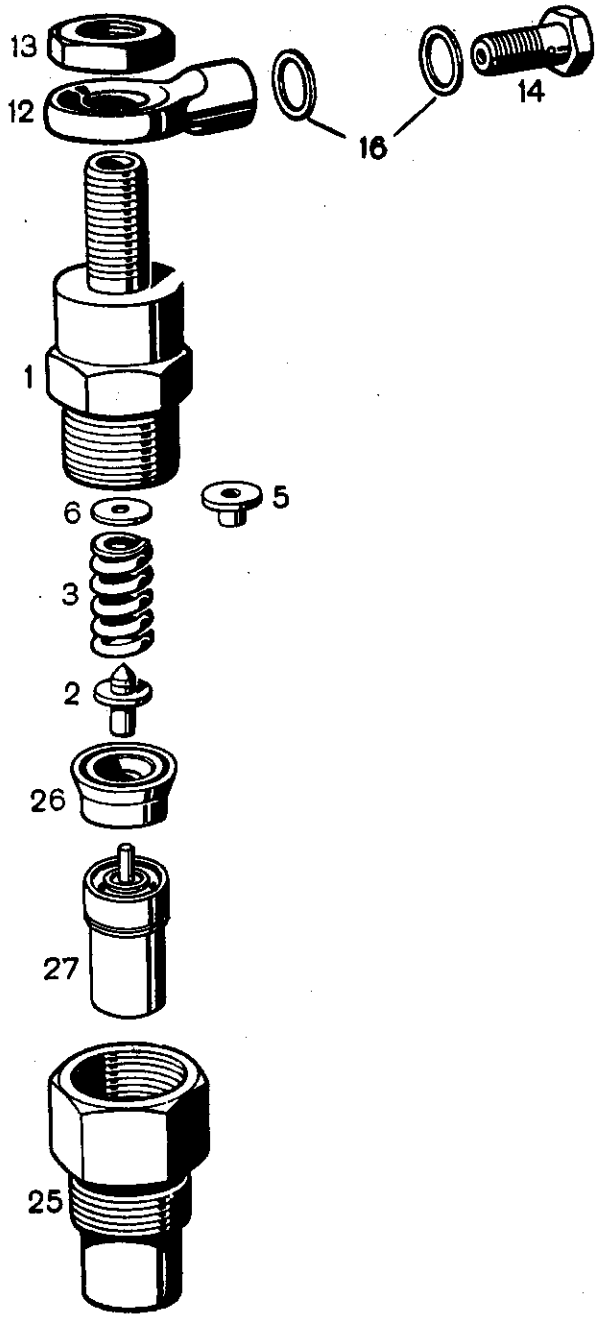




WESTERBEKE 10 & 20: FUEL INJECTION PUMP

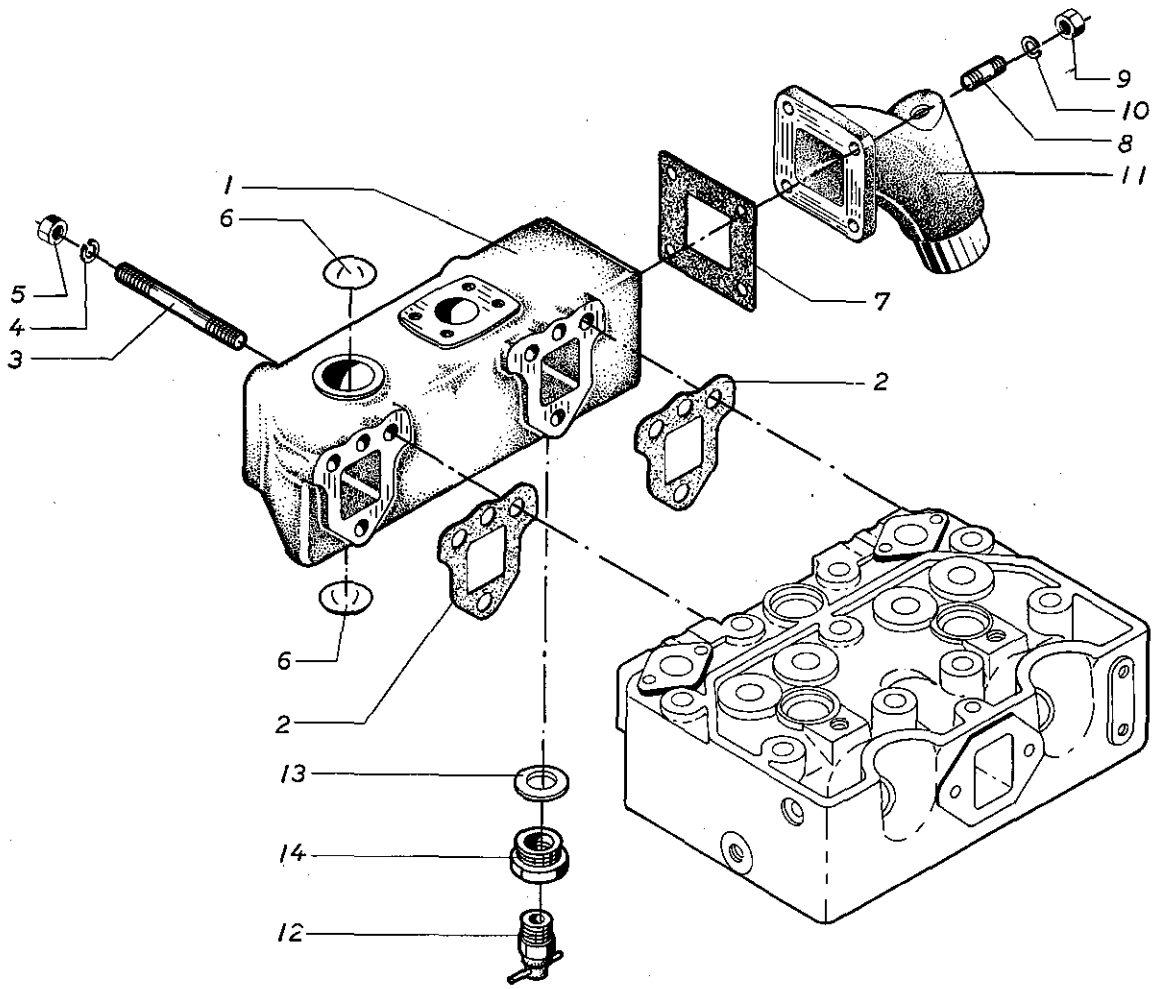
REF	PN	NAME	REMARKS	QUAN
1-1	18908	PUMP	P10 - FUEL INJECTION - COMPLETE	1
1-2	18910	PUMP	P20 - FUEL INJECTION - COMPLETE	1
2-1	16877	TAPPET	P10 - COMPLETE	1
2-2	18911	TAPPET	P20 - COMPLETE	1
3	16878	BOLT	BEARING - NOT SOLD AS SPARE PART	1
4	16879	ROLLER	NOT SOLD AS SPARE PART	1
5	16880	BUSHING	NOT SOLD AS SPARE PART	1
6	16881	SCREW		1
7-1	16895	RING	P10 - SPRING	1
7-2	18912	RING	P20 - SPRING	1
8	16894	PLATE	LOWER - SPRING	1
9	16893	SPRING	PLUNGER	1
10	16892	PLATE	UPPER - SPRING	1
11	16882	SHAFT		1
12-1	16883	SLEEVE	P10 - CONTROL - 18.70 MM	AR
12-2	18915	SLEEVE	P20 - CONTROL - 18.70 MM	AR
12-3	16884	SLEEVE	P10 - CONTROL - 18.85 MM	AR
12-4	18916	SLEEVE	P20 - CONTROL - 18.85 MM	AR
13-1	16890	SEAT	TO 85181 & 92146	1
13-2	18917	SEAT	FROM 85182 & 92147	1
13-3	18913	RING	PACKING	AR
14-1	16889	SPRING	DELIVERY - TO 85181 & 92146	1
14-2	18918	SPRING	DELIVERY - FROM 85182 & 92147	1
15-1	16891	SEAL	TO 85181 & 92146	1
15-2	18920	SEAL	FROM 85182 & 92147	1
16-1	16888	CONNECTOR	TO 85181 & 92146	1
16-2	18919	CONNECTOR	FROM 85182 & 92147	1
17	17157	NUT		1
18	17156	WASHER		1
22	16784	BOLT	BANJO	1
23	16886	BANJO		1
24	16766	WASHER	COPPER ASBESTOS - BANJO BOLT	2
29-1	16885	ROD	P10 - CONTROL	1
29-2	18914	ROD	P20 - CONTROL	1
34-1	18859	PLATE	P10 - ADJUSTING -0.15 MM	AR
34-2	16943	PLATE	P10 - ADJUSTING - 0,2 MM	AR
34-3	18857	PLATE	P20 - ADJUSTING -0,2 MM	AR
34-4	18858	PLATE	ADJUSTING - 0,3 MM	AR

WESTERBEKE 10 & 20: FUEL INJECTOR



WESTERBEKE 10 & 20: FUEL INJECTOR

REF	PN	NAME	REMARKS	QUAN
1	16768	INJECTOR	COMPLETE	NA
2	16776	SPINDLE		1
3	16771	SPRING		1
5	16783	BUSHING		1
6-1	17162	WASHER	0.1 MM	AR
6-2	16779	WASHER	0.15 MM	AR
6-3	17163	WASHER	0.2 MM	AR
6-4	16780	WASHER	0.25 MM	AR
6-5	17164	WASHER	0.5 MM	AR
6-6	17165	WASHER	1.0 MM	AR
6-7	16781	WASHER	2.0 MM	AR
6-8	16782	WASHER	3.5 MM	AR
12	16777	BANJO	FUEL RETURN	1
13	16778	NUT		1
14	16767	BOLT		1
16	16989	WASHER	BANJO BOLT	2
25	16770	HOUSING	NOZZLE	1
26	17203	DISC		1
27	16896	NOZZLE		1


1
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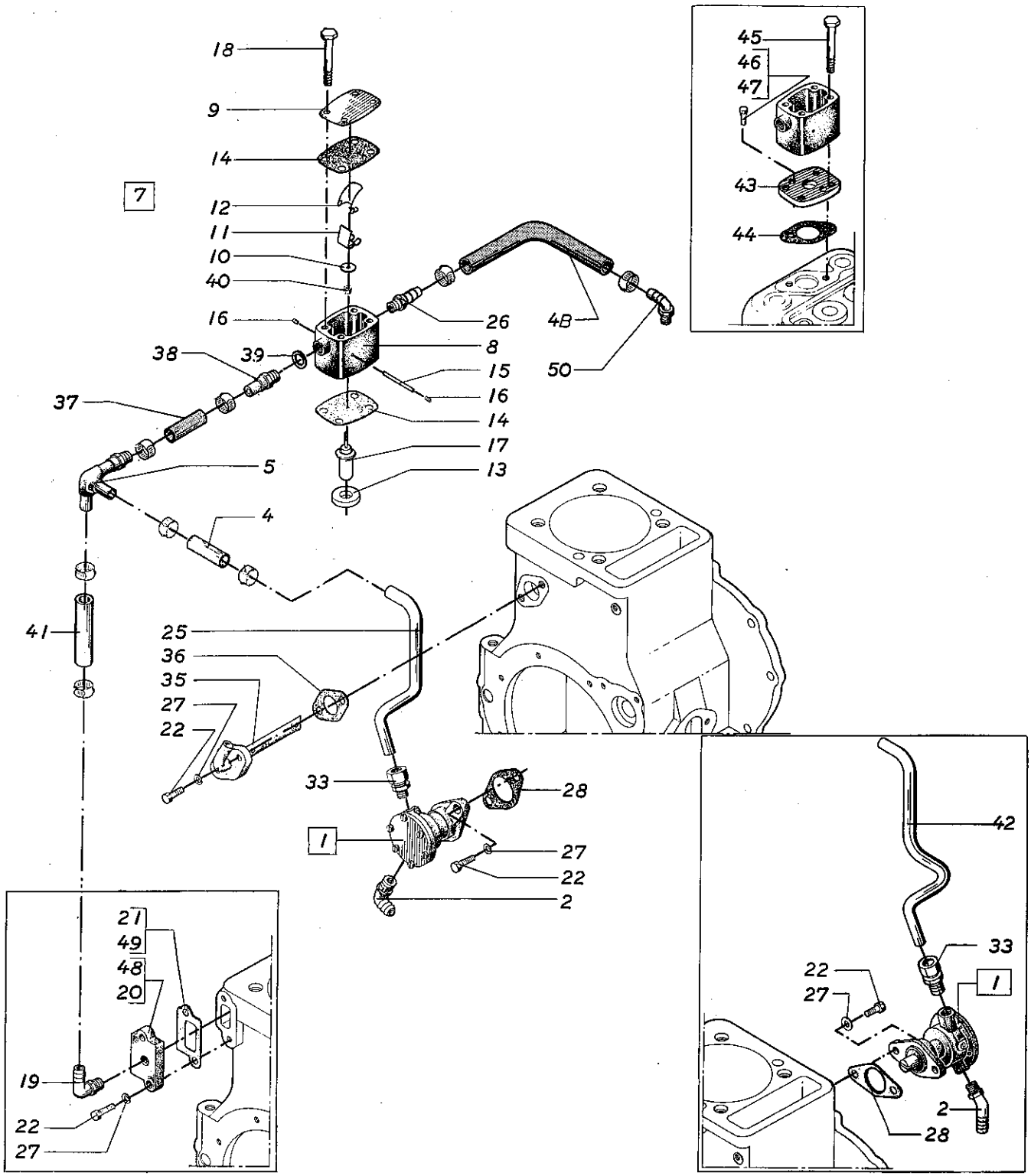
12

WESTERBEKE 10 & 20: AIR INTAKE AND EXHAUST SYSTEMS

REF	PN	NAME	REMARKS	QUAN
1-1	17040	MANIFOLD	P10 - EXHAUST - WATER COOLED	1
1-2	18710	MANIFOLD	P20 - EXHAUST - WATER COOLED	1
2	18740	GASKET	P20	2
3-1	17086	STUD	P10	4
3-2	18831	STUD	P20	4
5-1	17195	NUT	P10	4
5-2	17189	NUT	P20	4
6	18738	DISC	P20 - EXPANSION	4
7	17039	GASKET		2
8	17045	STUD		4
9	16787	NUT		4
11	19128	ELBOW	WATER INJECTED	1
12	18956	DRAINPLUG		1
13	16794	GASKET		2
14	18874	PLUG	P20	1
15	16898	PLUG	P10	1
16	17046	ELBOW	EXHAUST - WATER INJECTED	1
17	17047	ELBOW	P10	1
18-1	17048	LINE	P10	1
18-2	18654	LINE	P20	1
19	17049	ADAPTER		1
20-1	17085	FLANGE	P10 - AIR INLET SILENCER TO HEAD	1
20-2	18744	FLANGE	P20 - AIR INLET SILENCER TO HEAD	1
21	17192	SCREW	P10	1
22	16842	SILENCER	AIR INTAKE	1
23	16765	STUD		2
24	17195	NUT		2
25	16620	ELBOW	WATER INJECTED - OPTIONAL	AR

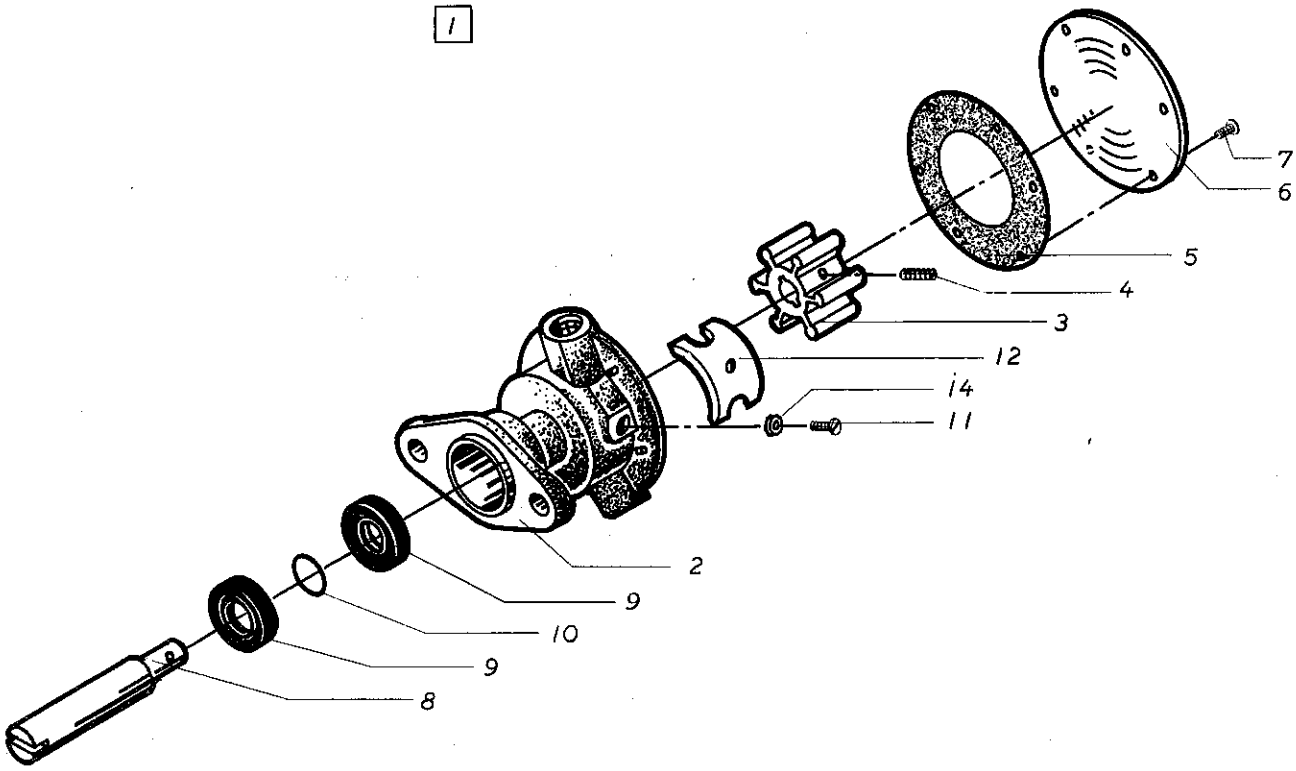
WESTERBEKE 10 & 20: COOLING SYSTEM WITH ORIGINAL THERMOSTAT



WESTERBEKE 10 & 20: COOLING SYSTEM WITH ORIGINAL THERMOSTAT

REF	PN	NAME	REMARKS	QUAN
1-1	18907	PUMP	P10 - SEA WATER - COMPLETE	1
1-2	18903	PUMP	P20 - SEA WATER - COMPLETE	1
2	17065	ELBOW		1
4	17066	HOSE	P10 - SPECIFY LENGTH	AR
5	17069	ELBOW	P10	1
7	17070	THERMOSTAT	COMPLETE	1
8	17071	HOUSING	THERMOSTAT	1
9	17072	COVER		1
10	17073	PLATE		1
11	17074	FLAP		1
12	17075	SPRING		1
13	17076	RING		1
14	18707	GASKET		2
15	17078	SHAFT		1
16	17079	SCREW		2
17	17080	ELEMENT		1
18	17081	BOLT	FROM 85122	4
19-1	18872	ELBOW	P10 - TO 85966	1
19-2	17065	ELBOW	P20 - TO 92946	1
20	16923	COVER	WATER INLET	1
21	16924	GASKET	FROM 85071 TO 85966 & TO 92946	1
22	18816	SCREW		4
25	18649	TUBE	P10 - FROM 85122	1
26	17088	NIPPLE	P10	1
28	17089	GASKET		1
33	18873	NIPPLE		1
34	18767	HOSE	P20	1
35-1	18761	COVER	P20 - FROM 92947	1
35-2	18760	COVER	P10 - FROM 85967	1
36	18679	GASKET		1
37	17066	HOSE	P10	AR
38	18758	NIPPLE	P20	1
39	17202	GASKET	COPPER	1
40	18841	NUT		1
41	17066	HOSE		AR
42	17087	HOSE	P10	1
43	18746	NIPPLE	P10	1
44	18736	GASKET	P10	1
45	17081	BOLT	P10	2
46	18802	SCREW	P10	2
47	18821	SCREW	P10 - COUNTERSUNK	2
48	18745	COVER	P10	1
49	18725	GASKET	P10	1
50	17065	ELBOW	P10	1

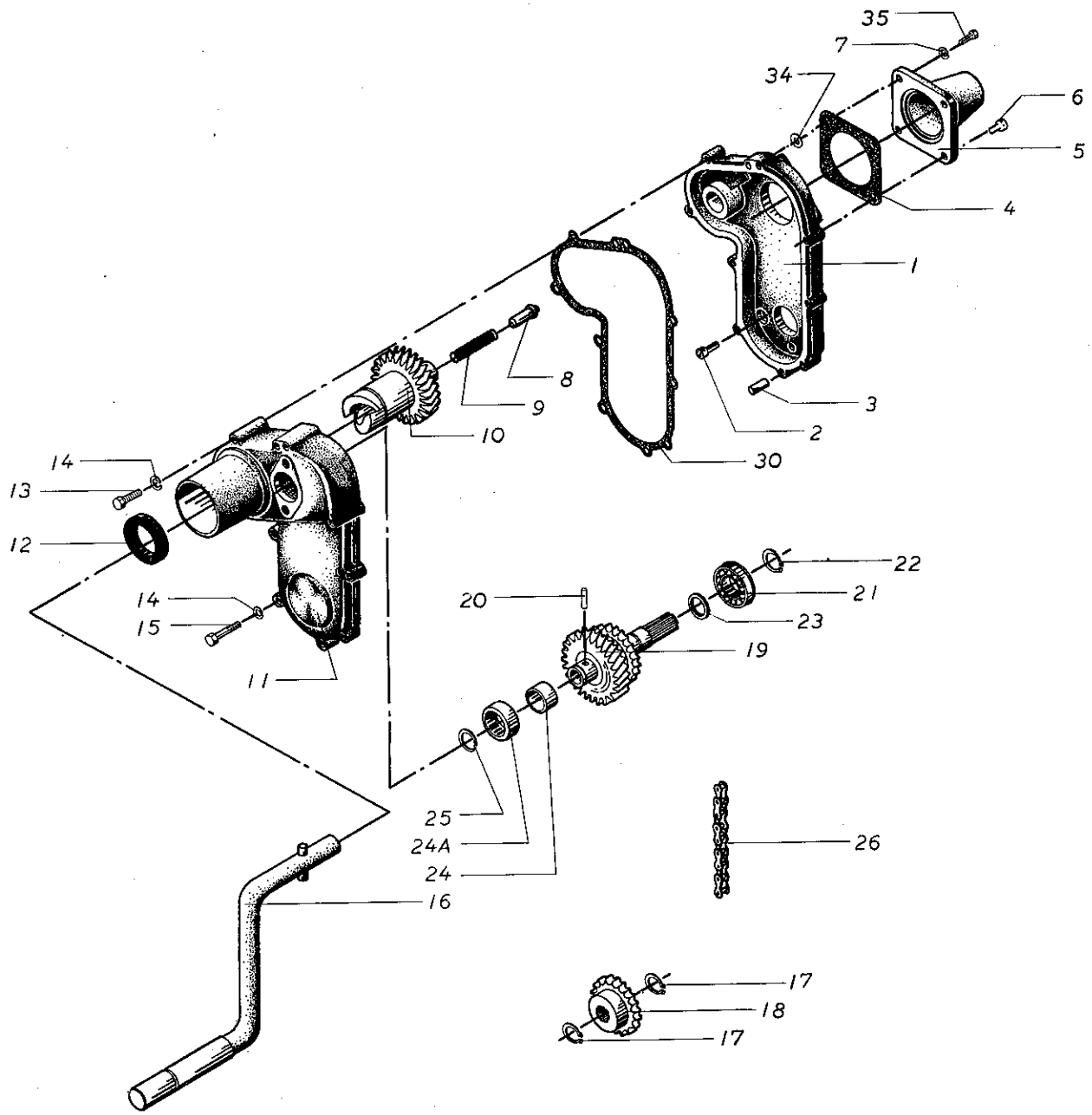
WESTERBEKE 10 & 20: SEA WATER PUMP



WESTERBEKE 10 & 20: SEA WATER PUMP

REF	PN	NAME	REMARKS	QUAN
1-1	16869	PUMP	P10 - SEA WATER - COMPLETE	1
1-2	18903	PUMP	P20 - SEA WATER - COMPLETE	1
2	17028	HOUSING	PUMP	1
3	17031	IMPELLER	WITH BUSHING	1
4	17036	SCREW		1
5	17032	GASKET		1
6	17027	COVER		1
7	17035	SCREW		6
8	17030	SHAFT		1
9	17033	SEAL		2
10	17034	O RING		1
11	17035	SCREW		1
12-1	17029	CAM	P10	1
12-2	18905	CAM	P20	1
14	17037	WASHER	COPPER	1
15-1	18902	REPAIR KIT	P10	AR
15-2	18906	REPAIR KIT	P20	AR

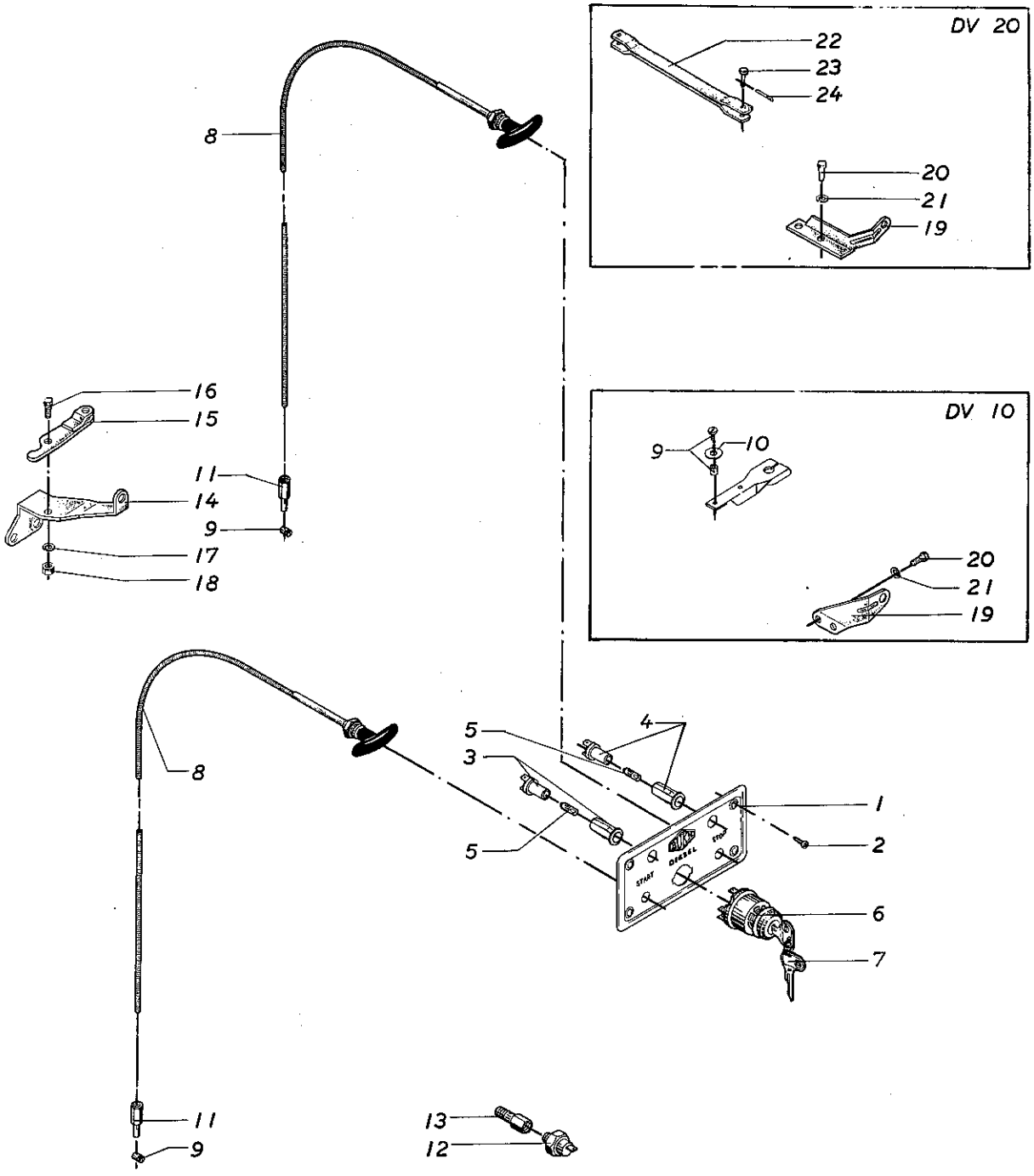
WESTERBEKE 10 & 20: HAND CRANKING SYSTEM



WESTERBEKE 10 & 20: HAND CRANKING SYSTEM

REF	PN	NAME	REMARKS	QUAN
1-1	17000	HOUSING	HALF - TO 85966	1
1-2	18668	HOUSING	HALF - FROM 85967	1
2	17001	SCREW		4
3	17002	PIN		2
4	17011	GASKET		1
5	17010	FLANGE		1
6	17012	SCREW		2
8-1	17013	GUIDE	VALVE SPRING - TO 85966	1
8-2	18669	GUIDE	VALVE SPRING - FROM 85967	1
9	17014	SPRING	STARTING HANDLE CLAW	1
10	17015	GEAR		1
11	17016	HOUSING	HALF	1
12	17017	SEAL		1
13	17019	BOLT		4
15	18805	BOLT		4
16	17020	CRANK		1
17	17147	CIRCLIP		2
18	17003	SPROCKET		1
19	17004	SHAFT	WITH SPROCKET AND GEAR	1
20	17006	PIN		1
21	17005	BEARING		1
22	16793	CIRCLIP		1
23	16907	WASHER		1
24	17007	SLEEVE		1
25	17008	CIRCLIP		1
26	17009	CHAIN	HAND STARTING	1
27	17021	BEARING		1
30	17018	GASKET	HAND STARTING HOUSING	1
34	18638	GASKET		1
35	18804	SCREW		2

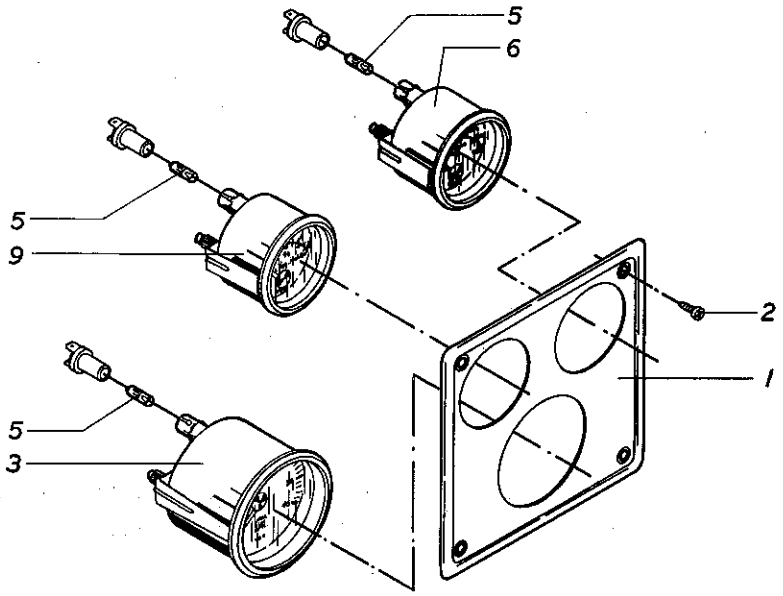
WESTERBEKE 10 & 20: STANDARD INSTRUMENT PANEL

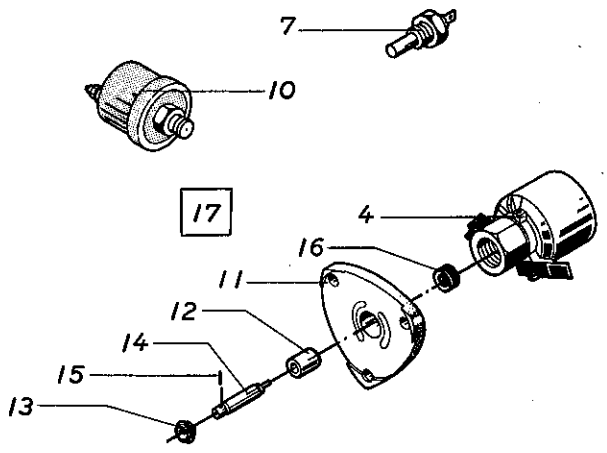


WESTERBEKE 10 & 20: STANDARD INSTRUMENT PANEL

REF	PN	NAME	REMARKS	QUAN
1	18646	PANEL	INSTRUMENT	1
2	18826	SCREW	SELF TAPPING	4
3	18890	LAMP	CONTROL - RED	1
4	18891	LAMP	CONTROL - ORANGE	1
5	18889	LAMP		2
6	18887	SWITCH	IGNITION	1
7	18922	SPANNER	FOR IGNITION SWITCH	1
8	18878	CABLE		2
9	18881	NIPPLE		2
10	18861	WASHER		1
11	18880	NIPPLE		2
12	17209	GAUGE	OIL PRESSURE	1
13	18733	NIPPLE		1
14	18704	BRACKET	FOR REMOTE CONTROL STOP	1
15	18768	ARM		1
16	17012	SCREW		1
17	18842	LOCKNUT		1
18	18865	WASHER		2
19-1	18705	PLATE	P10 - CABLE - FOR DECOMPRESSION HANDLE	1
19-2	18706	PLATE	P20 - CABLE - FOR DECOMPRESSION HANDLE	1
20	16939	SCREW		2
21	16940	WASHER		2
22	18769	ROD	P20 - CONNECTION	1
23	18726	KEY	P20	2
24	18844	PIN	P20 - SPLIT 1.5 X 12	2

WESTERBEKE 10 & 20: DELUXE INSTRUMENT PANEL

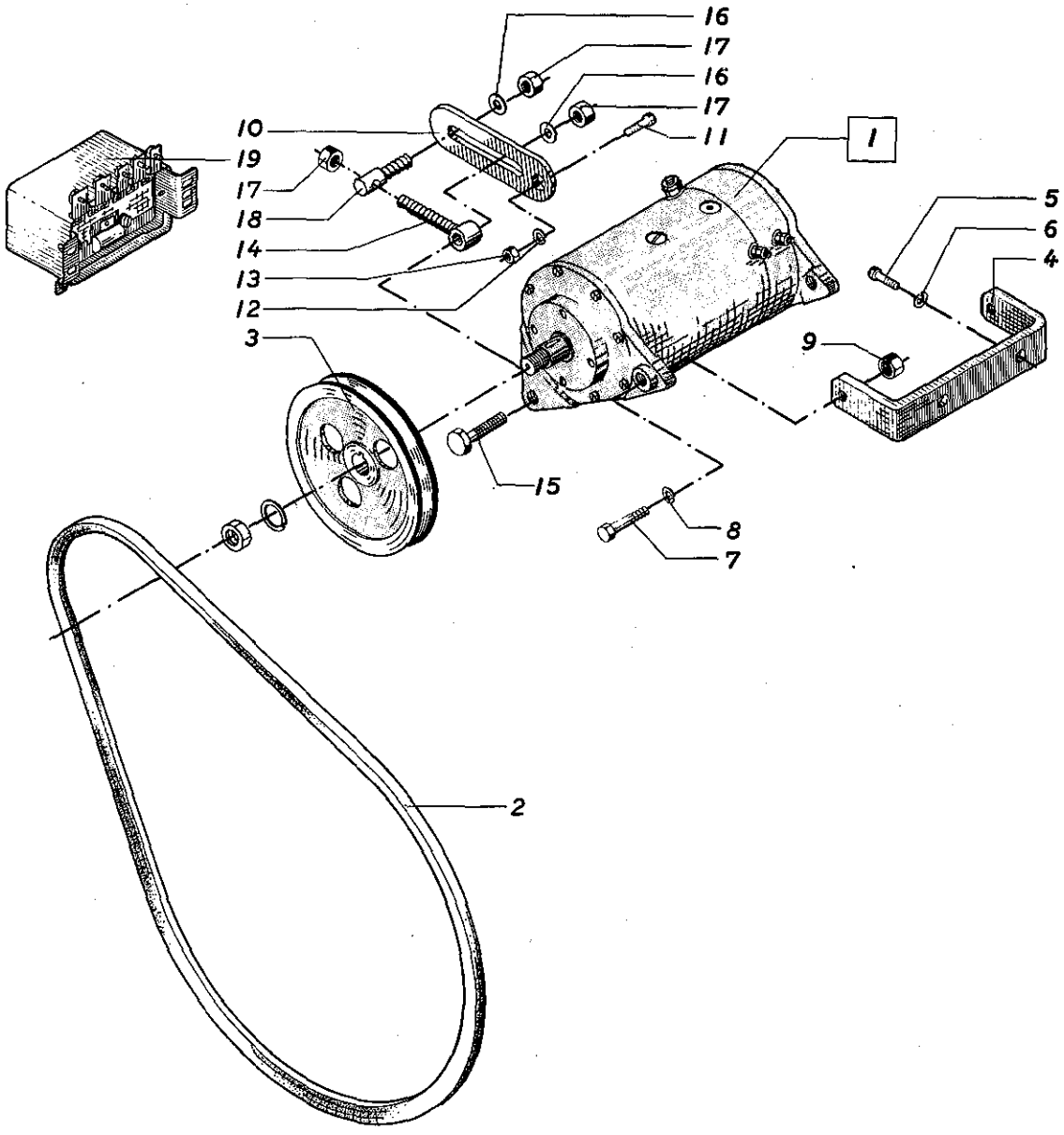




WESTERBEKE 10 & 20: DELUXE INSTRUMENT PANEL

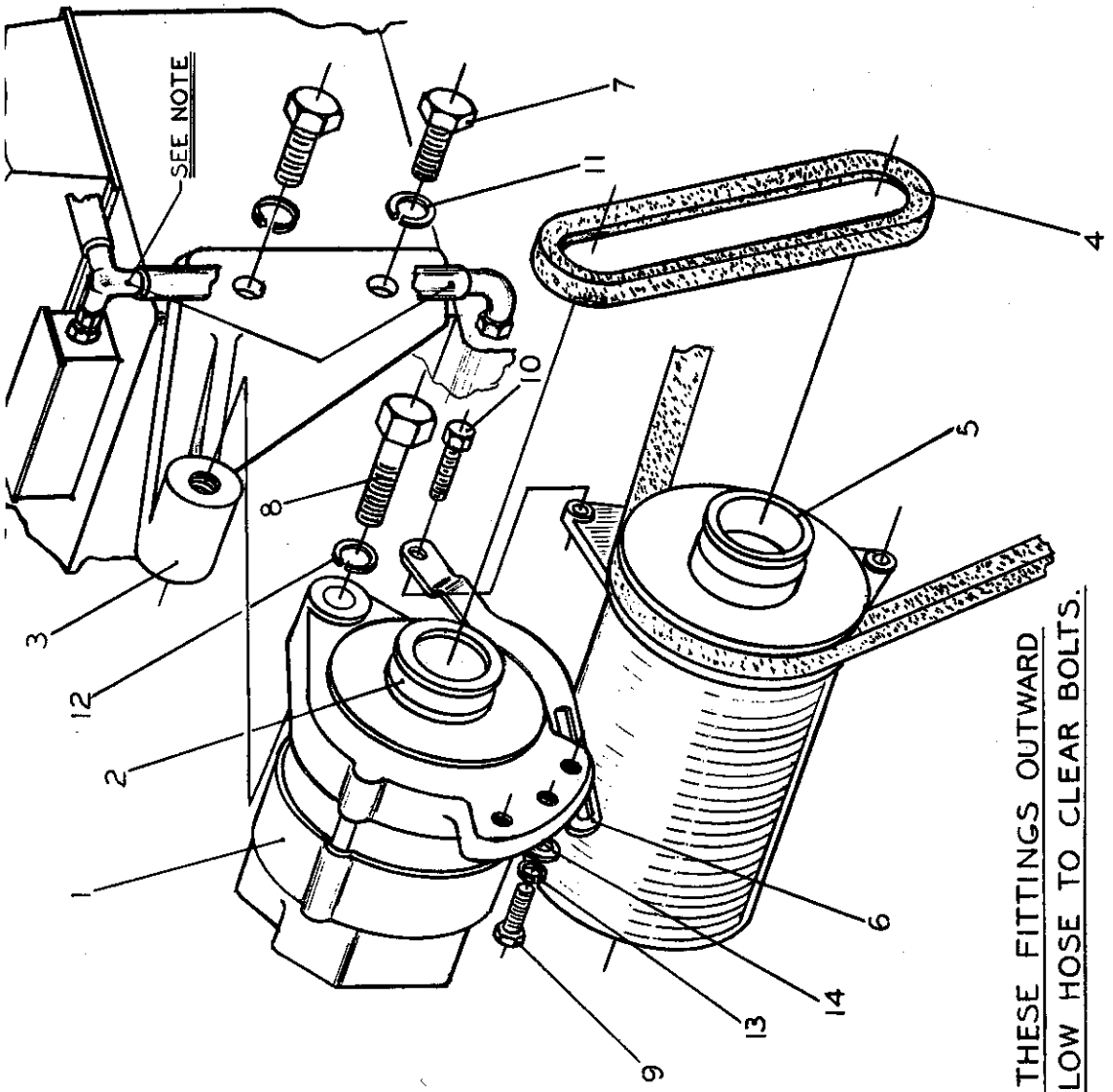
REF	PN	NAME	REMARKS	QUAN
1	18647	PANEL	INSTRUMENT	1
2	18826	SCREW	SELF TAPPING	4
3	17213	TACHOMETER		1
4	17212	GENERATOR	TACHOMETER	1
5	18888	LAMP		3
6	17214	GAUGE	WATER TEMPERATURE	1
7	17211	SENDER	WATER TEMPERATURE	1
9	17215	GAUGE	OIL PRESSURE	1
10	17210	SENDER	OIL PRESSURE	1
11	18724	COVER	LUBE OIL PUMP	1
12	18883	BUSHING		1
13	18715	RING	SUPPORTING	1
14	18716	SHAFT	DRIVING	1
15	18843	PIN		1
16	18900	RING		1
17	17580	COVER	COMPLETE	1

WESTERBEKE 10 & 20: COMBINATION STARTER/GENERATOR



WESTERBEKE 10 & 20: COMBINATION STARTER/GENERATOR

REF	PN	NAME	REMARKS	QUAN
1	15954	GENERATOR	STARTER	1
2	18877	VBELT		1
3	17042	PULLEY	VBELT	1
4-1	18675	BRACKET	P10	1
4-2	18676	BRACKET	P20	1
5	18813	SCREW		2
7	18815	SCREW		2
9	17189	NUT		2
10	18702	PLATE		1
11	18814	SCREW		1
13	17189	NUT		1
14	18766	SCREW	ADJUSTING	1
15	18811	BOLT		1
16	17197	WASHER		2
17	17195	NUT		3
18	18703	BOLT		1
19	15952	REGULATOR		1



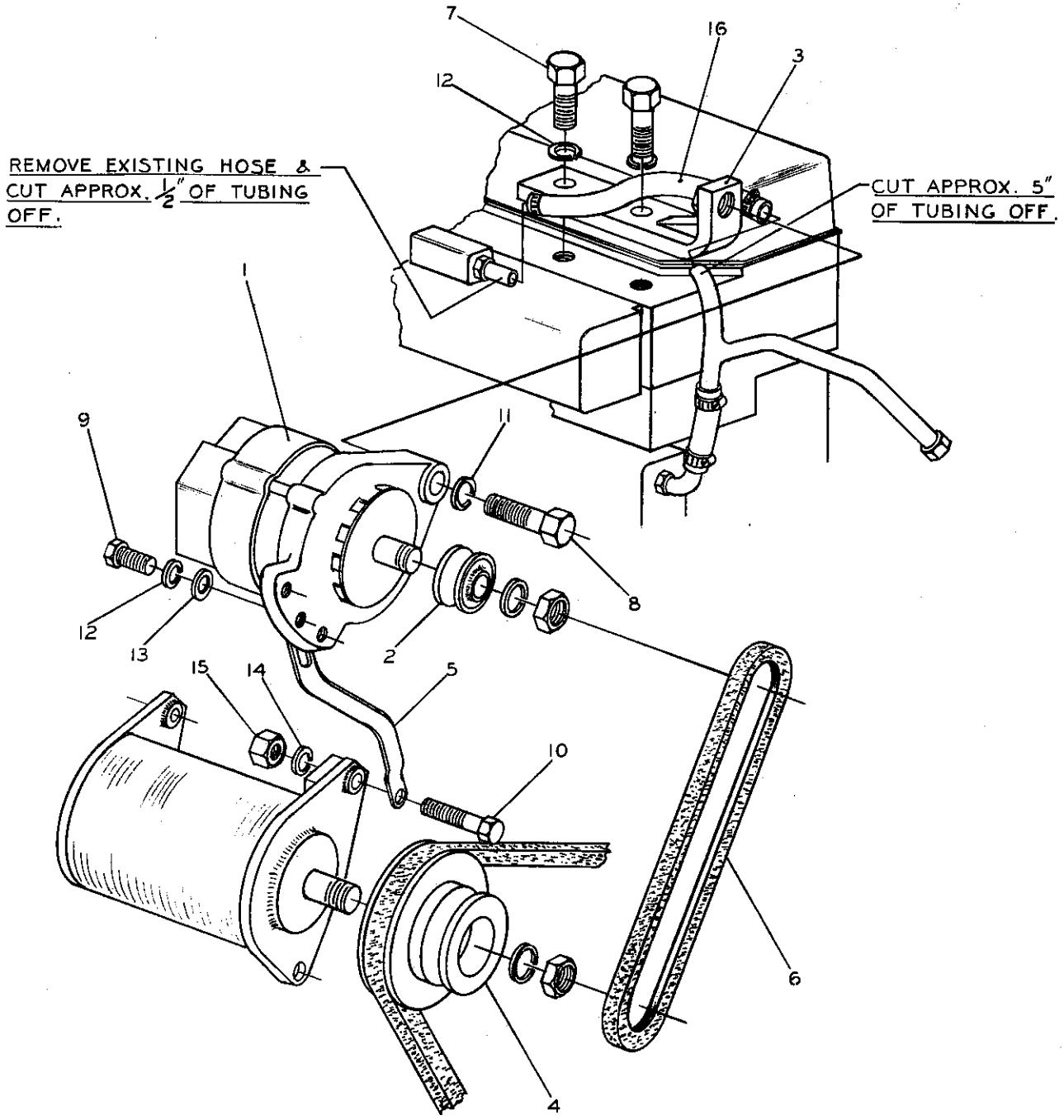
DWG*17245

NOTE:
BEND THESE FITTINGS OUTWARD
TO ALLOW HOSE TO CLEAR BOLTS.

WESTERBEKE 10: ACCESSORY ALTERNATOR KIT - THRU 1973

REF	PN	NAME	REMARKS	QUAN
1	19270	ALTERNATOR	55 AMP	1
2	15213	PULLEY	ALTERNATOR	1
3	16537	BRACKET		1
4	15214	BELT		1
5	13707	PULLEY	STARTER	1
6	16542	STRAP	ADJUSTING	1
7	13629	SCREW		2
8-1	11550	REGULATOR		1
8-2	11670	WIRE		1
8-3	11549	HARNESS		1
8-4	16656	DIAGRAM		1

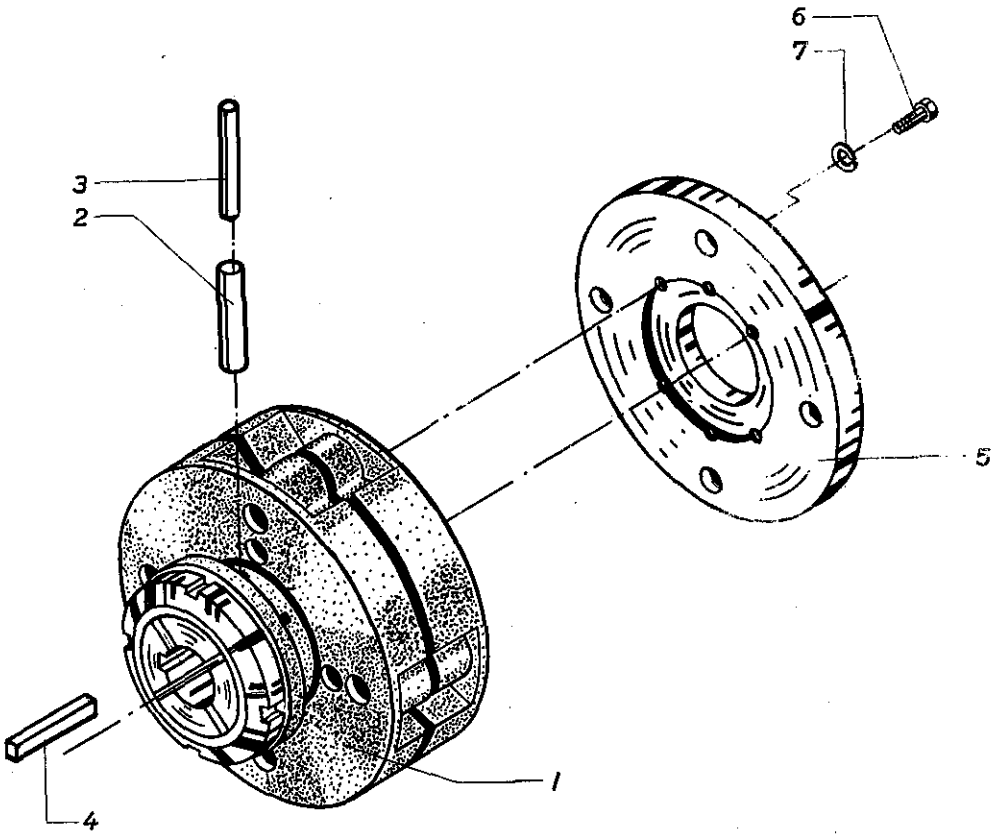
WESTERBEKE 20: ACCESSORY ALTERNATOR KIT - THRU 1973



WESTERBEKE 20: ACCESSORY ALTERNATOR KIT - THRU 1973

REF	PN	NAME	REMARKS	QUAN
1	19270	ALTERNATOR	55 AMP	1
2	15213	PULLEY	ALTERNATOR	1
3	11265	BRACKET		1
4	13707	PULLEY	STARTER	1
5	16542	STRAP		1
6	15215	BELT		1
7	13619	SCREW		2
8-1	11550	REGULATOR		1
8-2	11670	WIRE		1
8-3	11549	HARNESS		1
8-4	16656	DIAGRAM		1
16	16694	HOSE		8"

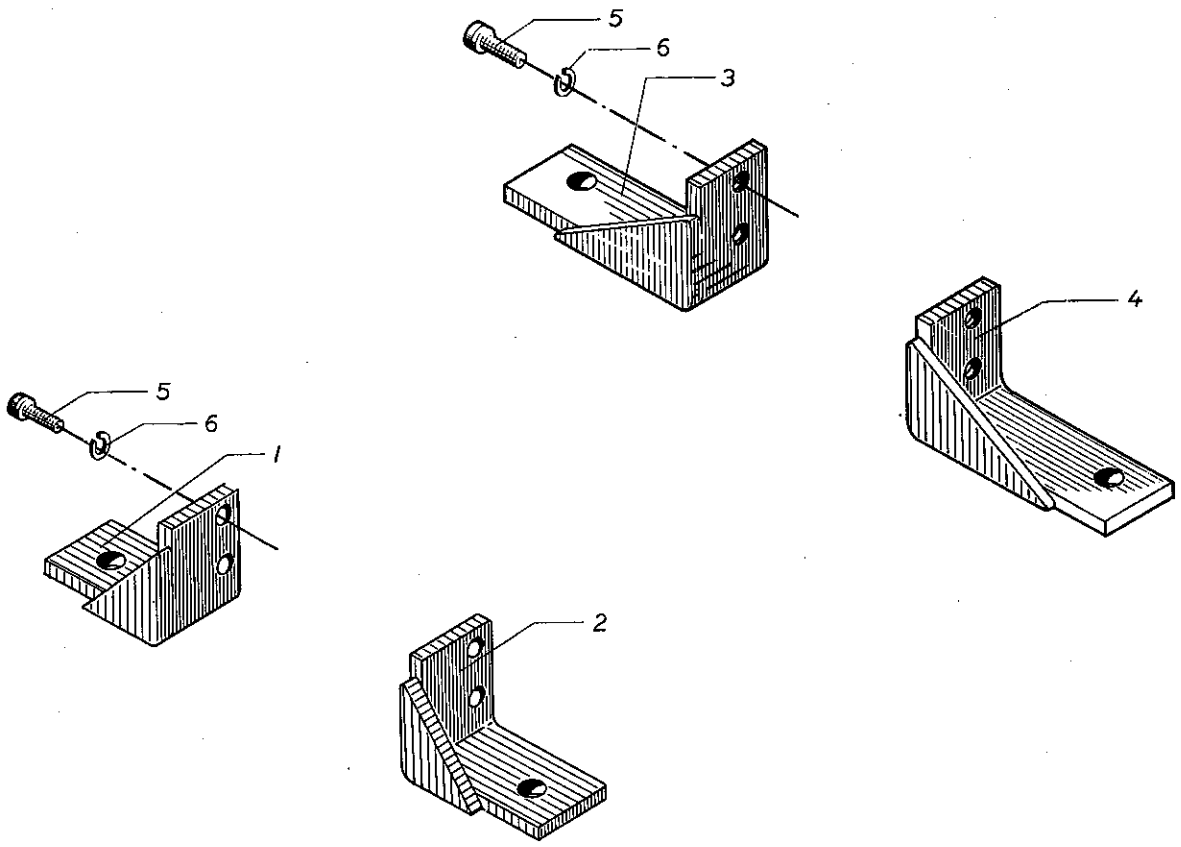
WESTERBEKE 10 & 20: COUPLINGS



WESTERBEKE 10 & 20: COUPLINGS

REF	PN	NAME	REMARKS	QUAN
1	18871	COUPLING	FLEXIBLE	1
2	18846	PIN		1
3	18845	PIN		1
4	18677	KEY	DRIVING	1
5	18662	FLANGE	INTERMEDIATE	1
6	17012	SCREW		6
7	18697	COUPLING	PROPELLER SHAFT - 1"	1
8	18804	SCREW		6

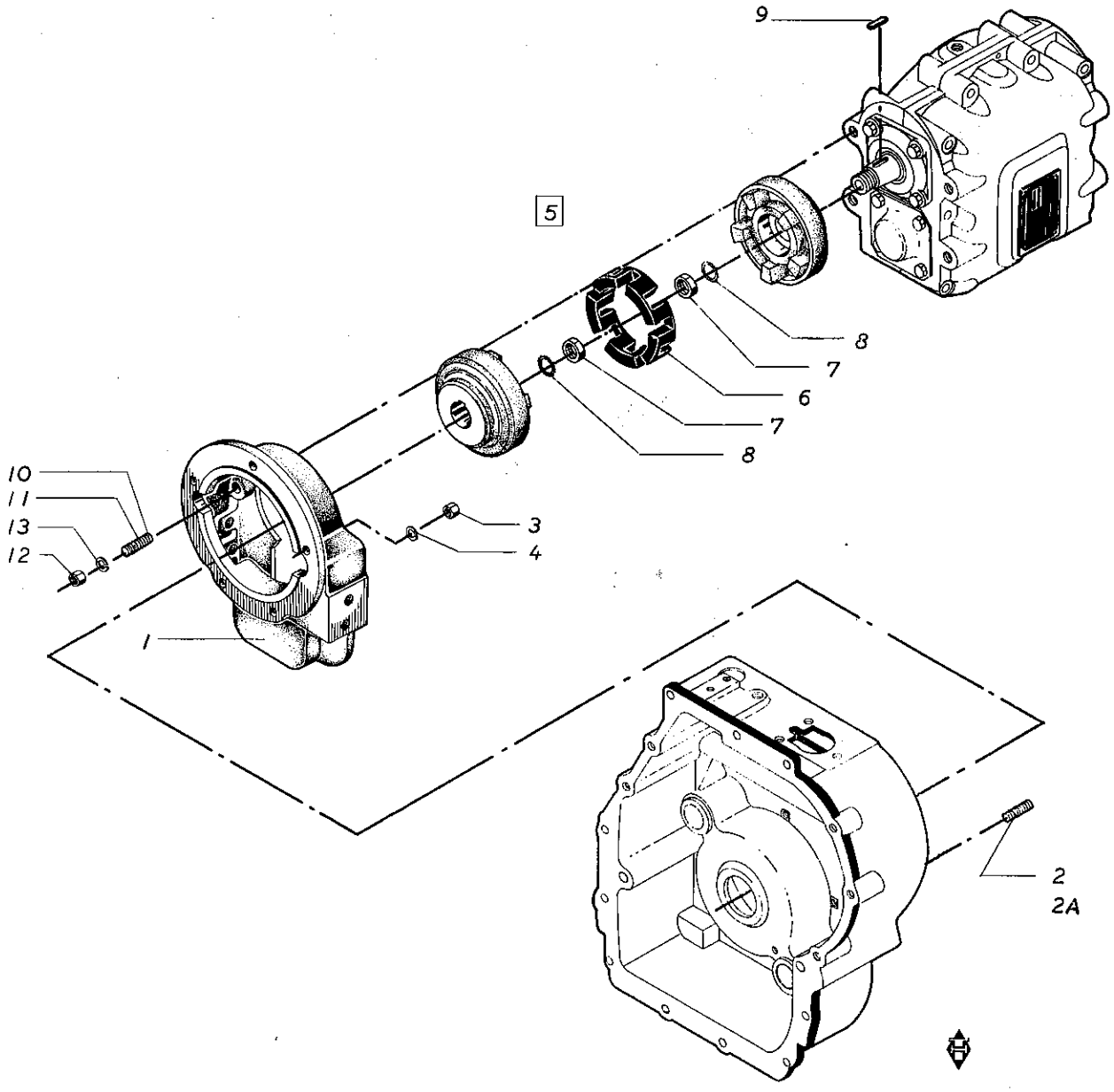
WESTERBEKE 10 & 20: MOUNTING SYSTEM



WESTERBEKE 10 & 20: MOUNTING SYSTEM

REF	PN	NAME	REMARKS	QUAN
1	18748	MOUNT	FRONT RIGHT	1
2	18749	MOUNT	FRONT LEFT	1
3	18750	MOUNT	REAR RIGHT	1
4	18751	MOUNT	REAR LEFT	1
5	17192	SCREW		8
7-1	18875	MOUNT	FLEXIBLE - REAR	2
7-2	18876	MOUNT	FLEXIBLE - FRONT	2
8	18798	SCREW		4
9-1	18694	WASHER	REAR MOUNT	8
9-2	16698	WASHER	FRONT MOUNT	4

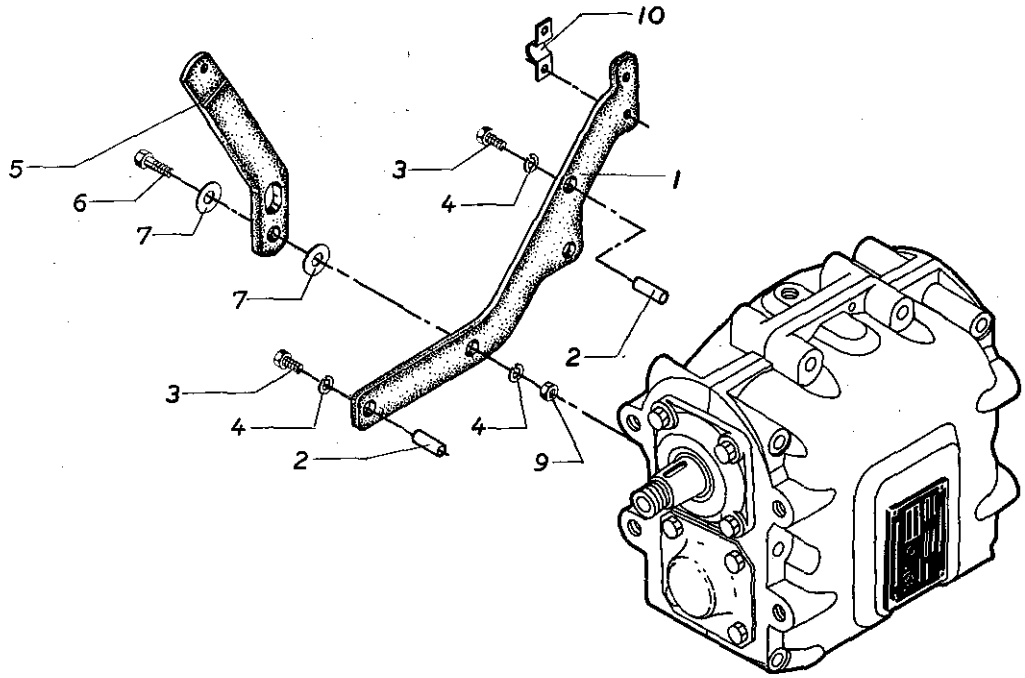
WESTERBEKE 10 & 20: BACK END ARRANGEMENT

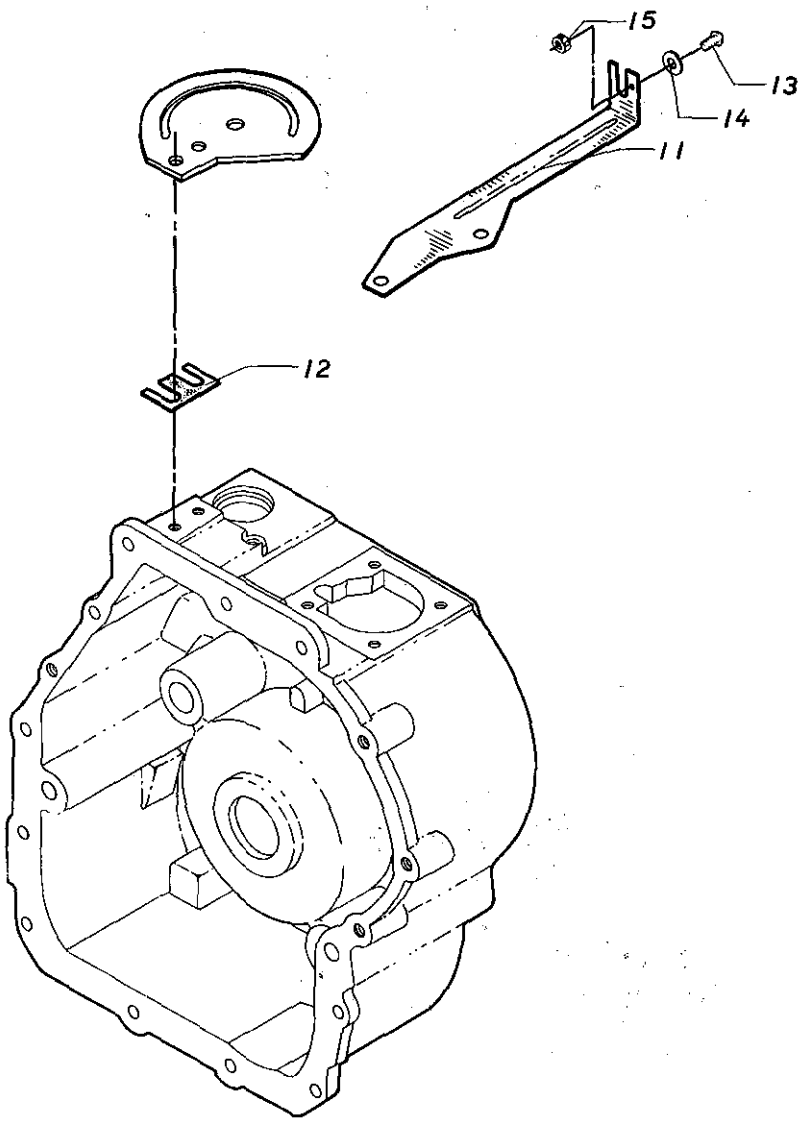


WESTERBEKE 10 & 20: BACK END ARRANGEMENT

REF	PN	NAME	REMARKS	QUAN
1	17058	ADAPTER		1
2-1	16765	STUD		3
2-2	18828	STUD		2
3	17195	NUT		5
4	18828	STUD		2
5	18924	COUPLING	FLEXIBLE - COMPLETE	1
6	18925	INSERT		1
7	18840	NUT		2
8	18856	WASHER		2
9	17179	KEY		1
10	18830	STUD		2
11	18829	STUD		2
12	17189	NUT		4

WESTERBEKE 10 & 20: TRANSMISSION (LINKAGES)

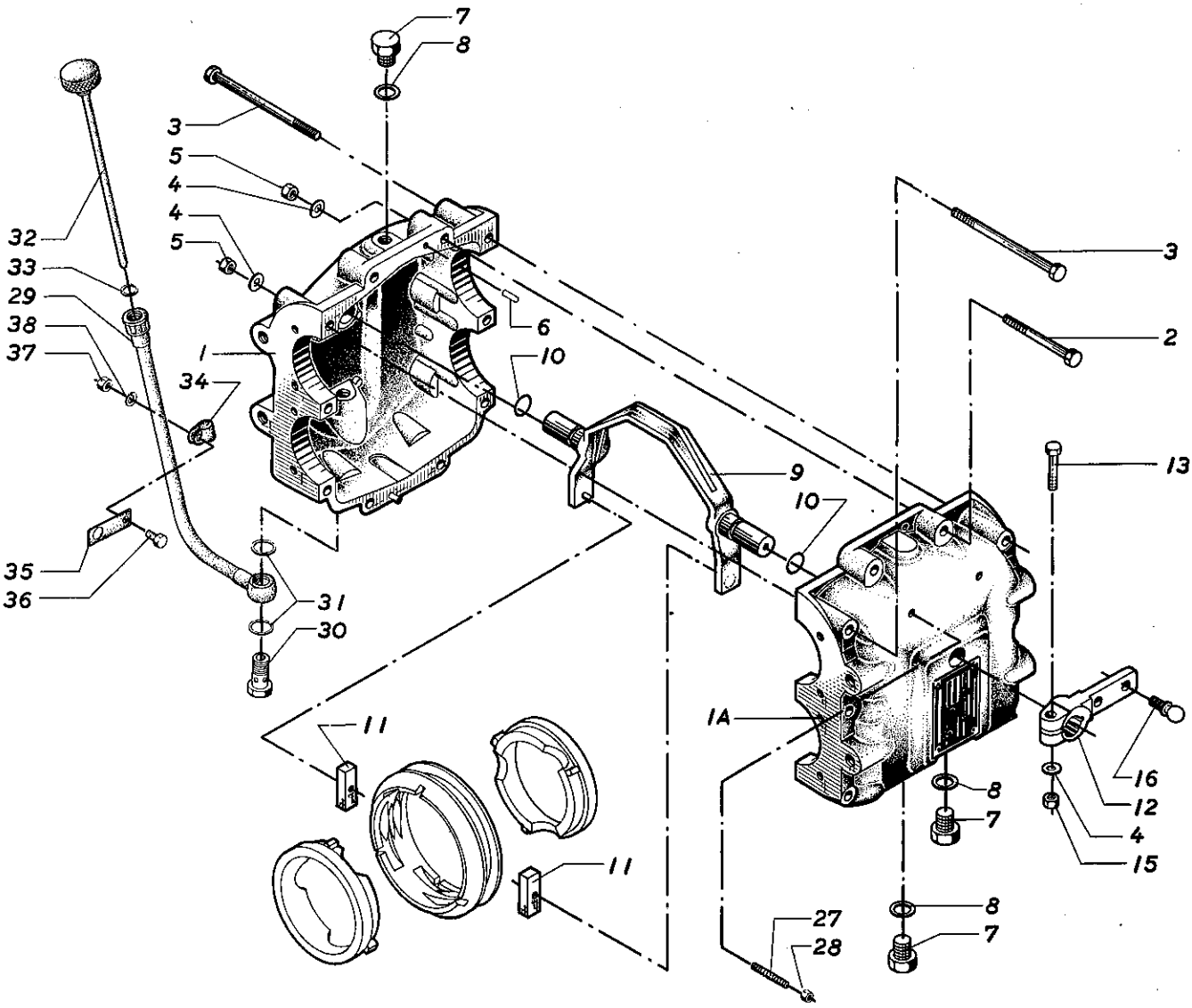




WESTERBEKE 10 & 20: TRANSMISSION (LINKAGES)

REF	PN	NAME	REMARKS	QUAN
1	18687	BRACKET	FOR REMOTE CONTROL	1
2	18688	SPACER		1
3	16789	SCREW		2
5	18644	ARM	GEAR SELECTOR	1
6	18643	BOLT	GEAR SELECTOR ARM	1
7	18868	PLATE		2
9	17195	NUT		1
10	18879	SADDLE		1
11	18641	PLATE	CABLE	1
12	18678	PLATE	DISTANCE	1
13	18824	SCREW		1
14	18850	WASHER		1
15	18835	NUT		1

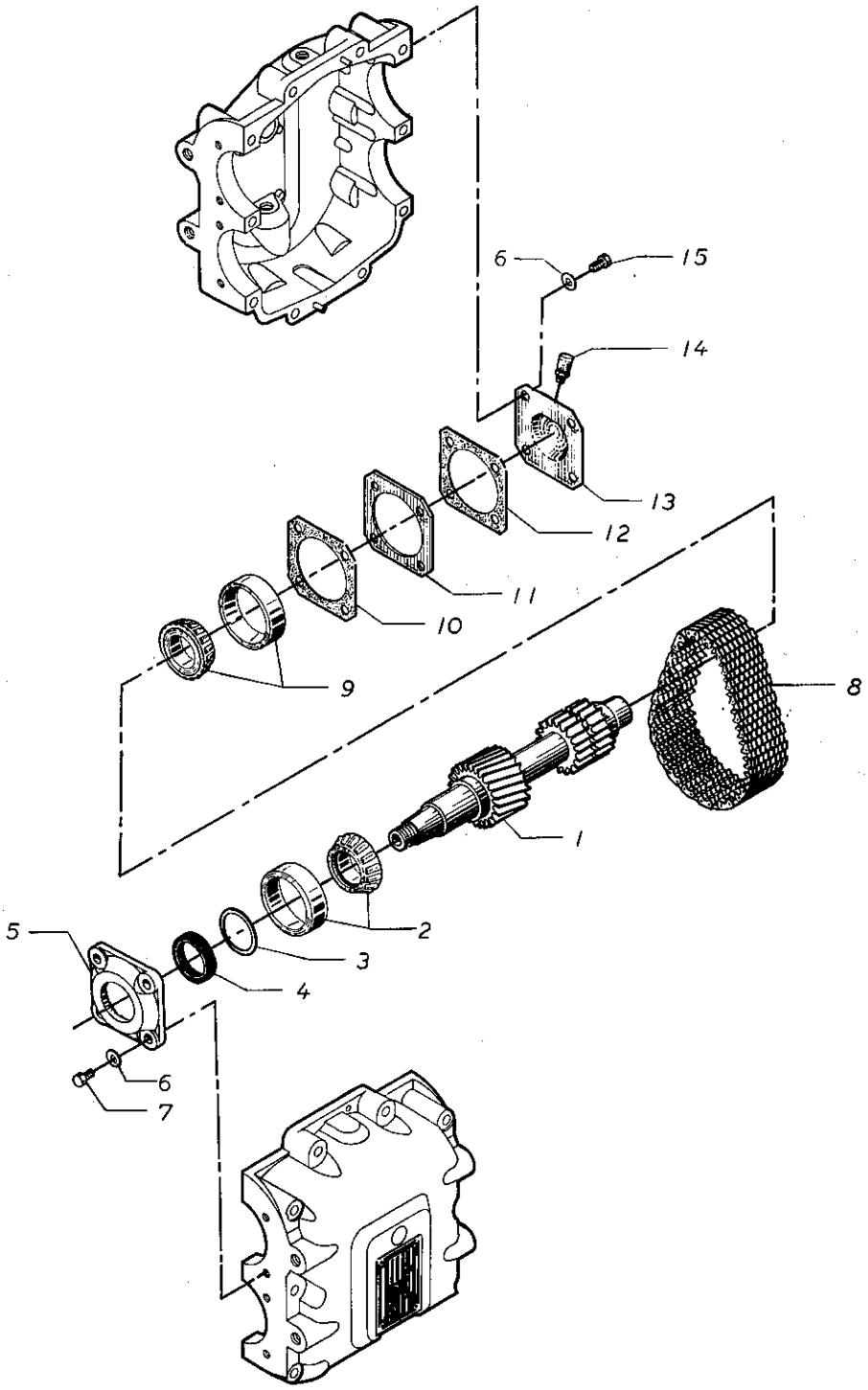
WESTERBEKE 10 & 20: TRANSMISSION (HOUSING)



WESTERBEKE 10 & 20: TRANSMISSION (HOUSING)

REF	PN	NAME	REMARKS	QUAN
1-1	17094	HOUSING	P10 - GEARBOX	1
1-2	18926	HOUSING	P20 - GEARBOX	1
2	17096	BOLT		4
3	17097	BOLT		6
4	18866	WASHER		12
5	18837	NUT		9
6	17095	PIN		2
7	17098	PLUG		4
8	18864	GASKET		4
9	17138	FORK		1
10	17135	GASKET		2
11	17134	SHOE		2
12	17136	ARM		1
13	18810	BOLT		1
15	18837	NUT		2
16	17137	JOINT	BALL & SOCKET	1
27	18827	STUD		2
28	18836	NUT		2
29	18756	TUBE	DIPSTICK	1
30	16767	BOLT	BANJO	1
31	17202	GASKET		2
32	18762	DIPSTICK		1
33	18898	RING		1
34	18886	SADDLE		1
35	18689	STRAP		1
36	18799	SCREW	HEXHEAD	1
37	18839	NUT		1
38	20037	TRANSMISSION	2:1 - COMPLETE	1

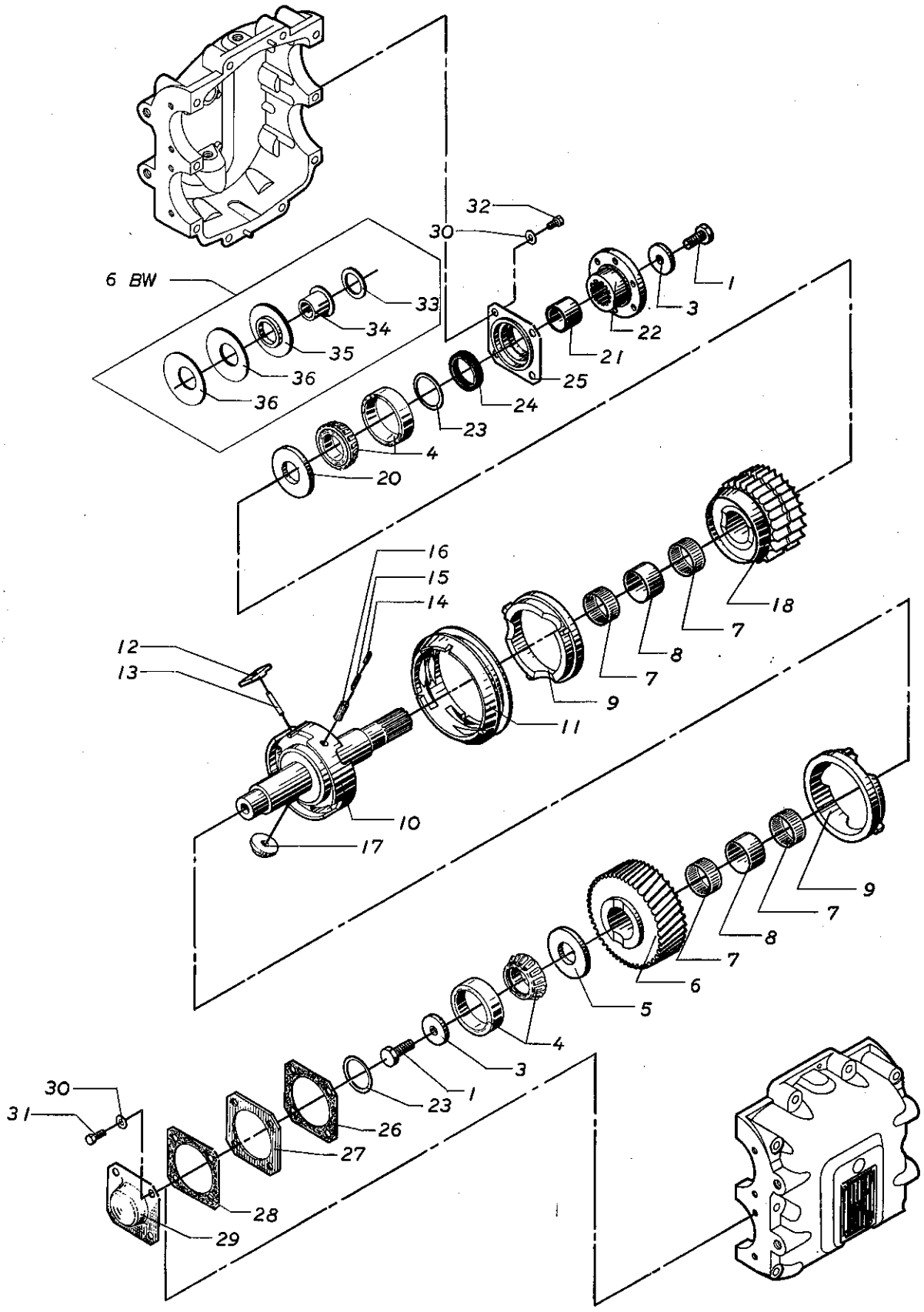
WESTERBEKE 10 & 20: TRANSMISSION (INPUT SHAFT)



WESTERBEKE 10 & 20: TRANSMISSION (INPUT SHAFT)

REF	PN	NAME	REMARKS	QUAN
1-1	17115	SHAFT	P10 - INPUT - 2,5:1	1
1-2	18927	SHAFT	P20 - INPUT - 2,5:1	1
2	16786	BEARING	BALL	1
3-1	17099	WASHER	0,5 MM	AR
3-2	18930	WASHER	P20 - 0,2 MM	AR
3-3	17100	WASHER	0,1 MM	AR
3-4	17101	WASHER	0,3 MM	AR
3-5	17102	WASHER	1,0 MM	AR
3-6	17103	WASHER	P10 - 0,5 MM	AR
4	17105	SEAL		1
5	17106	COVER		8
6	18866	WASHER		4
7	18809	SCREW		1
8	18931	CHAIN		1
9	17114	BEARING	BALL	1
10	17112	GASKET	P10	1
11	17111	PLATE	P10	1
12	17107	GASKET	P10	1
13-1	17108	COVER	P10	1
13-2	18932	COVER	P20	1
14	17109	VENT		4
15-1	18807	SCREW	P10	4
15-2	18809	SCREW	P20	

WESTERBEKE 10 & 20: TRANSMISSION (OUTPUT SHAFT)



WESTERBEKE 10 & 20: TRANSMISSION (OUTPUT SHAFT)

REF	PN	NAME	REMARKS	QUAN
1	17116	BOLT		2
3	17117	WASHER		2
4-1	17114	BEARING	P10 - BALL	2
4-2	18882	BEARING	P20 - BALL	2
5	17118	WASHER	P10	1
6-1	17119	GEAR	P10	1
6-2	18953	GEAR	P20	1
7	17121	BEARING	NEEDLE	4
8-1	17122	SLEEVE	P10	2
8-2	18939	SLEEVE	P20	2
9-1	17120	CONE	P10	2
9-2	18940	CONE	P20	2
10-1	17123	SHAFT	P10 - OUTPUT - 2.5:1	1
10-2	18934	SHAFT	P20 - OUTPUT -2.5:1	1
11	17129	COLLAR		1
12	17130	BLOCK		3
13	17125	PIN	P10	3
14	17128	PIN		3
15	17127	SPRING		3
16	17125	PIN	P20	3
17	17124	BLOCK		3
18-1	17131	SPROCKET	P10	1
18-2	18941	SPROCKET	P20	1
20	17132	WASHER	P10	1
21	18952	SPACER		1
22-1	17141	FLANGE	P10	1
22-2	18951	FLANGE	P20	1
23-1	17099	WASHER	P10 - 0.5 MM	1
23-2	17100	WASHER	P10 - 0.1 MM	1
23-3	17101	WASHER	P10 - 0.3 MM	1
23-4	17102	WASHER	1.0 MM	1
23-5	17103	WASHER	P10 - 0.15 MM	1
23-6	17104	WASHER	P10 - 0.4 MM	1
23-7	18935	WASHER	P20 - 1.2 MM	1
23-8	18936	WASHER	P20 - 1.4 MM	1
23-9	18937	WASHER	P20 - 1.6 MM	1
23-10	18938	WASHER	P20 - 1.8 MM	1
24	17105	SEAL		1
25	17106	COVER		1
26	17107	GASKET	P10	1
27	17111	PLATE	P10	1
28	17112	GASKET	P10	1
29-1	17110	COVER	P10	1
29-2	18933	COVER	P20	1
30	18866	WASHER	P10 - 8 MM	8
31-1	18807	SCREW		4
31-2	18809	SCREW	P20	4
32	18809	SCREW		4
33	18948	SPACER	P20 - 1.8 MM	AR
34	18949	BUSHING	P20	2
35	18950	THRUSTWASHER	P20	2
36	18954	PLATE	P20	4

WESTERBEKE 10 & 20: MISCELLANEOUS

REF	PN	NAME	REMARKS	QUAN
1-1	16804	GASKET SET	P10 - ENGINE - COMPLETE	AR
1-2	18962	GASKET SET	P20 - ENGINE - COMPLETE	AR
2-1	18964	GASKET SET	P10 - ENGINE - VALVE GRINDING	AR
2-2	18963	GASKET SET	P20 - ENGINE - VALVE GRINDING	AR
3-1	18965	GASKET SET	P10 - TRANSMISSION - COMPLETE	AR
3-2	18966	GASKET SET	P20 - TRANSMISSION - COMPLETE	AR

MADE IN DENMARK BY
MOTORFABRIKEN BUKH A/S
(DV SERIES)
FOR
J. H. WESTERBEKE CORP.