Marine Corrosion

An Alternative Approach to the Prevention of Corrosion in Wooden and Fiberglass Hull Fishing and Recreational Vessels

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INTRODUCTION

Much has already been written regarding the causes and effects of galvanic corrosion in the marine environment. Vessel owners and users have seen the effect, and no doubt paid heavily, of galvanic corrosion on metal fittings and machinery, and in many cases for the serious deterioration of wooden hulls.

This publication seeks to illustrate an alternative approach to the prevention and reduction of damage caused by galvanic corrosion in wooden and fiberglass vessel hulls and fittings.

This summary report is based on the author's research and reports published by the White Fish Authority, England, over the last ten years.

The research was prompted by the loss of vessels at sea and the high incidence of near disaster caused by metal failures in wooden and fiberglass vessels.

The systems outlined in this publication reduced the incidence of corrosion caused by stray currents.

INITIAL CORROSION PROTECTION

In the first instance, the primary aim of a vessel owner/operator is to reduce or eliminate damage to the vessel by galvanic corrosion. Basic theory tells us that this can be achieved by the fitting of protective or sacrificial anodes to the vessel hull and connecting this anodic metal to the inboard metal fittings to be protected.

The first example, shown in Figure 1, is of a vessel hull fitted with an engine, fuel tanks, shaft, stern gear, screw, rudder and upper deck metal structures. The hull can be made of wood or fiberglass, and the usual mix of metal fittings associated with a propulsion and steering system are assumed to have been chosen to be within the normal recommended range of metals in the electric-mechanical series. The major point to note is that no electrical equipment has been fitted at this stage.

Following normal US practice, all metal fittings in the engine room are bonded together. The first variation of the alternative approach should now be noted: the bonding should be of copper tape of a minimum size of 12 x 1.5mm. The bonding should form a loop so that if a break or bad connection should occur, continuity will be ensured. Where the bonding tape runs on the hull, it should be insulated with tape. The connections to the protective sacrificial anodes should be double checked for security and liberally coated with silicon grease to protect them from bilge water. The upper deck structures and fittings should not be connected to the engine and steering bonding. The propulsion shaft should be connected into the bonding via a carbon brush.

Four anodes should be used, (size and/or weight determined by past experience or by Mallon and Kolbe, 1979, (figure 2)).

WOODEN OR FIBERGLASS HULL — Figure 2.

30' Cruiser	40' Cruiser	48' Cruiser	58' Cruiser	78' Dragger
16 lb.	35 lb.	44 lb.	68 lb.	93 lb.

Using the bonding system and anode weights described and illustrated, maximum protection for the installed metal fittings will be achieved, and will have established our basic cathodic protection system.

General Tips

Where continuity of metal is broken, e.g. in metal pipes with a rubber or plastic pipe insert, copper tape should be used to bridge the insert, thus ensuring no break in the bonding security.

A protection current controller should also be considered to eliminate over-protection, as this can cause paint shedding and other problems.

The anodes should be checked at least once a year and replaced when 80% of the zinc material has wasted away. If an anode is functioning correctly, it should waste. An anode that is as new after twelve months should be investigated, and its bonding connections checked for security.

Electrical Installation

At present, it is common practice in the USA to connect the negative pole of the battery and generator units to the vessel bonding installation. An alternative approach to the reduction of corrosion does not recommend such practice, but seeks to isolate the electrical system from the bonding and protective anode circuit.

Even the simplest and smallest inboard engine installation will have a battery start associated with it. Once a battery is installed along with its associated distribution system, the potential for stray current corrosion is established. At present, most marine engine start units are based on automobile systems where the metalwork of the engine, etc., is used as the negative return in the circuit. Many European manufacturers are now supplying two pole insulated units to help in the reduction of corrosion through stray currents. The two figures 3 and 4 illustrate this concept.

Wherever a single pole start motor is already fitted, then a double pole isolating switch should be fitted between the battery and the engine start motor to reduce stray current corrosion. The switch should only be closed when it is required to start the engine. Once the engine is running, the switch should be opened. It is particularly important that the switch is kept open and checked that it is open whenever the vessel is lying in port or in a marina. Figure 5 shows the simple wiring diagram associated with a starter motor isolation switch. However, most working or recreational vessels need much more in the way of an electrical installation to provide the safety, efficiency, and comfort required in today's demanding environment.

To maintain the initial electrical isolation already fitted with the engine start motor, a double pole insulated return system is suggested. This is easily appreciated when the reader studies the simple circuit diagram illustrated in Figure 6. A point to note is that all wiring is two pole through double pole switches and double pole fuses or circuit breakers. At no point is a connection made to the bonding system previously described. Whatever the choice of primary power source, be it 12VDC, 24VDC, 110VDC, or 110VAC, the two wire insulated return system should be employed.

A simple electrical leakage check system can now be incorporated. This comprises two test lights of a similar voltage rating as the primary voltage source, two fuses and two spring return switches connected as illustrated in Figure 6. The ground symbol on the diagram is the bonding system, and is the only connection from the electrical circuit to the bonding system. The test circuit only requires the spring return switches to be closed, and if the electrical distribution circuits and services associated with it are secure both lamps will glow at half intensity. Should a fault occur within the distribution network, then one or the other of the lamps would glow brighter. In this instance remedial action would be required at the earliest opportunity. A more detailed fault analysis program is listed at the end of this publication.

As navigation and electronic equipment is fitted into a vessel, most manufacturers call for an effective ground connection to be made to their equipment to ensure its efficient operation. Using a two wire insulated return electrical system, the ground connections for electronic aids must not, under any circumstances, be made to the bonding system or any metal work in the vessel. An efficient grounding system in a fiberglass or wooden vessel is the fitting of a copper plate of a minimum $0.8M^2$ size to the wetted area of the hull. This plate should have a 100mm insulated copper tape connected to it, and run up inside the vessel to a convenient central point within the vessel. All electronic equipment, ground connections should then be made to this point. If possible, electronic equipment for marine use should be purchased with the power source not connected via either pole to the case of the instrument.

An example of equipment grounding is illustrated in Figure 7.

By using the bonding, electrical distribution and grounding systems described in this publication the incidence of damage and deterioration due to corrosion should be markedly reduced. A final point: if an electrical leakage fault is indicated on the test system, remedial work to rectify the fault is required immediately. Failure to do so will mean that stray current corrosion is under way and a failure of a component or a major machinery system will occur, and under expected circumstances it will occur at sea at the most inconvenient time.

Test Procedures

If the insulated return two wire electrical system and isolated grounding and bonding procedures are installed in a vessel with a wood or fiberglass hull, electrical security must be maintained to ensure that stray current corrosion does not get encouragement from equipment, cabling, or bonding failures.

Remember, electrical leakage can cause corrosion currents which will attack pipework, valves, pumps, engines, stern glands, and hull fittings.

The major causes of electrical leakage in this system are generally due to the entry of water via:

(1) Broken or missing cable insulation
(2) Exposed connections caused by broken or missing covers on terminal blocks
(3) Seal failure on distribution boxes, lights, switches, and deck fittings

With the simple ground detection circuit fitted as shown in Figure 6, electrical security can be checked in the following manner:

(1) Stop all engines.
(2) Switch off all equipment and services; i.e., radios, echo sounders, and radar equipment switched off at their cabinet switches. All lights are switched off--do not forget accommodation lights, deck lights, navigation and masthead lights.
(3) Switch ON all circuit breakers and main switches at the switchboard or main distribution area.
With a secure electrical installation, there should be no voltage between the battery and the bonding system.
Close both ground test switches; the two test lamps should glow with an equal intensity.
If a fault is present, one lamp will glow brighter than the other, or in the event of a full ground fault, one lamp will be out and the other at maximum intensity.
(4) If a fault is apparent, switch OFF in turn the main circuit breakers or switches until both lamps return to equal intensity. The last operated switch or circuit breaker that causes the lamps to return to normal is the circuit or distribution network with the ground fault in it.
(5) Investigate all the cabling, switches, distribution boxes and services fed from this breaker until the cause of the fault has been found and corrected.
(6) Repeat the test until you are satisfied the distribution system is secure.
(7) Return all main circuit breakers and distribution switches to ON position.
(8) Start the main engine.
(9) Close the test ground switches.
(10) Increase the engine speed until the generator/alternator shows a charging current into the battery.
(11) Have a second person switch on each service one at a time, including the electronic gear.
(12) If at any time during this operation the test lamps become unbalanced, investigate and correct the cause.

Once these tests are completed and the electrical bonding and grounding system considered secure, the ground test switches should be routinely checked daily while at sea or weekly while in port.

FIGURE 1. Bonding Layout and Anode Location

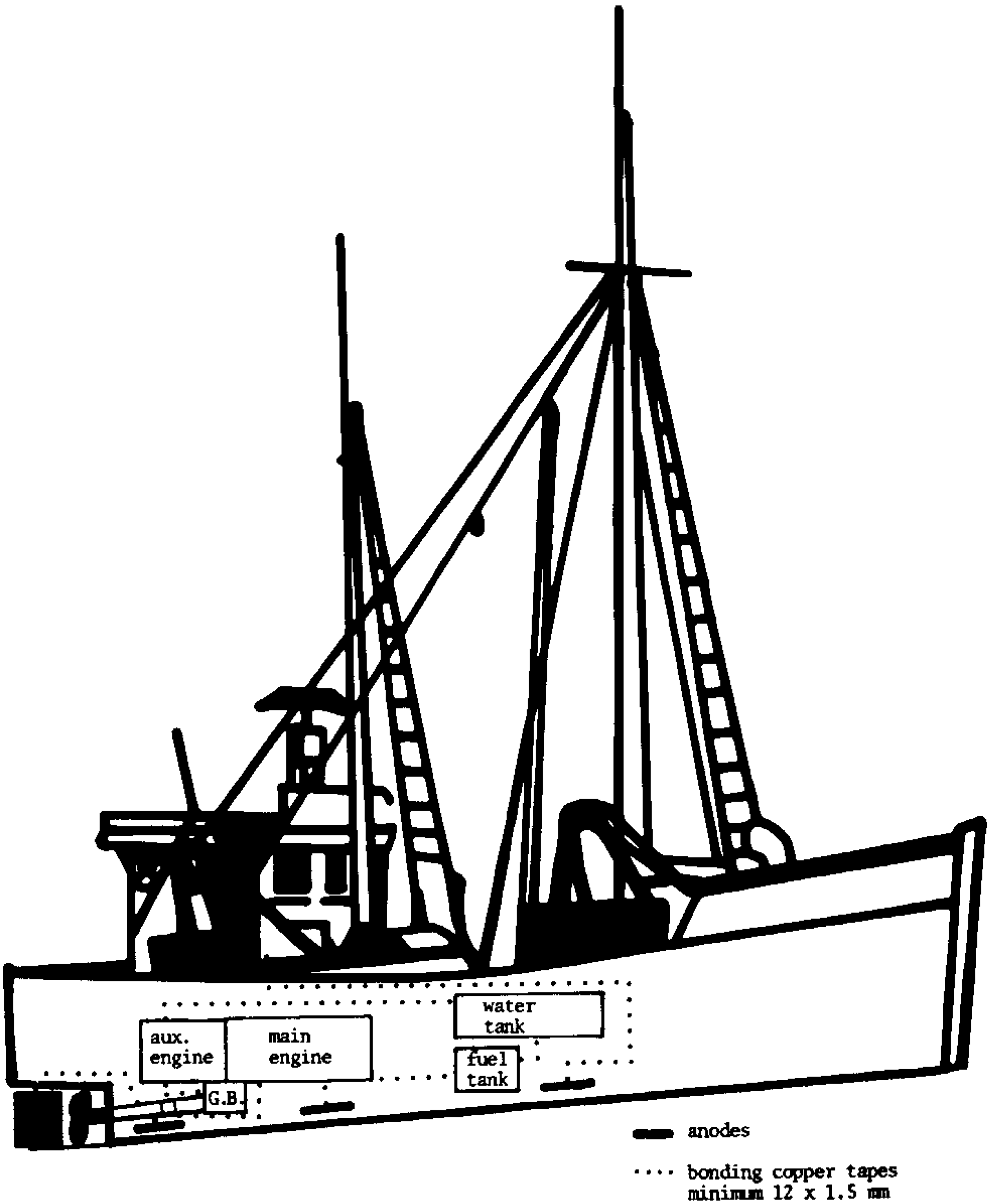

FIGURE 3. Common Return Engine Start System

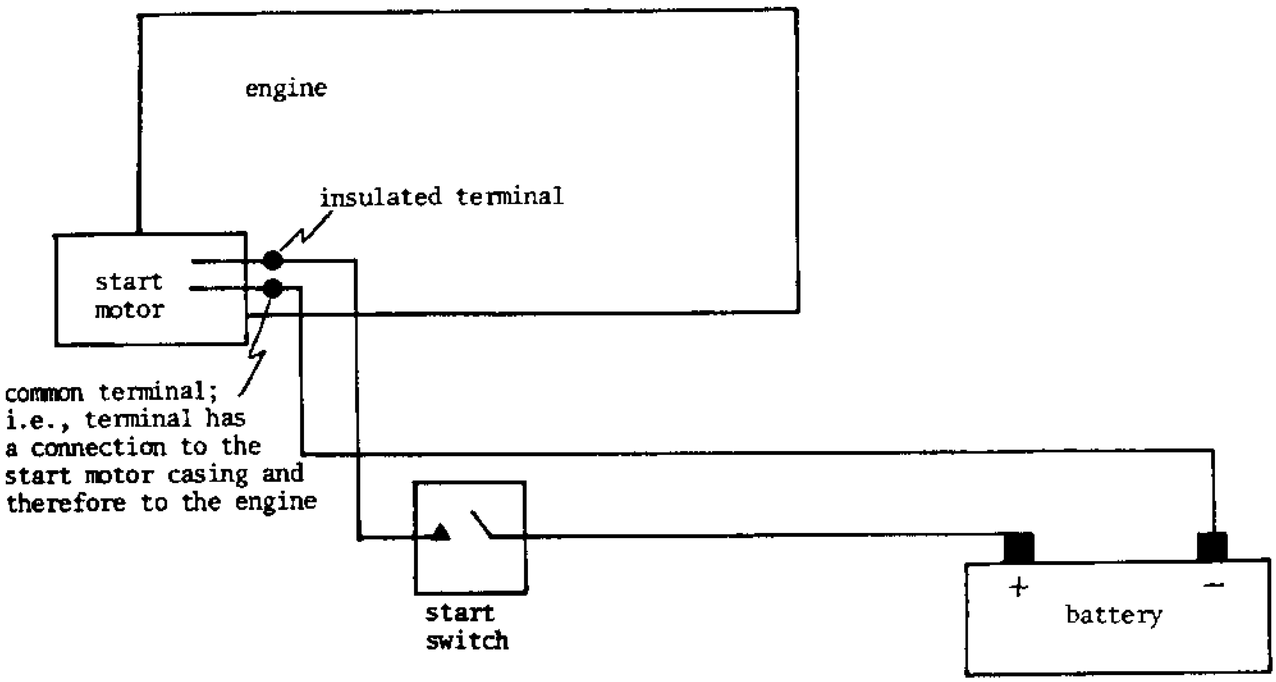

FIGURE 4. Double Pole Insulated Engine Start

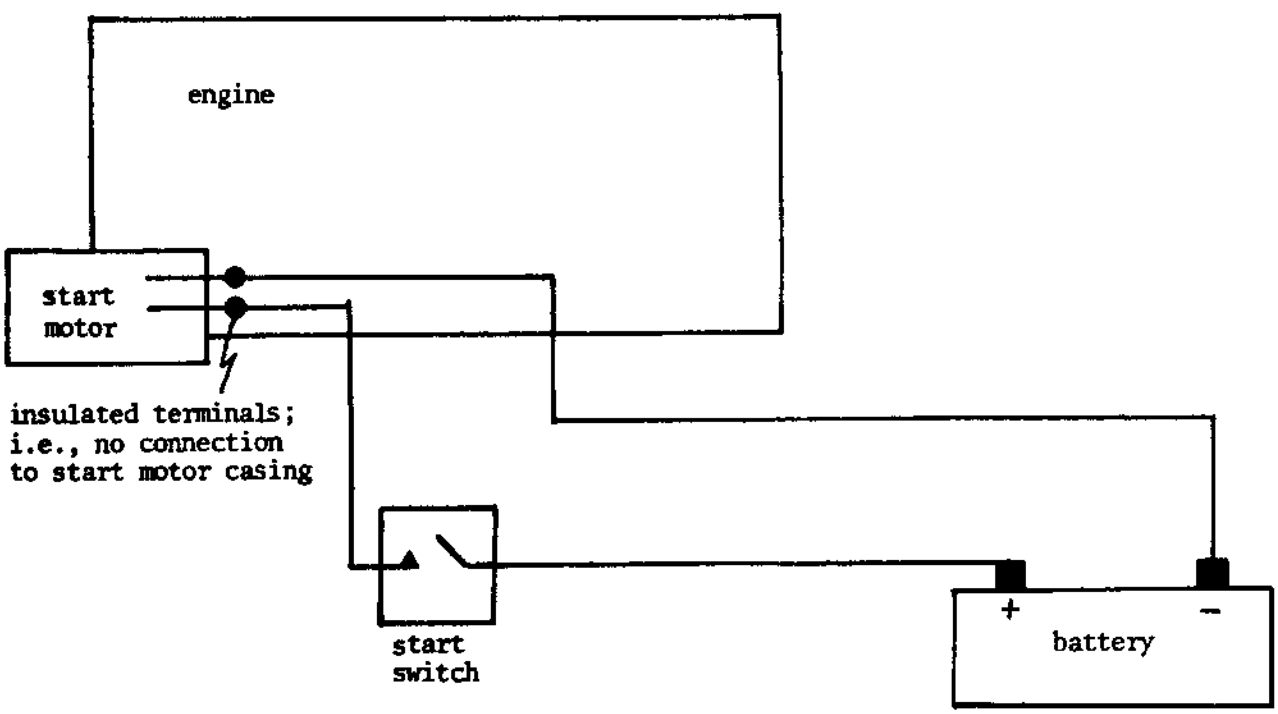

FIGURE 5. Start Motor Isolating Switch

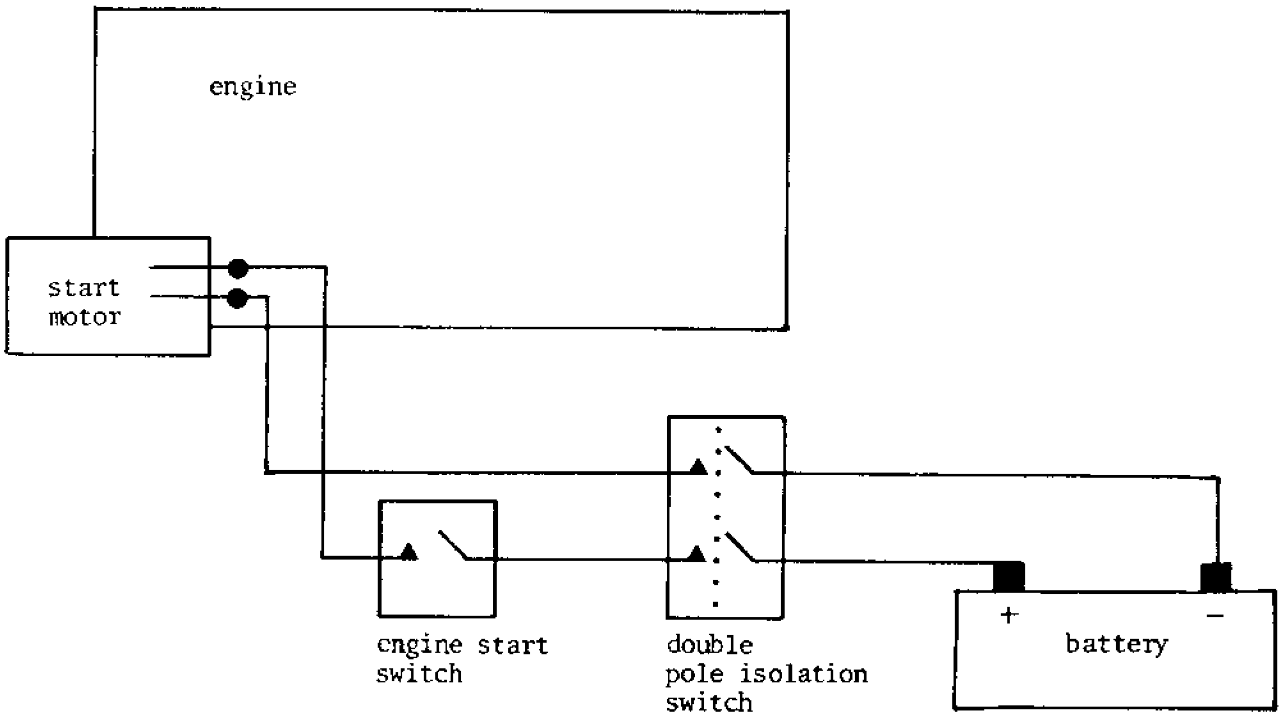

FIGURE 6. Two Wire Insulated Return Electrical System

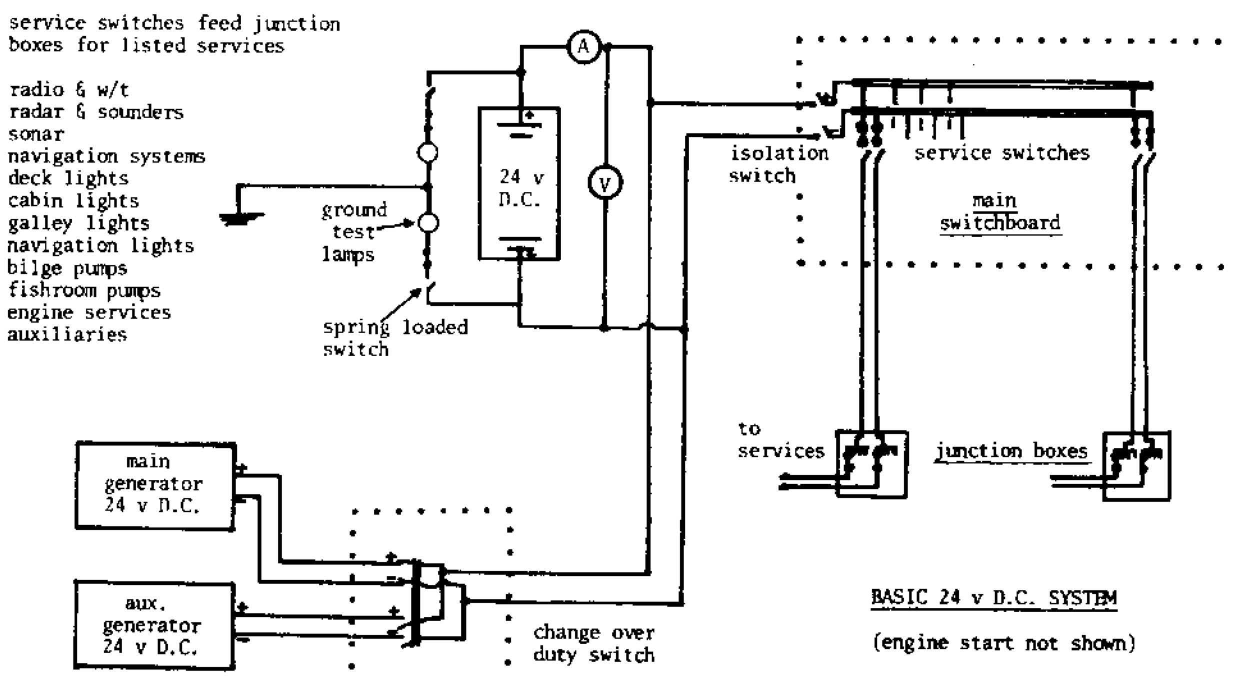

FIGURE 7. Electronic Equipment Grounding Layout