NEWSLETTER

RETIRED CHARTERED ENGINEERS ASSOCIATION
WORTHING

Hon. Secretary: S. Oliver. Elphin, North Drive, Angmering, BN16 4JJ ☎ 01903 787116

FORTHCOMING EVENTS

5th April	Wednesday	**Outing** to Shoreham Airport see pages 7 & 11 for details and signing up
17th May	Wednesday	**Outing** to HerstmonceuxCastle, Science Centre and Telescopes see pages 8 & 11 for details and signing up
21st June	Wednesday	**Outing** to Wey and Arun Canal see pages 9 & 13 for details and signing up
19th July	Wednesday	**Garden Party** see pages 9 &13

Coffee Mornings

Denton Lounge, Worthing Pier. Every Monday

Albion Inn, 110 Church Road, Hove.	First Wednesday of the month 5 Apr, 3 May, 7 Jun, 5 Jul, 2 Aug
The Spotted Cow, Angmering	Third Thursday of the month 20 Apr, 18 May, 15 Jun, 20 Jul, 17 Aug
Beach Hotel, Worthing (with Ladies)	Last Thursday of the month 30 Mar, 27 Apr, 25 May, 29 Jun, 27 Jul, 31 Aug

Coffee mornings commence at 10.30 a.m., except at The Beach, which is from 10.45 a.m.

Copy date for next Newsletter 8 Aug

Membership

We welcome the following new members:

2000 **JONES, D.A.** F.I.Mech.E., M.I.Mar.E. *44 Lincoln Wood, Haywards Heath.* *RH16 1LJ (01444 412213)* 1974 -99, AMEK-BKW (Formally Babcock Int. group-process div.)Chiefengineering technologist. 35yrs in the design, fabrication/construction & commissioning of fired and unfired heat transfer plant for the petrochemical, process, marine and nuclear industries. *Interests:* Sailing-dinghy and big boat, Sea fishing, DIY	1999 **WARR, H.J.J.** F.I.E.E. *12 Greater Paddock, Ringmer, Lewes.* *BN8 5LH (01273 813404)* 1951-86 with EMIED, then EMI ElectronicsLtd. Digital computer design. Managed scientific computer service. Project manager for series of MOD study contracts. Finally Chief Scientific Engineer for Radar Products Group. *Interests:* Study of military history, collection of military antiquities
2000 **WOODGATE, J.M.** M.I.E.E. *31 Chichester Place, Brighton, BN2 1FF* *(01273 278599)* 1965-75 Chief designer (HV) Foster Transformers Ltd. 1975-84 Works Manager CGS Resistance Co. Ltd. 1984-91 Manager, Works Eng. Dept. Furguson Ltd. 1992-97 Authorising engineer Portsmouth healthcare NHS trust *Interests:* Piano playing, Music, DIY, Volunteer Volks Electric railway assoc.	2000 **PILLING, C.** M.I.Chem.E., M.I.Gas.E., M.I.Mgt. *84 Marine Crescent, Goring by Sea.* *BN12 4JH (01903 522356)* Various posts within British Gas (now Transco) throughout the UK both in commercial and operational fields. Consultant in gas transportation matters for the opening of the European gas market. Based in Belgium. *Interests:* Tropical and marine fishkeeping, Still and video photography, Keep-fit, DIY, Astronomy, Foreign travel
1999 **HURST, L.G.** M.I.Mech.E. *9 Meadow Lane, Fetcham, Leatherhead.* *KT22 9UW (01372 373959)* 1944-62 Silica Gel Ltd. Draughtsman/Project Engineer 1962-99 Dryvent Ltd. Engineer/Director 1957-69 Visiting lecturer at the Borough Polytechnic *Interests:* Fly fishing, Photography	2000 **CROOK, A.W.** F.R.I.N.A.. *Ashdown Place, Forest Row.* *RH18 5LP (01342 822513)* 1944-59 Vickers Armstrong, Barrow - designing all types of merchant and Naval vessels. 1959-73 Lloyds register of shipping - surveying passenger ships worldwide. 1978-89 Panama bureau of shipping - chief ship surveyor. 1973-78, 1990-99 Passenger safety consultant. *Interests:* Stamp collecting, Jazz music, Gardening, Passenger vessels histories, European and local history.
2000 **WILLIAMS, R.K.** B.Sc.(Eng.) M.I.Mech.E. *3 James Close, Burgess Hill. RH 15 0QH* *(01444 242891)* 1956-60 Student apprentice Babcock & Wilcox 1961-69 Commissioning engineer B&W conventional and nuclear steam plant. 1969-98 Ewbank & partners, design and project management of power plant and various types of oil and gas production, storage and transportation facilities. *Interests:* Classic cars, Photography, DIY, Cooking	

2000 **SHIPMAN, H.S.** M.B.E., M.I.Mech.E., M.I.Gas.E., M.I.Mgt. *12 Revell Drive, Fetcham, Leatherhead. KT229PS (01372 459267)* D. Napier & Son, aircraft engines. Electroflo Ltd. industrial instrumentation. Free-piston engine Co, power plant. Shell-Mex & BP, fuels. BP oil, specialisation - LPG. LP gas association, Tech. manager, now consultant *Interests:* Sailing, Music, Piano	2000 **LAFLIN, A.S.** M.I.E.E. *2 Crabtree Lane, Lancing, BN15 9BQ* *(01903 763991)* Principal lecturer in electrical engineering at South Thames College Senior operations engineer in commercial television Design engineer with GEC research labs Technical assistant GEC patent dept. *Interests:*Water colour painting, Gardening, DIY

To date we have 114 members which includes 9 life members and there are in addition 7 widows who are treated as members.

H. Philp, B.Sc., M.I.Mech.E., M.I.E.E.

Sadly we have to record the death on 25th February, of our senior member, Henry Philp, aged 97.

Henry had all the attributes of the man-in the -street's perception of the Scottish Engineer - dour, but with a twinkle in his eye; a man of few words, but each one carefully chosen and meaningful. This rather formidable stature was well known and respected in the oil industry both in the U.K. and the Middle East. He was always interested in the latest developments - his computer was one of the few possessions he took with him to the nursing home.

Henry and John Gurney were for many years the "father figures"of the Hove coffee meetings (they were virtually the same age). Henry was also a personal friend of our founder, Herbert Cooch, with whose family he remained in touch until the death of Cooch's widow.

Though not without its moments of tragedy, I'm sure Henry would readily agree that his life was a full and rewarding one. He will be remembered with respect and affection by all who knew him.

Ernest Ayling

The Sodium Sulphur Battery System - talk by Eur. Ing J. Cockburn, member ,held at Field Place, Tuesday 7th March, 2000 at 2.30 p.m.

How many people have heard of or seen a sodium sulphur battery? Not many of you I expect. In this lecture I will first describe the sodium sulphur battery system and its characteristics, and then describe a number of recent applications, including its use in an underwater vehicle project in which I was involved.

Historical Background

The drive to develop exotic battery systems really started with the first oil crisis in the early 1960s, in an attempt to develop a battery with a much greater energy density than that obtainable from the lead acid battery in common use for traction purposes. J T Kummer conceived the idea of a sodium sulphur battery, and by the end of the 1980s more than $100M and 2000 man years of effort had been expended world wide in an attempt to develop a working system. The energy density of an electrochemical cell or battery may be quoted in either gravimetric (Wh/kg) or volumetric (Wh/l) terms, and both are relevant when comparing different battery systems, depending upon the context The traditional lead acid traction battery can only achieve about 35 Wh/kg, whereas values of 100 Wh/kg or more are offered by some of the advanced battery systems now being developed, including the sodium sulphur system. It is worth emphasising that one has to be very careful when comparing energy densities of different systems that one is actually comparing like with like. Some batteries such as lead acid only require to be assembled from a number of cells to form an operational system, whereas others require extensive and complex ancilliary subsystems in order to work. As we shall see the sodium sulphur system is one of these.

An electric vehicle powered by a sodium sulphur battery system is not new. As long ago as 1972 Ernest Marples the then Transport Minister drove a van powered by an early sodium sulphur battery system around Parliament Square in London. The fact that a practical working vehicle – the Ford Ecostar – only became available for widespread trials during the 1990s only serves to show how much time is required in practice to successfully develop a new battery system.

The sodium sulphur battery system was developed in Europe for electric vehicle use independently by two separate commercial organisations, Asea Brown Boveri (ABB) at Heidelberg and Chloride Silent Power Limited (CSPL) at Runcorn, and both organisations invested a large amount of money over a 20 year period. Late on in development CSPL were bought by the German electrical company RWE. In contrast, the Japanese have concentrated on power storage type applications, and several very large static installations are now in use.

Unlike conventional secondary cells such as lead acid or nickel cadmium, which use a solid anode and cathode and liquid electrolyte, the sodium sulphur cell is unusual in having a liquid sodium anode and liquid sulphur cathode, with a solid β'' alumina electrolyte. β'' alumina is unique in having a crystal structure which has very high ionic conductivity to the alkali metals, of which sodium is one, and is thus an ideal separator and electrolyte for a sodium sulphur battery. The problem is how to manufacture components from it which will not crack at the working temperature of the battery or shatter under shock loads in use.

The chemists among you will immediately realise that since both sodium and sulphur are solid at room temperature it will be necessary to heat the cell for the reactants to be in a liquid state. In practice a working temperature of between 250 and 350º C is adopted in order to achieve sufficiently high ionic conductivity for high power traction type applications and to ensure that the reaction products remain liquid at all states of discharge. A practical sodium sulphur battery thus consists of a large number of individual hermetically sealed cells connected in a series/parallel arrangement, surrounded by an electric heater, and housed in an outer container which provides both adequate mechanical support and a very high level of thermal insulation.

Cell Description

The characteristics of the ABB cell are taken as an example. This cell has a capacity of 40 Ah and is 237 mm long by 37 mm diameter. It consists of an inner sodium reservoir forming the negative electrode, contained in a β'' alumina tube which serves as both electrolyte and separator. This assembly is surrounded by the sulphur positive electrode and outer cell container. Because sulphur is a non-conductor it is impregnated into a carbon felt matrix to obtain a low resistance current collector and a current path to the positive terminal on the outer container. A key safety requirement for any sodium sulphur cell design is to provide a means of limiting the rate at which the sodium anode can react with the sulphur cathode, either electrochemically by the passage of Na+ ions through the β'' alumina electrolyte, or chemically in the event of a cell failure resulting from cracking of the electrolyte or external mechanical damage. In the ABB cell the electrolyte tube is lined with a close fitting metal sleeve which acts as the negative terminal. It has a small orifice at its lower end through which the molten sodium can flow and its close fit in the electrolyte tube ensures that, as the bulk sodium level falls as the battery discharges, the whole of the inside surface of the electrolyte remains wetted with sodium through capillary action. The hole size is such that sodium can flow only at a rate sufficient for the designed maximum cell current.Because only sodium ions can pass through the β'' alumina electrolyte no secondary reactions can take place and hence the coulombic efficiency of the cell is 100%. It is thus possible to accurately monitor the state of charge by continuously integrating charge and discharge current with time, a very attractive attribute for a battery system. During recharging, the completion of charge is indicated by a sudden increase in cell resistance due to polarisation of the sulphur electrode, so that completion of charge may readily be detected remotely as an increase in charging voltage. In practice it is essential to limit this voltage rise by correct charger design since the application of an excessive overvoltage can destroy the cell by initiating failure of the electrolyte.

Electrochemistry

Although the overall electrochemical equation may be expressed as:

$2Na + 3S \quad Na_2S_3 \quad E = 2.08$ volts

in practice things are a little more complex. As the discharge proceeds a series of complex sulphides of the form Na_2S_n are produced, each with a different value of cell emf, not all of which dissolve readily in the remaining sulphur. The cell voltage remains constant at 2.08 volts between 100% and 40% charge and then falls linearly towards a theoretical minimum of 1.74 volts. In practice the nominal zero state of charge and guaranteed capacity are specified using a higher minimum value of 1.92 volts in the interests of cell reliability, equivalent to 80% of the theoretical capacity. Discharge to 1.87 volts is permissable in an emergency, but if done frequently such deep discharges have a significant effect on cell cycle life, reducing it by a factor of four.

ABB offered two sizes of development battery, Types B120 and B240, the number referring to the number of cells. Either 120 or 240 cells are installed in a rigid inner metal framework incorporating a heating element and twin thermocouples. This framework is enclosed within a double walled stainless steel outer container which provides both mechanical containment and thermal insulation. The inner and outer walls are separated by a 30mm gap, and the space between is filled with load bearing insulation and evacuated to a high vacuum in order to provide a high level of thermal insulation. The performance of this insulation system is such that with the cells at their working temperature of 295 to 300º C the nominal battery thermal loss is only 70 watts, and the outer skin temperature of the battery is less than 20º C above the external ambient temperature.

In electric vehicle applications the peak power capability is as important as the energy density, since it is the peak power performance which determines how fast the vehicle can accelerate, and nobody wants to drive a milk float. In that situation excess heat is produced in the battery and in automotive applications some form of external cooling system is provided. The ABB batteries contained an oil cooling circuit which was connected externally to a heat exchanger, which could be be used to provide vehicle heating if required.

Battery Description

The 120 or 240 cells can be configured as a number of parallel strings, depending on the output voltage required. For example with 120 cells, 4 parallel 30 cell strings will produce a 60 volt 160 Ah battery whilst the same number of cells connected as 10 parallel 12 cell strings will produce a 24 volt 400 Ah one. In each case the guaranteed available energy when new is 9.6 kWh when discharged from 2.08 to 1.92 volts per cell. With the 240 cell design higher output voltages are possible, and these are preferred for electric vehicle applications. 4 parallel strings of 120 cells will produce a 120 volt 160 Ah battery having a guaranteed energy of 19.2 kWh, and larger batteries having a greater number of cells can provide a terminal voltage of 240 volts or more. Such high voltages pose interesting safety questions for vehicle servicing. It is worth noting here that the lower voltage solutions with a greater number of parallel strings are inherently more reliable in the event of a single cell failure, unless a way of bridging failed cells can be provided. Given the sealed nature and high temperature of the battery this has proved very difficult to engineer.

Battery Management Unit

An essential part of any sodium sulphur battery system is a battery management unit (BMU). The purpose of the BMU is to control the temperature of the batteries and to monitor their operation and state of charge. One version capable of controlling up to four individual batteries consists of a full width card frame containing 15 plug-in Eurocards. All functions are controlled by a microprocessor and are normally fully automatic in operation. Specific cards interface with the thermocouple, battery heating and voltage monitoring cables from each battery via front panel connectors, and connections are also made to a current shunt in order to monitor the total battery discharge or charging current.

The BMU performs the following functions:

- Control of Battery heating
- Charge control and monitoring
- Earth leakage monitoring
- Monitoring of individual battery voltages
- Monitoring of overall system health

Information relating to these functions is displayed on the BMU by means of a LED display and can also be displayed remotely. Electrical power for battery heating and for the BMU is obtained either from an external AC supply (if available) or from the battery system itself.

Applications

Electric Vehicles

It was the potentially high volume and lucrative automotive applications that drove both the Chloride and ABB development programmes, and both companies produced a number of sodium sulphur powered vehicles as technology demonstrators. I have actually driven a sodium sulphur powered BMW series 3 car in Heidelberg, and an interesting experience it was, once one got used to the lack of engine and exhaust noise. It was certainly not lacking in acceleration. Volkswagen also worked with ABB in demonstrating a hybrid version of the Golf, in which a small diesel engine worked in parallel with the electric system.

It is a commonly held view in automotive circles that the most likely way in which electrically powered vehicles will be marketed will be as combined electric and hydrocarbon fuelled hybrid designs, as even advanced battery technology does not offer sufficient range when used on its own. It is salutary to calculate the total energy and effective refuelling (charging) rate of a hydrocarbon powered vehicle in electrical terms.The calorific value of petrol is nominally 13.12 kWh/kg, or 9.45 kWh/l, compared to the 100 Wh/kg of an advanced battery system. A 50 litre fuel tank contains 470 kWh of energy, and a forecourt petrol pump transfers energy at a rate of 20 MW/hour, assuming a typical pumping rate 35 l/min.

Ford Ecostar

One of the most successful demonstrator programmes has been that based on the Ford Ecostar. This is an Escort sized light van which uses a single large battery housed under the floor in front of the rear axle. Its capacity is equivalent to three ABB B120 sized batteries. The programme commenced in 1993, and over 1 million vehicle miles have now been accumulated, by far the most of any electric vehicle programme world wide. One of these vehicles was run very successfully a few years ago by the Hampshire Constabulary in Winchester.

Autonomous Underwater Vehicle

In 1991 Marconi Underwater Systems initiated a programme to develop an Autonomous Underwater Vehicle (AUV) to provide a test bed for researching key technologies such as energy and propulsion, navigation and guidance systems. Initial design studies had shown that to be a useful vehicle it would require an endurance of about 24 hours, and that the energy system would have to provide at least 36 kWh, which precluded a lead acid battery system. It was also the intention to construct the vehicle using existing 533 mm (21 inch) diameter torpedo hull sections, and this put further constraints on the design of the energy system. It just so happened that at the time that the programme started ABB had available the B120 design of sodium sulphur battery which had a cross section almost ideally matched to the available hull cross section. A decision was taken to adopt the ABB sodium sulphur battery system, and four B120 12 volt batteries of the type already described were configured to provide a terminal voltage of 12 volts and connected in series to provide a 48 volt 38 kWh system. The use of a 48 volt dc bus allowed a wide range of readily available commercial components such as contactors and connectors, in wide spread use on fork lift trucks and similar applications, to be used in the battery system. In addition, there was a wide range of power supply modules developed for the telecommunications industry which were designed to run off a 48 volt dc supply. A further important factor was that of safety, and a 48 volt dc system was much easier to engineer in a safe manner than would have been a higher voltage system.

Unlike a conventional torpedo which goes sufficiently fast to exploit hydrodynamic lift from the hull, the AUV was a very low speed vehicle with a speed of only 4 knots, so that it had to be neutrally buoyant when running and dynamically and statically stable. A drop keel was used to give the vehicle positive buoyancy at the end of a mission and ensure that it returned to the surface and stayed there until recovered, although this approach reduced the available payload mass. The high mass and low centre of gravity of the battery system ensured that the vehicle metacentric height remained above the vehicle centre of gravity even after the keel had been released.

Propulsion power demands were very low at 600 watts, and the total power load was only 1.3 kW, giving a nominal discharge time of almost 30 hours. In practice all the loads had constant power characteristics, requiring an increase in battery current once the battery charge state fell below 40% of its fully charged capacity.

The four batteries were housed in two battery containers designed to inteface with the hull using the same rails and fixing lugs as standard heavyweight torpedo batteries. The trays were constructed from stainless steel on account of its poor thermal conductivity, and each battery was isolated thermally from its tray by 4mm thick microtherm insulation. Because the total power was so low, joule heating by the internal resistive battery losses were insufficient to balance the radiated heat losses. Instead, prior to release of the vehicle the batteries were heated to 340º, and then allowed to cool slowly to the normal operating window of 295 to 300º C over a period of 12 hours during the first half of the mission, so that battery energy was not required for battery heating on missions of less than this duration.

The battery system was assembled and commissioned at Heidelberg during December 1991 and delivered to Marconi in January 1992. During the subsequent 2 years in which the system was in use the battery system was kept at working temperature and proved ideal for its purpose. The battery system could be readily recharged through an access port without splitting the hull, and the need to keep a mains heating supply attached whilst ashore was met by a circuit in the umbilical cable.

Utility Power Storage

Since 1984 the Tokyo Electric Power Company Inc. (TEPCO) and NGK Insulators have been developing a sodium sulphur (NAS) battery energy storage system for load levelling and peak power electricity supply. A range of much larger cells than those developed in Europe has been satisfactorily developed, and more than 2250 charge/discharge cycles and greater than 90% efficiency are now being obtained. Research into improved performance and reduced costs continues. Whereas existing plant uses 295 Ah T4.2 cells each 390 mm long and 68 mm diameter, the latest T5 cell is 515 mm long and 91 mm diameter with a capacity of 740

Ah. Like the ABB cells described earlier the NGK cells all have a metallic safety tube inside the β'' alumina electrolyte tube to control tha rate of sodium flow in the event of catastrophic cell failure.

Since 1998 a 6MW (48MWh) battery system – claimed to be the largest in the world – has been operating satisfactorily for load levelling at TEPCO's Tsunashima substation. This is based on three battery installations of 2MW each – one battery installation per phase – and uses the Type T4.2 cell. Each 2MW unit comrises 8 parallel strings of 250 kW (2MWh) and each 250 kW string consists of 10 series connected 25 kW units. Since each 25 kW unit employs 480 individual T4.2 cells, there is a total of 480 x 10 x 8 = 38400 individual cells in each 2MW unit.

A new 6MW installation based on the larger capacity T5 cells is now being constructed with the aim of reducing the battery cost to less than Y0.2 Million per kW.

Besides the development of the sodium sulphur batteries themselves, solid state inverters/converters based on IGBT technology have also been developed to interface the DC battery system to and from the AC grid.

Recent History

Development of the sodium sulphur battery system for automotive applications in Europe has now ceased, partly on safety grounds, but also because the lack of any prospect of a volume market near term caused the companies concerned to withdraw further funding. The system is still being developed in Japan, however, where large installations are being successfully operated for ac peak power and load levelling applications.

Acknowledgements

Formal acknowledgement is made to the Institution of Electrical Engineers for permission to use material from the paper Development of a Compact Sodium Sulphur Battery by Kodama and Kurashima, published in the July 1999 issue of the IEE Power Engineering Journal.

The information on the Ford Ecostar project was downloaded from the Ford Ecostar internet web site wwwu.ford.com/electricvehicle/ecostar.html

All other material has been taken from papers previously presented by the author.

Jim Cockburn

Outing with partners to Shoreham Airport, on Wednesday 5th April, 2000 at 2.30 p.m.

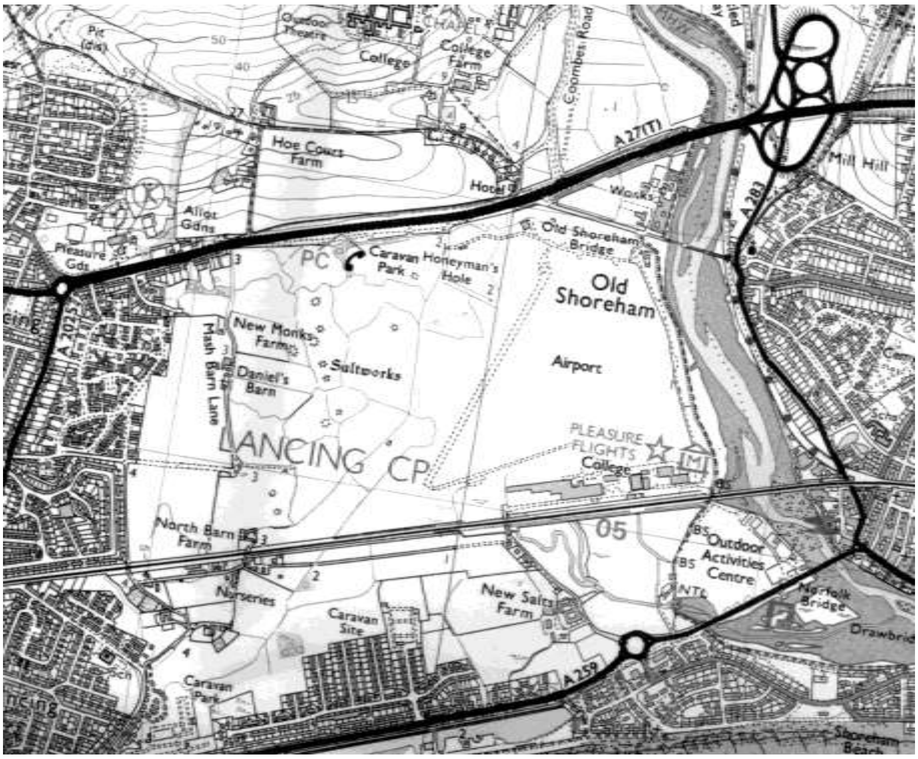
The tour includes a short but detailed history of Britain's oldest licensed airfield given in the Departure Lounge of the 1930's Art Deco Terminal Building. Following this a visit to the resident aircraft hangar where there are, at close quarters, a wide variety of Shoreham based aircraft, some dating from the early post-war period.

On leaving the hangar the tour then passes Shoreham's largest operators hangar, Southern Air Limited, where helicopters and fixed wing aircraft can be found under maintenance conditions. Leaving this area, the tour continues along the western taxiway towards the Sussex Police Helicopter Unit. It is here that we will provide a detailed description of the airborne police role in Sussex. There are many aircraft parked in the areas you will visit and we will try to answer all questions you have.

Please dress in a suitable manner taking into consideration the British weather.

The cost of the tour will be £3.00 per person. Meet at The Archive Visitors Centre at 2.30 p.m., which is alongside the terminal buildings car park.

A 3 course lunch can be obtained for about £9.50 at The Restaurant in the Terminal Building for a maximum of 20 persons, please indicate on the reply form your choice of menu if you intend to join the party for lunch.

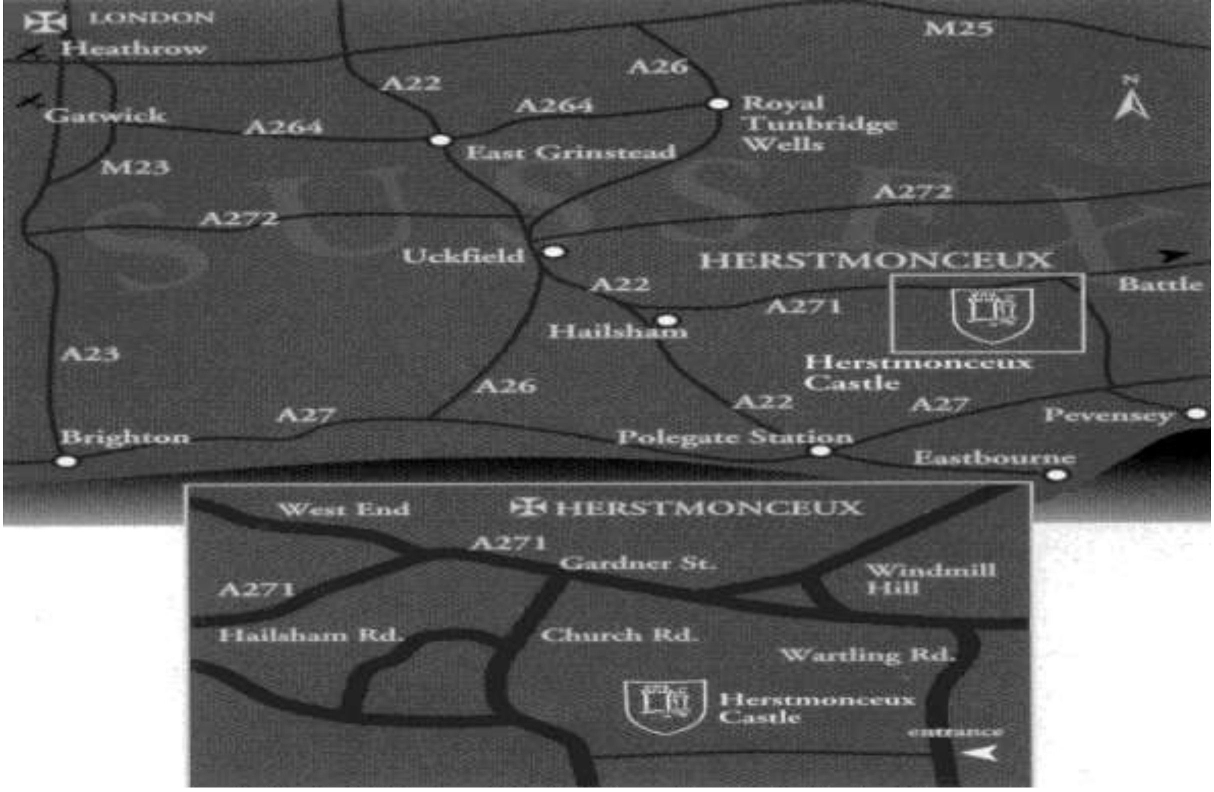


Closing date for applications 27th March, 2000 - please return form on page 11.

Outing with partners to **Herstmonceux Castle, Science Centre and Telescopes,** on Wednesday 17th May 2000.

Meet 11.00 a.m. at the visitor centre for coffee in the tea rooms. The guided tour of the Castle will commence at 11.30 a.m.and last for about one hour allowing adequate time to have a snack in the tea room or eat a picnic lunch in the gardens. The guided tour of the Telescopes has been arranged to start at 2.30 p.m. and will last for about 40 minutes. Afterwards members are free to try their hands on the exhibits at the Science centre

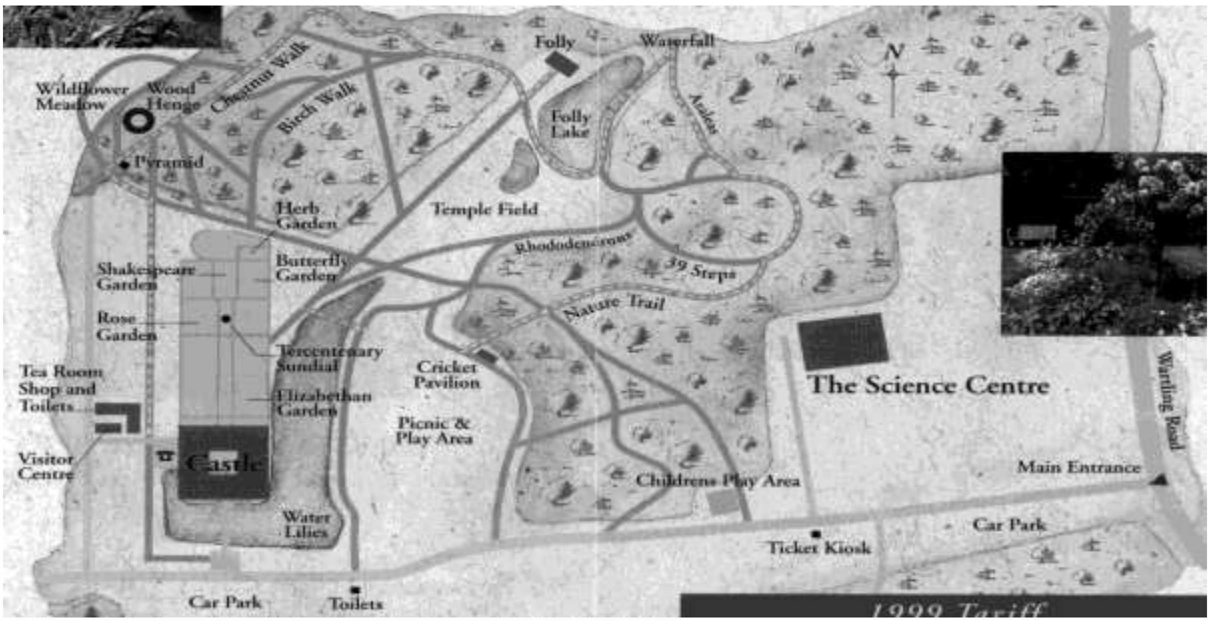
Herstmonceux is renowned for its magnificent moated castle, set in parkland and superb Elizabethan gardens. Built originally as a country house in the mid-15th century, Herstmonceux castle embodies the history of medieval England and the romance of renaissance Europe. The castle is a working Study Centre of Queens University, Kingston, Ontario and is not open to the public, however we are having a special guided tour commencing at 11.30 a.m.



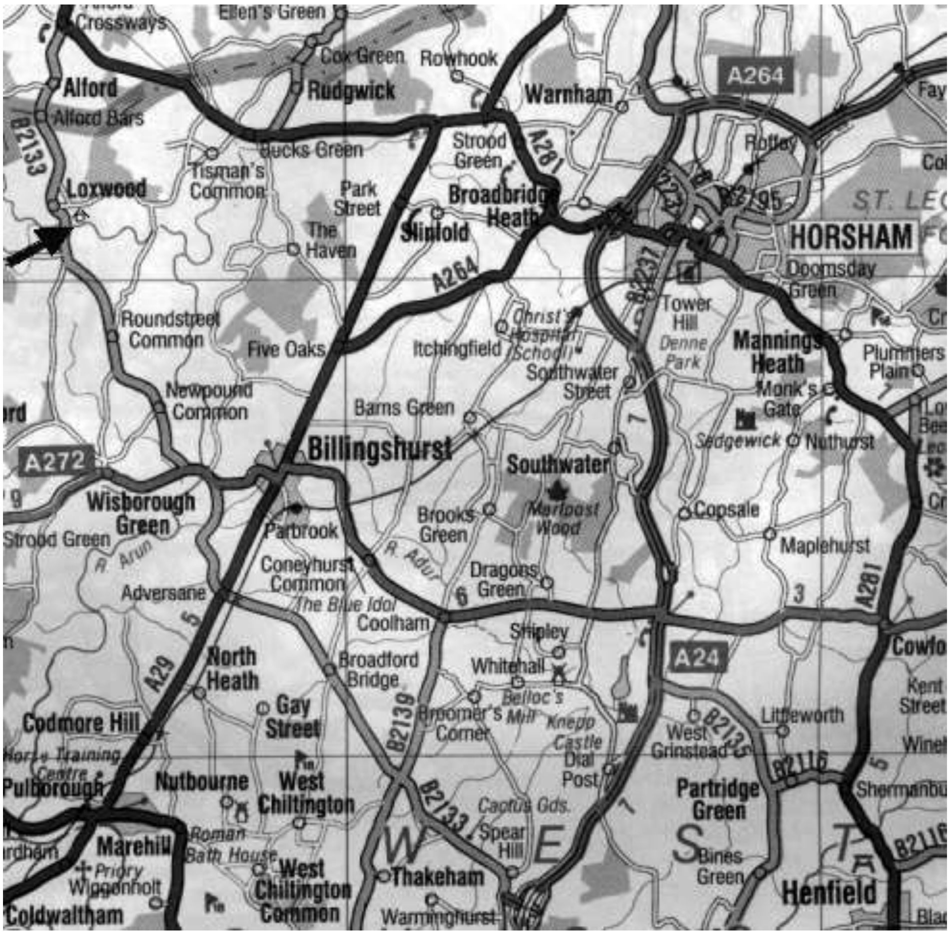
Hertmonceux was the home of the Royal Greenwich Observatory from 1945 to 1985. All major telescopes have been moved away but the equatorial group of telescopes remain as well as the 90 ft high dome which housed the 100" Isaac Newton Telescope.

The cost per person is £8 to cover all entrance fees and the guided tours.

Closing date for applications 26th. April 2000 - please return form on page 11.



Outing with partners to Wey and Arun Canal, on Wednesday 21st June 2000 at 2.30 p.m.



The trip is limited to 30 persons being the capacity of the boat and is reserved wholely for the RCEA and starts from the landing stage beside The Onslow Arms.
Cost of the return cruise which lasts about 2 hours will be £4.50 per person
A pub lunch can be obtained at The Onslow Arms please indicate on the reply coupon if you intend to partake of lunch at the Onslow Arms.

Closing date for applications 7th. June 2000 - please return form on page 13 together with your cheque for payment.

Garden Party **with partners, on Wednesday 19th July 2000 at 2.30 p.m.**

At " Elphin" NorthDrive, Angmering, Lttlehampton, BN16 4JJ

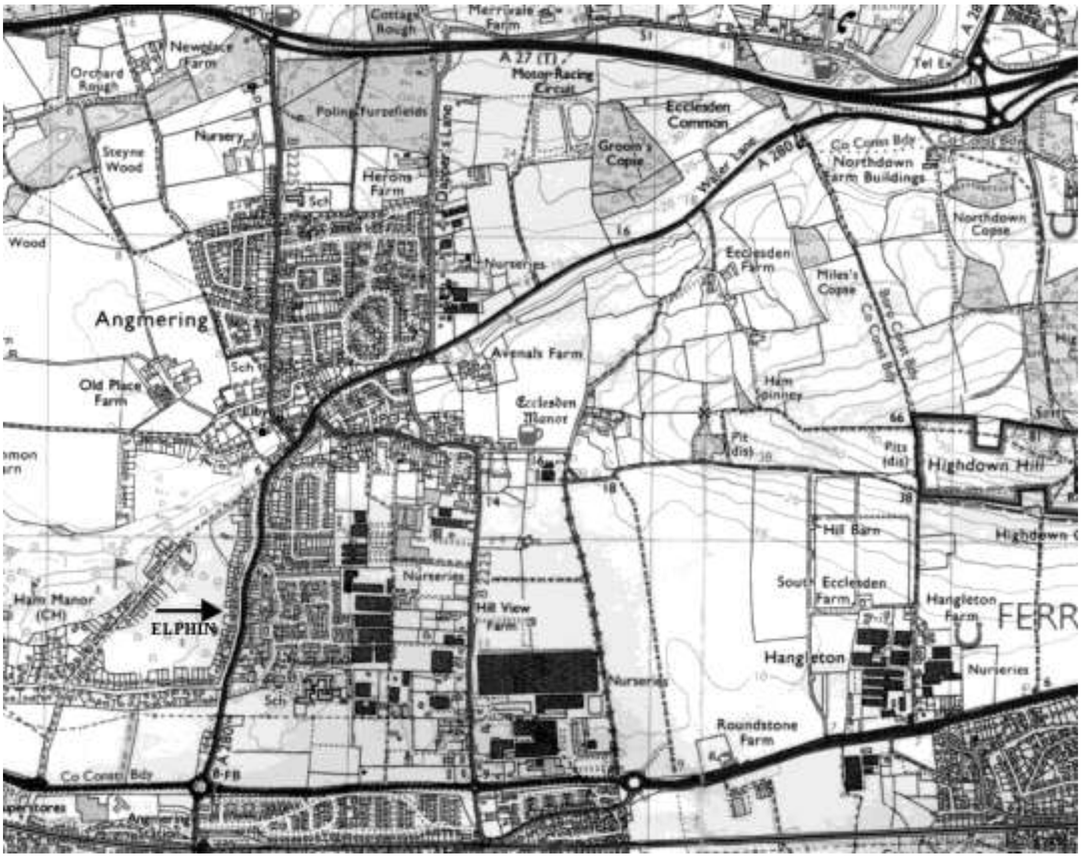
This is a chance for members and their partners to meet informally over a cream tea In particular a warm welcome is extended to newer members who are requested to make a special effort to attend this function and meet other members.

For gardening enthusiasts, come and identify some of the specimens.

Seating is limited, so if some members could put folding/ camping chairs in the boot of their car, it could prove helpful.

In the event of rain, the function will be postponed until the following week ie Wednesday 26th July at 2.30 p.m. Telephone 01903 787116 by 1.30 p.m. on the day, if the weather is bad.

North Drive runs parallel to the west side of Station Road which runs from Angmering village to Angmering Station. Elphin is the 11th house from the south end of the drive or the 20th from the north end and has a 24m long stepped brick wall outside.



Don't forget to wear your name badge

Closing date for applications 5th. July 2000 - please return form on page 13.

Please note that no confirmation of your application will be made and no tickets will be issued. However if there are any problems, eg there is a waiting list, then you will be notified.

To: S. Oliver, “Elphin” North Drive, Angmering, Littlehampton, BN16 4JJ Tel: 01903 787116

I wish to participate in the outing to **Shoreham airport** on Wednesday, 5th April 2000 at 2.30 p.m.

Full Name ....(Block capitals)

Address ....

....

Phone No............................

My guests will be………………………………………

I enclose a cheque for …………..payable to RCEA for the guided tour (£3.00 per person)

I would like to join the group for lunch at the Restaurant at Shoreham Airport. Number of places……

Please fill in number of items required below:

Soup……….or Pate……….

Cod & chips……..or Quiche Lorraine……….or Sweet & sour chicken…………

Choice of dessert

Applications by 27th March, 2000

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To: S. Oliver, “Elphin” North Drive, Angmering, Littlehampton, BN16 4JJ Tel: 01903 787116
I wish to participate in the outing to **Herstmonceux** on Wednesday, 17th May 2000 at 11.00 a.m.

Full Name ....(Block capitals)

Address ....

....

Phone No............................

My guests will be………………………………………

I enclose a cheque for …………..payable to RCEA for entrance and the guided tours (£8.00 per person)

Applications by 26^{6h} April, 2000

To: S. Oliver, “Elphin” North Drive, Angmering, Littlehampton, BN16 4JJ Tel: 01903 787116

I wish to participate in the outing on the **Wey & Arun Canal** on Wednesday, 21st June 2000 at 2.30 p.m.

Full Name ....(Block capitals)

Address ....

....

Phone No............................

My guests will be………………………………………

I enclose a cheque for ………….payable to RCEA for the cruise (£4.50 per person)

I would like to join the group for lunch at Onslow Arms. Number of places……

Applications by 7th June, 2000

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To: S. Oliver, “Elphin” North Drive, Angmering, Littlehampton, BN16 4JJ Tel: 01903 787116

I wish to participate in the Garden Party on Wednesday, 19th July 2000 at 2.30 p.m.

Full Name ....(Block capitals)

Address ....

....

Phone No............................

Name of partner…………………………….

Applications by 5th July, 2000