JOHN LETHBRIDGE 1675–1759

Inventor and Diver

It is a special kind of individual who, at the age of 39 living in a comfortable home with a caring wife and large family, sets out for the dangerous life of a world-travelling treasurer-seeking sea diver. Such an individual was the inspiring character John Lethbridge.

His early upbringing was in and around the hamlet of Wolborough, near Newton Abbot. A member of the well respected Lethbridge family he was a trustee of endowed parish property in that hamlet and became established as a wool trader in Newton Abbot. Unfortunately, the decline of the wool trade in Devon created serious financial problems so he started thinking about other ways to make a living. In his own words: 'Necessity is the parent of invention, and being in the year 1715 quite reduced, and having a large family, my thoughts turned upon some extraordinary method to retrieve my misfortunes, and was prepossesed that it might be practicable to contrive a machine to recover wrecks lost in the sea'.

Why he should have decided on a sea faring venture is not entirely clear; perhaps it was because he lived in a county fortunate enough to have the open sea on two borders and with excellent ports. Considerable sea trade existed to the Americas, Africa and China through the towns of Plymouth, Dartmouth and Brixham so tales of shipwrecks must have been told throughout the county. It is possible that these stories influenced his idea of salvaging valuable cargo from sunken vessels.

Lethbridge started his new venture with a couple of experiments. Perhaps for dramatic effect, he arranged the first to take place at noon on the day of a solar eclipse. In his own words: '. . . and the first [step] I took towards it [the new venture] was going down into a hogshead [barrel], upon land, bunged up tight, where I stayed half an hour without communication of air'.

The scene must have been strange. An orchard with a collection of friends and neighbours, nervous in the eerie swiftly gathering darkness of the eclipse, sitting around a large barrel with Lethbridge inside. The sunshine reappeared as they heard a knock on the wood and relieved friends released him. The diving engine inventor had made his first experiment to discover how long he could survive in a closed space without replacement of his air supply.

The next experiment was to test his ability to remain encased in the barrel under water. Described again in his own words: '. . . then I made a trench near a well, at the bottom of my orchard in this place in order to convey a sufficient quantity of water to cover the hogshead, and then try'd how long I could live under water without air pipe or communication of air'. Encouraged by the surprising fact that he could remain longer under water than on dry land, Lethbridge then designed what he called his diving engine and commissioned a well known London cooper to construct it as follows: '. . . perfectly round, about 6 feet in length, about 2 and a half feet diameter at the head, and about 18 inches at the foot . . . iron hoops . . . to guard against pressure . . . there are two holes for the arms, and a glass about 4 inches diameter . . . to look through . . . in direct line with the eye, two airholes . . . into one of which is conveyed air by a pair of bellows before going down to the bottom'. With this apparatus lowered from the side of a ship so he was in a horizontal position, Lethbridge believed he could work at water depths to 18 metres for periods of about thirty minutes before being hauled to the surface for the air to be replenished by bellows connected to one of the two air holes.

Diving for sunken treasure was not a new activity at this time. Previous years had seen the appearance of various forms of diving bells, weighted casks and submarine boats with air systems. Even at the time Lethbridge was experimenting in Devon, a Major Becker was reported to be demonstrating his engine made from leather and glass by walking three quarters of a mile along the bottom of the River Thames in London.

There were individuals who had obtained patents for their ideas and a claim was made by a Mr Symonds of Harbertonford that he had invented an engine similar to Lethbridge's and demonstrated it on the River Dart. Lethbridge was adamant that he had no knowledge of the Symond's design.

It was however remiss of Lethbridge not to have registered his invention since it was designed to be used without the emcumbrance of piped air and specifically for retrieving articles from the sea bed. Of all the other inventions, none has been reported as helping to achieve such great financial rewards.

He demonstrated his engine for many years but, despite his entreprenarial character and spirit, work contracts eluded him; no doubt because he had no boat, no knowledge of sea faring and no personal connections with individuals influential in the business on which he was embarking. However, after a prolonged and succesful demonstration of his skills to directors of the English East India Company he met Jacob Rowe, an experienced diver and the owner of a patent for similar equipment.

They went together to the Isle of May to dive onto the English East Indiaman Vansittart which had sunk at an extemely dangerous site below the edge of a reef with immense surf. Lying in a prone position with his arms sealed by leather sleeves protruding through the wooden wall of his engine, breathing increasingly stale air with water slowly seeping in, buffeted by currents and surf breaking overhead, working conditions were abysmal. He often laboured for six hours moving about in a twelve foot square retrieving items from the sea bed, blasting with primitive underwater explosives when needed, the only communication with the surface ship by a signal rope on which he tugged coded commands. If he had been trapped in the sunken wreck's rigging or by rocks, nothing could have saved his life. In the words of his grandson: 'He was a man highly esteemed for honour and integrity . . . no Danger ever annoyed him whilst he was at work on the wreck of a ship with water up to his Chin'.

A year later Lethbridge and Rowe returned to London with a vast treasure from Vansittart including 27 chests of silver. This was shared out by the Master of the Royal Mint, Sir Isaac Newton, and the fortune enabled Lethbridge to set off on his own to explore the wreck of the Royal Anne off Lizard Point, Cornwall.

News of the venture came to the attention of the directors of the Dutch East India Company who had suffered severe losses through recent shipwrecks; in particular they were anxious to salvage treasures lost in Table Bay, Cape Town, South Africa. After lengthy negotiations a contract was signed in Holland and work commenced. Unfortunately the operation was unsuccesful mainly because of shifting sandbanks obscuring the sunken cargo.

At about this time, the Company received news that the vessel Slot ter Hoge [Castle of Hooge] was wrecked at the island of Porto Santo [now named Porto do Guilherme], Madeira, in the Atlantic ocean. A salvaging contract in 1725 with Lethbridge agreed he would receive a basic fee of ten pounds per month plus expenses plus bonuses to be left 'to the generosity of the Directors'. Lethbridge sailed to the sheltered bay there and with a team of divers achieved great success retrieving the treasures.

They then returned to Table Bay for further attempts at that site because the Company attached great importance to this operation. All the divers were treated with much respect, being offered the best food, liquor to help them perform the arduous task; accommodation was provided in The Castle used by the Governor!

Then followed a series of profitable ventures before Lethbridge sailed home to be with his family in 1728. He suffered illness but four years later returned to the Slot ter Hoge site for more exploration. Tragically Ellen his wife died the following year. More work took him to Marseilles, Southern France and then again to the wreck in Porto Santo; unfortunately, illness thwarted his ambition to complete the site final clearance of the Slot ter

Hoge. This vessel was explored recently by marine archaeologist and veteran salvage diver Robert Stenuit with a team who were intrigued with, and admired, John Lethbridge's life and exploits. They were able to recover items and silver bars worth a fortune!

Incredibly, at the age of eighty one, he applied for a contract from the English East India Company to salvage the vessel Dodington, sunk on Bird Island, Algoa Bay, off the coast of South Africa on a jagged inlet smashed by breaking surf and surrounded by sharks. It is likely that Lethbridge anticipated his involvement in this venture as organising the logistics rather than physical work but this demonstrates again his extraordinary tenacity and courage. The operation was considered too dangerous by the Company and he received no contract.

His amazing career ended and he retired. He had worked on the wrecks of some sixteen vessels, all lost in the space of twenty years and his achievements funded the purchase the estate of Odicknoll, Kingskerswell, near Wolborough, allowing his family to live in considerable comfort. The diving engine was last observed in grounds belonging to Holdsworth, the last Governor of Dartmouth but a replica of it exists to this day.

The Wolborough Parish Register records Lethbridge's burial on 11 December 1759 with the words:

'Mr John Lethbridge the Elder, Inventor of
a most famous Diving Engine
by which He Recovered from the Bottom of the Sea
in different Parts of the Globe
almost an Hundred Thousand Pounds for the
English and Dutch Merchants
which had been lost by Shipwreck . . .'

Modern-day diving techniques with sophisticated equipment allow safe and efficient robot operations to depths exceeding 6,000 metres. The sea-going vessel 'MV John Lethbridge' was extensively refitted in 2005 at Falmouth for SubSea Resources PLC and is being used for underwater exploration. There are published lists identifying tens of thousands of wreck sites with hundreds of millions of pounds worth of sunken cargo. Most treasure is owned by governments or insurers but generally 90 percent of the value is awarded to those who, like John Lethbridge, have the courage to retrieve it.

J A Knivett

JOSEPH WHIDBEY 1755–1833

Marine Engineer

Most Devonians will be aware of the stone breakwater across the entrance to Plymouth Sound, and some may have benefited, on returning from voyages in craft large and small, from the shelter it provides from the stormy seas outside. Perhaps fewer realize that the breakwater was constructed during the Napoleonic wars nearly two hundred years ago to provide shelter for the British fleet from violent storms on an otherwise unprotected coast. Although, as in all engineering projects, many people were involved in the implementation of the breakwater project, the man principally involved in its planning and construction was Joseph Whidbey.

Joseph Whidbey rose from obscurity – his place of birth and the circumstances of early years widely unknown – to become a Fellow of the Royal Society and one of the leading engineers of his day. In the eighteenth century there was, of course, no formal training or accepted apprenticeship for becoming an engineer, but the position of Master of one of His Majesty's ships was perhaps one of the more unusual steppingstones to an engineering career. At that time the Master on a ship of the Royal Navy was the senior non-commissioned officer responsible for sailing and navigation, perhaps equivalent to a warrant officer today. In 1786 Whidbey was Master of the Europa then stationed in the Caribbean under its Captain George Vancouver, when they were ordered to undertake a survey of the entrance to Port Royal harbour in Jamaica. The two men co-operated on the work. In view of its accuracy, the resulting chart was considered to be a model of hydrographic survey work. It was later published under their joint names. In 1791 Vancouver was appointed to undertake surveys of the north-west coast of North America, and Whidbey sailed with him as Master of his ship Discovery. Their joint work on hydrographic surveys of the north-west coast, which lasted until 1794, was well received by the Admiralty and the scientific community, and it was at this time a friendship was established between Whidbey and Sir Joseph Banks, President of the Royal Society, who considered that Whidbey was mainly responsible for the success of the work on the north-west coast. During his time with Vancouver, much of it spent in small boats surveying the creeks and inlets of the American coast, Whidbey learnt much about good anchorages and the protection of ships from storms, which he was able to put to good use during his subsequent career.

On his return from America, Vancouver recommended Whidbey for promotion to rank of Master Attendant. In 1799, as Master Attendant at the Sheerness dockyard, Whidbey was responsible for the salvage of a Dutch frigate lying in 9.8 metres of water on the Great Nore in the Thames Estuary. The salvage of the vessel was considered to be a major achievement, and, encouraged by Sir Joseph Banks, Whidbey presented a paper on the salvage work to the Royal Society in 1803. In the same year Admiral Lord St Vincent, another member of the Royal Society, commissioned Whidbey to undertake a survey of Torbay with a view to finding a safe anchorage for the Channel Fleet. Lord St Vincent, who during the succeeding years was at various times First Lord of the Admiralty and Commander in Chief of the Channel Fleet, was concerned at the vulnerability of the fleet to storms along the south west coast, especially in time of war. This was Whidbey's first visit to Devon where he was to spend much of his working life over the next thirty years. The published chart resulting from Whidbey's surveys indicates an area in the middle of the bay as the site for an artificial island to provide protection for ships in the bay from rough weather. Nothing resulted from this work, but Lord St Vincent continued to be concerned at the lack of a safe refuge for the fleet and concluded that Plymouth might make a better anchorage than Torbay. In 1806, his colleagues in the Admiralty having been similarly persuaded, Whidbey, along with the respected engineer John Rennie, was asked to undertake a similar survey in Plymouth Sound.

Whidbey had worked with Rennie in 1804, after being transferred from Sheerness to Woolwich, where silting was a problem, and he may have known him earlier. John Rennie, was a civil engineer with experience of bridge construction as well as harbour and river works. He had been called in by the Admiralty to advise on how the silting problem at Woolwich might be overcome, and dredging costs reduced. Rennie appears to have appreciated Whidbey's wide practical experience in marine matters and, along with Sir Joseph Banks, proposed Whidbey for election as a fellow of the Royal Society in 1805.

Rennie and Whidbey, accompanied by Samuel Hemas, Master Attendant at Chatham, who was also familiar with the Plymouth area, visited Plymouth in March 1806 at the time of high spring tides, and, advised of the urgency by Lord St Vincent, submitted their report to the Admiralty a month later. This recommended that an artificial island about a mile long built of stone rubble should be formed in the centre of the Sound over the shallows occurring at the Shovel rocks, without obstructing the existing channels nearer to the shore on either side. The alternative of breakwaters running from the shore on either side was discounted because they would indeed tend to obstruct the existing channels. It was estimated that the work would require two million tons of rock and cost about £1 million. In discussions that followed, it was strongly recommended that Whidbey should be appointed to superintend the work. However, although the admirals were keen for the work to proceed, it was a time when Britain's fortunes in the war with France were at a low ebb and the government, conscious, then as now, of the many calls on its limited resources, felt it could not afford the high cost. The project was shelved.

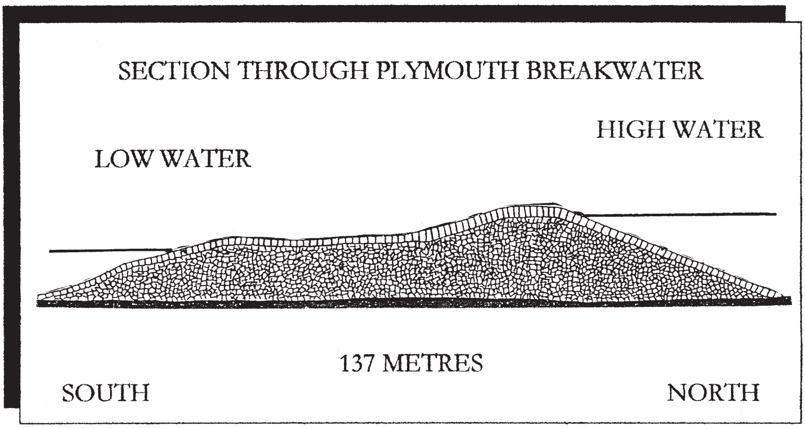
Over the next few years Whidbey remained at his post at the Woolwich dockyard and continued to liaise with Rennie regarding the silting problem there. He attended meetings at the Royal

Society and, amongst others, corresponded with Lord St Vincent. Meanwhile, behind the scenes, the Admiralty, ever conscious of the lack of a safe anchorage for the Channel Fleet, continued to press the Government to allow the breakwater project to proceed. Britain's fortunes in the war with France gradually improved and, finally, in January 1811 the go-ahead was given. The project was to follow the plan proposed previously by Messrs Rennie & Whidbey and be carried out under the superintendence of Whidbey. Extra funds were included in the Naval estimates and the work was to proceed with all urgency.

Whidbey arrived in Plymouth in August 1811, which was to be his home for the next nineteen years. The first thing to be done was to negotiate with the landowner, the Duke of Bedford, for access to the proposed quarry site at Oreston This was chosen for its good limestone rock and because of its proximity to deep-water in the shelter of the Cattewater. Rennie and Whidbey designed a special vessel for carrying the heaviest rocks, which were loaded onto trucks and run aboard on rails. On arrival at the breakwater site, the rocks were discharged from their trucks over the stern. With an upper and lower deck and two tracks on each deck, about twenty-four 5-tonne rocks could be carried. Eventually, ten vessels of this type were brought into use. To ensure that the rocks could be discharged in the required positions, Whidbey set out the site early in 1812, fixing marker and mooring buoys at strategic points. Work also started on opening the quarries, building the loading berths on the Cattewater and laying a railway between the two. Separate contracts were let for quarrying the rock and for transporting it to the breakwater site. William Stuart was appointed resident engineer overseeing the work at the quarry site. The Prince Regent's birthday, 8 August, was chosen for the official starting date, when a 7-tonne rock was discharged from the stern of the first specially-designed vessel to the accompaniment of music and in the presence of 2,000 spectators.

The work of excavating, transporting and discharging rock at the breakwater site continued apace. By 1813 the mound became visible at low water and in the following year the length above water level was sufficiently extensive to allow ships to anchor in its lee. The approved design allowed for seaward slope of 1:3 (one length vertical to three lengths horizontal), although Rennie had favoured a slope of 1:5. In those days, there were no design charts and tables, as now, relating rock size, slope and wave height, so the slope chosen depended upon the experience of the engineer. Whidbey considered that the steeper slope would be adequate. In 1817, however, a violent storm washed much of the rock from the seaward side over the crest, leaving a seaward slope of about 1:5. Despite this, and a recommendation from Rennie that the plan should be modified to provide a 1:5 seaward slope, Whidbey, supported by the Admiralty on grounds of cost, continued to adhere to the original plan, until once again the mound was reconfigured by a hurricane in November 1824. Rennie and other leading engineers were called in to assess the damage. They proposed modifying the design to provide a 1:5 seaward slope, faced with coursed granite masonry above low water level, needing over half a million tons of additional rock.

Although Rennie had a major influence on the design, his role was that of advisor rather than Engineer, in the manner that became the practice later in the nineteenth century and continued almost to the present day, where a client wishing to implement a project would appoint an Engineer to advise on the optimum scheme, prepare detailed designs, award contracts and supervise



construction. Whidbey, as an employee of the Admiralty, was in charge of the setting out and construction of the work, directing progress and letting and supervising contracts for the excavation and transport of rock. Soon after arriving in Plymouth Whidbey established his home and site office at Bovisand Lodge overlooking the Sound and the site of the breakwater construction from the east. From a jetty below his house he could board his yacht Nonnio and be on site within half an hour. He was paid a salary of £1,000 per year plus expenses, a handsome sum at a time when a gentleman could live comfortably, if not extravagantly, on £300 a year.

Although Whidbey may have been wrong in his belief that a 1:3 rock slope would withstand the onslaught of winter storms, he was much esteemed by his colleagues in the engineering and scientific community for his sound common sense, backed up by much practical experience gained both during his time surveying on the coasts of north-west America and at Sheerness and Woolwich. In 1809 he was elected an Honorary Member of the Society of Civil Engineers, which indicated perhaps that his colleagues, while appreciating his contribution to engineering, still did not consider him a true engineer. In 1822, however, he was transferred to the class of Ordinary Member, indicating that his apprenticeship was over! Whidbey's work in calming the waters in Plymouth Sound was much appreciated by the citizens of Plymouth, and in 1814 he was made a Freeman of the City.

Apart from his work at Plymouth, in the 1820s Whidbey was consulted about a number of harbour improvements elsewhere, including at St Ives and Ilfracombe in Devon and further afield at Whitehaven and for the Port of Glasgow and the River Clyde. In 1822 the idea of a breakwater in Torbay was revived and Whidbey and Stuart carried out a survey and prepared cost estimates for the Admiralty, but again the scheme did not proceed.

Whidbey remained in charge of the breakwater works for nearly 20 years. He retired in 1830, and William Stuart took over the supervision of the works. The strength of the revised design with 1:5 seaward slope was proved in a fierce storm in October 1836, which the breakwater withstood with a minimum of damage. Completion work, including the construction of a lighthouse at the seaward end, continued until 1865, the total cost of the work then being a little short of £1.5 million.

After his retirement Whidbey moved to Taunton, where he died in 1833 and where his tomb can still be seen in St James's churchyard. Whidbey's portrait by the artist J Posford hangs today in the London headquarters of the Institution of Civil Engineers, along with the portraits of other distinguished engineers.

M C D La Touche

ALFRED JAMES SIMS 1907–1977

Warship Designer and Submarine Expert

Alfred Sims, who became the first Director General Ships and Head of the Royal Corps of Naval Constructors, had a modest start to life. He was the youngest of five children and was born in the Devon village of Revelstoke, near Plymouth, on 11 October 1907 where his father was the maintenance engineer on the local estate of Lord Revelstoke. In due course he attended Regent Street Higher Elementary School in Plymouth and at the age of fifteen he entered the Royal Dockyard, Devonport as an Electrical Fitter Apprentice, transferring to a Shipwright Apprenticeship two years later.

In the early twentieth century it was virtually impossible for a lower middle class boy to attend University but a Dockyard apprenticeship offered a good education and a satisfactory career to those young men who were able to pass the entrance examination. Alfred Sims duly took the examination and passed top of his intake.

The Royal Dockyard schools were unique with their training and education. At the end of the first year, half the boys went into craft training whilst the remainder carried on with their academic education. A similar elimination was repeated at the end of the second and of the third year. Accordingly, those apprentices who completed the fourth year were the cream of the original intake (and many in later years wore a numeral 4 badge on their lapel to denote their achievement). Again, Alfred Sims was top of his intake and in 1928 won a Cadetship to the Royal Corps of Naval Constructors.

This award was given only to very few apprentices from the nationwide Royal Dockyards and in effect set the ex-apprentices on a professional engineering career. Sims, together with the other new entrants to the RCNC, was sent to the Royal Naval College, Greenwich to study naval architecture, during which time, although a member of a civilian organization, he wore a Royal Naval officer's uniform. Again, he passed out as top of his entry in 1931 with an outstanding First Class Professional Certificate. As was the custom, he then spent a year at sea, still in naval uniform, gaining experience in various ships of the Mediterranean Fleet before being appointed to Chatham Dockyard.

Sims spent four years at the Royal Dockyard, Chatham as an Assistant Constructor where he was in charge of submarine construction, supervised the drawing office and carried out pioneering work on the application of welding in warship construction. During the latter part of that appointment he was the lecturer in Naval Architecture at the Chatham Royal Dockyard School.

In 1936, he joined the Admiralty in the Naval Construction Department. He worked with the Submarine Design Group on the Triton Class submarine. For the rest of his career he continued to have a particular, and increasingly important, association with submarine design, construction and operation. In 1938, he was appointed to the Staff of Rear Admiral Submarines in the rank of Constructor Lieutenant Commander, shortly afterwards being promoted to Constructor Commander. This was a very early promotion to senior rank.

In 1940, Admiral Max Horton, was appointed Flag Officer Commanding Submarines, Gosport and a close wartime association began between the two experts. Sims moved with Admiral Max Horton and his staff to London early in the war, and remained with him when the Admiral was appointed Commander-in-Chief, Western Approaches. In this appointment, Admiral Max Horton was responsible for the transatlantic convoy system. Sims advised him on anti-submarine warfare, and on submarine construction.

During this period he won the respect of those serving at sea for his dedication to the Service and for fostering a good relationship between those bearing the brunt of the war and those who were working to produce better submarines. He was also commended for his work in re-structuring captured German equipment. For this dedicated, and essential work, he was awarded an OBE in 1943. A year later, due to his versatility, he was sent to the Far East to investigate 'The Habitability of Naval ships under Wartime Conditions'. This was in anticipation of the eventual swing of resources to the war against Japan in the Far East and the formulation of a policy for air conditioning ships of the Royal Navy. He afterwards wrote the first edition of the Ventilation Manual, which became invaluable to later designers.

Then in 1944, when he was only thirty seven years of age, he was sent to the Admiralty at Bath, as a very young Chief Constructor in charge of submarine design and building. In 1947, he produced a paper for the Institute of Naval Architects on 'British submarine design during the war'. He had by then established his position as the principal authority on submarine design in the United Kingdom.

With the coming of peace, the training of Naval Constructors returned in the Autumn of 1947 to the Royal Naval College, Greenwich. With his outstanding academic record and experience in senior appointments, Sims was the natural selection to become the first post-war Professor of Naval Architecture. Much needed to be done to bring the course up to date. Wartime experiences and great technological advances demanded a complete re-think on warship construction and during his five years in the chair Professor Sims completely re-wrote the syllabus and the course notes. His students from that time recall his dedication to the task and the late hours he spent preparing his material. He expected the same dedication and determination from his students, one saying that you 'either loved him or hated him'. He alone was responsible for returning the Greenwich course to its pre-eminence amongst schools of naval architecture in Britain and was the mentor for a fresh generation of naval architects, many of whom later served, with distinction, under him at the Admiralty at Bath.

By 1952, after completion of five years as Professor of Naval Architecture and the inauguration of a completely re-designed course, Alfred Sims was able to hand over his chair and return to the Admiralty at Bath. He was put in charge of the section responsible for aircraft carrier design and was particularly concerned with the completion of the aircraft carriers HMS Ark Royal and Hermes together with the extensive modernization of HMS Victorious. A year later he was promoted to Assistant Director and submarine construction and design were added to his responsibilities. He held this post until 1958. Sims had come to the forefront of his profession at, for him, a most favourable time.

The post war period was a critical time for the Royal Navy. After six years of war the Fleet was in poor shape and overtaken by technical advances, particularly in electronic warfare, weapon systems and ship propulsion. Most ships were of pre-war design. It had been shown that battleships and large cruisers with their heavy gunnery were obsolete and that the future strength of the Navy lay in aircraft carriers, frigates and submarines. Because of his experience, Alfred Sims was the ideal man to control and influence the design and build of the post-war submarine fleet.

The Admiralty was early in appreciating the advantages of nuclear propulsion, and in particular its application to submarines which until then been limited in speed and range. Frequent surfacing for air was necessary to recharge batteries and nuclear power appeared to offer the chance of speeds in excess of 25 knots (28.8 miles per hour) with unlimited endurance. Study teams were formed in the early 1950's with the aim of having a nuclear powered submarine by mid 1962. In 1956 a draft Staff Requirement for a nuclear submarine was agreed and the following year the United States offered to release nuclear information.

Then in January 1958 the President and the Prime Minister signed an agreement for the United Kingdom to purchase a complete nuclear propulsion plant. This opened the way for

Britain's first nuclear powered submarine (S101), later to be known as HMS Dreadnought. This ship was designed at the Admiralty at Bath by a team under the overall direction of Alfred Sims, built at Vickers Shipyard, Barrow on Furness and launched by Her Majesty the Queen on Trafalgar Day 1960. She was completed on time and on cost.

In 1957 an extensive enquiry into the organization of the departments of the Controller of the Navy was carried out. The committee recommended that these various departments should be formed into three separate units responsible for Ships, Weapons and Aircraft respectively and that each should be headed by a Director General. Alfred Sims was chosen to become the first Director General Ships, and he spent an intensive period from April to October 1958 preparing the terms of reference and working practices of the new organization.

In October 1958 he took up his new post, becoming responsible to the Admiralty Board for the old departments of Naval Construction, Engineer-in-Chief of the Navy, Electrical Engineering and Naval Equipment. At the same time he became Head of the Royal Corps of Naval Constructors. He had not only reached the top of his own profession but also had assumed responsibility for other engineering disciplines within the Royal Navy at a time when there were great advances.

Many new classes of warship were commissioned to be armed with missile and advanced gunnery systems. But in particular, he laid down the hull of Britain's first submarine based Polaris ballistic missile nuclear deterrent HMS Resolution in February 1964, to be launched by Queen Elizabeth, the Queen Mother in 1966. HMS Resolution was followed by Repulse in 1967, Renown in 1967 and Revenge in 1968. These ships served as Britain's nuclear deterrent for thirty years.

Further design and construction programmes during Sims period as Head of the Royal Corps of Naval Constructors included a large helicopter-carrying cruiser, a new design anti-submarine frigate, a guided missile destroyer and a new mine-countermeasure vessel. These vessels included extensive use of electronics, gas turbine propulsion and new weapon systems. It was almost certainly the most intensive period of change that the Royal Navy had known and Sims presided over all these programmes. He was a hard taskmaster but led by example. He was knighted in 1960.

Sir Alfred Sims served as Director General Ships, and Head of the Royal Corps of Naval Constructors, for ten years, retiring in 1968. Retirement did not see the end of Sir Alfred's activities. He was soon engaged in work for the Civil Service Commission and for various institutions concerned with maritime affairs and education. He was elected as the first professional President of the Royal Institution of Naval Architects in 1971 and served in this position for five years, after which he was elected an Honorary Fellow of the Institution, the highest honour that the Institution can award. He was Prime Warden of the Worshipful Company of Shipwrights 1975/76 and was in great demand as a speaker and as a lecturer. He was an Honorary Research Associate of the University College, London and was actively concerned with Bath University, being awarded the Honorary degree of Doctor of Science in 1974.

Sir Alfred James Sims, KCB, OBE, DSc, RCNC Warship Designer and Submarine Expert died at the Forbes Fraser Hospital, Bath on 25th, August 1977 in his seventieth year following a long and distinguished career associated with an incredible number of naval projects.

J C Calderwood

ROGER HOPKINS 1775–1847

Civil Engineer

Born in 1775, Roger Hopkins was one of the sons of Evan Hopkins of Llangyfelach who was engaged in the late eighteenth century in the construction of canals, tramroads and other works associated with the mining industry of South Wales. Evan was responsible for the design and construction of the inclined plane at Glynneath connecting the canal network and this plane, unusually, used a Trevithick high-pressure steam engine to transfer the canal barges from one level to the next. There followed a contract to build the Aberdare Canal in 1809 and with son David, a further tramroad on to the Aberdare Ironworks. His son Roger had by this time emerged as an engineer in his own right having received training and experience from his fathers activities.

Roger Hopkins married Mary Harris, daughter of the Reverend R Harris of Pwllheli, Caernarvonshire, at St Mary's Church, Swansea in 1806. In that year he became trustee of the Baptist Meeting House of the Swansea General Baptist Church. He was elected a corresponding member of the Institution of Civil Engineers in 1824.

Hopkins had, in 1804 been involved with the tramroad between Pen-y-darren and Abercynon in South Wales upon which Richard Trevithick tried the first railway locomotive steam engine. In 1810 he was engaged as engineer on the Monmouth Railway which was built partly through the Forest of Dean. In 1811 he was permitted to supervise work on the Severn and Wye Railway, where progress was poor and three years later came to Bideford to plan a tramroad or railway for Lord Rolle, to run alongside the River Torridge to Great Torrington. This project came to nothing.

In April 1821 the Plymouth and Dartmoor Railway appointed Hopkins as assistant engineer requesting he inspect and report on the state of the railroad between Crabtree and Jump (Roborough), where it seemed that William Stuart, the part-time engineer in charge, had deviated from the agreed route. The findings from Hopkins's report were so serious that it became necessary to amend the earlier Act of Parliament approving the works. Hopkins was sent to Parliament to guide a new Bill at the Lord's Select Committee stage and, with the Earl of Shaftesbury in the Chair, stated to the committee 'that the necessity for the present application to parliament for the Bill was not manifest until the month of April last, and originated in the impracticability the Railway found with proceeding with the work on the original line . . .' A new Act was passed, and William Stuart was dismissed. Hopkins completed the supervision of the construction and the railway was opened in 1823.

During this same year Hopkins competed against James Rendel for the approval of the Earl of Morley to be allowed to construct a bridge at Laira, Plymouth. Hopkins wished to construct a multiple span wooden bridge and Rendel, planned first a suspension bridge and then a five span cast iron bridge. In the event Rendel was successful in this project but at the same time Hopkins was successful in a scheme for building a wooden bridge between Shaldon and Teignmouth.

Late in December 1823 Hopkins set off for an extended spell in London where for the next five months he assisted in the preparation of an estimate and tender to supply Dartmoor granite for the whole construction of the new London Bridge. The Plymouth and Dartmoor Railway Company would benefit from this by transporting granite from Dartmoor to the quays in the River Plym estuary. Still in London, he finalised the design in February 1824 for the proposed bridge between Shaldon and Teignmouth.

The Bill to erect the bridge at Teignmouth received Royal assent in June 1824 and three years later the Teignmouth and Shaldon bridge was opened to traffic by the Duchess of Clarence. It cost £20,000 and measured 510 metres in length, comprised thirty-three timber arches and masonry approaches with a swing section over the main channel. It was the longest wooden bridge in England and only surpassed in the whole of Europe by the Pont de Lyons.

In 1827 the Hopkins family were established in Plymouth at 5 Brunswick Terrace, where Roger lived with his wife, Mary, and three sons Rice, Thomas and Evan. The eldest son, Rice who was born at Swansea in 1807, began his career on the tramroad, at the age of fifteen, as a pupil of his father and was elected a corresponding engineer of the Institution of Civil Engineers in 1836. It is interesting to note that Evan, the only son not to become a civil engineer, married the daughter of William Stuart, whom Hopkins had displaced from the Plymouth and Dartmoor Railway.

In 1828 Roger Hopkins designed and constructed the Royal Union Baths which were opened in May 1830 to much praise. However, within twelve years they were demolished to make way for the Millbay railway.

In 1831 he returned to North Devon to make a survey for the proposed Bideford and Okehampton Railway but this 34 kilometre route did not come to fruition. Also in 1831 he developed a acheme for the formation of a floating harbour at Swansea, together with a bridge across the river and the proposed new channel.

In 1831, Sir William Molesworth, a landowner, engaged Hopkins to survey a railway route from Wadebridge to Wenfordbridge with branches to Bodmin and Rutherbridge. The Bodmin and Wadebridge line was Cornwall's first standard gauge railway and also the first with steam traction. It was opened from Wadebridge to Bodmin and Wenfordbridge three years later.

In 1836 the partnership of Roger, Rice and Thomas Hopkins, based at Bath, owned mines in South Wales and built, owned and directed the Victoria Ironworks in Ebbw Vale. In March of that year they proposed a railway from Tremoutha Haven to

Launceston and in 1837 they built a 11 kilometre tramroad from their pit at Gwauncaegurwen in the Swansea valley to the Swansea canal. However by 1840 the Victoria Ironworks had failed and the works were handed over to the Monmouthshire and Glamorganshire Bank Company in repayment of a debt of £12,500.

By late 1842, Roger Hopkins had turned his back on South Wales and settled in Boulonge, France. In March 1845 he wrote to David Mushet at Colford, Gloucestershire, who had previously recommended Hopkins to the Plymouth and Dartmoor Railway, asking him to join in a new company to erect furnaces, not only in Boulogne, but also all over France. Hopkins does not appear to have received Mushet's support.

He returned to England and died at the home of his elder son, Rice, at 109 Upper Stamford Street, Lambeth, on 27 June 1847 in his seventy-second year leaving a legacy of remarkable civil and railway engineering works.

A B George

JOHN AMBROSE FLEMING 1849–1945

Electrical Engineer

There can be no doubt that John Ambrose Fleming deserves to be listed among the 'giants' of electrical and electronic engineering research and applications during the second half of the nineteenth century and the first half of the twentieth.

He was born in Lancashire in 1849, the eldest of seven children of James Fleming a Congregational Minister and his wife, Mary Ann. The family moved to London in 1853, to be near to his maternal grandfather, John Bazley White, who lived at Swanscombe in Kent where, at a very early age, Fleming saw and used mechanical tools in his grandfather's Portland cement works in Kent.

At University College School from 1863, he quickly demonstrated a great ability in mathematics and soon developed ambitions for a career in engineering. Unfortunately, he was unable to afford the fees for this training so decided to pursue a career in teaching science. He enrolled at University College, London (UCL) in 1867 to study experimental physics, chemistry and mathematics. Physics, chemistry and maths, formed the launch pad for engineering careers, both then and now.

Fleming suffered the experiences of all impoverished students which are by no means modern phenomena and during 1868 financial difficulties forced him to temporarily discontinue his education. However, a post in a City stockbroker's office enabled him to study part-time for the University of London BSc, in which he received a first class honours in 1870. After graduating, he took a post teaching science at Rossall School in Lancashire and when, by 1872, enough money had been saved, he returned to his chemical studies at the Science Schools in South Kensington.

Fleming's growing passion though was electrical engineering which drew him to the physics laboratory and the experiments being conducted there. He was invited to give the first paper at the inaugural meeting of the Physical Society of London in 1874 and following this recognition, he was appointed science master at Cheltenham College. He had, by now, become in modern terms 'a workaholic'.

He read the works of Michael Faraday on electro-magnetic induction and developed ambitions to become involved with proposals for national standards of electrical resistance, corresponding with James Clerk Maxwell at the new Cavendish Laboratory in Cambridge. He was anxious to study under Maxwell at Cambridge and joining St. John's College there he began to study for the Natural Sciences Tripos for which he gained a first class honours in 1880 finding time also to pass the London University DSc examination in the summer of 1879. This same year saw the death of his father so, never one to shirk responsibilities, in addition to his lecturing duties he worked in the university's engineering workshop in order to support his widowed mother and younger brothers and sisters.

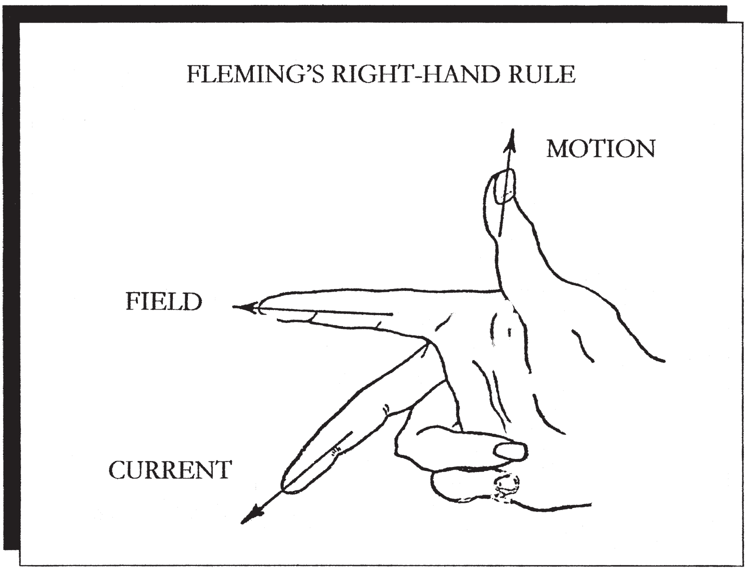
He was married to Clara Ripley on 11 June, 1887.

Fleming was appointed Professor of Physics and Mathematics at University College, Nottingham in 1881, resigning this post one year later in favour of a well-paid consultancy with the Edison Telephone Company in London. This company later merged with the Swan lighting company to form Ediswan and the first Ediswan filament bulbs were manufactured at their Ponders End factory

As the Company's 'chief electrician' he developed innovative photometric apparatus for the factory's quality control process, then in 1884 received another invitation – to lecture electrical technology at University College, London. At UCL, Fleming built his own laboratory but maintained very strong links with the Ediswan Company. In the following year he was appointed as the first Professor of Electrical Engineering at UCL, a post he held until his retirement in 1926.

To give his students clear guidance in predicting the motion of a current-carrying body (conductor) in a magnetic field, Fleming devised, about 1885, his famous 'Right-Hand Rule'. viz. 'If the first finger of the right hand is pointed in the direction of the magnetic flux (field) and the thumb is pointed in the direction of the conductor's motion, then the middle finger, held at right angles to both the thumb and the first finger, indicates the direction of the induced force'. Untold numbers of students of physics and electrical engineering, over the last one and a quarter centuries are eternally grateful to Ambrose Fleming. They have been able to reproduce this diagram and so earn a valuable few examination marks. Of course, for many years a number of the more ill-mannered students, caught by their lecturers sticking up two fingers, have been able to protest their innocence by claiming that their thumb was included !

In 1885, Fleming became profoundly interested in the use of alternating currents for long distance power transmission and his



researches culminated in his books 'The Alternating Current Transformer' – 2 volumes 1889–92.

Around this time, another 'giant' in the early years of electrical research and development was Ferranti who designed transformers of various sizes and proposed electrical power should be generated on a large scale, outside the great centres, where land was cheap and both water and coal were readily available. The installation of the first large-scale power station at Deptford Works was successfully completed in 1888 but there were dangerous surges in the famous 10,000 volts Ferranti electricity mains cables laid from the Deptford Power Station. Fleming was consulted and was able to suggest remedies.

It is however, even considering all Fleming's other achievements, the invention and research related to the Thermionic Valve which ensures his place among the greats in the history of electrical and electronic engineering. His key discovery, made in 1904, was a revolutionary new technique for handling high-frquency electro-magnetic waves, thus making radio transmission possible and marking the birth of modern electronics.

Fleming realised that use could be made of an effect noted by Edison in that, if a metal plate is introduced into an ordinary evacuated carbon filament electric lamp then current will flow in one direction only. From this fact he developed a device which would act in relation to electric current in the same way that a flap valve acts in a water-pipe. The system was improved later by others, but Fleming had made the fundamental break-through.

The background to this invention can be traced back to Edison who had encountered a major problem with the carbon filament lamp – the blackening of the inner glass of the bulb caused by the evaporation of the carbon. The lamp had a filament formed into a single loop and it was noticed that a thin line was formed on the glass wall where the carbon deposit was lighter.

Fleming was aware of the Edison Effect and his first published comment on this was in the January 1890 Proceedings of the Royal Society of London from which it was clear that Fleming had been carrying out his own research. The basic physics may seem quite elementary today:

> when a piece of metal is placed in a vacuum and heated, some of the electrons break away and form a cloud near the surface. This breaking-away or boiling-out of electrons from a metal is called thermionic emission.

Edison had noticed this effect but it was Fleming who showed that the electrons sent out from the heated filament could be attracted to a positively charged adjacent plate called an anode. So the diode valve, a vacuum tube containing a heated emitter and a plate, capable of changing (rectifying) alternating current to direct current was born.

Although the basic work on the diode valve had been completed by the mid 1890's there were no radio applications at that time and a few years were to elapse before he was able to claim his prize by being granted a patent for his Thermionic Valve on 16 November 1904.

On 9 February 1905, Fleming's new device the Thermionic Valve was revealed to the world in his paper read at the Royal Society 'On the conversion of electrical oscillations into continuous currents by means of a vacuum valve'. Marconi was persuaded to adopt the thermionic valve but by including an additional circuit, it was Marconi not Fleming, who converted the valve into a robust detector of wireless signals. By 1906, valves began to be used as wave detectors in practical wireless telegraphy and an amendment to Fleming's two electrode valve was made by an American patentee who produced the three electrode valve which could act as an amplifier as well as a detector. Developments in wireless telephony were to lead to extremely important scientific contributions for the Allied Forces during the First World War.

Towards the end of the nineteenth century Fleming had turned his attention to the subject of alternating currents at higher frequencies in Wireless Technology and he became Scientific Adviser to the Marconi Wireless Telegraph Company. He was responsible for the design of most of the electrical equipment at the Poldhu, Cornwall, station used by Marconi in 1901 when the transatlantic communications from Nova Scotia were achieved. In fact the plans for the first long distance wireless station in the world at Poldhu, Cornwall, were drawn up in the Electrical Engineering Department at UCL.

Marconi failed to adequately acknowledge Fleming's contribution to the transatlantic transmission and relations between the two became very strained. Marconi discontinued Fleming's advisory role to his company in 1903 but a few years later the consultancy contract was renewed. It required Fleming to surrender all patent rights to the Marconi company so he did not receive the financial rewards expected for this research.

However, he played an important role in the Marconi company's many years of bitter litigation with the American, de Forrest, over the originality of de Forrest's 1906 patent for the three electrode valve, which was subsequently employed as an amplifier in many radio receivers. Fleming's apparent victory in the American courts in 1917 was overshadowed by the death of his wife. Ironically, it was only two years before his own death in 1945 that the American court overturned the original verdict, by ruling that Fleming's patent had always been invalid.

Fleming continued with his major research programmes, produced technical publications and lectured on the new electrical technologies in the Christmas seasons at the Royal Institution in 1917–18 and 1921–22.

In 1926 he retired from University College London, almost 77 years of age, and lived in a house in Sidmouth, Devon, built to his own design, with his two sisters. He used the basement as a laboratory and this area was a private domain. Maintaining contact with UCL after his retirement he was, as professor emeritus, in demand to give special lectures which involved frequent journeys to London. Later he had an additional motive for his visits to London, other than his academic reasons. He had met a popular young singer, Olive Franks from Bristol who often gave concert performances including work for the BBC in London. Fleming attended many of these engagements and they were married in 1933.

Having been elected as vice-president of the Institution of Electrical Engineers in 1903 he received the Faraday Medal of that Institution in 1929 and was also knighted that same year. He was also elected president of the Television Society of London.

Small, localised electric power stations had been springing up all over the country including Exeter and Fleming acted as advisor to several of these.

In his few periods of relaxation Fleming enjoyed painting, sketching and foreign travel. Unfortunately, he had experienced hearing difficulties from birth and his deafness worsened as he became older. Not an easy man to get on with, this hearing problem was possibly a contributing factor. He eventually became chronically deaf and more difficult and unreasonable, often raging at shop assistants in his local newsagents if the newspapers had failed to arrive, even during the war years.

During the latter part of his life Fleming was a man of strong religious convictions and both he and his wife were regular worshippers at Sidmouth Parish Church. He died at his home in 1945 ninety five years of age and was buried at Salcombe Regis.

As part of the UCL Introductory speech given at the 1927 Centenary Address, the Chairman said: '. . . for nearly, if not quite, half the century . . . Professor Fleming has been contributing to those changes in the political, social and business life which are due to mechanical invention, which is the fashion to call progress, and more especially he has contributed to the necessary machinery for communication by telegraph and telephone both with and without wires'.

It is impossible that he, or in fact anyone, could have foreseen the world-wide explosion in the use and sale of mobile phones in recent times or even anticipated the dramatic increase in size and weight of large power transformers. But these dramatic developments have occurred and it is largely due to the pioneering research and subsequent practical applications inspired by Fleming that today we can take these and many other electronic and electrical devices for granted. Sir (John) Ambrose Fleming must always, quite justifiably, be remembered as 'The Telecommunications to Transformers Man'.

J J Brough