The results in "Dido" were very satisfactory, except for the aerial training unit which needed redesign from being a very noisy "mangle". Ranges against medium and high aircraft were 60-110 miles; against low aircraft better than type 79, but did not meet the requirements; against a Battleship 12 miles. The second set was fitted in "Prince of Wales" by Jan '41: ranging was possible at 22,000 yds, accuracy ± 25 yds; 15-in. shell-splashes at 18,000 yds. Production deliveries began in Feb, 8 months after orders were placed and only 5 months after the first set was installed in "Dido". Later "common T and R" switching was introduced, so that one aerial could be used both for transmission and for reception.

Air and Surface Warning for Small Ships Sets had to be developed with lighter aerials and using less office space. Equipments were developed on 214 MHz following the initial use of the AM ASV set as type 286. This employed a Yagi transmitting aerial at the top of a non rotatable mast and 2 receiving Yagis lower down and inclined outwards for beam switching: the ship had to be manoeuvred to get the bearing and only look ahead was provided.

Types 290/291 replaced the 286 and had a rotating aerial with common T and R. The transmitter utilised the NT99 valves which had been developed by GEC Labs from the smaller E1046 type of air-cooled-anode valves for 50 cm use. It gave 100 kW output. Ranges were 17,000 yds against a Battleship 6,000 yds against a U-boat and 30-35 miles against aircraft. Type 291 was fitted in all coastal craft and submarines.

50 cm Development

Since 1938 work had been continuing on 50 cm in close co-operation with GEC, who were developing the necessary valves, miniature copper anode triodes E1046, the famous "micropups". Two of these NT93s gave 15-20 kW at 600 MHz; in 1940 E1046B (NT99) 30 kW. Trials in "Sardonyx" in 1939 gave promising results. C F Hereford recalls: "Coales' directional 'bird-cage' array with its, literally, gold-plated dipoles passed on to the receiver almost as strong a signal from the back as from the front of the array." The way of the innovator is hard! At the end of 1939 a staff meeting at the Admiralty to consider Radar priorities, stated the requirement for a radar rangefinder for short-range AA armament. The 50 cm technique was sufficiently advanced to meet this requirement; the definitive trials were carried out at Southsea Castle in Feb and March 1940 and confirmed that 5,000 yds on an aircraft could be obtained with 2 single Yagi aerials on the pom-pom director Type 282; ☞ Fig 10 ☜ facing page 64 With an aerial of greater gain echoes from the Nab Tower at 10,000 yds were obtained and in Nov 1940 12,000 yds on an aircraft from 2 arrays of 3 Yagis (fishbones)

that could be mounted on the AA Director, Type 285. See Fig 8 of reference 40d. Range accuracies of ± 180 yds were possible.

In June 1940 an experimental set was mounted on "Nelson's" main armament director. The results were surprisingly good, 30,000 yds on a convoy. But this was due to "anomolous propagation", caused by special atmospheric conditions in that fine summer, bending the propagating waves to follow the curvature of the earth, one of the earliest occasions that such propagation had been encountered: an unfortunate occurrence during trials of experimental apparatus!

The first prototype 50 cm equipment a Type 285 was given trials in "Southdown", a Hunt Class Destroyer in Sept '40. The first surface gunnery equipment, Type 284, was fitted on the director control tower in "King George V" at a height of 90 ft in Dec 1940 and gave maximum reliable ranges of 20,000 yds on a cruiser (Dido class), 12,000 yds on a destroyer and 7,000 yds on a surfaced submarine. The 284 in Suffolk with a 6-fishbone array first made contact with "Bismark" in the Denmark Strait at a range of 26,000 yds in June '41, and was used to shadow the Bismark for the next 24 hours. Type 284 was also the range-finder for most of the ships that finally sank her.

The accuracy of surface fire was markedly improved, but against aircraft the improvement was not so great because the prediction equipment at that time could not take full advantage of the great increase in accuracy and continuity of the range data provided; and because of the problem of the 'dead-time' interval caused by the time required to set the fuse, load the gun and fire. This was countered by barrage fire at a preset range between 1000 and 5000 yds and automatic firing at the correct present range. This, although technically very successful, was not liked at sea because it meant that fire had to be withheld until the target was very close, and then there was only one chance of destroying it.

The order for production of 200 of these 50 cm equipments was placed in May 1940, 4 months before the design was finalised. Deliveries from contractors began in Nov '40. The hundredth set was being fitted in July '41. In 1944 the 282/4/5 series were the most widely fitted sets in the Navy.

All the sets underwent progressive improvement. The power of the transmitter was increased to 50 kW, and later 100 kW at 1 microsecond; beam-splitting, in bearing only, and common T and R were fitted in 1942 (ref 40d). The former gave a bearing accuracy of ± 3-5 minutes of arc with the 21 ft wide ('pig-trough') arrays of 284, and enabled blind fire to be introduced against surface targets. The culminating action in which this was decisive was the sinking of the "Scharnhorst". In this action, for the majority of the salvos there was no visual point-of-aim whatever (26.12.43). The CinC in HMS "Duke of York" wrote:-

"The target was initially detected by 273 at 45,500 yds and at 30,400 yds by 284, and the amplitude of the echoes becmae sufficient to hold bearing firmly on the bearing tube at 25,800 yds. From this time on, bearing continued to be held without difficulty on the beam tube and, with the table to indirect, range and speed--across plots stabilised, all guns at the ready and the director laying by Stabilised Sight, the moment to open fire was awaited with some confidence. It had previously been determined to close to within starshell range if possible or, in the event of the enemy firing first, to fire blind at the moment of seeing her guns flash.

Starshell was fired from the port 5.25 battery and at once provided illumination; at first impression "Scharnhorst" appeared of enormous length and silver-grey in colour. The table was switched to 'direct' at once, the settings already estimated were retained, and the first ten-gun broadside was fired at 1651 at true-range of 11,950 yds to score a straddle and a hit low down and well forward. Scharnhorst immediately turned away behind a smoke float ..... Later when illumination became unsatisfactory blind fire was maintained as the range slowly opened as the "Scharnhorst" drew away. 44 broadsides were fired, 25 being reported as straddles and 16 others as 200 yds or less, all by Radar spotting on panels L12 and L14. "Scharnhorst" was also engaging with her main armament and despite starting 2500 yds short she soon had the range, and Duke of York was straddled several times. This for the control was the most testing time of the whole engagement, for no visible results were coming from own fall of shot and the large orange flashes on the horizon appeared extremely menacing. The minimum range in blind fire was 13400 yds at about 1717 and opened until at 1824 at 22,000 yds, the Type 284 developed a temporary defect. One of the shots at 17-18,000 yds, it later transpired, had winged "Scharnhorst" on or near a propeller shaft and reduced her speed. The range was quickly closed and tracking by Type 284 started again at 22,000 yds. ..... She did not appear to observe the approach of the "Duke of York", who opened fire with a broadside at 10400 yds. This created enormous havoc aft. Direct fire was now possible and 25 broadsides were fired, with many hits. At 1922 when the 72nd broadside fell, it was noticed on all Radar tubes that the echo, after appearing as a normal straddle, developed into a great bunch of width 800 yds either side of the target; at the same time a considerable explosion occurred aft in "Scharnhorst".

Fire was checked at 1929 after 80 broadsides, by which time she was a blazing wreck, very low in the water - she sank shortly afterwards."

'And above them all the fires are quenched' (Dante, Inferno Canto 14, last line). How few of that company were able to say, as Dante, with Virgil his guide at the exit from Hell, in the last line of the Inferno, 'Then we came forth to see the stars once more.'

Ship Fitting

At the outbreak of hostilities the responsibility for testing and tuning wireless equipment in new construction ships, and in those undergoing large repair, was the responsibility of A9 Section, which formed part of the Experimental Section of HM Signal School at Portsmouth. For ships in commission this function was carried out by the Port Wireless Officer (PW/TO) stationed in the Royal yards and bases.

Installation specifications were produced by HM Signal School and issued through the Admiralty in the 9,000 series and these, together with guidance layout drawings, where necessary, were used by the dockyards and shipbuilders for guidance in installation. Equipment for specific services was provisioned annually and the programme of building and large refits was such that requirements could be worked out well in advance.

At the beginning of the war a few long-range warning sets were fitted, and the production of these sets and others, notably Gunnery Radar, was envisaged. The production and fitting programme was speeded up and A9 Section was expanded to deal with the situation. Temporary experimental officers and assistants were recruited and given a short course of training and sent into the field.

Towards the end of 1940 a quantity of Air Ministry ASV sets were obtained and a number of these sets (renamed Type 286) were fitted in ships, principally those in Western Approaches Command. A special party was formed in the Signal School to deal with this commitment.

Early in 1941 the fitting of Type 286 was rapidly expanded; more officers were attached to the Signal School to deal with its fitting and a number were lent to the Home ports to advise dockyards on layout problems and to carry out maintenance in ships. Stores were taken over from the Air Ministry, held in bulk at Flowerdown W/T Station, and issued on charge to fitting-out officers. This was not a very satisfactory arrangement from the accounting point of view, but was the simplest way of dealing rapidly with installations in ships which became available at short notice. As the numbers of ships being fitted with radar equipment increased, the problem of maintenance became serious. Fitting out parties were strengthened, but even so, many hours were spent in travelling to and from operational bases, often only to fit a new valve or minor component. This situation improved when officers were attached to operational bases to deal with the problem.

By August 1941 the experimental section of HM Signal School had moved to Lythe Hill, Haslemere, and become the Admiralty Signal Establishment. A9 Section and the Type 286 fitting-out Section amalgamated and became known as the M Section

From then progress was rapid; by the end of 1941 the country had been divided into well-defined areas and it was possible to keep in touch with every phase of ship-fitting in any part of the United Kingdom. As the tempo of production and fitting increased, the staffs at fitting-out bases were strengthened and more accommodation was required. These fitting-out staffs were still nominally under the control of the M Section at Haslemere and had no official status in the Command organisation. Authority suddenly became aware of these mushroom growths and steps were quickly taken to place them on a proper basis. The result was the Port RDF Officer on the staff of the Flag Officer in whose area they were based.

The M Section at Haslemere continued to function as a headquarters for all information on fitting problems and was a clearing house for all enquiries concerning layouts, stores and technical advice. Bulletins were issued on every conceivable item of information which would be of help to the Port RDF Officer. If "A" discovered that the reason for trigger units in "X" set breaking down was due to an incorrectly rated resistor, he reported it to M Section who, after confirmation with the technical department concerned, sent the information out to all bases by the next mail. An "A message" or AFO generally followed, but the Port RDF Officer was thus always kept up-to-date and able to take prompt action with the ships in his area.

The fitting-out staffs worked long hours and their hardest work began when fitting of sets was completed and testing and tuning began. All-night sessions were commonplace, and although in most cases ships would sail with sets complete and working, the time allowed for tuning and testing was wholly inadequate. As a result ships would arrive at Scapa Flow with 50 per cent or more of their equipment out of action. To cope with this a small group of officers was based at Scapa Flow, their main job being to tidy up loose ends and ensure that ships got good value out of their working-up period. In addition, M Section had a "Flying Squad" of experienced Naval and Civilian technical officers whose job it was to join certain ships before completion to assist with tuning and testing, sail with the ship to her working-up base and not leave until she was a satisfied customer.

By the beginning of 1943 the Port RDF Officer was as firmly established and recognised as the PW/TO, and it was part of the routine that all ships should be visited immediately on arrival in harbour.

A very close liaison grew up between the radar officers in ships and the Port RDF Officer; it persisted throughout the rest of the war and was responsible for a great deal of the success with which equipment was fitted, maintained and operated in the Fleet.