REEDS

HANDY POCKET GUIDE

OUTBOARD MOTOR TROUBLESHOOTING HANDBOOK

BLOOMSBURY

REEDS OUTBOARD MOTOR TROUBLESHOOTING HANDBOOK

A POCKET GUIDE TO OUTBOARD ENGINES

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ADLARD COLES NAUTICAL
BLOOMSBURY
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Introduction

Regular maintenance is the key to reliability. Outboards are both compact and often complex pieces of machinery operating in a harsh environment. The last thing you want to be doing is lifting the lid when out on the water. This pocket companion highlights the daily checks and maintenance needed before and after each trip to keep your outboard running as it should.

But if there is a breakdown, this book offers a simple guide to troubleshoot the problem and provides clear step-by-step instructions to get you going again.

Chapter 1
Outboard Types

Several types of outboard are available, from small lightweight electric troll and dinghy propulsion systems, to 2-strokes, 4-strokes, diesels in some cases with a choice of prop or waterjet propulsion. They also range in size

from 20 to 100lbs of thrust for electric variants, and from 2hp to 300hp in combustion form.

The best of both worlds. This fisherman has a powerful outboard to get him out to where the fish are and then an electric outboard mounted on the bow to troll quietly around.

ELECTRIC OUTBOARDS

Electric outboards are light and simple to maintain. Their only limitation is their range. There are two types: the cheaper fresh water variety, and those for use in sea water. While the latter can be used in fresh, the former are made of materials that will suffer electrolytic corrosion when used in salt water, and the parts will quickly fizz away, so beware.

THRUST	SHAFT LENGTHS	MAX AMP DRAW	VOLTS	MAX BOAT LENGTH
40	30in (0.8m)	42	12	Tenders
45	36in (0.9m)	42	12	17ft (5.2m)
55	42in (1.1m)	50	12	21ft (6.4m)
55	36in (0.9m) 42in (1.1m)	50	12	21ft (6.4m)
80	42in (1.1m)	56	24	25ft (7.6m)
101	52in (1.3m)	46	36	25ft (7.6m)

2-STROKE VS 4-STROKE OUTBOARDS

Thanks to stricter emission controls, the latest 2-stroke outboards fitted with direct fuel injection systems have been refined to use less oil in the fuel mix. The latest Yamaha, Mercury OptiMax, Evinrude E-TEC and Tohatsu engines are now just as quiet, clean-burning, and fuel efficient as their 4-stroke rivals, and retain a strong second-hand value.

2-STROKE OUTBOARDS

PROS

Lighter

Accelerate faster and better top-end speed

Less expensive

Easier to repair

Simple design with less to go wrong

Strong second-hand market

Good parts availability

Good resale value

CONS

More pollution (carbureted 2-stroke outboards)

Greater exhaust smoke (carbureted 2-stroke outboards)

Must remember to mix oil with the petrol (non oil injection models)

Rougher idle than 4-stroke outboards

Noisier than 4-stroke outboards

Harder to start (carbureted two-strokes)

Carburetors can gum up if not used for a long time

Spark plug fouling (carbureted 2-stroke outboards)

4-STROKE OUTBOARDS

PROS

Quiet and smooth running

Better fuel economy

Less pollution

No oil/gas mixture

Accepted on any body of water

Very reliable and easy to start

CONS

Heavier than 2-strokes

More expensive to repair

Less powerful than 2-strokes

More expensive to purchase

Harder to transport and store without a stand

WATERJET

Waterjets are ideal for use where safety is paramount such as on specialist rescue boats.

PROS

Safe – no external propeller

Good top-end power

Good directional ability

Less susceptible to damage

CONS

Susceptible to weed intake

Heavier than propeller variant

Less low-end power

More expensive

DIESEL OUTBOARDS

Diesel outboards are more rugged than 2- and 4-stroke petrol engines but, for the present, are available in a limited mid-sized horsepower range. They are also heavier and are used primarily on work and fishing boats where economy and reliability are more important considerations than high-end speed.

PROS

More economical

Greater reliability

Greater low-end torque

Simple design with less to go wrong

Strong second-hand market

Good resale value

CONS

Heavier than 2-stroke and 4-stroke outboards

Greater exhaust smoke

Limited horse-power range

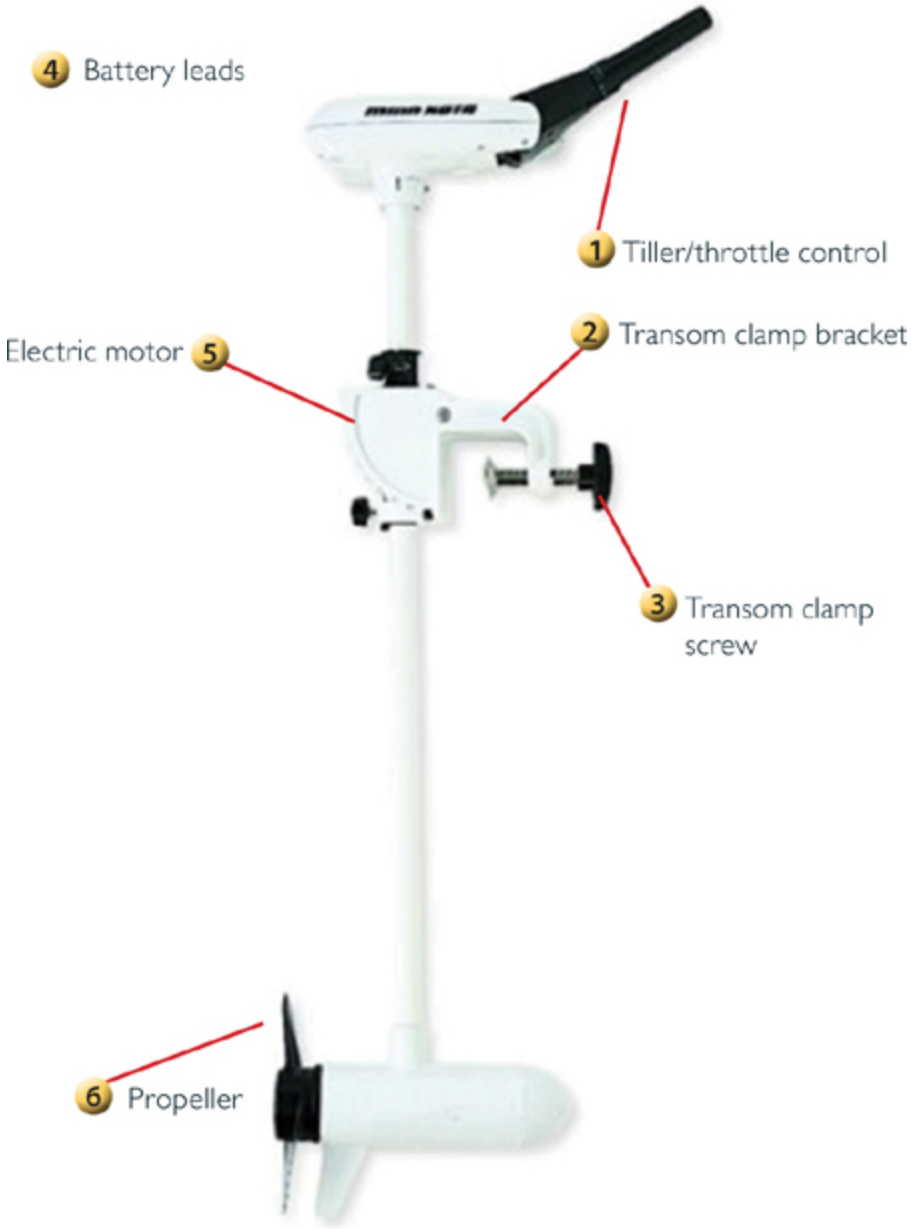
Rougher idle than 4-strokes

Noisier than 4-stroke outboards

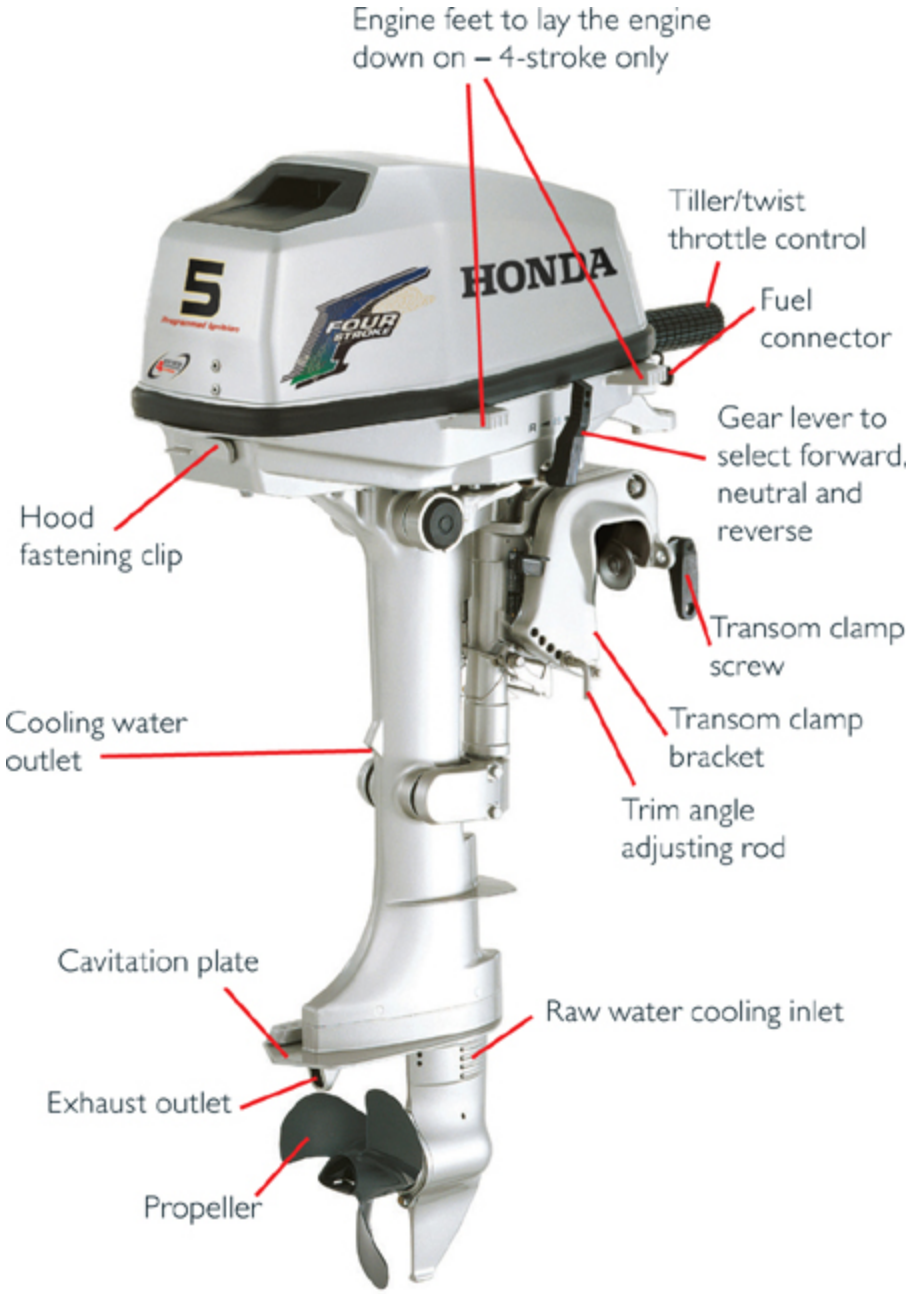
Less top-end power

Chapter 2
Anatomy of an Outboard

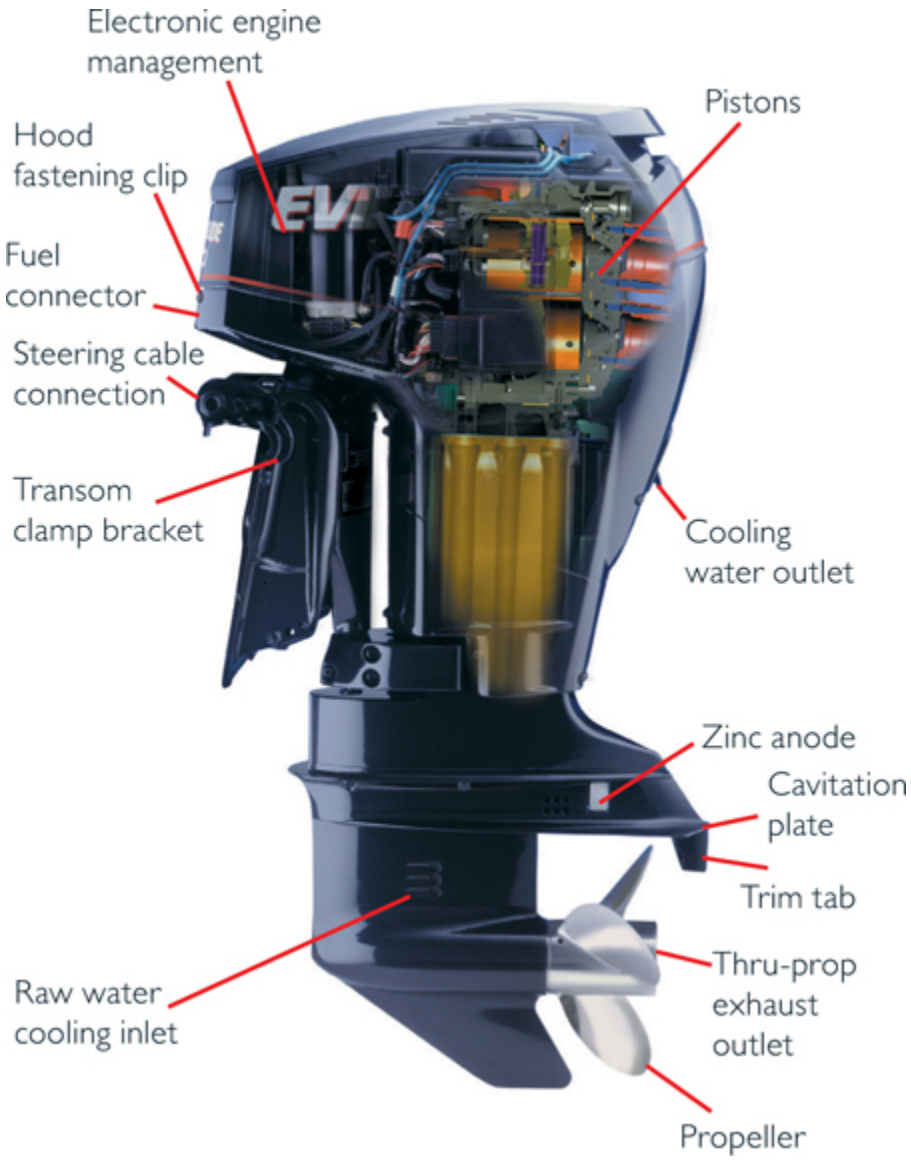
ELECTRIC


4 Battery leads
1 Tiller/throttle control
2 Transom clamp bracket
Electric motor 5
3 Transom clamp screw
6 Propeller

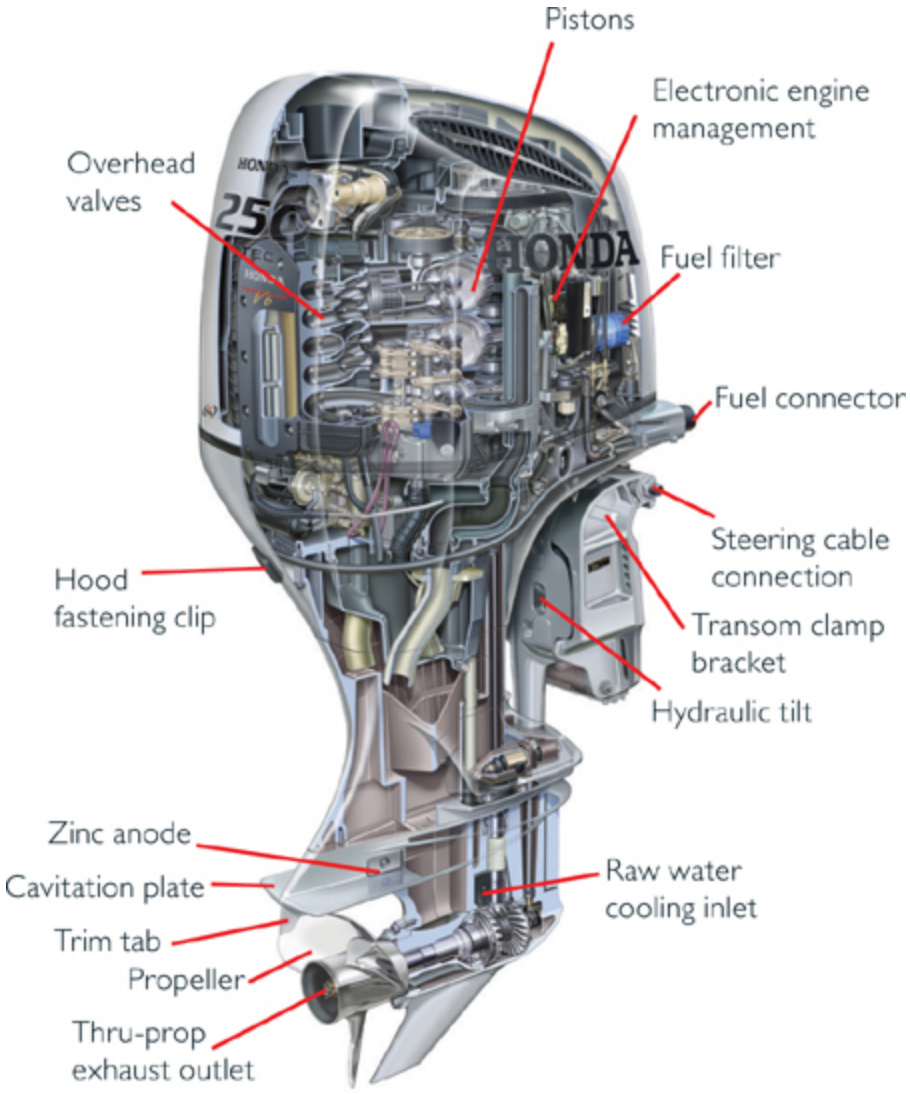
5HP 4-STROKE



50HP 2-STROKE



250HP 4-STROKE


Pistons
Electronic engine management
Overhead valves
Fuel filter
Fuel connector
Steering cable connection
Hood fastening clip
Transom clamp bracket
Hydraulic tilt
Zinc anode
Cavitation plate
Raw water cooling inlet
Trim tab
Propeller
Thru-prop exhaust outlet

Chapter 3
Simple Troubleshooting

OUTBOARD MOTOR DOESN'T START	
FUEL – See chapter 4, page 26	**1)** Check that there is fuel in the tank and fuel lines are connected correctly. **2)** Pump the primer bulb within the fuel line until it is hard and full of fuel. **3)** 2-strokes: • Is the fuel of the correct petrol/oil mix (most often 50:1)? • Has the engine flooded? One telltale is blue exhaust smoke. • Remedy: remove the spark plugs, clean and refit.
ENGINE IGNITION	**1)** Check that the kill cord is attached to the ignition/gear control. **2)** Check that the gear lever is set to neutral.

APPEARS IMMOBILISED – See chapter 5, page 48	**3)** Check the battery switch is turned on. **4)** Check the battery leads are connected properly and are clean and free from corrosion. Clean with wire brush if necessary. **5)** Check that the fuse has not blown. If there are doubts, replace with a new one. **6)** Check connections to the starter switch. Make sure they are not loose or corroded.
ENGINE WAS RUNNING BUT STARTED TO COUGH, THEN STOPPED – See chapter 4, page 26	**1)** Check that there is fuel in the tank. **2)** Check that the fuel air vent is wide open. **3)** Check the fuel line for obstructions, loose connections or splits in the hose. **4)** Check the fuel filter/water separator. Is water visible in the glass bowl? If so, drain filter bowl. Replace filter if there are any signs of rust particles or debris.
ENGINE SUDDENLY STOPS – See chapter 7, page 66	**1)** Check that the kill cord has not pulled out from the ignition/gear control. **2)** Check the fuel system. **3)** Check for a blockage in the water intake at bottom of skeg. If so, this could have caused the engine to overheat. Some engines are fitted with an overheat caution system which will have set off a warning light or bleep. Clear the blockage and allow engine to cool down before restarting. **4)** If there is no blockage, check that water pump is working.
ENGINE STARTS BUT RUNS UNEVENLY – See chapter 4, page 26	**1)** Remove the spark plugs and check their condition. Check that the gap at the tip of each plug is correct and not eroded. **2)** If they are oily, the petrol/oil mix may be wrong. **3)** A rusty stain signals a leaking head gasket.
ENGINE VIBRATES	**1)** Check engine mounting bolts and clamp screws are not loose.

EXCESSIVELY – See chapter 10, page 96	**2)** Check to see if the propeller fouled with weed or flotsam. **3)** Check the propeller blades for damage.
PROPELLER IS NOT TURNING – See chapter 8, page 84	**1)** Has the shear pin broken? **2)** Check the gear selector cables.

Chapter 4
Fuel System

2-STROKE OUTBOARDS – FUEL MIX

A 2-stroke engine relies on a percentage of 2-stroke mix oil in the fuel to lubricate the pistons, so the correct fuel mix is imperative for the continued smooth running. This is listed in the outboard handbook. Early outboard designs like the British Seagull run on a 25:1 mix. More recent 2-stroke engines operate on 50:1 and some of the last, before manufacturers changed to 4-stroke engines, run on 100:1 mix. OMC – manufacturers of Evinrude and Johnson outboards before the two ranges were taken over by Bombardier – developed the Variable Ratio Oiling system (VRO) in which the 2-stroke oil is drawn automatically from a separate tank to the petrol tank. Other manufacturers used similar systems called Oil Metering Systems (OMS). These engines run on regular petrol/gas from the fuel tank and draw a variable mix of oil automatically to meet the changing lubrication needs of the engine – less oil on tick-over, more when running fast or under load.

Here is a ready calculator for 2-stroke outboards that require the fuel to be pre-mixed in the tank:

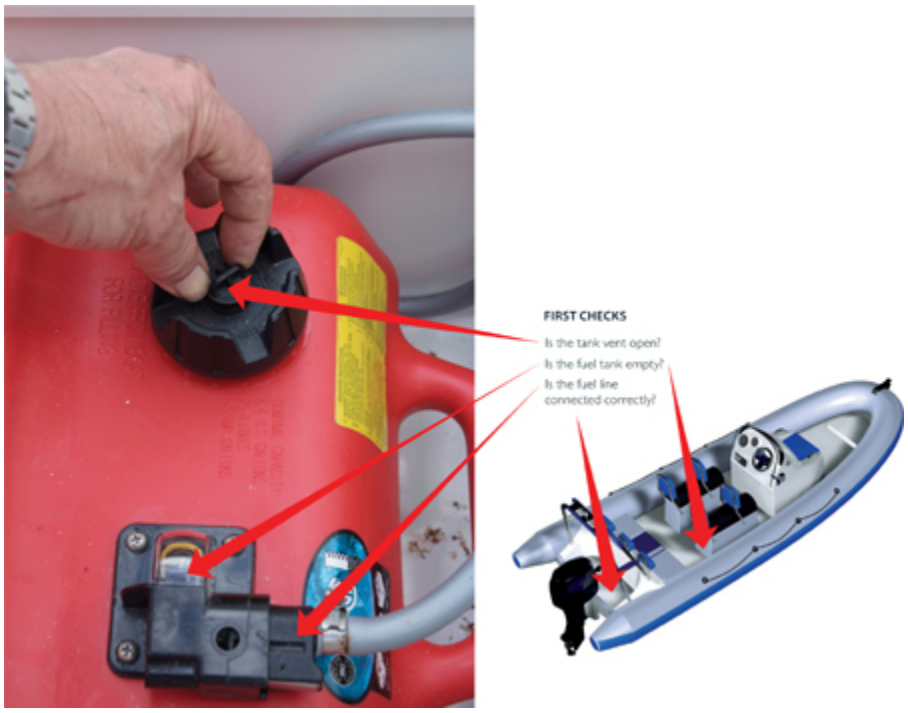
LITRES	PETROL/OIL MIX	AMOUNT OF OIL
1	25:1	40 millilitres
1	50:1	20 millilitres
1	100:1	10 millilitres

US GALLONS	PETROL/OIL MIX	AMOUNT OF OIL
1	25:1	5.12 US oz
1	50:1	2.56 US oz
1	100:1	1.28 US oz

4-stroke outboards run on regular gas/petrol.

Always pour the oil into the tank first before adding the petrol/gas to ensure a good mix.


1:50
LOW
SMOKE
Two stroke oil
Zweitaktöl
Aceite para motor de
dos tiempos
Oleo de dois tempos
Olio per motori a 2 tempi
Tweetaktolie
1 l.
Husqvarna



FUEL SUPPLY PROBLEMS

Problems with the fuel supply are the most common cause of poor running and impromptu stopping.

The first check is to see if you have run the tank dry. The second is to check whether the breather valve, usually found on the filler cap, has been left shut during transportation, and has led to a vacuum build-up within the tank.

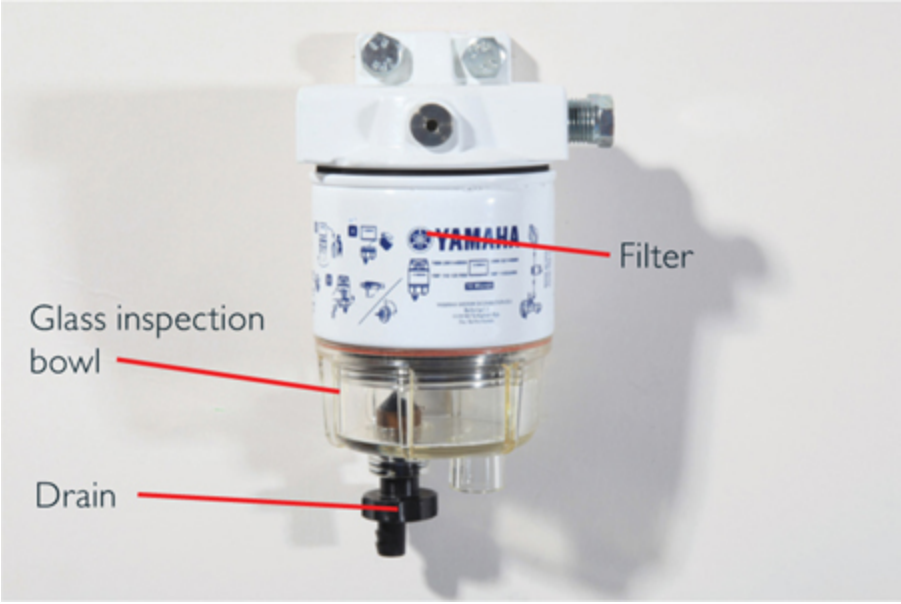
Boats with built-in fuel tanks can also suffer vent problems when salt builds up and blocks the gauze filter in the opening and stops it ‘breathing’ properly. The salt crystals can usually be scraped away with a sharp knife, but if it has got really bad, there is no option but to replace the vent.

FUEL CONTAMINATION

Has water got into the fuel?

Is there any rust or sediment in the tank blocking the filter system or that has worked its way through to block any of the jets within the carburetor or fuel injection system?

The first place to check is the water separator/fuel filter usually fitted close to the engine. The original Lucas/CAV type filters conveniently have a glass inspection bowl in the bottom of the unit, but these no longer meet EU regulations. The glass has been replaced with an aluminium bowl which necessitates a strip down simply to check for contaminants. If telltale globules of water and/or sediment are present then a new filter is required, and you will need to check and clean the filter in the carburetor/injector too.



To inspect or replace the filter, place a container beneath it to catch the spill. The Lucas/CAV type has a plastic drain screw in the base and is dismantled by undoing the central bolt at the top.

The third type of fuel filter popular in North America, is the spin-off fuel/water separator which is removed simply by gripping the filter and unscrewing it clockwise when looking from above.

Remember to remove and replace the rubber ring gaskets each time you take off the filters. Their reuse will invariably lead to leaks.

Change the filter at least once a year – twice if the boat gets a lot of use – to ensure trouble-free running.

HOW DID WATER GET INTO THE SYSTEM IN THE FIRST PLACE?

Check the fuel tank. It is not uncommon for water to be present in the tanks on the fuel dock, especially during Spring and Autumn when extremes of temperature can lead to condensation in the storage tanks. The same can

happen in the boat tanks too if they are not kept topped up. If water is present, then there is no alternative but to drain down the entire fuel system within the boat.

If the fuel tanks are steel, then water will be corroding the inside of the tank and causing the rusty sediment in the bottom. The simple solution here is to replace the tank with a plastic variant and get rid of the problem forever.

Some built-in fuel tanks are fitted with an anti-siphon valve that is known for sticking and can lead to fuel starvation. Simply removing the valve on boats operating in North America is not an option because they are part of mandatory US Coastguard and ABYC safety standards for petrol fuelled boats, and instead must be replaced.
If the fuel line has an anti-siphon device this must be replaced and not simply bypassed.

Other systems bypass this problem by running the fuel line above the highest point of the tank, which also prevents the fuel tank from draining its contents into the bilge. This system will also have had to pass fuel safety regulations, so don’t consider making changes to the run of pipe work. If alterations are required, you will need to have this carried out by a certified engineer.

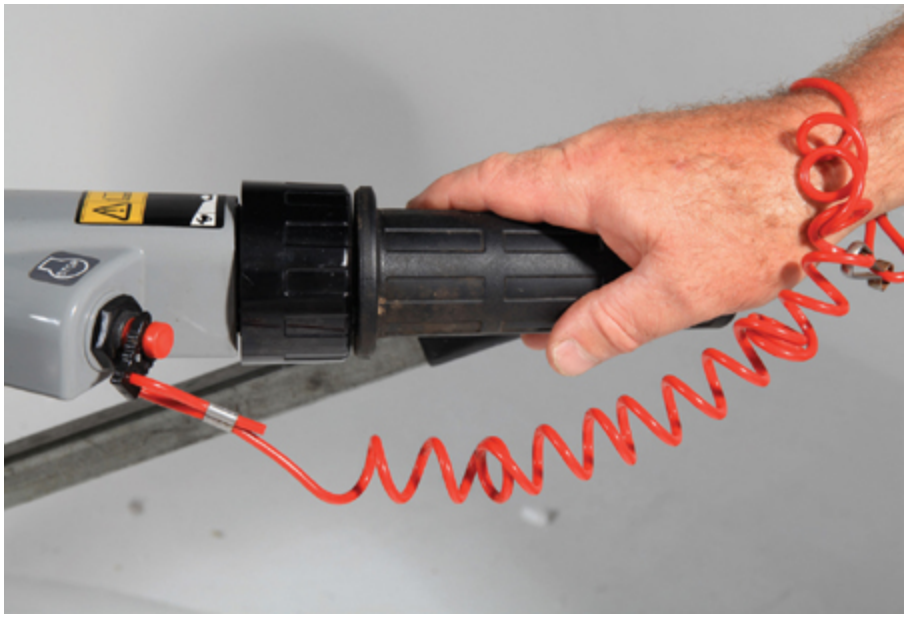
The last line of defence against fuel contamination is often a filter under the engine cowl. With some makes, this is integral with the fuel pump. Some manufacturers like Honda include a sensor to warn when water is in the fuel. Unscrew the cover to check for any contaminants across the mesh or membrane.

The primer bulb used to hand-pump an initial supply of fuel to the engine also doubles as a one-way valve. If fuel is not getting through, check that the fuel line from the remote tank to the engine is connected the right way round. There is an arrow moulded into each bulb, so check that this is pointing towards the engine and not towards the tank.

To clean the gauze filter fitted on outboards with integral fuel tanks, remove the fuel tap and pump through clean petrol, catching it in a container, then reassemble.

To replace disposable fuel filters, expand the hose clamps that secure the fuel pipe by squeezing their protruding ends together in the jaws of a pair of pliers and remove the filter. Ensure that the arrow on the replacement filter is in line with the fuel flow.

Chapter 5
Ignition System



If the outboard is misfiring or won't start at all, begin the troubleshooting by looking for the obvious.

1. Check that the kill cord is attached to the ignition/gear control.

2. Check that the gear lever is set to neutral.

3. Check that the battery switch is turned on.

4. Check that the battery leads are connected properly and are clean and free from corrosion. If necessary, clean with wire brush.

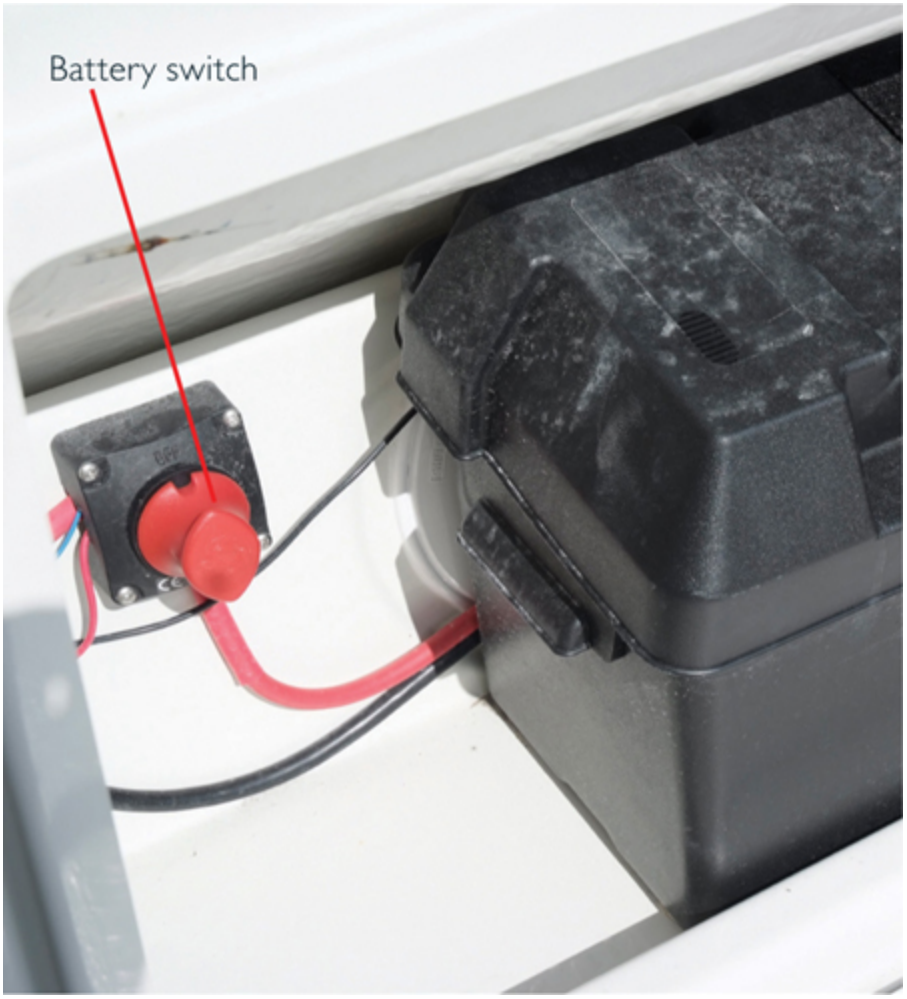
5. Has a fuse blown?

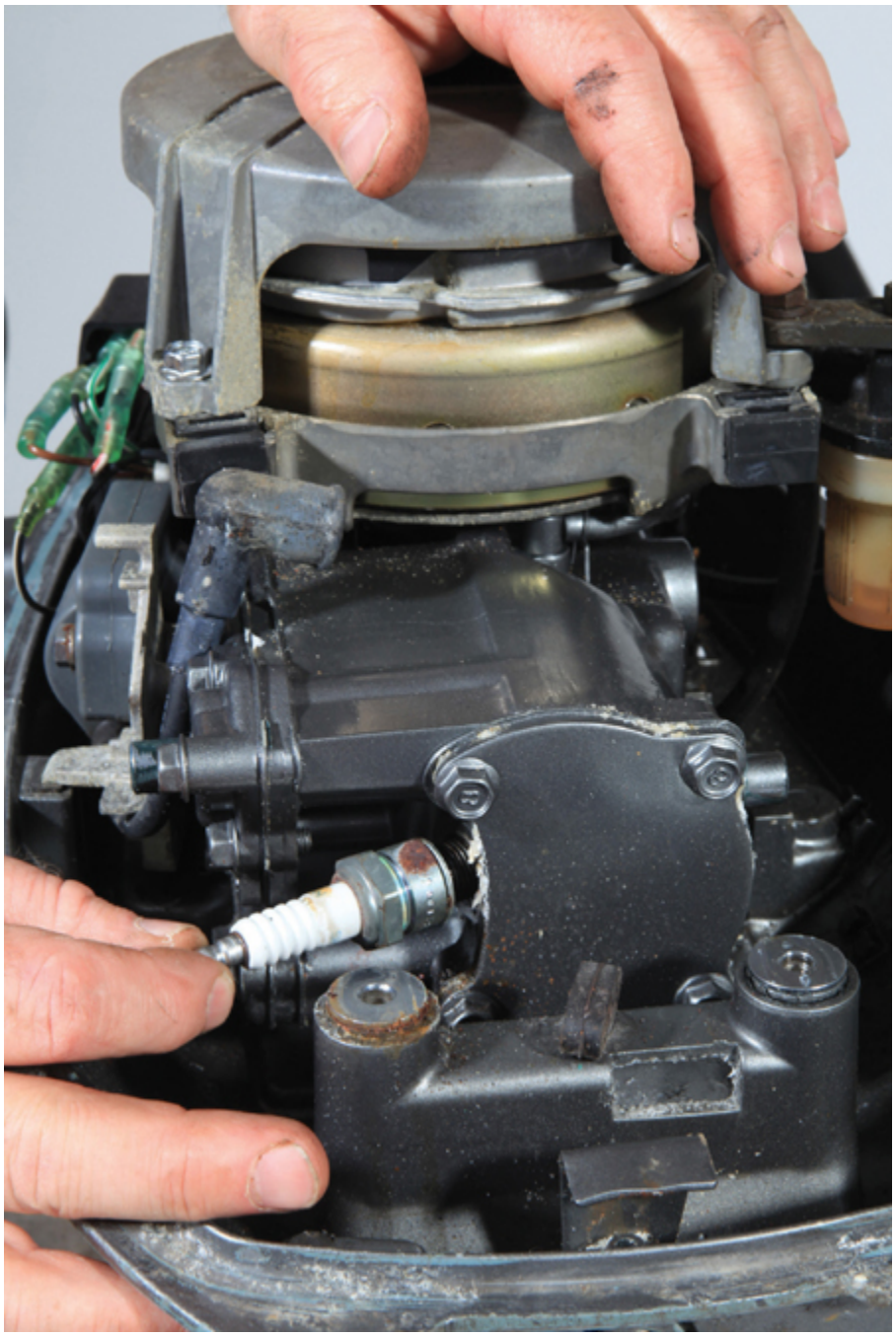
6. Is there corrosion on the battery terminals or connectors to the starter motor?

7. Are there any loose connections or frayed wires within the ignition system?

8. Is there a ‘stop’ button within the system? Has it been reset?

9. Some large outboards have an engine tilt stop switch to guard against it being run when the leg is raised too far to pick up cooling water. Ensure the outboard is fully ‘down’.





IS THERE A SPARK?

Remove each plug in turn, reconnect the high tension lead, and after disconnecting the fuel line, wedge the spark plug against the engine block, turn the engine over and check for a spark. If it is in direct sunlight, shade the engine with the hood so that you can see the spark clearly.

If the spark is bright and blue in colour, the spark plug is serviceable. If it is yellow, or low in its intensity, then the plug needs replacement.

Are the plugs in good condition? If they are burning properly, the central electrode insulators will have a light brown colour to them.

If they are wet or, in the case of a 2-stroke engine, oiled up, the engine may simply have been ‘flooded’ with fuel during the prolonged starting procedure and the plugs will need to be cleaned. It is also a good idea to turn over the engine a few times with the spark plugs removed to clear any remaining fuel from the cylinders.

Is the gap between the central electrode and grounding bar correct? Check this with the correct feeler gauge specified in the outboard manual and adjust as necessary.

Are the central electrodes corroded? If so, then it is time to replace them.

Does the number on the spark plug match the specification listed in the handbook? If not the plugs may be of the incorrect heat range and need to be replaced.

One final act of precaution is to spray the high tension leads with WD40 or similar water dispersing oil.

If problems remain, then it is time to call in the marine engineer or dealer, because specialist tools and pullers may be required to remove the flywheel and check the coil and engine management system.

OILY DEPOSITS
Incomplete oil combustion, which could be caused by too much oil in the fuel mixture, or a spark plug or engine temperature that is too cool.

DRY, BLACK DEPOSITS
This is usually a sign that the fuel mixture is too rich, but before adjusting your carburetor check to see if the engine compression is a bit weak.

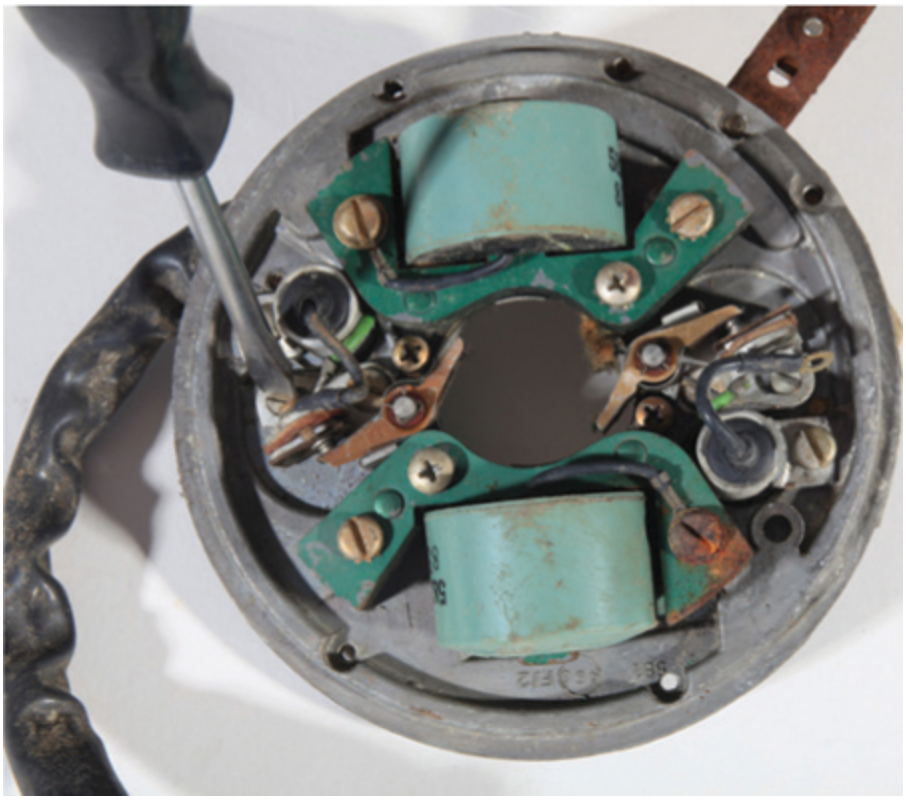
BURNT ELECTRODES
Overheated spark plug. Incorrect timing adjustment, defective cooling, inappropriate thermal rating for the application. Use a 'cooler' spark plug.

NORMAL
The insulator is light brown in colour. Its thermal rating is appropriate.

WORN OUT ELECTRODES
This spark plug shows signs of over 200 hours of use. Replace it with a spark plug of the same type.

CHECKING THE POINTS

If the spark plugs are not the cause for not starting, the next check is on the ignition timing points within the flywheel. No two outboard designs appear the same, so it is vital to make this check with the engine manual close to hand.



1. To access the ignition system and replace or clean the points, remove the starter mechanism from the top of the flywheel. This should reveal access holes to the points (by turning the flywheel) without the need to actually remove the wheel. If this is not possible, then remove the central nut holding the flywheel to the crankshaft. This may require a special tool and may require the dealer to check it out.

2. Disconnect the wires connecting the points to the condenser and coil, using needle-nose pliers or tweezers.

3. Remove the screw holding the points to the back plate with a magnetic screwdriver to ensure that the screw does not drop down into the flywheel, and lift out the points assembly.

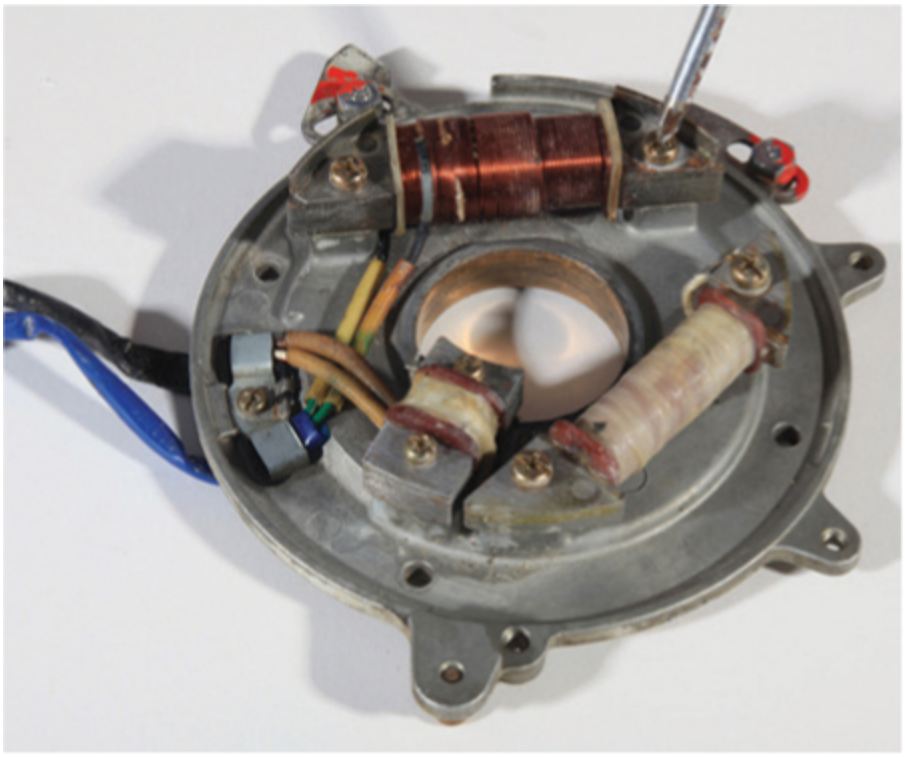
4. The points assembly is an inexpensive component, so replacing them is preferable to cleaning the contacts with emery paper. During fitting, ensure that any location studs seat down correctly on the back plate.

5. Reconnect the leads to the condenser and coil.

6. Rotate the flywheel by hand until the points are fully open, then, using a feeler gauge, adjust the gap by swivelling the entire assembly until this corresponds with the gap listed in the manual. This will usually be between 0.015 – 0.020 inch (0.40 – 0.50 mm).

7. When set to the right gap, tighten the retaining screw holding the points assembly to the back plate, keeping the feeler gauge in place to maintain the correct gap.

8. Reassemble the cover plates and starter components above the flywheel and test the spark.



The latest outboard engines carry a sealed electronic engine management system. These are much more reliable, but when they do go wrong, there is no alternative but to unplug the box and invest in an expensive replacement.

Chapter 6
Starting System

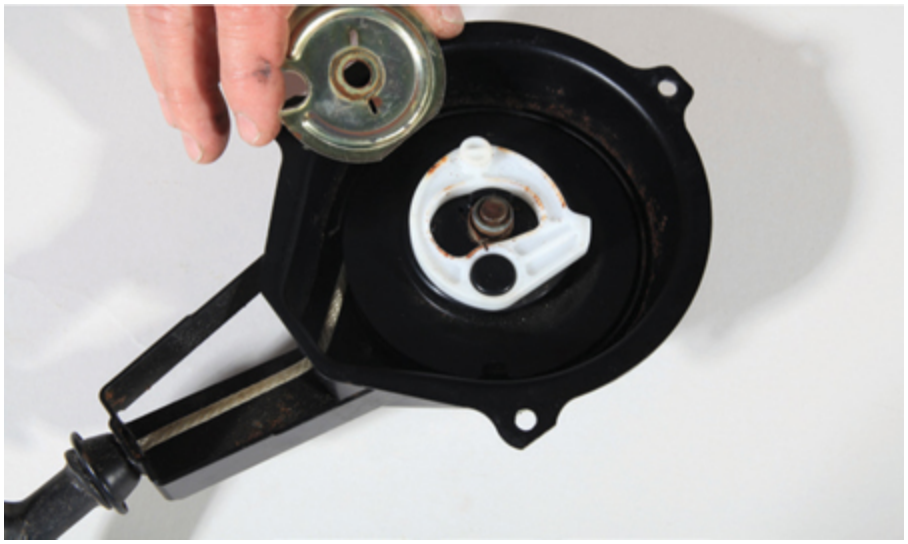
HOW TO REPLACE THE STARTER CORD

The starter cord takes an inordinate amount of abuse, and if yours has not broken yet, it will!

Be prepared. Keep a spare cord in the tool box and buy the recommended cordage from a dealer. Not only will it be the right length and circumference, but woven to resist the high wear rate.

1. Remove the engine hood and pull through whatever is left of the old cord to load up the return spring mechanism. If the cord broke when well extended, it may be necessary to turn the flywheel one or two turns to get sufficient tension.

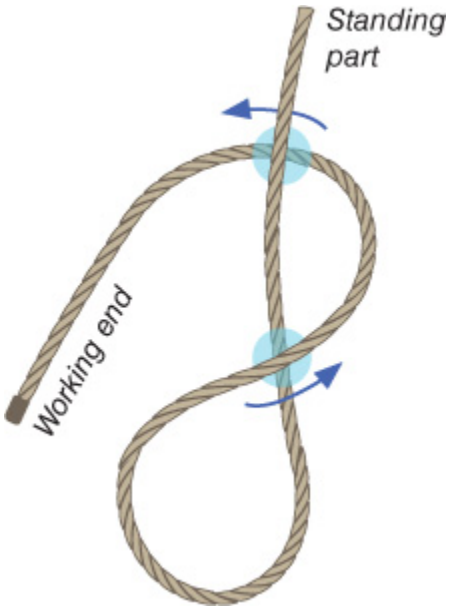
2. Lock the flywheel in place with a screwdriver or piece of wood to stop the recoil mechanism from unwinding.



3. Remove the old cord from the drum.

4. Thread the new cord through from the front of the outboard housing to the hole in the drum, tie a figure-of-eight stopper knot in the end and pull tight to seat it in place on the drum.

5. Remove the old cord from the pull handle, thread through the new cord, tie off with a figure-of-eight stopper knot at the end, and seat it within the handle.

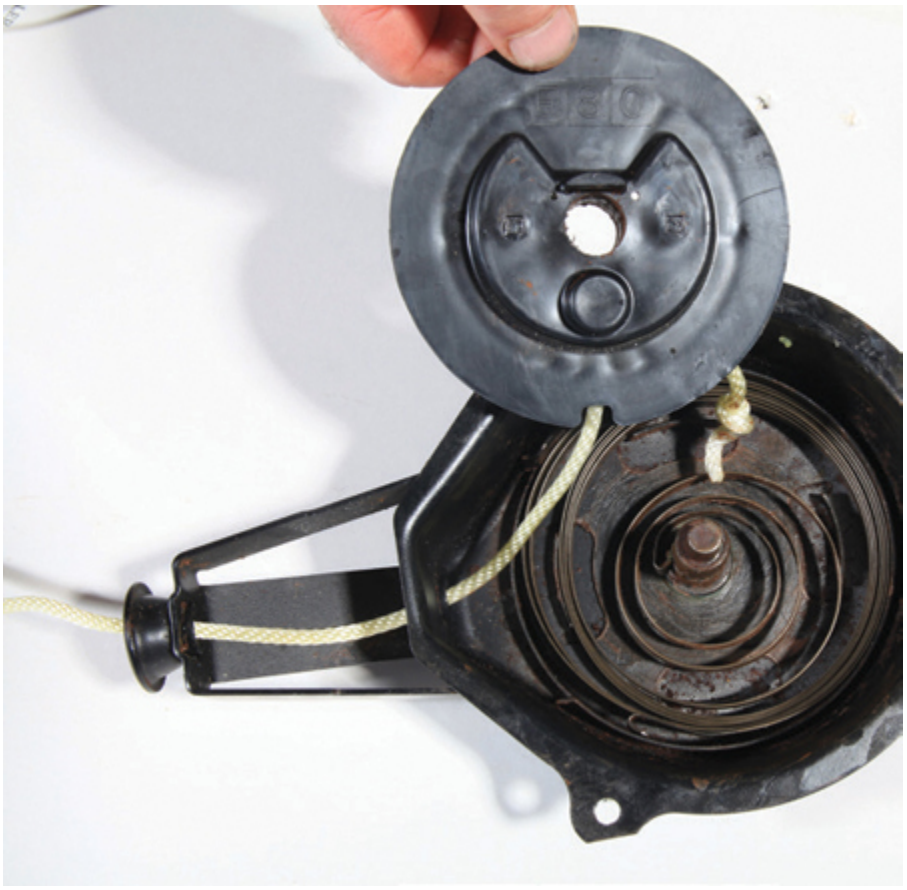


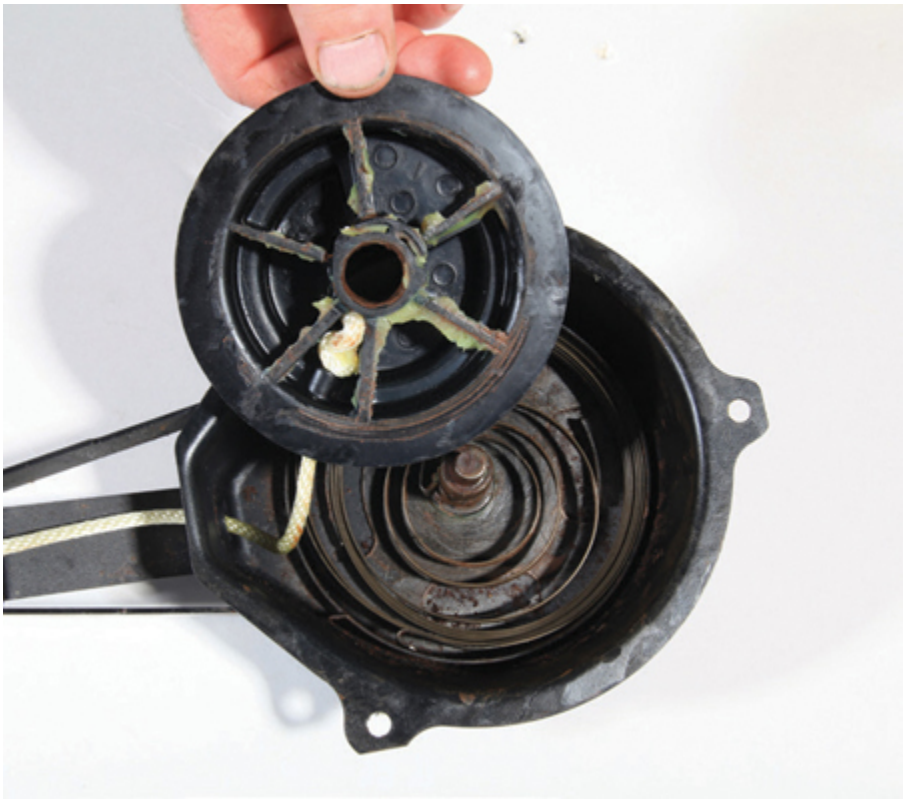
1. Form a loop.

2. Pass the working end (tail) round the back of the standing part.

3. Return the standing part through the loop.

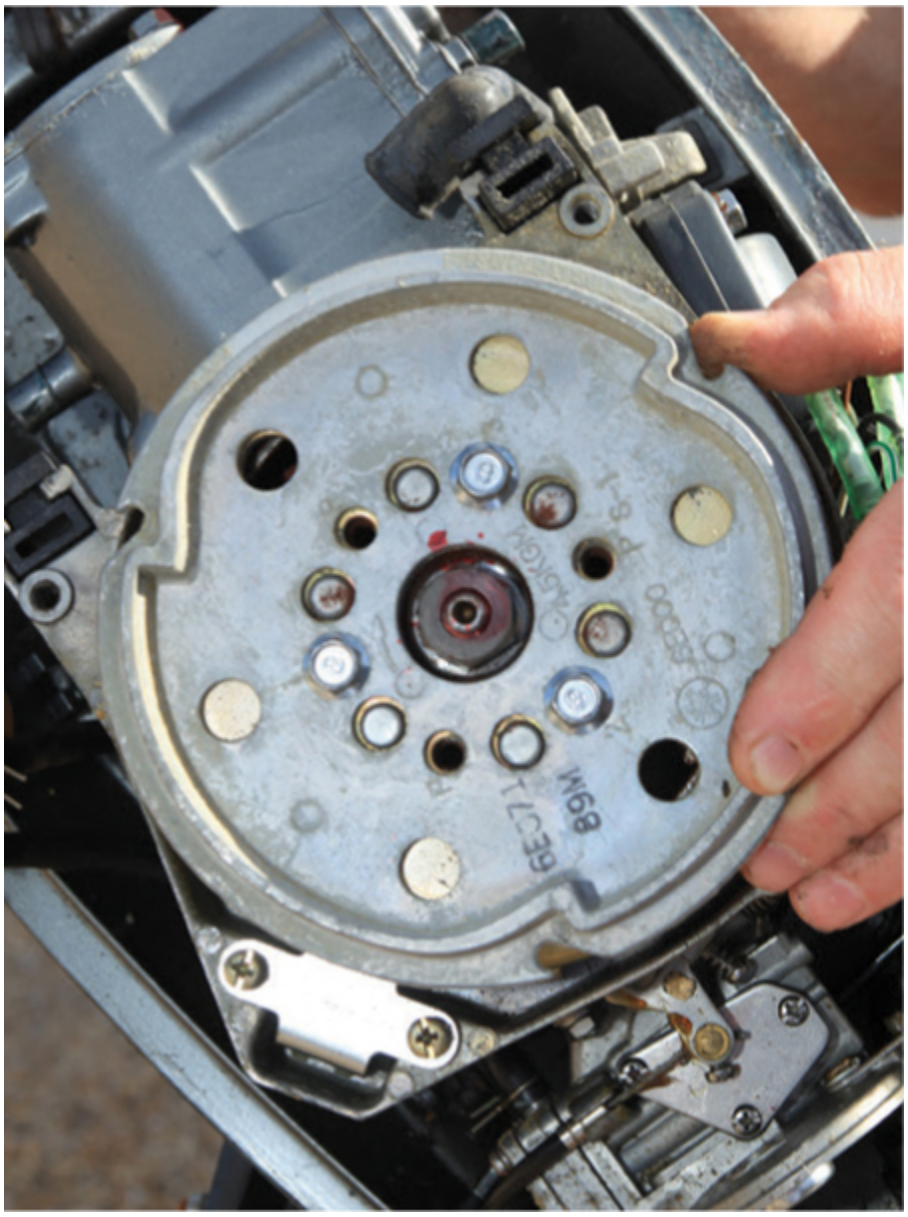
4. Pull tight.





6. Pull on the handle to fully extend the cord, release the temporary lock on the flywheel, and allow the recoil mechanism to slowly roll up the cord.

7. If the cord is of the correct length, the handle will fit snugly up against the housing. If the handle and cord hang loose, then either the flywheel needed to be wound round further to fully charge the recoil mechanism, or the cord is too long. Make whichever adjustment is necessary.



If the starter cord breaks while at sea, and the fitting of a replacement is not practical at that time, it is usually possible to restart the motor by wrapping

a temporary starter cord around the flywheel and pulling on this to turn the engine over.

ELECTRIC STARTERS

Outboard motors are commonly fitted with an inertia starter. These rely on the spinning starter motor ‘throwing’ the drive cog upwards to engage with the teeth around the flywheel ring gear. The most common problem is that the starter spins too slowly to engage with the flywheel. This can be caused by:

1. Low battery power.

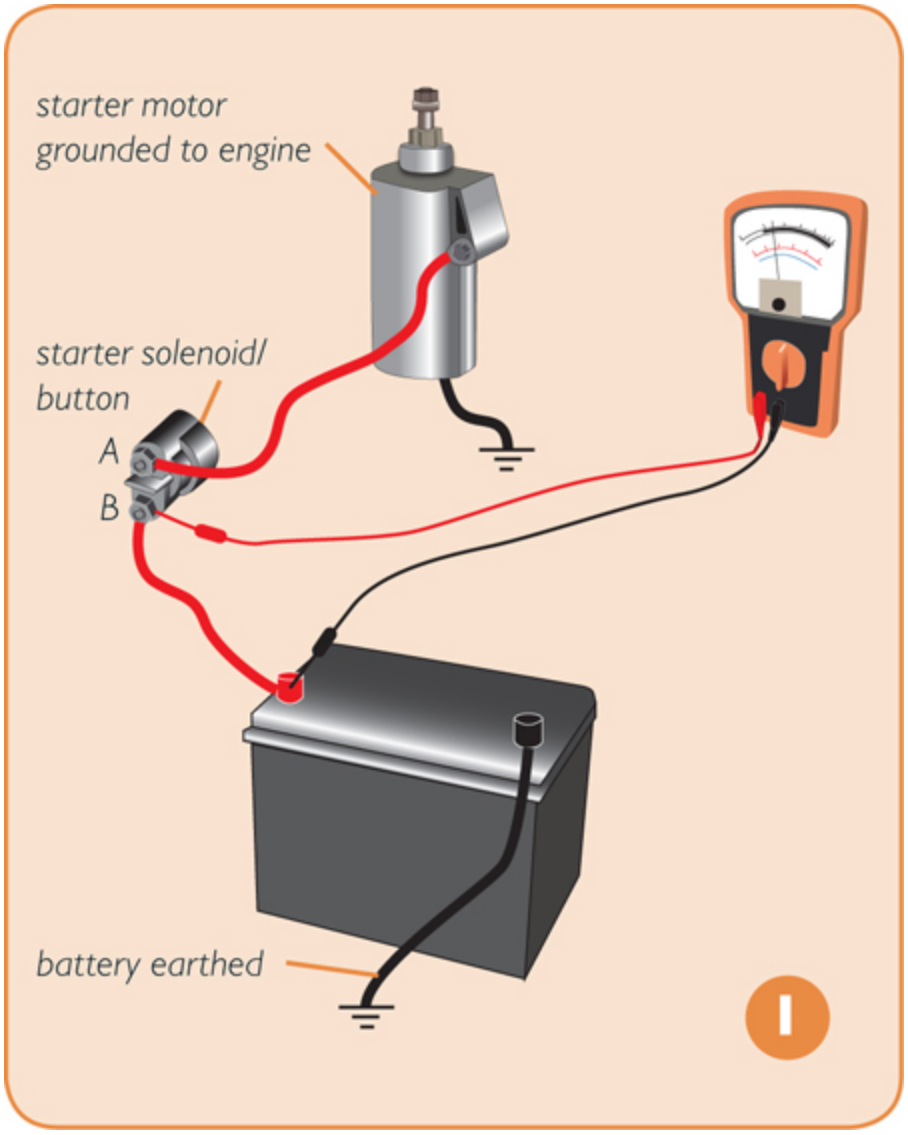
2. Corroded or loose wiring terminals.

To check the battery, perform an open circuit voltage test (see here).

If the battery is low, recharge or replace it.

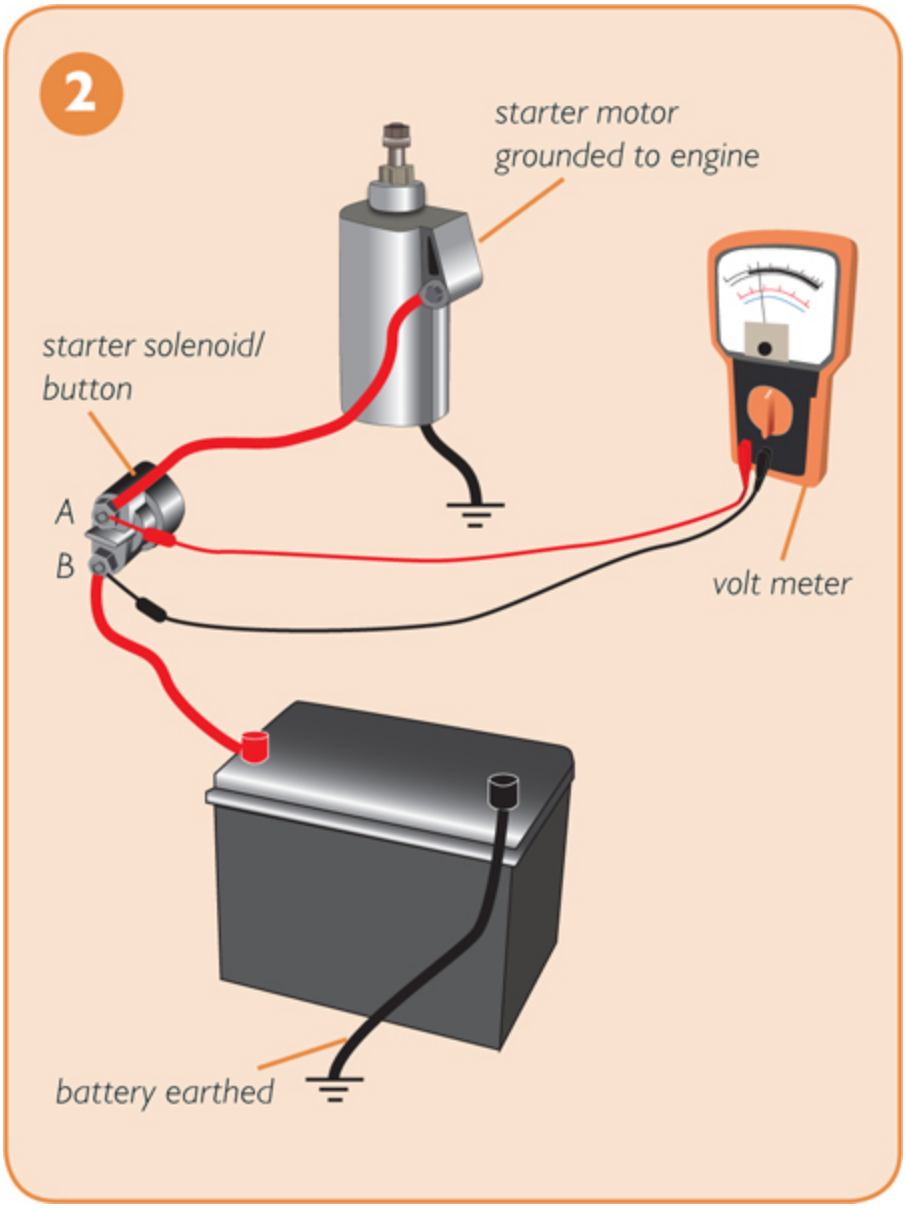
Once the battery is fully charged, check that the black grounding plate from the battery is free from corrosion and bolts are tight. Now check the voltage readings with a multimeter at the following points within the starter circuitry.

I Input lead from battery to starter button/solenoid: the reading should be almost identical to the direct reading across the battery. If not then this suggests a bad connection or broken wire between battery and solenoid.



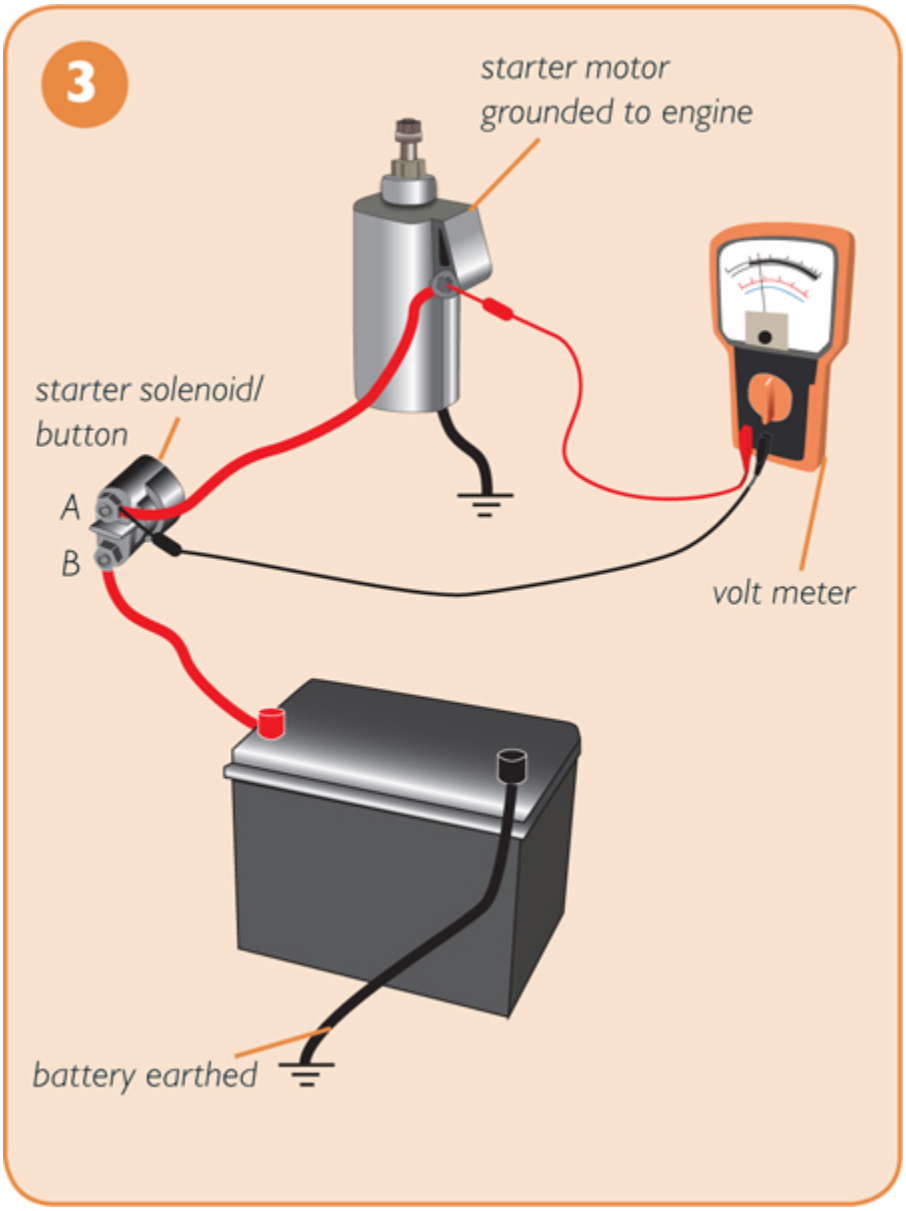
VOLTAGE CHECK AT STARTER BUTTON/SOLENOID

2 Output lead from starter button: first disable the ignition system so that engine does not fire up during the following four tests. Turn key or press the starter button while pressing the red test probe against the output lead. If the reading is less than 12 volts, the problem is likely to be within the starter button/solenoid. Replace with a new button.



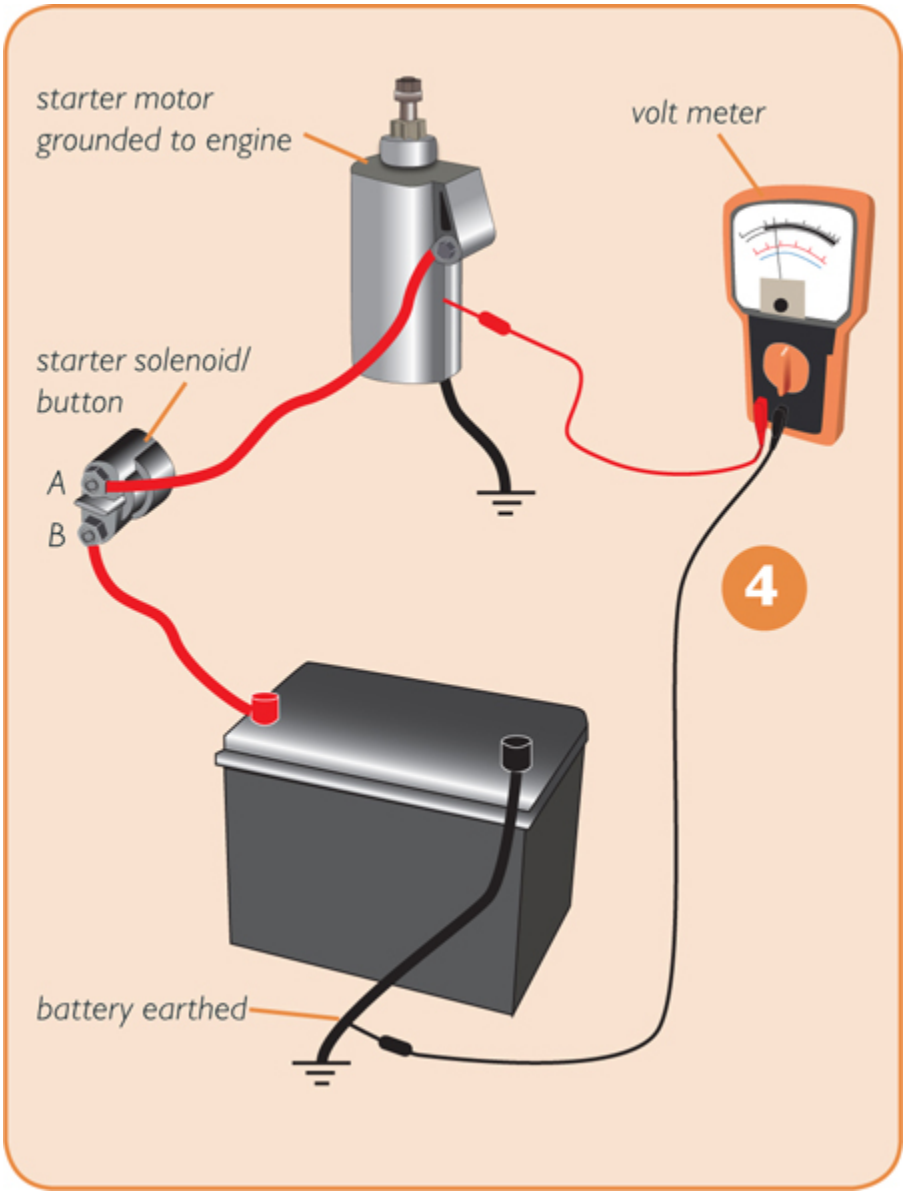
VOLTAGE DROP TEST BETWEEN SOLENOID AND STARTER MOTOR

3 Input lead to neutral safety switch: turn key or press the starter button. The reading should not exceed 0.2 volts. If it does, the connection to the starter motor may be corroded or the cable too thin. This should be the same size as the battery cables.



VOLTAGE DROP TEST BETWEEN BATTERY AND STARTER MOTOR

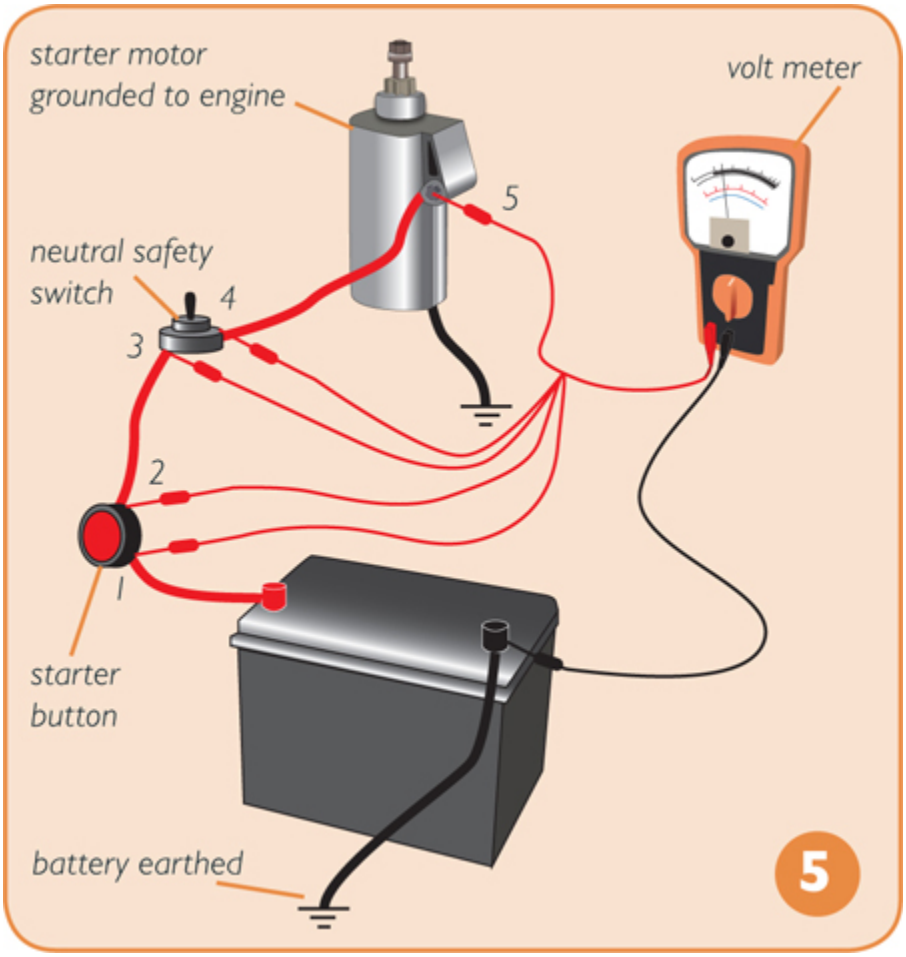
4 Output lead from neutral safety switch: first check that the gear lever is set to neutral, then turn key or press the starter button. If the reading is above 0.3 volts, there is either a bad connection at the engine or the negative battery post, or the cable is undersized.



INTERGRATED CIRCUIT VOLTAGE TEST

5 Set the gear lever to neutral, turn on the ignition and check the voltage across each section of the circuit in turn, Input lead to starter motor: If the readings are less than 12 volts (or fail to match the reading from across the two battery terminals, there will be corrosion or a broken wire between point 4 and 5. Repair or replace. If there is 12 volts reaching point 5, but the starter motor does not work, then the problem is with this motor which will require specialist repair or replacement.

Modern remote control systems are now very complex. Checking the starter switch, neutral switch or even the cabling between them can require specialist knowledge and is best left to the dealer to test.



REPLACING THE STARTER COIL SPRING

If the starter cord fails to rewind itself, the likelihood is that the starter coil spring has broken. Before replacing it, check the outboard manual to see if any special tools are required. If so, then this is a job for the dealer. If not, start by removing the starter assembly.

1. Undo the stopper knot to release the handle and unthread cord from the hole within the engine cover.

2. Undo the central nut holding starter assembly to the engine mounting bracket.

3. Keeping the central bolt within the assembly, lift out the entire assembly including pull-cord pulley and spring.

4. Mount entire assembly on its side within a vice, clamping the bottom of the bolt between two pieces of wood to protect the thread.

5. Grasp the end of the recoil spring with a pair of pliers and pull out.

6. Release the starter assembly from the vice and separate the pulley and pinion gear assembly from the spring housing, and remove remaining parts of the spring.

7. Inspect for wear and replace parts as necessary (the pinion gear teeth that engage with the flywheel are always rounded).

8. Install new recoil spring into its housing with spacer washer and spring retainer and lubricate with lithium grease.

9. Reinstall pulley, ensuring that the pin on the bottom of the pulley engages with the bent loop on the end of the recoil spring.

10. Reposition the pinion gear on the pulley.

11. Lubricate the centre mounting bolt with engine oil, and insert it through the centre of the rewind mechanism ensuring that washers and shims are all in place.

12. Screw a nut up on the end of the bolt to temporarily hold the rewind assembly together.

13. Reinstall the pull cord, wrapping it counter-clockwise around the pulley.

14. Holding the spring housing in one hand, pull the cord out with the other and feed the end of the recoil spring into the slot on the side of the housing until the loop reaches the side of the housing.

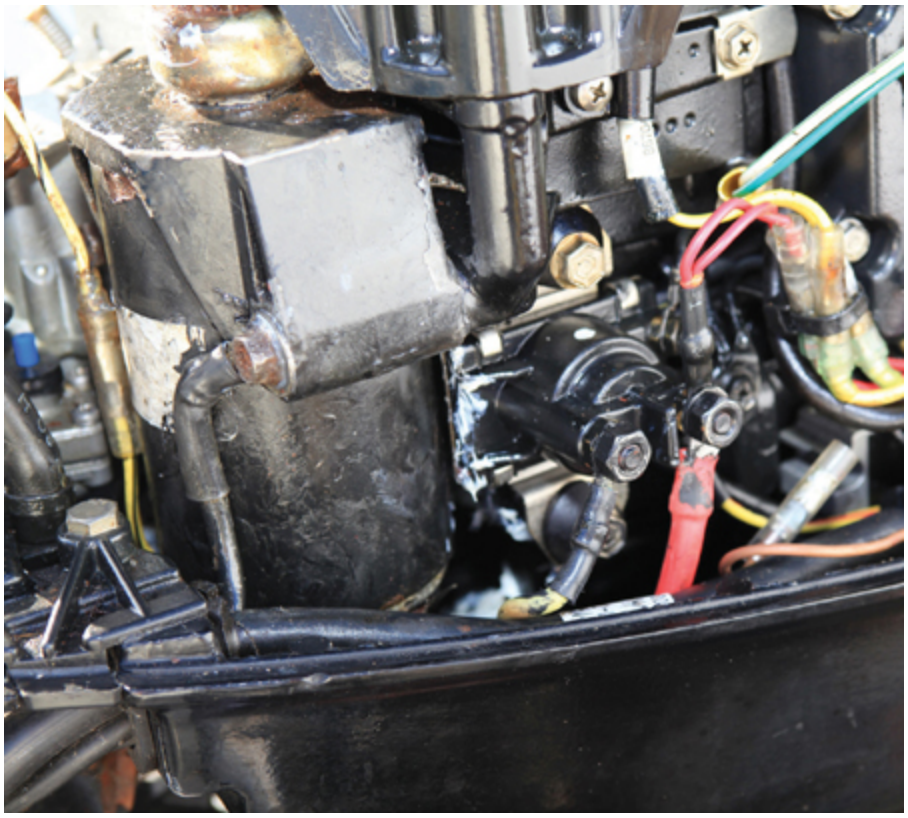
15. Rewind the pull cord anticlockwise around the pulley.

16. Reinstall the spring for the pinion gear and remove the temporary nut from the central bolt, carefully keeping the assembly together with your other hand.

17. Add thread-locking glue to the central bolt and re-screw the assembly back onto the engine mounting bracket, ensuring that the positioning tab for the recoil spring remains in place before tightening.

18. Thread the loose end of the starter cord through its hole in the engine housing and re-attach the handle.

19. Check that the starter lockout lever functions correctly, and have a test pull on the starter cord. If it rewinds, the job is done.



The starter solenoid makes a heavy draw on battery power. Keep the terminals clean.

ELECTRIC START SYSTEMS

Outboards with an electric start also have a charging system to keep the battery charged and to power nav lights and other auxiliary systems. If there is no life when you turn the key, the problem is likely to be one of four things.

1. The kill cord is not connected or the engine is in gear.

2. The battery terminal key is switched off.

3. The battery is duff.

4. The charging system is faulty.

The kill cord, gear lever and battery key positions are all simple to check, but checking whether the battery or charging system is faulty takes more time to analyse.

ALTERNATORS

While larger outboards carry standard belt-driven DC alternators similar to those found on a car engine, many small outboards have an AC alternator or stator within the flywheel assembly. The problem with AC current is that it alternates, so while this can power lights when the engine is running, it cannot be used to charge DC batteries without a rectifier within the system.

AC RECTIFIER TEST

The rectifier is the most common source of problems within the charging system on the boat. These can be caused by a voltage spike, overheating and even a momentary reversal of polarity. Testing the rectifier will require having the workshop manual open to identify the individual wires. Some rectifiers can be tested in-situ, but on others this will have to be tested on the bench. Follow the workshop manual precisely or give the task to the dealer.

TESTING THE BATTERIES

1. Check acid levels. If the electroplates are visible, top up with de-ionised (distilled) water.

2. Check the voltage reading using a multimeter across the positive and negative terminals. To ensure accurate results, this test needs to be performed several hours after the battery was last used or topped up, and with all inboard systems turned off.

OPEN CIRCUIT VOLTAGE TEST

REMAINING CHARGE	VOLTAGE READING
100 percent	12.6+
75 percent	12.4
50 percent	12.2
25 percent	12
0 percent	11.7-

*gel batteries will read higher than wet cell batteries

BATTERY CAPACITY/DRAIN TEST

This is best tested by removing the battery and taking it to your dealer who will quickly ascertain whether the unit has reached the end of its life.

TROUBLESHOOTING CHARGING SYSTEM PROBLEMS

SYMPTOM	CAUSE/SOLUTION
VOLTMETER ON INSTRUMENT PANEL UNDER-READING	Fault within charging system. Call in dealer to test entire system.
BATTERY REQUIRES CONSTANT TOP UPS	Faulty regulator overcharging battery, or battery at end of its life.
LIGHTING BRIGHTNESS INCREASES WITH ENGINE REVS	Faulty regulator overcharging. Three step voltage check. This is a simple way to verify engine charge rate and also highlights problems with the regulator if one is fitted. Turn off all systems on the boat, then turn on the ignition switch. **1.** Using the voltmeter, take a direct reading from the battery terminals to establish a base voltage. **2.** Start the engine and set it to run at 2,000rpm. Take a fresh battery reading. The voltage reading should increase by between 1 and 3 volts. If it is more, then the rectifier is faulty and will need to be replaced. If there is no increase in unloaded voltage, then there is no charge coming from the engine. **3.** With the engine still running at 2,000rpm, turn on all electrical accessories. Take a new battery reading. The

	voltage should drop to no less than 0.5v of your base voltage. This is your regulated voltage. If the reading is less than 0.5v, then engine charging system or alternator does not have sufficient amperage capacity for your boat. Your dealer should be able to supply a replacement heavy duty alternator or stator set.

Chapter 7
Cooling System

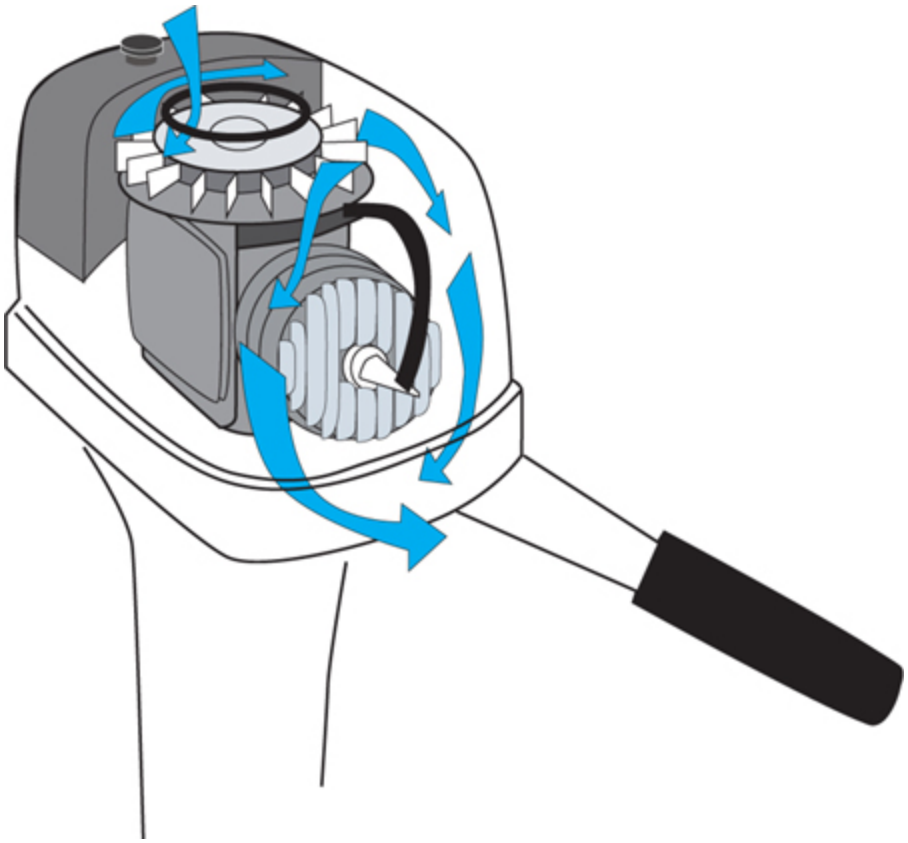
AIR COOLED OUTBOARDS

Simple outboards like the British Seagull and Briggs & Stratton marques have given way to complex 4-stroke engines with raw water cooling. Yet these famous brands are still sought after second-hand purely because of their simplicity and ease of service.

Airflow is generated by a fan within the flywheel that directs air over cooling fins within the cylinder head casting. The only thing that can go wrong is if oil and dirt is allowed to build up around these fins, or the hood or deflector plates, which channel the air around the engine, are removed or damaged. A periodic clean is all that should be needed to keep these old stalwarts running at the right temperature.

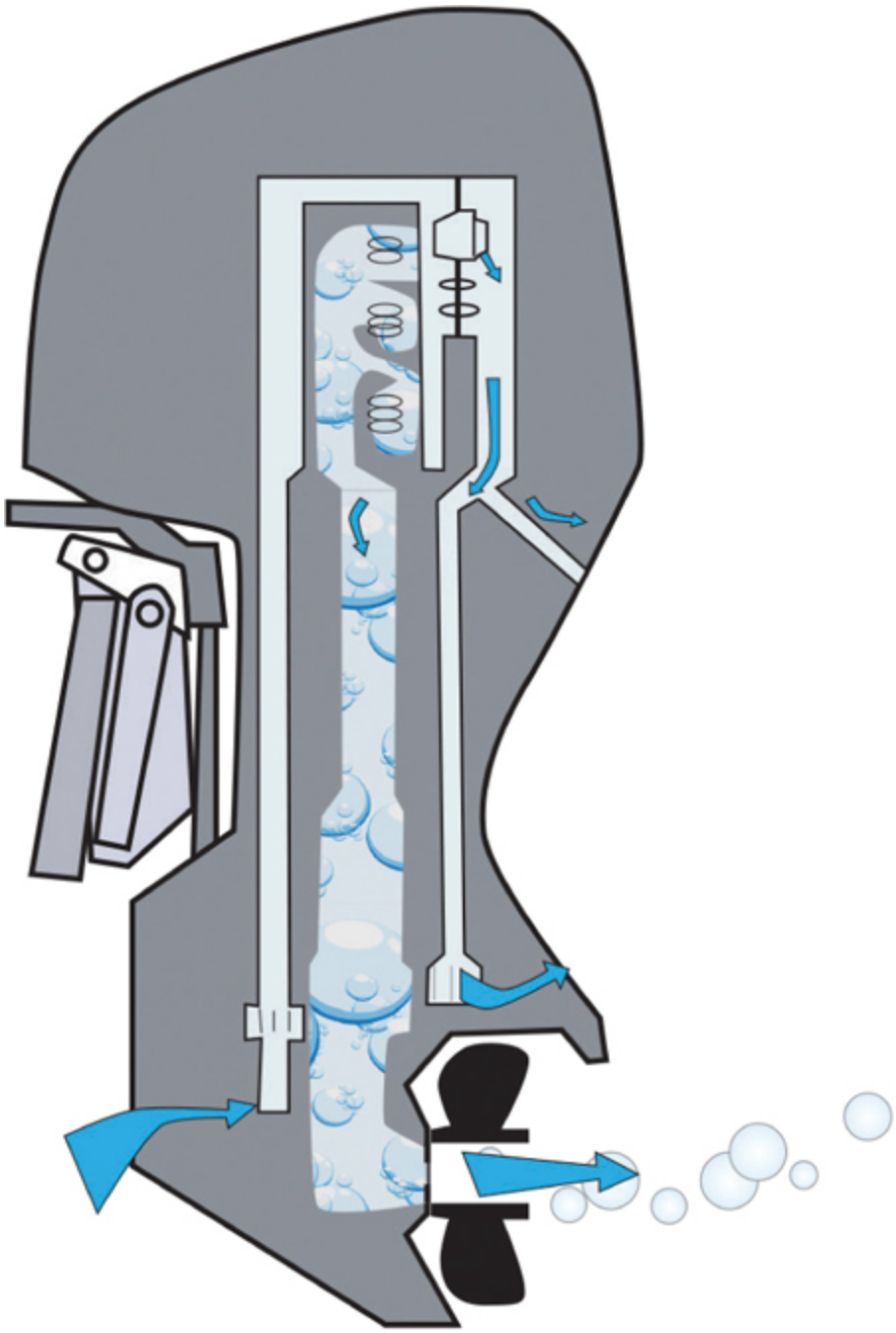
AIR COOLED HEAD/WATER COOLED EXHAUST

There are a large number of small second hand 2-stroke outboards still running that combine an air-cooled head with a water cooled exhaust system, including British Seagull. These have a water inlet on the forward edge of the skeg and a pump within the leg which pushes raw water around a water jacket surrounding the exhaust. For servicing of the water pump, go to here.



WATER COOLED OUTBOARDS

This system has been adopted by all manufacturers of modern outboards. Raw water is picked up on the forward edge of the skeg and a pump within the leg circulates the flow around the cylinder head and either down through the exhaust to an outlet either on the aft side of the skeg, or in the case of many larger outboards, out through the propeller hub along with the exhaust gases. Many engines also have an exhaust/water relief port just under the head for when the engine is running on tick-over.



DOS AND DON'TS

1. Never run these outboards with the water inlet port out of the water because this will destroy the impeller within moments. When testing the engine out of the water, always connect a hose to the inlet (see here).

2. Never run in shallow waters. Apart from probable damage to the prop, any sand and grit sucked up is likely to damage the pump.

EARLY SYMPTOMS OF OVERHEATING

1. Loss of power.

2. Burning smell.

3. ‘Pinking’ noise from the engine.

4. Paint discolouration around the power head.

Stop the engine immediately and check out the cause. Continued use is likely to lead to seizure, or at the very least, a cracked or warped head and blown gaskets.

LIKELY CAUSES AND RESPONSES

1. 2-strokes: wrong fuel/oil mix. Did you fill up with straight petrol? Is the oil reservoir empty? Add oil.

2. Obstruction to water flow. Check inlet port for weed or plastic. Check outflow.

3. Faulty thermostat. Remove and test in pot of water on stove.

4. Faulty water pump or impeller (see here).

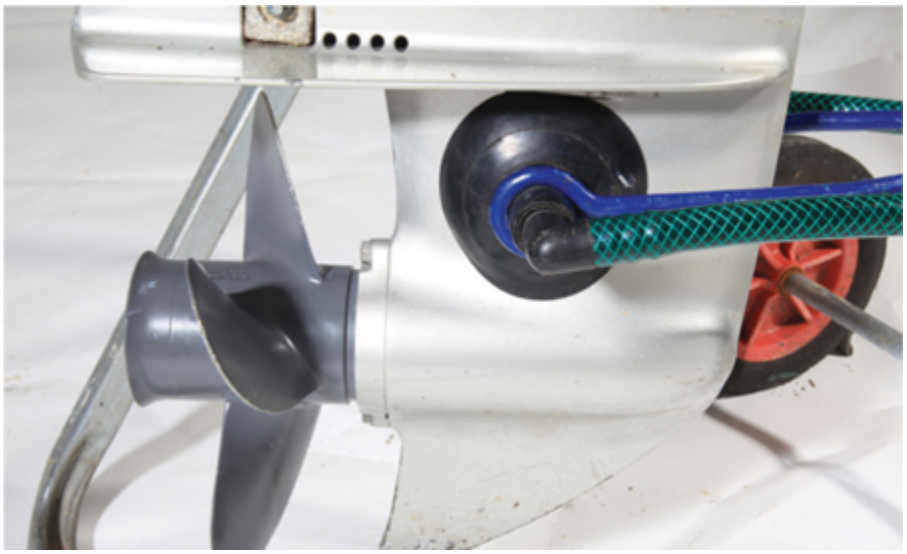
5. Engine set too high on transom and running with inlet port out of the water.

6. Wrong spark plugs.

FLUSHING THE COOLING SYSTEM

This should be done if not after every outing in sea water, then certainly at the end of a weekend.

1. Connect a freshwater hose to the inlet port or fit flushing muffs.



2. Turn the tap partially on to replicate normal water flow through the engine. Full flow may be too strong and add unnecessary pressure on seals.

3. Run the engine in neutral at 2,000rpm long enough to warm the engine and open the thermostat so that fresh water passes through the entire cooling system.

4. Leave engine running for 5–10 minutes to fully flush engine.

TESTING THE THERMOSTAT

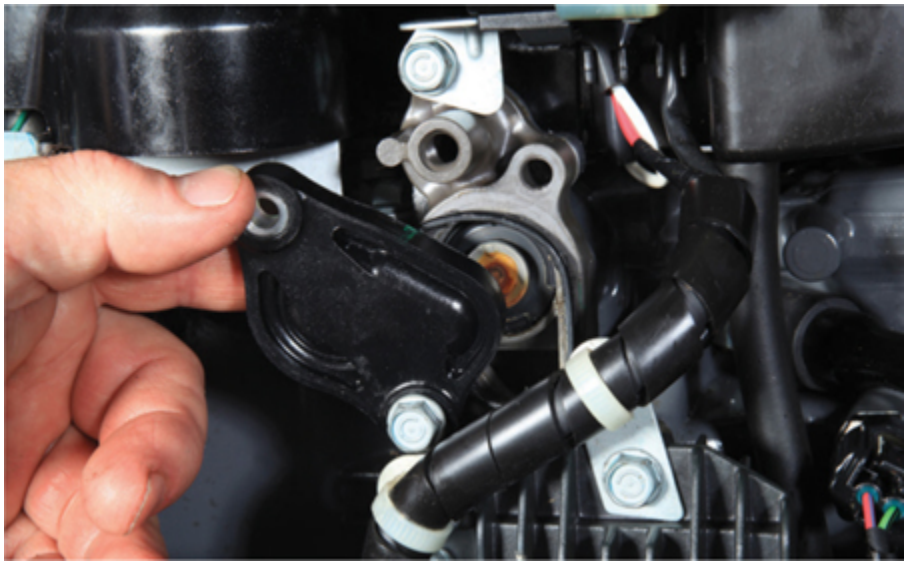
If water is entering the cooling system but the flow is not matched at the outlet port, a sticking thermostat is the likely cause. Find where they are located in the outboard handbook. Some V engines have two thermostats.

1. Remove the bolts holding the cover.

2. Pull thermostat from cavity.

3. Clear any debris from the cavity and flush the engine.

4. Clean the thermostat with a wire brush.

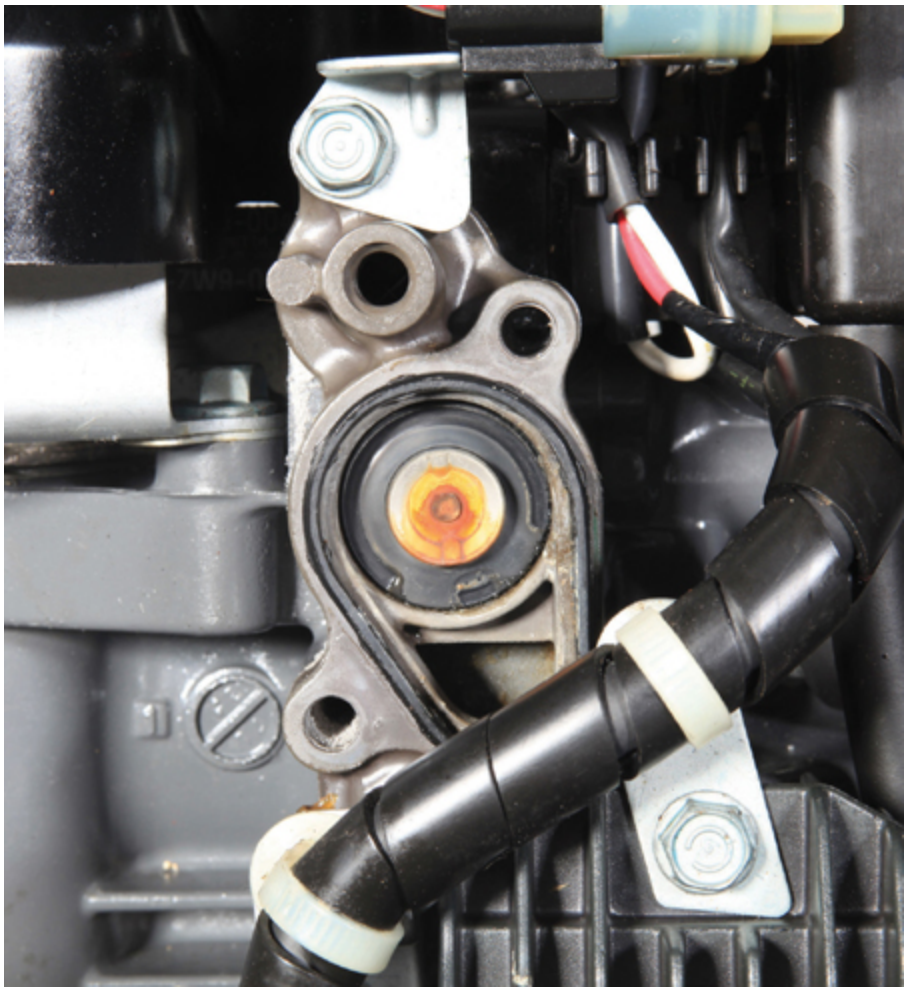


5. Place thermostat in pot of fresh water and heat on stove.

6. Monitor water temperature with a cooking thermometer.

7. If the thermostat does not open at the requisite temperature listed in the handbook, replace it.

8. When refitting the thermostat cover, always replace the gasket to avoid the possibility of leaks splashing on the ignition system.



WATER PUMP SERVICE

At some point in the life of every outboard, the water pump, located in the lower unit, will need attention. This will involve removing the lower unit, and a replacement water pump kit and a copy of the engine workshop manual will be needed. The fastenings and shaft connections vary from one outboard to another, so it is imperative to follow the strip down procedure described in the manual.

1. Locate the fastening bolts holding the lower unit to the main casing and remove.

2. Disconnect the shift rod, being careful not to change its height adjustment.

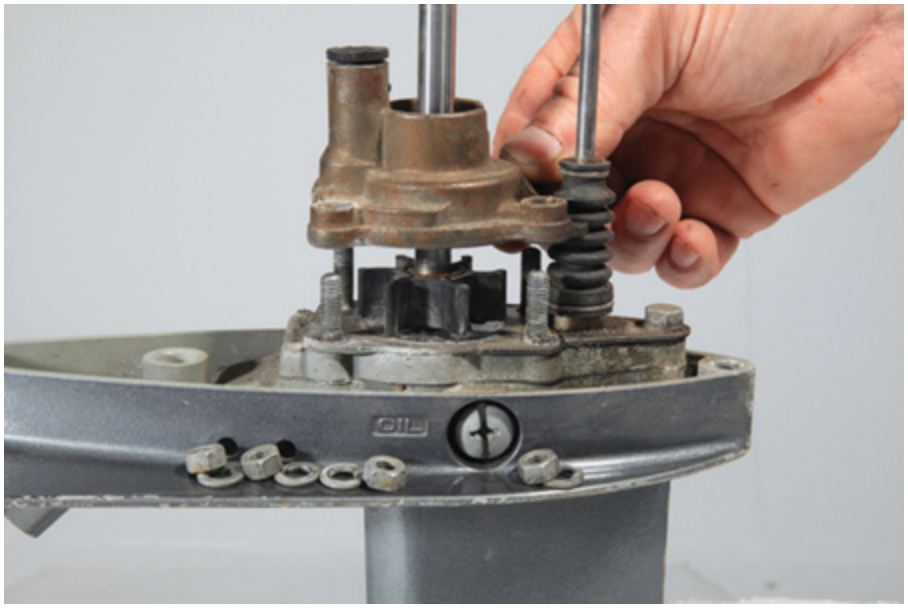
3. Remove the lower unit and hold the skeg upright in the jaws of a vice, using softwood as padding to avoid damaging the unit when tightening it in place.

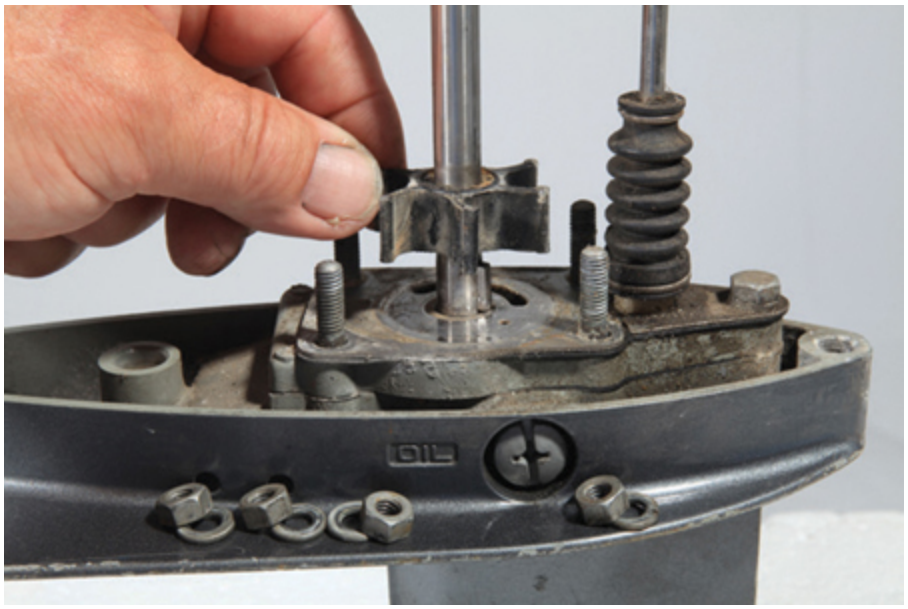
4. Remove the O-ring seal at the base of the driveshaft (if there is one).

5. Locate the water pump housing and remove the bolts holding it in place.

6. Lift the pump housing off its seating and up over the drive shaft.

7. Note which way the fins on the impeller are bent in the pump casing and ensure the new impeller goes back the same way.





8. Remove the impeller and check out the housing and baseplate for scoring caused by sand and grit being sucked through the inlet, and replace with the new items from the water pump kit.

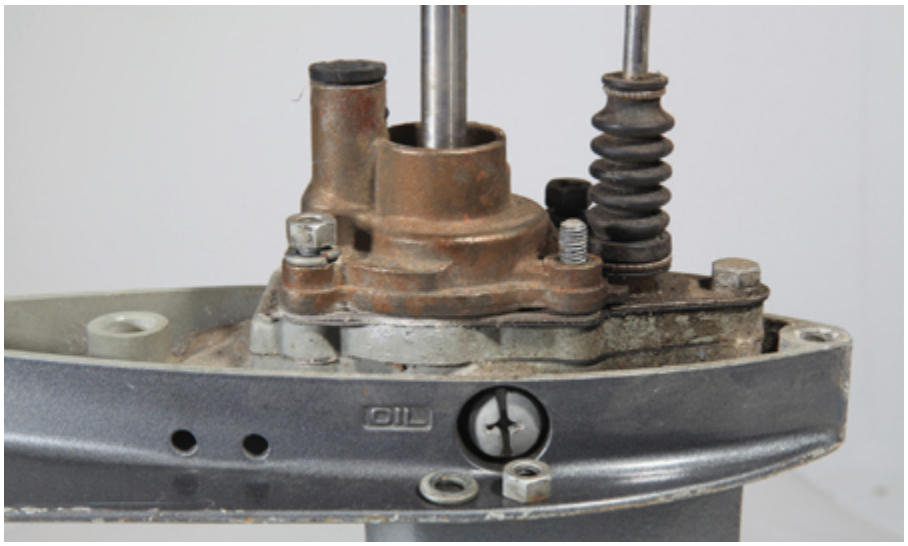
9. Fit the new impeller, using thick grease to hold the impeller key in place on drive shaft.

10. Wipe the inside of the pump housing with oil and reassemble, using fresh gaskets supplied with the pump kit. As you lower it over the impeller, turn the housing anticlockwise to tuck the fins inside.

11. Align the pump housing and push it down on its seating, then refit the bolts using Loctite or similar compound to secure them in place. Do not over tighten.

12. Before re-attaching the lower unit to the main casing, replace the O-ring on the base of the drive shaft (if one is required) and grease the splines on the engine side of the driveshaft. Be careful not to disturb adjustment to the shift rod.

13. Check the tube connecting the water pump to the engine water jacket for any kinks or perforations and replace if necessary.



REINSTALLING THE LOWER UNIT REQUIRES TWO PAIRS OF HANDS

Remember to use new gaskets and O-rings supplied with the pump replacement kit.

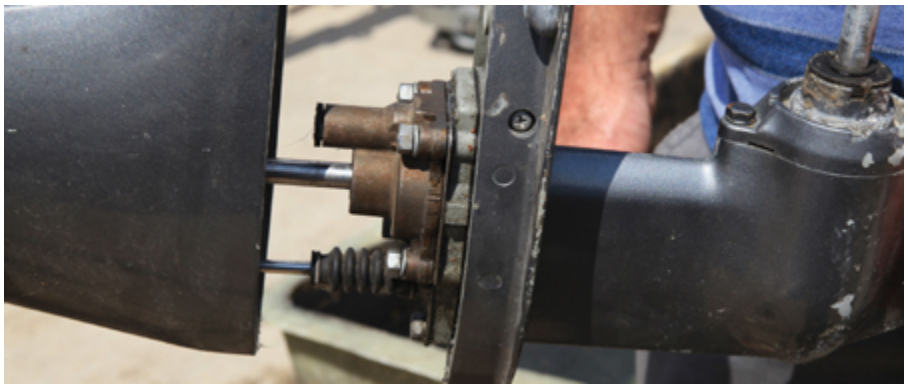
THIS IS THE ROUTINE:

1. As the unit is raised in place, use a screwdriver to steer the water tube within the water pump housing.

2. Do the same with the gear shift linkage to ensure that it goes through the bottom pan of the power head and is aligned correctly with the shift-lever linkage.

3. To align the drive shaft, turn the flywheel a small amount to engage the splines.

4. Before pushing the lower unit up in place, check with a torch shining up into the casing that everything is lined up correctly.

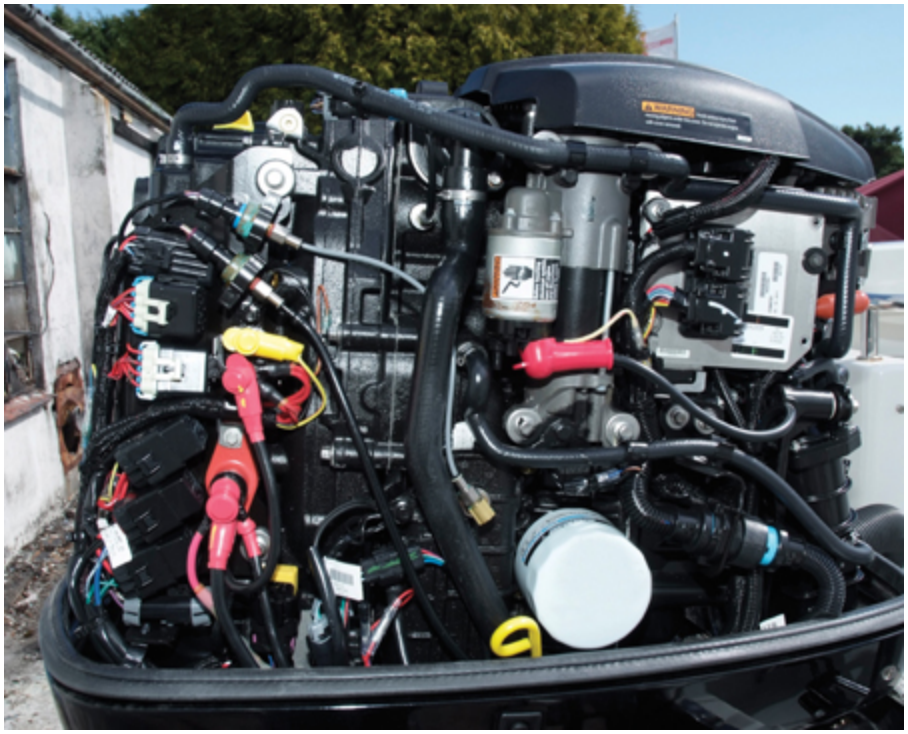


5. The lower unit should slide up in place without any force. If it doesn’t, then something is misaligned. Lower the unit and start again.

6. Once the lower unit is in position correctly, refasten it to the casing, coating the ends of the bolt threads with Loctite or similar locking compound.

7. Reinstall the gearshift linkage at the top of the casing in accordance with the outboard workshop manual. Do not attempt to shift through the gears without turning the prop. This can damage the linkage. Wait until the outboard is in the tank or has a hose connected to the flush pipe, and run the engine to check that the pump works and the gear lever is aligned correctly.

Chapter 8
Lubrication System

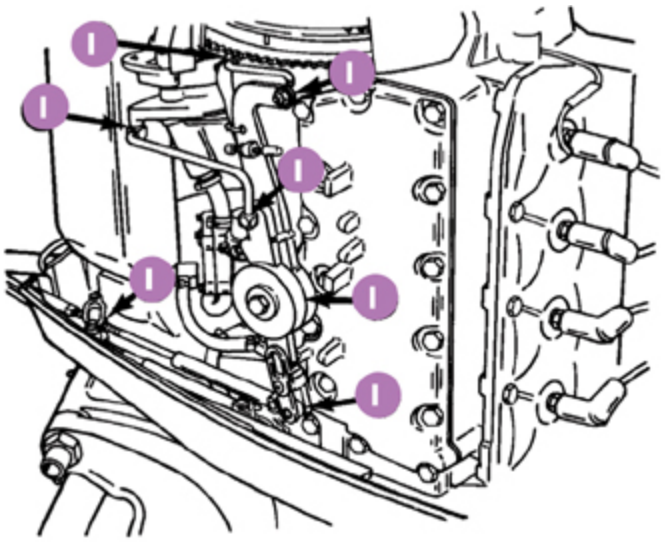


Top up grease points on the outboard at least once a year, and more often when the unit is left hung on the transom all season. These are the main grease points:

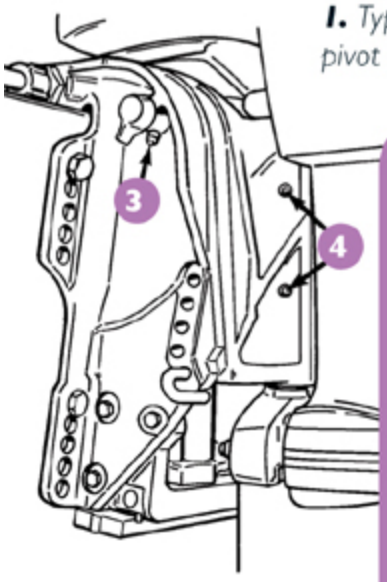
1. Throttle linkage
2. Gear linkage
3. Steering arm
4. Hood release catches
5. Transom mount pivot points
6. Tilt mechanism

Use the type of grease recommended in the outboard handbook and pump it through the nipples until the old grease and any water is pushed out. Wipe away any residue.

ENGINE



1. *Typical throttle/shift linkage lubrication pivot points*

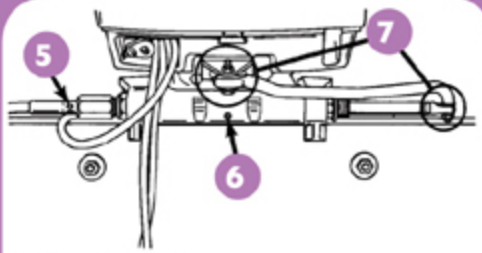


TRANSOM/TILT MOUNT

2. *Upper shift shaft lubrication*

3. *Tilt lock lever grease point*

4. *Swivel pin greasing point fittings*



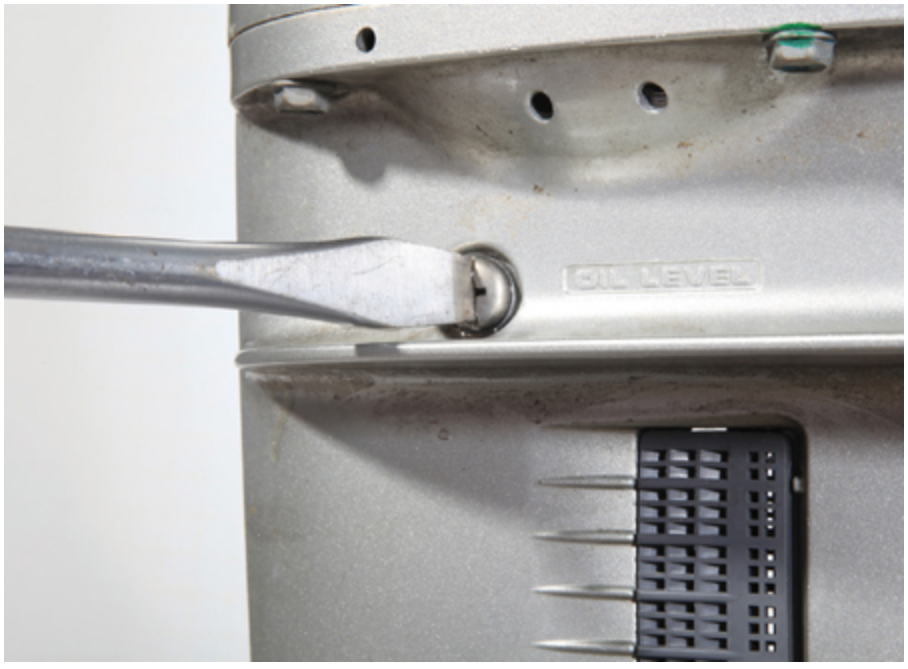
STEERING BAR

5. *Ride-guide steering grease fitting*

6. *Tilt tube grease fitting*

7. *Steering link rod pivot grease point*

Chapter 9
Drive System



GEAR CASE OIL CHANGE

Drain out the oil from the gear case and replenish with fresh oil as specified in the outboard handbook. Most lower end units have two screw plugs – one for filling, the other for draining. In some cases it is necessary to remove the propeller in order to access the plugs.

TO DRAIN THE OIL:

1. Place a large container beneath the skeg.

2. Stick tape to the bottom of the skeg for oil to run down directly into the container.

3. Remove the lower drain plug.

4. Unscrew the filler plug. This acts as a vent, allowing the oil to flow out.

5. Inspect the oil. Is it milky? This signifies water ingress through the oil seal around the prop shaft which will need to be replaced.

6. Rub some of the oil between thumb and fingertips. Are there any particles or metal filings? This indicates damage to the gearing. Stripping down the lower unit and replacing the oil seal invariably requires specialist tools, and is a task best left to the dealer.

7. Check the drain plug O-rings and replace as necessary.

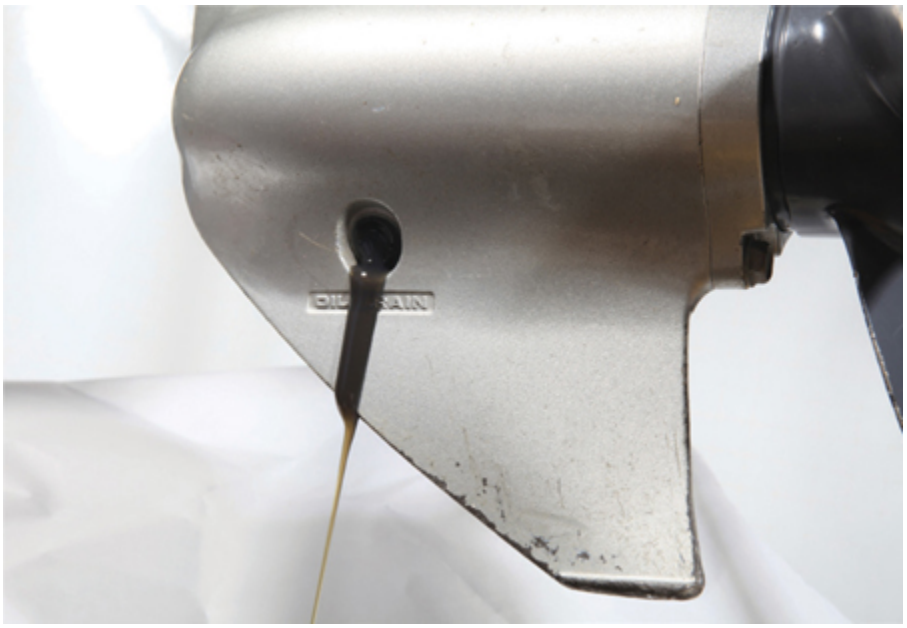
8. Refill with the correct oil listed in the outboard handbook, using a proprietary pump available from your dealer that fits both the oil container and the bottom drain hole, or the tube as shown in the picture.

9. Pump the oil to fill the gear case from the bottom up.

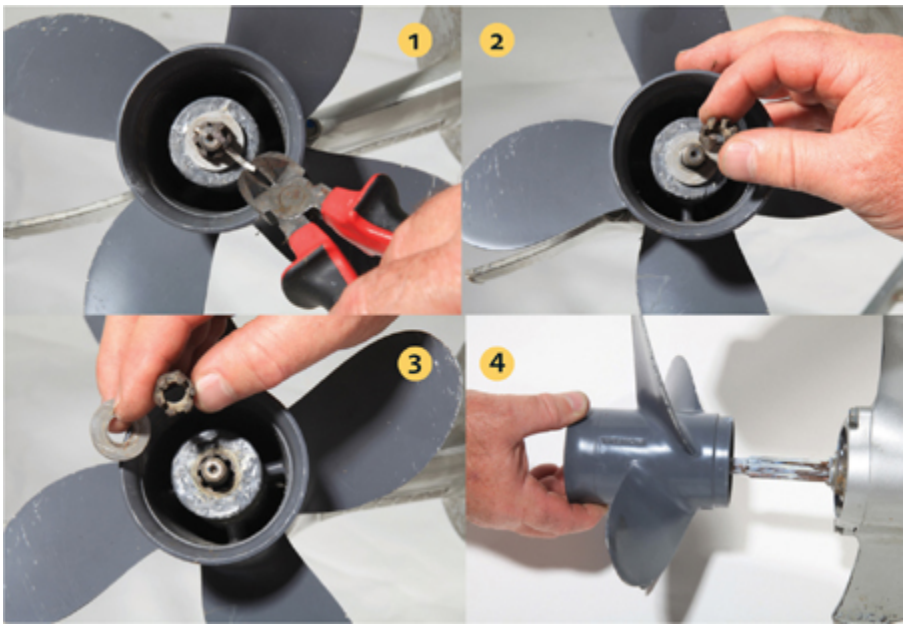
10. Once oil begins to emerge, refit the top drain plug, remembering to include the O-ring seal.

11. Remove the pump and refit the lower drain plug.

12. Tighten both plugs and check for leaks.




Hallmark



REMOVAL AND REPLACEMENT OF THE PROPELLER

This is a simple job to do.

1. Remove the split pin (if there is one) locking the retaining nut in place.

2. Remove the shear pin.

3. Undo the retaining nut.

4. Slide the prop off the shaft.

TO REPLACE:

Grease the shaft.

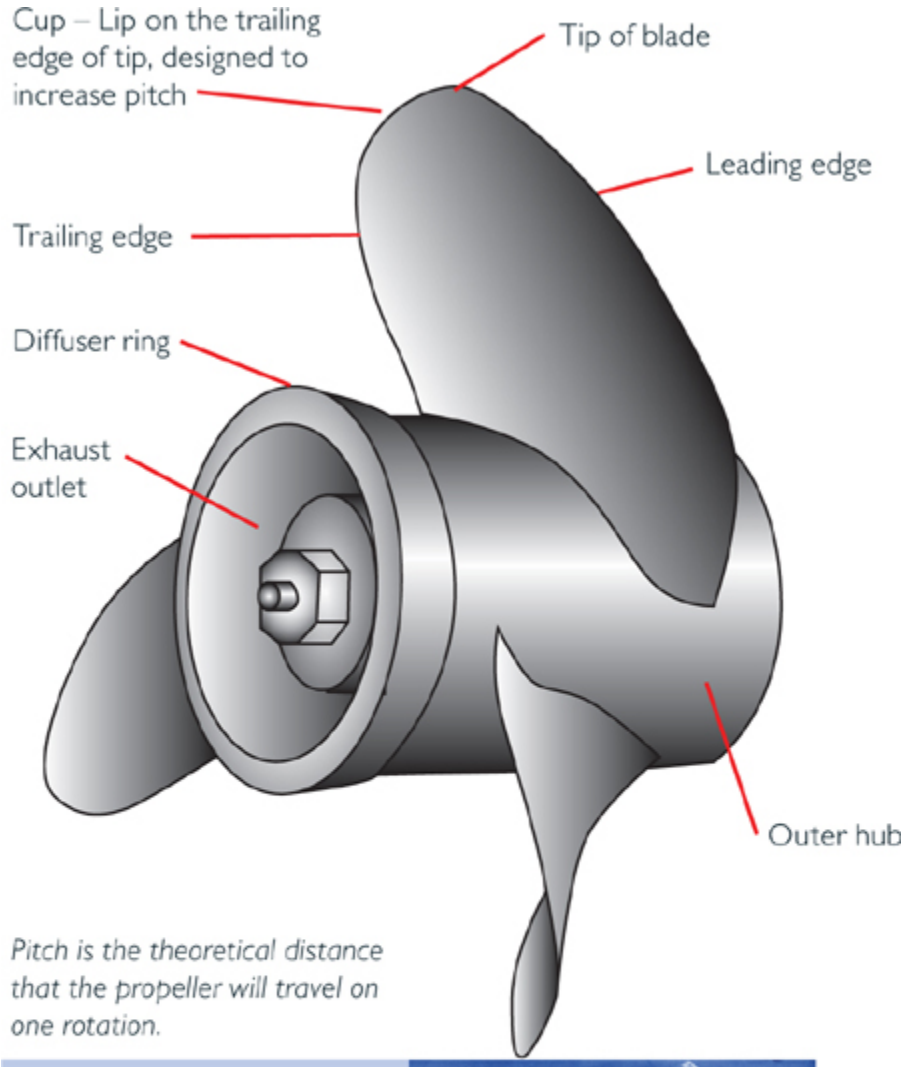
1. Line up the prop hub with the key line on the shaft and push on.

2. If the nut is of the Nilock type, renew this each time. These nylon lined locking nuts have a one time usage.

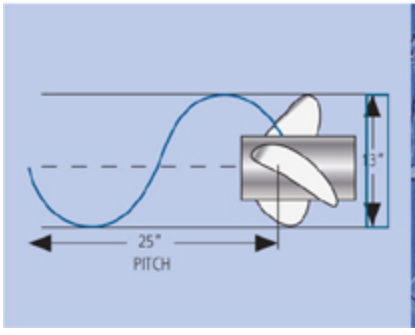
3. Renew the shear pin each time in case it is weakened during the removal process.

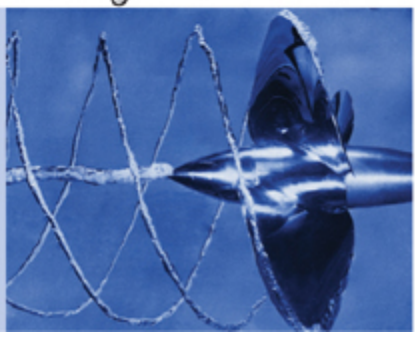
4. Tighten the retaining nut and replace the locking split pin.

PARTS OF THE PROPELLER



Pitch is the theoretical distance that the propeller will travel on one rotation.





CHOOSING THE RIGHT PROPELLER

The propeller needs to be matched to both the engine and the boat. If the outboard is pushing a heavy displacement vessel it will need a shallow pitched prop, because the standard one may be under such load that the engine cannot operate within its optimum rev range. If the outboard is powering a fast planing hull, then it will require a coarser pitch so that the engine doesn't over-rev.

> Pitch is the theoretical distance a propeller would move through the water if it were a solid. All props are far less efficient, even when new. There is the problem of cavitation where pressure exerted on the water causes the oxygen to vaporise and leave a string of air bubbles trailing from the tip of the blades. The difference between theoretical and what happens in practice is called 'slip'. This can be as little as 10% on a lightly loaded fast planing hull, and 50% on a heavy displacement hull.

There are also props that are designed specifically for work in weedy areas. The prop that comes with the engine as standard will invariably be a general

purpose aluminium one, but you can also purchase high performance props made of stainless steel and even composite ones which are the cheapest to replace.

PROP COMPARISON	WEIGHT	FLEX	REPAIR	COST
Composite	Least	Little	Not possible	Least
Aluminium	Medium	Little	Easy	Medium
Stainless steel	Greatest	Least	Difficult	Greatest

Most outboard manufacturers and propeller suppliers have a prop selection calculator on their websites, which will provide an initial guide, and the engine dealer should have, at the very least, a comparison table listing engine size and boat type matched with the correct propeller size. This is stamped on the hub and is invariably annotated in inches. Thus, 12 x 17 refers to a prop with a diameter of 12 inches and a pitch of 17 inches.

Selecting the wrong propeller not only reduces performance, but can also damage the engine. An outboard that does not reach its recommended RPM with the throttle wide open is ‘over-propped’ and the higher torque loads puts a tremendous strain on the pistons, crankshaft, and bearings. This is overcome by fitting a propeller with a smaller pitch.

Conversely, an outboard that revs beyond its recommended RPM limit will suffer higher than normal wear and requires a propeller with greater pitch. As a guide, a 1 inch change of pitch will increase or decrease the engine’s performance by 200rpm. The optimum is achieved when, under normal load, the engine reaches its maximum recommended rev limit, and the boat reaches its best speed.

If all else fails you can always experiment with various pitched propellers to find which one operates closest to the engine’s optimum rev limit listed in the engine manual.

This is the routine to test/check that you have the right propeller matched to the performance of your boat. For best results the outboard will require a

tachograph, and the boat a speedometer, to provide an accurate guide to measure against.

1. Check the recommended RPM limit in the outboard manual.
2. Make several test runs in calm water with the existing propeller to establish a benchmark, adjusting the engine trim to achieve the best speed.
3. If the RPM reading is below that recommended in the manual, subtract the reading one from the other to find the difference. For example:

Recommended top end of operating range	5,600rpm
Tachometer reading	4,800rpm
Difference	800rpm
Divide difference by 200 (800÷200)	4

Thus the replacement prop should have 4 inches less pitch.

NUMBER OF BLADES

When the number of blades is changed, diameter and pitch may require a minimal adjustment to keep the RPM within the correct range. For most purposes, 3- and 4-blade props can be used interchangeably on outboards without much change in performance.

PROP SELECTION – 2, 3 OR 4 BLADES

Michigan Match - Aluminum

Stiletto - Stainless steel

Comprop - Composite

Apollo 3-Blade - Stainless steel

Solas Stainless steel - 3-Blade

Solas Aluminum - 3-Blade / 4-Blade

CUPPED PROPELLERS

These have a curved trailing edge to the blades and enable the prop to maintain performance at higher trim levels and in tight corners. Cupped

props achieve a higher top-end speed or at least the same speed at a lower engine RPM. They also promote more efficient fuel consumption.

SINGLE AND MULTIPLE ENGINE PROP APPLICATIONS

Single-engine installations invariably have right-hand rotation propellers to balance out the right-hand driver position. When dual engines are fitted, counter-rotating propellers are used to balance the steering and stop the props from ‘walking’ the boat sideways whenever it is airborne.

Most manufacturers recommend outward rotating propellers: right-hand rotation on the right side, and left-hand rotation on the left side.

OUTBOARDS UP TO 25HP

Smaller engines come as standard with an aluminium sweptback, weed-shedding blade shape of moderate pitch. These are thick in blade shape for durability, and of a flat pitch/rake design that is easy to repair and intended for submerged operation with all the blades rotating well below the surface.

Most manufacturers offer stainless steel alternatives for increased performance and durability.

High-reverse thrust propellers are also available. These are not of the weed shedding shape, but have rounded symmetrical blades and pitch distribution to give the propeller similar performance characteristics in forward and reverse. These are designed for submerged operation on displacement-type, slow, heavy boats such as sailboats and workboats.

30–60HP

There is a greater range of propeller options for this family of engines. Slow speed displacement boats require the large diameter/large blade area lower pitches, such as 12.5 inches diameter × 8 inches pitch, 12.25 inches × 9 inches and 12 inches × 10.5 inches. Runabouts use the higher-rake middle pitches of 12 – 16 inches. Where extra durability is required, stainless steel counterparts exist for all pitches from 12 inches to 16 inches. These propellers may turn a little lower in RPM, but will generally hold better in turns because of their slightly higher cup. Higher pitched 17 inch and 19 inch props are available for lighter, faster boat designs.

75–115 HP DISPLACEMENT BOATS

These use the lowest pitch 10–13 inch aluminium and stainless steel heavy-duty propellers with a large thick diameter/blade area.

13–15 inch pitch propellers are suited for heavy planing situations, particularly on boats operated at higher altitudes, which may benefit from having lower-pitch general-purpose propellers.

40+ KNOT SPEED BOATS

Faster outboard powered sport boats can utilise higher pitch stainless steel props of 23+ inches. Where top speed is the main consideration, specialist surface piercing propellers are an option.


EVINRUDE
115


EVINRUDE
40

Chapter 10
Fitting on the Transom

Outboards, particularly the smaller powered variants, come in two shaft sizes: standard and long shaft. It is important to have the correct one. The long shaft engines are invariably used as auxiliary power on small yachts that often hobbyhorse in a seaway, lifting the standard sized leg out of the water at times, and on deep drafted displacement craft. The optimum measurement between the bottom of a dinghy or planing hull and the anti-cavitation plate is between 0 and 25mm (1 inch). On small yachts, where the transom is often clear of the water anyway, distance will need to be all the greater, to ensure that the prop remains in the water at all times. If the blades break clear of the surface, then it will simply suck air down and the engine will over-rev and overheat.

On tenders and planing hulls, the engine must be clamped on the centreline of the boat. If the boat is fitted with a transom hung rudder then an outboard bracket bolted to one side solves the problem of mounting. Some brackets

also have a vertical mechanism that allows the outboard to be raised out of the water when not in use. The bracket needs to be mounted far enough to one side not to interfere with movement of the rudder.

With twin outboard installations, ensure that the propellers contra-rotate – the port hand clockwise and starboard hand engine counter-clockwise – otherwise the boat will pull to one side.

This outboard installation allows for the engine to be raised and tilted clear of both the water and rudder.

ENGINE TRIM AND TILT

Depending on size, your engine will have either a manual or electrically operated hydraulic tilt mechanism to lift the leg out of the water when not in use. This is also used to set the trim of the engine to match the angle of the transom together with the angle that the boat rides across the water. If the bow rides too high with a normal load, then the outboard is angled too far out. Conversely, if the boat has bow-down trim, then the outboard is angled too far in.

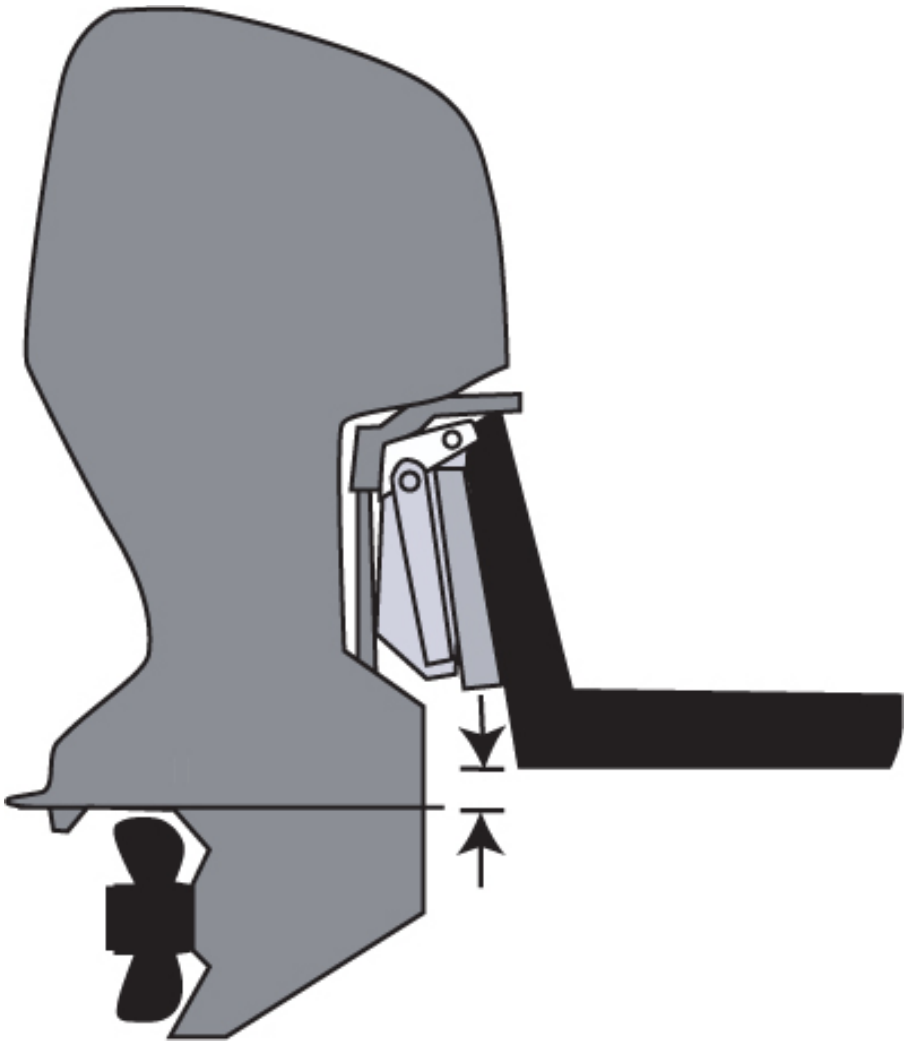
Adjustment on manual tilt outboards is via an adjustment rod that slots into a row of holes within the engine bracket. Each hole adjusts the trim angle by approximately 4 degrees. To raise the bow (trim out), move the rod away from the transom.

The power tilt mechanism can suffer when the boat is left in the water for extended periods, so regular greasing of movable parts is essential.

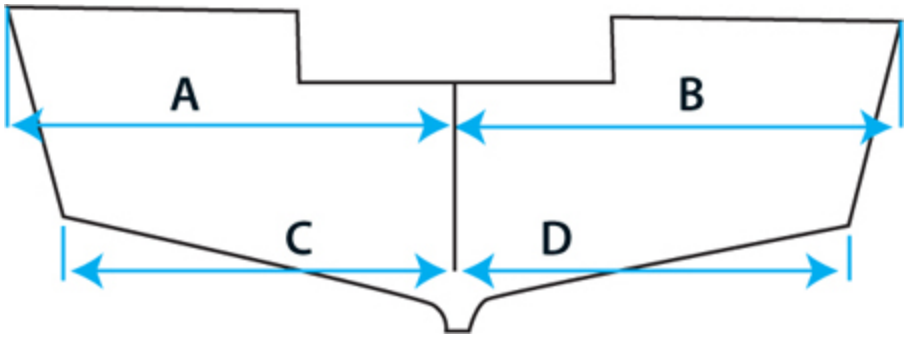
To lower the bow angle (trim in), move the rod towards the transom. The trim and tilt hydraulic mechanism is usually controlled by a rocker switch either on the throttle/gear lever, or with a switch on the dashboard. This gives infinite control of engine trim while the boat is moving to counter changes in weight distribution and even sea state. You may well find that the boat will get up to planing speed faster with the engine trimmed out, and then ride much better and more economically trimmed in once the boat has achieved planing mode. You can judge this by the speed achieved and level of engine revs.

When towing on a trailer with the engine raised, secure a block of wood between the engine and transom bracket to take the load off the tilt mechanism.

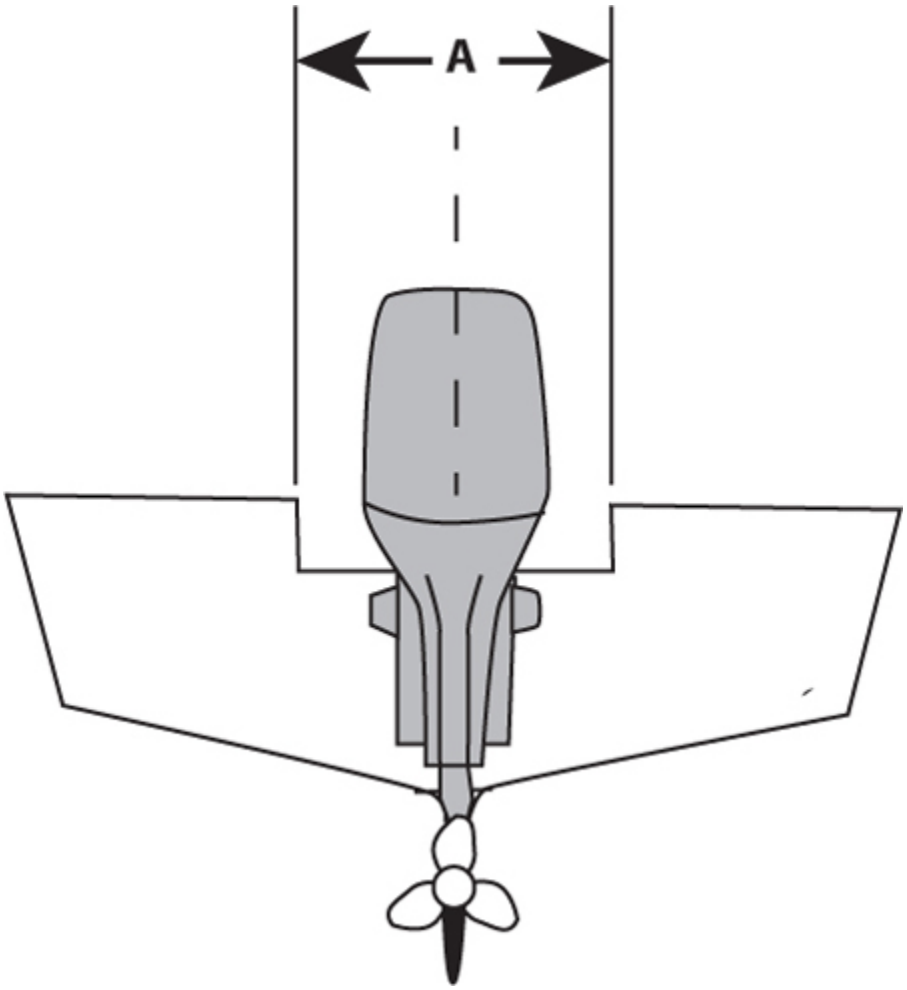
FITTING OUTBOARD MOTOR ON TRANSOM



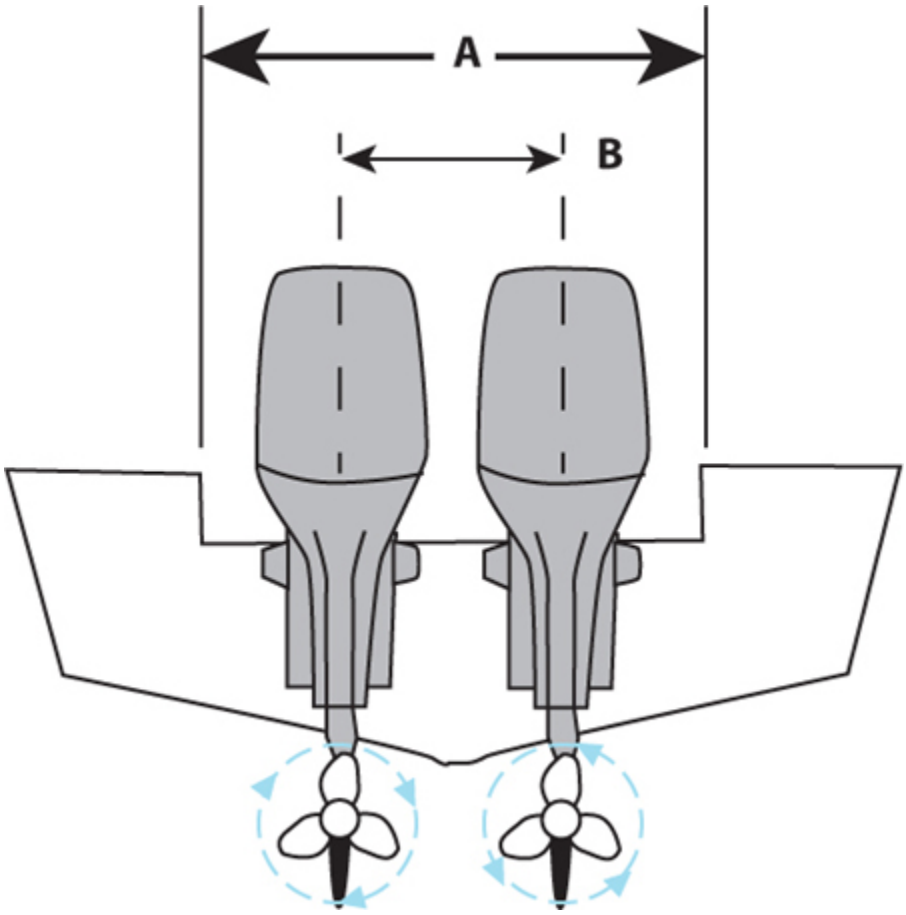
The optimum measurement between the bottom of a planing hull and the anti-cavitation plate on the outboard is between 0 and 25mm (1 inch).



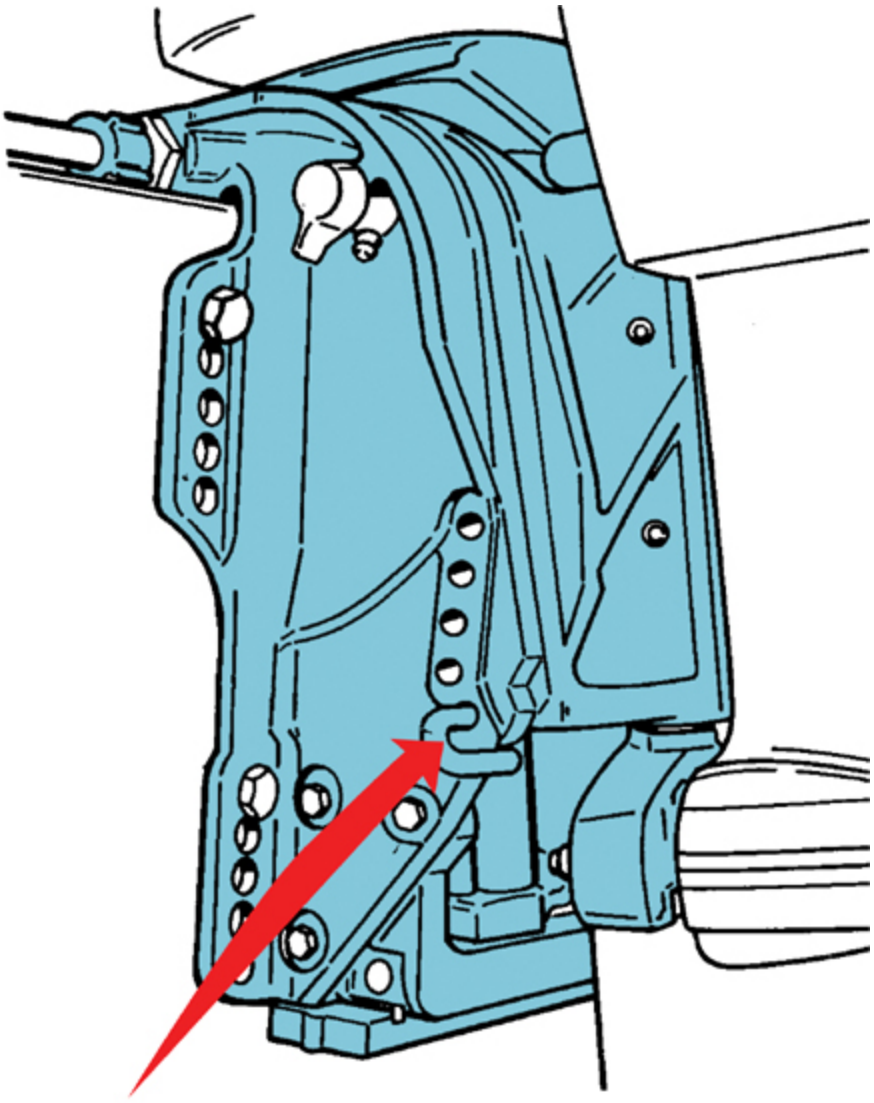
Locate the centreline of the transom by ensuring that A and B, and C and D are equal length.



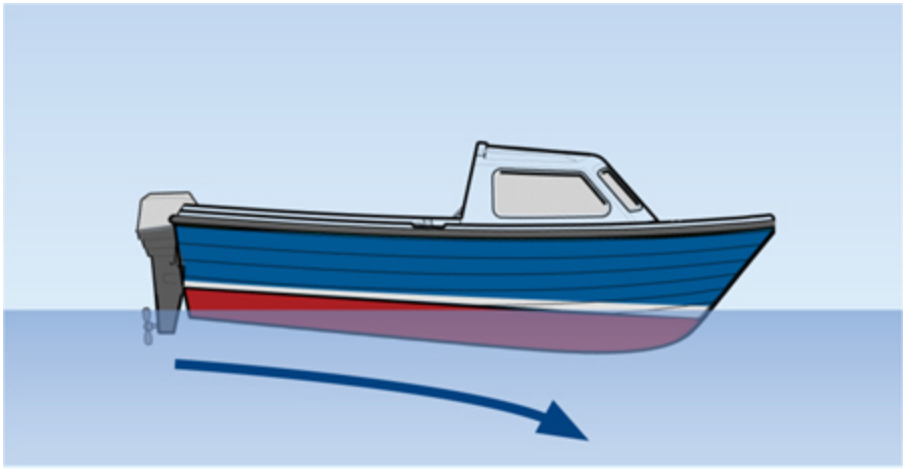
Minimum transom opening.



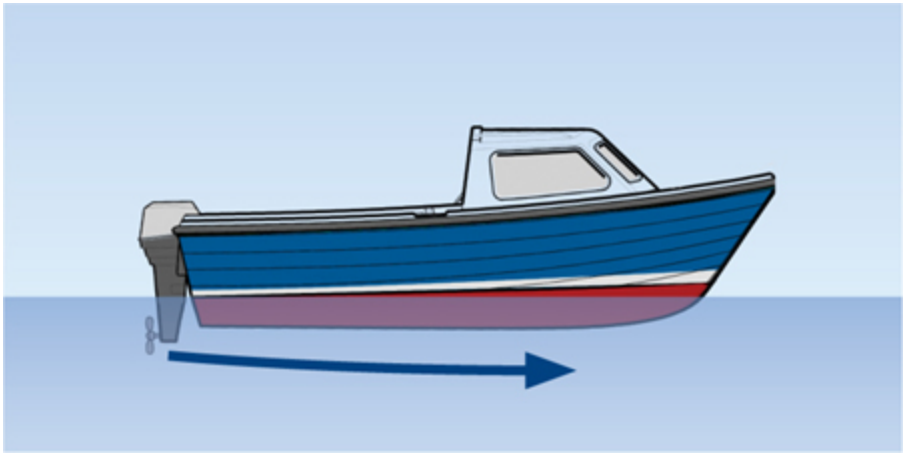
Engine centreline for dual engines.



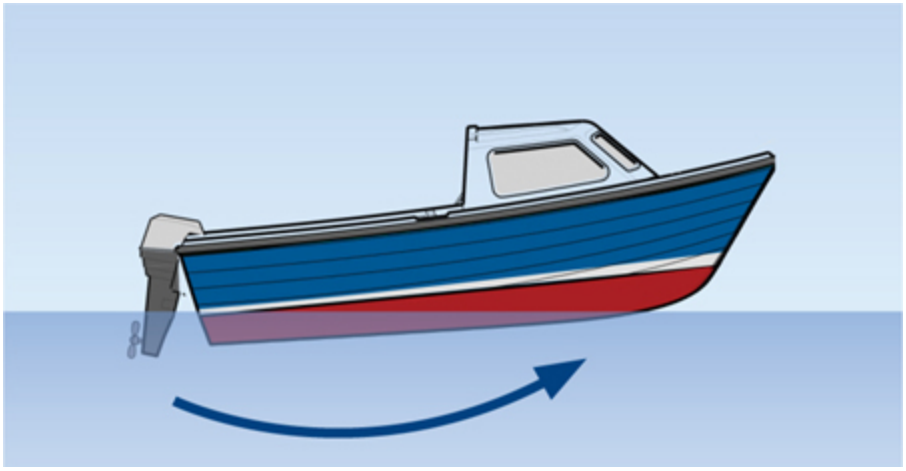
The transom tilt bracket has an adjustment bar to alter the angle of trim between the outboard leg and boat transom.



Trim down has the effect of pushing the bow down and reducing slamming in head seas.



Trim level for flat water conditions.



Trim up pushes the bow up to reduce the chance of the boat burying when running in following seas.

Chapter 11
Maintenance and Winterising

Outboards continue to work in a harsh environment only if they are checked over every time they are used, and serviced readily.

Once the season is over, they need to be winterised to hinder internal corrosion, so that they are ready to be fired up the following Spring.

DAILY CHECKS

1. 2-strokes – Check that the fuel oil tank is topped up.

2. Check the crankcase oil dip-stick level and top up if necessary.

3. Check fuel levels are sufficient for the trip.

4. Open the fuel vent.

5. Check the fuel separation filter for any signs of water, and drain if necessary.

6. Check that the engine mounting bracket is secure.

7. Check the prop and skeg for fishing line or bags wrapped around the hub and remove.

8. Look for tell-tale signs of an oil leak. If the propshaft oil seal is leaking, this needs immediate attention.

9. Once the engine is running, check the cooling water outlet to be sure that the water pump is working and there are no blockages in the system.

10. At the end of the day, fit a hose or muffs to the water intake within the skeg and flush out with fresh water.

Leave the outboard leg in the water, and it will soon foul up.

PERIODIC CHECKS

Lift the hood on a monthly basis and check the following:

1. Look for signs of corrosion around the thermostat and cylinder heads. This indicates gasket failure.

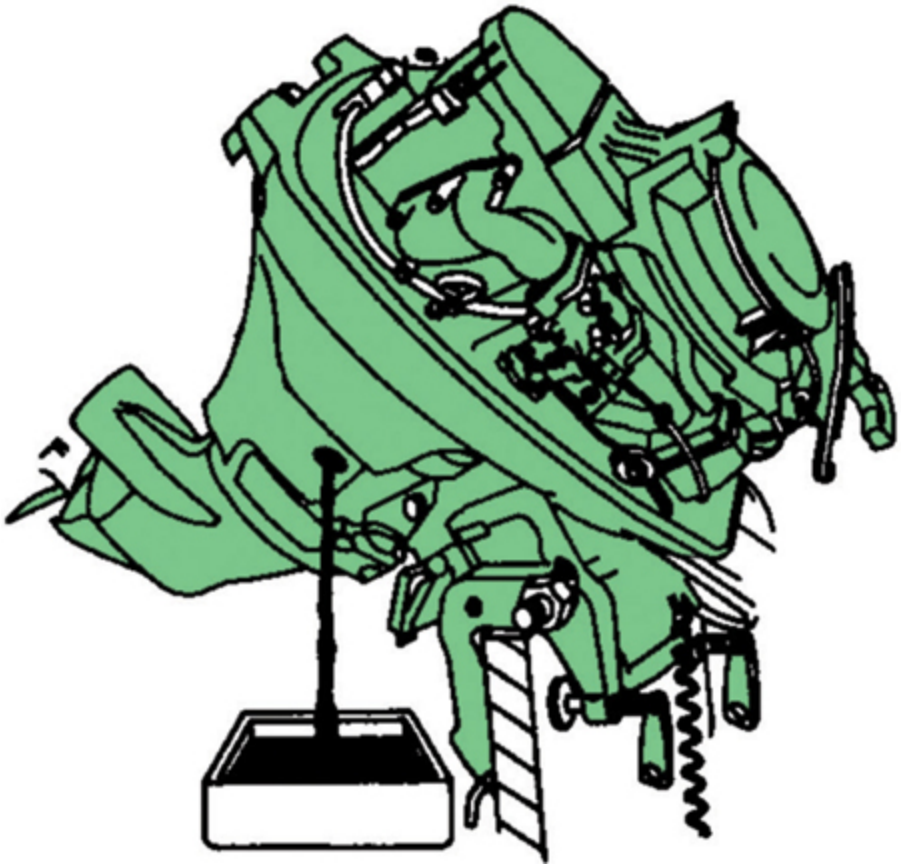
2. Look for corrosion around electrical connections. Clean and spray with WD40 or similar water dispersing oil.

3. Check the gear shift and throttle controls. If they show signs of stiffness, lubricate the moving parts, including the cable ends.

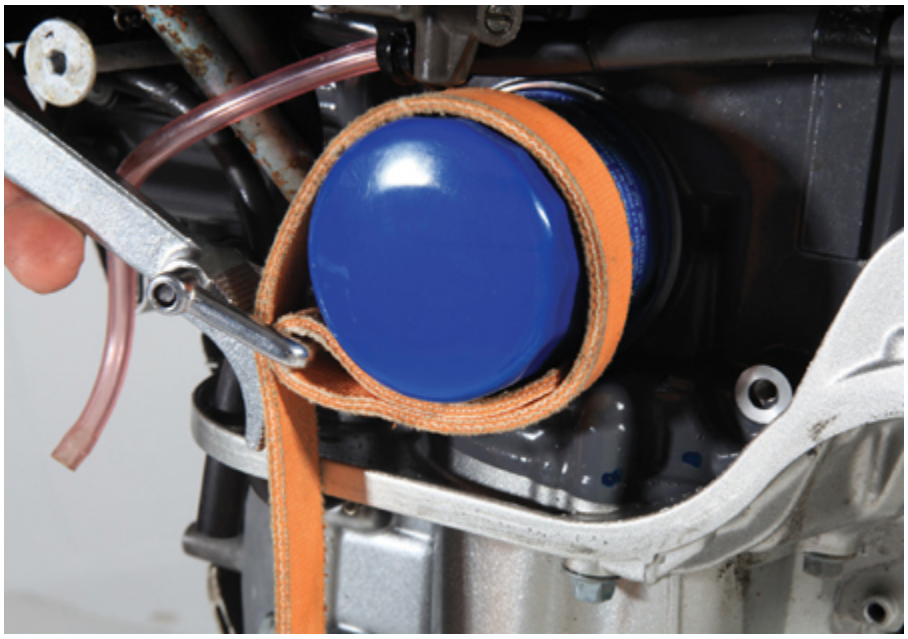
4. Check batteries and replenish with ionised water if the top of the cell plates are exposed.

5. Check the propeller for minor nicks around the leading edge of the blades and file flat where necessary.

This prop would perform much better if nicks along the leading and trailing edges were smoothed with a file.



Some outboards have a sump drain in the leg. This allows for the engine to be tilted over and drained, without the need to remove the outboard from the transom.



Use an adjustable belt grip to remove oil and fuel filters. Never spike them with a screwdriver because this will lead to spillage.

When winterising the engine, remove the sparkplugs and spray with inhibiting oil.

ANNUAL SERVICE

1. Pump grease into all the nipple points around the engine, including gear shift and throttle linkages, steering arm and tilt mechanism as per

manufacturer’s instructions listed in the handbook.

2. Drain sump and replenish with fresh oil as specified in the outboard handbook.

3. Replace all oil and fuel filters within the system.

4. Replace spark plugs with those specified in the outboard handbook.

5. Drain out the oil from the gear case and replenish with fresh oil as specified in the outboard handbook. See here.

6. Look for signs of corrosion around the thermostat and cylinder heads and if necessary clean up and replace the gaskets.

7. Check for corrosion around electrical connections. Clean and spray with WD40 or similar water dispersing oil.

8. Check for tell-tale rust stains around the hoses and for signs of abrasion, and replace if necessary.

9. Check oil level within the hydraulic tilt system, and the hydraulic arms for signs of rust and leakage, and replace/repair as necessary.

10. Check the propeller for nicks and distortions around the blades and file flat where necessary, or replace. Also, check the vulcanised rubber hub for cracks or any breakdown in the joint. Either have the prop re-hubbed, or replace it.

11. Check the sacrificial anodes on the leg and replace if worn down by electrolytic action.

Chapter 12
Undrowning the Engine

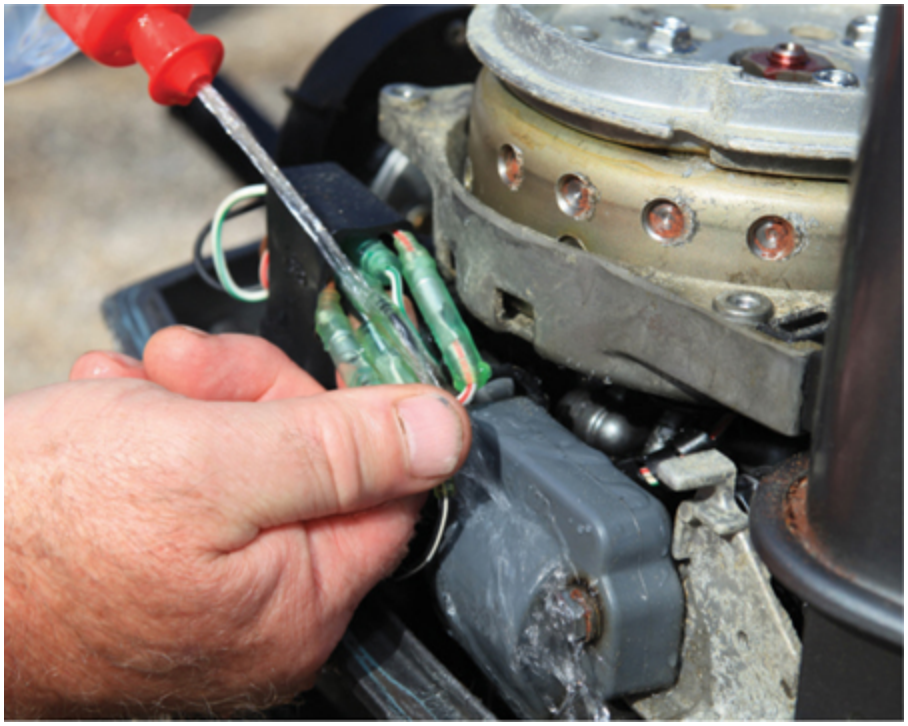
Don’t panic. This may not be as bad as it seems, but you must act quickly.

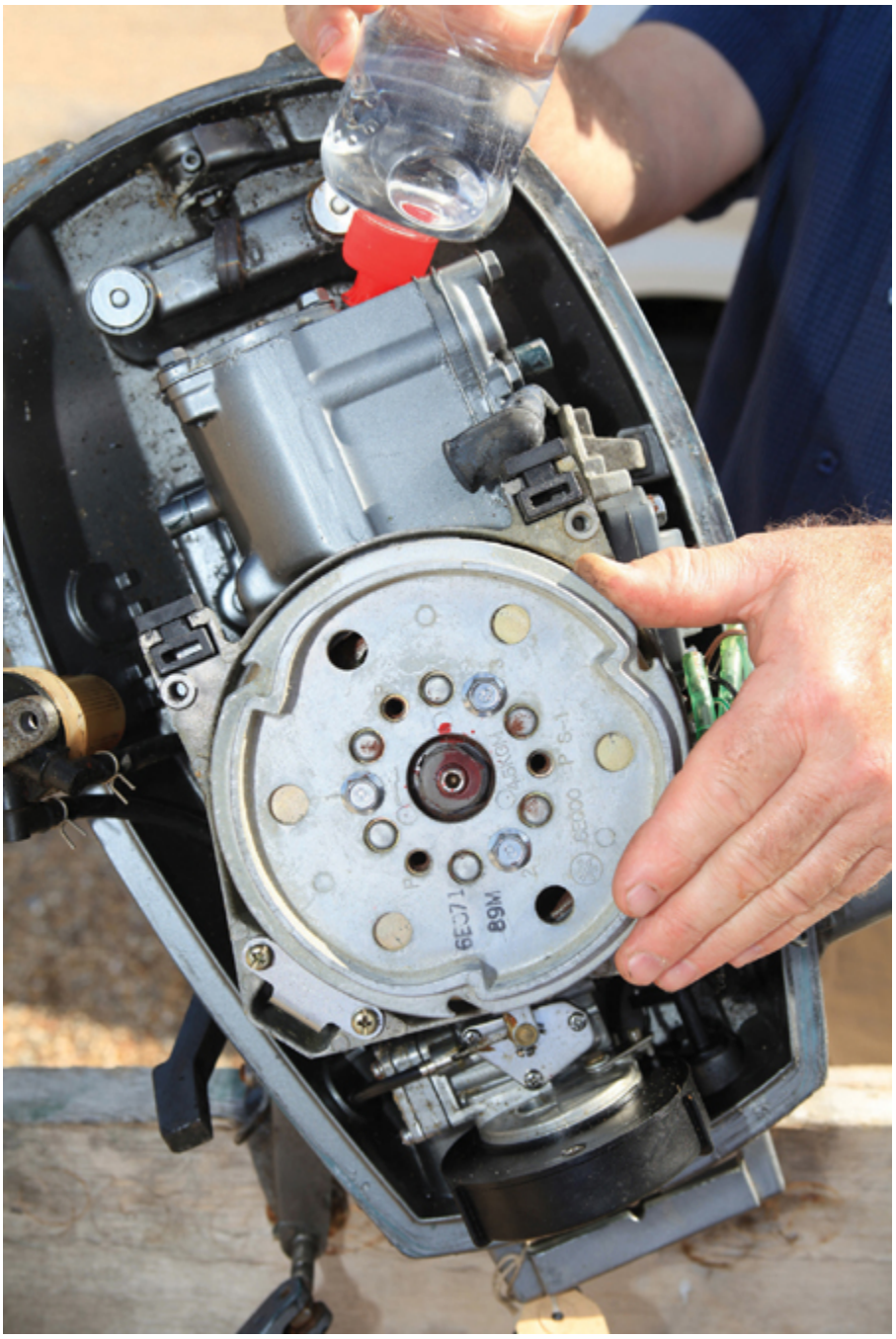
1. The corrosion process will start the moment the engine is exposed to air, so unless a service engineer is able to start work on it immediately, leave the engine submerged until you are ready. If it has been dunked in seawater, then it is best to pull the unit out and sink it in fresh water, but if a pool or tank is not readily available then leave it where it is overnight.

2. Disconnect the battery and disable the ignition system by pulling off the plug connecting the ignition pack.

3. Once recovered from the water, remove the spark plugs and turn the outboard over to drain all water from the cylinders, before washing the entire engine in fresh water. Use a water bottle to squirt fresh water into semi sealed areas including the electrics.

Then tilt the engine over to drain water out of the spark plug holes, and turn the flywheel by hand to pump out any water trapped within the valves and piston rings.





4. Pour engine oil into the plug holes and continue to turn the flywheel to coat all moving parts.

5. Turn the outboard upright and drain the fuel system, disconnecting the carburetors or injection system if necessary.

6. Spray the entire engine with WD40 or similar water dispersing oil.

This completes the emergency treatment. The remainder is best left to a service engineer who will have the specialist tools required to strip down the electrical system and replace the parts that cannot be salvaged. The starter motor and alternator, both expensive parts to replace, can be sent off to a specialist to rebuild, and it may be possible to salvage the coil and engine management box by drying them out, spraying with WD40 and re-drying before reassembling. The engine oil in 4-stroke engines together with that in the gearbox and any hydraulic oil must be flushed out and replaced. Once rebuilt, the engine could be treated to a final wash and wax with car polish before being run for the first few hours with, in the case of 2-strokes, the same fuel oil mix prescribed in the handbook for running the engine when new.

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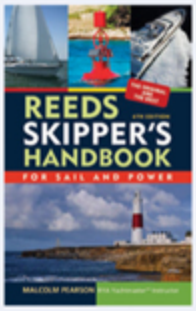

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