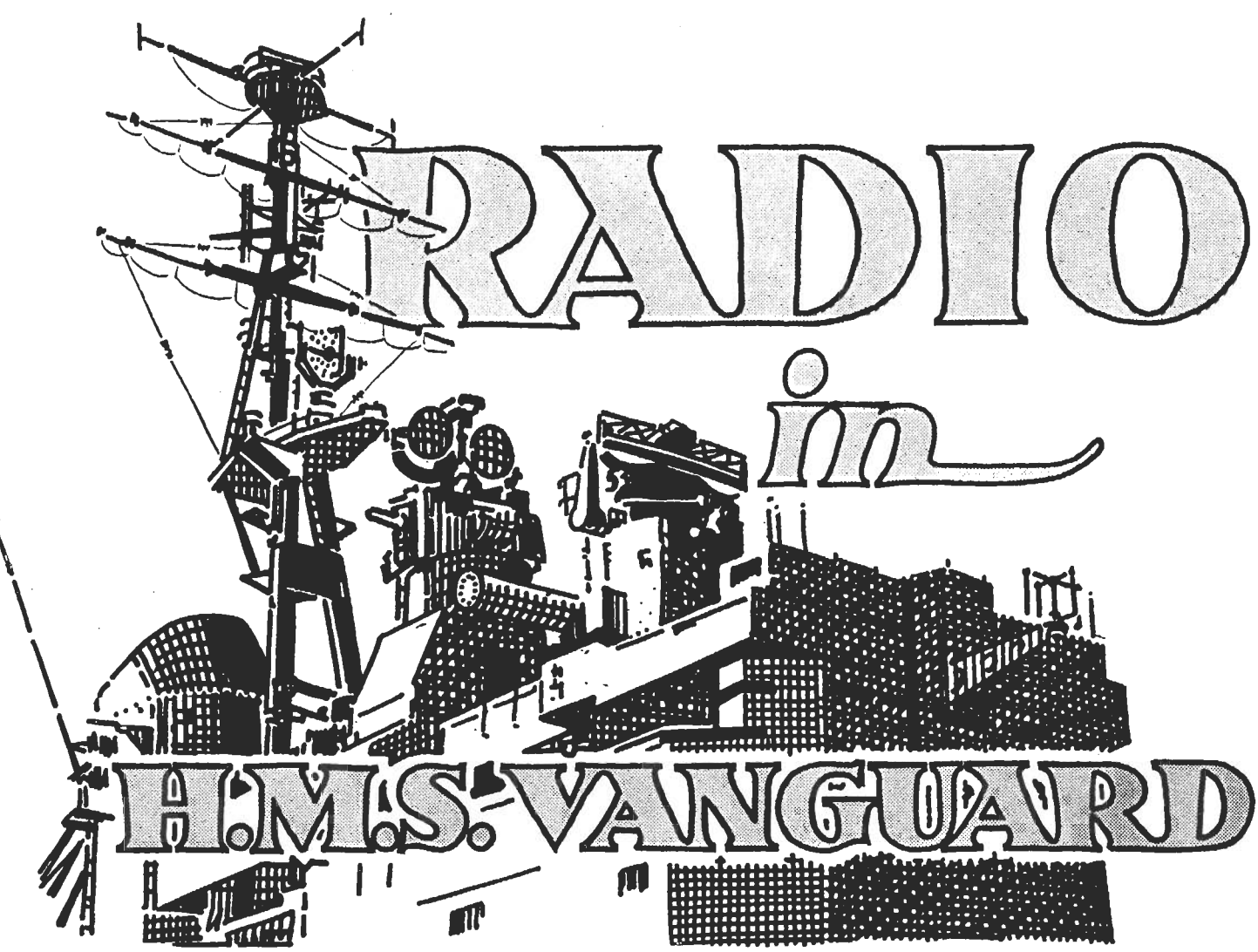


The Royal Visit to South Africa has recently thrown the spotlight of public interest on H.M.S. 'Vanguard.'

In this article the author gives a survey of the special radio arrangements which have been made to meet the many additional commitments occasioned by The Royal Cruise.

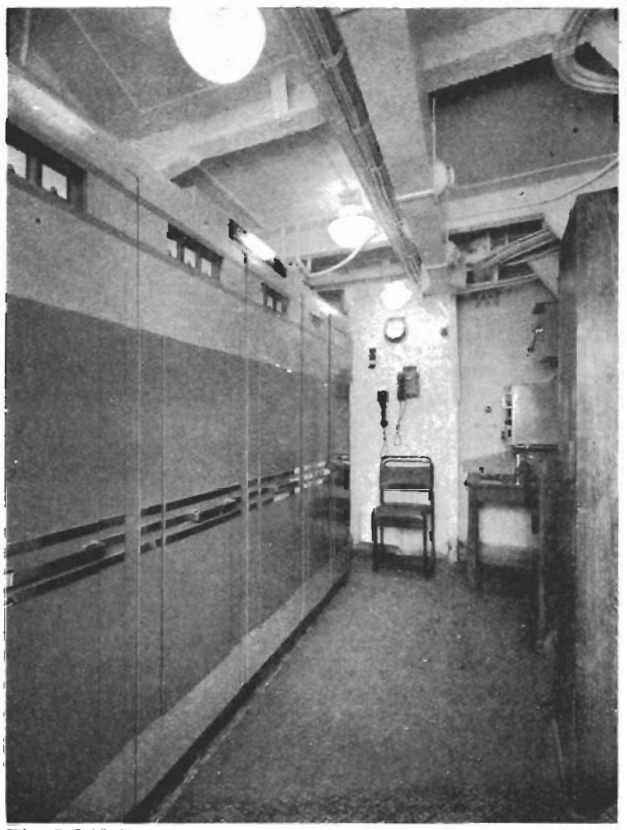
When the VANGUARD was selected to convey Their Majesties the King and Queen to South Africa and back in the first half of this year, it was decided to augment her normal radio communication facilities. The large amount of traffic expected to be handled to and from the ship, including both official messages and "copy" from the two Press correspondents accompanying the Royal Party on the voyage, called for duplex automatic telegraphy, i.e., a two way radio teleprinter line (A/T). The second requirement was for *long* range duplex R/T comparable to that provided in the big Atlantic liners to enable calls to be put through to and from the ship to any telephone extension in Britain or South Africa. This was also needed so that programmes could be relayed from the ship for transmission by the B.B.C. and South African Broadcasting Stations. Thirdly, it was decided to provide facilities for the facsimile transmission of Press photographs from the ship. And lastly, satisfactory reception of broadcasting programmes throughout the compartments occupied by the Royal Party and their suite was required.

The last item, being the simplest and independent of the other three, is best dealt with first. Installation of separate broadcast receivers in all the cabins concerned was ruled out owing to the difficulty of providing satisfactory aerials. It was also doubtful whether such sets could be operated successfully in the face of the interference to be expected from the ship's high power transmitters. A re-diffusion system was therefore decided on, similar to that already feeding the whole ship, but with the difference that three programmes were to be available instead of one. Three standard Naval S.R.E. receivers were installed in the special Radio Control Room (further described below) fed through feeders from receiving aerials separated as far as possible from the ship's transmitting aerials and feeding loudspeakers in every required compartment, each having a volume control and programme selector switch. In addition, individual Murphy A40 RG radio-gramophones have been installed in the King's day cabin and the Equerries' smoking-room, whilst a Decola electric gramophone is available for use on deck

or wherever it may be required for entertainments.

All the other special facilities—automatic telegraphy, long range R/T and facsimile—had one thing in common. For satisfactory operation they needed a higher radiated power on H/F than any existing transmitter in the ship could give. Theoretical calculations demanded 4 Kw for R/T and 1 Kw for A/T. The rated power of the ship's 57 DMR transmitter is approximately 3 Kw when sending morse but only 500 watts on R/T. But since to meet the normal naval requirement of continuous tuning from 1·5 to 25 mc/s it is provided with a simple single wire aerial system, the radiated power is considerably less. The first decision taken therefore was to install a transmitter of higher rated power ; the second to provide it with a more efficient aerial system.

The solution to the first problem was not as easy as would seem at first sight. There was no time to develop a special transmitter for the purpose in the few months available : one had to be found amongst the products of commercial firms. But the commercial requirement for transmitters of such power is in general limited to shore stations where a greater height is available than is found between decks in a warship. Thus, for example, the Marconi SWB series, which have done yeoman service in naval shore W/T stations, had to be rejected because one could not be accommodated between decks in the VANGUARD. In fact, only one suitable transmitter was found ; the DS10 which had just been designed by Standard Telephones and Cables with special reference to ship use and which fulfilled all the requirements. The firm agreed to loan and install in the VANGUARD the first and only model of this set which had been produced.



The DS10 Equipment

This transmitter employs a unit system of construction whereby up to six radio-frequency cabinets may be added to the power cabinet, enabling up to three of six spot frequencies to be selected for simultaneous operation. A Modulator cabinet may also be added for M.C.W and R/T operation. The transmitter is capable of :—

(a) 2 *C.W. channels at* 5 *Kw each or* 3 *C.W. channels at* 3 *Kw each, with independent keying, or*

(b) 2 *C.W. channels at* 3 *Kw each with common keying, or*

(c) 1 *C.W. channel at* 3 *Kw plus* 1 *R/T channel at* 3 *Kw.*

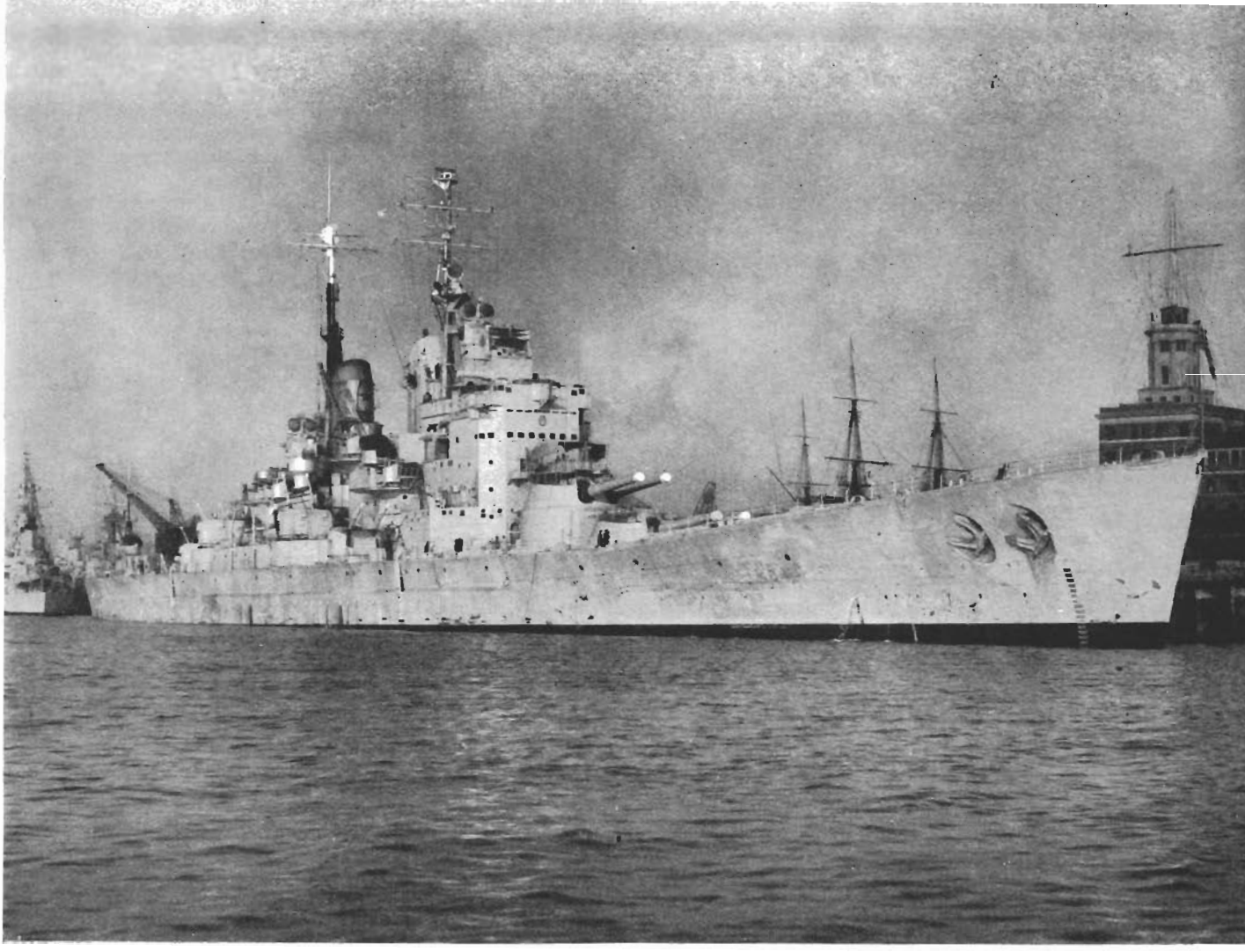
Both (b) and (c) permit simultaneous transmission on two different frequencies. The frequency range covered is 2·5 to 22 Mc/s.

The transmitter as fitted in H.M.S. VANGUARD consists of two R/F cabinets, a modulator, and a twin power cabinet bolted together to form a remarkably compact unit. The overall dimensions of the transmitter as installed are only 6 ft. 6½ in. high, 9 ft. 3 in. long, and 3 ft. 1½ in. deep. A space of 3 feet is allowed in front of the set for access to the controls and for withdrawing individual units for maintenance, the set being designed to make rear access unnecessary. The R/F circuits consist of a crystal or master oscillator selected at will, followed by two amplifier-doubler stages and a driver stage. The output circuit employs a pi-network and is calibrated directly in frequency. The exciter tuning stages are ganged together and also calibrated directly in frequency. By this means tuning is simplified. Beam tetrodes are employed as exciter valves, and pentodes for the driver and output valves, the latter having a 5 Kw rating and being air-blast cooled. No neutralising is necessary. The final stage feeds into a splitting circuit for balanced feeders, with a line reactor to provide exact matching, or simply into the line reactor in the case of an unbalanced feeder.

The modulator consists of two pentode pre-amplifiers, a phase splitter, two beam-tetrode push-pull amplifiers, and a push-pull cathode-follower driver for the Class " B " final modulator. The final stage uses two airblast cooled triode valves capable of fully modulating the final R/F stage. Automatic gain control is obtained by rectifying part of the output of the first push-pull amplifier and feeding back the D.C. as bias to the first pentode stage. The final R/F stage is modulated on screen as well as anode, thus giving substantially complete modulation.

The power equipment is split into two cabinets and includes the main 6,000-volt rectifier, the intermediate 1,500-volt rectifier and two 500-volt rectifiers for low power circuits and bias. Mercury vapour rectifiers are used for the 6,000 and 1,500 volt supplies and Selenium rectifiers for lower voltages. The transmitter operates from a three-phase 50/60 c/s supply on a three-wire circuit, with 400 volts between phases, which is the same as that already provided for VANGUARD'S radio equipment. It is designed for operation in tropical conditions, three air-blowers being provided for air-blast cooling of the valves while a fourth blower is employed for ventilation.

The aerial problem in H.M.S. VANGUARD was



simplified, in comparison with that normally met in a warship, because the special transmitter was only required for communication with the U.K. and South Africa throughout the outward voyage in February and the return trip in May. The optimum frequencies could be predicted in advance, and as a result, six bands were allocated (i.e., 3, 5, 7, 14, 17 and 22 mc/s). For 3 mc/s a two wire vertical $\frac{1}{4}$ wave aerial was rigged. For 5 and 7 mc/s there are two sloping two-wire aerials (3/4 wave) each folded at the lower end in order to suppress radiation from the bottom $\frac{1}{4}$ wave. For 14 and 19 mc/s two half-wave two-wire omni-directional dipoles are provided. The latter is also used on 22 mc/s. All five special aerials are on the mainmast and are connected by pyrotenax feeders to the DS 10 transmitter which is installed in No. 2 R.C.M. office on the port side of the after super-structure. Aerial trunks and the large aerial tuning unit normally associated with a warship's transmitter are eliminated. Some readjustment of the VANGUARD'S normal aerial rig has been necessary.

Another compartment similarly situated on the other side of the ship was selected as a Control Room for all the special radio facilities. For automatic telegraphy, standard G.P.O. type teleprinters (one for transmission, one for reception, and one spare) are installed here together with the necessary tape perforators and Creed relays, providing for either direct or re-perforated transmission and reception, the latter being a requirement for high speed working.

The R/T equipment fitted in the Radio Control Room includes :—

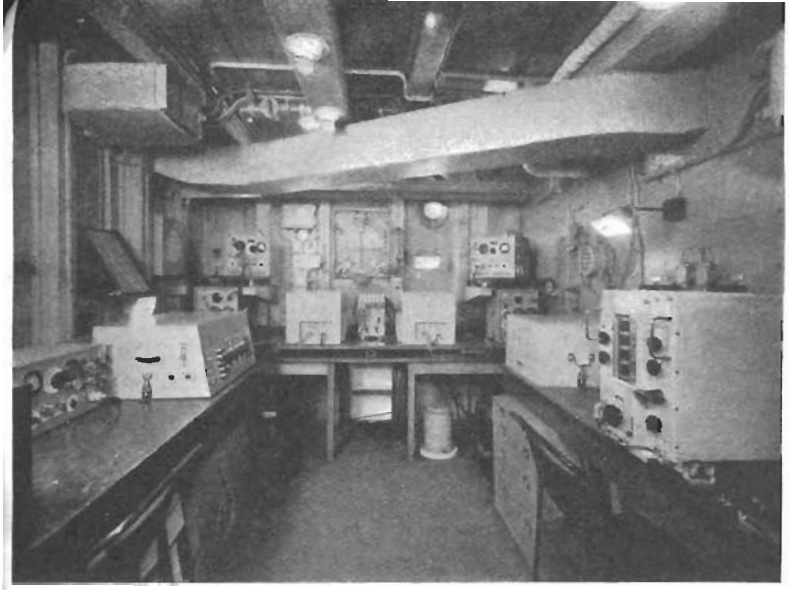
(a) *A switchboard to connect the transmitters and receivers to the handsets in the Royal apartments and other selected positions in the ship. The latter include plug-in points forward and aft for the high grade moving-coil microphones used for broadcast commentaries.*

(b) *Modulator 2C and Coding Switch to prevent interception by casual eavesdroppers.*

(c) *Electronic Voice Operated Switching (EVOS), a device for suppressing the transmitter carrier during reception, to provide interference-free duplex working.*

(d) *A Voice Operated Gain Adjusting Device (VOGAD) to give a constant "speech voltage" output for large variations in "speech voltage" input.*

The above mentioned switchboard is fitted at the technical operators' position and serves also to connect the automatic telegraphy and facsimile apparatus to the transmitter. The latter is a high quality type recently developed by Muirheads who, at the Admiralty's request, loaned and installed the



The Recording Room

first available model. It employs photo-electric scanning at the transmitter, the variations in light intensity modulating the frequency of an audio-frequency tone of constant amplitude, which tone is used to modulate the amplitude of the radio frequency carrier wave. At the receiver the frequency modulated tone modulates a beam of light projecting on to a photographic film. H.M.S. VANGUARD is only provided with facsimile transmitting equipment, but there is a receiver printing direct on to sensitized paper for monitoring purposes.

All radio receivers are of the new B40/41 type. For monitoring purposes receivers are installed in both the Special Transmitter Room and the Radio Control Room ; but reception is normally carried out on receivers in the Ship's Receiving Room sited in the forward superstructure just below the bridge. This separation from the transmitters (the ship's other transmitters are, like the special one installed aft) is necessary to avoid mutual interference, the aerials, both single wire and vertical whips, being rigged on and around the foremast. Since this only provides a separation of 100 feet (the masts are only this distance apart although the ship is 800 ft. long), two whips have been fitted right aft on the quarter deck and two right forward on the forecastle with matched feeders leading to the receiving room in order to provide the maximum possible freedom from interference from the ship's transmitters. Other additional receiving whips have been fitted on the fore-side of the bridge structure.

It was appreciated that at the particular time when the B.B.C. commentator on board might wish to broadcast, it would not be practicable to establish a satisfactory R/T connection with a shore station. The B.B.C. has therefore provided disc type recording equipment which is installed in the " Y " office which has been converted into a Recording Room. This has the necessary connections to the Control Room and from thence to the special transmitter.

All this special equipment is duplicated to ensure continuous operation despite temporary breakdowns and the need for taking out of service for maintenance. The ship's 57 DMR is used as a standby for the DS 10, switching arrangements being provided in the special Control Room for connecting the A/T, R/T, and facsimile equipments to it if the need arises.

The automatic telegraphy service to and from the VANGUARD is operated with existing naval shore stations in the U.K. and South Africa. Other special facilities are however being worked with G.P.O. stations in the U.K., and the Capetown terminal of Cable and Wireless (Overseas) Ltd. In the U.K. the VANGUARD circuit is connected from the G.P.O. Overseas Terminal in London as requisite by line to private subscribers' telephones, to the B.B.C., or, in the case of facsimile, to Electra House on the Embankment, the London Headquarters of Cable and Wireless, who are the operators of this system in the U.K. Daily schedules for working A/T, R/T and facsimile in turn with both U.K. and South African terminals are necessary since only one can be satisfactorily operated at a time from the ship and the amount of traffic to be handled makes this acceptable.

All the special equipment was installed whilst the ship was undergoing conversion for the Royal Cruise last year and was ready by the end of November. The ship's shakedown cruise in December provided an opportunity for extensive trials, and the results achieved indicated that the decision to install all this largely naval equipment at short notice without the usual development trials was fully justified. Further results are awaited with keen interest since, apart from meeting the operational requirements for automatic telegraphy, long range R/T and facsimile for this particular cruise, invaluable experience will be obtained towards the solution of the many problems involved in providing such facilities in other warships.

The installation of all this special equipment has been arranged by the Admiralty Signal Establishment, who in conjunction with Admiralty departments, were responsible for the overall scheme and the solution of the many novel problems involved at very short notice. But the G.P.O., and B.B.C., and Cable and Wireless and the manufacturers of the equipment used, gave unstinted help throughout.

The Bridge Receiving Room showing B40, B41, 612 and Aerial Exchange

The Bridge Receiving Room showing B40, B41, B28, and Remote Control Units