Ferro News

November 1996 Bi-Monthly Newsletter for Ferrocement Boat Owners Issue 1

Welcome Aboard

Welcome to the first addition of Ferro News. If the enthusiastic responses I received from many of you are to be any guide of the determination and resolve we will have as a group I believe that a regular newsletter like Ferro News will thrive and be of benefit to all ferrocement boat owners. I hope this newsletter evolves into a forum for discussion on many different aspects relating to boating. While emphasis will be put on ferrocement boats, other topics will be covered including first-hand experieneces, products, fitting-out and much more. The success of the newsletter will depend on your contribution. As co-ordinator of this group and a ferrocement boat owner I am always keen to hear your suggestions, specific problems, or great ideas.

To ensure that you receive your bi-monthly copy of this newsletter, and have not already contacted me with your mailing details, drop me a note ASAP. See page 5 for contact details.

"Does anyone today think that ferrocement is any sort of stuff to build a yacht out of?"

Attitude

By Ian McFarlane "S/V Lilly-Ann"

I was approached by a passer-by recently while working on the topsides of my Hartley South Seas, ferrocement 38' sloop. First he lent over, tapped the hull, then whilst looking quite puzzeled, asked:

"What's she made out of?"

"Ferrocement", I replied

With a frightened look he then asked: "Does anyone still think that ferrocement is any sort of stuff to build a yacht out of?"

.... and then add water !

It has a familar ring to it, don't you think?

So why is it that ferrocement yachts have had a bad reputation in the eyes of some?

Most of these pontoon-walkers or armchair-sailors as I like to call them have had little more than hearsay experience. I've been involved with several ferrocement boats for many years and believe that I can offer an informed opinion on the matter.

There are many devotees of ferrocement, especially in Australia and New Zealand. However ferrocement construction is by no means limited to these areas. Many excellent examples of yachts constructed in this medium can be found in the US and UK as well.

We should also understand a little about the the properties of ferrocement hulls before we rush to condemn it as a construction medium.

Ferrocement has developed a bad reputation not

(Continued on page 6)

inside...

YACHT SPOTLIGHT

By Trudy Snowdon "S/V Lilly-Ann"

Probably one of the most popular ferrocement yachts in Australia and New Zealand, would have to be the "Hartley South Seas" 38'. This month, we shall have a close look at "TAVA", a modified "South Seas" recently purchased by Len Brind, who is working hard to make it a comfortable live-aboard yacht and return it to cruising condition. The hull was built in New Zealand by Roy Schoon, who worked as a consultant surveyor for Hartley in the '70s. If anyone knows how to build a ferrocement boat, it's Roy. We hope to hear from Roy in the comming months. Well, by coincidence both TAVA and Roy are now in Brisbane.

TAVA's hull design was lengthened to 40 feet by adding a couple of inches between each frame. The resulting extra two feet makes a noticible difference in terms of living space. Other modifications were made to the design including a bridge-deck separating the cockpit from the companionway. The resulting cockpit is shallower and the companionway smaller which are good features for an off-shore cruising boat. The cockpit floor has been raised giving full access underneath for stowage and inspection of the huge 24" steering quandrant. The mast was stepped 8" forward of the designed position to overcome the healthy weather helm tendancy of the "South Sea". On the day Len took us out for a trial sail, the wind was blowing a steady 10 - 15 knots north-east, and with the 450 sq feet genoa and 350 sq ft main drawing well, I estimated boatspeed at around 7.5 knots. Ferrocement boats are often held in poor regard for their windward ability, but not TAVA. She had no trouble as we tacked to windward out from the Manly Boat Harbour and navigated our way between Green and St Helena Islands.

Genoa sheeting is made easier by having a double spreader rig, with the shrouds meeting the deck some 12" inboard of the toerail. This is another thoughtful design customisation.

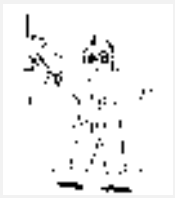
One of the major maintenance tasks undertaken by Len, has been to replace the underwater paint system. The previous system had lasted over 12 years and given that the expected life of many systems is around 10 years, it was time for a new system. After some investigation of various paint systems, Len decided upon the fairly new Bote-Cote CopperPoxy anti-fouling system. This system contained a high percentage of copper solids, which is exposed after the final coat is burnished. The main advantage of this system is that maintenance is a simple blast-off and scrub down every six months, saving both on anti-fouling and slip hire.

... a simple blast-off and scrub down every six months, saving both on anti-fouling and slip hire ..

A Hartley South Seas. Tava was modeled from this popular design.

Len has a number of projects ahead of him including the refurbishment of his interior and the overhaul of his standing rigging and running gear. Stern davits for the dinghy and a new bimini are also high on his list of things to do.

Trudy Snowdon - First Mate on the yacht "Lilly-Ann" hopes to feature a readers yacht each issue.



Marine Electrical Systems

Part I

By Cameron Clarke "S/V JUPITER"

While cruising the Pacific Coast, Mexico, Central America, and the Caribbean, I conducted several hands-on seminars for cruising sailors to learn about and improve their electrical systems. I now present this same material to others, via a multi-part posting of articles to help you understand and troubleshoot your boat's electrical system. This self-directed seminar aims to help you understand the material without diagrams or graphics.

Part 1: ELECTRICAL CONNECTIONS

This part examines proper Wire size for amp loads, use of Ring Terminals, connections, resistance, and losses in the wiring system. This is the most important material in this seminar. If there is nothing else you learn in this material, you will benefit most from this part. Concentrate on learning this part as it sets up the understanding for all the following material.

... There are many types of wire, many of which have little use in marine applications ...

We begin by defining a few items. A ring terminal is a preformed copper piece, often zinc or solder plated, which is placed over the end of a prepared (insulation striped back to reveal copper) wire and crimped with a tool to make a tight connection to the wire. The end of the terminal has a hole, not unlike a washer, that is used to attach to something usually by a screw. The screw will keep the terminal captive, unless of course the screws falls out of the hole. A fork terminal is similar, except there is a slot in the washer which allows the terminal to slide over or away from the attaching screw without removal. A ring terminal will prevent a wire falling off and causing a short. For this reason, I recommend them over spade (slide on/off) and forks. Fork terminals sometimes have bent up ends to eliminate this problem and are a good substitute when you might inadvertently lose the screw in the bilge.

I define a connection as any point two physical metallic conductors are made to touch, ie "connect". Connections can be "crimped" (squeezed together via a special tool - please do not use pliers), soldered (heated with an iron and a lead-tin alloy is melted into the air space), or by any mechanical means (two or more wires or terminals held together by a nut and bolt, etc). If two wires are connected in a manner which each wire has a crimped terminal, then I count 3 connections, one for each crimped terminal (2) and one for terminal to terminal (1), or 3 total. Perhaps this seems a minor point, but I shall elaborate as to why it is important for you to consider this detail. By counting and examining connections in a wire path, you will solve many problems. Stay with me.

There are many types of wire, many of which have little use in marine applications. Sometimes it is impossible to buy the right types or better grades in foreign ports. That is ok, as long as you recognize that and can deal with other problems later. Anchor Marine makes a very good wire for marine use and I would always recommend it when available. It is composed of many fine strands, each tinned (coated with tin to prevent salt corrosion of the underlying copper) and the insulation resists oil and saltwater, much better than household or automotive wire. If you consult a wire resistance table, you will notice there is less resistance in multi-stranded tinned wire than other types.

Copper Wire Table @ 95 deg F follows:

US Wire Guage	Ohms per foot	Max Ampere load (continous)
00	0.0000811	200
0	0.000102	125
2	0.000162	90
4	0.000253	70
6	0.000403	50
8	0.000641	30
10	0.00102	25
12	0.00162	20
14	0.00258	15
16	0.00409	7
18	0.00651	3

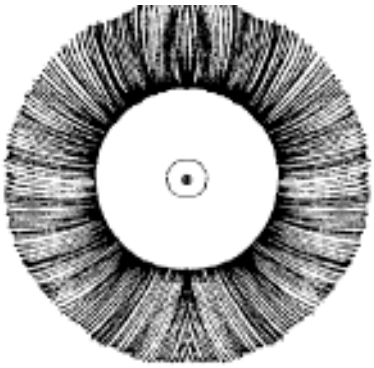
Use the table above to compute resistance of wire runs, include length both to and from device. If you use 25 feet of #14 two conductor wire for a cockpit lamp, then you have 50' of #14 wire.

(Continued on page 7)

Product Watch

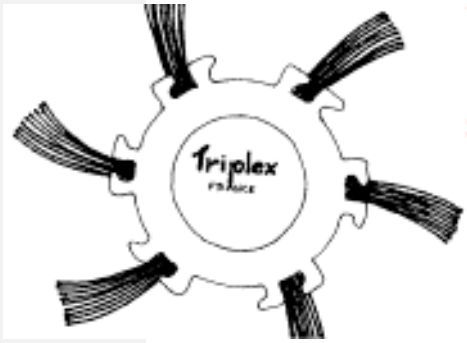
By Len Brind "S/V Tava"

My yacht TAVA was the feature in this months *yacht spotlight.* What Trudy didn't mention is the significant amount of exterior teak trim that extends the full length of the deck. Fourteen window surrounds, three large hatches, companion-way doors, cockpit trimming, and no-less than 80 feet of toe rail and belting. I prefer to keep the original teak finish, rather than succumb to the temptation to paint the lot! However, keeping all this teak real-estate up to stratch requires considerable effort in sanding, staining and varnishing. What annoys me more than anything else, is how often I have to revarnish the timberwork, given the harsh sub-tropical climate of Brisbane. So anything that makes this job easier, faster, or last longer must be a good idea. This month I'm going to show you a couple of products that will make sanding and stripping easier and faster, and next month we'll look at how to make timber finishes last longer.



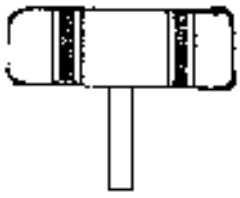
Thin Bristle Brush.

The first of these stripping devices (shown below) attaches to the end of my electric drill and comes under the brand name Triplex. Manufactured in France, it is distributed by some Mitre 10 stores. It looks a bit like a wire brush, but has synthetic bristles. These brushes come in two grades and the bristles are colour coded. Red for course, and Blue for medium. They are available in a variety of shapes.



Thick Bristle Brush. Attaches to any power-drill. Strips paint and varnish without damaging or scoring the timber.

The two most useful for stripping varnish are the thin bristle brush with bristles extending all around the wheel hub which is 7.5mm deep. The second is a thick bristle brush which has bristles arranged in clumps and the hub is 20 mm deep. Both brushes can be used on metal as well as wood. They are excellent for stripping paint and varnish without damaging or gouging the underlying surface. I find the thin bristle brush excellent for stripping paint close into corners or along joins. The thick bristle brush is better suited to larger areas. The thin bristle brush retails for $19.00 and the thick bristle brush at $27.00.



The wide bristles make faster stripping on larger areas.

The second range of products I've found to be particulary usefull for stripping paint and varnish is the range of Scotch Brite Surface Conditioning Discs manufactured by 3M. These are more cost-effective and faster for larger areas than the bristles brushes. I use the pads that fit my 4" angle grinder. These pads are best described as a flexible sanding disk that is made from what looks to be similar material to the kitchen Scotch Brite, but much tougher. Unlike normal sanding disks, these pads don't gouge the surface, and come in several grades: fine, medium and course. I find the medium grade the best for stripping soft paint and varnish. These pads come in a variety of sizes to fit all your favourite power tools, from 7" sander/polishers to belt sanders. The Scotch Brite range includes: Clean and Strip Discs, Surface Conditioning Discs, Cleaning and Finishing Discs, Light Deburring Discs.

The narrow bristles are excelent for stripping joints and corners.

Your Say - Q&A

Your Say will be a regular section in the newsletter, where all can contribute. You can ask questions of other readers, present your ideas and opinions on any boating subject. It is important that we have input from everyone.

Q. Where can I insure my Hartley Fijian ferrocement yacht? - ***Sean SA***

A. I contacted nearly every insurance company in the phone book, none would have anything to do with a ferrocement hull. Most could not explain why, nor were they prepared to write a specific policy excluding the areas for which they had most concern. I have been told that Anchorage in Sydney will insure provided a favourable survey is produced along with photos of construction etc. However the premium seem to be 3 times that of non-ferrocement yachts of same value. - ***Len "S/V Tava", Qld***

Q. What under-water paint systems are other owners using? What problems are you experiencing?

I know many owners who have spent a lot of time and money trying new systems, hoping that they are better than the somewhat inadequate systems applied 10 - 20 years ago. Most problems, besides the most catastrophic, surface 3-6 years after the system is first applied. I'd like to hear from all of you and I'll combine that with some research for a full article next month.

My own boat has now been in the water for 10 years, and after the fourth year small blisters appeared in the solid keel sections, approximately 10% of the total surface area. Each year these reappear, patching does not seem to help. - ***Ian "S/V Lilly-Ann", Qld***

Q. I would be keen to hear of any information regarding the treatment of rust-weeps - ***Joseline Qld***

COMMING EVENTS

I would like to hold a meeting at least once each two months to further facilitate informal discussion amongst ourselves and that I might get to meet some of you face to face. I would be good to arrange an "open boat" type meeting where we all can get to have a sticky-beak at each ofther's pride and joy.

For those of you not close to Brisbane, I will report back to you via this newsletter.

As most of us have a very busy schedule leading up to Christmas, I'll defer this event until the new year. Watch for the next newsletter for details.

CONTACTS

Ian McFarlane
Trudy Snowdon

"S/V Lilly-Ann"
69 Manly Road, Manly Q 4179
Ph: (07) 3348 6567
e-mail: mcfarli@citec.qld.gov.au

Len Brind

"S/V Tava"
Ph: 018 159 925

(Continued from page 1)

because of its properties, but I believe because of the following reasons:

- Ferrocement was, unfortunately, marketed as a medium that anyone could build a boat in within 12 months, with just a little help from the wife and kids! As many found out this was not the case. For starters anyone who has ever built anything at all will know to multiple estimates by 2 or 3 times if a worthwhile result is to be produced, especially for most it is the first attempt As well most home builders can only devote part of their time to the construction of their yacht, squeezing it between jobs and family commitments. Do the sums and that stretches out to about 8 years. Many builders alarmed by slow progress, speed up work and cut corners at the expense of quality. Many also attempt the plastering themselves. As this process must be performed quickly and the first time builder doesn't get much chance to practice, plastering is often not completed to a high standard. It is good advice to get this part done by a professional ferro plasterer, which now days can be hard to find.

... properly protected ferrocement presents extremely low maintenance - lowest of all materials ...

This doesn't mean the home builders can't produce good work, there are in fact many examples of ferrocement boats in Aus/Nz that are far superior to professionally build yachts. We hope to feature some of these over the coming months.

Building a ferrocement boat is a labour intensive process, but are you going to find building any boat easy? If you really want to sail and cruise and the building process is secondary to your objectives (or not at all) don't build a boat, buy one! You'll be on the water faster, and it will be a lot cheaper.

But for those who enjoy building things don't be discouraged.

- The standard of professionally built yachts is often poor, leaving a very poor benchmark. I believe most builders didn't understand what they were building, resulting from having little understanding of the material and it's properties.

It makes me cry to see some excellent designs betrayed by sloppy workmanship.

- Ferrocement was also marketed as cheap. Well it is. However to build a yacht to today's expectations the hull amounts to only 20 % of the total costs. Many private builders under budgeted and skimped on fittings and finish, which is a poor advertisement for ferrocement yachts.

- Many boat owners have very little understanding of electrolysis and do not fit sacraficial anodes or fit them correctly. Some even believe that ferrocement yachts don't need protection. Over the years, this causes the armature to be eaten away severely weakening the hull. Unfortunately this state is not repairable. In a large marina its not unusual for a yacht of 40' to consume 1-2 Kg of zinc per year.

Of course electrolytic corrosion affects other boats too. I knew of a fiberglass yacht owner who mentioned that he replaced his prop every 3 years, at considerable expense. It is all avoidable.

So be careful buying a second-hand boat. Inspect it thouroughly. This goes for any boat.

- Insurance companies now-days rarely insure on individual merit. Instead make broad sweeping generalisations and of course have taken all of the above points quite happily on board. Insurance is becoming more important to many yachties today, and therefore this has influenced many to condem ferrocement yachts with ignorance.

All of the above have nothing to do with the properties of ferrocement.

Many people have visions of 2" thick ferrocement sections, in fact most designs are 5/8". If properly protected ferrocement presents extremely low maintenance - lowest of all hull construction materials.

Everything has its pros and cons.

An interesting test Hartley performed during the early days was to beat a newly completed hull with a sledge hammer so that it shattered the concrete. Two years later the boat was removed from the water and no sign of damange was visable.

(Continued from page 3)

Multiply 50 feet times 0.00258 ohms per foot from table above to determine 0.129 Ohms of wire resistance, without allowance for any connection or terminal resistance, just wire itself. I would use at least #14 wire for a bilge pump, if the run were over 100' I would consider using #12.

But the major concern is connections! If you possess a very accurate ohmmeter you can directly measure the electrical resistance of each connection, expressed in ohms. Don't worry about this for now. My analysis over the years says the average connection (even crimped after it is used six months) measures a mere 0.03 ohms.
The average connection that was crimped and soldered measures 0.01 ohms. What does this mean?

Take our two preceding pieces of wire. There were three connections, right? That is what I counted. I would estimate the resistance in that wire after six months service to be about 0.09 ohms (3 x 0.03). Again not much, right? It would be much higher if corroded by salt water.

Ok, now lets examine a typical circuit in a boat. How about the bilge pump? A typical 12 volt pump would draw about 5.4 amps pumping water. What comprises the wiring circuit? Lets see, there is a battery, a battery switch, a + terminal distribution block, a fuse, an on/off switch, a float switch, the pump, a - terminal distribution block, back to the battery. Agree? Oh, plus some wire. Now I will examine this again and indicate in parenthesis (#) the number of connections.

... I suggest crimp and solder all new connections made for items drawing more than 3 amps ...

The positive post of the battery is connected (1) to a battery lug, which is connected (1) to wire, connected (2 wire to lug & lug to switch) to battery switch (1 for switch contacts too), connected (2) to a wire connected (2) to pos. distribution post. From post (2) to fuse (2 + 2 for removable fuse) via wire, and to on/off switch (5) each wire to lug plus switch itself), connected to float switch (1), then wire (1) to +lead of bilge pump, -lead of pump (1) neg. distribution post (2), and
neg. distribution post (2) to negative battery post (2) via wire and terminals. Did you follow that? That's 29 connections! 29 connections times 0.03 ohms each results in 0.87 ohms over all. That does not account for any wire losses, just connections. How did we get so many connections in the first place? Can we eliminate any?

Let's cheat a little to make our example a little easier to understand, at least the math, OK? Lets say there were only 20 connections, each 0.03 ohms. The result, 20 x 0.03 is 0.6 ohms. We will also assume no wire resistance loss, which of course is impossible. A typical battery voltage in use would be 12.5 volts to run our pump. What then is the voltage the pump actually sees? Does it receive the full 12.5 volts? No. The voltage is reduced at the pump in proportion to the resistance of the wire path (the sum of connection resistance and wire resistance) and the current
draw. In other words, more resistance or more current draw reduce voltage. Ohm's law states current in amperes times resistance in ohms equals the voltage drop in volts. So 5.4 amperes times 0.6 ohms equals 3.24 volts. What this means is that the wiring and connections, (the wiring network) consumes 3.24 volts, so that the bilge pump receives only 9.26 of the original 12.5 battery volts. Power measurement is the product of amperes times voltage and is expressed in watts.

	Battery	Wire Network	Bilge Pump
Volts	12.5	3.24	9.26
Amps	x 5.4	x5.4	x5.4
Watts	67.5	17.5	50.0

In summary:
Note: Amps remain the same in each item as the system is wired totally in series. The full amount of current must flow through each and every component, wire, terminal, and connection.

In this example the Battery must provide 67.5 watts to provide the pump with 50 watts, as 17.5 watts are consumed in the wiring network and lost as heat. That is a 26% Loss of power!

This is the point in the class we get our voltmeters out and actually measure the voltage drop from connection to connection. Try it yourself! Take the positive lead of your voltmeter (set to measure 15 volts or so) and attach it to the positive battery post with a clip. Then put the negative lead on any connection down the wire path of something drawing current. You can measure the drop in each wire and connection as you continue down the path. (Note: you may have to adjust measurement scale. Always work your way down the scale to avoid damaging you meter). Got a lamp on? Try measuring the voltage at the bulb, then at the battery. What is the difference in value? Where did the voltage go? It was dissipated as heat in connections and wire. Ever notice a wire get warm or hot? Ever feel the heat in the battery wires after starting your diesel? Want to make it start easier? Reduce the resistance in the connections. Want to know which connections need repair? Feel them for heat.

What can be done? It would be hard to have fewer

(Continued on page 8)

(Continued from page 7)

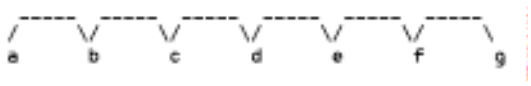
connections. Many installations will have even more connections than this. What we can do is keep the connection esistance low. I suggest crimp and solder all new connection made for items drawing more than 3 amps. In the example above, if we reduce the per-connection resistance to 0.01 ohms, the power loss would be reduced from 26% to about 8% and the pump more water per minute, reducing the on time, thus conserving battery energy. That means you can charge for less time.

When I talk of ring terminals, I like to pass around some examples of wire I removed from boats. Some have crimp terminals that were squeezed by a pair of pliers, not the proper tool. Some are not squeezed enough and are mechanically loose, meaning you can push or pull and move the wire in the connector. Others are squeezed beyond recognition. You have seen them. They are in every boat. Some were in mine too. I have examples of properly crimped connectors on good, tinned multi-strand wire, and on non-tinned copper. I have crimped and soldered terminals. On each of these, I place a tag indicating the resistance in ohms of each. The values range from a
low of 0.01 ohms (did you guess the crimped & soldered terminal?) to well over 8 ohms (a loose crimp on untinned copper). Many are in the 0.5 to 2.5 ohm range, as the wire has oxidized inside, after the crimp was made. The poorest connections result from using untinned wire. Next come crimps made without the proper tool. Can you find
any terminals so described in your vessel? Invest $6 to $10, buy a good crimp tool, and replace those loose or improperly crimped terminals with new ones well made. It will save you energy and future trouble shooting time.

...solder each crimped terminal for lowest possible resistance and longevity ...

Often short pieces of wire, 1" to 3" in length, with a ring or fork terminal on each end is used to interconnect other wires, attempting to establish all interconnected wires at the same voltage potential, but in a series string of connections. For some reason, boats made in Taiwan use tons of these along with barrier strips in place of bus bars. Ever look inside one of those really fancy yachts at the boat show and open the electrical panel? You will see, row after row of barrier strips (black phenolic strips with screws to attach wires), and many short pieces of wire to interconnect the wires. Look hard, as the bundling of wires can make it hard to spot. Electrically it looks something like this:

Each link will add about 0.09 ohms of resistance if well made. I have shown 6 links to get from point a



to point g. That results in 0.54 ohms between points a and g. We call this a series string. To make the panel look nice, the feed point would be point a. It would look messy if it were the middle, point d, so point a is often the feed. If the circuit breaker or fuse of your bilge pump were connected to point g, then 5.4 amperes would flow through each link in the series string. Right? Yes! And 0.54 ohms
times 5.4 amps result in a 2.9 Volt drop just across the series link! Now add that to the 3.24 volt drop from the wiring network and see if the pump works very well! A series string is bad because of all the added connections. There are preformed strips, one piece of metal with many fork like terminals, that are made to use in place of the wire links. Remove the links where possible and use the preformed strips. Any questions?

Another method, is to change either the feed point, or the load point (where along the strip, point a to g, a wire is taken to a fuse or circuit breaker) for larger amperage devices, i.e. Ham radio, VHF radio, etc. You can increase time between battery charges just by moving a connection or two, to reduce wiring network losses. Does this make sense? Sure it does, if you can reduce your wiring loses by 8 to 10 percentage points, its the same as adding capacity to your batteries. In addition the range of your radios will be increased and most likely last longer.

A few boats have bus bars, copper bars with many screws for securing ring terminals. These are much better electrically than barrier strips. Bus bars are designed to make many connections at one voltage potential and very little interconnection resistance. They do that very well. Barrier strips were made to make many independent, non-interconnected connections appear neat. They do that very well. Some builders have not realized this.

If I could tell boat manufacturers something, I would tell them to use a combination of bus bars and barrier strips to make up their electrical panels (often pre-made outside the boat) and solder each crimped terminal for lowest possible resistance and longevity. The panel should be designed with strong posts to attach heavy gauge positive and negative wires to the battery.

I really like the use of distribution panels, because they are neat and place all the electrical distribution in a common location. However they add a considerable number of extra connections in the wiring path and are often the source of many loose or poorly made crimp terminals. Extra care need be taken to make the panel a true asset.

Marine instrumentation manufacturers recognize loose, corroded, and poor electrical connections cause problems and premature failure in their

(Continued on page 9)

(Continued from page 8)

equipment (radios, radar, GPS receivers, etc.) and instruct the customer to connect their equipment directly to the battery. How many times have we read this in the instructions? How many wires do you have on your battery posts? This is a bad and unsafe practice. Yes, I can recognize the importance of lowering the circuit impedence by having the power source as close to the battery as possible, but first we must provide for safety. Small, unfused wires can easily short and cause a fire. It has happened many times. If the battery terminals are maintained clean, the wire size adequate, and the terminal and connections made properly, clean and tight, then there is no reason not to connect the equipment to a properly fused and laid out panel. The only small wires directly atttached to the battery should be those used for battery voltage and temperature sensing for a sophisticated regulator system. More about that in a future article. Often the overall system performance, i.e. battery charge hours, can be increased 10% to 15% by just remaking the battery to distribution point cables, using proper sized tinned wire with new terminals properly crimped and soldered for longevity.

...With very bad connections, a VHF will cut in and out very rapidly, a term called "motorboating", making it difficult or unable to understand ...

Have you ever heard of a HAM radio 'FM'ing? It is generally due to poor connections resulting in a decrease of voltage (and power) available to the transmitter as these typically draw 20 amps during transmit. Also, a VHF radio will have more power out, if it has more voltage in. With very bad connections, a VHF will cut in and out very rapidly, a term called "motorboating", making it difficult or unable to understand.

Many items will perform better and last longer, like motors, fluorescent lamps, inverters with less resistance in the wiring network. Incandescent lamps will be brighter and burn out sooner.

Now before you go and tear your electrical system apart, keep in mind which items will benefit the most. Don't take everything apart. Start at the Battery terminals. Are they clean and mechanically tight? Are the battery wires properly terminated into the proper sized connectors? The what electrical items are used more often or have longer on times? Decreasing electrical resistance to electric refrigeration, inverters, 12 volt appliances like TV's and VCR's, HAM radios, older Radar units,

VHF radios, and any cycling pumps will produce dramatic increases in system efficiency for little work invested.

Once I was asked, "I have a strange problem. I have a cabin light that does not work. The bulb is good. When I take the bulb out, I measure 12 volts at the socket, but it won't light when in the socket. What can be wrong?" When I measured the voltage cross the bulb, I observed only a quarter volt or so, not enough to light the bulb. A connection in the wire path was so badly corroded, the high electrical resistance did not allow enough current to light the lamp, yet a voltmeter needs very little amperage to measure voltage. The result, the wire net was current limited and would not light the lamp. The cure; isolate and repair the connection. I had seen this in another boat where the wires ran through a small hole drilled in a bulkhead. The insulation was damaged at the hole and salt water oxidized the copper to green dust (a form of copper oxide). It was hard to locate, as the actual fault was in the middle of the bulkhead.

Can you think of other reasons to count the number of connections and clean up the ones with heavier current loads? We will return to this again and again. Believe me!

cameron@unix.infoserv.net