



Copy of H1, John Harrison's first clock aimed at the longitude prize



H4—Harrison's first watch to be tested at sea. (130 mm dia.)

The Search for Longitude by Bob Bryson

On Thursday 6 November I went with other SIHG course members on a visit to Greenwich organised by Geoff Roles. Most of those on the trip found their way to a special exhibition in the National Maritime Museum entitled "Ships, Clocks, and Stars - the Search for Longitude".

Greenwich is well known as the home of the prime meridian and of the observatory. What is not so well known is that the observatory was founded in 1676 "so as to find out the so-much desired Longitude at Sea, for perfecting the art of Navigation". The technique of finding latitude at sea was well established at the time of Columbus who, by measuring the height of the sun above the horizon, was able to sail to the Americas along a line of latitude on his 1492 voyage. The quest for longitude was however to occupy minds for another 300 years. In 1707 four homebound British warships, with no means of accurately determining their position, were wrecked on the Scilly Isles with the loss of nearly 2,000 lives. This incident led to the British Parliament passing the Longitude act of 1714 offering a prize of £20,000 (worth about £2.75m today) to the person who could solve the longitude problem.

As latitude could be determined by viewing the heavens, for many years an astronomic solution to the longitude question was favoured. Since 1650 Galileo's method of observing the predictable eclipses of the moons of Jupiter became the accepted method of finding longi-

tude on land. But the method proved impractical at sea because, as Galileo himself observed, the pounding of one's heart was enough to cause the whole of Jupiter to jump out of the telescope's field of view. In theory as the earth turns 360 degrees in 24 hours, local time thus varies by 4 minutes per one degree of longitude; one degree of longitude representing a distance of between 68 miles at the equator, and zero at the Poles. Since local time can be easily established from the height of the sun, to calculate ones longitude all that is needed is a measure of celestial time, or the time at a know meridian such as Greenwich.

English clockmaker John Harrison (1693-1776) dedicated his life to making a clock that would enable Greenwich Time to be carried to every corner of the world.

The lunar distance method turned out to be Harrison's main rival for the Longitude prize. By measuring the distance between the moon and the sun it was possible to calculate the celestial time. This method took many hours of calculation and Astronomers Royal from Flamsteed to Maskelyne in 1762 attempted to produce tables to make such calculations easier. Nautical Almanacs published between 1766 and 1907 contained these lunar tables.

Another, but less practical, method was to attempt to measure the difference between true North (by using say the North Star) and mag

(Continued on page 2)

Contents

- 1 The Search for Longitude by Bob Bryson
- 2 Notices
- 3 Venues, Times & Contacts + Diary 20 January 2015 - 31 March 2015
- 4 An Obituary of Rosamond Hanworth, 1919-2014
- 5 How Steam Reforming Saved the Gas Industry by Fred Starr, report by Margaret Levett
- 5 The AIA 2014 Conference at Chester (Part 2) report by Glenys & Alan Crocker
- 6 Flash In The Pan by Roy Johnson

Diary January 2015

- 20 Tue SIHG Guildford: Railway Electrification by Peter Bosomworth, Locomotive Engineer and Railway Enthusiast.
- 22 Thu SIHG Leatherhead: (Attendance is for the full course only.) Three Victorian Railway Bridges by Douglas Irvine - Structural Engineer.
- 29 Thu SIHG Leatherhead: Steam Power in Miniature by Frank Paine, Lecturer.

(Continued from page 1)

The Search for Longitude

netic North and comparing this difference to a chart showing the variation around the globe. While a number of these charts were on show at the exhibition, the method failed mainly because changing magnetic fields made it impossible to keep the charts up to date. A more bizarre method involved wounded dogs. This method first put forward in 1687 relied on a miraculous powder which, while painful, could heal at a distance. A wounded dog was to be placed aboard a ship and at noon on shore an old bandage from the dog would be dipped in the solution. This would cause the ship board dog to howl giving the Captain the required time signal!

The exhibition had on display all five of Harrison's clocks, as well as some of the chronometers made subsequently in an attempt to mass produce and hence reduce the cost of the original designs. By 1780, four years after John Harrison death, an Arnold or Earnshaw chronometer could be purchased for £65-£80.

Harrison was by trade a carpenter not a clockmaker but by 1725 he had something of a reputation as a clockmaker, albeit using wooden parts and bearings. After hearing about the longitude prize he visited London in 1730 and on receiving encouragement from George Graham FRS, spent the next five years building the clock subsequently known as H1. Like his earlier clocks, H1 had bearings of lignum vitae wood that require no additional lubrication. To enable operation at sea, balance weights and coil springs replaced the conventional pendulum.

The clock was tested on a trip to Lisbon, although to win the prize a trip to the West Indies was mandated. Following the successful voyage, instead of pressing for the longer test, Harrison asked for £500 so he could build a better clock. This clock, H2, took Harrison until January 1741, but this clock never went to sea. H3 having taken nearly twenty years to build, was also never put to the

test as Harrison had a change of heart. In 1753 John Jefferys had made a pocket watch for Harrison to his design, and Harrison thought that a smaller, faster running watch-like device might prove as accurate as a large clock. So in 1755 Harrison set about manufacturing H4. Both H3 and H4 (the watch) were completed around 1759. At sea on a voyage across the Atlantic, H4 lost only 5 seconds in 81 days. (See images of H1 and H4 on page 1.)

The prize should have been awarded to Harrison after this trial; however the Board of Longitude paid out only half the £20,000, insisting on further tests and that replica watches be built. (One could argue this was a sensible new provision of the revised Longitude act of 1765 as each watch had cost several hundred pounds, while to use the rival lunar distance method needed only a quadrant and a copy of the recently published Nautical Almanac.) Harrison eventually agreed to disclose his design and a number of copies were made. Harrison himself, although now elderly, made an austere copy of H4 known as H5.

Under pressure from the King, Parliament awarded Harrison a further £8,750 in 1773. The terms of the longitude prize were again revised by an act of 1773 requiring duplicate time pieces to be submitted but this prize was never claimed.

Captain Cook took the first official replica of H4 - made by Kendall called K1 - on this second voyage in 1772, and remarked that it gave great service.

K2 was aboard the Bounty when the mutiny occurred in 1789, and the watch remained on Pitcairn Island until 1808. By the time Charles Darwin set sail in 1831 there were no fewer than 22 chronometers on board HMS Beagle.

The board of Longitude was disbanded in 1828 and by 1860 the Navy alone owned 800 chronometers distributed across its fleet of some 200 ships. □

Diary February 2015

- 3 Tue SIHG Guildford: Harry Ferguson and the Agricultural Revolution by Ed Marshall.
- 5 Thu SIHG Leatherhead: Papermaking in Hertfordshire – Michael Stanyon, Archivist.
- 12 Thu SIHG Half Term Visit - Frogmore Paper Mill.
- 17 Tue SIHG Guildford: Prehistoric Metalworking from Scratch - Relearning Ancient Knowledge by Fergus Milton, metallurgist at Butser Ancient Farm.
- 19 Thu SIHG Leatherhead: (Attendance is for the full course only.) Nineteenth Century Monorails – Adrian Garner, Lecturer
- 26 Thu SIHG Leatherhead: Mille Miglia 2014 by Angela Hume, Brooklands.

SIHG Newsletter No 203 January 2015 *DIARY*

Enquires to Programme Co-ordinator Bob Bryson: meetings@sihg.org.uk.

39th series of SIHG Industrial Archaeology Lectures

alternate Tuesdays, 19:30-21:30, Education Centre, The Cathedral, Guildford (map: www.sihg.org.uk).
Single lectures at £5, payable on the night, are open to all.

Thursday Mornings Lectures at Leatherhead, 10:00-12:00,

Room G6 The Institute, 67 High Street Leatherhead KT22 8AH

Non-member full fee £50 SIHG member £45. (Please note that attendance is for the full course only.)

Venues, Times & Contacts of Other Organisations

Please check venues and times carefully.

Brooklands: open Summer 10:00-17:00, Winter 10:00-16:00; £11/£9.90; Brooklands Rd, Weybridge, Surrey KT13 0QN; www.brooklandsmuseum.com; 01932 857381.

BIAG, Berkshire Industrial Archaeology Group: 19:30; £2.50; Garden Room, Watlington House, Watlington Street, Reading RG1 4RG; www.biag.org.uk.

Brunel Museum: Walks from Bermondsey Tube; just turn up Wed 16:30, Sun 10:45; £9/£7.
Boat & train from Embankment tube station (not pier) for Brunel sites along the Thames; just turn up Tue/Thu/Sat 10:45; £9/£7 (+ transport costs). Museum: Railway Avenue, Rotherhithe, London SE16 4LF; 020 7231 3840.

Croydon Airport Visitor Centre: some Sun, 11:00-16:00, free; Airport House, Purley Way, Croydon CR0 0XZ.

Cuffley Industrial Heritage Society: 20:00, £4; Northaw Village Hall, 5 Northaw Road West, Northaw EN6 4NW; www.cihs.org.uk.

DBRG, Domestic Buildings Research Group (Surrey): East Horsley Village Hall, Kingston Avenue, East Horsley, Surrey KT24 6QT. (O.S. ref TQ091542): There is no need to book and non-members are welcome.

Didcot Railway Centre: 10:30-17:00; £10.00/£9.50; Didcot Parkway railway station, Didcot, Oxfordshire OX11 7NJ; www.didcotrailwaycentre.org.uk; 01235-817200.

Docklands History Group: 18:00, £2; Museum of London Docklands, No 1 Warehouse, West India Quay, Hertsmere Rd, Canary Wharf, London E14 4AL; www.docklandshistorygroup.org.uk; 01689 851982.

GLIAS, Greater London Industrial History Society: 18:30; Swedenborgian Lecture Theatre, Barter Street by King-sway Underground Station; www.glias.org.uk.

Greenwich Industrial History: 19:30, £1; Old Bakehouse, rear of Age Exchange Centre, opp Blackheath Stn, Bennett Park, 11 Blackheath Village, SE3 9LA; no parking.

Guildford Museum: Castle Arch, Guildford, Surrey GU1 3SX; Mons to Sats, 11:00-17:00 + Bank Holiday Mondays; www.guildford.gov.uk/museum, 01483 444751.

HIAS, Hampshire Industrial Archaeology Society: 19:45, free; Underhill Centre, St. John's Road, Hedge End, Hants SO30 4AF; www.hias.org.uk; 01962 855200.

IWA, Inland Waterways Association:
www.waterways.org.uk; 0203 612 9624.

London Canal Museum: Open 10:00-16:30; Talks 19:30, £4/£3; 12/13 New Wharf Road, London N1 9RT; www.canalmuseum.org.uk; 0207 713 0836.

Museum of London: 150 London Wall, London EC2Y 5HN
Museum of London Docklands: Mon-Sun: 10:00-18:00; no.1 Warehouse, West India Quay, London E14 4AL; www.museumoflondon.org.uk/docklands,
info.docklands@museumoflondon.org.uk, 020 7001 9844

National Trust: www.nationaltrust.org.uk, 01483 561389.

Newcomen Society London: 17:45, free; Fellows' Room, Science Museum, Exhibition Road, London SW7 2DD; <http://newcomen.com>.

Newcomen Society Portsmouth: 18:30; free; Portland Building, University of Portsmouth, Saint James's Street, Portsmouth PO1; <http://newcomen.com>.

Portsmouth Historic Dockyard: 10:00-17:30, site ticket, annual £26/£24.25; HM Naval Base, Portsmouth PO1 3LJ; www.historicdockyard.co.uk; 02392 728060.

Railway and Canal Historical Society: 18:30, free?
The Rugby Tavern, Rugby Street, London WC1N 3ES; www.rchs.org.uk.

Rural Life Centre: open Summer Wed-Sun 10:00-17:00, Winter Wed/Sun 10:00-16:00; £8.50/£7.50; Old Kiln Museum, Reeds Road, Tilford, Farnham, Surrey GU10 2DL; www.rural-life.org.uk; 01252 795571.

STEAM - Museum of the Great Western Railway: 10:00-16:00, £8/£6.50; Kemble Drive, Swindon SN2 2TA; www.steam-museum.org.uk; 01793 466 646.

SIAS, Sussex Industrial Archaeological Society:
www.sussexias.co.uk.

Watercress Line, Mid Hants Railway: all day travel £14, free on non-running days; Station Rd, Alresford, Hants SO24 9JG; (or Station Rd, Alton, Hants GU34 2PZ); www.watercressline.co.uk; 01962 733810.

Weald & Downland Open Air Museum, 10:30-18:00, £11.50/£10.50; Singleton, Chichester, West Sussex PO18 0EU; www.wealddown.co.uk; 01243 811348.

SERIAC 2015 Saturday 25 April 2015

The South East Regional Industrial Archaeology Conference at Ashburton Hall, Queen Elizabeth II Court, Sussex St, Winchester SO23 8UJ. *The Programme/Application Form is enclosed.*

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Castle Arch Guildford Surrey GU1 3SX, Group President: Prof AG Crocker FSA

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Rosamond Hanworth, 1919-2014

Rosamond Viscountess Hanworth, a Past President of the Surrey Archaeological Society (SyAS) who played a supportive role in the formation of the Surrey Industrial History Group (SIHG), died in October at the age of 97. We remember her in particular presenting the Annual SIHG plaque in 1989 to the Surrey and Hampshire Canal Society for its campaigning and practical work in achieving the restoration of the Basingstoke Canal. The ceremony took place at Oldham and the accompanying photograph (above) shows Rosamond, as she wished to be known in SyAS, presenting the plaque to Robin Higgs on the towpath of the canal beside the Society’s trip boat, the *John Pinkerton*. The SIHG AGM was held on the boat on this occasion. We then sailed along the canal to King John’s Castle, walked along the towpath to Greywell Tunnel and had a meal at the *Fox & Goose*. Rosamond also presented the plaque in 1993 to Tony Reid of the Old Farm at Sheer.

She was also for many years the Editor of *Surrey Archaeological Collections* and encouraged SIHG members to publish industrially-oriented articles in its pages. This is one reason why one of us (Glenys) became an Assistant Editor and in due course succeeded her as Editor. We were very pleased that we were able to attend the service of thanksgiving and remembrance for her life held at St Mark’s Church, Whitely Village. She was also a great supporter of the Trust that created and manages the Village.

Alan and Glenys Crocker

Exhibitions

until 14 March 2015 at Guildford Museum: First World War Commemoration
until 12 April 2015 at London Canal Museum: The Story of the British Army’s Use of Canals in Belgium in WW1 Waterways on the Western Front
Until 31 December 2015 at STEAM, Reading; The Role of the GWR and its Employees during WW1 A Railway at War - Exhibition
Proposed Working Party at Vale End Pumping Station, Albury Volunteers wanted, please contact Alan Crocker

Diary March 2015

- 3 Tue SIHG Guildford: The London Water Ring Main by John How, voluntary consultant, Inland Waterways Association & Basingstoke Canal Society.
- 5 Thu SIHG Leatherhead: (Attendance is for the full course only.) History of Lubrication by Peter Longstaff - ExxonMobile
- 12 Thu SIHG Leatherhead: (Attendance is for the full course only.) The Lighter Side of the V Force - Bill Turnill, ex Vulcan Pilot.
- 17 Tue SIHG Guildford: Superseding the Seamstress; a history of the sewing machine by Dr Martin Gregory, Newcomen Society & HIAS.
- 19 Mar SIHG Leatherhead: Preserved Railways in the USA – Alan Thomas, SIHG.

Surrey Industrial History Group Officers

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SIHG Guildford Lecture 18 November 2014

How Steam Reforming Saved the Gas Industry *by Fred Starr, report by Margaret Levett*

Fred Starr explained that after WW II the gas industry was entirely dependant on coal, but coal was in short supply and output was dropping. Furthermore, the quality of available coal was going down and the UK had no dollars available to import suitable coal.

After nationalisation in 1948 the gas industry began to investigate the production of gas from oil and the steam reforming of LDF, light distillate feedstock, (low grade petrol) but early plants had limited output and pressure. The major breakthrough was the introduction of the ICI steam naphtha reformer which produced gas on a continuous basis at high pressure, using feed stock which was readily available and did not produce unnecessary ammonia and tar based by-products. The high pressure meant that the gas could

be piped over large distances.

However replacing many small plants with a few large ones produced trouble when these broke down; this occurred once when the stainless steel headers in two plants failed simultaneously bringing the whole of the West Midlands motor industry to a halt.

The main problem with the ICI process was the low calorific value of the gas produced, necessitating the addition of propane and butane. This was overcome using the gas industry's own processes as additions to the ICI plants.

However, despite the success of these plants, the Gas Industry decided to convert to North Sea Gas in the mid 1970s bringing steam reforming to an end. □

The AIA 2014 Conference at Chester (Part 2) *report by Glenys and Alan Crocker*

The Monday evening lecture was on *Alderley Mines and the work of the Derbyshire Caving Club*. We went on the corresponding visit next day and were led underground by members of the Club who have researched the mines and run tours there. The site is on the sandstone ridge of Alderley Edge and is a Scheduled Monument. It spans the period from the Early Bronze Age to the late 20th century and has been worked for copper, lead and cobalt ore. It was quite a strenuous trip and some sensible members opted for the alternative visit to Nether Alderley cornmill. There were two groups underground and one at the mill; a breakdown in communication meant that we did not have time for lunch before the visit to the Macclesfield Silk Museums.

We went straight to Paradise Mills, which has working textile machinery, including hand-operated jacquard looms. Next door was the silk machinery museum housed in the former school of art, where fortunately there were cups of tea and cakes. Dinner was scheduled later than usual on Tuesday evening too. It followed an alternative tour to the mining landscape and iron works of north-east Wales and was held at the Llay Miners' Institute at Wrexham. The Institute is a splendid building, recalling more prosperous times. We gathered in the large assembly room for a Hotpot Dinner followed by a talk on *Salt in Cheshire*, in preparation for one of the next day's tours.



Paradise Mill, 1933
Community Archives and Heritage Group
www.communityarchives.org.uk/
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Wednesday was the last day of the conference and offered two tours: the salt landscapes, which we joined, and the Poynton coal-mining landscape between Macclesfield and Manchester. The salt trip first went to Nantwich, famous for subsidence and sloping buildings, where we visited the town museum. This has exhibits on the trades and social history of the town as well as relics of the salt industry, which include a 16th century 'salt ship', i.e. a hollowed-out timber brine tank. We next visited the Middlewich brine pump, sole surviving structure of the local industry and a Scheduled Monument, comprising a pumphouse and machinery. It was surveyed in 2010 by Oxford Archaeology North. From there we walked along the Middlewich branch of the Shropshire Union Canal to a pub for lunch. We then drove to the Lion Saltworks to see progress in restoring the complex, which is the only surviving open-pan salt works in the county. It is owned and run by Cheshire West and Chester Museums and is due to re-open to the public in 2015, having closed in 1986.

That was the end of the conference. It had been enjoyable and interesting as always, and a pleasure to be on a campus, at Chester University, where everything was close at hand. Next year's conference will be at Brighton. □

Wey & Arun Canal Trust A request for help & an opportunity to be involved in some interesting research

The Wey & Arun Canal Trust is looking for some assistance with a planned historical publication to coincide with the 200th anniversary of the canal's opening in 2016. Ideally we would like to modernise the existing pictorial histories of the canal (in which we don't hold copyright), with new material where possible. There would be some funding available for research effort - is this something that could interest one of Surrey Industrial History Groups members?

Thanks and regards, Julian Morgan, Publications
& IT Director, Wey & Arun Canal Trust,
julian_morgan@weyandarun.co.uk

SIHG Guildford Members' Evening 16 December 2014

Flash In The Pan by Roy Johnson

The title was used to introduce a talk on that particular aspect of firearms development associated with "ignition"; basically the action which causes a gun when loaded with propellant and projectiles, to "go off" or "fire".

The first recorded "hand cannons" of the fourteenth century were primitive devices which were almost as dangerous to the user as they were to the enemy. The method of ignition was simply induced by touching a glowing splint or some form of burning fibre on a stick, to the "touch hole" which connected the flame through to the main charge.

To provide a more controlled mechanical precision to the weapon, the "Matchlock" was devised whereby the glowing "match" or "burning cord", clamped at the end of a pivoted serpentine lever, was presented to the touch hole by pressing the remote end to "trigger" the discharge and thus the "round" or bullet contained within the barrel.

An alternative method of ignition was to provide a shower of sparks. This was initially accomplished by mechanically rotating a serrated steel wheel against a piece of pyrites, similar to the system later used manually in cigarette lighters. The "Wheellock" with its key or *spanner* wound spring mechanism was expensive to manufacture and was soon replaced by the "Snaphance" the name in German relating to the action resembling a "pecking hen". Sparks were produced by releasing a spring loaded flint striking a steel anvil. Development of the "Snaphance" produced the more sophisticated "Flintlock" whereby a close fitting, primed "pan-cover"

was moved aside exposing the touch hole at the same time as the flint containing "cock" struck the anvil (now called the "Frizzen").

Sporting shooters were often plagued by wet and windy weather, where misfire was still likely when small amounts of external priming (black powder) could become lost or damp. A solution was sought and achieved by replacing the "cock" with a "hammer" to stimulate a small explosion from a "fulminate" material placed over the touch hole. Tiny amounts of fulminate (unstable compounds; typically acid reduced crystals of various chemicals) were eventually encapsulated in miniature copper tubes or thimbles to be struck at the breech area of the weapon to give reliable firing.

The simple percussion "cap" eventually became the favoured method in preference to an array of ingenious innovations including the "Maynard tape", later used to give hours of pleasure to children with cowboy pistols.

Early revolvers relied on a rotating cylinder of usually six pre-loaded chambers, each with its own percussion cap firmly pressed on a nipple at the end. This lasted until the advent of the all-in-one cartridge consisting of: bullet, metal or cardboard case and a percussion end piece. Progression through the location of the fulminate eventually settled more or less universally with a "centre-fire" cap location giving rise to the *bullet* or munitions we know today. ☐



Matchlock
Early German musket
with serpentine lock



8-shot **matchlock** revolver
Germany ca. 1580



Wheellock pistol or *Puffer*,
Augsburg, c. 1580

Snaphance lock
cocked and ready to fire
showing the cock and
frizzen rotated back



fired
showing the cock and
frizzen rotated forward



Images from Wikipedia

The deadline for **submitting copy** for the next Newsletter is **10 March 2015**. *Submissions are accepted in typescript, on a disc, or by email to news@sihg.org.uk. Anything related to IA will be considered. Priority will be given to Surrey-based or topical articles. Contributions will be published as soon as space is available. Readers are advised that the views of contributors are not necessarily the views of SIHG.* Website: **www.sihg.org.uk**