# Chapter 2 Cooling system

## Contents



## Specifications

| | |
|---|---|
| **Cooling system** | |
| Coolant mixture | 50% antifreeze, 50% water |
| Antifreeze type | Any high quality ethylene glycol mixture with aluminium engine type corrosion inhibitors |
| Capacity: | |
| Overall | 1.5 litre (2.64 Imp pint) |
| From low to full | 185 cc (0.32 Imp pint) |
| Reservoir tank capacity | 215 cc (0.38 Imp pint) |
| **Radiator** | |
| Radiator: | |
| Core width | 290.6 mm (11.44 in) |
| Core height | 180 mm (7.08 in) |
| Core thickness | 16 mm (0.63 in) |
| Cap opening pressure | 0.9 ± 0.15 kg cm² (12.8 ± 2.13 psi) |
| **Water pump** | |
| Type | Centrifugal impeller |
| Reduction ratio | 32/20 (1.60:1) |
| **Thermostat** | |
| Opening temperature: | |
| RD350 LC II | Not available |
| Other models | 71° ± 2°C (156° ± 35.6°F) |
| Fully open temperature: | |
| RD350 LC II | Not available |
| Other models | 85°C (185°F) |
| Maximum lift: | |
| RD350 LC II | Not available |
| Other models | 7.0 mm (0.28 in) |

## 1 General description

The Yamaha LC models are provided with a liquid cooling system which utilises a water/antifreeze coolant to carry away excess energy produced in the form of heat. The cylinders are surrounded by a water jacket from which the heated coolant is circulated by thermo-syphonic action in conjunction with a water pump fitted in the engine right-hand cover and driven via a pinion and shaft from a crankshaft mounted pinion. The hot coolant passes upwards through flexible pipes to the top of the radiator which is mounted on the frame downtubes to take advantage of maximum air flow. The coolant then passes downwards, through the radiator core, where it is cooled by the passing air, and then to the water pump and engine where the cycle is repeated.

The flow of coolant is regulated by a thermostat, a temperature sensitive valve unit contained in a housing on top of the cylinder head. When the engine is cold, the thermostat remains closed, effectively stopping the coolant from circulating through the system. This allows the engine to reach its normal operating temperature rapidly, minimising wear. As the water temperature rises, the thermostat begins to open and the coolant starts to circulate to keep the engine at the optimum temperature.

The complete system is sealed and pressurised; the pressure being controlled by a valve contained in the spring loaded radiator cap. By pressurising the coolant the boiling point is raised, preventing premature boiling in adverse conditions. The overflow pipe from the radiator is connected to an expansion tank into which excess coolant is discharged by pressure. The expelled coolant automatically returns to the radiator, to provide the correct level when the engine cools again.

## 2 Draining the cooling system

1 It will be necessary to drain the cooling system on infrequent occasions, either to change the coolant at two yearly intervals or to permit engine overhaul or removal. The operation is best undertaken with a cold engine to remove the risk of scalding from hot coolant escaping under pressure.

2 Place the machine on its centre stand and gather together a drain tray or bowl of about 2.0 litres (4.0 pint) capacity, and something to guide the coolant from the cylinder barrel drain plugs into the bowl. A small chute made from thick card will suffice for this purpose, but do not be tempted to allow the coolant to drain over the engine casings – the antifreeze content may discolour the painted surfaces.

3 To gain access to the radiator filler cap it will be necessary to remove the fuel tank. Remove the seat, then release the single retaining bolt at the rear of the tank. Check that the fuel tap is set to the "ON" position, then pull off the left-hand side panel to reveal the fuel and vacuum pipes. Slide the clips down the pipe and prise each one off its stub. Lift the rear of the tank and pull it back to free the mounting rubbers at the front. The radiator filler cap will now be accessible near the steering head.

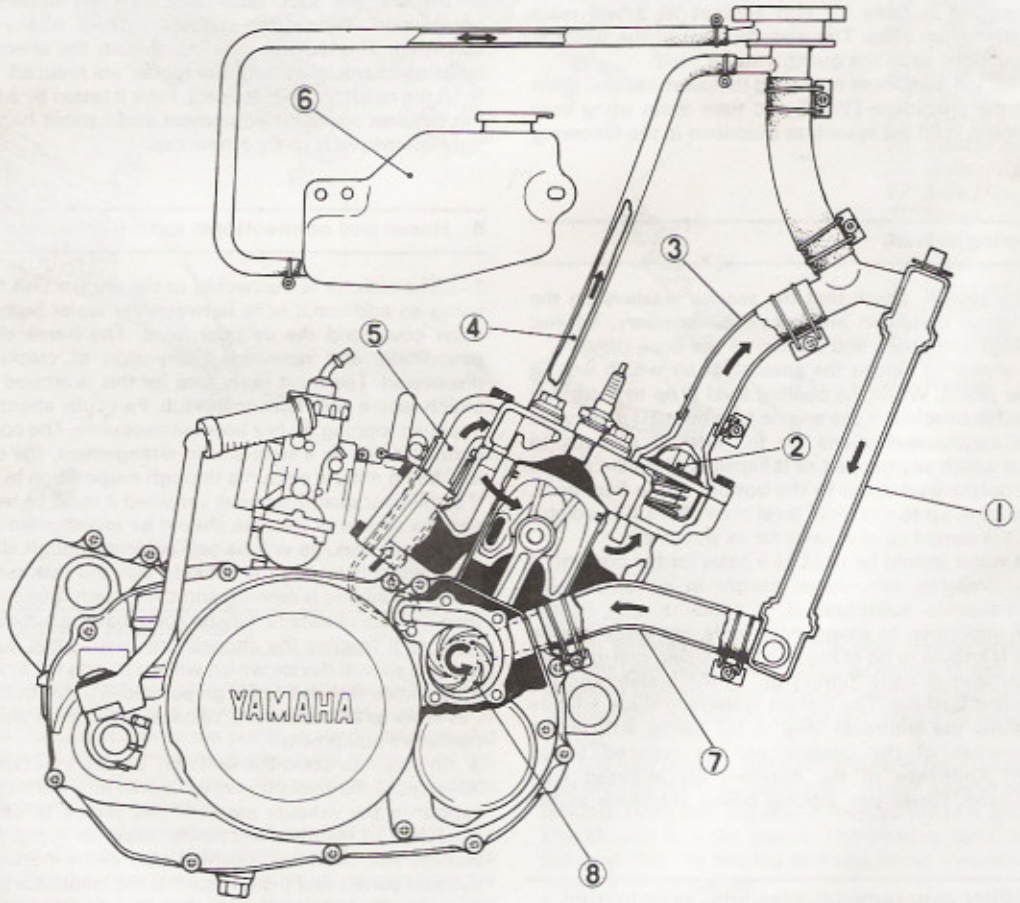



**Fig. 2.1 Cooling system components**

*1 Radiator*
*2 Thermostat*
*3 Top hose*
*4 Bypass pipe*
*5 Pump to cylinder hose*
*6 Expansion tank*
*7 Bottom hose*
*8 Water pump*

4 Slacken and remove each of the cylinder barrel drain plugs in turn, using the chute to guide the coolant clear of the crankcase outer covers and into the bowl. If the system is to be drained fully pull off the pipe from the expansion tank and allow this to drain. Drain any residual coolant by detaching the hose at the front of the right-hand outer cover stub.
5 If the system is being drained before an engine overhaul little else need be done at this stage. If the coolant is reasonably new it can be re-used if it is kept clean and uncontaminated. If, however, the system is to be refilled with new coolant it is advisable to give it a through flushing with tap water, if possible using a hose which can be left running for a while. If the machine has done a fairly high mileage it may be advisable to carry out a more thorough flushing process as described below.

## 3 Flushing the cooling system

1 After extended service the cooling system will slowly lose efficiency, due to the build up of scale, deposits from the water and other foreign matter which will adhere to the internal surfaces of the radiator and water channels. This will be particularly so if distilled water has not been used at all times. Removal of the deposits can be carried out easily, using a suitable flushing agent in the following manner.
2 After allowing the cooling system to drain, refit the drain plugs and refill the system with clean water and a quantity of flushing agent. Any proprietary flushing agent in either liquid or dry form may be used, providing that it is recommended for use with aluminium engines. NEVER use a compound suitable for iron engines as it will react violently with the aluminium alloy. The manufacturer of the flushing agent will give instructions as to the quantity to be used.
3 Run the engine for ten minutes at operating temperatures and drain the system. Repeat the procedure TWICE and then again using only clean cold water. Finally, refill the system as described in the following Section.

## 4 Filling the cooling system

1 Before filling the system, check that the sealing washers on the drain plugs are in good condition and renew if necessary. Fit and tighten the drain plugs and check and tighten all the hose clips.
2 Fill the system slowly to reduce the amount of air which will be trapped in the water jacket. When the cooling level is up to the lower edge of the radiator filler neck, run the engine for about 10 minutes at 900 rpm. Increase engine revolutions for the last 30 seconds to accelerate the rate at which any trapped air is expelled. Stop the engine and replenish the coolant level again to the bottom of the filler neck. Refill the expansion tank up to the 'Full' level mark. Refit the radiator cap, ensuring that it is turned clockwise as far as possible.
3 Ideally, distilled water should be used as a basis for the coolant. If this is not readily available, rain water, caught in a non-metallic receptacle, is an adequate substitute as it contains only limited amounts of mineral impurities. In emergencies only, tap water can be used, especially if it is known to be of the soft type. Using non-distilled water will inevitably lead to early 'furring-up' of the system and the need for more frequent flushing. The correct water/antifreeze mixture is 50/50; do not allow the antifreeze level to fall below 40% as the anti-corrosion properties of the coolant will be reduced to an unacceptable level. Antifreeze of the ethylene glycol-based type should always be used. Never use alcohol based antifreeze in the engine.

## 5 Radiator and filler cap: removal, cleaning, examination and refitting

1 Drain the cooling system as described in Section 2 of this Chapter. On models so equipped, remove the lower fairing section (see Chapter 5 for details).
2 Disconnect the hose from the filler neck and the radiator top and bottom hoses from their respective stubs on the radiator. Release the screws which retain the plastic radiator grille and lift it away.
3 The two radiator mounting bolts can now be removed and the radiator lifted away. The bolts pass through rubber bushes, as does the locating peg on the top of the radiator which is similarly isolated. Note the order of these so that the radiator can be refitted correctly.
4 Remove any obstructions from the exterior of the radiator core, using an air line. The conglomeration of moths, flies and autumnal detritus usually collected in the radiator matrix severely reduces the cooling efficiency of the radiator.
5 The interior of the radiator can most easily be cleaned while the radiator is in-situ on the motorcycle, using the flushing procedure described in Section 3 of this Chapter. Additional flushing can be carried out by placing the hose in the filler neck and allowing the water to flow through for about ten minutes. Under no circumstances should the hose be connected to the filler neck mechanically as any sudden blockage in the radiator outlet would subject the radiator to the full pressure of the mains supply (about 50 psi). The radiator should not be tested to greater than 1.0 kg/cm² (15 psi).
6 If care is exercised, bent fins can be straightened by placing the flat of a screwdriver either side of the fin in question and carefully bending it into its original shape. Badly damaged fins cannot be repaired. If bent or damaged fins obstruct the air flow more than 20%, a new radiator will have to be fitted.
7 Generally, if the radiator is found to be leaking, repair is impracticable and a new component must be fitted. Very small leaks may sometimes be stopped by the addition of a special sealing agent in the coolant. If an agent of this type is used, follow the manufacturer's instructions very carefully. Soldering, using soft solder may be efficacious for caulking large leaks but this is a specialised repair best left to experts.
8 Inspect the four radiator mounting rubbers for perishing or compaction. Renew the rubbers if there is any doubt as to their condition. The radiator may suffer from the effect of vibration if the isolating characteristics of the rubber are reduced.
9 If the radiator cap is suspect, have it tested by a Yamaha dealer. This job requires specialist equipment and cannot be done at home. The only alternative is to try a new cap.

## 6 Hoses and connections: examination and renovation

1 The radiator is connected to the engine unit by two hoses, there being an additional hose between the water pump in the right-hand outer cover and the cylinder head. The hoses should be inspected periodically and renewed if any sign of cracking or perishing is discovered. The most likely area for this is around the wire hose clips which secure each hose to its stub. Particular attention should be given if regular topping up has become necessary. The cooling system can be considered to be a semi-sealed arrangement, the only normal coolant loss being minute amounts through evaporation in the expansion tank. If significant quantities have vanished it must be leaking at some point and the source of the leak should be investigated promptly.
2 Serious leakage will be self-evident, though slight leakage can be more difficult to spot. It is likely that the leak will only be apparent when the engine is running and the system is under pressure, and even then the rate of escape may be such that the hot coolant evaporates as soon as it reaches the atmosphere. Such small leaks may require the use of a special device which will pressurise the system whilst cold and thus enable the leak to be pinpointed. To this end it is best to entrust this work to an authorised Yamaha dealer who will have access to the necessary equipment.
3 In very rare cases the leak may be due to a broken head gasket, in which case the coolant may be drawn into the engine and expelled as vapour in the exhaust gases. If this proves to be the case it will be necessary to remove the cylinder head for investigation. If the rate of leakage has been significant it may prove necessary to remove the cylinder barrels and pistons so that the crankcase can be checked. Any coolant which finds its way that far into the engine can cause rapid corrosion of the main and big-end bearings and must be removed completely.
4 Another possible source of leakage is the stub between the crankcase and the right-hand outer cover. If its O-ring seal becomes damaged or broken it is possible that coolant might find its way into the transmission, and any sign of emulsified transmission oil or water droplets inside the cover should be investigated promptly before corrosion takes place.

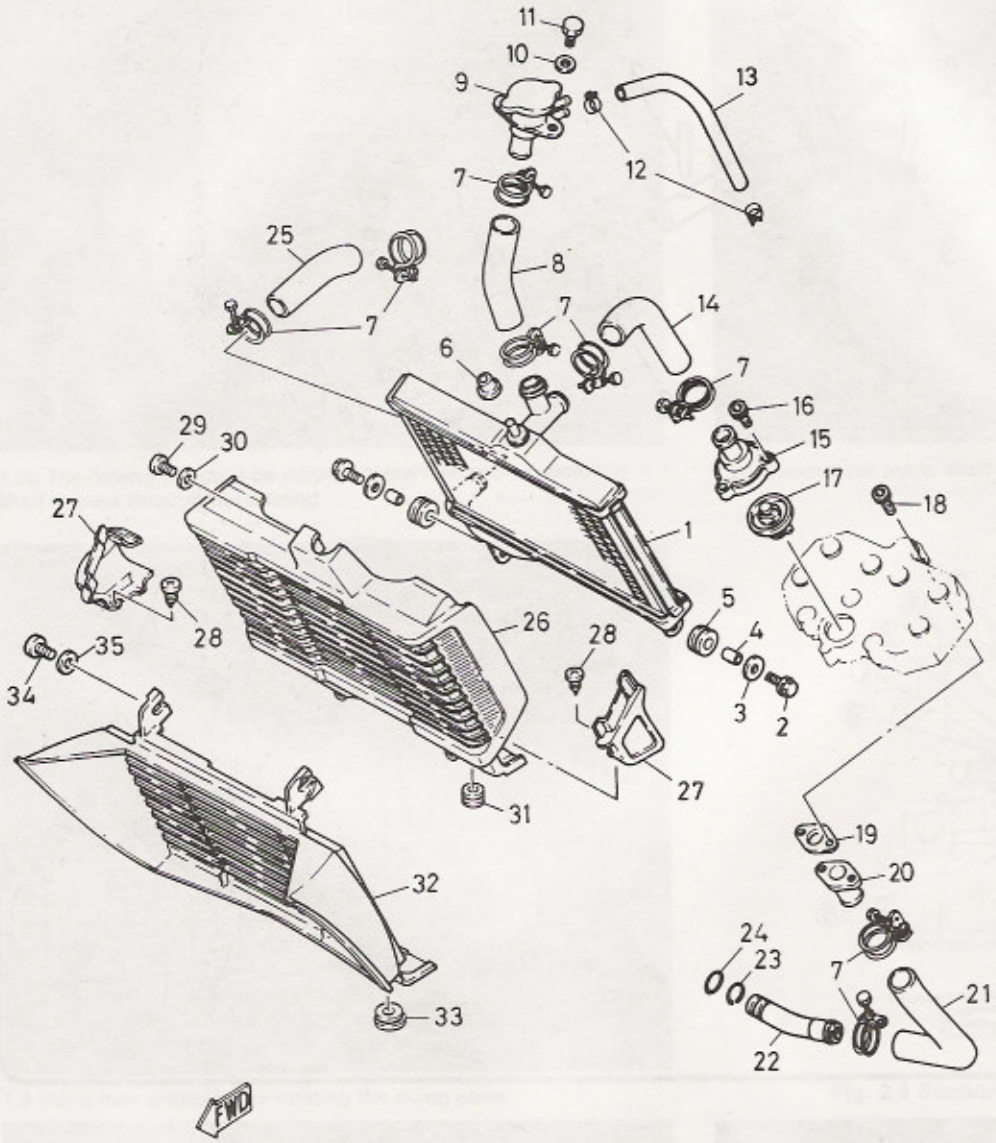



**Fig. 2.2 Radiator and thermostat**

*1 Radiator*
*2 Bolt*
*3 Washer*
*4 Spacer*
*5 Grommet*
*6 Grommet*
*7 Hose clamp*
*8 Filler neck hose*
*9 Radiator cap*
*10 Washer*
*11 Bolt*
*12 Pipe clip*
*13 Bypass pipe*
*14 Top hose*
*15 Thermostat housing*
*16 Bolt – 3 off*
*17 Thermostat*
*18 Bolt – 2 off*
*19 Gasket*
*20 Pipe union*
*21 Pump to cylinder hose*
*22 Hose union*
*23 Circlip*
*24 O-ring*
*25 Bottom hose*
*26 Grille – RD350 LC II*
*27 Side plate*
*28 Screw*
*29 Screw*
*30 Washer*
*31 Grommet – 2 off*
*32 Grille – RD350 F and N*
*33 Grommet*
*34 Screw*
*35 Washer*

*Items 26 to 31 – RD350 LC II*
*Items 32 to 35 – RD350 F and N*

## 7 Water pump: removal and overhaul

1 The water pump will not normally require attention unless its bearing has become noisy if there is obvious leakage of coolant into the transmission oil. To gain access to the pump, drain the coolant and the transmission oil fully, then remove the pump cover followed by the right-hand outer cover itself. Carefully drain the residual coolant from the pump before dismantling commences.

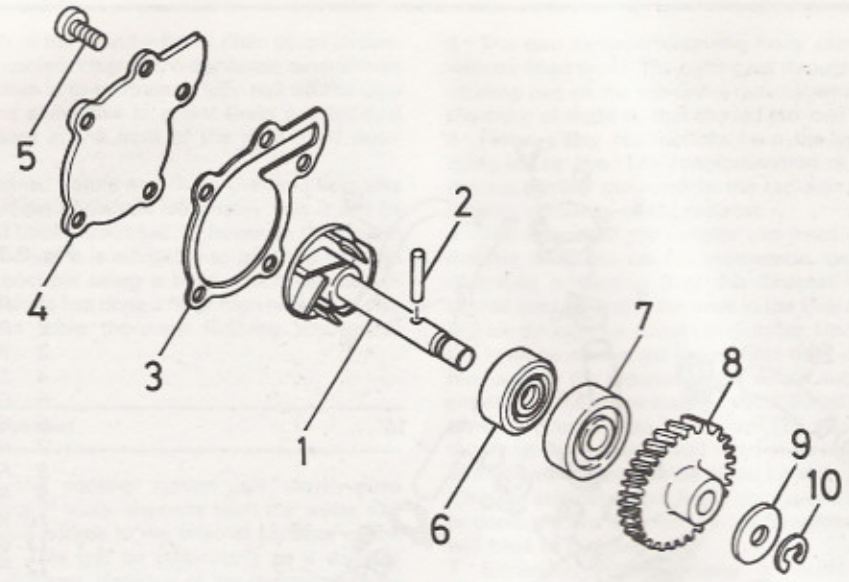
2 The water pump is located immediately above the oil pump, the two sharing a common drive pinion on the crankshaft. To dismantle the water pump it will first be necessary to remove its driven gear by displacing the circlip which secures it to the pump spindle. The locating pin should be removed by pushing it through and out of the spindle.

3 Unscrew the five cover screws and remove the cover and gasket. The impeller and spindle may now be displaced and removed. If the bearing or oil seal is worn or damaged they should be renewed as a set. The two components can be driven out from the oil seal side, having first heated the casing in an oven to 90° – 120°C (194° – 248°F). If using this method it is best to remove all seals, plastic parts and the oil pump first.

4 An alternative method is to pour boiling water (100°C) over the bearing boss area, but it is not advisable to use a blowlamp or other localised heat source in view of the risk of warpage. Once heated, the bearing and seal can be driven out using a suitable round bar or an old socket.

5 The new bearing and oil seal should be greased prior to installation and tapped home using a large socket against the outer race of the bearing. Note that the seal is marked WATER SIDE on one face, and this should face the pump. The bearing serial number should face outward. Tap the bearing and seal home ensuring that they both seat squarely in the casing.

6 Clean the impeller and spindle, being particularly careful to ensure that any corrosion that may have formed around the seal area is removed and the spindle left completely smooth. If the spindle is badly pitted in this area it may be necessary to renew it to avoid rapid seal wear. The spindle should be greased prior to installation and care should be exercised during fitting to avoid damage to the seal face. Complete reassembly by reversing the dismantling sequence, using a new gasket on the pump cover joint. Where practicable, tighten the cover screws to 0.8 kgf m (5.8 lbf ft).



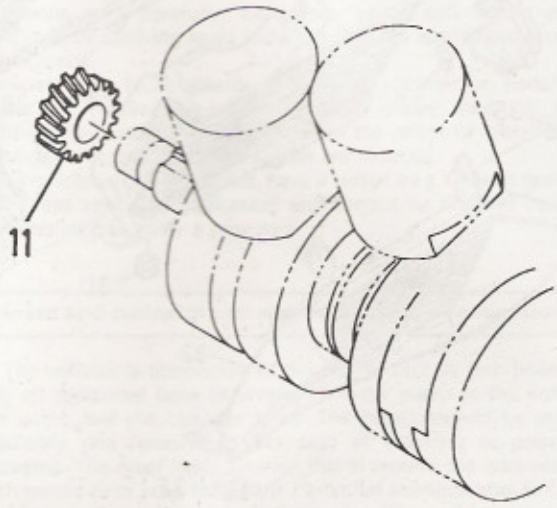
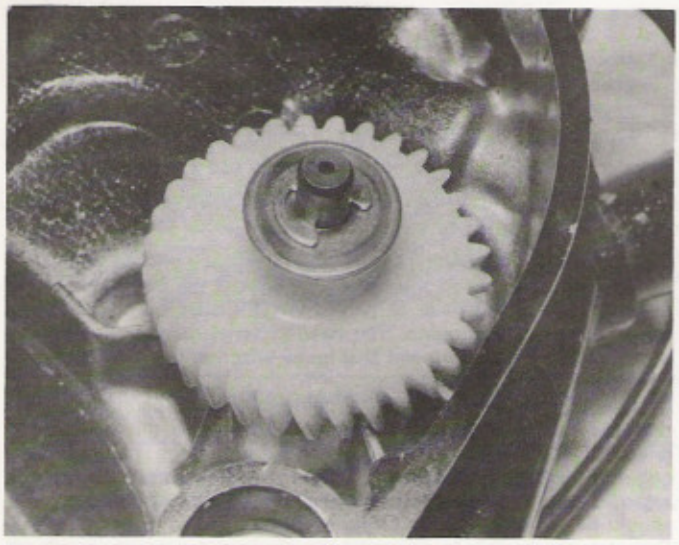
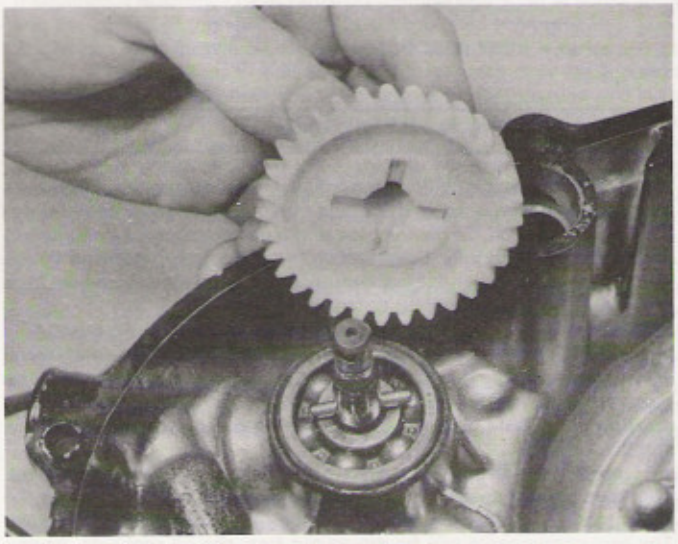




**Fig. 2.3 Water pump**

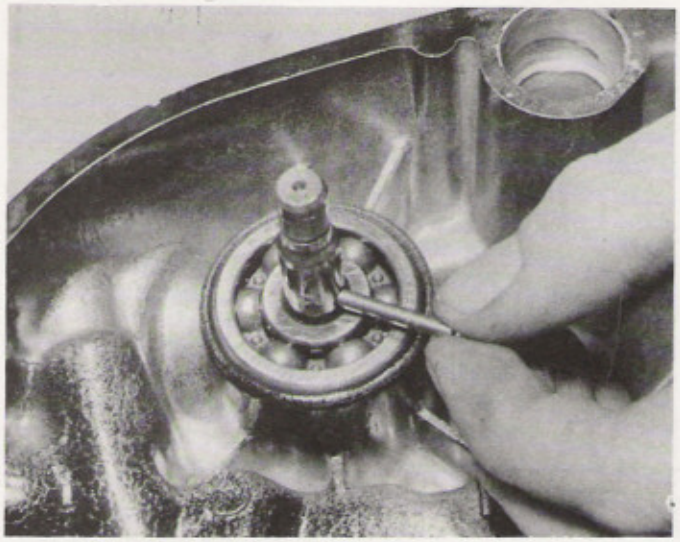
1 *Driveshaft*
2 *Locating pin*
3 *Cover gasket*
4 *Pump cover*
5 *Screw – 5 off*
6 *Oil seal*
7 *Bearing*
8 *Driven gear*
9 *Washer*
10 *Circlip*
11 *Drive gear*



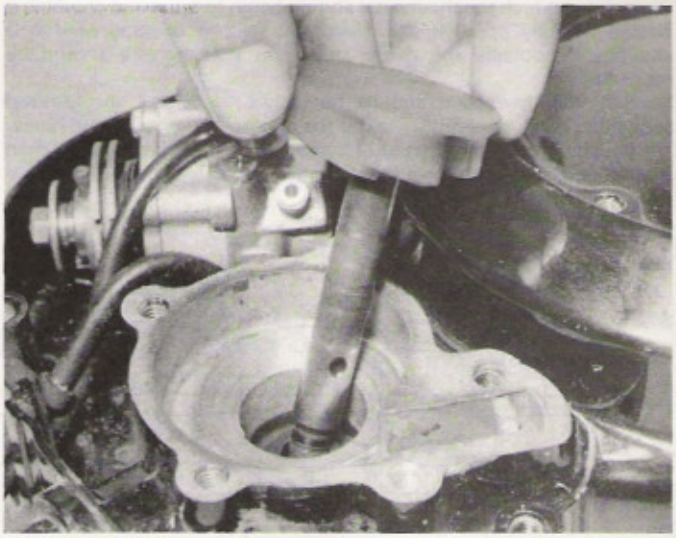
7.2a Remove the circlip and the plain washer ...



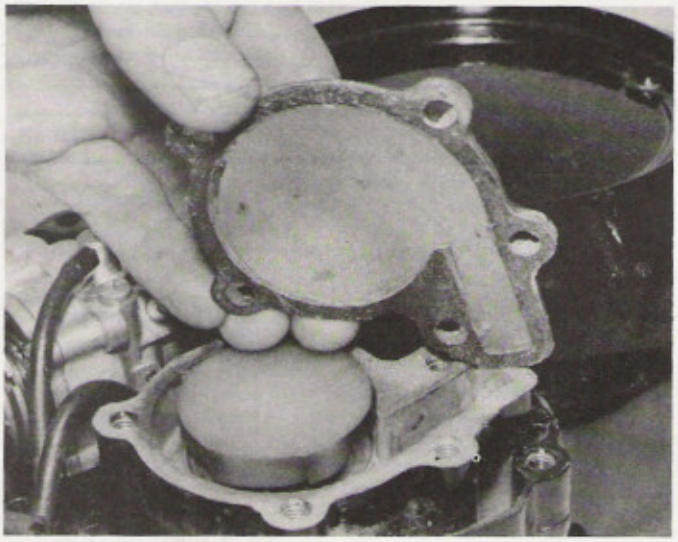
7.2b ... and lift away the white plastic pump pinion



7.2c The driving pin must be displaced and removed to allow the shaft to pass through the bearing



7.2d Remove the pump shaft together with the integral impeller



7.3 Use a new gasket when refitting the pump cover

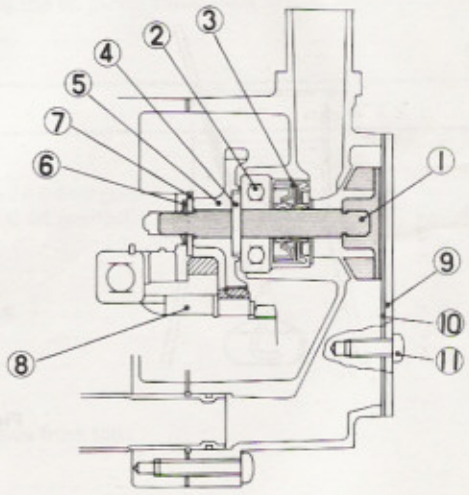



**Fig. 2.4 Sectioned view of water pump**

| | | | |
|---|---|---|---|
| 1 | *Driveshaft* | 7 | *Washer* |
| 2 | *Bearing* | 8 | *Drive gear* |
| 3 | *Oil seal* | 9 | *Pump cover* |
| 4 | *Locating pin* | 10 | *Gasket* |
| 5 | *Driven gear* | 11 | *Screw* |
| 6 | *Circlip* | | |

## 8 Water temperature gauge and sender: testing

Water temperature is monitored by an electrically operated gauge in the instrument panel controlled by a sender unit which screws into the cylinder head water jacket. A description and test procedure of these components will be found in Chapter 7.

## 9 Thermostat: removal and testing

1 The thermostat is automatic in operation and should give many years service without requiring attention. In the event of a failure, the valve will probably become jammed open, in which case the engine will take much longer than normal to warm up. If, conversely, the valve gets jammed shut, the coolant will be unable to circulate normally and the engine will tend to overheat badly. Neither condition is acceptable, and the fault should be investigated promptly.

2 Before the thermostat can be removed it will be necessary to drain the cooling system as detailed in Section 2. The system need not be drained fully, but the coolant level must be well below the thermostat housing on the cylinder head. Disconnect the hose from the thermostat housing stub, then release the three screws which secure the thermostat housing to the cylinder head.

3 Lift away the housing and remove the thermostat from it, taking care not to damage the rubber seal. If the valve is jammed open this will be obvious during the initial inspection, and further testing is unnecessary; fit a new thermostat and then refit the cover using a new gasket and refill the cooling system.

4 The thermostat can be tested by using an old saucepan or similar and a thermometer capable of reading at least 100°C (212°F). Place the thermostat and the thermometer in the saucepan and fill it with water. Heat up the water and watch the thermostat and the thermometer as the temperature rises. The accompanying chart shows

the point at which the thermostat should begin to open and at which it should be fully open. If the thermostat fails to operate, or if it is significantly outside the range shown in the chart, it should be renewed.

5 Refit the thermostat and its housing by reversing the removal sequence. Use a new rubber seal if the original is damaged and renew the housing gasket as a matter of course. Fill the cooling system, then run the engine to check that the thermostat operates normally and that there are no leaks.

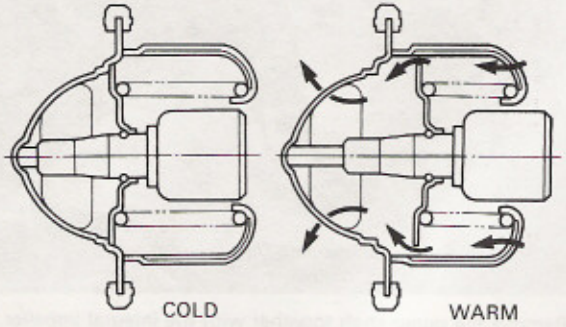
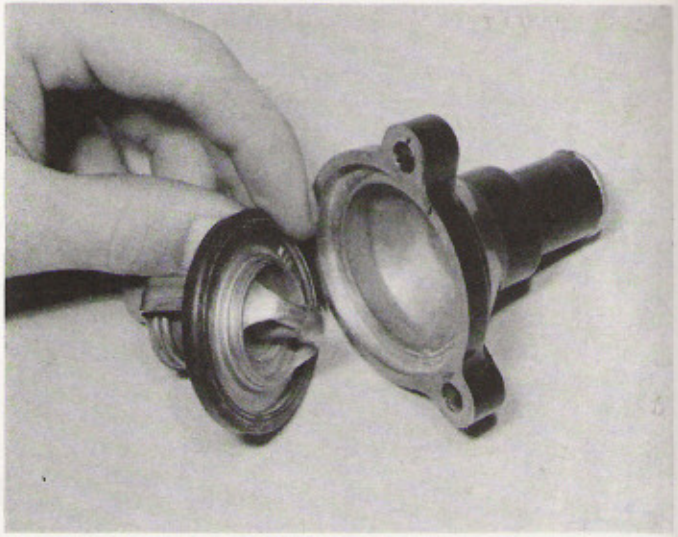



**Fig. 2.5 Thermostat operation**



9.3 Check the condition of the rubber seal around the thermostat – renew if damaged

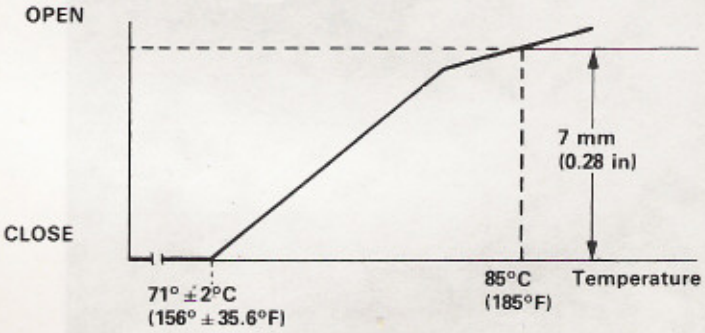



**Fig. 2.6 Thermostat test**