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## INSTALLATION, OPERATION AND MAINTENANCE NOTES

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1. Introduction. The Aquair 50 is a dual capability alternator which can be wind or water driven. It is capable of producing up to 50 watts of 12 or 24 volts DC electricity.
2. The alternator. This incorporates a single phase stator and a six pole permanent magnet rotor. The stator is bolted to the front inner end of the aluminium alloy body and the rotor revolves inside it on a stainless steel shaft, running in two permanently sealed grease-packed ball bearings. The front bearing is given additional protection by a shaft seal. The two halves of the body are sealed by an O ring and the output wire passes through a sealed cable gland. The entire alternator is thus waterproof.
3. Suspension for water drive. In the water driven mode the alternator is fitted with a gimbal ring. This incorporates removable stainless steel pivots, which must be split-pinned to the ring, after assembly. The pivots rotate in removable acetal bushes located in the alternator body "ears". (See figure A).

The gimbal ring is attached to the boat's stern pulpit or other convenient structure, by two lanyards, top and bottom. These lanyards must be located by the pins provided on the gimbal ring. It is suggested that a clove hitch knot is used, with one half either side of its pin. For proper gimbal action it is essential that the lanyard attachment points are at 90 degrees to the pivot axis. This will ensure self alignment of the alternator shaft and water turbine tow rope and thus minimise power loss and wear.

4. The water drive. This is achieved by a two bladed water turbine trailed on the end of at least 100 feet (30 metres) of braided rope having a diameter of not less than 8mm. Stainless steel shackles are attached to either end of the rope via simple fisherman's bend knots. An acetal shackle connector is fitted to the alternator shaft.

This connector can be attached to the shaft with either a short or long cap screw. The former will give a safety break load of about 350 lb (160 kg) and the latter 700 lb (320 kg), as it goes through both sides of the connector, instead of only one. In each case a shakeproof washer should be fitted beneath the head of the cap screw. It is recommended that the long cap screw is used. The holes should be inspected frequently for signs of incipient failure.

At speeds in excess of about 7 knots, depending on sea state and mounting height of the alternator, the water turbine may start breaking surface. This must not be allowed to continue, due to large snatching loads it can impose on the system. It may also cause the rope to knot up around the turbine shaft. Under such conditions the preferred remedy is a longer tow rope. Alternatively, the turbine shaft may be loosely sleeved with brass tubing for extra weight. This added weight will however reduce performance at low speed, due to increased droop.

Steady drag is 10 lb (4.5 kg) at 3 knots, 20 lb (9 kg) at 5 knots and 30 lb (13.5 kg) at 7 knots.

It is recommended that the stern pulpit, if used as a securing point, should be counterbraced from the point of attachment to some strong point on the boat, in order to prevent damage in the event of snagging. The alternator and the gimbal ring are designed to withstand an ultimate load of 1000 lb (450 kg).

At 12 volts nominal the alternator starts charging at about  $2\frac{3}{4}$  knots and its output increases progressively to 3 Amps at 6-7 knots. The latter is an average figure as the alternator drive RPM fluctuates considerably, particularly under rough sea conditions. Halve the Amps for approximately 24 volt output. The addition of weight to the turbine reduces output, at low speed, as previously stated.

CAUTION - To avoid any risk of personal injury, the boat speed should be reduced to 1 - 2 knots before attempting to haul in the water turbine, as it can produce considerable torque at higher speeds.

5. Suspension for wind drive. In the wind driven mode, swivel tubes are located in the alternator body ears and secured by M8x4.5 hexagon head set screws, shakeproof washers and nuts. (See figure B). The unit is then slung aloft by a halliard or some other suitable hoist, attached to the upper swivel eye. The lower swivel eye is tied to the deck by a rope. Either the top or bottom or both, should be triangulated to resist horizontal movement of the unit. There should be as little vertical tension as possible in the hoist, to minimise friction in the PTFE swivels. For safety reasons the wind turbine should be hoisted well above head height.
6. The wind drive. The turbine blades are made of polypropylene and are mounted in an aluminium alloy hub having a stainless steel sleeve. In case of damage, the blades can be replaced individually by separating the two halves of the hub. If no replacement blades are available, the unit can still be run provided that diametrically opposed blades are removed, to retain centrifugal balance. For convenience of handling it is suggested that the wind turbine is not fitted until the alternator unit has been hoisted clear of the deck and the wind vane fitted. The wind turbine should be attached to the alternator shaft by use of the short cap screw washer, and the protruding side of the hub should face the alternator. This will ensure exact balance about the swivelling axis and minimise yawing effects due to boat motion. The wind vane should be attached to the rear of the alternator body by the fasteners provided. The alternator output wire must be secured in such a way that it cannot foul the wind turbine. From time to time it may be necessary to unwind it if wind shifts or boat heading changes are continually in the same direction.

VERY IMPORTANT NOTE - The turbine blades must be assembled in the hub with their concave/hollow side facing into the wind. If reversed there will be a drastic reduction in performance. Ensure that the capscrew attaching the wind turbine hub to the alternator shaft is done up really tight, using a thread sealant such as Loctite. The shakeproof washer must also be used.

The 12 volt wind driven output, Amps vs windspeed, is as follows: ( halve Amps for approximate 24 volt output).

0 Amps at 7 knots, 1 Amp at 14 knots, 2 Amps at 20 knots, 3 Amps at 26 knots, 4 Amps at 40 knots. Maximum output is 55 watts.

A gust of 10 - 11 knots is required to start fan rotating. This arises from the cyclical magnetic torque between the permanent magnet rotor and the stator. This is sometimes referred to as cogging. Once rotation has been triggered this torque averages out and the turbine will then keep rotating, though not charging, down to windspeeds of 3 - 4 knots.

The wind turbine has been tested to 85 knots windspeed and there are no known limitations within the conditions which any yacht is likely to survive.

Drag is 8 lb ( 3.6 kg ) at 20 knots, 40 lb ( 18 kg ) at 50 knots and 75 lb 34 kg ( estimated ) at 85 knots.

7. Rectifier and associated wiring. A bridge rectifier, fitted outside the alternator, converts AC to DC and also prevents reverse current flow. For 24 volt units the rectifier is not fitted but an external voltage doubler unit is used instead.

The alternator output wires have a core area of  $1\text{mm}^2$ . This is adequate for runs up to 25 feet ( 8m ) but should be increased pro-rata for longer runs if losses are to be minimised.

A 0.1 micro-Farad capacitor is fitted to the alternator, to suppress electrical interference.

The wiring code should be strictly observed - RED for battery POSITIVE, BLACK for battery NEGATIVE. A fuse of 10 Amps - 12 volts or 5 Amps - 24 volts should be fitted. Reverse connection could cause rotor demagnetisation.

CAUTION - when the Aquair 50 is charging a battery its output voltage is held to that of the battery. However, when run open circuit it can produce voltages high enough to give an unpleasant electrical shock and care should therefore be exercised when handling leads. The alternator should be connected direct to the battery and not via battery switches, to prevent the possibility of damaging electrical equipment by over-voltage, during battery disconnection.

8. Maintenance. No oiling or greasing is required for any of the bearings. However the life of the front bearing is highly dependent upon proper action of the shaft seal which protects it. The space between the seal and the front bearing should be kept packed with water resistant grease. This should be inspected annually and replaced, if necessary, with a new seal.

The alternator shaft and wind turbine sleeve should be kept free from nicks and dents and they should never be forced together or they may become difficult to separate without damaging the bearings.

In the event that the wind turbine is accidentally dropped or shock loaded it should be taken apart and the blade root spigots examined for possible fracture, which might not be externally apparent.

In areas such as the Tropics, where there is much ultra-violet light, it is recommended that the blades are painted ( with white epoxy paint for example ) to prolong their life. Before doing this it is permissible for them to be lightly sanded for better paint adherence.

On prolonged cruises inspect the tow rope end fittings at regular intervals to cater for the possibility of unusual wear and tear or damage from flotsam.

All fasteners should be examined for security from time to time. They are made of stainless steel with metric threads.

Should the stator ever be removed, the gap between it and the rotor should be temporarily shimmed all round, to ensure concentricity, when bolting it back on.

All electrical connections should be kept scrupulously clean. The alternator output wire has been made long enough for it to be led below decks where a dry connection can be made.

9. Bearing replacement. ( If required)

(a) Remove rear cover. Some force may be required as the bearings are mated to the shaft by Loctite.

(b) Drive out alternator shaft, from front to rear, using a hide headed hammer or equivalent, to avoid damaging the end of the shaft. Once again some force may be required.

(c) Forcibly remove bearings and reject, even if previously undamaged, due to the force transmitted through the balls during removal. Do not lose or mix up spacers either side of rotor. ( 1 in front, 2 behind).

(e) Clean out bearing housings with fine emery paper. Carry on until bearings can just be slid in by hand. Then degrease interfaces and replace bearings using Loctite of the screwlock strength grade (222).

(f) Clean up shaft with fine emery paper. Degrease shaft to bearing interfaces and smear with Loctite of the screwlock strength grade (222). Reassemble ( not forgetting spacers). If the shaft seal should have been removed for any reason, it should be replaced with a new one.

IMPORTANT NOTE - Use correct strength of Loctite. If it is too strong damage may occur on any subsequent dis-assembly. If bearings cannot be slid onto shaft by hand then shaft needs easing. Do not use force or bearings may be damaged.

10. Electrical fault finding Any source of electrical failure can be most easily traced with a standard testmeter. One crude check is to short circuit the output wires, when the alternator should be noticeably more difficult to turn by hand. Alternatively when turned by hand the alternator should produce a measureable voltage. Sub-standard performance could be due to :-

(a) Poor connections.

(b) A faulty rectifier.

(c) Blades back to front in the wind driven mode.

Should the alternator itself be suspect, it should be rig tested, in a lathe for example. When charging a 12 volt battery the output should be as follows:-

0 Amps at 220 RPM, 1 Amp at 430 RPM, 2 Amps at 640 RPM, 3 Amps at 910 RPM and 4 Amps at 1750 RPM.

When charging a 24 volt battery, using the 24 volt doubling system, output should be as follows:-

0 Amps at 230 RPM,  $\frac{1}{2}$  Amp at 370 RPM, 1 Amp at 520 RPM,  $1\frac{1}{2}$  Amps at 690 RPM and 2 Amps at 1050 RPM.

With properly functioning magnets the alternator should have a triggering torque of about 5lb inches (6kg - cm). A substantially lower figure would indicate weak magnets.

## 11. Leading Dimensions.

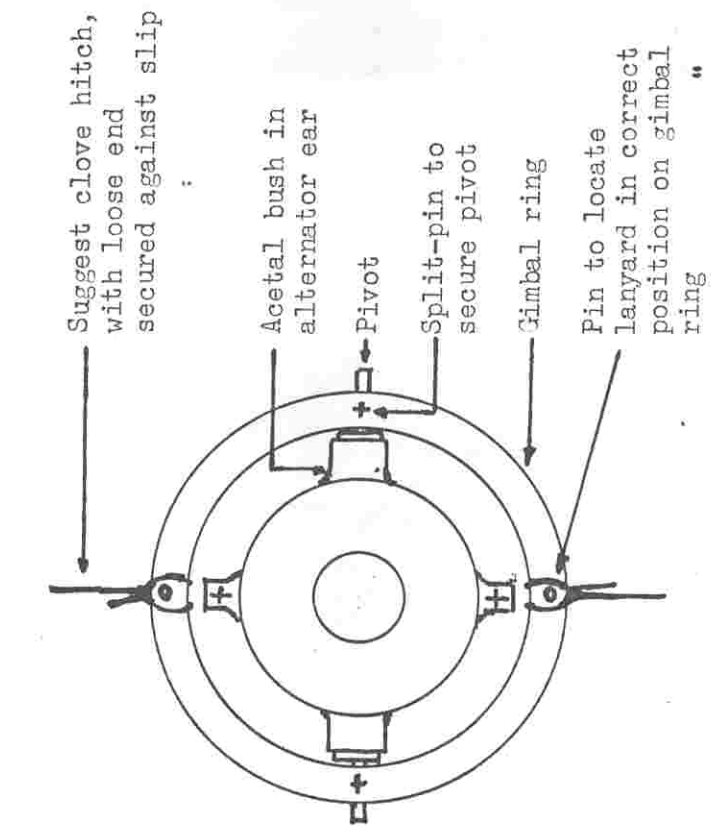
Alternator body diameter	6.3 in	(160mm)
Alternator body length	2.8 in	( 71mm)
Alternator shaft protrusion	2.6 in	( 66mm)
Outside diameter of gimbal ring	11.0 in	(280mm)
Weight of alternator and gimbal ring	11.0 lb	( 5 kg)
Diameter of water turbine	11.0 in	(280mm)
Overall length of water turbine and shaft	35.0 in	(890mm)
Weight of water turbine and shaft	6.3 lb	(2.9kg)
Diameter of wind turbine	26.4 in	(670mm)
Weight of wind turbine	5.3 lb	(2.4kg)
Distance between swivel eyes	29.5 in	(750mm)
Suspended weight of wind driven set up	21.0 lb	( 10kg)

## 12. Suggested spares.

- (a) Water turbine with shackle connector for alternator shaft.
- (b) Two bearings.
- (c) Shaft Seal.

To cater for dropping overboard, or mislaying items when switching between wind and water driven modes, consideration should be given to carrying spares of the various fasteners involved.

A temporary water turbine can always be made up from a length of steel bar and a small outboard or similar prop. A pitch of about 7" should be sought, though this is much finer than normally found. If the prop. has much blade area, the diameter should be restricted to 10" or so, or drag will be excessive, causing trouble with prop. surfacing. The prop. will have to be weighted to at least 6 lb.



Attach lanyard to stern pulpit or convenient structure. Take up slack to give approximate rope angles shown. The shorter the lanyards the better

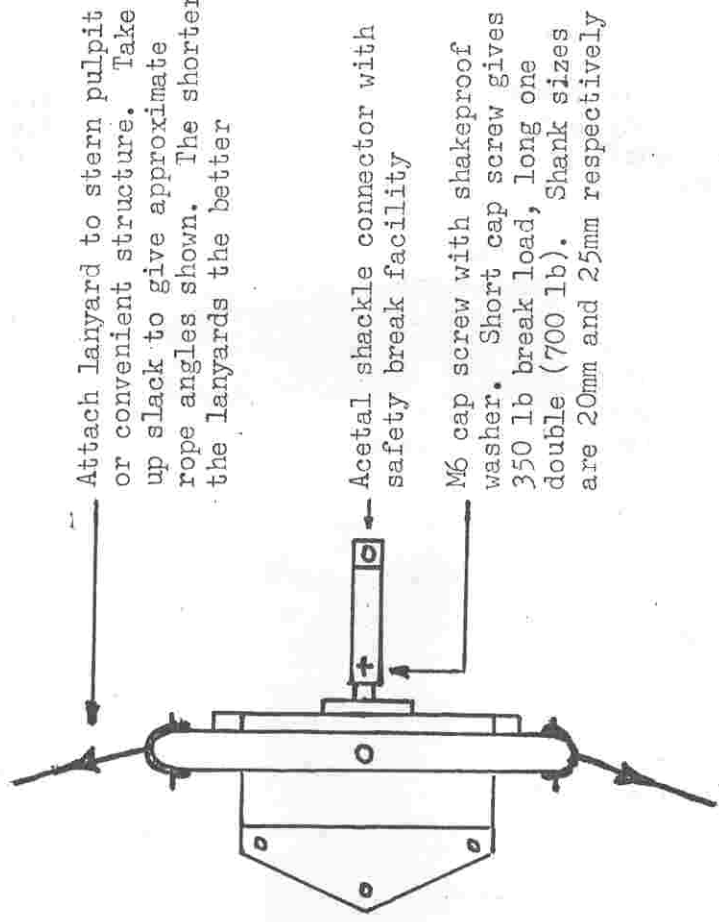
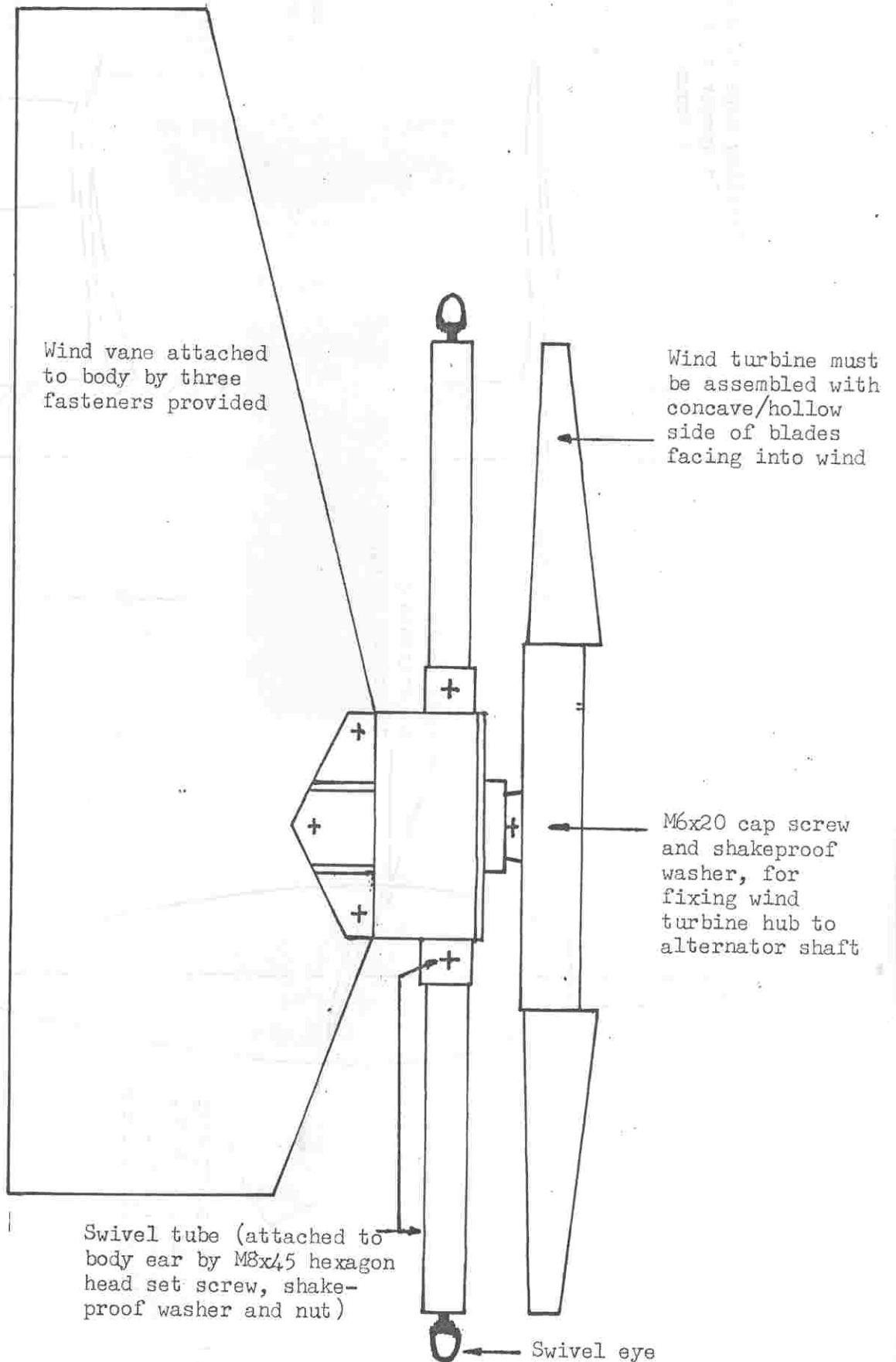
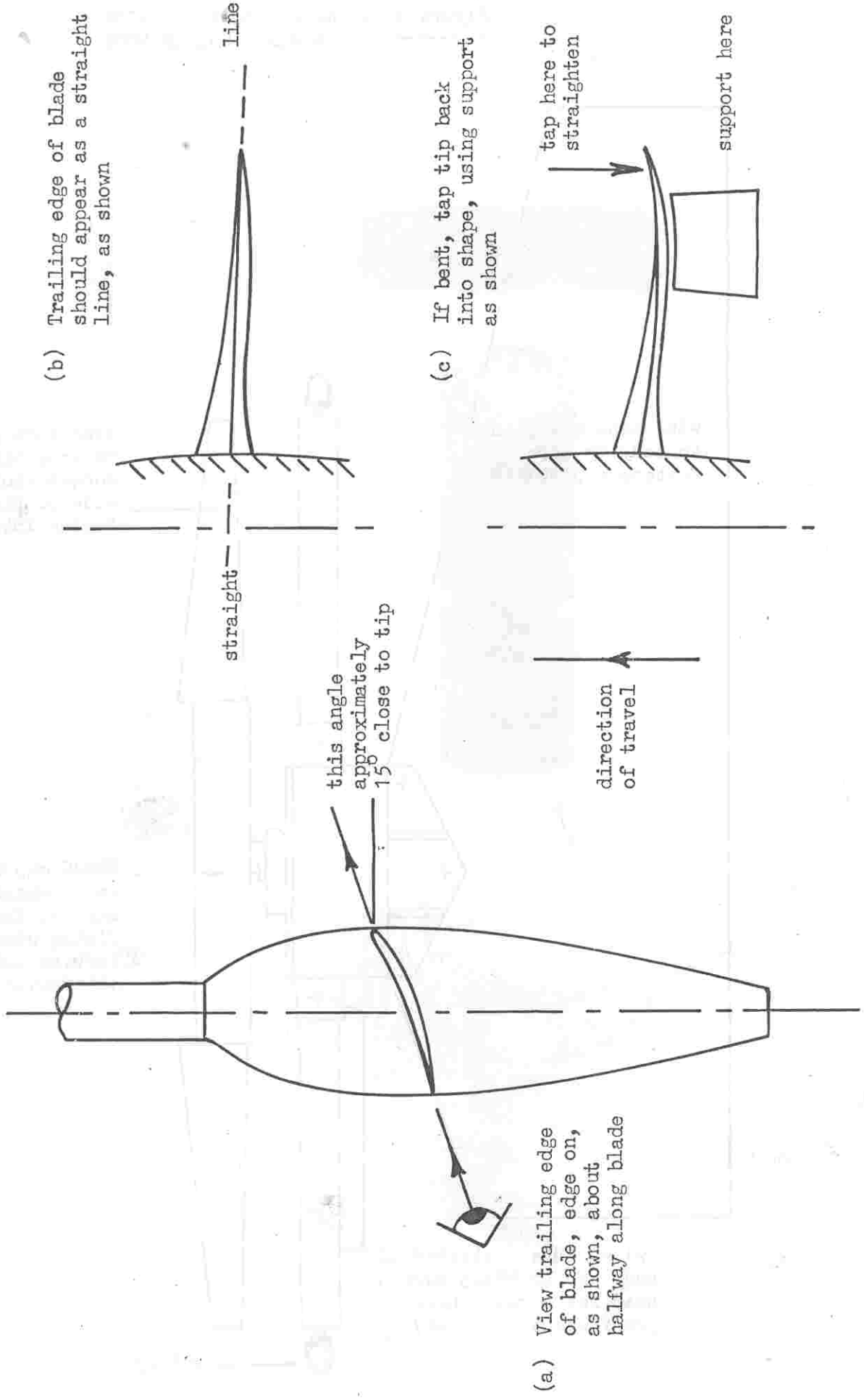


Figure A - AQUAIR 50 ALTERNATOR  
IN WATER DRIVEN MODE

Figure B - AQUAIR 50 ALTERNATOR  
IN WIND DRIVEN MODE





WATER TURBINE BLADE MAINTENANCE

Careless handling (eg dropping on deck) may lead to blade tips becoming bent, usually in direction shown, causing reduction in pitch and much increased drag and premature surfacing of water turbine