KINGFISHER DIESELS LTD

KD26

OWNER'S MANUAL

The Parts Lists for both the engine and gearbox are bound separately and accompany this manual.

Kingfisher Diesels Limited has a policy of constant improvement and there may be slight differences between a particular engine and the contents of this manual. If in doubt, please contact the Technical Service Department.

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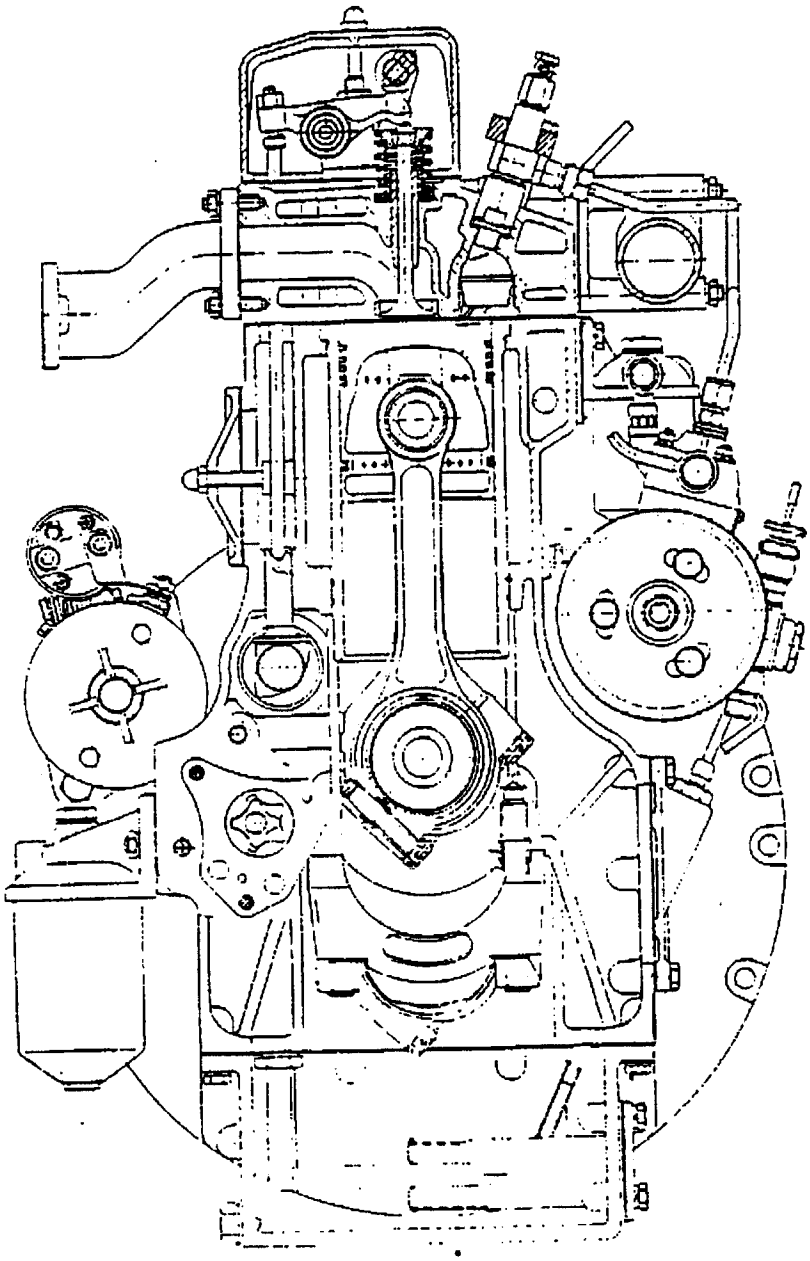
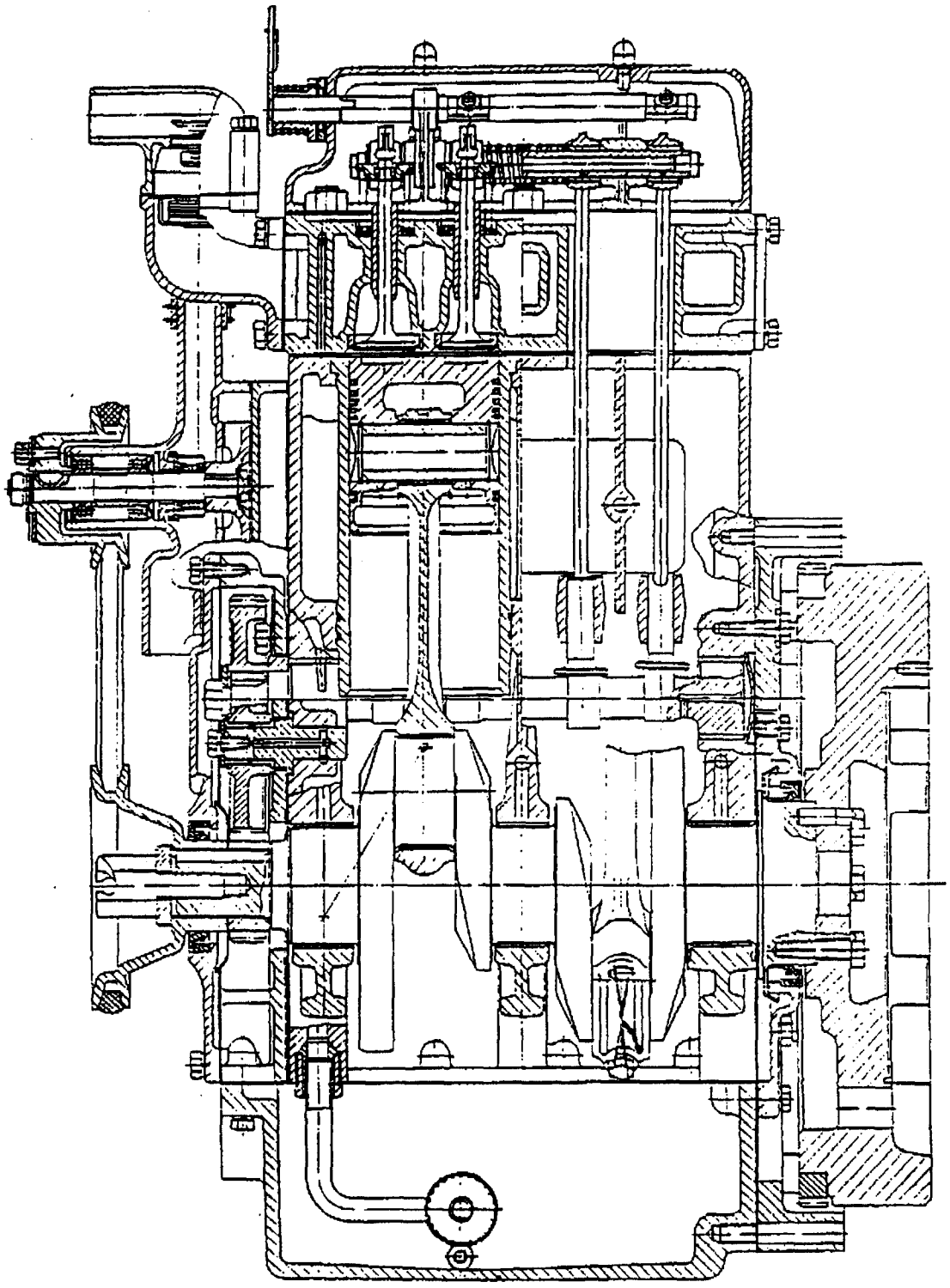
INDEX

Appendices

KD26 CROSS SECTION



KD26 LONGITUDINAL SECTION



TECHNICAL SPECIFICATION

General Data

Engine type	Vertical, four stroke water cooled diesel, indirect injection
No. of cylinders	2
Bore/stroke mm.	95/115
Cubic capacity	1.63 litres
Compression ratio	19:1
Fuel consumption at max. output	<258g/kw.h.
Oil consumption at max. output	<2.3g/kw.h.
Maximum speed rev/min.	2,900
Maximum no load speed rev/min	2,200
Maximum output Kw./B.H.P.	19.4/26.4
Thermostat	70 deg. C. opening
Fuel filter cartridge	Lucas CAV 7111296
Oil filter cartridge	Crosland 111
Inlet valve opens	17 deg. BTDC
Inlet valve closes	43 deg. ABDC
Exhaust valve opens	43 deg. BBDC
Exhaust valve closes	17 deg. ATDC
Inlet valve clearance (cold)	0.25 mm. (0.010")
Exhaust valve clearance (cold)	0.30 mm. (0.012")
Decompression clearance	1 1.5 mm.
Injection starts at 2,000 rev/min	16 deg. BTDC
Rated fuel delivery per 200 strokes	12 ml. per cylinder
Opening pressure of injector	130 +/- 5 kg./sq.cm.
Normal oil pressure kg/sq.cm (p.s.i.)	2.0 - 5.3 (30 - 80)
Minimum at idling speed kg/sq.cm.(p.s.i.)	0.5 (7)
Oil pump capacity at max. engine speed	12 litres/min.
Max. oil temperature	95 deg. C.
Water pump capacity at max. engine speed	62 litres/min.
Vee belt size	B44
Max. water temperature	95 deg. C. (60 deg. if raw water)
Exhaust gas temperature	<470 deg. C.
Minimum idling speed	450 rev/min.
Engine sump capacity	7 litres
Injection pump oil capacity	550 ml.

Tightening Torques	kg.m.	ft.lbs.
Cylinder head nuts	16	115
Rocker gear retaining nuts	4	30
Main bearing caps	14	100
Big end caps	11	80
Flywheel bolts	11	80
Flywheel housing	5	35
Gear train cover	5	35

Running Clearances and Wear Limits

All dimensions are in mm. To convert to imperial dimensions, see the Conversion Factors section below.

Location	Standard Clearance	Wear Limit
Big-end and crank pin	0.05 - 0.118	0.30
Big-end end float	0.17 - 0.44	0.50
Piston pin and small end	0.02 - 0.051	0.15
Piston skirt and liner	0.16 - 0.225	0.5
Top piston ring and groove	0.05 - 0.087	0.2
All other rings and groove	0.03 - 0.062	0.18
Top piston ring gap clearance	0.3 - 0.5	3.0
All other rings gap clearance	0.25 - 0.4	3.0
Crankshaft journal & bearing	0.07 - 0.155	0.3
Crankshaft end float	0.07 - 0.2	0.4
Camshaft journal & bearing	0.075 - 0.142	0.25
Camshaft end float	0.12 - 0.34	0.4
Idler gear shaft & bush	0.02 - 0.063	0.25
Valve stems & guides	0.05 - 0.1	0.2
Rocker shaft and arm bush	0.036 - 0.083	0.2
Inner and outer oil pump rotors	0.06 - 0.15	n/a
Oil pump rotors & pump cover	0.05 - 0.10	n/a
Water pump impeller & back surface	0.03 - 1.2	n/a

Conversion Factors

To convert kg/sq.cm. to lbs/sq.in (p.s.i.) multiply by 14.23
To convert kgf.m. torque to lbf.ft. multiply by 7.233
To convert N.m. torque to lbf.ft multiply by 0.738
One millimetre is equivalent to 0.040"; thus 0.1mm. is equal to 0.004"

INSTALLATION

A copy of Kingfisher Diesels' standard Marine Installation Instructions will have accompanied your engine when it was despatched. **Do not install an engine without reference to these instructions which can affect your warranty.**

A new engine should be serviced after the first 20 hours running by a Kingfisher authorised Service Agent in accordance with the schedule set out below. Failure to have this service carried out may invalidate your warranty.

FUELS AND LUBRICANTS

Kingfisher engines sent to U.K. customers ar pre-filled with oil which should be changed at the 20 hour service.

Export engines are despatched empty for safety reasons.

The following should be used in normal use.

Application	Lubricant	Capacity Litres
Engine and injection pump	BP Vanellus C3-15/40 or equivalent to A.P.I. CE/SF specification	7
Water pump & Jabsco pump	Calcium based grease	
Gearbox MA100	~~SAE 30-50~~	

Note. BP Vanellus oil is formulated for marine use an ves additional protection during periods when the engine is not used.

Fuel	High grade light diesel fuel, gas oil or DERV.

PRE-START CHECKS

1. Check the engine oil level and top up if required.

2. Turn on fuel supply if applicable.

3. Check that battery master switch is in the "ON" position and that the battery charge is sufficient.

4. Open engine sea cocks if applicable.

5. Open throttle to about 1/4 ensuring that gear selector is in neutral.

6. Check that stop control has been pushed fully home.

STARTING AND RUNNING

1. Complete pre-start checks.

2. Operate starter for 10 seconds maximum. If the engine does not start, wait for 40 seconds before a further attempt. If it does not start after four attempts, and unless the temperature is below freezing, check the fuel system. In severe conditions, no more than 20 ml. of engine oil may be added to each cylinder via the inlet manifold as a starting aid.

   If the engine is to be used frequently at temperatures which cause difficult starting, the use of a manifold heater is recommended. This is available from Kingfisher Diesels, or a proprietary kit such as the Lucas "Thermostart" can be fitted.

3. If starting by hand, operate the decompressor lever, crank engine as vigorously as possible, release decompressor and continue cranking until engine starts.

4. If a wet exhaust system is fitted, check exhaust pipe for emission of cooling water. Check instrument readings.

5. Allow engine to run at approximately 800 rev/min and check for any unusual sounds. Allow engine to warm up before applying full load.

6. Operate gearbox controls only when engine is at idling speed. Check that propeller is rotating and therefore free of obstruction before opening throttle - which should be done gradually to prevent excessive smoke.

7. Monitor instruments frequently and be alert for any unusual sounds. If abnormal instrument readings or engine noise should occur, stop the engine immediately,

ascertain the cause and rectify it. Delay in correcting faults tends to be expensive and may result in rejection of a warranty claim.

8. To stop the engine, allow it to idle for 20 - 30 seconds and operate the stop control until it has stopped. Return the stop control to the run position.

9. **DO NOT USE THE DECOMPRESSOR TO STOP THE ENGINE EXCEPT IN EMERGENCY.**

10. In the unlikely event of your engine speeding up unexpectedly, close the throttle, operate the stop control and operate the decompressor as necessary, in that order, to control the engine.

11. A smoky exhaust is indicative of poor injectors, a cold engine or excessive load.

12. Diesel engines are prone to glazing up of the cylinder bores if allowed to run for prolonged periods without load. This results in loss of power, dirty exhaust and uncontrolled oil consumption. The remedy is to remove the cylinder head and break the glazes. Glazing has been known to occur in less than an hour.

MAINTENANCE - ROUTINE

Every 8 hours

1. Stop engine, pause for two minutes and check engine oil level by removing dipstick, wiping clean and inserting again before withdrawing to read the level. Top up as necessary.

2. Check engine bay bilge for any oil or water leaks and rectify as necessary.

MAINTENANCE - 1ST. 20 HOURS FROM NEW OR MAJOR OVERHAUL

Keep engine on light load and no more than half to two thirds throttle during this period to allow the moving parts to bed in and work harden.

1. Using a torque wrench, tighten down the cylinder head nuts to 16 kg.m. (115 lbf.ft.).

1A. Using a torque wrench, check tightness of nuts holding down the rocker gear to 4 kgf.m. (30 lbf.ft.).

2. Carry out operations 3,4,5,6,7,8,9,14 and 15 from the following schedule.

Every 150 hours or at least annually

Carry out the following steps.

3. Drain the engine oil whilst hot and replace with new oil.

4. Renew the engine oil filter element (see Section 5 for details).

5. Slacken or remove the injector pump oil level indicator plug and add engine oil through the filler cap until oil shows at the pipe pointing downwards from the level plug. Do not overfill. Tighten the indicator plug and replace filler cap. See Section 4 for details.

6. Check gearbox oil level using the dipstick.

7. Check tightness of all mounting bolts, prop. shaft couplings, oil cooler mounting bolts, manifold nuts etc.

8. Check alternator belt tension. There should be approximately 0.5" or 12 mm. free vertical movement in the top section of the belt.

9. Check engine and gearbox carefully for any oil or water leaks.

10. Replace fuel line filter cartridge element(s) and bleed fuel system.

11. Turn the Stauffer grease cap on the Jabsco pump one complete turn clockwise or until resistance is felt. If it will not turn, it has probably run out of grease. Unscrew the cap, refill it and replace it using no more than three turns.

12. Sparingly grease the engine water pump via the grease nipple or Stauffer cap (3 turns).

Every 450 hours

In addition to the above, carry out the following.

13. Remove the fuel injectors and have them cleaned and checked in a diesel service shop. This work is covered in the following section if service facilities are not available.

14. Drain the lubricating oil in the injection pump whilst hot by removing both drain plugs, slacken or remove the level indicator plug and fill with new oil no higher than the level indicator plug in the side. (See Section 4).

15. Check tappet clearances and adjust if necessary. Correct clearances are 0.25 mm. (0.010") for the inlet and 0.3 mm (0.012") for the exhaust when cold. When replacing the rocker cover, ensure that the slot in the end of the decompressor shaft is vertical **with the screw heads angled towards the injectors**. Replace the rocker cover. Operate the decompressor and **turn the engine over two full turns by hand** to ensure the valves are clear of the pistons. See Section 3 for further details.

16. Remove the Jabsco pump impeller and check for wear. Replace if necessary.

17. Remove and clean the air cleaner element as described in Section 4.6. In dusty conditions, this should be done more frequently so as to maintain cleaning efficiency and air flow.

18. Remove and clean the gearbox oil strainer. Change the gearbox oil.

Every 900 hours

In addition to the 450 hour schedule, carry out the following.

18. Check the fuel injector timing advance and adjust if necessary.

Further maintenance such as decarbonizing the combustion chambers, cylinder head overhaul, bearing replacement etc. will probably become necessary eventually the need for which will depend on a particular engine and the use to which it has been put. In general, short periods of use will reduce the number of serviceable hours which can be expected, whereas prolonged running will increase the number of hours.

If an engine is used consistently for short runs, the frequency of oil changes should be increased, in extreme cases to every 50 hours.

MAINTENANCE - LAYING UP

If the engine is to be unused for more than four months, it should be laid up as follows.

1. Empty the fuel tank and drain or pump out any condensation or debris in the bottom. Pour in sufficient inhibiting fuel such as Esso IL 1838 to reach the engine fuel supply pipe, plus about three litres. Alternatively, pour in regular fuel to which has been added 10% of clean sump oil or preserving oil.

2. Empty and carefully clean all fuel filter units, replacing elements if they are due. Bleed the system and

run the engine until warm and until the new fuel has been drawn into the engine.

3. Renew the engine oil and filter whilst hot. Renew the injector pump oil. Run the engine for at least five minutes whilst hot to circulate the oil thoroughly. If the engine is to be laid up for more than six months, use preserving oil in the sump in place of regular engine oil. This oil must be replaced within 15 hours after recomissioning.

4. Remove the top of the air cleaner and with engine idling at around 800 rev/min., operate the engine stop control and decompressor simultaneously whilst at the same time squirting a laying up preserving spray into the air inlet manifold. Continue spraying until the engine stops. On no account release the decompressor until the engine has stopped.

5. As an alternative to 4. above, allow engine to cool and remove the injectors. Place exactly 25ml. of preserving oil in each cylinder (a disposable medical syringe is handy for this) and rotate engine slowly by hand three or four turns. Replace injectors, checking that they and their seats are clean. Take care not to damage the delicate nozzles.

6. Remove rocker box and liberally apply clean engine oil to the valve stems and rocker gear. Rotate engine carefully until all four valves are closed. Replace rocker box, taking the precautions set out in Section 3.

7. Drain all cooling water from the engine block, water cooled manifold and heat exchanger (if fitted) by opening drain cocks. Alternatively add 50% anti freeze (to prevent corrosion) to the circulating water and run engine for at least 30 minutes to mix thoroughly. (This procedure may be omitted if there is no danger of frost.)

8. Remove cover of the Jabsco cooling pump, drain water and apply glycerine to the impeller. Replace the impeller if necessary. If the boat is removed from the water, open sea cocks (if fitted) and ensure that all raw water is drained from the system. Grease and close the sea cocks.

9. Top up gearbox with oil right up to the filler cap.

NB. Be sure to remove the excess oil prior to reuse.

10. Slacken alternator belt.

11. Store engine in as dry and well ventilated condition as possible.

12. Trickle charge lead acid batteries monthly to prevent discharge and sulphation. Disconnect them from the engine alternator to prevent damage to the diodes when charging.

13. Fill fuel tank almost to the brim (leaving a gap to allow for any temperature rise) to prevent condensation in the tank.

14. Protect air inlet, exhaust and other engine openings by stuffing with rag, plugging or loosely tying a polythene bag e.g. over the air cleaner.

RECOMISSIONING

Before restarting a laid up engine, carry out the following procedures.

1. Remove all pluggings etc. and reconnect any disconnected tubing, e.g. breather vents.

2. Refill the cooling system if it has been drained, checking carefully for any air locks. (This is not applicable to raw water systems which are usually self priming.)

3. Remove excess oil from the gearbox.

4. Turn engine over at least two full turns by hand without using decompressor. This should not be difficult if done slowly and ensures that there is no excess oil in a cylinder which could cause damage under a normal start. If excess oil is evident, turn engine several times with decompressor operative, and repeat the process.

5. Reconnect batteries.

6. Open sea cocks if applicable.

7. Retighten alternator belt.

8. Start engine in the usual way. Check immediately for cooling water from the exhaust pipe if a wet system is in use, and check all other instruments for correct readings. Listen carefully for any unusual sounds. As the engine warms up, speed up briefly to help clear any air locks in the cooling system. Check the fresh water coolant level as air locks clear and replenish as necessary. N.B. Do not suddenly remove the coolant cap from a warmed up engine as the pressure inside could cause scalding. If in doubt, stop engine and check system.

DISMANTLING

DISMANTLING IS NOT RECOMMENDED UNLESS IT IS REALLY NECESSARY.

UTMOST CLEANLINESS MUST BE OBSERVED AT ALL TIMES WHEN DISMANTLING AN ENGINE, ESPECIALLY FUEL SYSTEM COMPONENTS. ENSURE AN ENGINE IS THOROUGHLY CLEAN EXTERNALLY BEFORE REMOVING ANY COMPONENT.

ALWAYS LIBERALLY SMEAR WORKING SURFACES WITH CLEAN OIL BEFORE REASSEMBLING.

3. MAIN ENGINE STRUCTURE

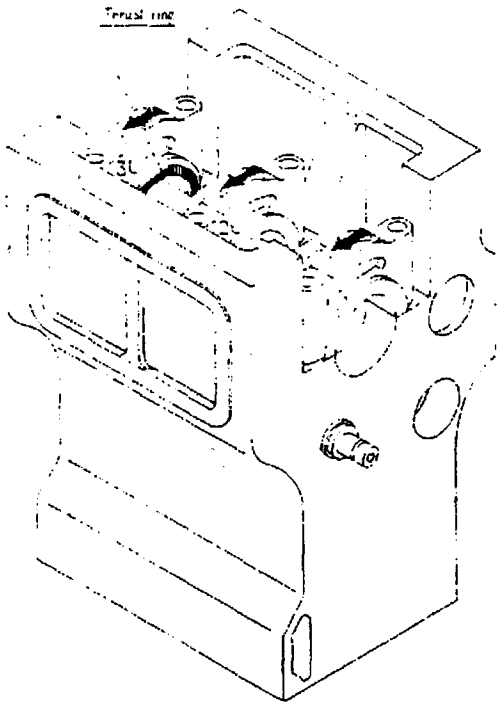
3.1 Cylinder Block and Bearings

The block is a single iron casting fitted with replaceable wet liners. Before installing a new liner, it should be fitted without seals to check the protrusion above the block face which should be 0.06 - 0.16mm. (0.002 - 0.006").

Liner seal dimensions are fairly critical and the use of Kingfisher seals is recommended, available from your Kingfisher service centre.

Check a new liner <u>after</u> installation for diameter and ellipticity at a point 165mm. below the top. Diameter should be 95mm + 0.035mm (0.001") and ellipticity should be within 0.025mm. (0.001").

Main bearing caps are marked with arrows which point towards the crankcase inspection cover. They are also numbered sequentially. The caps are NOT interchangeable or reversible. Bolts should be tightened gradually and evenly to **14 kg.m. torque (100 ft.lbs.)** and locked with tabs or wire.



Main bearing shells are in pairs. Particular care must be taken to align the oil hole in one shell of each pair with the oil holes in the bearing seat. The shells for the first and third bearings are the same and interchangeable prior to use, but not afterwards.

The third bearing cap contains the end float thrust spacers. These must be installed with the alloy face outwards. If crankshaft end float exceeds 0.4mm. (0.016") the spacers must be replaced.

The sintered bushes for the camshaft are installed on the two ends of the left side of the block. The longer, front, bush has two oil holes which must be aligned with those in the block. The rear, shorter, bush has one hole which must likewise be aligned. The front face of the front bush should be flush with the block, whilst the rear of the rear bush should align with the bottom of the blind plate hole.

At the front of the block is the timing gear housing, located with dowel pins. The sump extends forward underneath this housing and care must be exercised when reassembling to ensure that all three surfaces are correctly aligned to avoid oil leaks. Take care that no surplus paper gasket extends into the three-way joint.

When refitting the housing cover, first attach it with two or three bolts, quite loosely. Then fit the belt pulley on to the crankshaft and push it through the oil seal whilst the bolts are still loose, so as to locate the cover correctly. Fit the remaining bolts and tighten evenly and gradually.

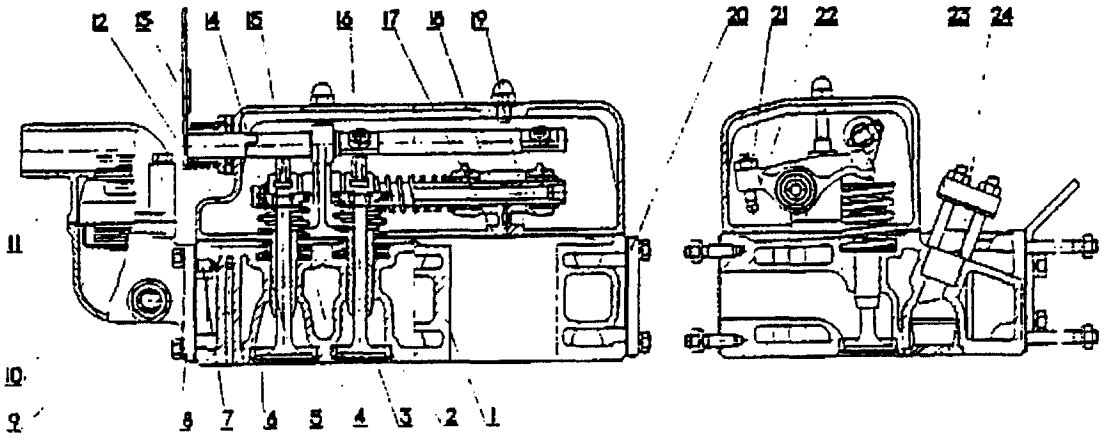
At the rear of the block are the flywheel housing and rear oil seal. The oil seal cover can be removed by evenly and alternately screwing in two M8 bolts. If the sump has been removed, tighten the oil seal cover bolts first before the sump bolts so as to keep the rear of the block and the sump flush with each other.

On the right side of the block is an inspection cover through which can be dismantled the connecting rods with the engine in situ.

Also on the right of the block is a water drain cock.

3.2 Cylinder Head

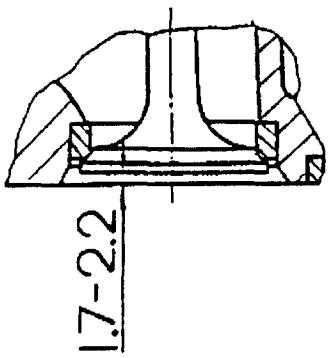
The cylinder head general arrangement is shown below.

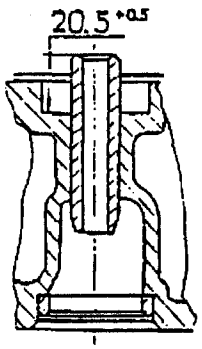


1. Cylinder head
2. Exhaust valve seat
3. Exhaust valve
4. Outer valve spring
5. Inner valve spring
6. Inlet valve
7. Oil passage plug
8. Front cover
9. Water sensor socket
10. Thermostat
11. Thermostat cover
12. Rocker Box
13. Decompressor lever
14. Valve spring cap
15. Valve collets
16. Rocker arm
17. Rocker bracket gasket
18. Rocker bracket
19. Rocker shaft
20. Rear cover
21. Nut M8 x 1
22. Tappet adjusting screw
23. Injector clamp plate
24. Combustion chamber insert

The combustion chamber insert and the cylinder head face are machined after the insert has been pressed in. Replacement of an insert should not be attempted without reference to Kingfisher Diesels Ltd.

The valve head face should be recessed from the cylinder head face by 1.7 - 2.2mm. as shown in the diagram. The valve guides, which are a press fit, should protrude 20.5mm. + 0.5mm above the bottom of the spring recess.





After extended use, the valves and their seats are likely to deteriorate and leak. If the erosion of the mating faces is minimal, the valves can be cleaned and relapped into their seats. To achieve this, the valves should be removed using a valve spring compressor, cleaned and rotated to and fro in their seats using a lapping tool and fine grinding paste. Valves must be lapped and returned to their original locations. Ensure no paste reaches the stems or guides. As a test, paraffin or kerosene poured on the valve head should not leak past the seat within two minutes. When lapping is complete, carefully wash away all traces of paste, liberally oil the valve stems and refit the valves in the cylinder head.

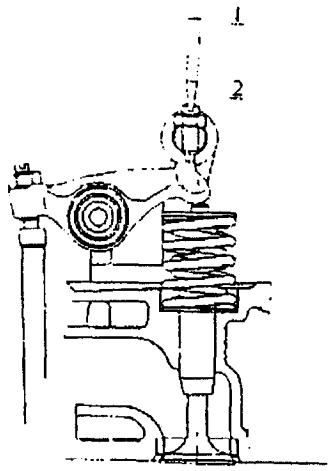
If the valves are badly burned, they should be replaced, as should the valve guides if they are excessively worn.

Valve seats can be reground in situ. If the seating band becomes too wide, the seat should be reamed to reduce it. Eventually, valve seats can be replaced. They are of modular cast iron and there is a specified interference fit - see "Fits and Wear Limits of Main Components". Ensure the valve head recess is as specified.

Valve tappet clearances are 0.25 mm. (0.010") inlet and 0.30 mm. (0.012") exhaust. Ensure valves are closed before adjustment by turning until the relevant piston is at the top of its compression stroke.

The No. 1 cylinder rocker bracket contains an oilway which must line up with the oil drilling in the cylinder head. Therefore ensure that the bracket and its gasket are the correct way round.

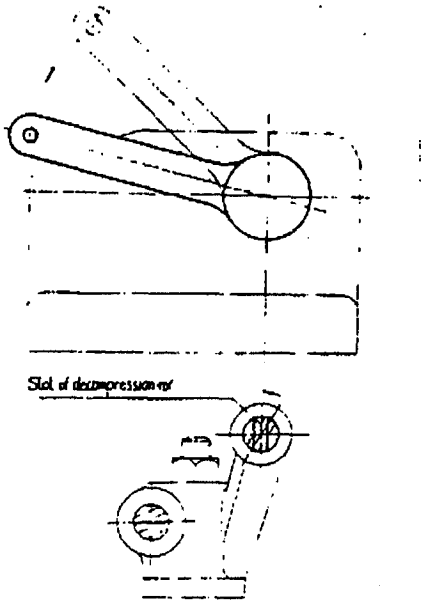
The decompressor operates by holding the exhaust valves open a maximum of 1.5mm. Any excess opening will cause the piston to hit the valve with serious damage. To set the opening correctly, rotate the decompressor shaft until the screws are vertical, then turn the engine until one exhaust valve is shut. Turn the screw above that valve until it is just touching the rocker arm. Turn the screw a further 1 to 1.5 turns **maximum** and tighten the locknut. Repeat for each valve and check clearance by turning the engine slowly by hand with the decompressor operative.



Decompressor adjustment

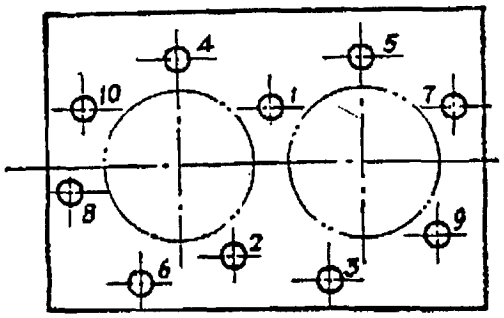
When removing the rocker box, remove the cap nuts and lift the cover clear.

When refitting the box, turn the decompressor shaft until the long slot in the end is vertical **and the screw heads are angled towards the injectors**. Check that the spade end to the decompressor lever shaft is also vertical and refit the rocker box.



With the decompressor operative, turn the engine slowly by hand to check the installation. If solid resistance is felt, either the adjustment screws have been screwed in too far, or, the shaft is 180 degrees out of position and the screw heads are engaging on the rocker arms causing excess lift.

When refitting the cylinder head, always use a new gasket. Examine the head and block faces carefully for any signs of burning or other imperfections, especially if there has been gasket failure (in which case it is wise to have the head skimmed flat in a machine shop). Degrease the head and block faces (but not the gasket) and ensure they are completely clean. Tighten the nuts gradually and evenly in the order shown below, with the final tightening to **16 kg.m. (115 lbf.ft.)**.



Note that the valve gear is secured by self locking aircraft nuts which should be tightened alternately two turns at a time and torqued to 4 kgf.m. (30 lbf.ft.).

After the engine has run for 30 minutes and is still hot, torque down the cylinder head nuts again. Recheck the valve gear securing nuts and valve clearances when cold.

3.3 Crankshaft and Flywheel

The crankshaft and flywheel assembly comprises the hand starting jaw, vee belt pulley, drive gear, crankshaft, ring gear and flywheel.

The crankshaft is nitrided and regrinding is not feasible.

On each end of the crankshaft, there is an oil thrower ring and oil sealing sub-assembly. The flywheel is positioned with a 10mm. diameter dowel pin and secured with six high tensile M12 bolts. These should be tightened evenly and diagonally to a final torque of **11 kg.m. (80 lbs.ft.)** and locked with tabs.

If the crankshaft is replaced, the dowel pin hole in both the flywheel and crankshaft should be reamed together.

Marks for top dead centre, bottom dead centre and advance angles are marked on the outer periphery of the flywheel.

The ring gear is an interference fit on the flywheel and is shrunk on after heating to 200 deg. C. in oil. The chamfered side must face outwards.

Each crank pin has an oil drilling through to the journal to provide it with a continuous oil feed. Ensure that none of these is obscured by incorrect fitting of bearing shells (see section 3.1 Cylinder Block for further details).

3.4 Piston and Connecting Rod

This assembly comprises the piston, rings, piston pin and circlips, connecting rod, big-end cap, bolts, dowel sleeves, small end bush and big-end bearing shells.

If piston rings are difficult to remove, soak the ring (or the entire piston) in release oil, diesel fuel or paraffin for as long as is necessary. Wear tolerances are set out under Technical Specification in Section 1.

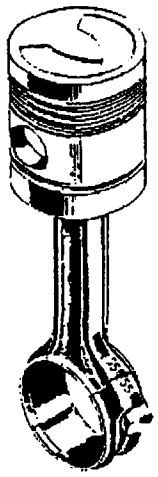
The piston has five ring grooves for three compression rings (the top one is chrome) and two oil rings. A single combined oil scraper ring may be used in which case the lower oil groove becomes redundant. Before fitting rings, place them square in the liner and measure the end gap. In the top ring, it should be within the range 0.3 - 0.5 mm. (0.012 - 0.020") and in the others 0.25 - 0.40mm. (0.010 - 0.016"). If the gap is insufficient, grind the ends of the ring until it is.

Rings should be installed using a ring expander. Take care to stagger the gaps of adjacent rings, and do not align the gap in the top ring with the combustion chamber, or the gap in the oil ring with the ends of the piston pin.

The connecting rod has a bronze bush pressed into its small end. The oil hole in the bush must be aligned with the hole in the connecting rod so as to collect splashed oil.

When assembling the piston to the connecting rod, insert a circlip in one end of the piston first, heat the piston to 100 - 120 deg. C. using an electric oven or oil bath and quickly push in the piston pin through the piston and small end bush. Then insert the other circlip. Ensure that the horseshoe shaped depression in the piston is on the same side as the upper, marked, split in the big-end (see drawing).

The big-end cap is located by two dowel sleeves and is machined after assembly. A cap must therefore only be fitted to its own rod, and always the same way round (as marked).



Piston & con. rod Assembly

The big-end bolts are hardened and tempered and are copper plated up to 0.01mm. which has a self locking effect. After repeated dismantling, the bolts should therefore be renewed.

Used but serviceable bearing shells should only be refitted in their original positions.

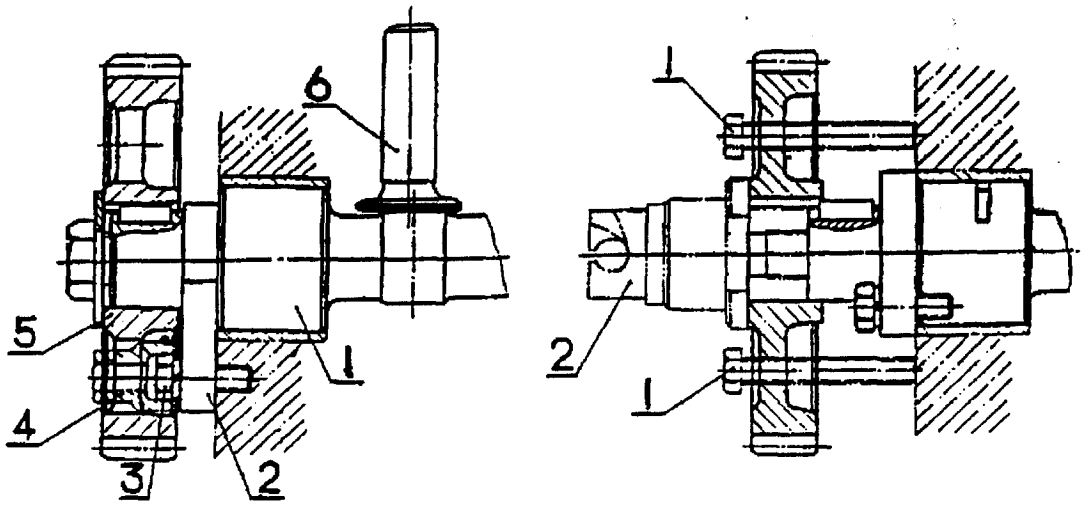
Before installing the piston assembly in the block, ensure that it is thoroughly clean and liberally oiled. Use a ring compressor to squeeze the piston rings and carefully push the assembly into the liner. Ensure that the horseshoe shaped recess in the piston crown is on the same side as the injector pump.

Tighten the big-end bolts carefully, alternately and evenly to **11 kg.m (80 ft.lbs.)**, having previously oiled the crank pin. Check that the axial float of the big end on the crank pin is in the range 0.17 - 0.44mm. (0.007 - 0.018").

3.5 Valve Gear

The valve gear comprises the camshaft, tappet, push rod, timing gear and thrust plate. The major components are shown on the following page.

The thrust plate controls the end float of the camshaft and is mounted at the front of the shaft. The end float should be within 0.12 - 0.34 mm. (0.005 - 0.014").



1. Camshaft
2. Thrust plate
3. Fixing bolt
4. Socket spanner
5. Timing gear
6. Tappet

1. Extractor bolt
2. Starting jaw

The camshaft can be removed complete with its gear by removing the thrust plate retaining bolts with a socket spanner. Take care not to let the tappets drop out into the sump. The gear can be removed from the shaft if required by screwing two M8 bolts into the gear after removing the retaining nut or dog. When reassembling, do not hammer the gear on because of the risk of loosening or distorting the plate on the other end of the block. The gear can be pressed on using its retaining nut or dog. Bend up the tab washer after tightening.

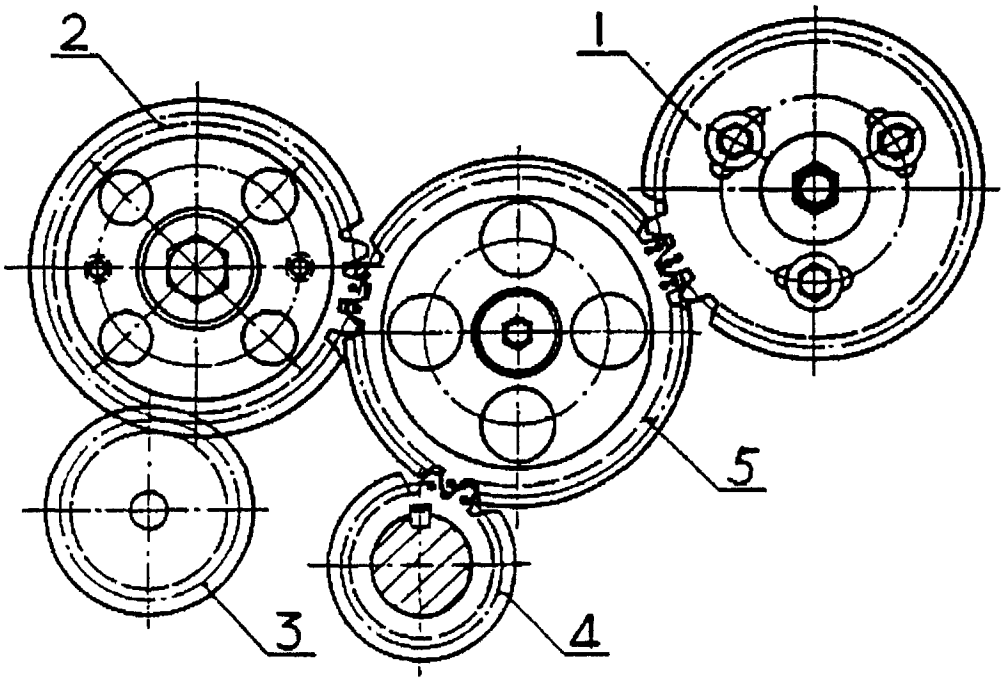
For details of the camshaft bushes, see Section 3.1 Cylinder Block.

3.6 Gear Train

The gear train comprises the crankshaft main driving gear, camshaft timing gear, injection pump driving gear, oil pump driving gear, and idler gear.

The idler gear shaft is installed in the block by press fit. There is an oil hole in the gear shaft which connects to the main engine oil supply, so that the idler gear bush and the rest of the gear train receive lubrication.

The position of each of the gears, except the oil pump gear, in relation to one another is critical and the marks must be aligned as shown in the drawing below.



Gear train

1. Injection pump gear
2. Camshaft gear
3. Oil pump gear
4. Crankshaft main drive gear
5. Idler gear

After the gear train is assembled, the meshing clearance of all gears should be checked and should be in the range 0.13 - 0.17mm. (0.005 - 0.008"). Their wear limit is 0.3mm (0.012"). End float of the idler gear should be maintained between 0.22 and 0.55mm. (0.009 and 0.022").

4. FUEL SYSTEM AND GOVERNOR

A diesel engine functions by drawing in unrestricted amounts of air into its cylinders and injecting precisely controlled quantities of fuel just before the top of each compression stroke. The high compression temperature ignites the fuel.

The fuel system is therefore a most critical component in a diesel engine. Many of the parts are precisely mated to one another during manufacture and they should only be disturbed when necessary. Delicate components should be handled with great care and every component must be returned to its original location.

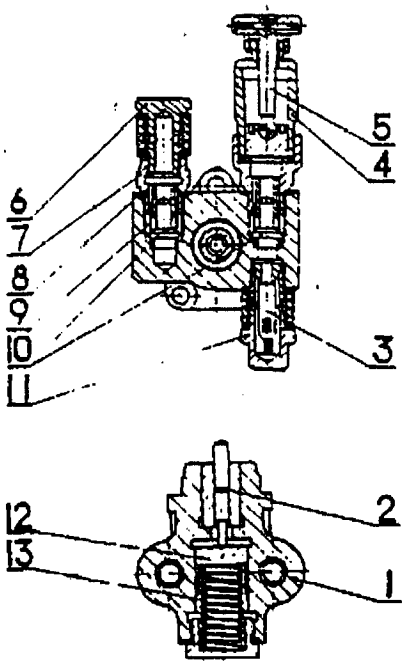
The injection pump is mounted on the side of the engine and delivers a precisely metered quantity of fuel to each cylinder via an injector for each firing. Incorporated within the injection pump unit is a fuel lift pump and the engine speed governor.

Because of the precise nature of the fuel delivery system, the fuel must pass through at least two cartridge type filters so that any water and particles can be separated out. If the fuel is in poor condition, it should be allowed to stand for at least 48 hours to allow water and debris to settle to the bottom. Take care not to pour in the debris with the fuel.

4.1 Lift Pump

The lift pump is a single acting piston type driven by a cam within the injector pump. For hand priming or bleeding purposes, the knob can be unscrewed and the pump operated by hand. It should be pushed in and screwed home after use. The components are shown below.

1. Pump body
2. Tappet couple
3. Gauze filter
4. Hand priming body
5. Hand priming piston sub-assembly
6. Banjo bolt
7. Banjo joint
8. Copper washer
9. Non return valve spring
10. Non return valve
11. Inlet banjo bolt
12. Pump piston
13. Piston spring



There are two non return valves which may become worn after extended use and should be replaced. Other components are matched and should operate freely without jamming when reassembled.

4.2 Fuel Filter

Information on fuel filtration is set out in the Appendix and should be studied carefully. Engines are supplied with a Lucas CAV filter unit containing a model 296 disposable filter cartridge. The use of a precipitating type pre-filter within the fuel line upstream of the lift pump is strongly recommended. If fuel sources are not reliable, a water trap and agglomerator should be installed as well.

The cartridge unit is replaced by unscrewing the centre bolt, lowering the bottom unit and removing the cartridge. Take care to ensure that all sealing rings are in place when fitting a new cartridge. After fitting a new cartridge, the system will require bleeding by slackening the 10 mm. slotted screw on the injection pump close to the lift pump knob and operating the lift pump by hand until all the air and aerated fuel have escaped. Finally tighten the screw whilst at the same time pushing the pump handle in to ensure that no air is drawn back into the injection pump. Do not overtighten. Screw in the pump handle.

4.3 Fuel Injection Pump.

The pump components are illustrated on the following page.

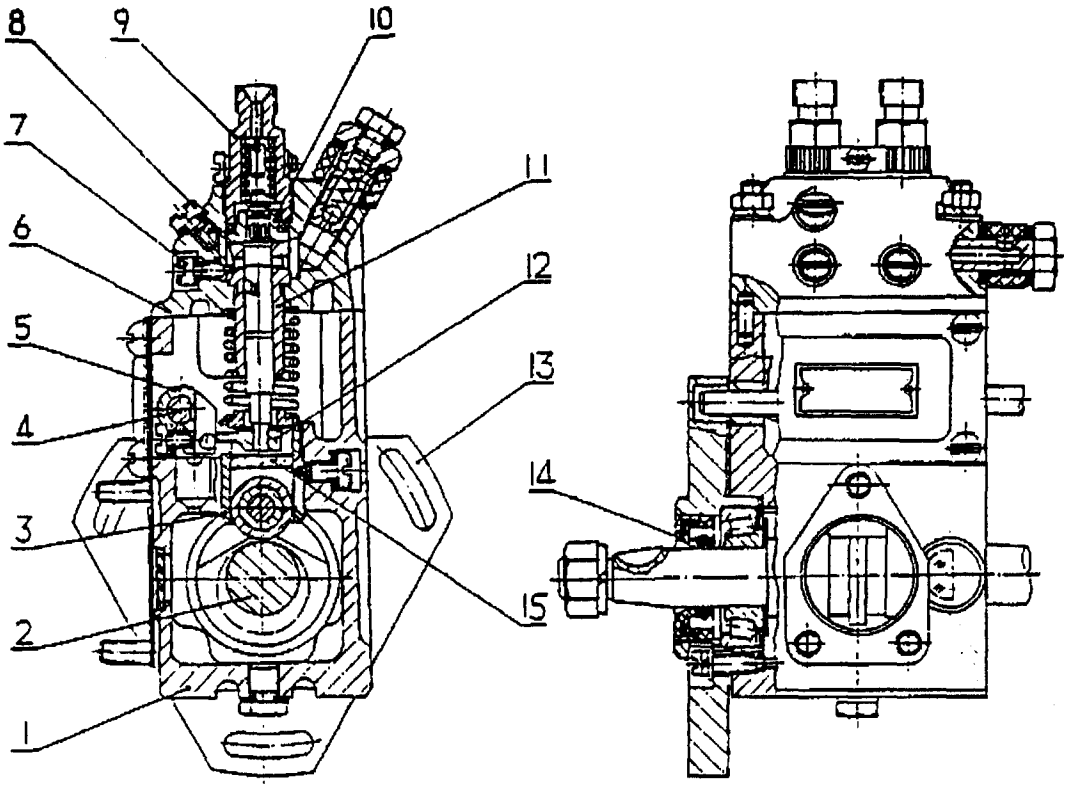
The pump is an integral two cylinder plunger type. As the camshaft rotates, the roller follows the cam profile causing the plunger to reciprocate via the tappet, adjusting block and spring. As the plunger moves upwards, it compresses the fuel which then lifts the delivery valve and passes on to the injector.

The plunger is lapped to its cylinder and the delivery valve is lapped to its seat. These parts are all mated in pairs and must on no account be interchanged when dismantled.

The plunger diameter is 8mm. On the upper part is machined a vertical channel. On the periphery is machined a helical groove which intersects with the vertical channel. The channel and groove are used to vary the amount of fuel delivered by partially rotating the plunger. The quantity is controlled by the governor, which turns the plunger via the control pull rod, driving fork and adjusting arm.

At 12 hr. rating, the pump is rotating at 1,000 rev/min. and each pump cylinder should deliver 60 ml/min. Any adjustment should only be carried out by a trained diesel mechanic using special equipment.

The Injection Pump.

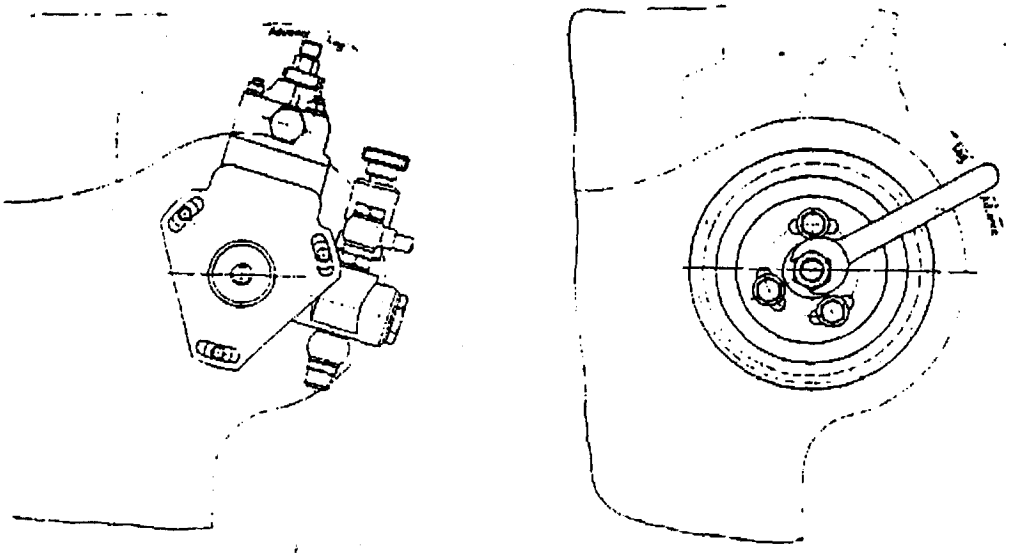


1. Lower body sub-assembly
2. Camshaft sub-assembly
3. Push rod sub-assembly
4. Control push rod
5. Driving fork
6. Upper body sub-assembly
7. Lock screw
8. Vent screw
   Delivery valve holder
10. Delivery valve couple
    Plunge couple
12. Adjusting arm
13. Triagonal flange
14. Bearing seal sub-assembly
15. Adjusting block

4.3.1 Injection Timing

Injection timing can be checked either by disconnecting an injector pipe and observing fuel flow (spill method), or by using electronic equipment whilst the engine is running.

To use the spill method, remove an injector pipe from the pump and turn the engine slowly. At the moment that the fuel starts to rise and overflow from the pump outlet, read the degrees of advance on the engine flywheel periphery. Using this method, the advance should be between 16 and 19 degrees before T.D.C. The difference between the two cylinders should be less than one degree: excessive discrepancy should only be corrected by a trained technician dismantling the pump and changing the adjusting blocks.



Injection timing measurement

When using electronic equipment, which measures the swelling of the injector pipe caused by fuel flow, the recorded advance is likely to be several degrees less. **Refer to the equipment manufacturer before using.**

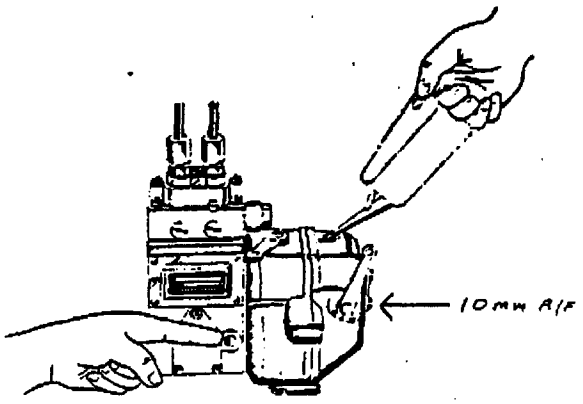
If adjustment is required, it may be achieved in either of two ways. One is to rotate the entire pump body which requires loosening of the two nuts and one bolt at the pump flange, as shown in the drawing. Turning the top of the pump towards the engine advances the timing, turning away from the block retards it.

The second method is to rotate the injection pump driving gear on its shaft, as shown in the second drawing. The three bolts securing the gear to the flange must first be loosened. Rotating the shaft clockwise relative to the gear advances the timing, rotating anticlockwise retards it.

The injection pump operates with its own oil supply, the level of which should be checked every 150 hours. On some versions, there is a perspex window in the side of the pump; on others, there is a banjo bolt and short overflow pipe pointing downwards positioned at the correct oil level, whilst on others one of the 10 mm. A/F bolts on the back of the governor housing acts as level indicator. Slacken or remove the appropriate bolt, remove the filler cap/vent and add clean engine oil slowly until the correct level is indicated. Tighten the banjo or bolt and replace the filler cap. Do not over tighten, and do not overfill, or the sensitivity of the governor will be impaired.

In due course, the pump oil may become contaminated with fuel and it should therefore be changed every 450 hours. There are two drain plugs, one each in the bottoms of the pump and governor components, and both should be removed for draining.

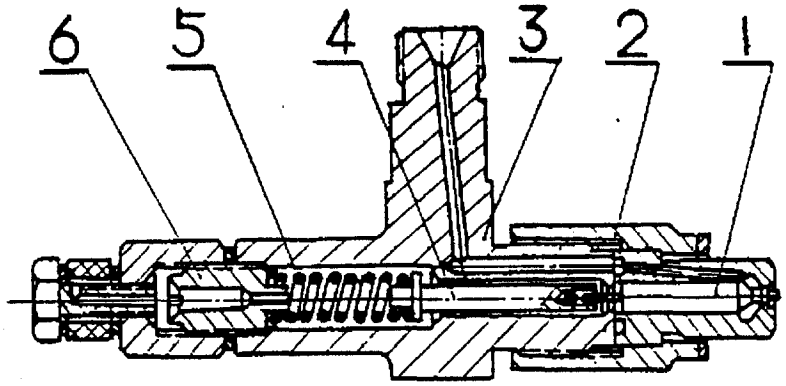
If the oil level rises during engine running, check for leaks due to an excessively worn plunger or lift pump. Remedy any defect without delay.



Injection Pump Oil Level

4.4 Fuel Injector

The injector is of single hole pintle type comprising a needle valve, nozzle holder, injector body, push rod assembly, adjusting spring and screw etc. as shown in the drawing below. It can be dismantled with care for servicing.



Injector

1. Needle valve couple
2. Nozzle holder
3. Injector body
4. Push rod sub-assembly
5. Adjusting spring
6. Adjusting screw

The nozzle hole is 1.0mm. in diameter and the spray angle is 4 deg. The needle valve and nozzle body are lapped in pairs and neither part should be interchanged with another.

The injection pressure should be set using a rig at 125 - 130 kg./sq.cm. (1,780 - 1,850 lbs/sq.in.). The adjusting screw, acting against the spring, controls the pressure.

Excessively high pressure will result in rapid wear of parts, whilst too low a pressure will result in incomplete combustion, smoky exhaust and burnt needle valve.