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THE CONTRIBUTION OF LAURENCE, SCOTT & ELECTROMOTORS LTD TO THE ROYAL NAVY

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ABSTRACT

A firm of electrical engineers, established in Norwich in 1883 under the technical direction of William Harding Scott eventually became known as Laurence, Scott & Electromotors Ltd.

The firm occupied premises in King Street, Norwich but in 1898 moved to their present site, the Gothic Works, Hardy Road, Norwich. The firm specialised in the design and manufacture of DC motors and dynamos. In 1898, as a result of the of the founder's interest in Naval matters, they designed their first Naval equipment for an Armoured Cruiser HMS BEDFORD. The Company continued to play a part in the design of Naval electrical power equipment and in 1908 they supplied the first DC Propulsion Motors to the C Class submarines.

In recent years from 1990 to 1998 they have supplied main power electrical equipment to Britain's Trident missile submarines.

In the interval they have supplied a myriad of Fan Motors, DC Switchboards, Plotting Tables, Motor Generator Sets, Fire Control Computers, Pump Motors, DC Machines & AC Machines to the Fleet.

INTRODUCTION

William Harding Scott was a young electrical engineer, working for a London firm of installation contractors called Hammonds. While carrying out this work, using electrical dynamos of poor construction, he expressed the view that he could design and build better quality machinery. Jeremiah Colman wanted to install new electrical machinery in his Carrow Works in Norwich when he was introduced to Scott by one of Scott's colleagues at Hammonds, E A Paris. In 1883 Colman set Scott up in his own premises, known as the Gothic Works, in King Street Norwich.

The business expanded, Paris left and Scott was joined by the financier Reginald Laurence, who organised and helped to fund the move of the factory in 1896 to more spacious premises in Hardy Road, the present location of the Gothic Works. Thus was the start of the Company then known as Laurence Scott & Co Ltd [1].

NAVAL BEGINNINGS

Scott's machines were DC dynamos and motors. He was a great innovator and had a healthy contempt for machines designed by professors with no idea of what was necessary to ensure reliability under normal working conditions. He was especially critical of some machines designed by Professors Ayrton & Perry [2]. Scott was responsible for a number of exciting innovations in those early years, including the 4 pole DC machine, the totally enclosed machine, practicable machine lubricating systems and methods of starting and controlling DC machines. It is interesting to note that in 1883 Scott had mastered the methods of machine design, that we now understand as the magnetic circuit, three years before the scientific work was reported by the more eminent, but probably less practical, Professor J Hopkinson FRS of Cambridge University [3].

The Company started to take an interest in marine work when it developed, in 1890, a small self-contained, steam reciprocating- driven dynamo, called the Norwich Shiplighter [1].

The Royal Navy began to be interested in electrical equipment for warships. I quote the words of LSE's Chief Draughtsman of 1943, H O Clark, recalling his and the Company's first foray in 1898 into what was called Admiralty work [4]:

At this time the Admiralty was not electrically minded. Lighting they had and a few electric bells but the first real application of an electric motor was for the Aft Capstans on armoured cruisers of the BEDFORD Class. An anchor on warships had to be carried at the stern in addition to those at the sharp end (sic) of the ship and everything had to be smart in appearance, as the bollard was in the middle of the quarter deck..

The machine installed was an LS, 4 pole, DC motor with a series-parallel controller, magnetic blowouts and fire and waterproof resistances in cast iron cases.

A DEVELOPING BUSINESS

The business developed with the application of motors for example to ammunition hoists, to increase the rate of fire of medium calibre guns, a lesson learnt in the Boer War. Also to the use of motors to drive the fans necessary to move air around the steel hulls of increasingly large ships. LS participated in an experiment in 1902 driving a 12.5 inch Sirocco fan against a 25 inch Sturtevant fan, blowing the latter backwards. Pump motors were also important and LS's first vertical pump motor for marine applications was produced in 1907 [1]. Such equipment played an important part in the technical fit of the DREADNOUGHT Class battleships being produced from 1906 onwards [5].

At this time the Royal Navy was also developing their submarine fleet. The first Class built in substantial numbers from 1908 were the C Class, based on the Holland design, powered by a petrol engine and equipped with 2 18 inch torpedo tubes

[5]. LS were invited to design the electric propulsion motor system and developed the first of a long line of submarine, main electric propulsion motors. These generally took a similar form, ultimately consisting of two coaxial armatures with interpoles and full compensation on the field. This configuration gave low brush wear, high availability, even in the event of the failure of a single armature, low inertia and a rapid electromechanical response when manoeuvring. The electrical system of the early submarines is of particular interest.

DC machines must not only be well-designed but also be part of an integrated system. Scott developed some of the speed control equipment, which was an essential part of marine propulsion and winch systems.

THE FIRST WORLD WAR

LS played a major part in equipping the Fleet with electrical machinery during the First World War. This was based on powering the fans, hoists, lifts, winches and pumps they had been working on before the war. They also played a significant part in contributing to the manufacture of shells, which were in such short supply from 1915 onwards. During these years the Company's concentration on DC machines started to become a matter of concern. It was clear that for domestic and industrial use AC systems were likely to succeed in the future and some Directors sought to turn the Company's interest towards these developments. Scott was not in favour of these moves, he was dismissive of the induction motor whose speed could not be varied. The developments of power electronics and controls, which would allow the induction motor to emulate the DC machine, without the pain of the commutator and brushes, lay many years in the future [4].

BETWEEN THE WARS

LS started to address the AC issue by deepening a relationship they had had since 1902 with the Manchester firm of Electromotors Ltd, which reputedly had a successful AC induction motor design. The tie initially involved marketing one another's products but in 1927, with some opposition from parts of the Board, Electromotors was acquired and the Company became Laurence, Scott & Electromotors Ltd [4].

Marine applications concentrated on the winch, which needed the flexibility and torque of the DC machine. Other ship auxiliaries formed a major part of the output of the Gothic works. However, LSE was severely affected by the slump, which brought major ship projects to a halt, leaving the factory full of half completed work in progress with no hope of payment

The benefits of Electromotor's AC designs proved illusory and it was not until the recruitment by the Company in the 1930s of P A Mossay as Technical Director, followed a few years later by Dr B Schwarz, that LSE began to perfect their AC ranges. In fact three of these men's products, the Trislot Induction Motor, the NS AC Commutator Motor and the Emcol machine were to prove the backbone of the Company's production in the years to come.

Scott died in 1938 shortly after his 75th birthday, which had been celebrated in style in Norwich with the attendance of many of the Company's employees. The commemorative menu is preserved and gives an insight into Scott's outstanding technical knowledge and innovation. The Company was one of the few electrical enterprises funded solely by British capital to survive the rigours of the early years of the 20th Century and the Slump. This was in part due to the quality of Scott's technical leadership.

It was about this time that the Company started discussions with the Admiralty on the manufacture of a new product, the Plotting Table. This marked the beginning of the Instrument Department, later to become the Special Products & Instrument Department, SPID, still continuing today in Norwich as Defence Equipment Ltd [4].

THE SECOND WORLD WAR

The Second World War was a period of enormous activity for LSE, which changed the face of the Company. Large amounts of specialised engineering were required, particularly by the Admiralty, which were delegated to LSE, because of their considerable Naval experience. The Instrument Department work expanded to include more sophisticated plotting tables, gunnery fire control computers, stabilised sighting platforms and servomechanisms.

A new stream of work arose because of the vital need for anti-submarine defences. The Naval establishment responsible, HMS OSPREY in Portland started to place work with LSE before the war in 1936. This work was placed in great secrecy with LSE receiving the instructions but having no idea of the purpose to which the equipment would be put. Eventually it became clear that the Company was constructing the training and directing gear for the sonar transducers being fitted to large number of escort vessels and other warships. The records showed that they manufactured [4]:

Directing Gear	*950*
Training Units	*2350*
Domes	*324* [6]
Trunks	*521*
Training Controls	*500*

A quote from TJ Barfield in 1946, who worked on the OSPREY equipment in the war, gives some idea of the atmosphere [4]:

We could not have produced all this gear without a great deal of help from sub-contractors. At one time we had 40 working for us. They ranged from firms like BTH, Davey Paxman,Reavells, Cowan Sheldon, to the landlord of the White Hart Hotel at a little town not far away. It was no easy matter to keep all these firms and individuals supplied with material and up to scratch in the matter of deliveries and workmanship.

Submarine work included the propulsion equipment for S & T Class boats, including the ill-fated HMS THETIS, which sank on her maiden voyage off Moelfre in Anglesey when a sailor opened a bow torpedo tube with the bow cap open. One of the main propulsion motors from the THETIS was salvaged, rewound and saw service at the Gothic Works as a load machine on the Test Bed. Propulsion Motors, or 'Subs' as they were known, proved ideal for loading the larger machines which were now being produced by LSE as they moved into the AC age. Their usefulness stemmed from their reliability and flexibility.

THE POST WAR WORLD

The Company's records show the overwhelming increase of AC work throughout the war years, including a report in 1944 by PA Mossay on early work in the USA on the electronic control of induction motors with thyratrons. The Navy was still firmly in the DC age. I can well remember that even by 1964 the smart appearance of an AC switchboard on a relatively new Type 12 Frigate was considered a great innovation over earlier DC distribution systems, still in service on Type 15 Frigates. That AC switchboard was produced by our sister company, Whipp & Bourne of Rochdale. LSE started to produce a large range of shockproof induction motors to meet this new AC demand, many of them manufactured at the Manchester factory. These had and still have a bewildering array of enclosure arrangements, demanded by particular pump, fan or drive requirements. For example:

Externally Ventilated
Externally Ventilated Drip Proof
Totally Enclosed Fan Cooled
Totally Enclosed Fan Cooled Water Tight Drained
Totally Enclosed Fan Cooled Submersible
Totally Enclosed Fan Cooled Air Bell
Totally Enclosed Water Cooled Submersible
Totally Enclosed Water Cooled Air Bell

The late 1950s introduced LSE to a new technology, nuclear power. The Company had taken a keen interest in the early British nuclear power experiments, designing submerged induction motors for driving the CO_2 circulators on the prototype reactor being built at Windscale. A crucial influence on this work was K K Schwarz, son of Dr B Schwarz, soon to become the Technical Director.

At the same time the Royal Navy was developing its first nuclear submarine, HMS DREADNOUGHT launched in 1963. Her Pressurised Water Reactor raised steam for the two steam turbines, which provided propulsion power, marking the end of the 'Sub'. However, the submarine still needed reliable auxiliary power for the reactor pumps and services. This was provided from the battery into a smaller DC power system coupled to the AC power system by two Motor Generator sets. The boat also had a DC Emergency Propulsion Motor to provide propulsion in the event of a complete steam failure. LSE participated by supplying the DC Switchboards, the MG sets and the EPMs. This innovative power system has provided a model for some of the changes in Naval propulsion since, with the introduction of mixed prime movers, low fuel costs coupled with the ability to achieve burst high speeds.

THE PRESENT DAY

In recent years the Company has supplied equipment for all the Royal Navy's nuclear submarines including VALIANT, WARSPITE, SWIFTSURE Class, RESOLUTION Class, TRAFALGAR Class and most recently for Britain's Trident Nuclear Deterrent the VANGUARD Class. For surface ships we have supplied the Type 22 Frigate and the more recently the innovative CODAG Type 23 Frigates, the NORFOLK Class with its specialised power system. A particularly interesting project was for the Royal Fleet Auxiliaries FORT VICTORIA and FORT GEORGE, which have commercial High Voltage and Low Voltage distribution equipment

The Company has had to change enormously during this period, as traditional markets in Defence, Nuclear and Fossil-fired Power Stations have dwindled or disappeared. The AC induction motor reigns supreme and is used at power outputs up to 20MW. It is also used in unusual Variable Speed Drive configurations, the ultimate product of those American experiments of the 1940s. The Company has joined forces with a number of previous competitors, which form the Rotating Machines Division of FKI Engineering, including:

Laurence, Scott & Electromotors Ltd
Brush Electrical Machines Ltd
Marelli Motori SpA
Froude Automotive Test Products
FKI Industrial Drives

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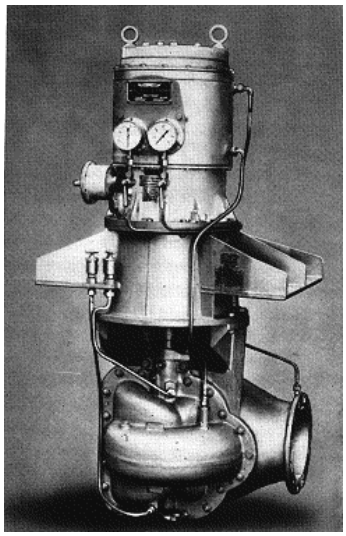
HMS VANGUARD, TSSBN05, 1990

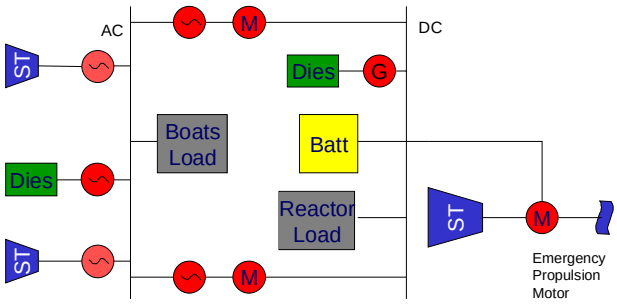
Equipment fitted:
2 AC Switchboards, W & B
2 DC Switchboards, LSE
2 Diesel Generators, BEM
2 Motor Generator Sets, LSE
Emergency Prop Motor, LSE
55 Motors, LSE
Test Cell Dynamometers, Froude



Typical LSE Vertical Mounted Shockproof AC Motor driving a Pump, 1950

Electric Ship Technologies, 1980

Nuclear Submarine HMS TRAFALGAR



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