

AMPAIR[®] 100
 Operation Installation & Maintenance Manual
 Manufactured by Ampair[®]

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SAFETY - READ BEFORE ASSEMBLING OR USING

Use

Stopping: The wind turbine has been designed to survive storms; however, it is a good plan to stop the machine if a hurricane is expected or to carry out inspection. To do this, proceed with caution, approach the Ampair from downwind and grasp the tail vane (use a boathook for marine generators). Then carefully turn the machine off wind and, when the blades stop, throw a rope over them and tie down. Never throw a rope into the turning blades.

To avoid personal injury wear sturdy gloves as a precaution. The wind turbine blades are capable of causing GRAVE PERSONAL INJURY and should be treated with the same respect as an aircraft propeller

When first using the Ampair it is advisable to do it in fairly calm weather and low wind speeds.

WARNING: An Ampair is a piece of rotating equipment and should be treated with care. Never allow it to become entangled in hair, clothing, or equipment. It is capable of causing GRAVE INJURY and should be treated with the same respect as an aircraft propeller.

WARNING: Check all fixings at regular intervals, especially after severe winds.

Connection

NEVER CONNECT WITHOUT RECTIFIERS

The generator must never be connected to a system without its rectifiers in circuit, to do so risks discharging the battery to which it is connected.

CORRECT CONNECTION

It is important to connect the system in such a way that the generator cannot feed any electrical load without the battery being connected. The generator output should therefore go to the battery side of any isolator switch. Failure to observe this point could place over-voltage on the system and damage sensitive electronic equipment.

Protection

PROTECTING THE SYSTEM

Do not omit the fitting of fuses, simple in-line fuse carriers maybe used in the battery line.
Fuses = 10 Amp - 12V systems: 5 Amp - 24V systems

OBSERVE POLARITY

Reverse polarity will blow the battery fuse or destroy the rectifiers if no fuse is fitted. When wiring the system be aware that if the generator is connected to the battery REVERSE POLARITY the output rectifiers may be destroyed or the internal soldered connections to the brush holders may melt. Check and double-check polarity before final connection.

CORE 1 (formerly BROWN) = + Positive
CORE 2 (formerly BLUE) = - Negative

DISCONNECTING THE GENERATOR

When disconnecting the generator please be aware that when it is spinning, the output voltage, in the absence of a battery, will rise. This can give a mild electric shock to a person handling the connections.

WHEN TO FIT A REGULATOR

It is advisable to fit a voltage regulator if the generator is regularly left to charge batteries when insufficient or no loads are present. Under these conditions overcharge will slowly drive off the battery electrolyte, which, if not topped up, will eventually damage the batteries.

CAUTION

When planning your installation, observe the following:

1. Regularly inspect a newly installed system to check that all is well. Do not limit this to monitoring the electrical output, but also check for smooth mechanical operation. Any defects need to be remedied immediately.
2. Do not assemble the generator, vane and turbine until the electrical installation is complete.
3. Fit the tail vane first. If you fit the wind turbine first the machine will turn out of control & be a danger to approach.
4. Take care when disconnecting the generator in a high wind as the terminal voltage is enough to give a mild electric shock.
5. Very careful attention must be given to the strength and integrity of the mounting. This should be capable of withstanding a peak horizontal load of 120kg (250lbs).
Note. The mounting pole should be vertical. The space between the blade tips and the mounting pole must be left clear. i.e. no clamps or other items should diminish this clearance. The pole base should have a rigid mounting. (The mounting should not rest on a resonant surface such as the centre of a cabin roof since this may transmit any vibration making the machine audible inside).
6. When mounting the Ampair on its pole or bracket the cable needs to be fed down through the mounting. When arranging this cable make sure it cannot chafe at the point where it leaves the mounting pole. Either lead the cable out of the bottom of the pole in a gentle curve or drill an exit hole in the pole large enough to take a rubber grommet to protect the cable from the sharp edges of the hole.

PACKING LIST - PRE-INSTALLATION CHECK

AMPAIR GENERATOR

Check that a complete and undamaged set of parts has been received. Have you received the voltage ordered 12V or 24V? The recyclable carton contains:

- Generator, complete with assembled hub and pivot.
- Ampair 100 manual
- Six wind turbine blades: three colour coded pairs (see coloured code on base of blade).
- Direction vane (tail fin)
- Two hardware kits:

Kit 1. Wind Vane Fixings

Wind Vane Clamp Plate (Marine)
3 M8 x 25mm screws
6 M8 plain washers
3 M8 nyloc nuts

Kit 2. Blade Fixings

12 M8 x 40mm fasteners
12 M8 shakeproof washers
12 M8 nuts

AMPAIR STERN MOUNT KIT (SMK)

The Ampair SMK carton contains:

- Pole A, 800mm, Four 6.5mm holes each end, two 10.2mm holes centrally
- Pole B, 800mm, Four 6.5mm holes each end.
- Pole C, 970mm, 25mm OD, strut pole,
- Stay wires, two, terminated by thimbles and "D" ring nuts.
- Bag 1, containing, yoke, two angle feet and backstay clamp shell.
- Bag 2, containing, two anodised aluminium alloy joiner tubes.

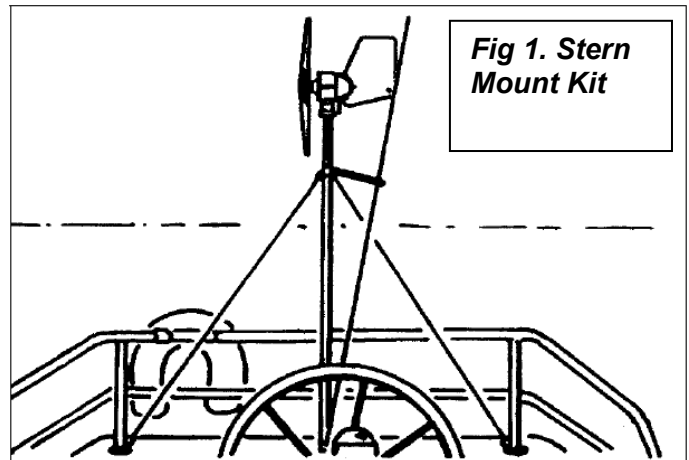
Two hardware kits:

Kit 1. Strut, yoke & feet fixings

- 1 M6 x 40mm screw
- 2 M6 x 35 hex screw
- 3 M6 shakeproof washers
- 3 M6 Nyloc nuts
- 1 M10 threaded rod 75mm
- 2 M10 shakeproof washers
- 1 M8 x 60mm hex bolt
- 2 M8 plain washers
- 1 M8 Nyloc nut

Kit 2: Joiner tube fixings:

- 16 M6 x 10mm screws
- 16 M6 shakeproof washers

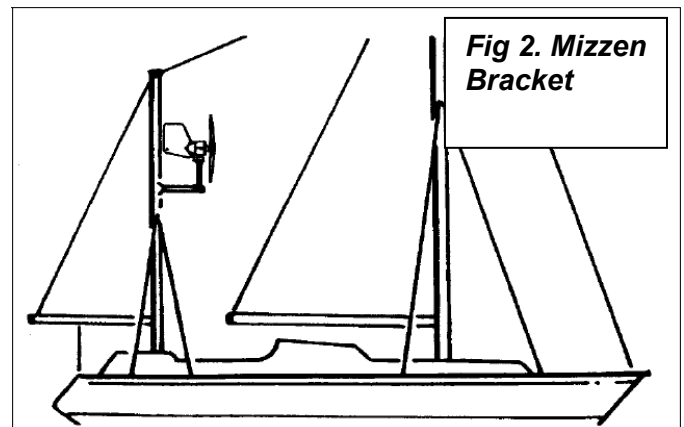


This arrangement places the blade tips 2 metres (7 feet) above the base fixing. If there is a raised area adjacent upon which people may stand, raise this base accordingly.

MIZZEN BRACKET

The Ampair Mizzen bracket carton contains:

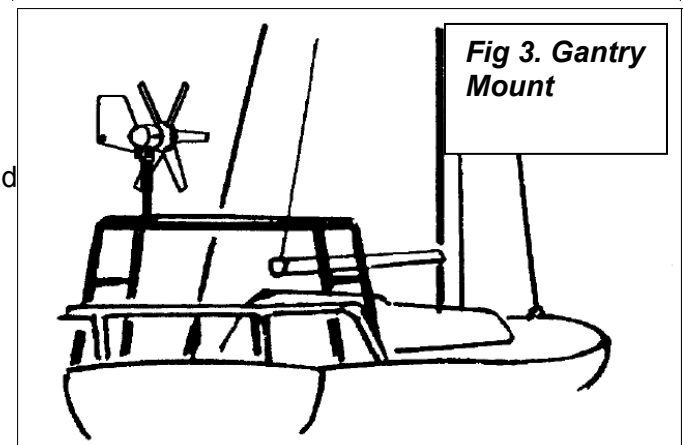
- the bracket
- 2 M10 x 150mm threaded rod
- 8 M10 nuts
- 8 M10 plain washers
- 4 M10 shakeproof washers



GANTRY MOUNT

Carton contains:

Pole with base flange (800mm height x 48mm outside



SYSTEM DESCRIPTION

Introduction

The Ampair is a wind driven generator capable of supplying up to 100Watts of electrical power at either 12 or 24 volts for charging batteries.

The generator

The unit consists of a two part cast aluminium body, the two parts sealed by an "O" ring. Two six pole permanent magnet rotors run, with their poles in line, on a stainless steel shaft. The shaft runs in two sealed grease-packed ball bearings with the front bearing protected by a shaft seal. Two six-pole stators are arranged with their poles staggered at 30 degrees to minimise "cogging" or break-out torque and so allow easy starting. The unit is assembled with one stator in the main body casting and the other in the nose piece. During assembly these are precisely aligned on the test bench to give optimum performance. A small timing mark is made at the junction of the case halves to allow accurate re-assembly.

The alternating current output of the stators is rectified by two bridge rectifiers, one per stator. The DC output of the two rectifiers is paralleled and passes to two carbon brushes mounted in brush holders located on the sides of the lower body section. The carbon brushes carry the output to two phosphor-bronze slip rings mounted on the stationary pivot shaft, allowing the machine to rotate to follow the wind. To absorb any electrical noise arising from the slip-rings and brushes, a metal oxide varistor is wired across the output between rectifiers and brushes. The output is electrically isolated from the case.

The body is mounted on the pivot shaft where it runs on a sealed grease-packed ball bearing at the top and a composite plain bearing at the base. The top bearing is captive in the body; the lower bearing is located in the body by a stainless steel spiral retaining ring. The pivot section contains an "O" ring seal on each brush holder cap, an "O" ring around the lower bearing to body junction and a "V" seal where the pivot shaft passes through the lower bearing.

The pivot axis passes through the centre of gravity of the assembled machine. This is necessary to ensure alignment into the wind in light breezes without undue spinning.

The wind turbine consists of six cambered and twisted compression moulded blades of glass-fibre reinforced polypropylene. This material has exceptional fatigue resistance and retains its durability down to sub-zero temperatures.

The blades are factory selected for balance to less than one gramme and are delivered as colour coded matched pairs. The blades are retained by M8 x 40mm stainless steel fasteners with shakeproof washers and nuts, two of each per blade, in a hub assembly consisting of two aluminium alloy plates mounted on a turned and anodised aluminium alloy hub centre piece. The hub centre is bolted to the plates by three M6 x 40mm stainless steel screws with shakeproof washers and nuts. The hub is fitted to the generator shaft taper where a dowel pin is located to prevent relative rotation and retained by an M10 plain washer and nyloc nut with a left-handed thread.

An aluminium alloy tail vane is clamped to the rear of the generator body using three M8 x 25mm stainless steel screws, six plain washers and three lock nuts. The vane of marine generators is provided with a grab hole at its lower corner to facilitate turning the unit cross-wind to stop the wind turbine rotating when required.

Low Temperature Operation: Plastic materials do not perform well in extreme cold, becoming brittle and breaking. This applies to wind turbine blades, whether glass filled or not. Operation at around 0°C should not be a problem, but most materials are vulnerable at -20°C and cannot be warranted to survive indefinitely. Ampair's glass filled polypropylene blades, moulded with large sized fibres in a compression process, are superior to nylon, carbon polymer or other plastics in this respect. However, when ice factors are also considered, the prediction of blade reliability is even more difficult. Other materials are also suspect. Examples are Nitrile used in exposed seals and "O" rings and basic PVC cable sheathing. For this reason Ampair uses Neoprene and Viton™ components where possible and "Arctic" grade PVC. Grease used in sealed bearings allows performance to -30°C or below, but component tolerances (ball and ring) can lead to greater friction and increased wear causing reduced bearing life.

INSTALLATION

Never assemble the generator, vane and turbine until the electrical installation is prepared.

Choice of mounting position (land based units)

The wind generator should be sited as high as practicable, clear of windbreaks or buildings and away from sources of turbulence. These conditions are shown diagrammatically below.

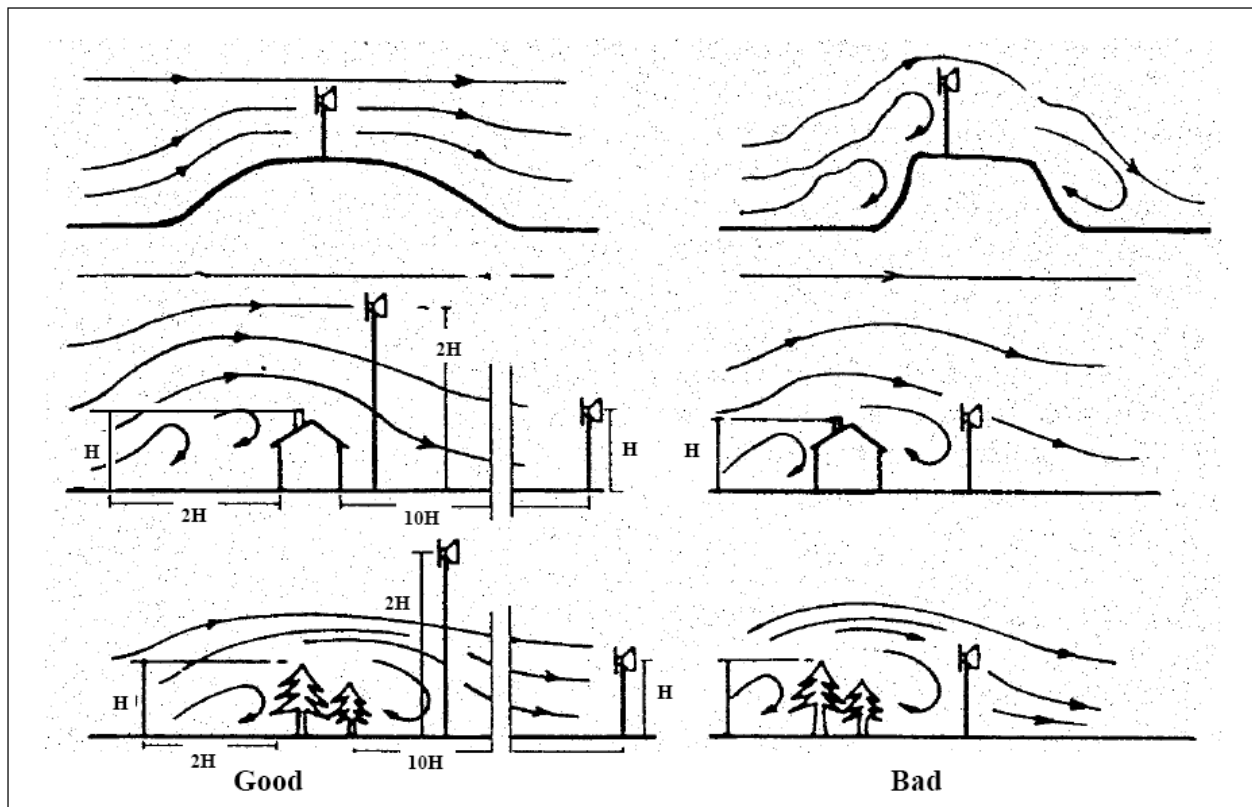


Figure 4: Wind Turbine Location Guides

Warning: Before a wind generator is installed in an excessively windy location, the operators must satisfy themselves that the site is suitable. It may be necessary to log site wind speed and direction data at various heights prior to installing the machine. Any indication of turbulence means that the generator should be re-sited or raised above the turbulence. Wind data must be local and not from close-by. Wherever possible avoid roof top mounting which can give rise to turbulence, shock loads and vibration.

Mechanical aspects of land installations

Free-standing installations should generally conform to Figure 5 below. Very careful attention must be given to the strength and integrity of the mounting. This should be capable of withstanding a peak horizontal load of 120kg (250lbs). The main components are:

Mast: of steel tube (water pipe or scaffold tube), alloy tube or wood (telegraph pole) If the guys are unsuitable (grazing cattle) then use a telegraph pole one third buried or a lattice tower as an expensive alternative.

Guys: Usually galvanised steel wire protected by plastic sheath and fitted with end thimbles. Don't use a material that will stretch or deteriorate. Three equally spaced guys (120°) will assist raising and lowering the assembled mast. A high mast will require intermediary guying. The top guys hold the mast upright, the lower prevent it from buckling. The top fixing point should allow for minimum overhang of the generator, i.e. be only a short distance below the wind turbine blade tips.

Tensioners: The simple and easiest method of tensioning guys, but adjustment must be uniform, since it is the guys that resist the thrust of the wind turbine.

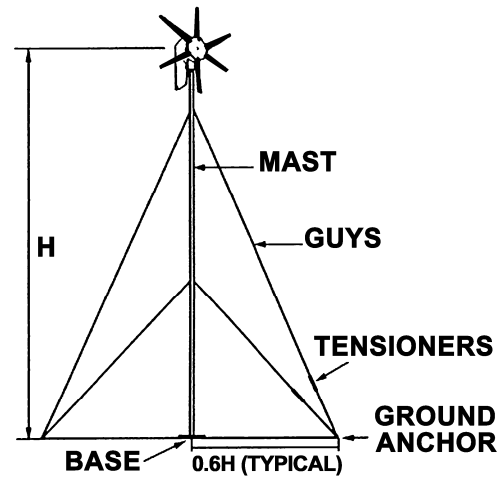


Fig 5: Pole Mount Layout

Ground anchors: These should be suitable eyebolts fixed in the ground and in line with the guys. Anchors in soft earth may require concrete, gravel or clay soils require "auger" type anchors (see Figure 6) and rocky ground may need drilling and expanding rock anchors. Only the eye should be visible above ground. Avoid waterlogged soils which have poor holding and always anchor below the frost level.

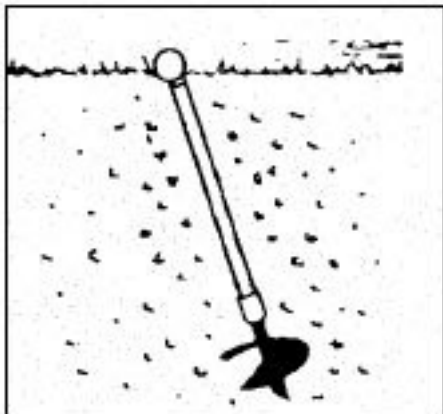


Fig 6: Ground Anchor

Base: This is to carry the weight of the generator and mast only. Fixing again depends on the ground state but metal pegs driven into soil are often sufficient. A lattice tower would need a concrete base with *rawlbolt* fixings. It is often convenient to make a pivot arrangement for the base in-line with one guy anchor to aid raising and lowering.

Lightning: Directly earth all metalwork. Bury output cables (½m depth) between mast and battery position for better protection than suspending in air. Either run cabling through plastic conduit or use a type specified for burying.

Choice of mounting position (marine units)

There are four basic alternatives in the confined quarters of most small boats as shown in Fig 7:

- On a tall stayed pole on the stern of a boat (the stern mount kit).
- On a bracket on the mizzen mast of a yacht (the mizzen bracket).
- On a custom made welded 'pushpit' structure, "A" frame, gantry etc. (gantry mount).
- At the main or mizzen masthead of a yacht.

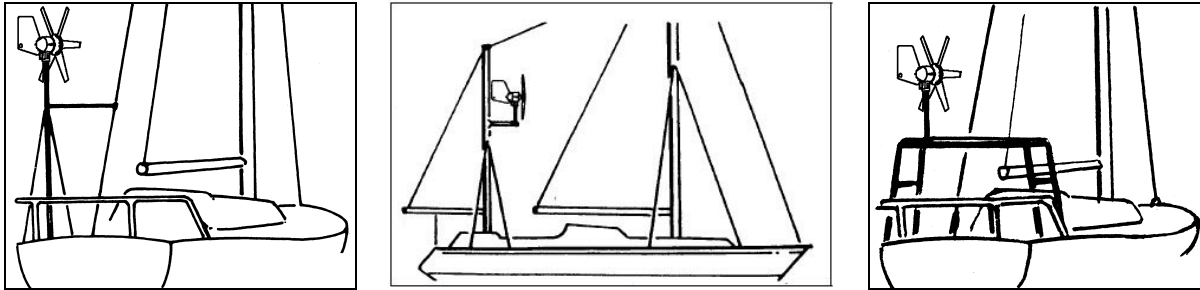


Fig 7: Alternative Mounting Positions

On a small boat space is at a premium and so the aim should be to get the wind turbine high up, away from people on the busy deck. This has the advantage of placing the turbine up where the wind is stronger, but has the disadvantage of adding top weight. Mast tops are generally the most congested location on a boat and so these are seldom utilised as a mounting location, irrespective of top weight considerations but are excellent when achieved. On ketches (other than junk rigged ones) the mizzen mast provides a good location, but for sloops stern pole mounts or stern gantry mounts are more typical compromises. The advantage of a stern pole is that it can be de-rigged fairly easy (e.g. to put a boat into racing trim for a season) whereas gantries are for committed cruisers and will also typically be designed as tender davits, aerial mounts, and solar panel mounts.

Very careful attention must be given to the strength and integrity of the mounting. This should be capable of withstanding a peak horizontal load of 120kg (250lbs). Note. The mounting pole should be vertical. The space between the blade tips and the mounting pole must be left clear, i.e. no clamps or other items should diminish this clearance. The pole base should be mounted where the structure is very rigid. The mounting should not rest on a resonant surface such as the centre of a cabin roof since this may transmit any vibration making the machine audible inside.

Installing Stern Mount Kit

a) Check: Ensure that a complete and undamaged set of parts has been received.

b) Pole position: The pole base fixing may be moved to one side provided that, when viewed from above, the angle between the strut and either wire is greater than 45 degrees.

c) Pole assembly: Using the joiner tubes and M6 x 10mm screws and shake-proof washers, assemble the poles so that pole A (holes in the middle) is the top pole, pole B (no holes in the middle) is the middle pole and the Ampair pole becomes the bottom pole (two holes only at one end for fixing the feet).

A thread locking solution (e.g. Loctite 641) will stop screws shaking loose due to long term vibration. It may be easier to feed the cable through the poles as they are assembled.

d) Feet: Using the M8 x 60mm bolt, washers and nut, fix the feet to the pole end and screw down the feet. The feet should be arranged so the pole can pivot in line with the strut. This usually means aligned fore and aft unless the pole is off-centre.

e) Stay Wires: Having assembled the poles with joiner tubes, site the pole and attach the two stay wires with the yoke in place on the pole. Find suitable points for the stay wire base fixings, allowing for the fact that these will be under considerable tension in use. "Bottle screws" are suggested as a tensioning method.

f) Backstay strut: File the groove in the strut pole end and clamp shell to accommodate the backstay wire diameter less 0.5mm. Cut the strut pole to length required. Drill the hole for the

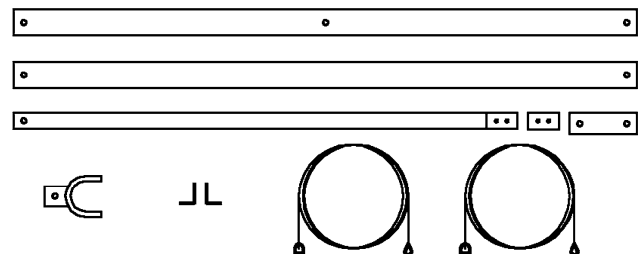


Figure 8: SMK Components

strut to yoke bolt in situ to ensure correct orientation of holes. Ideally the strut should form a right angle with the backstay.

Installing Mizzen Bracket

The major load that the bracket has to withstand is one of torsion, hence the box section. At 100mm wide this is close to the width of many mizzen masts and any slight difference can be accommodated by bending the end plates to suit or by spacing with nuts and washers.

Drill through the end plates and mizzen and fit using M10 fixings. Use at least four Monel rivets on each side or two M10 bolts/studding right through the mast. If the mast is hollow use spacer tubes to avoid crushing. Do not insert rubber washers as in time these will deform and then the load bearing structure will fatigue. Leave a minimum of 50mm (2") blade tip clearance. Attach fairleads to prevent running rigging flapping into the turbine.

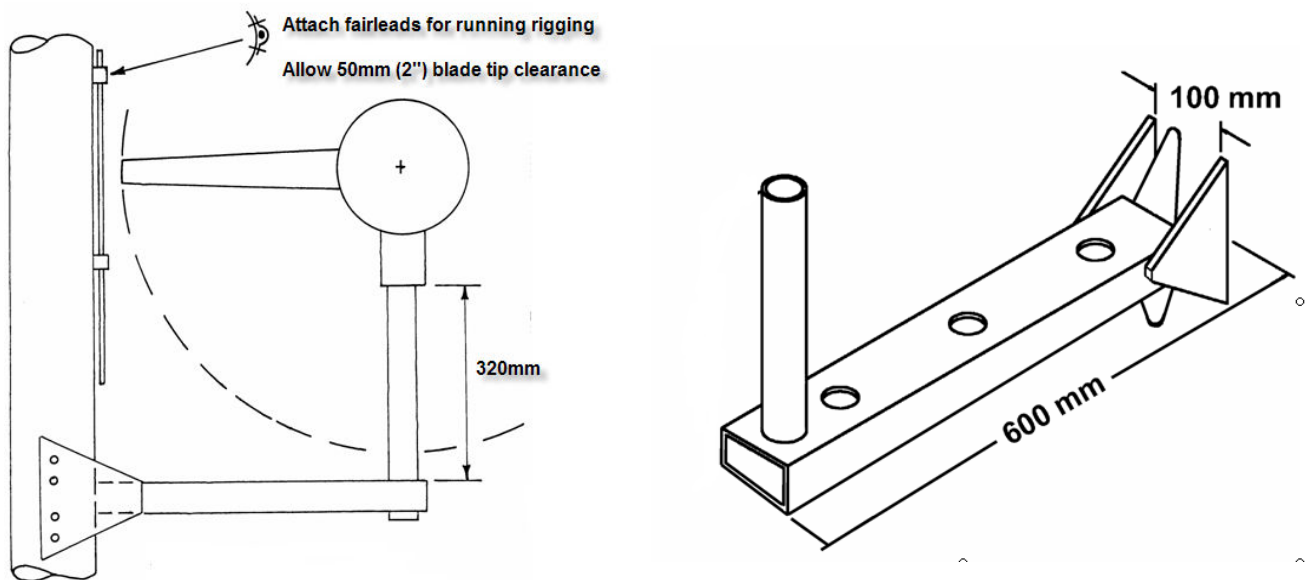


Fig. 9. Mizzen bracket mounting

Installing Gantry Mount

The gantry mount is simply a pre-welded pole structure in alacromed and powder coated alloy that can be bolted onto an existing structure. The top is pre-drilled and reamed to accept the Ampair pivot.

Do not insert rubber washers as in time these will deform and then the load bearing structure will fatigue. Leave a minimum of 50mm (2") blade tip clearance. Attach fairleads to prevent running rigging flapping into the turbine.

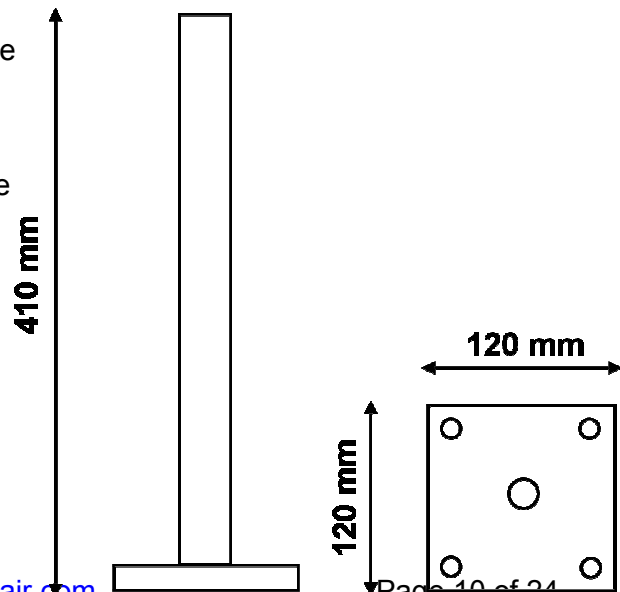


Figure 10: Gantry Mount

ELECTRICAL INSTALLATION

Cables: The Ampair 100 is fitted with 5m of 1.5sq mm cable. Having sited the Ampair 100 measure the cable run distance to the batteries. If this distance is less than 10 metres (20 metres 24v systems), use 1.5sq mm (16 AWG) cable. If less than 20 metres (40 metres 24v systems), use 2.5sq mm (14 AWG) cable. Use a similar type of cable to that on the Ampair. Always use tinned stranded conductors for marine locations. When mounting the Ampair on its pole or bracket, the cable needs to be fed down through the mounting. When arranging this cable make sure it cannot chafe at the point where it leaves the mounting pole. Either lead the cable out of the bottom of the pole in a gentle curve or, drill an exit hole in the pole large enough to take a rubber grommet to protect the cable from the sharp edges of the hole.

Connectors: To carry power from the Ampair to the wiring on the boat or building we recommend that a quality watertight connector be fitted. In the case of combination of locations, a watertight socket can be fitted at each site. The plugs and especially the sockets should have watertight caps when not in use.

Installation: Wiring between the socket (or junction box, deck gland etc.) and the battery area should be clipped at regular intervals to the structure for safety and a neat job

Protection: The simplest possible arrangement feeds the power from the Ampair directly to the battery, through an in-line fuse rated at 10 Amps (5 Amps 24v system) in the positive line next to the battery as shown in Figure 11 below.

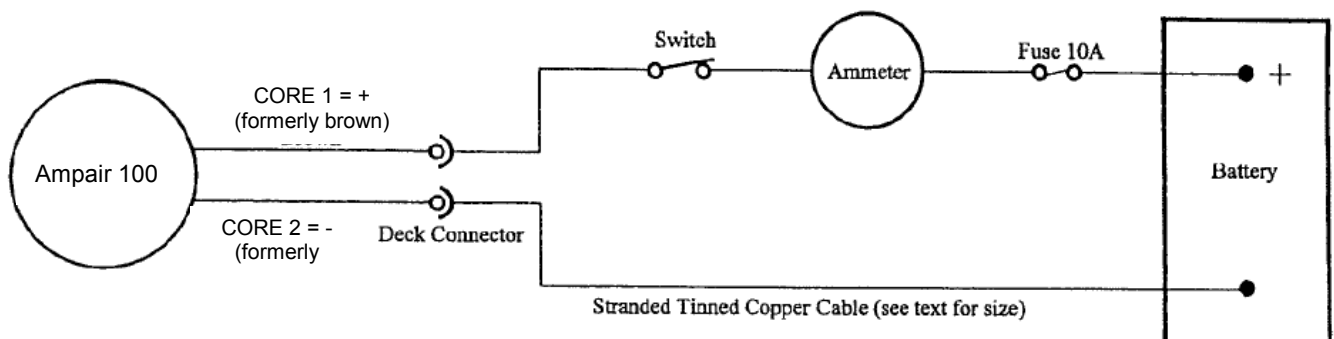


Figure 11: Basic Wiring Diagram

CAUTION: **IT IS MOST IMPORTANT TO FIT A FUSE.** The fuse should be next to the battery terminal since, in the event of a fault or damage to the cable, the battery will supply a large fault-current.

CAUTION: **When wiring the system be aware that if the Ampair is connected to the battery with REVERSE POLARITY the output rectifiers and brush fuses can be destroyed. Check and double-check polarity before final connection.**

CABLE COLOURS: CORE 1 (formerly BROWN) = + Positive
CORE 2 (formerly BLUE) = - Negative.

CAUTION: The Ampair generator output **MUST GO STRAIGHT TO THE BATTERIES.** If the Ampair is connected on the DOWNSTREAM (load-side) of the battery isolator switch, it leaves scope for damage to electrical equipment on the boat. Under these conditions it is possible to run the Aquair whilst the battery is isolated. This can subject the system to excess voltage.

CHARGE CONTROL REGULATION

An Ampair used as a semi-permanent wind charger may well need regulation, in which case the appropriate model should be wired in the system. Ampair manufactures three Charge Control Regulators for protecting lead acid batteries from overcharge. They are not “shunt” type regulators, which dissipate excess charge as heat, but an electronic power switch, which disconnects the generator from the battery at the regulation voltage.

Regulators S1B & S3B have a single 100-watt input (Ampair, Aquair or UW). Regulator type S1B has one output battery connection. Regulator S3B has three output connections to serve up to three battery banks with a common negative. The third regulator D1B has two 100 watt inputs (any two from Ampair, Aquair, UW or solar panels), supplying a single battery bank at a fixed regulation voltage.

All regulators have 2 level sensing. The lower voltage (Lo) connection regulates at 0.4 Volts below the high (Hi) connection for 12V systems (0.8V for 24V systems). “Hi” connection is appropriate for liquid electrolyte batteries and/or live aboard situations. ‘Lo” connection for gel batteries and/or infrequent use.

The battery voltage is sensed at the regulator output connection, therefore install the regulator as near the battery as practicable and keep the connecting cables short.

All regulators feature the same multi-stage regulation programme which has regulation voltages of Lo = 13.6V. Hi = 14.0V for 12V systems (27.2V & 28.0V for 24V systems).

Charging is continuous until the Lo or Hi voltage is reached, depending on the battery output used. The generator is now disconnected from the battery. Off-charge, the battery voltage will fall. At a voltage of 0.5V below the regulation voltage a 30-second time delay is activated. This delay prevents the regulator from oscillation (hunting) when charging batteries under load. After 30 seconds has elapsed, the generator-to-battery connection is remade and charging continues to the regulation cut-out voltage.

A cycle counter counts the charge/disconnect cycles and at the tenth cycle increases the regulation voltage for one cycle only by 0.4 volt to Lo 14.0V or Hi 14.4V for 12V systems (0.8V for 24V systems Lo = 28.0V, Hi = 28.8V). This provides an equalisation charge for the battery. Subsequent cycles return to the lower settings until a further 9 cycles are completed.

Ammeter: We recommend fitting an ammeter to monitor charging.

Use 10A for 12v, 5A for 24v. Fit an ammeter with a linear scale (moving coil type) or low outputs will be indiscernible.

Fuses: Battery protection fuses should be fitted. Use 10A in 12v system, 5Amp for 24v.

Wiring: Use suitably insulated cable of 1.5 sq. mm (16 A.W.G.) between regulator and battery in single source systems; 2.5 sq. mm (14 A.W.G.) for dual source. For input wiring to the regulator see appropriate generator wiring section. The use of screened cables is recommended if the cables run close to equipment radiating strong electrical fields e.g. radio transmitters or aerials.

Installation of charge control regulator

Make sure the generator is not operating whilst connecting to the regulator. Connecting with live wires can damage the electronic regulation circuit.

At initial start-up, allow a time of 1-2 minutes for circuit timing functions to become active.

Protecting the system:

Fuse warning - never omit fuses, simple in-line fuse carriers may be used; they protect your system from excessive battery currents in the event of a serious electrical fault. If they keep blowing, find out why.

Fuses = 10A for 12V systems; 5A for 24V systems.

The regulators are internally protected by SAE fuses, which are not substitutes for battery protection fuses. The fuses must be next to the battery terminals since, in the event of a fault, the batteries would source the fault current. Check and double-check polarities before making connections, insert the fuses in the fuse carriers last of all.

Corrosion:

This is the enemy of all electrical connections, especially in marine environments. Site regulators in a weather proof location: as dry as possible, and splash proof. Inspect all terminations and connections for signs of corrosion. Rectify by cleaning, remaking etc. Use tinned copper wire for extension leads to prevent corrosion spreading inside cable insulation.

Operating problems:

A digital multi-meter is useful for checking operational faults, if no permanent monitoring instruments are used. Battery voltage levels and those of the charging source can be read directly. Charging current readings will require the multi-meter to be installed in line. In this way currents into and out of the regulator can be observed. Do not remove battery connections since regulator operation depends on a very small supply current. If the regulator is suspect then it can be temporarily bypassed by connecting the source positive direct to a battery positive. The negative connections are common and do not need disturbing unless regulator replacement is necessary. Use the multi-meter continuity range to confirm all cable runs are low resistance.

Operation:

When installed, the generator and regulator will run and maintain the batteries automatically. The unit may be run in conjunction with any other charge-source with no known interactive problems. Regular battery inspection and topping up must still be carried out to obtain maximum battery life.

Faulty regulator:

Each regulator is individually tested and a chart recording kept of its operation. Each regulator has a unique serial number and a test date. Please provide these with any queries. If the regulator is suspect, then it can be temporarily bypassed i.e. connect the rectifiers directly to the battery terminals observing correct polarity. If this reinstates correct charging, then the regulator must be serviced or replaced. Regulators draw a small current (typically 1mA at 12V) from the battery to activate the sense and control circuits. **Without this connection the regulator will be inoperative.**

SERVICING

If the regulator is suspect, then it can be temporarily by passed i.e. connect the generator directly to the battery terminals observing correct polarity. If this reinstates correct charging, then the regulator must be serviced or replaced. Regulators draw a small current (typically 1mA at 12v) from the battery to activate the sense and control circuits. Without this connection the regulator will be inoperative.

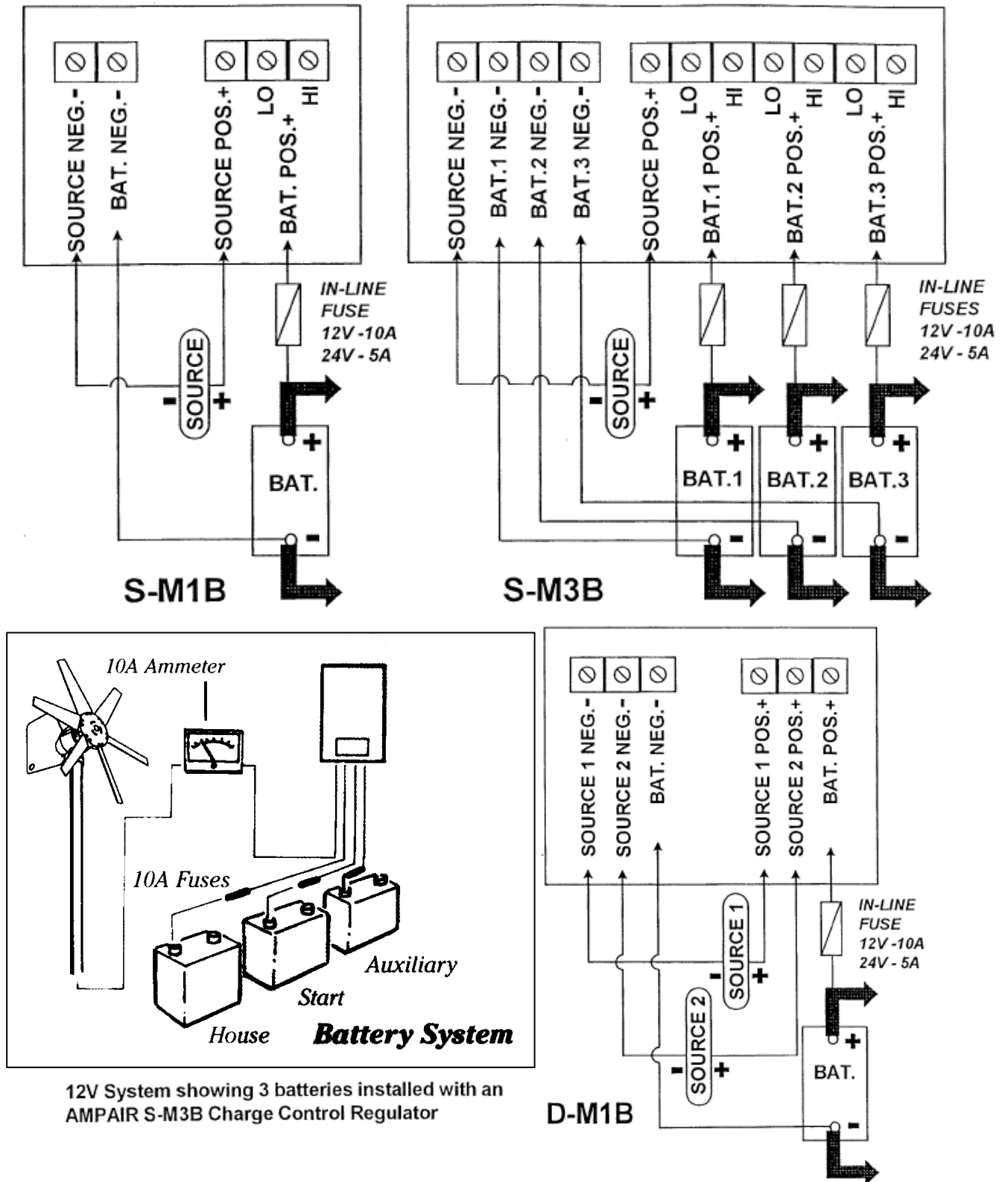


Figure 12. Charge Control Regulator - Wiring Diagrams

The use of screened cables is recommended if the cables run close to equipment radiating strong electrical fields e.g. radio transmitters or aerials.

FINAL ASSEMBLY

See sectioned drawing, figure 15.

a) Mounting the Ampair: Put a thin film of grease on the pivot shaft and its fixing screw threads to prevent corrosion. Bring the Ampair body to the mounting arrangement, pass the 2 core cable down the mounting pole, insert the pivot shaft of the Ampair into the top and secure the fasteners. The top of the pole is made to compress the lower pivot bearing "V" seal by about 2mm, if you have made your own fixing tube, be aware of this point to ensure free turning and weather proof sealing.

b) Output Cable: Make the final electrical connections to the battery, as shown in the electrical section, Insert the fuse or fuses in their carriers.

CAUTION: To avoid injury, fit the tail vane first. If you fit the wind turbine first, the machine will turn out of control and be a danger to approach.

c) Tail Vane: Clamp the tail vane using the M8 x 25mm screws washers and lock nuts.

d) Wind turbine: Assemble the blades to the hub with the concave or hollow side facing the wind. Using the M8 x 40mm fasteners, shakeproof washers and nuts, fix the blades in place observing the colour-coded pairs. These must go opposite each other.

WARNING: FAILURE TO INSTALL BLADES IN MATCHING PAIRS CAN CAUSE THE MACHINE TO RUN OUT OF BALANCE.

The holes in the blades are a deliberately tight fit and it may be necessary to turn the fasteners as they are inserted. First, evenly tighten all the nuts by hand, then, fully tighten opposite pairs with a spanner. Finally, recheck the tightness of all the nuts.

CAUTION: Put a rope over the Ampair passing through the blades to prevent its turning as you carry out the final checks. Once the mounting is complete, make sure all personnel are clear, turn the Ampair to face the wind and whilst holding the vane step back and remove the rope.

OPERATION & PERFORMANCE

STARTING & STOPPING

Starting: It is assumed that the Ampair has been assembled and installed in accordance with INSTALLATION section in which case it will now be operating.

Stopping: The wind turbine has been designed to survive storms; however, it is a good plan to stop the machine if a hurricane is expected or to carry out inspection. To do this, proceed with caution, approach the Ampair from downwind and grasp the tail vane (use a boathook for marine generators). Carefully turn the machine off wind and, when the blades stop, throw a rope over them and tie down. Never throw a rope into the turning blades.

CAUTION: To avoid personal injury wear sturdy gloves as a precaution. The wind turbine blades are capable of causing GRAVE PERSONAL INJURY and should be treated with the same respect as an aircraft propeller.

PERFORMANCE

The graph shows the output for a range of wind speeds. The drag due to the wind turbine is about 22kg (50lbs) at 50 knots wind speed.

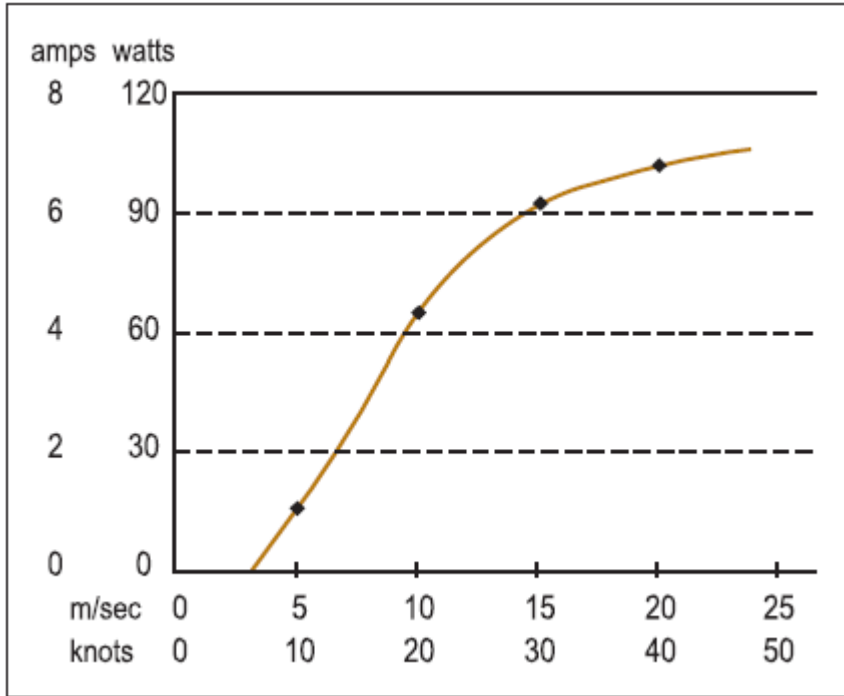


Figure 13: Ampair 100 Wind Generator Power Curve

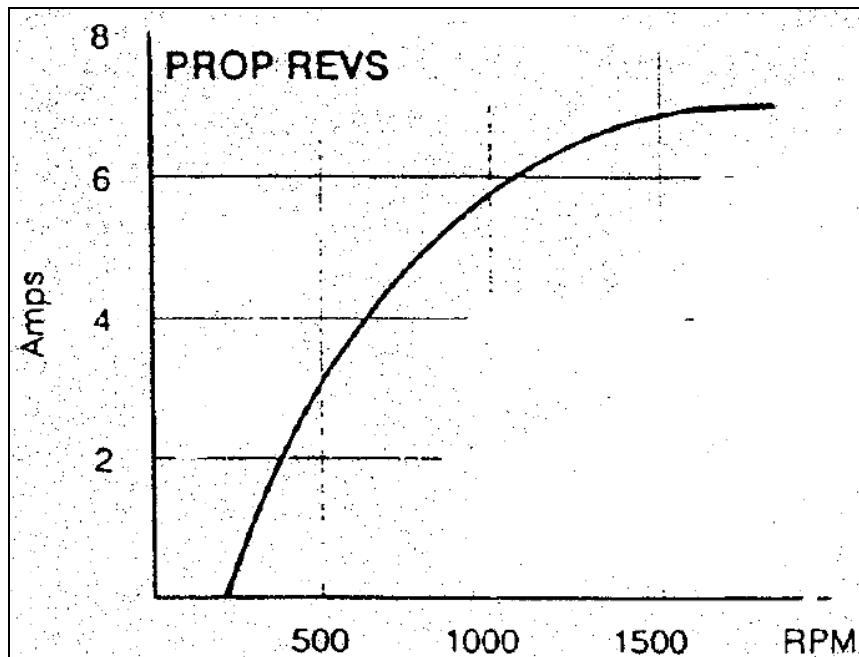


Figure 14: Ampair 100 Wind Generator Speed Curve

INSPECTION & MAINTENANCE

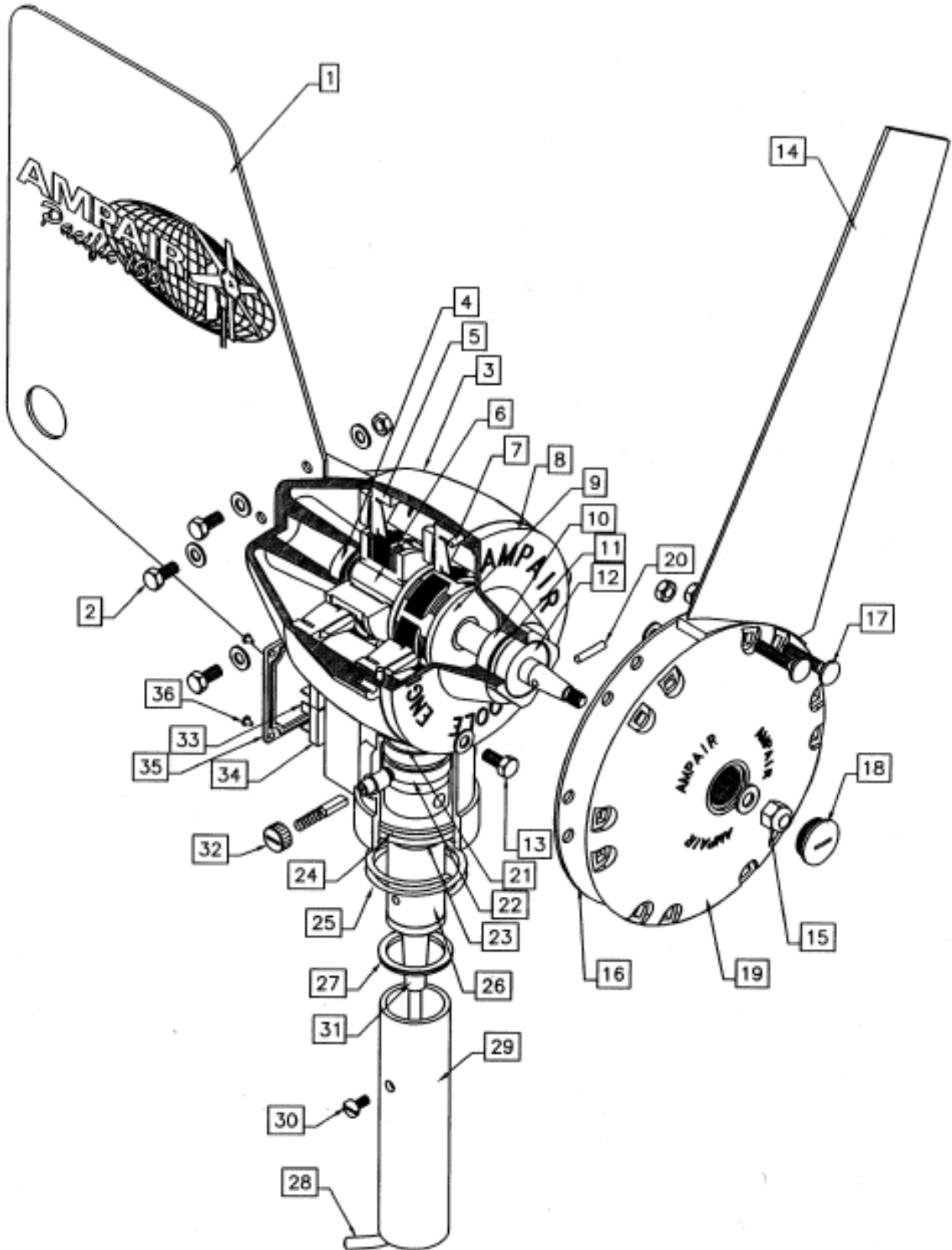


Figure 15: Sectioned Drawing

KEY TO SECTIONED DRAWING

1. Tail vane
2. M8 x 25 screw, plain washer x 2, & nyloc nut (3 of each)
3. After-body
4. Rear ball bearing: Type 6202. 15 x 35 x 11mm with frictionless cover
5. Six pole stator (2 off)
6. Shaft
7. "O" ring seal: international size 358
8. Fore-body
9. Six pole permanent magnet rotor (2 off)
10. Front ball bearing: Type 6203. 17 x 40 x 12mm with frictionless cover
11. Internal circlip: 40 x 1.75mm
12. Shaft seal: 17 x 40 x 7mm rubber coated, plain lip
13. Hexagon head set screw M8 x 25mm, fibre washer, plain washer & shakeproof washer (2 of each)
14. Wind turbine blade (6 off, available as balanced pairs)
15. Nut Nyloc M10 left handed thread & plain washer
16. Hub plate rear (1 off)
17. M8 x 40mm square shoulder fasteners, shakeproof washer & nut (12 off)
18. Sealing cap
19. Hub plate front
20. Dowel for locating hub centre
21. Ball bearing: Type 6202 15 x 35 x 11mm with double seals
22. Slip-ring assembly
23. Lower bearing (composite)
24. O" ring seal: international size 332
25. Spiral retaining ring
26. Pivot
27. V" seal (neoprene)
28. Output cable: tinned, stranded copper flex, twin 1.5 mm² arctic grade PVC sheath
29. Mounting pole
30. Socket cap screw M8 x 16 and shakeproof washer
31. Cable gland with flexible tail
32. Brush cap, brush, "O" ring seal (international size 012 neoprene), brush holder & spring connector (2 of each)
33. Suppressor: metal oxide varistor
34. Rectifier with M5 x 16mm pan head screw (2 of each)
35. Rear cover plate
36. Self-tapping screw, Number 8 x 3/8" UK designation (4 off)

General characteristics

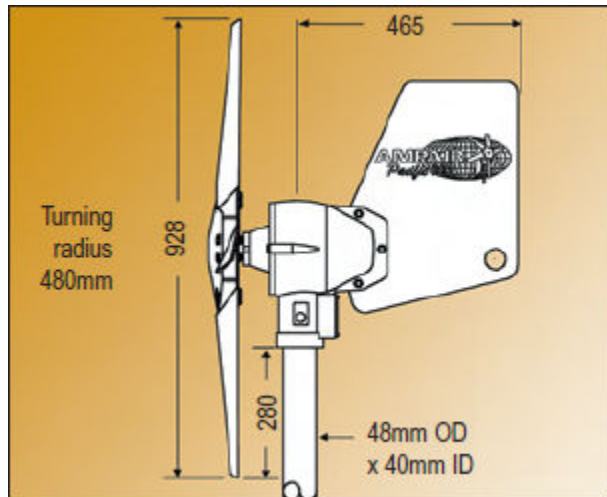


Figure 16: Ampair 100 Wind Generator Dimensions

Ampair Body		
Shaft diameter	17mm	
Pivot shaft diameter	40mm	(1.58")
Body height (from machine base)	275mm	(10.75")
Body diameter	175mm	(6.89")
Body length (including shaft)	290mm	(11.4")
Body length	240mm	(9.5")
Generator body and pivot weight	9kg	(21 lb)

Assembled Ampair Wind Generator		
Wind turbine diameter	928mm	(36.5")
Tip of blades below top of pole	284mm	(11.2")
Mounting pole length	800mm	(31.5")
Mounting pole outside diameter	44mm	(1.75")
Mounting pole inside diameter	38mm	(1.5")
Turning radius	480mm	(19")
Mounted weight excluding poles	12.5kg	(28 lb)

Electrical	
Output nominal voltage	12V or 24V
Peak output power	100W
The output is fully rectified and isolated from the case.	

Inspection

Check all fixings at regular intervals, especially after severe winds. First stop the machine, see section on Stopping.

CAUTION: To avoid personal injury wear sturdy gloves as a precaution. The wind turbine blades are capable of causing GRAVE PERSONAL INJURY and should be treated with the same respect as an aircraft propeller.

Regularly inspect the following:

- Hub to shaft nut (priority number 1)
- Blade fasteners & nuts
- Hub-centre screws
- Wind turbine blades
- Tail vane screws
- Pole mount screws
- Brushes

The Ampair wind generator should be inspected regularly, particularly after stormy weather, for signs of accidental damage. Any minor nicks in the edge of a blade may be dressed out but the blade must be replaced if there is any sign of damage or cracking near the root. Since the blades are supplied as matched, balanced pairs, any damaged blade must be replaced along with its opposite number. The unit may be run with two blades missing, whilst the replacements are obtained, at reduced performance since difficulty in starting will be encountered.

SMOOTH RUNNING

The design of the blades makes the Ampair a very quiet running machine. If vibration is encountered, this is evidence that the turbine is running out of balance. To prevent any resultant noise and the risk of fixings working loose, it is most important to take action. Remove the turbine, take out the blades and examine them to check that the pairs are placed opposite. If they are correctly assembled and the machine is still vibrating, contact Ampair.

To confirm correct blade performance, firstly weigh the blades, the pairs should be the same weight, within one gram. Secondly, lay the assembled turbine on a flat surface face down, this will reveal any blade bend as the tips should be above the surface by an equal amount plus or minus 3 mm.

Any other machine noise should also be investigated. Only after very extended running life should there be any detectable bearing noise. If this is the case, refer to the maintenance section for instructions on their replacement.

WARNING: NEVER ALLOW THE MACHINE TO RUN OUT OF BALANCE

The blade material has exceptional fatigue resistance which is of the utmost importance in hostile locations such as tropical sunshine and mountain tops. The material is, however, subject to slow degradation due to ultra violet light which increases towards the tropics and with altitude. This process is slow and when it becomes apparent as a white powderiness of the blade surface, particularly along leading and trailing edges, the blades may be carefully painted with two-pack polyurethane after a light sanding. **DO NOT MIX UP THE BALANCED PAIRS.**

The shaft seal protecting the front bearing should be renewed after 2 - 3 years of regular use. Also the lower bearing and "O" seal. The bearings should be replaced when they become noisy.

Regularly check the security of the fixings on hub, vane and pole.

If damage to the paint occurs, clean off any corrosion and repaint.

Clean the brushes, taking care not to damage the brush spring when handling.

Major disassembly

- Stop the Ampair see Section on Stopping.
- Disconnect from the batteries, removing the fuses first, see Figures 4 & 5 (Circuit diagrams).
- Remove the wind turbine. The centre nut has a left handed thread and so is rotated clockwise to remove. Pull the hub away from the machine and give a very careful tap on the end of the shaft with a rubber faced mallet if necessary. If difficulty is encountered in removing the hub from the shaft, avoid hammering on the shaft-end. Ampair offer a purpose made puller, you can improvise a puller out of a piece of metal plate, drilled for the three hub centre plate fixings, and three M6 x 60mm bolts.
- Remove the tail vane.
- Feed some excess cable length up the pole.
- Remove the fasteners from the pivot and lift the machine off the pole.

PIVOT SECTION

With the machine on the bench, undo the two black brush holder caps and remove the brushes to a safe place. Prise out the end of the spiral retaining ring from around the pivot lower bearing. Withdraw the pivot assembly, a good tug may be needed. Inspect the slip rings, clean if necessary. Inspect the lower bearing, if this is loose, obtain a replacement. Inspect the top bearing in the pivot housing. Inspect the "O" rings and "V" seal, replace if worn. It is sometimes easier to remove the Ampair generator head with the pivot in situ. Disconnect the battery first and remove the brushes. Uncoil the retaining ring and lift the body over the pivot. The exposed slip-ring must be protected from the environment if the generator is removed for further servicing.

When reassembling put silicone grease (not petroleum grease or jelly) around the shaft where it passes through the lower bearing. Slide the bearing and "V" seal down the shaft about 20mm and wipe grease around the shaft. Slide the bearing back up the shaft and remove the excess grease, wipe a fillet of grease around the point where the "V" seal sits and slide the "V" seal into place. Before reinsertion wipe the slip rings to remove any trace of contamination due to handling and put grease around the lower bearing "O" ring. Gently slide into place and wind the spiral retaining ring into its groove. Clean and replace the brushes. Re-check the pivot for excess side play, if this is suspect replace the lower bearing and "O" ring. Failure to do so may wear the pivot. If the rectifier cover is removed, it must be totally resealed before returning the Ampair to service.

ELECTRICAL SECTION

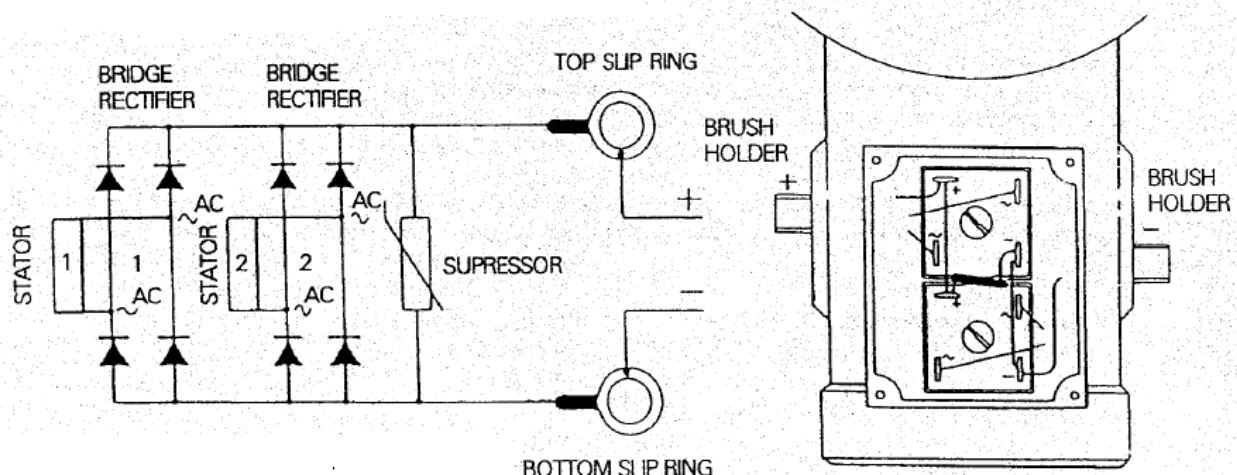


Figure 17: Ampair 100 Internal Wiring Diagram

Note: By far the most common cause of reduced output is corroded wiring between Ampair and battery. Before suspecting the machine, check any screw terminal or crimp connections and all cable runs between Ampair and battery.

Possible faults to consider if reduced output is suspected:-

- a) **Poor wiring connections.** Inspect all the screw terminals in the Ampair circuit for signs of fatigue or corrosion.
- b) **Sticking brushes** or associated brushgear contact problems. See Pivot Section.
- c) **Faulty Rectifiers.** The rectifiers and metal oxide varistor should last the life of the machine. The most likely cause for their demise is accidental reverse polarity connection of Ampair to battery. If this is suspected the rectifier diode bridges must be checked. **Reverse polarity connection can also melt the solder on the brush holder spring connections**, these can be checked by removing the pivot and looking into the lower body section.

A simple method of checking the machine's output is to disconnect it from the battery and short together its output leads whilst turning the shaft by hand. A marked increase in resistance to turning should be felt as the shorting occurs.

RECTIFIER DIODE TEST:

This test will show if the rectifier diodes are either open or short circuit. If your multi-meter has a diode check feature, select this (if not select the highest resistance range). Connect the meter leads to the DC output and note the reading. Now reverse the connections.

METER LEAD POSITION	MULTIMETER SETTING			CONCLUSION
	DIODE TEST		OHMS x 100	
RED meter lead to positive	No reading	or	Many Megohms*	OK
	Reading	or	Low resistance	Failed
BLACK meter lead to positive	1.2V (two diode drops)	or	Markedly less*	OK
	No reading	or	High resistance	Failed

**This test is not as conclusive as the diode test method, however, provided the first reading is a very high resistance and the second reading far lower, then the test is valid. Actual values will depend on the voltage supplied by the particular meter for its resistance ranges and some meters cannot check 2 diodes in series.*

The rectifiers are located in the small box on the back of the Ampair body. To inspect them remove the four screws and the plate. This has been sealed with polyurethane sealant. After removing the screws insert a thin blade to cut the seal. The sealant must be renewed on re-assembly after the mating faces have been cleaned. Failure to do this can cause severe brush gear corrosion in future. Unsolder the 'commoning' links between the rectifier outputs and check outputs separately. If a new rectifier has to be fitted, unhook the spring connections to the brush holders in the lower body section noting polarity, (CORE 1 (formerly Brown wire) = positive output = upper brush holder) and unsolder the four stator wires from the rectifiers.

- d) **Faulty stator.** Check A C input to rectifiers or check for coil continuity and isolation from the case. The resistance should be less than two Ohms (approx. three Ohms 24V units)

Note: Do not attempt to modify a 12V machine to 24V. Whilst at first sight this may appear possible by connecting the outputs of the stators in series, greatly reduced output will be encountered since they are not in phase. A 24V machine with 24V windings is available.

ALTERNATOR SECTION

Referring to figure 15. undo the two M8 x 25mm screws on the front of the Ampair and pull the nose piece away from the main body. Do this very carefully as it cannot be withdrawn far due to the front stator wiring connection. The shaft and bearings are located using Loctite anaerobic adhesives so some force may be necessary to part them. A puller may have to be improvised to do this. This job should, therefore, be done on a suitable work bench. The rear bearing needs a bearing puller to remove it, if no puller is available, a dummy shaft may be fixed in the bearing centre using epoxy adhesive and, when cured, the bearing worked loose. The front bearing may be drifted out following removal of the seal and circlip.

Prior to re-assembly, the bearing housings, the bearings inner and outer surfaces and the shaft surfaces should all be thoroughly cleaned and de-greased. When re-assembling use adhesives as follows:

Stator to body	Loctite 648
Bearings to body	Loctite 641
Shaft to bearings	Loctite 641

When replacing the fore-body, make sure that the "O" ring is in place and well smeared with silicone grease. Assemble the body checking that the wiring to the front stator cannot touch the rotor. Ensure that the timing marks on the body junction line coincide. If the "cogging" or break out torque has been correctly minimised, 12 minor, equal "lumps" of resistance per revolution will be felt when turning the shaft by hand. This resistance should not exceed 2 kg-cm (30oz-in). When doing this make sure that the output leads are not shorted together.

STATOR/ROTOR REPLACEMENT

This is normally a factory operation. Rotor damage is unlikely, but sometimes occurs due to corrosion or other mechanical problems. Considerable force is necessary to break the adhesive bond between the rotor and shaft and a bearing press with guide tools to protect the shaft is needed. Rotor/shaft assemblies can be returned for replacement.

Stator failure only normally occurs due to salt water immersion. Any accident causing this necessitates the immediate cleaning of all parts with fresh water and then drying thoroughly. Leaving to dry naturally causes the loss of stator winding insulation due to salt corrosion resulting in electrical leakage and shorted turns. Stator replacement involves baking in an oven to break adhesive bonds prior to drifting out the old stators, thoroughly cleaning the castings and replacement fitting/wiring. Full workshop facilities are needed for this.

RECOMMENDED SPARES

To cater for the possibility of accidental damage, it is suggested that a spare pair of blades be carried. Other spares worth considering are:

Shaft seal	Replacement may be required after 1-2 years use.
Pivot seal	Replacement may be required after several years.
Pivot lower bearing	Replacement may be required after several years.
Brush set	In case of loss during servicing.
2 bearings	Unlikely to be required but an insurance policy
Rectifier assembly	Unlikely to be required unless polarity is accidentally reversed, however, another insurance policy.

WARRANTY

Please see Ampair terms and conditions, available on request. Please keep your invoice as proof of purchase.

SERVICING & REPAIRS

Units should be returned to:

Ampair
Park Farm, West End Lane, Warfield
Berkshire RG42 5RH
United Kingdom
Tel +44 (0) 1344 303 313
Fax +44 (0) 1344 303 312
Email: service@ampair.com
Web: www.ampair.com

Ampair reserves the right to change specifications, without prior notice, in the interest of product development.