FITTING SEX TO THAMES

It was with sadness that the editorial board heard of the recent death of Professor John Coales. Professor John rose to a position of great eminence in electrical engineering, becoming a Fellow of the Royal Society and Emeritus professor of Engineering at the University of Cambridge. But he never forgot his early days as a scientist working for the Admiralty at HM Signal School. This organisation has subsequently become absorbed into DERA but at the time was engaged on pathfinding work on radio direction finding which led to the naval radar systems that were to prove vital to the successful outcome of the Second World War. Professor Coales had promised to write an article for the *Review of Naval Engineering* and was working on about the time when he died. Unfortunately this undoubtable fascinating insight into the history of naval radar will now never be published, but there follows a short extract from an earlier article on radio direction finding which was first published in the *Journal Of Naval Science* in August 1984.

Professor Coales joined HM Signal School and His Majesty's Scientific Service in 1929. In December 1930 he was transferred to the radio direction finding section under a Mr Horton, X4, where he became X42 and joined another scientist (Mr Crampton - X41), a retired signal boatswain named Gates and an engine room artificer who was there to make and modify pieces of equipment. This was the sum total of the effort on radio direction-finding except that the design for production was carried out by a group of mechanical designers and the experimental equipment and prototypes were all made in the well equipped workshops. It was an enormous tribute to Mr Horton that, with this tiny research and development team, the Royal Navy led the world in ship direction-finding in the 1930s.

At the beginning of 1931 the only D/F sets fitted in the fleet had **Bellini-Tosi crossed loop aerials** suspended from the mainstay amidships and usually between the funnels where the ship errors were found to be the least (about +/- 4°). In some ships there was **a D/F cabin** immediately below the centre point of the antennae but in others it was in the bridge structure and the R/F signals were carried by paper-insulated cables to it. Conventional goniometers having a coupling factor of less than 20% were used but they had an interesting divided pointer invented by one of the group of designers (Mr Harris) whereby the operator set the pointer at a chosen signal level on one side of the minimum, opened a catch which unlocked one arm of the pointer and then turned to the same signal level on the other side of the minimum and read off the observed bearing from the central arm of the pointer which bisected the angle between the outer arms and was therefore at the signal minimum. In this way much better accuracy was obtained, particularly when minima were blurred. All sets were fitted with a sense finder and were also fitted with what was called a semicircular corrector devised by Horton some years previously. This device greatly improved the sharpness of the minimum, particularly at night when ionospheric reflections caused trouble, by feeding some of the signal from a vertical antenna into the search coil circuit in quadrature phase, adjusted by means of a variable capacitor. This cancelled out, as nearly as possible, signals induced by ionospheric reflection or the ship's structure, which caused the blurring of the minima.

In the 1930s it had become clear that the Royal Navy needed D/F much more for intelligence than for navigation and so accuracy was required at long ranges both day and night. Further, since communication between ships was going more and more to short waves high frequency direction-finding (H/FD/F) had to be developed. It had also become quite clear to Horton that H/FD/F would only be possible in ships if the Bellini-Tosi aerials could be **replaced by rotating frame-coils** fitted high above the superstructure and rigging.

Up to 1930 RN submarines had no radio direction-finding but in 1929 trials were carried out in ***HMS Oberon*** of a rotating frame-coil mounted on a periscope from which was developed a set called SEX that to be fitted to the new River Class submarines, ***Thames, Severn*** and ***Clyde*** and the programme was known as *'fitting sex to Thames!'* In 1931-32 John Coales carried out trials of a prototype set in submarine L22 while Mr Crampton was responsible for the development and fitting-out programme.

Since the only way to get a rotating frame-coil well above the superstructure was to mount it at the masthead, in about 1930 Horton persuaded the Controller that **HMS *Amphion*,** one of the new **cruisers** being designed, should have a single tube self-supporting foremast with a remote power-controlled rotating coil on a small platform at its head. The naval constructor in charge of the ship's design was very nervous, even frightened, of this proposal and so **the requirement** was transferred to her sister ship **HMS *Apollo*.** As an interim measure it was agreed that **HMS *Exeter*,** which was then being built, should have a small platform at the foretop on which a remotely controlled rotating coil would be mounted just in front of the wooden topmast.

The Admiralty Research Laboratory (ARL) had been commissioned to develop remote power control for the searchlights of HMS *Exeter* so they could be controlled from the bridge. For this purpose the novel hydraulic motors developed by ARL were to be used. They would be controlled by magslip sensors and repeaters that were also developed at ARL (familiar to mature readers of the *RNE* and similar to the American synchros) and they would replace the M-type motor drives and repeaters of the gyrocompasses which were not self aligning. Tests were carried out during 1931 and 1932, using this ARL remote power-control system for the D/F coils, and the system was proved capable of rotating a 3ft diameter coil at speeds up to 90°/sec. Thus when HMS *Exeter* commissioned in 1932 she not only had remotely controlled searchlights but also a remotely controlled D/F coil on her foretop mast.

In the meantime John Coales was busy extending the frequency range of the D/F systems to 27MHz in the hope that the proudly sited antenna in HMS *Apollo* would prove suitable for HF/DF. He had the advantage of being able to use existing HF receivers but needed to design a frame coil that would pick up sufficient signals over the whole range and a very low loss feeder system. This he achieved and proved in the code-named SHx trials in HMS *Concord* in 1932. As a result of these and other successful trials it was decided to proceed with the development of rotating coil D/F equipments operating over the full range of frequencies from 100KHz to 27MHz for fitting in the City class of cruisers, the first of these being fitted in HMS *Newcastle* on which John Coales spent three weeks calibrating the system.

It was not possible to get sites for rotating coils that were clear of the masts and superstructures so, in parallel with the remotely controlled frame coils, a small cross frame Bellini-Tosi type antenna was designed that could be fitted to the mast head which, in ships like HMS *Nelson*, was some 200ft above the sea. These screened coils gave a much improved performance on medium wave but were unsuitable for short wave reception. Also ships that could not accept the remotely operating rotating coil we late served with a small Adcock type of antenna which could be fitted at the masthead.

Throughout the period from 1931-37 minor improvements in receiver design and feeder cables improved the performance of ship's radio direction finding but the only major advances came from redesigning the frame coils and placing them at the highest points in the ships. It was this that made HF/DF possible in the Royal Navy long before any others as was demonstrated at the Naval Review at Spithead in 1937 when no foreign ship had a D/F antenna situated in a position in which it could possibly have been used on frequencies above about 1,500KHz, whereas at the time HMS *Newcastle* could operate up to at least 22MHz.