www.electric-boat-association.org.uk
Volume 18 Number 1 Spring 2005

Electric Boat NEWS

The Journal of the Electric Boat Association Supported by the Broads Authority

Fuel Cells Afloat • The Summer Season
Electrics at Sea • Outboard Pioneer

CLASSIFIED ADVERTISEMENTS

Electric Skiff: 16'3 x 4'2 black grp simulated clinker hull (moulded from original Yare rowing skiff). Pine/Jarrah planked decks and cockpit sole, mahogany inset transom. All woodwork epoxy treated both sides, high gloss varnish finish. Fitted Briggs and Stratton electric motor, 4QD controller, 4 x 12v (38 ah) batteries giving 24 volts. Side wheel steering, many brass original parts used. Complete with fully galvanised custom built trailer. £4,200. For picture see page 9.
Contact Paul Morton 01603 721343 Mobile 07860 731767.

Moth – Frolic 18 – 200 Electric Day Boat: Length 18'. Beam 4' 8. Electric pod engine, fibreglass hull, hardwood joinery with brass fittings, green tonneau cover, built-in battery charger, new batteries fitted August 2002, cushions. Price £7,750 o.n.o.
Telephone Jan Smulders 01628 522159 (Bourne End)

Members wanting to buy or sell electric boats, motors, fittings or associated equipment are invited to submit a 50-word entry direct to the Editor (Note: No agents or brokers). The information contained in members' private advertisements is provided by the advertiser and the Editor is unable to vouch for their accuracy. It is the responsibility of prospective purchasers to satisfy themselves as to the accuracy of the information given and of the condition of goods advertised.

Information sheets from the Electric Boat Association

1. **PRODUCT GUIDE & EBA TRADE MEMBERS**
(free upon request)

2. **SOLAR PHOTOVOLTAICS** by Paul Lynn

3. **ELECTRIFYING YOUR BOAT** by Hawthorne & Wagstaffe

4. **HULL DESIGN FOR ELECTRIC BOATS**
by Andrew N Wolstenholme

5. **LEAD ACID BATTERIES – OPERATION & MAINTENANCE**
by CMP Batteries

6. **HIGH SPEED ELECTRIC BOATS** by Lorne Campbell

7. **HYBRID POWER** by John Hustwick

8. **TRAILERS AND TRAILING** by Paul Lynn

9. **FITTING OUT AND LAYING UP YOUR BOAT** by John Hustwick and Ian Rutter

Available:
Free to members Nos. 2-9
Non-members @ £1.50 per copy

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EBA CALENDAR

April

18th	EBA Event	Launch Supper Maidenhead Rowing Club

May

7th – 8th	EBA Represented	Lowestoft Boat Show
14th – 15th	EBA Event	Cruising weekend on River Great Ouse
22nd	EBA Represented	The River Festival The Docks, Bridgwater

June

10th – 12th	EBA Represented	Beale Park Thames Boat Show Pangbourne
15th – 21st	EBA Interest	RYA Rally River Thames
18th	EBA Event	Biennial General Meeting Cookham Reach Sailing Club incorporating a Thames picnic cruise
18th – 19th	EBA Represented	Dartmouth Go Boating Event
23rd – 26th	EBA Interest	Reading Water Fest

July

9th – 10th	EBA Interest	Shrewsbury River Festival
10th	EBA Represented	Steam and Electric Boat Day Sudbury, Suffolk
16th – 17th	EBA Represented	Thames Traditional Boat Rally Henley

September

10th	EBA Event	Norfolk Cruise weekend incorporating
11th	EBA Represented	Broads Electric Boat Show

October

tba	EBA Event	Laying Up Supper

For further details of the above, or notice of other events, please contact the Secretary

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CONTENTS & EDITORIAL

Contents

For years there has been talk of using hydrogen to supply emission-free electrical power, but it was only when I saw a fuel cell turning a boat's propeller at the London Boat Show that I realised that this technology is far from being just a dream. So it's very interesting to discover more about some of the experimental fuel-cell powered boats already on the water.

For the crews of our more conventionally-powered electric boats, the summer season is starting with the Launch Supper this month and a busy programme of events in May and June. The EBA will be represented at the Lowestoft and Beale Park Boat Shows as well as at the Bridgwater River Festival. Unfortunately, because there was very little interest from business members in the proposed Electric Boat Show at Huntingdon, this has reluctantly been abandoned as an official EBA event, although some members will be exhibiting at Hartford Marina over the weekend of 21st and 22nd May. As last year's one-day cruise on the River Great Ouse attracted a record attendance, this has been extended to the two days of 14th and 15th May. On 18th June at Cookham we combine business and pleasure with the EBA Biennial General Meeting followed by a picnic and Thames cruise.

More details of forthcoming events are on page 8. Keep an eye on the EBA website for updates – and fingers crossed for fine weather for all our boating activities.

Sylvia Rutter

Copy Deadlines:

Material to be considered for inclusion in the next edition of Electric Boat News should be sent to the Editor (preferably by email) by the following date:

Summer 1st June

Editor
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Cookham Dean, Berkshire, SL6 9TR
Tel: 01628 476158
Email: sylvia_rutter@onetel.com

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...and America Page 18

FUELLING THE FUTURE

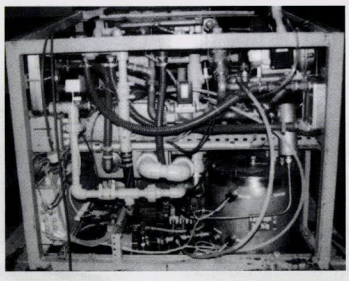
With the increasing interest in using fuel cell technology to produce electricity, Kevin Desmond has been investigating a variety of projects using fuel cells in boats.

In 1970 Professor Karl Kordesch built a hydrogen alkaline fuel cell/battery hybrid vehicle for four passengers, which operated for three years in city traffic. Fuel cell use for the propulsion of boats came thirty years later.

In 2000, Zemar, the marine division of ZeTek installed a 5kW fuel cell system in the *MV Leipstadt* trip boat which made her maiden voyage on 1st June at Expo 2000 in Leipzig.

etaing GmbH was the first German company with a fuel cell system, named Europ 21, which was specially developed for private and commercial maritime use. Europ 21 uses a ZeTek alkaline fuel cell to turn oxygen from the air and hydrogen into electricity using a cold combustion process. The only by-product is pure water. In the second quarter of 2000 the system was installed in a demonstration pleasure boat, the 12-metre *Hydra*. A tough light plywood open boat with an eight kilowatt DC Lynch motor, *Hydra* could accommodate 20 passengers.

Hydra in Leipzig


Hydra's fuel cell system

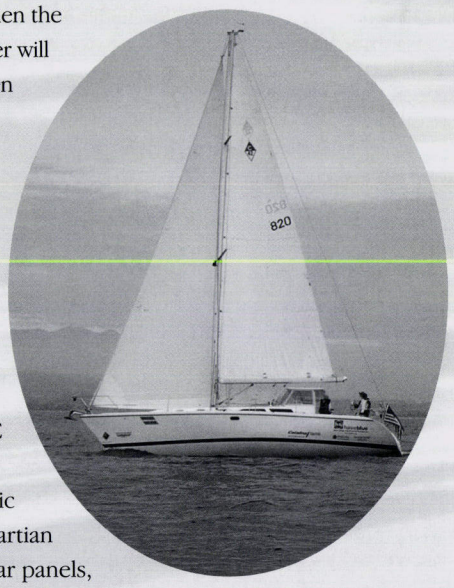
Hydra went on trials around the canals of Leipzig, followed by public demonstrations in Bonn and along the Ketelvaart and Leie canals of Ghent in Belgium, carrying over 1,600 passengers. Everything was primed for further development but then unfortunately in September 2001 etaing went into liquidation.

Elsewhere in Germany, however, there were other developments. On 22nd October 2003 in Kressbronn on Lake Constance, MTU Friedrichshafen unveiled the first yacht with a fuel cell propulsion system certified by Germanischer Lloyd. The 12 metre-long yacht was named *No.1* and its auxiliary fuel cell system, the 'CoolCell', used in calm waters and for manoeuvring in harbours, supplies electrical energy for the propulsion system as well as for the onboard power supply. It is an electric hybrid system comprising gel batteries and several fuel cells, which are manufactured by Ballard Power Systems, and it emits no pollutants. There are four fuel cell modules, with an electrical output of 1.2 kilowatts each, along with nine lead acid batteries, which together can deliver up to 20 kilowatts.

Meanwhile in San Francisco Bay, the Duffy Electric Boat Company launched a 10 metre water taxi carrying 18 passengers which has a fuel cell/battery electric hybrid engine. The boat is equipped with four Anuvu Power-X fuel cells, each capable of generating 1.5 kilowatts and it can cruise at five knots while emitting only water vapour. The hydrogen used in the fuel cell equipment is derived from boron carried on board in pellet form.

The trials of this boat resulted in Anuvu finalising details to be the San Francisco Water Transit Authority's contractor for the world's first fuel-cell powered commuter ferry. The 149-passenger ferry, a 79 ft double-decker, will run between 'Frisco' and Treasure Island. It will have a 240 kilowatt power plant using twenty individual 12 kilowatt fuel cell stacks wired together which will be fed hydrogen via a metal hydride cylinder. When the ferry is docked, the cylinder will be restocked with hydrogen via a pipeline.

Also in California, a Catalina 42 Mk II sailing yacht is currently being used as a test-bed for hybrid fuel propulsion. Called the *Haveblue X/V-1*, the vessel is testing a variety of systems producing DC electricity: the Solomon ST-74 regenerative electric motor/generator ('the Martian Wheel'), 640 watts of solar panels, and a Rutland 913 wind

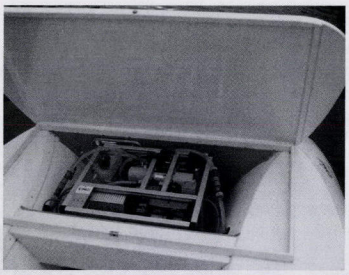

Haveblue X/V-1

generator. The vessel's ultra-pure fresh water is produced by a customised Spectra Newport 400 reverse osmosis water maker. Then an on-board electrolysis unit produces hydrogen and oxygen from the water and the hydrogen can be stored in tanks on board to be used by the fuel cell.

The X/V-1 will obtain water from wherever it is afloat and will be virtually independent of shore power. Haveblue is gathering data with the aim of designing systems for mass production by boat builders around the world. Under its current schedule the boat will be fully integrated in late spring with all-hydrogen sea trials starting by this summer.

In Switzerland the company MW-Line (who supplied the solar-powered boat for Chichester harbour) is testing fuel cell propulsion in a boat called *Hydroxy3000* which is intended for family leisure use on inland waterways. The company is working with a number of Swiss universities and research institutes and the project is supported by the Swiss Federal Energy Department.

Hydroxy3000 is a seven metre long catamaran which can take six passengers. Without passengers it weighs 1500 kilos and the catamaran design combines stability with manoeuvrability. It is virtually silent and produces no emissions, protecting fresh water resources on lakes and rivers.

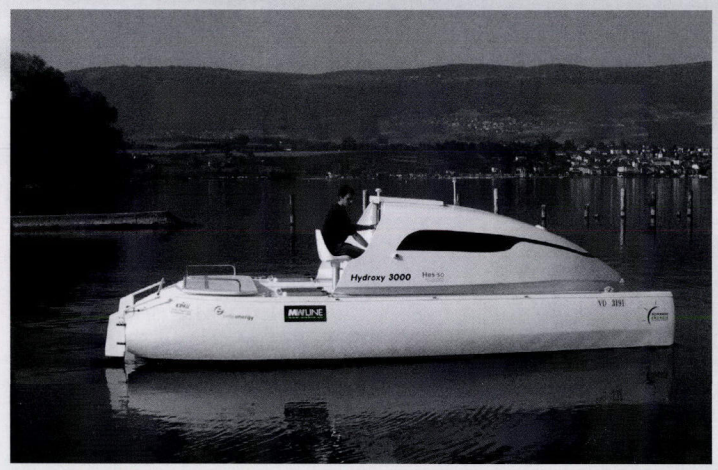


Fuel cell on Hydroxy3000

The boat has two six kilowatt electric motors supplied by a three kilowatt water-cooled proton exchange membrane fuel cell at 48 volts. It can travel at twelve kilometres per hour, or a maximum of eighteen with battery buffer. The three kilowatt fuel cell stack has 73 fuel cells which deliver a 60 amp current with a variable voltage of 40-60 volts. Hydrogen is stored at 200 bar in two pressurised aluminium/carbon containers at the front of the boat.

The German navy is using fuel cells in submarines. Germany has always been at the forefront of submarine technology: its first *U-32* 'Unterseeboot' saw service in 1914-1918 among the 'wolf packs' and in 1940, before she was sunk, the second *U-32* conducted nine patrols, sank 20 ships and damaged five more. The third *U-32*, a Type 212 built by Thyssen Nordseewerke of Emden, is a diesel-electric submarine developed by Howaldtswerke-Deutsche Werft (HDW). It features an air-independent propulsion system using nine 34 kilowatt Siemens hydrogen fuel cells. This allows the submarine to cruise under water for weeks without surfacing, silently and with no exhaust heat.

HDW is the first shipyard in the world to offer a fuel-cell propulsion system ready for series production. This has major implications for the world's shipbuilding industry. An initial order of four Type 212 submarines was placed by the German Government in 1998. Two more are being built by Fincantieri for the Italian Navy. The submarines are 56 metres long and can travel submerged at 20 knots. Their range is 11,000 nautical miles at 11 knots surfaced, 250 miles at 4 knots submerged.

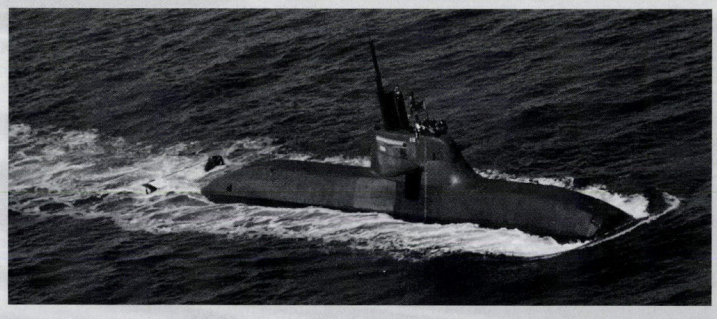


Hydroxy3000

The idea of using fuel cells to generate electricity has been around for a long time: British physicist William Robert Grove invented the hydrogen fuel cell in 1838. The technology took off in every sense during the space race of the 1960s, with fuel cells on board the Gemini and Apollo spacecraft. In recent years, with increasing concern about the burning of fossil fuels, it is being developed for use in power stations, cars and bikes. Boeing are even experimenting with a fuel-cell powered aircraft.

Fuel cells use the chemical energy of hydrogen to generate electricity without combustion or pollution. Hydrogen gas is passed through a series of platinum-covered polymer membrane cells. Each cell strips electrons from the gas, creating a small flow of electricity, and when lots of cells are added together a significant amount of electricity can be generated.

In the UK the fuel cell system used to power the lights on the Trafalgar Square tree last Christmas was assembled and installed by the Aberdeen company siGEN and sponsored by BOC and Johnson Matthey, both members of the London Hydrogen Partnership. The system will be used at public events across London and will be on loan to the College of North West London as a training tool for students studying fuel cell and hydrogen technology. Transport for London is testing a fuel cell system to provide power for London buses and is looking at the use of the same technology for a boat. So we may see a fuel cell powered boat on the Thames before too long. As well as maybe one day a 'hydrogen economy' using silent, pollution-free technology to produce electricity.

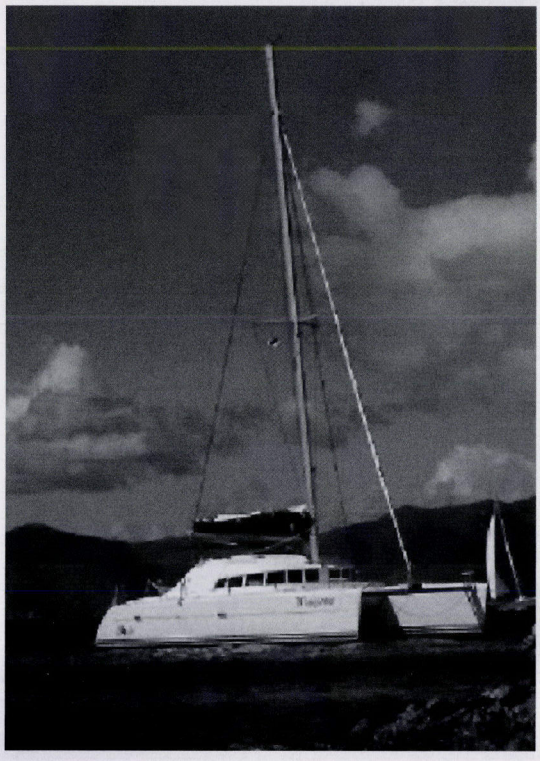


Fuel cell submarine U-32

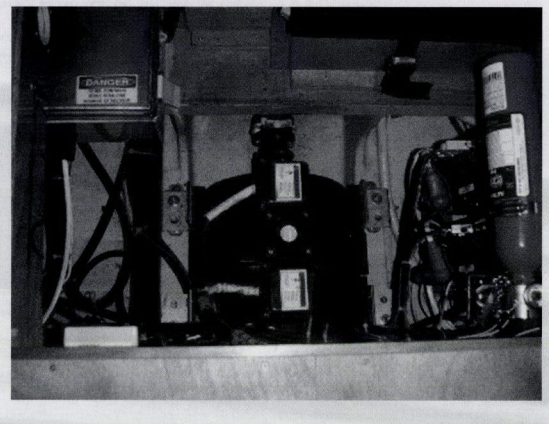
ELECTRIC BOAT FOR CHARTER

Brian Pickess reports from the Caribbean on a unique boat available for charter in the British Virgin Islands.

Waypoint, a 2004 Lagoon 410S2 owner's version catamaran, is revolutionising the sailing industry by being the world's first charter multihull to be powered by the Electric Wheel from Solomon Technologies. We were shown over the boat by Catamaran Charters' bareboat manager in Nanny Cay, Craig Cochran. *Waypoint's* twin brush-less ST74 (12 horsepower) motors with NdFeB magnets, are powered by twelve 12 volt batteries. Designed as a 'green boat', *Waypoint's* props and electric wheel system regenerate power by charging its batteries while sailing. Electrical regeneration occurs while sailing on the downside of waves.



The motors are designed for 150,000 hours of operation and with only four moving parts there is virtually no routine maintenance required. Galvanic corrosion and electrolysis have been eliminated with the use of the patented shaft collar. A powerful 15 kilowatt diesel generator in this hybrid boat ensures an uninterrupted supply of energy for *Waypoint,* when she is not sailing or connected to shore-power, to recharge the batteries and provide power for onboard luxuries such as air conditioning and the entertainment system.



Waypoint successfully completed a 3200 nautical mile crossing of the Atlantic from Lagoon's factory in Les Sables d'Olonne in France to Annapolis, USA, only the second Atlantic crossing by an electric powered catamaran sailing boat. *Waypoint's* electric regeneration abilities were put to use when sailing, providing power for charging of her batteries and for all of her electrical needs. In fact, so much excess power was generated that the delivery captain had to run the air-conditioning and water heater for hours just to avoid over charging the batteries!

On windless days the electric motors propelled her at up to 7 1/2 knots and ran for 4 - 5 hours on a full battery charge. The efficiency of the motors is such that 90-94% of the energy is actually used for propulsion. *Waypoint's* seaworthiness was proven as she passed through three different gales with wind speeds as high as 57 knots and 30-foot seas without any problem.

Waypoint arrived at the Catamaran Company's Nanny Cay base in the British Virgin Islands in December 2003 to begin her charter life. Her owners Dennis and Denise English were part of the crew on this 1300 nautical mile trip from Virginia to Nanny Cay which took eight days.

The unique owner layout of the electric 410 will provide savings in galley and cockpit space. Seven people can now be accommodated on board, as opposed to six on traditional owner layouts. *Waypoint* has now completed a trouble free and successful first charter season.

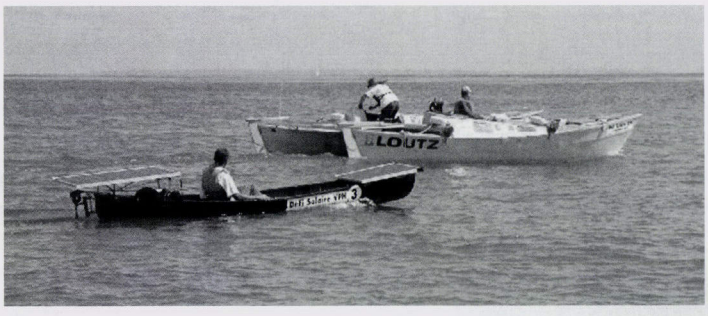
NEWS

EXTRA DISCOUNT FOR BROADS ELECTRIC BOATS?

The working group studying the tolls structure for boats on the Broads has recommended that the discount for electric boats should be raised from 25% to 30%. The group, which represents key boating interests on the Broads including the Norfolk and Suffolk Boatbuilders Association, also recommended a reduction in rates for small non-powered craft and modification of the toll system to help hire fleets.

The recommendations were welcomed and approved by the Broads Management Committee on 24th March. Tollpayers will have a chance to comment on the proposals in April and May, with a final decision on the level of charges from April 2006 to be made by the Broads Authority in July.

CROSS-CHANNEL SOLAR CHALLENGE



Cedric Lynch in the 2003 French Solar Challenge

The fourth Solar Challenge organised by Concept Helios Propulsion will be for a Channel crossing between Seine Maritime and East Sussex by one or more solar-powered boats in the summer of 2006. A prototype boat the *Transmanche Solaire* is scheduled to be built in July 2005. The organisers are looking for more sponsors and for British solar boat contestants.

Two EBA members have been involved in previous Solar Challenges. Malcolm Moss (who holds the record for the first solar crossing of the Channel in his boat *Collinda* in 1997) took part in the first one and Cedric Lynch won the small boat section of the 2003 Solar Challenge in Normandy in his solar-powered canoe.

Concept Helios Propulsion is at 13 allée Aliénor d'Aquitaine, 76240 Bonsecours
Tel. 00 33 2 35 80 29 77, website www.bateauxsolaires.com
For more information contact Philippe Boegner,
Tel. 00 33 2 35 98 67 24 or e-mail: pboegner@aol.com

HAMBLEDEN JOINS BOURNE END

EBA business members Hambleden Sales & Charter are expanding their brokerage business to cover sales at the newly refurbished Bourne End Marina. This represents a development of their traditional river craft business in offering more modern boats for sale.

Bourne End Marina

Hambleden Sales & Charter will continue to operate from their base upstream of Bourne End at Hambleden Mill. Boats will be personally inspected and valued before being marketed through both companies' websites and display boards.

For more information contact Gillian Nahum on 01491 578870 or e-mail: gillian.nahum@virgin.net

NEW CHARGING POINTS AT BARTON TURF

Albert Lambert reports that the manager of Cox's Boatyard at Barton Turf near Norwich has installed 16 amp charging points which are fully rated for electric boat charging. In addition to those allocated for the private moorings, where Albert has been charging his boat *Patience* for over a year, the boatyard is now able to accommodate up to ten other boats. 'Go Electric' have been campaigning for more recharging facilities on the Broads and are hoping that the Broads Authority will in time install more charging points throughout the area.

The Manager of Cox's Boatyard is Eric Bishop,
Tel. 01692 536206, e-mail ebishop@coxsboatyard.co.uk

RYA THAMES RALLY

The Environment Agency and the RYA are organising a rally on the Thames from 15th to 21st June, offering help to inexperienced boaters or those new to the Thames. Throughout the rally a team of RYA instructors will be on hand with assistance and advice on things like mooring and using locks safely. There will be boat handling demonstrations as well as a Boat Handling Competition for adults and children.

Windsor Yacht Club, Penton Hook Yacht Club and Thames Motor Yacht Club are providing facilities and moorings and there will be a full social programme with barbecues, suppers and receptions.
The registration fee per boat is £60.

For more information telephone Katie Wales at the RYA on 0845 345 0370, e-mail cruising@rya.org.uk or see www.visitthames.co.uk/goboating.

GREEN POWER AT THE MILL

The Mill at Sonning Dinner Theatre on the Thames will soon be producing all its own electricity. A new scheme will not only generate enough power for the theatre's arc lights, footlights, spotlights and house lights but also for the restaurant, kitchen, dressing rooms, wardrobe areas, set construction workshops and offices.

The Mill at Sonning mill race

The project to install an 18.5 kilowatt turbine is under the supervision of Derwent Hydroelectric Power and is being funded by the owners of the Mill with contributions from Oxfordshire County Council, South Oxfordshire District Council and a corporate donor. About 162,000 units of electricity will be generated each year and an anticipated surplus will be sold back to the National Grid.

There has been a mill at Sonning since at least the time of the Domesday Book. The present building dates back to the eighteenth century and supplied flour to make Huntley and Palmers biscuits in Reading. It became derelict after its closure in 1969 until it was converted into a theatre and restaurant.

Completion date for the hydroelectric scheme is in two months time. Although at the moment plans do not include installing charging points for electric boats, the General Manager, David Vass, said he would certainly give this consideration once the project is up and running. So one day in the future it may be possible to enjoy a meal and a play while your electric transport is charging up at the back of the building.

More information from the Mill at Sonning website on www.millatsonning.com or telephone 0118 9697082

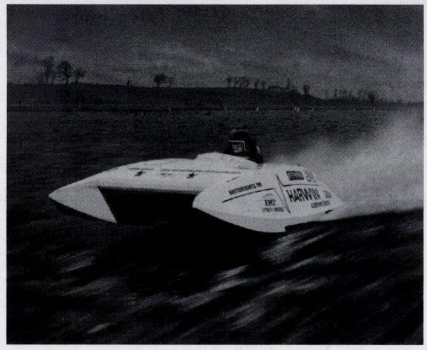
SHEEP AHOY!

An electric boat in the Midlands saved a sheep from a watery grave. EBA members Brian and Diane Cooke were on the River Soar in their boat *Blotto* when they spotted what they thought was a dog paddling along in front of them. But it wasn't a dog, it was a sheep, which had fallen in while being moved from one field to another. Fearing that its heavy fleece would become waterlogged and drag it down, they used the boat to nudge it towards the bank, while waving and gesticulating to the farmer, who hadn't noticed that one of his flock had gone astray. Then by carefully manoeuvring the boat, and with the help of the farmer and his assistant up to their knees in mud on the bank, they managed to get the sheep back on to dry land, where it trotted off, apparently none the worse for its experience – leaving Brian and Diane very pleased with their good (or should that be ewe?) turn.

RECORD-BREAKING BOAT TO RUN AGAIN?

An Stradag, which set the first officially acknowledged world speed record for battery-powered electric boats, may make an attempt to regain the record, now held by the United States. The boat, which has been on display at the Lakeland Motor Museum, achieved 50.825 mph at Holme Pierrepont in 1989 with 71 year old Fiona, Countess of Arran at the controls. It has just been sold to a Cumbrian businessman, Henry Engelen, who plans to have it refurbished it with a view to achieving speeds above the current record of 70.6 mph.

Agni Motors have offered to supply new and more powerful motors but Mr. Engelen is looking for further sponsors for items such as special paint, powerful quick discharge batteries and aerodynamic improvements. The record attempt may take place on Coniston Water in October this year.



The Countess of Arran capturing the World Speed Record in 1989 Painting by Arthur Benjamins

More information from henry.engelen@tinyworld.co.uk

ELECTRIC CRUISES IN HOLLAND

A classic Swedish launch has been restored in Holland for a cafe restaurant in Reeuwijk. The 12 metre long *Sälsten*, whose name means 'rare', was built in Sweden in 1924 to carry passengers to and from islands in the fiords (and is rumoured also to have been used for alcohol smuggling at one time). Brought to Holland in the 1990s, the boat has been rebuilt by the Tatje boatyard which installed a hybrid diesel/electric propulsion system to replace the original steam plant. It is estimated that the boat will travel under electric power for 80% of the time.

Sälsten can carry 20 to 25 passengers in comfort for cruises in the Reeuwijk lake district or further afield to Gouda or Rotterdam, and can be booked for parties, presentations and conferences. In addition to the *Sälsten* the restaurant, the Wapen van Reeuwijk, also has smaller Volta 540 electric boats for hire. **For more information on the *Sälsten* the restaurant's telephone number is 00 31 182 301774**

Sälsten at the Wapen van Reeuwijk

THE SUMMER SEASON

Not so much debs and diamonds – the Season for boating enthusiasts is more about crews and cruises, although picnics, Henley and even champagne may still have a part to play. With the summer season almost upon us, this is a round-up of some of the events the EBA will be involved in during the next few months.

East Anglian EBA members will be at the Lowestoft Boat Show on 7th and 8th May promoting electric boating and the 'Go Electric' grants on offer for the conversion of Broads boats to electric propulsion. At last year's event a lot of interest was shown in the scheme, with several grant applications made shortly afterwards.

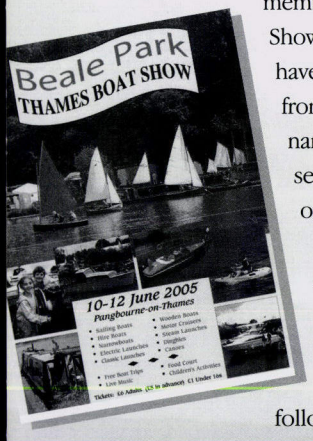
The following weekend, 14th and 15th May, EBA activities move to the River Great Ouse with crusing from Earith on Saturday and Sunday and a dinner organised on Saturday evening for those who wish to attend. Members with or without boats and invited guests will be very welcome to come for one or both days. Last year's Ouse Cruise, in beautiful weather, attracted the largest gathering of electric boats ever recorded on a waterway other than the Thames.

LINDA BARRELL

Ouse Cruise 2004

One week later the EBA stand will be set up at the Bridgwater River Festival, offering information to potential new members from the Somerset area. The festival site is next to the River Parrett and accessible from the Bridgwater & Taunton Canal and boat trips, exhibitions, craft workshops and music are promised by the organisers for May 22nd.

The next job for the EBA stand will be supporting EBA business members at the popular Beale Park Thames Boat Show from 10th to 12th June. This year's event will have over 170 exhibitors and feature a range of craft from dinghies and dayboats to classic launches, narrowboats and cruisers. The beautiful lakeside setting by the Thames is the ideal spot for trying out a range of boats.



June 18th is the date for the EBA Biennial General Meeting, to be held this year at Cookham Reach Sailing Club. After the morning meeting members will adjourn to Waters Edge at Bourne End for picnics, followed by a Thames cruise.

On July 10th the EBA will be represented at the Steam and Electric Boating Festival on the River Stour. This popular annual event, based at Sudbury in Suffolk, attracts a variety of boats, including the electric trip boat operated by the River Stour Trust.

The EBA will again be supporting business members at the Thames Traditional Boat Rally at Henley over the weekend of 16th – 17th July. The beautiful setting, relaxed atmosphere and the chance to see a variety of traditional boats always attract large crowds to this annual event.

With autumn approaching, the last main boating event of the year is the popular Norfolk Weekend on September 10th and 11th which combines cruising in convoy on the Saturday, followed by dinner, with a visit to the Broads Electric Boat Show at South Walsham Broad on the Sunday.

LINDA BARRELL

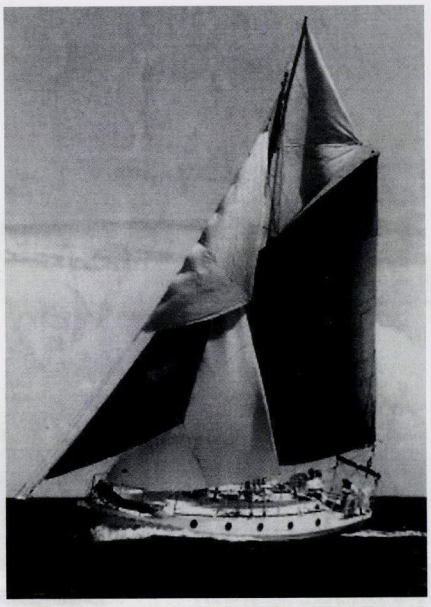
Broads Electric Boat Show 2004

More information:
Bridgwater River Festival
Tel. Caroline Dunn 01823 356156 e-mail: cldunn@somerset.gov.uk
Beale Park Thames Boat Show
Tel. 0870 777 7160 e-mail: events@bealepark.co.uk
Steam and Electric Boating Festival, Sudbury
Tel. John Morris 01473 822612
Thames Traditional Boat Rally, Henley
website www.tradboatrally.com
For the Great Ouse Cruise on 14th and 15th May contact EBA Secretary Barbara Penniall on 01491 681449 or look at the EBA website www.electric-boat-association.org.uk

ELECTRIC PROPULSION AT SEA

In October last year (Electric Boat News Volume 17 Number 3) EBA business member Graeme Hawksley discussed his development of a hybrid electric system for small ocean going craft which he is planning to install in his self-built boat *Maud*. In this article he goes into more detail and describes his progress so far.

The use of electric drive in the marine industry is highly polarised. Vessels are either small river craft using drive systems of up to a few kilowatts or very large passenger and cargo ships with many megawatts of power (for example the new Queen Mary II). When considering small vessels in tidal waters, use of electric drive is very limited. The higher power demands and range requirement of ocean going craft are not addressed by the existing inland waterway systems. Battery buffered hybrid/electric drive systems are well placed to bridge the gap between large and small vessels. A number of manufacturers are offering hybrid systems and the potential market is very large.



Sailing sloop Brilleau sister ship of Maud, which will have the hybrid system installed

If we look to the automotive industry, as an indicator of what could happen in the marine environment, we see some very interesting developments. Most major automotive manufacturers have hybrid/electric programs. This is partly driven by legislation (emission targets) and partly by the advantages hybrid systems offer. Hybrid cars are 30% to 50% more fuel efficient than their conventional counterparts. For slow speed motoring in city environments, battery power provides efficient pollution free operation. In America the Ford motor company calculates current hybrid vehicle sales as less than 0.2% of the market. By 2020 Ford estimates 15-25% of new cars will be hybrid. This massive growth will again be driven by legislation but also by the changing attitudes of the consumer. We are becoming receptive to the concept of paying more up-front for polluting less.

In a marine hybrid system battery power can be employed when operating conditions allow (see fig 1a). For extended range and power requirements an internal combustion engine (ICE) is utilised. This ICE can drive the vessel directly in a parallel hybrid system (fig 1b). Alternatively the engine can drive a generator to form a serial hybrid (fig1c).

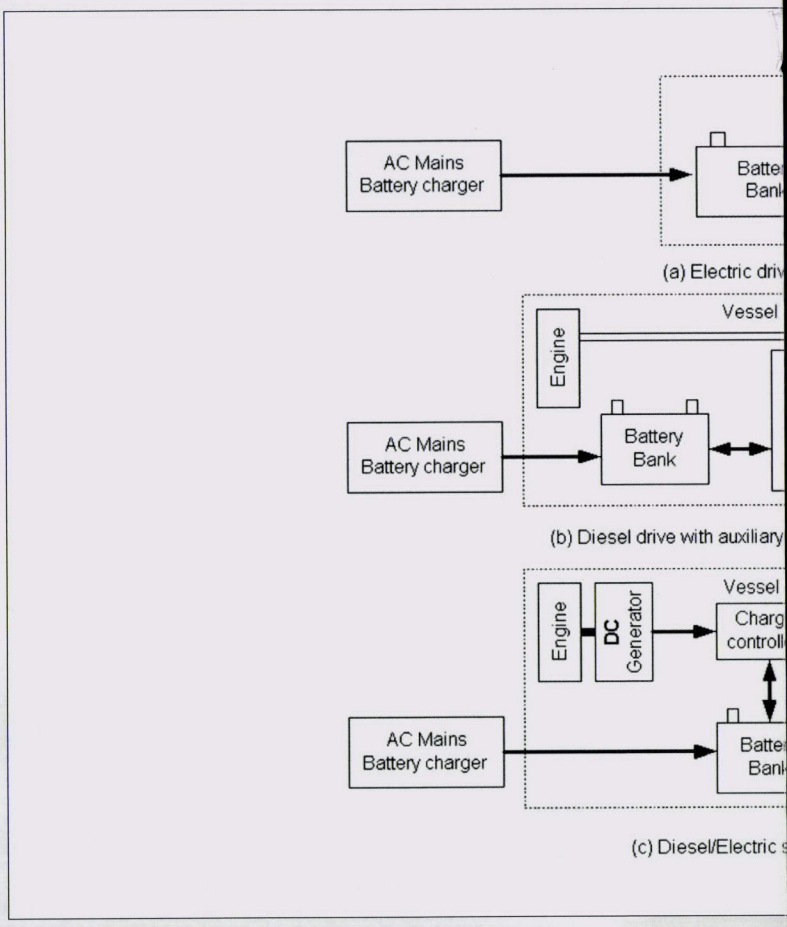


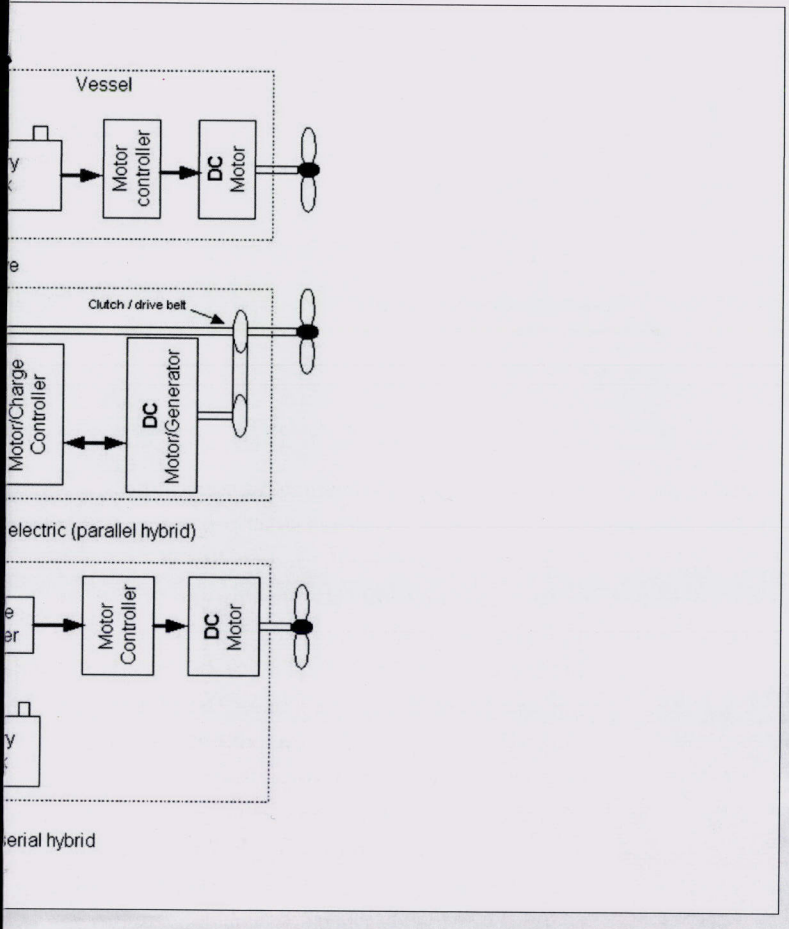
Fig 1, typical electric and Hybrid/electric drive systems.

Internal Combustion Engines are very inefficient machines. Roughly one third of the energy in the fuel appears at the output drive, one third is lost through heat in the cooling system and one third is lost through heat in the exhaust gas. Specific Fuel Consumption (SFC) is a measure of engine efficiency and is the ratio of fuel consumed to output energy generated. SFC units are usually expressed in grams/kilowatt hour (g/kWh) or pounds/horsepower-hour (lb/hp-h). An alternative method is to express fuel consumption in volume rather then weight giving Specific Volumetric Fuel Consumption (SVFC) measured in litres/kilowatt hour (L/kWh).

Internal combustion engines generally operate with highest efficiency when producing close to their continuous rated output power. For a diesel this would be at around 2500 rpm with its net continuous load applied. Under these conditions the SVFC of a small

marine diesel would be around 0.3 L/kWh. If the same engine is run at only 20% of its power output then the SVFC would be approximately double at 0.6 L/kWh. When running at less than 10% of rated power then SVFC is much worse.

Marine diesel propulsion engines achieve great power and range but may run under partial load for most of their life. Marine ICE



generators are sized to provide a desired peak power but can also spend a lot of the time servicing a much lower demand. In both propulsion and generator applications an ICE, running under low load, is very inefficient. Under these conditions there is a high specific fuel consumption together with a high level of emissions. If a propulsion system could be devised that did not require the ICE to run under low load conditions there would be significant scope to improve efficiency.

In the hybrid drive system of fig 1c, the battery buffer allows us to disconnect the immediate power requirements of the load from the power output of the generator. The generator could run at maximum output power while the load consumed little power, the majority of the energy charging the batteries. Conversely the generator could run at low output power while the load was high, with the majority of the power supplied by the batteries.

Under low load conditions the generator could be run in high power bursts with energy being stored in the batteries. Over a longer period of time power would then be supplied by the batteries to the load. Using this duty cycle approach the ICE could be kept running at close to maximum efficiency with the low power drive requirements being serviced better by the electric motor.

Batteries still require trickle charge and equalisation to keep them in top condition. If land based power points are available then this low power charging stage can be done by a mains charger. But an offshore hybrid system will operate for prolonged periods at sea and may still require the ICE generator to run for long periods, under low load, to keep the batteries in optimum condition.

Conventional charging techniques have been developed for use where there is an unlimited source of mains power available. ICE generator charging schemes are usually adapted from these traditional methods and are not best placed to utilise the generator in an efficient manner. Keeping the ICE generator at a constant high output power could soon overcharge and damage the cells. Reducing the generator output power as the batteries came up in charge would not maintain the ICE within its optimum range of efficiency. Pulse charging offers a solution to this problem.

Pulse charging of accumulators is a major field of research and many benefits are claimed. This technique applies current pulses to a battery bank with an amplitude far higher than would normally be experienced during standard constant current/voltage charging. These high current pulses provide rapid charging while reducing the requirement for traditional trickle charge and equalisation stages. The charging source is either providing high power or is switched off and this is an ideal situation for an ICE generator.
By implementing pulse charging with an ICE generator we keep the engine always running with maximum efficiency. The optimum SVFC of a typical diesel is 0.3L/kWh but further losses are incurred in generating/storing electricity and in driving the motor/propeller. Assuming the system can keep the generator running at maximum efficiency then SVFC, related to power reaching the water, will be approximately 0.8 L/kWh.

The energy efficiency of a typical lead acid cell is only 75 – 80%. For every 1000 Watt/hours you put in to the battery during charge you only get 750 Watt/hours out during discharge. This is mostly due to the cells internal resistance requiring a higher voltage to charge the battery and providing a lower voltage on discharge. In certain high demand operating conditions it can be more efficient to completely bypass the battery and provide power directly from the generator to the motor. For ultimate efficiency a hybrid system must be able to adjust power supply and charging methods according to the demands of the load.

Unique power control methods have been developed for my experimental hybrid. The system is able to recognise and implement the most efficient method of providing energy for the prevailing

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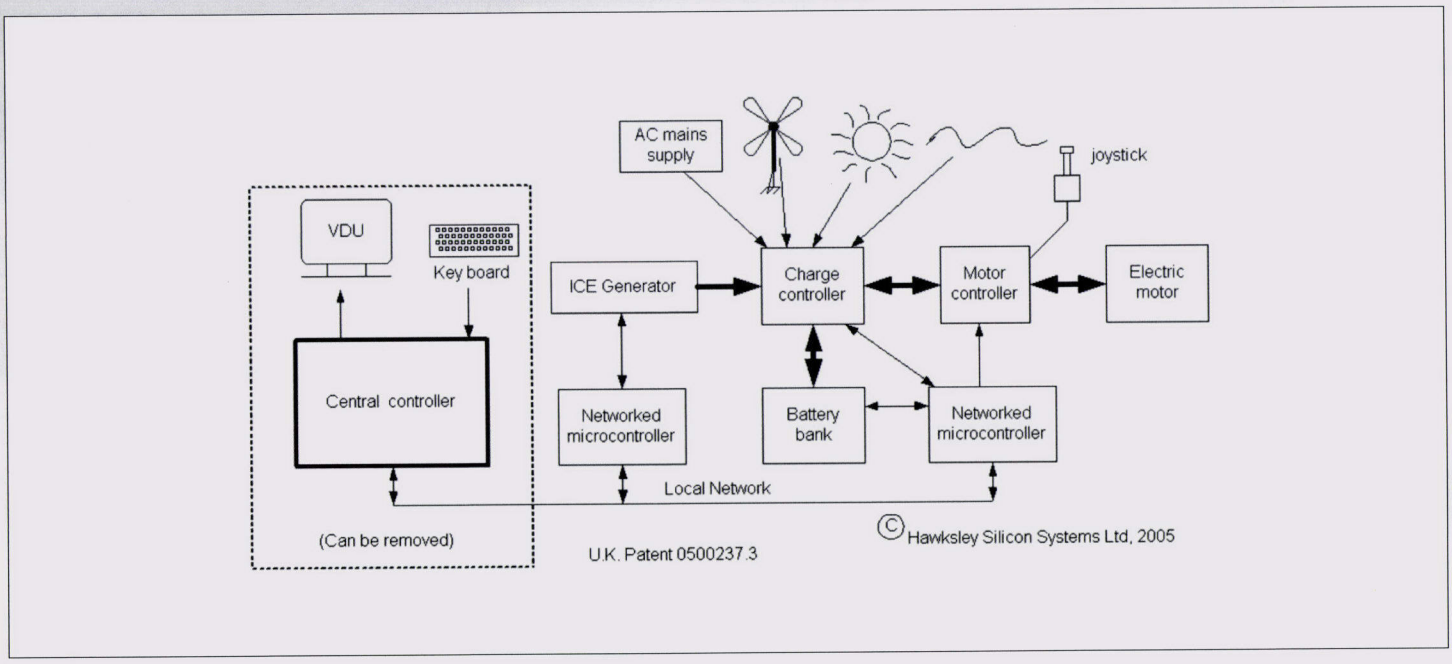


Fig 2, Block diagram of the hybrid control system

operating conditions. The charge controller can use constant current/constant voltage or pulse charging methods. Power can come direct from the generator, via the battery bank or any combination of the two. The system can also accept power from alternative charging sources (e.g. solar, wind, regenerative etc). This green energy is accumulated over time and can provide a significant contribution to the power budget. The ability to intelligently select charging sources can also allow trickle charging without running the generator. Patent protection is in progress (U.K. Patent 0500237.3) for the new techniques employed.

In a sailing boat we can use regenerative charging. When under sail the propeller is driven by water flow and the engine turns into a generator. We can thus recharge our batteries from the wind. A typical day sail may involve half an hour motoring out of the marina then five hours sailing followed by a half hour motor back home. If we regenerate during sailing and have a few solar panels then we may never need to use the ICE generator. During open ocean trade wind sailing a tremendous amount of electrical energy would be available.

The system under development is a serial hybrid (see fig 1c) and a diagram of the control system is shown in fig 2. The charge controller monitors the system's load and condition of the batteries. With regard to the power sources available, the most efficient method of supplying the load and charging the batteries is employed. A series of small computers (microcontrollers) monitor and supervise the system. These microcontrollers are connected together via a network and operation can be monitored by a central controller. This may sound a little complex but it is the same technology as employed in modern automobiles. The central controller is used to collect data during system trials and perform system diagnostics. During normal use the central computer is removed and the system operates autonomously.

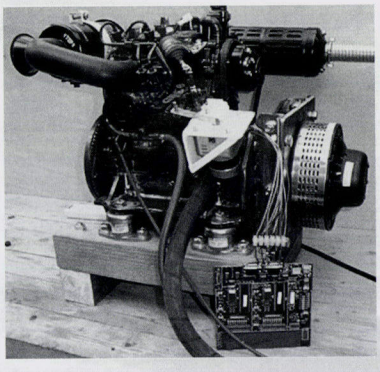


Fig. 3 Generator

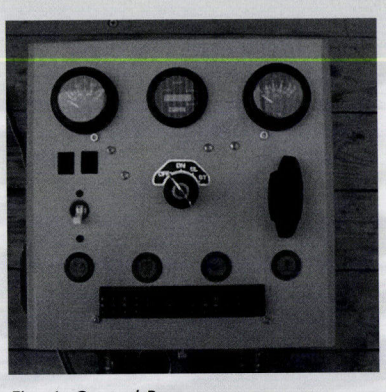


Fig. 4 Control Box

A brief specification for the experimental hybrid is provided in table 1. Calculations predict remarkably low fuel consumption for the size of craft. Bench trials will help to confirm the charging efficiencies obtained and later sea trials will show how close reality comes to predictions.

The majority of the system hardware has been designed and constructed. Fig 3 and 4 show the generator and control box. Simple software has been implemented to control the generator and provide charging current. The next design stage will involve further development of the system software and system trials.

I will keep you posted on future developments, until then I wish you fair winds, full batteries and empty Elsans!

Target craft	32' auxiliary sailing sloop of steel construction with a displacement of 8-9 tons.
Generator	Kubota twin cylinder water-cooled diesel, continuous rating of 8.2kW. Lynch 200D motor/generator, approximately 10kW rating as a generator.
Motor	Lynch 200D, 13.5KW at 72V
Motor controller	Bursa or 4QD
Battery bank	24 * 2V traction cells, 48V at 390AH (Pb Batteries)
Performance in calm conditions	Near hull speed (7kts) with 5kw delivered to water
Performance in force 7 conditions	Ability to manoeuvre out of danger in poor conditions. Progress to windward at greater than 2kts
Cruising range on battery power alone	6.8 hours at 5kts in calm conditions, (1.1kW delivered to water or 2.2kw delivered by motor, assuming 50% efficiency of motor & propeller). 17.5 hours at 4kts.
Operating range	Can operate for unlimited periods offshore while keeping the batteries fully charged and in optimum condition.
Endurance	Generator able to develop enough power to drive the motor directly (bypassing batteries) for prolonged periods of moderate power demand (> 5kW output power from motor).
Ships power capability	Supply 3.5kW of AC mains (via an inverter) Supply 12V at 30A for low voltage equipment (via DC-DC converter from main batteries)
Complexity of operation	Automatic control system that requires little operator intervention.
Fuel consumption targets, smooth water, assuming SVFC of 0.8L /kWh	3kts (requires 0.2kW to water) = 0.16L/h = 19nm/L 4kts(requires 0.43kW to water) = 0.34L/h = 12nm/L 5kts(requires 1.1kW to water) = 0.88L/h = 5.7nm/L
Data collection	For the experimental system extensive data collection and presentation will be required. This will involve a higher level of intelligence than in a production system

Table 1, System specification

LETTERS

From Andrew Sellon, East Anglia

Dear Nick and Sylvia

On the History page of your website, describing the iron-hulled 25ft (7.6m) Electricity, designed by Anthony Reckenzaun, you say: 'Power came from 45 Plante accumulators, modified by Messrs Selon and Volchmar to total 96 volts and supply power for six hours at 4hp to two Siemens D3 dynamos with regulators and reverse gear, belt-driving a 20 in screw propeller of 3ft pitch (500mm x 0.9m) at 350 rpm. Either or both motors could be switched into circuit at will. On 28 September 1882 Electricity made a pioneering trip on the River Thames to London Bridge.'

The Selon mentioned is my great granduncle, John Scudamore SELLON; being the pedant I am, would it be possible to change the spelling? Together with the American Brush, (to whom he initially provided office and manufacturing space in Hatton Garden), he founded the Electric Power Storage Company with production facilities at Millwall.

He was engaged in many aspects of the early electricity industry, firstly the Faure-Sellon-Volckmar cell and then also power production and distribution, domestic and commercial uses including lighting, and the powering of motor cars as well as launches, with which was associated Anthony Reckenzaun.

Their battery making activities metamorphosed into the Dagnite Co., since deceased, and he and Brush moved on from arc lighting to incandescent lamps. Brush is of course still well known in the fields of heavy traction and plant.

Unfortunately I know very little about the technicalities of whatever he was concerned with. Should you or a colleague have come across any information on the name Sellon, the Electric Power Storage Company or the Faure-Sellon-Volckmar cell I would be most grateful if you would let me know on andrew@sellon.vispa.com.

Yours Aye

Andrew Sellon

From Tony Edwards, Surrey

Dear Barbara,

I liked the editorial comment in the winter edition of EBN on fuel cells. I think it will take time to develop, although I am confident that we will soon see a working prototype on the water.

I would like to devote more time to this effort and think it would be prudent to forego my role as advertising manager. Fuel cells are an emerging technology with an unpredictable route to market availability.

I will notify you of any developments and hope I can be a contributor to the magazine as things progress.

Thank you for your help over the last two years.

Regards

Tony

The following letter is reproduced with permission from Canal Boat and Inland Waterways Magazine:

Dear Sir,

With the expected demise of the derogation to use 'red' diesel for marine use in December 2006 has anyone considered the status of diesel-electric boats?

If such a boat was defined as an 'electric' boat with on board generator would you not be able to continue using 'red' diesel to generate electricity and charge the batteries, particularly if you could show that the boat was capable of being powered from internal batteries and could therefore be truly classed as an 'electric' boat?

Dave McInerney

Editor's note: this is something that the EBA will investigate

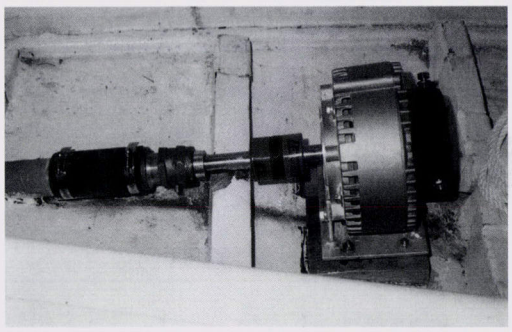
From Charles Mathys, Florida

Dear Ms Rutter,

Thank you for the complimentary copy of Electric Boat News.

Technical Officer Paul Lynn did an excellent job pointing out the strengths and weaknesses of my book. Concerning the lack of an index, it was not an oversight on my part, but rather my publisher's unfortunate decision.

Since finishing the book, I converted a 19.2 foot 0'Day Rhodes 19 sailboat to electric power. I concentrated my efforts on the use of electric outboard trolling motors and, in an inboard configuration, I used the equivalent of the Lynch motor: the ETEK motor sold by Briggs and Stratton in the US. This is quite a coincidence because Paul Lynn pointed out that those were two areas which were weak in the book.



ETEK Motor installed in O'Day Rhodes 19

I purchased and tested 3 trolling motors of various voltages from two manufacturers. The motors that I selected had the most thrust per watt of input power according to the manufacturer's specifications.

I collected a great deal of data from dynamometer tests and from in-the-water tests. The in--the-water tests compared the performance of various propellers to that of the stock 11 x 4.5 plastic prop. I also built a 2.2 to 1 reduction gear of the same diameter as the motor and fitted it at the propeller end of the motor. With the reduction gear I was able to determine the performance of a large 15 x 11 prop running at a much slower speed.

The following year, I tested the ETEK motor on the dynamometer for a good comparison with the best of the trolling motors. It was then installed just back of the centerboard well and connected to a 4 foot propeller shaft (as shown in the enclosed photo). Propellers of various sizes were used for the in-the-water tests.

The results were the best that I have obtained in my work on electric boats. With the seven foot beam, the boat is roomy, stable and proved to have a very efficient hull. With two of the propellers tested, a speed of 5 knots was obtained with a current of 22 amps at 36 volts. Using only three Type 27 deep-cycle batteries, the calculated range is 21 miles.

If you think that your readers would be interested in this data, I would be very happy to provide it to you or I could write an article for your journal under your direction or Paul Lynn's.

Please convey my thanks to Paul Lynn and my hope that we can work together in the future for the advancement of electric boating.

Charles A Mathys

Editor's note: Paul Lynn's review of Charles Mathys' book 'Electric Propulsion for Boats' was in the last issue of EB News (Volume 17, No. 4). I hope that Charles will write an article for the magazine and perhaps join the EBA

TECHNICAL REPORT

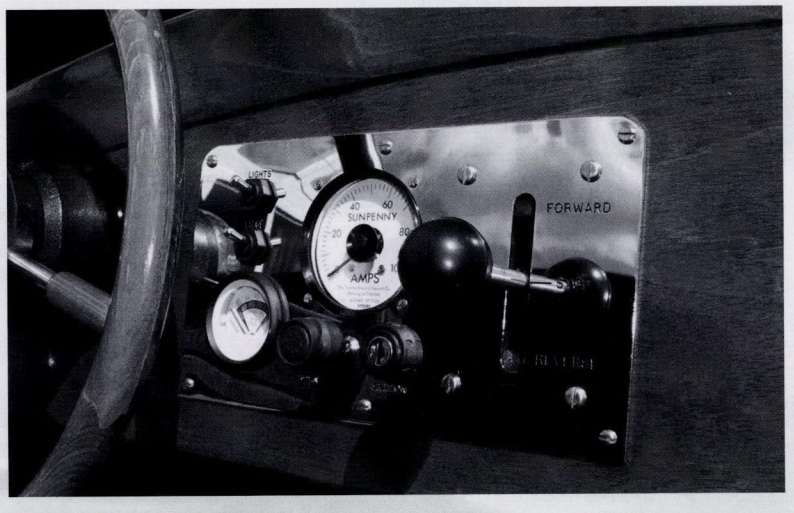
ELECTRIC POINTS: 'CHARGE AND DISCHARGE'

In the fifth of a series of short articles on technical aspects of electric boating, EBA Technical Officer Paul Lynn resumes his discussion of batteries.

This time I should like to start with an anecdote:

One day last summer Sylvia Rutter had several anguished telephone calls from an EBA member in distress. Travelling upstream on the Thames, he was running out of power and going more and more slowly. Fortunately he remembered that postcodes in bold in the EBA Directory denoted members with charging points. An hour's charge across a towpath gave him just enough power to get to Cookham Dean, where he was able to charge up overnight. But his fairly new electric boat had nothing to show him what was left in the battery, or how much current was being used. And if the boat had picked up weed round the prop the battery could have been drained very quickly, without the owner being aware of it.

It all sounds like the electric boater's bad dream – certainly inconvenient, and probably embarrassing. Can you imagine having no petrol gauge in your car, and no idea how many miles it does to the gallon (or perhaps I should say kilometres to the litre)?



IAN RUTTER

Ammeter and Battery Gauge

Before tackling this problem I should like to ride a hobby horse. In many minds there seems to be confusion between ampere-hours and amps. It is very important to realise that a fully charged battery holds a certain number of ampere-hours (Ah), it does not hold amps (A). The ampere-hour rating denotes the product of current in amps times the number of hours for which it can flow. For example a 100Ah battery in tip-top condition should be able to supply 1A for 100 hours, or 2A for 50 hours, or 5A for 20 hours. (This is not quite the whole story, because as we demand higher currents from the battery, its ampere-hour capability reduces somewhat. The so-called '5-hour rating' of a battery is probably the most suitable for electric boats because of their relatively high current drain). Unfortunately many people refer to a 100Ah battery as a '100 amp' battery, leading to endless muddle.

Let's assume you have four 12V batteries on your boat, each rated 100Ah at the 5-hour rate, and connected in series to give a 48V system. Now suppose that your 48V motor takes 15A from the battery bank when the boat is moving at 4 mph (6.4 kph). Your nominal cruising time is 100Ah divided by 15A, which is 6.7 hours. But since you should never deliberately run your batteries flat, it might be sensible to assume, say, 80Ah. This would allow 5.3 hours cruising at 15A draw, giving a range of 21 miles (34 km).

Such calculations are quite simple. But they are only possible if we remember that *batteries hold ampere-hours, not amps!*

I should also like to say a few words about the amount of energy stored by a battery. You will have noticed that so far we have talked in terms of amps and ampere-hours. But remember that a battery supplies current at a particular voltage, or 'pressure', very often 12 volts. In the above example four such batteries are connected in series to give 48 volts with a capacity of 100 ampere-hours. Recalling that amps multiplied by volts equals watts, we see that this particular battery bank holds 48 x 100 = 4800 watt-hours, or 4.8 kilowatt-hours (kWh) of electrical energy. One kWh is widely referred to as a 'unit' of electricity. Our domestic electricity bills are quoted in 'units', each one costing typically 8p (say 0.13 euro) – or only about a third as much if we use off-peak electricity. So the above battery bank holds 4.8 units, worth about 4.8 x 8 = 38p (say 0.63 euro) at the peak rate. Wonderfully cheap, this fuel of ours!

And finally back to Sylvia's anecdote. How can we prevent further phone calls by members in distress? Well, firstly, we should all know the capacity in ampere-hours (*not* amps!) of our batteries, and have some sort of meter to indicate how far they have been discharged (their 'state-of-charge'). I hasten to add that, in my experience, state-of-charge meters are not very accurate, and a simple voltmeter, which monitors the small but significant reduction in voltage as the batteries discharge, is hard to read and interpret accurately. But even the simplest and cheapest battery meter is surely better than nothing at all – especially if you are prepared to spend a bit of time learning its foibles before you attempt that 100 mile, 4 day cruise. And secondly, you should have a current meter (ammeter), telling you the amps (*not* ampere-hours!) being drawn by the motor, so that you can work out the remaining cruising time at your present speed – and check that weed in the propeller is not causing a high amp draw coupled with negligible progress. Thus equipped, there should be no cause for embarrassment!

NOTICEBOARD

WELCOME TO NEW MEMBERS

Private Members	Location	Boat where notified
Richard Muir	Stroud, Glos	Pleiades
Chris Davies	Haverfordwest	
P Blomfield	Uckfield, E Sussex	Margaret Anne

Business Members

Water Roo Electric Products	Buckfastleigh, Devon

Water Roo are suppliers of fun boats powered by a new electric drive system which they have developed

WIN A BOAT HANDLING COURSE

The prize of a one-day boat handling course on the Thames is on offer from Bisham Abbey Sailing & Navigation School in conjunction with the EBA. Members interested should send their details to EBA Secretary, Barbara Penniall and a draw for the winner will be made at the BGM in June. Winners should be prepared to be photographed and to report on their experiences for EB News.

NEW E-MAIL ADDRESS

The e-mail address for Dave Millin, Acting Vice-Chairman – Business Members is now davidmillin@fsbdial.co.uk

NEW ADVERTISING MANAGER NEEDED

Tony Edwards has resigned as EBA Advertising Manager to devote more of his time to work on the development of fuel-cell powered boats. EBA Secretary Barbara Penniall is dealing with the advertising on a temporary basis but would be delighted to hear from anyone who is interested in taking over this important role.

STANDING ORDERS

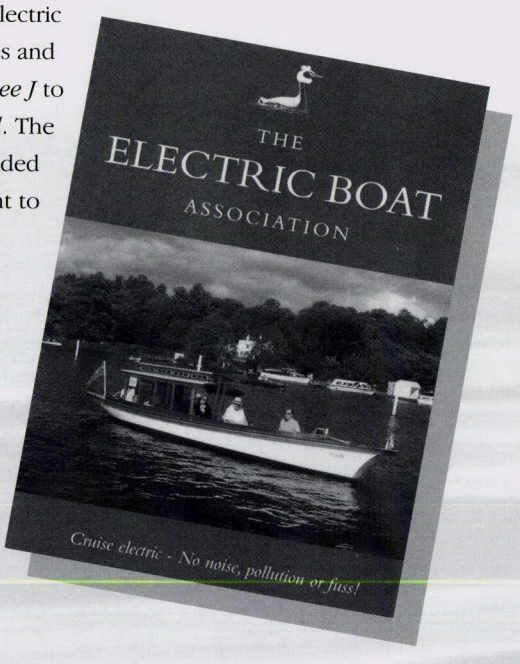
If you don't already pay your annual £25 subscription by standing order please consider changing to this method as it makes the job of the Secretary very much easier. Why not change the next time it is due?

HELP AT BOAT SHOWS

You will see from this issue of the magazine that the EBA will be attending a lot of events over the summer to promote electric boating. If any members can offer help in manning the EBA stand (if only for half an hour over a lunch break) John Hustwick and Barbara Penniall would be very grateful.

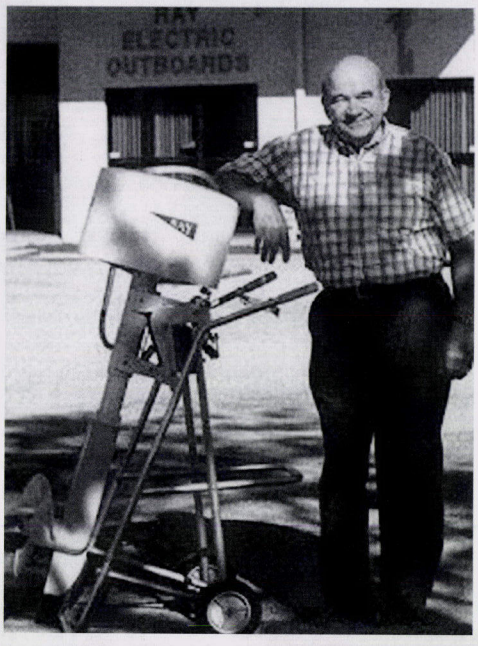
NEW EBA BROCHURE

The committee have commissioned a new brochure to replace the old leaflet with information about the association. In full colour and A-4 size, it features electric boats of various types and sizes from little *Jubilee J* to canal boat *Silver Sail*. The brochure will be handed out at shows and sent to people making enquiries about the EBA. It is also hoped to include it as an insert in boating magazines.



OUTBOARD PIONEER

Morton Ray is the designer and manufacturer of the Ray electric outboard. EBA members Derek and Hilary Chamberlain, who spend their summers on the Thames but their winters in Florida (which sounds a very sensible arrangement) have persuaded him to tell us something of his story.

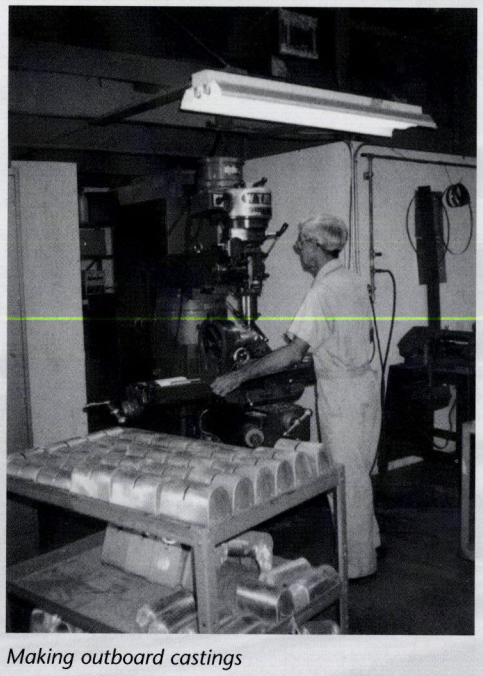


Morton Ray with his Ray electric outboard

Mort was born in Kentucky, grew up along the Ohio River where he rowed wooden jon boats with rake at the stern and learned through experience how hull design affects the power required to push displacement boats.

He became an outstanding high school student, graduated from West Point and later earned an MSEE degree from Carnegie Institute of Technology. Throughout all of this, he says his knowledge and love of boats never diminished, and after retiring from the U.S. Army in 1971 he was soon producing primary power electric outboards.

He got the idea for the Ray outboard one day while observing electric pontoon boats on nearby Lake Barcroft in Northern Virginia, an electric-only lake. These boats were powered by gasoline outboards that had been converted to electric. The concept was OK, but they were noisy and not very dependable. Mort recognised an opportunity to put some of his knowledge of boats and formal training to work, sure to be fun, but maybe also profitable. The first ten outboards were made in his basement in Annandale, Virginia.



DEREK CHAMBERLAIN

Making outboard castings

He did all the designing and manufacturing of definitive parts and the assembly. He says: "I did it all except for some help from Dot my late wife. I made the patterns, the gas fired crucible furnace to melt the aluminium, and the sand moulds. The castings and other parts were machined on a small Sears lathe. When we poured the molten aluminium into the moulds, it was Dot's job to hold one end of the crucible shank."

Mort soon learned that progress required the services of a foundry, and more sophisticated (match plate) patterns, which were both secured in short order. Eventually operations were moved to an industrial area in Alexandria, Virginia and the first employees were hired. In 1988 the factory was moved to Cape Coral, Florida where today an expert crew manufactures the Ray electric outboard in a modern facility.

DEREK CHAMBERLAIN

View of the workshop

Today Ray outboards are sold all over the world, for both private and commercial use. Recently an order was received from Taiwan for 35 motors for use on tour boats in a county operated park. One contract that Mort is most proud of is furnishing outboards for Silver Springs famous glass bottom boats, which began in February 2003.

"I'm also very proud of a couple of accolades picked up along the way" he says. "The first came because of an electric boat trip by Dot and me in 1995. We departed Fort Myers, Florida for Fort Lauderdale in the *Electric Explorer*, a 21 ft. super-efficient monohull of which we produced and sold a total of three. Equipped with twelve batteries it cruised at over 6 mph continuously for twelve hours drawing only 25 amps out of a full-out 80 amps on 48 volts. We were in layover in Fort Lauderdale. Underway hours were 72.2 covering 435 miles for the round trip at an average of 6.02 mph. Best daily average was 6.8 mph.

The Ray Electric Explorer

Mort and Dot on the 435 mile voyage

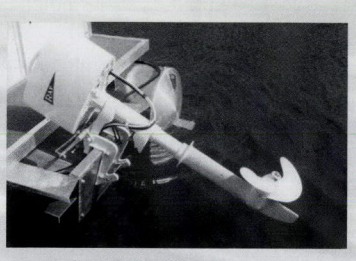
Unknown to us, over in England some members of the Electric Boat Association found out that our trip was the longest electric boat cruise in 1995, meaning we had won the Emsworth Trophy. Were we surprised when Derek Chamberlain presented the award to us at the annual meeting of the Electric Boat Association of the Americas. The plaque hangs proudly on my office wall. Thanks EBA."

The second award came from the EBA of the Americas, presented by Ken Matthews and Chuck Houghton in October 2000 at the meeting in St. Michaels, Maryland. The plaque reads 'Lifetime Achievement Award Presented to Morton Ray for Pioneering the Primary Power Electric Outboard Motor.'

"Where do we go from here?" Mort asks. "Well, we need to educate the public that there are such a things as primary power electric outboards, which are not trolling motors, and that electric boats aren't relegated forever to electric-only lakes. If we don't, there never will be a significant electric boat industry.

This education and expansion requires efficient displacement boats available for purchase. At present there are no such boats specifically designed for electric outboards. But such boats, as I explain on my website, are like having batteries that are three times better, significant enough in my opinion to make electric boats popular on general waters.

It's not quite as simple as just making efficient displacement boats. Copying 1902 launches will not work well for building an industry, no matter how fond some owners are of these boats. 21st Century styling and materials must provide for 21st Century popular boating activities. Form, as usual, follows function. The function below the water line is clear – provide the most efficient hull. Above the maximum waterline the designer is free to design for the intended use of the boat. As an example, imagine a fishing fibreglass jon boat that looks like a jon boat when viewed from above, but is like a launch up to the waterline, employing extreme flaring at the bow and stem.



Ray Calidonia outboard

Electric boats of both pontoon and monohull type are needed and each offers all the efficiency required. Fishing, cruising, runabout, rental, tour, and even cocktail boats for electric-only lakes, are needed. The latter, not needing performance, can take a third of the batteries now carried, due to efficiency.

The boat market in the U.S. is poised ready for a rapid expansion of electric boats within three years, possibly sooner. The expansion will be a significant factor in making boating more popular, which the National Marine Manufacturers Association constantly seeks to do."

Mort now has a new wife, Aly, who like Dot finds herself married to a workaholic and caught up in the saga of Ray Electric Outboards. Naturally gifted in spoken and written communications, Mort says, she promises to be a great help promoting the electric boats he envisages will become popular. Aly's comment: "I hope he becomes successful enough not to be a workaholic."

To learn more about the Ray outboard see www.rayeo-com

ELECTRIC BOAT BATTERIES

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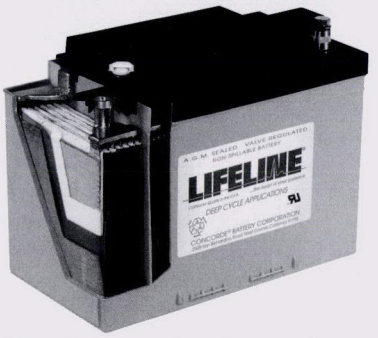

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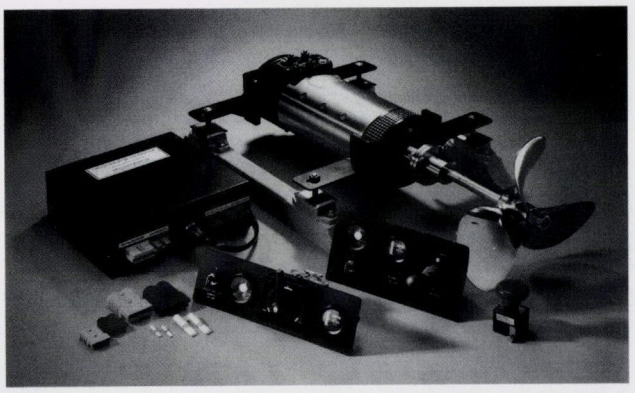
Electric Propulsion for Boats



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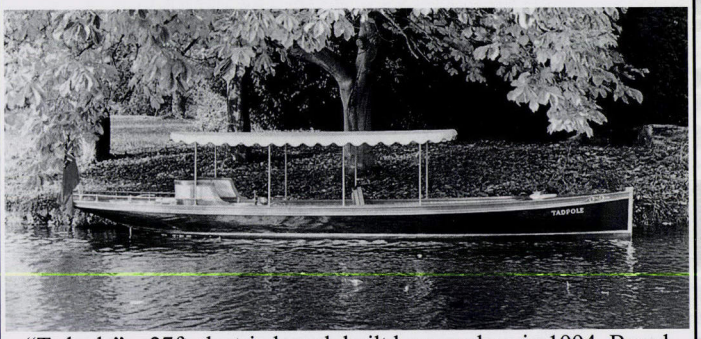

"Tadpole" – 27ft electric launch built by ourselves in 1994. Based on a design from 1884 and powered by original 72 volt DC Electric Motor dating from that time, with high efficiency, state of the art control system, she is currently for sale and is available for demonstrations at Hurley. Please call us for further details.

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