# Section 3: Operating Outboard Engines

## Learning Outcome 3

On completion of this section you should be able to operate marine outboard engines, recognise common defects and carry out user maintenance.

The areas you will cover in this section are:

**3.1 Basic construction of a marine outboard engine**

**3.2 Checks and procedures before starting outboard engines**

**3.3 Checks if an engine fails to start**

**3.4 Warm up periods**

**3.5 Engine overheating**

**3.6 Routine User Servicing**

# 3.1 Basic construction of a marine outboard engine

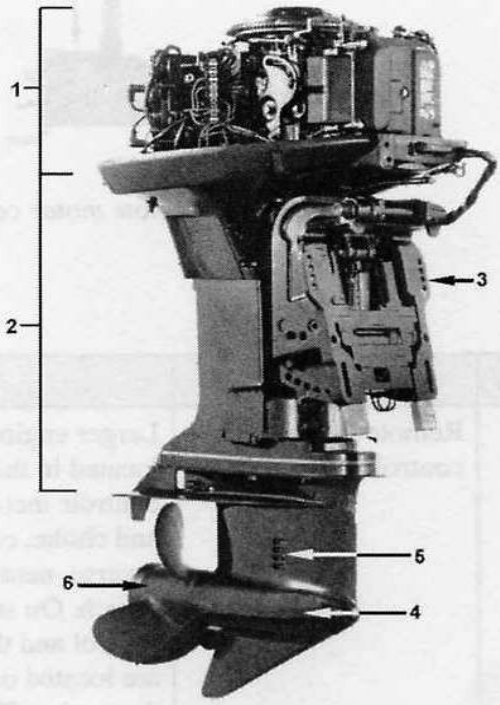
Marine outboard engines range in size from small electric driven units to large V8, 300 horsepower units. These engines are specifically designed and manufactured for use on vessels, although they still require a level of maintenance and care to remain in good working condition.

Outboard engines have the benefit that the one unit comprises the engine, gearbox and propeller. Unfortunately, outboard engines cannot provide the power or the economy required by many large commercial vessels.

Outboard engines are generally used on smaller commercial vessels such as water taxis, water authorities, water police or small charter vessels (fishing or scuba diving). They are also used as auxiliary engines on some larger vessels, particularly those under sail.

On larger sporting vessels and some commercial vessels, such as the Waterways Authority in New South Wales, twin outboard engines of the same power rating are used on the one vessel.

The following are illustrations of a standard outboard engine (courtesy of Outboard Marine Corporation) and its major components.

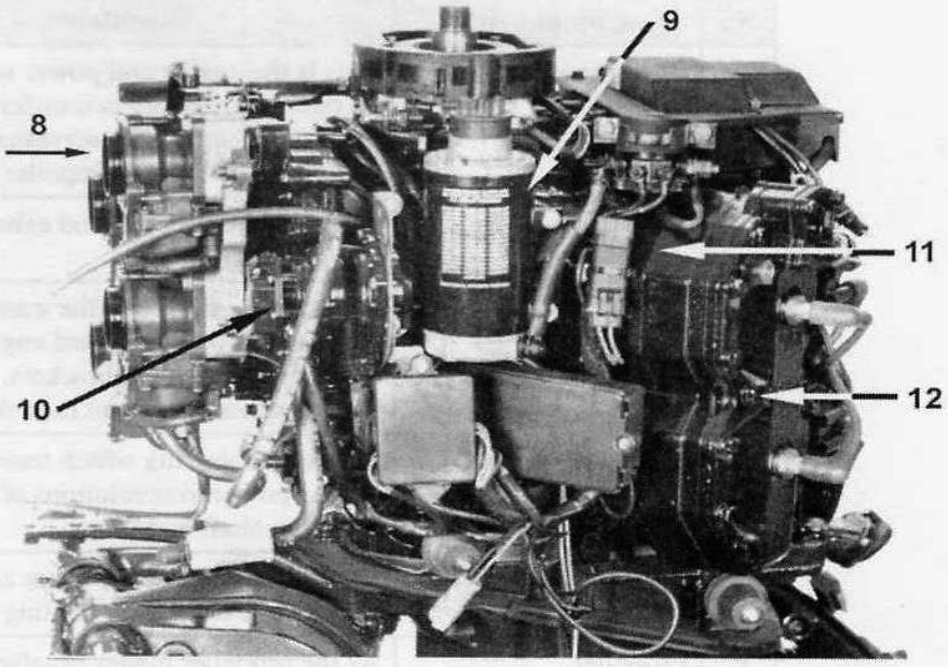



*Profile of outboard engine*

| No | Component | Function |
|---|---|---|
| 1 | Powerhead | This is the engine and power source of an outboard. Energy is transferred from the powerhead via the driveshaft and propeller shaft to the propeller |
| 2 | Midsection / Leg | Houses the driveshaft and exhaust channels/ports |
| 3 | Engine mounting brackets | Attaches the engine to the transom of the vessel. Small outboard engines use screw type mounting brackets, while large engines are bolted onto the vessel |
| 4 | Gearbox | Houses the gearing which transfers engine power to revolutions of the propeller shaft and thrust |
| 5 | Water intakes | Sea water enters at this point and flows through the engine for cooling purposes |
| 6 | Propeller | As the propeller blades revolve through the water the engine/vessel are thrust in the opposite direction to the water. |

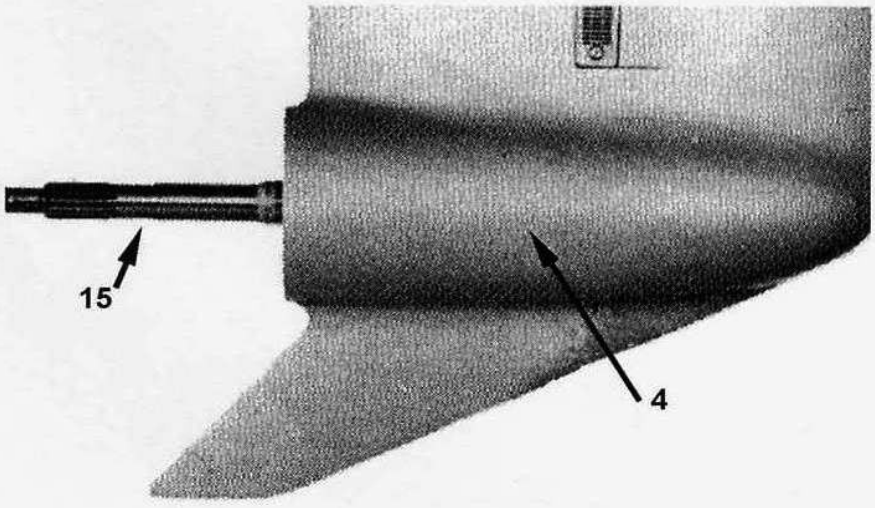

*Remote motor control*

| No | Component | Function |
|---|---|---|
| 7 | Remote motor control | Larger engines have remote controls located in the wheel house. These controls incorporate the ignition switch and choke, control handle (forward, reverse, neutral) and emergency stop switch. On smaller engines throttle control and the emergency stop switch are located on a tiller arm attached to the engine. This arm is also moved left or right to alter the direction of the vessel |




*Side view of powerhead*

| No | Component | Function |
|---|---|---|
| 8 | Carburettors | Fuel and air is mixed in the carburettors and channelled into the cylinder where combustion occurs |
| 9 | Electric starter motor | This unit spins the flywheel, which carries this momentum through to the crankshaft and pistons until the engine starts. |
| 10 | Fuel pump | Pumps fuel into the carburettors |
| 11 | Block | Houses the cylinders and pistons |
| 12 | Head | Holds a spark plug for each cylinder and fits onto the block |
| 13 | Cylinder | Houses the piston |
| 14 | Piston | Delivers the power stroke for the engine |




*Gearbox and propeller shaft*

| No | Component | Function |
|---|---|---|
| 15 | Propeller shaft | Is connected directly to the gearbox. The propeller fits onto the propeller shaft and is bolted into place. |

There are obviously many more components which make up a complete outboard engine and you will need to gain a greater understanding of these engines before undertaking any mechanical work. There are also technical courses available which offer qualifications in outboard motor mechanics.

All outboard engine manufacturers provide thorough maintenance and service manuals for each of their engines. The instructions contained in these manuals should be followed wherever possible to ensure that the engines remain in good working order.

# 3.2 Checks before starting

## Procedures

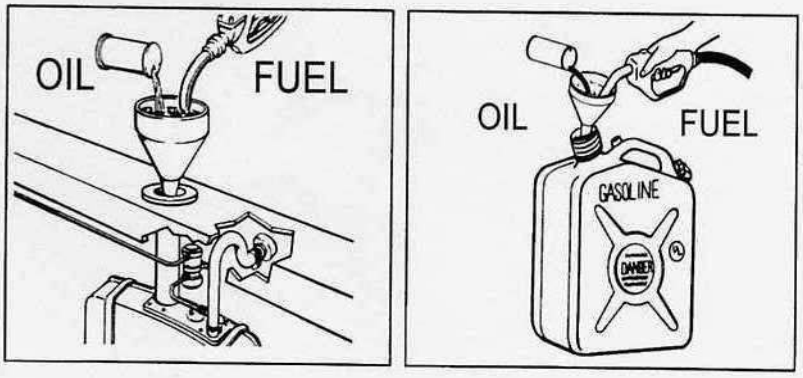
Before starting outboard engines, it is important to check the following:

- fuel, oil type (two stroke petrol, four stroke petrol or diesel)
- that the outboard is secured to the vessel
- fuel/air supply to the engine
- throttle and gear lever positions, reverse lock
- emergency engine stop clip and lanyard.

It is always best to consult the manufacturer's operating manual before operating an outboard engine.

The majority of smaller outboards (portable) are of the two stroke design. These require a specific fuel and two stroke oil ratio to be mixed in the fuel tank prior to being used by the engine. This will also apply to some larger two stroke outboards.

It is imperative that the fuel/oil ratio is correct at the time of fuelling as you will not be able to verify the ratio later. The oil content is the sole means of lubrication within the engine. If you are unsure of the fuel/oil mixture in a tank, replace it with a fresh amount. Do not simply top up the contents of a tank unless you are sure of the original mixture. It is also important not to leave two stroke fuel sitting for long periods (more than four months).




*Two Stroke Fuel Mixture*

Other types of two stroke engines use a form of oil injection. These systems automatically regulate the fuel/oil ratio required by the engine and receive two stroke oil from a reservoir separate from the fuel tank.

This level should be checked at regular intervals to ensure oil usage and the level topped up when refuelling with the manufacturer's specified type of two stroke oil.

The four stroke petrol and diesel engines also require a lubricating oil. The oil in this case does not become mixed with the fuel. It is circulated through the engine via a pump from a main reservoir and then returned to the reservoir. This also requires checking prior to starting the engine and topping up with the manufacturer's specified oil type.

If the outboard is fitted with a portable fuel tank, it might also be necessary to loosen the cock at the top of the tank to allow sufficient air to enter the tank to assist the fuel pump.

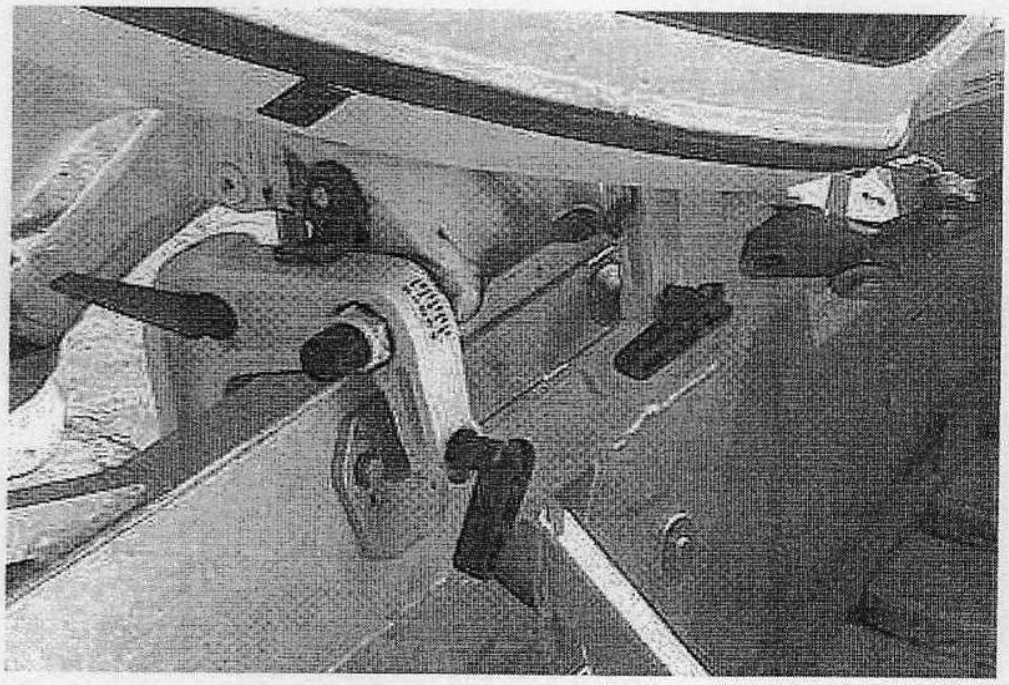
## How the outboard is attached to the vessel

Outboards are generally attached to the vessel in two ways:

### 1. Clamp screw and safety chain

This method uses two hand tightened screw thread clamps. When tightened, these trap the engine mounting plate of the vessel between the engine mounting bracket and the screw thread plates. It is used in conjunction with a safety/lanyard chain.

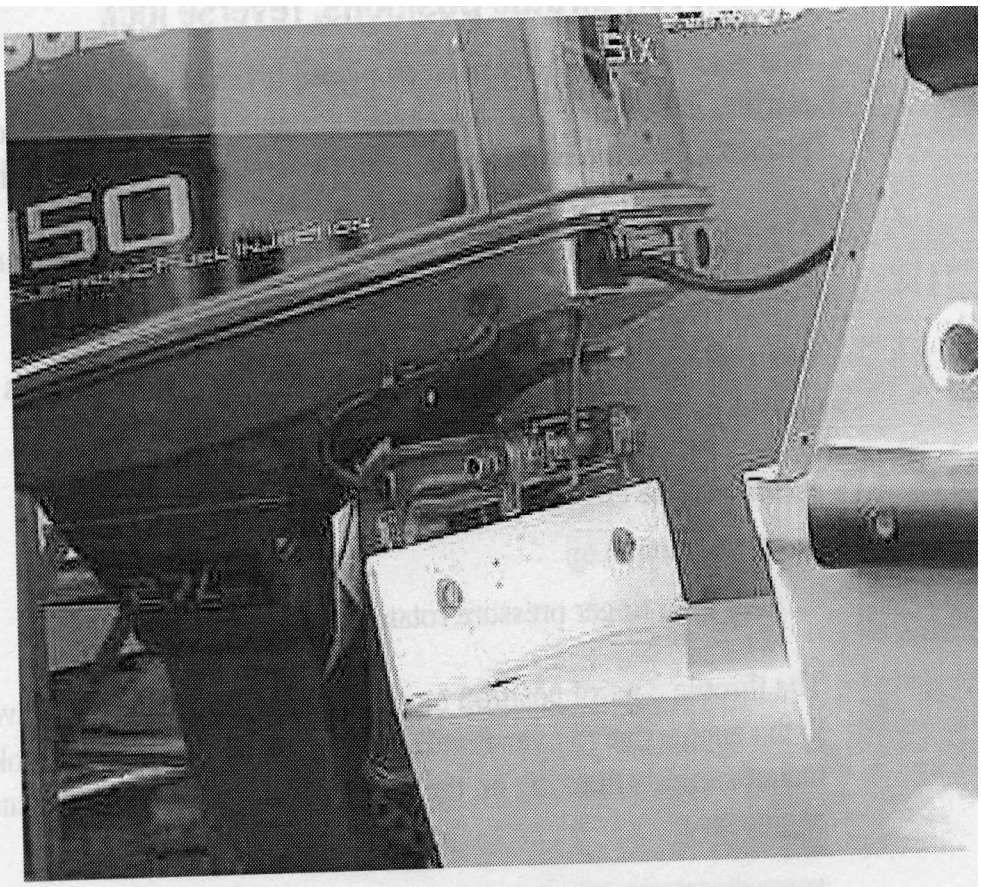
This is secured to the engine's mounting bracket and a secure part of the vessel. The hand screw threads should be checked for tightness prior to starting the engine and chain fastenings checked along with chain length to ensure the engine will not become submerged if it releases from its mounting.



*Clamp screw mounting*

### 2. Bolted to the transom

This method is far more secure with the engine bolted through the transom plate, usually in no less than four places. This system should be checked for tightness of mounting bolts and a visual check made for any sign of the bolts pulling through the hull.



*Bolt on mounting*

*Bolt on mounting*

## Gear lever, throttle positions, reverse lock

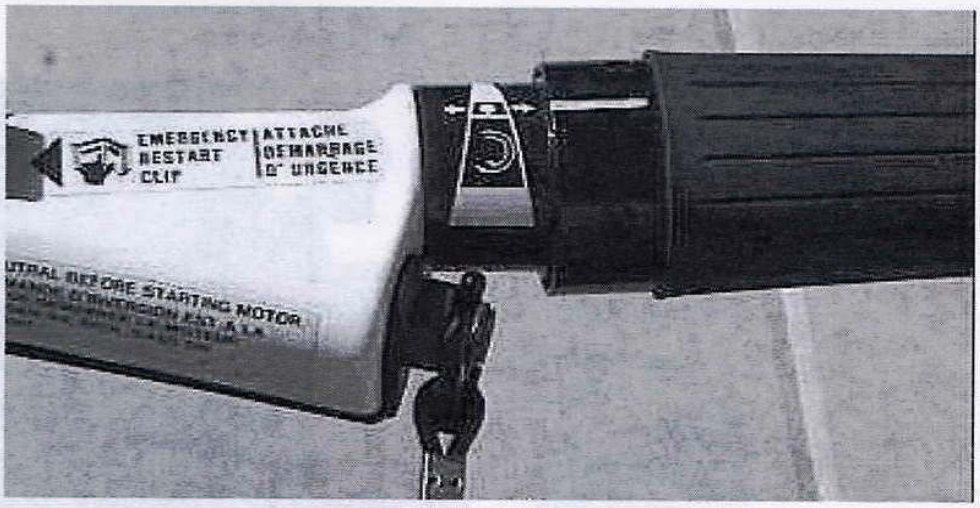
The gear selection lever must be placed in the neutral position prior to starting the engine. This is to avoid possible injury to any persons or property from the propeller or from the sudden propulsion of the vessel.

Most outboards will have an in-gear start prevention mechanism but these should not be relied upon.

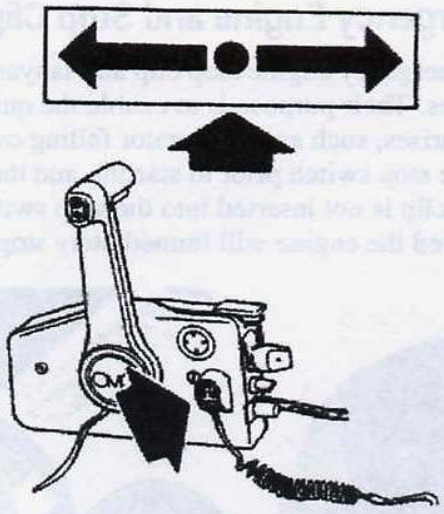
The simplest way to ensure the outboard engine (small engines only) is in neutral is to:

- remove the emergency stop clip from the engine
- tilt the engine up
- with light finger pressure rotate the propeller.

The throttle control position must also be checked. This is to avoid damage to the engine due to over-revving of the engine on start up. Look for the manufacturer's marking on the throttle or remote control, depending on the engine size.




*Correct starting throttle position*



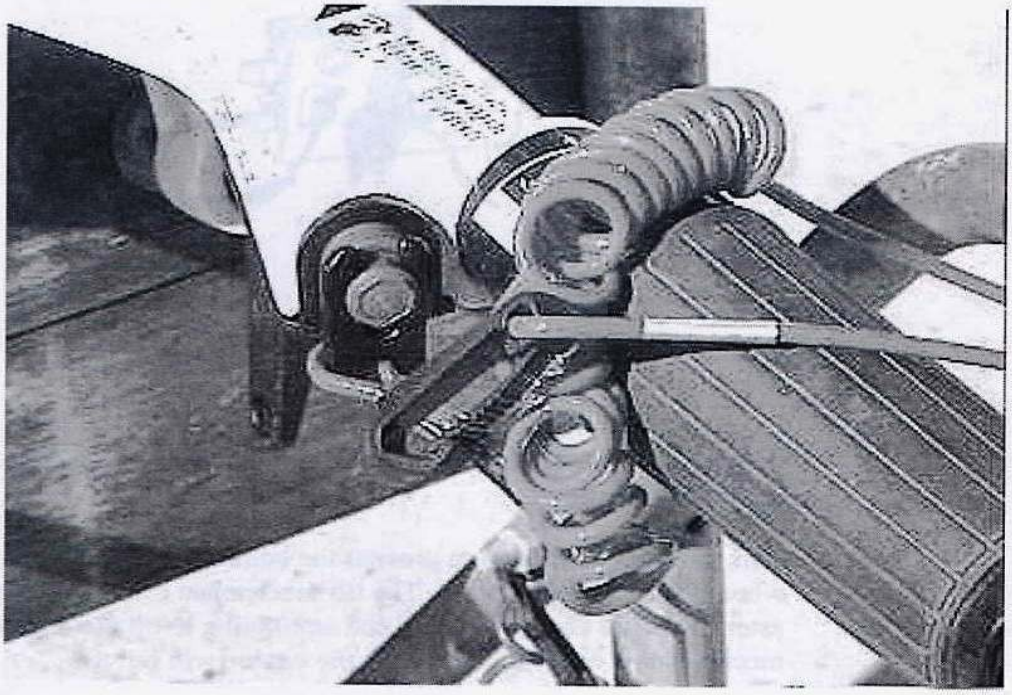
*Starting position*
*(Courtesy: Outboard Marine Corporation)*

A reverse engine tilt is fitted to smaller outboards which are not fitted with hydraulic trim tilt.

This mechanism is used to prevent the engine from tilting out of the water when being operated astern. The tilt mechanism can be tested by selecting astern with the engine stopped and attempting to tilt the engine. If the mechanism is operating correctly the engine will not tilt.

## Emergency Engine and Stop Clip

An emergency engine stop clip and lanyard should be used on all outboard engines. Their purpose is to enable the quick stopping of the engine if the need arises, such as the operator falling overboard. The clip is secured to an engine stop switch prior to starting and the lanyard attached to the operator. If the clip is not inserted into the stop switch the engine will not start and if removed the engine will immediately stop.



*Emergency stop switch and lanyard*

# 3.3 Checks if an engine fails to start

There are many reasons for an engine failing to start. It's a good rule of thumb to start with the simple checks in a logical order.

If the engine does not start, the following checks should be conducted.

Check that:

- emergency stop clip (if installed) is correctly connected
- fuel bulb is primed
- fuel tank breather open if manual breather is fitted
- gear selection lever is in the neutral position
- start battery is in good condition (if engine is electrically started)
- throttle and choke positions are in correct position, according to the manufacturer's specifications
- engine is not flooded
- fuel tank is not empty
- fuel filter is not clogged.

## Written Activity

Talk to your facilitator about troubleshooting if an engine fails to start.

Ask about problems that may be experienced, the possible cause and how to fix this problem.

Fill in the table below as you discuss the information.

| Problem | Possible Cause | How to Fix |
|---|---|---|
| | | |
| | | |
| | | |

# 3.4 Warm up periods

A warm up period is recommended after starting the engine, to help prevent cold seizure and premature wear of engine components.

During the warm up period, the engine should be allowed to idle without load or excessive revving.

Cold seizure can occur if an engine is not allowed to warm prior to normal operation.

This happens when heat from friction and combustion within the cylinder expands the piston at a much greater rate than the cylinder, resulting in the piston seizing in the cylinder bore.

The warm up period allows time for the piston and the cylinder to expand at a similar rate. The cooling water flow is controlled by a thermostat which allows the cooling water to remain in the engine. This assists with warming the cylinder until operating temperatures are reached, and then maintains the water cooling temperature.

# 3.5 Engine overheating

All engines become hot. The water cooling system is designed to control rising temperatures. An overheated engine can cause extensive damage, so it's important to watch for early signs. If steam is seen rising from the engine exhaust parts, it may indicate an overheating engine.

Overheating can be recognised through steaming off the engine cooling water being discharged from the engine. Many outboards are fitted with audible alarms, temperature gauges or engine revolution limiters which will indicate an overheat problem.

The engine should be shut down if weather and water conditions allow, or at least reduce the engine revolutions and load to an absolute minimum.

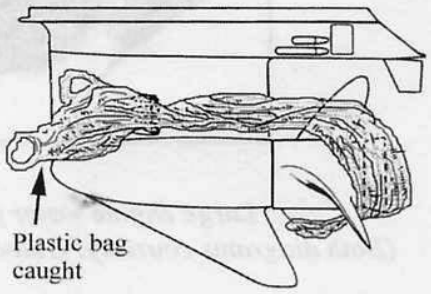
The most common reasons for overheating are either:

- obstruction to the cooling water intakes or
- water circulation pump failure.

Obstructions generally occur when floating plastic bags or similar matter, wrap around the gear leg blocking the water intakes.

These can be removed simply by:

- shutting down the engine
- disconnecting the emergency stop clip from the engine
- tilting the engine and
- removing the obstruction.

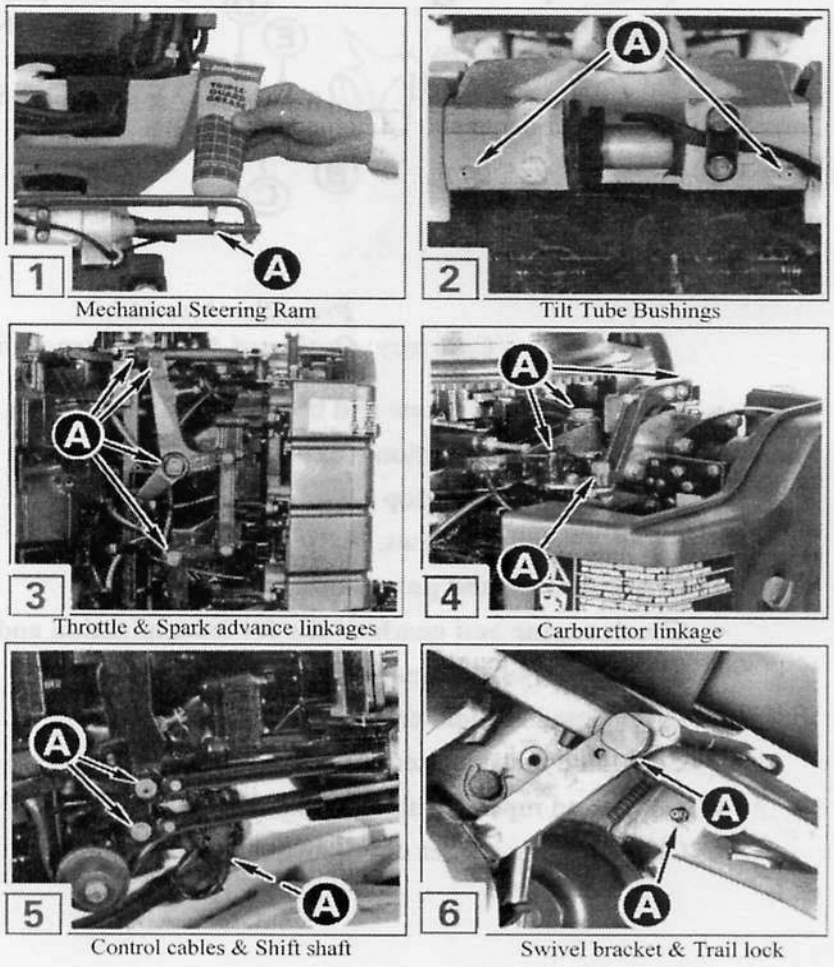



*Obstruction to water intakes*

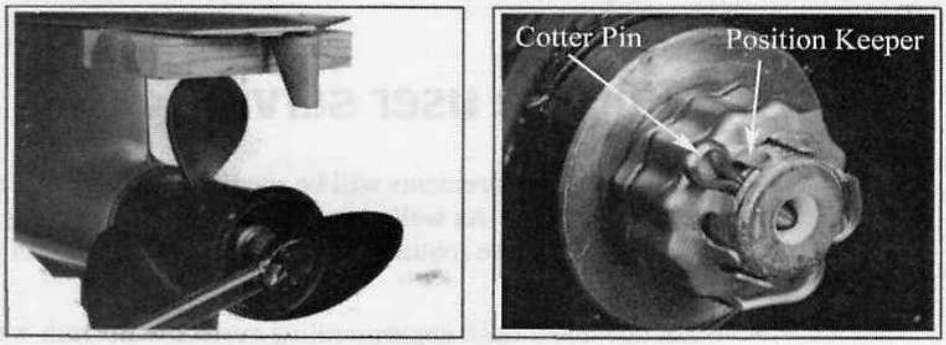
# 3.6 Routine user servicing

Engine servicing requirements will be specified in the manufacturer's maintenance manual. As well as following these instructions, it is good practice to follow these routine steps to service and maintain your outboard engine:

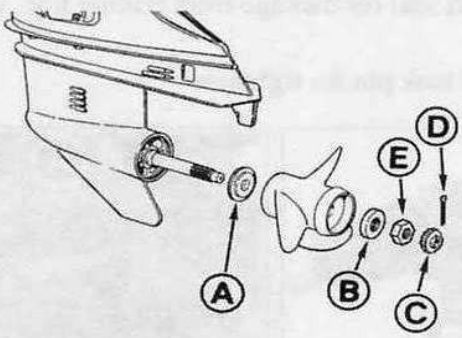
- Wash down and flush engine cooling system with fresh water after use in salt or muddy waters
- Lubricate grease points and control mechanisms
- Check propeller shaft seal for damage from fishing line, weed or other matter
- Check propeller and lock pin for tightness




*Lubricating grease points - large OMC engines*
*(Courtesy: Outboard Marine Corporation)*



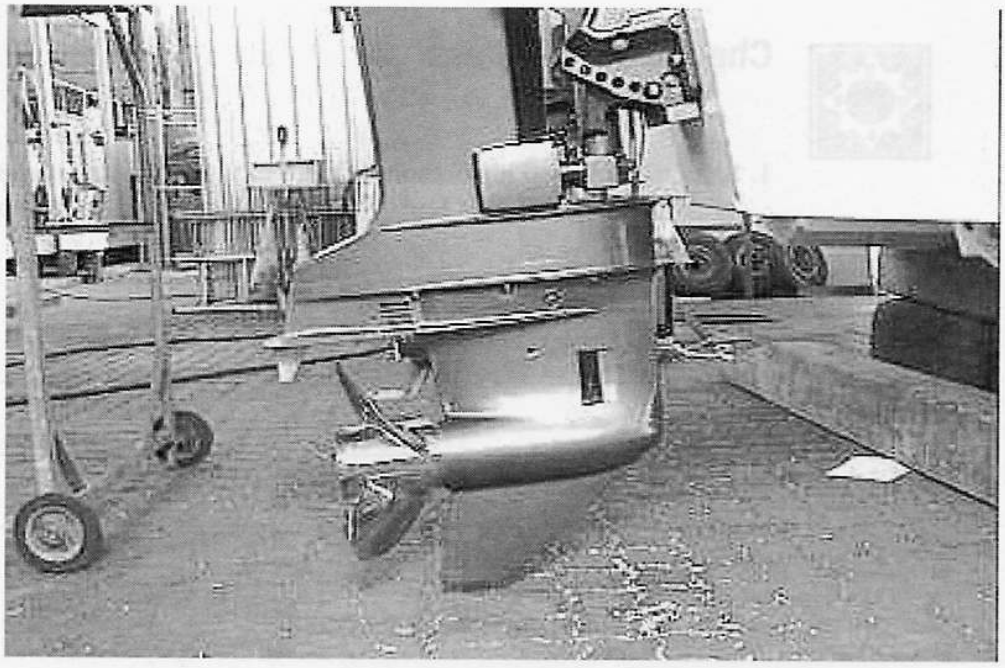

*Checking propeller*




A = Thrust bushing
B = Spacer
C = Position Keeper
D = Cotter pin
E = Propeller Nut
F = Propeller
G = Propeller Shaft

*Propeller Assembly*
*(Courtesy: Outboard Marine Corporation)*

- Check mounting screw and bolts for tightness
- Check battery condition (for electric start models)
- Emergency engine stop switch is operating correctly
- Check for loose screws, bolts and nuts
- Check throttle and gear controls operation
- Check engine and gearbox oils for contamination and adjust oil levels
- Check reverse lock mechanism
- Oil injected models check two stroke oil usage
- Emergency pull starter cord available
- Check and replace anodes as necessary
- Check cooling water circulation via tell tail.



*Gearbox and Propeller*

## Practical Activity

Ask your facilitator to see a working or model outboard engine.

From the information presented in this section, ask your facilitator to list the items you can now check on a working or model outboard engine.

| What checks you can make | Additional teaching tips or points to note |
|---|---|
| | |
| | |
| | |
| | |
| | |

## Check Your Progress

1. Sam had not used his outboard for 18 months because it was only an emergency vessel on a ferry. When he came to use it, the engine overheated.

   Why would this happen?

   _____

   _____

   _____

2. Why is a warm up period important?

   _____

   _____

   _____

3. What is a common reason for an engine overheating?

   _____

   _____

   _____

**Check your answers on the next page.**

## Answers to Check Your Progress.

1. The impeller on the cooling system may have perished and will need replacing.

2. Prevents seizure and premature wear of components. Allows time for the piston and cylinder to expand at similar rates.

3. Obstruction to cooling water intakes or water circulation pump failure.

Check any additional information with your facilitator.

## Assessment Criteria

Can you now:

- ❑ explain the basic construction of a marine outboard engine
- ❑ describe the checks and procedures before starting the engine
- ❑ describe the checks to be made if an engine fails to start
- ❑ explain the reasons for warm up periods
- ❑ identify engine overheating, response to prevent damage and correction of defect
- ❑ describe routine user servicing