FREQUENCY MODULATION

VERSUS

AMPLITUDE MODULATION

The question of Frequency Modulation versus Amplitude Modulation in R/T sets has been very much to the fore lately, and has received additional publicity through the use during recent operations, of American transportable sets employing Frequency Modulation on V.H/F. The following notes on this subject discuss the advantages and disadvantages of these systems, and mention the attitude of the other services.

The system of frequency modulation, in which the radio frequency carrier level remains constant and the frequency changes with the amplitude of the modulation as opposed to amplitude modulation where the radio frequency carrier frequency remains constant and the amplitude of the carrier changes with the amplitude of the modulation has been known for twenty years, and the fact that it has not as yet won universal application infers that the balance in its favour is by no means firmly established.

Frequency modulation is only applicable to R/T communications on direct wave paths. When sky wave communication is involved, frequency selective fading will render F.M. less intelligible than A.M. To speak of frequency modulation, as the term is usually understood, applied to M.C.W. is meaningless. Frequency wobbling, at audio rates, is applied to mitigate fading.

The possible applications of Frequency Modulation for Naval use are:-

(a) For transportable or portable R/T sets in the H/F band.
(b) V.H/F. ship to ship, ship to air, and ship to shore R/T. communication.

The R.A.F. are not adopting F.M. in their latest fighter direction sets but are planning to adopt it in the replacement sets.

The advantages claimed for F.M. are:-

(a) Reduction in size and weight of transmitter; or increased R/F power and consequent increase in range for the same D.C. input power.

(b) Greater freedom from interference of an impulsive nature, e.g. heavy click atmospherics and interference from ignition systems.

(c) Greater signal to noise ratio in the receiver once the signal is above general noise. The signal to noise ratio increases with the deviation used.

N.B. The deviation is the maximum change of frequency and is akin to the term percentage modulation in A.M.

The disadvantages are:-

(a) Greater complexity of the receiver.

(b) The problem of jamming an F.M. signal is easier than for A.M. In F.M. a strong carrier will suppress a weaker signal on the same frequency, and the signal is not heard. (This has been termed "capture effect".)

In the U.K. the Army have investigated the use of F.M. for transportable sets in the H/F band 2-12 Mc/s using powers of the order of 10-20 watts, and have introduced the system in the Type 42 set retaining, however, the means to use A.M. as an alternative.

The Army report that the apparatus used in F.M. introduces no great complexity and that the maintenance involves no great problem.

A mission representing S.R.D.E. and certain M. of S. contractors carried out tests under conditions of severe atmospheric interference at Lagos in West Africa and report as follows:-

> "F.M. showed the same advantage over A.M. for direct ray working under conditions of tropical atmospherics as has been found in this country under conditions of 'man made static'.
>
> It will be seen that the advantage of F.M. is greatest when the intelligibility with A.M. is about 20 - 30% (i.e. a bad R/T channel with many repeats). Under these conditions the intelligibility with F.M. is 60 - 70%. In terms of range it was found that with F.M. the sets could keep good communication up to about half as far again as with A.M. This also confirms experience in this Country".

N.B. The sets involved in these trials radiated 5 - 10 watts in the band 2 - 12 Mc/s and a deviation of 4 - 5 Kc/s was used.

In America F.M. has been more widely used and a typical set is the S.C.R. 300A a portable set weighing 38 lbs., and operating on 40 channels in the range 40 - 48 Mc/s with a deviation of 20 - 25 Kc/s and designed to give a range of 3 - 5 miles.

With regard to the improved performance of the F.M. system under conditions of severe interference of an impulsive type it has been argued that an A.M. receiver fitted with an amplitude limiter will give equal performance. The F.M. receiver employs an amplitude limiter as an intrinsic part of the system. Trials are shortly being carried out in this Country to test this point by S.R.D.E.

Little information is available as regards the mutual interference between adjacent F.M. channels and the closeness of spacing that can be tolerated. It is intended to carry out tests in the V.H/F. band to obtain information on this point.

As regards the question of the frequency band taken up by the two systems, the band width taken up by A.M. is about $\pm$ 5 Kc/s throughout the frequency. For F.M. the greater the deviation, i.e. band width, the better the system but on radio frequencies in the 2 - 12 Mc/s band deviations of $\pm$ 4 - 5 Kc/s give intelligible speech. Appropriate figures on the V.H/F. would be 30 Kc/s on 100 - 150 Mc/s.

Although F.M. signals can be received on A.M. receivers there is a loss of efficiency and the full advantages of the system can only be obtained by using an F.M. receiver; if the A.M. receiver is tuned to the carrier, frequency signals will be a good strength but distorted; by using the receiver slightly "off tune" signals will be intelligible but the strength will be reduced.

W/T RECEIVERS

- INTERFERENCE SUPPRESSION -

Pulse limiters have now been developed for the majority of W/T receivers used for the communication purposes in H.M. Ships. There are some types of receiver, however, in which the R/F gain is not great enough to develop the potential necessary to operate a diode limiter; the two most important receivers in this category are the B.29 and B.20 (S.R.E. Receiver). It is hoped that the recently introduced Patt. 56152 Filter H/F design 12, a low-pass filter with a cut-off at 30 Mc/s. will be effective with these latter receivers and trials are now in hand.

The following schedule summarises the present position, but it should be noted that it may be some little time before Noise Limiters Design 4, 5, 6 and 7 can come into bulk production, owing to design and manufacturing difficulties. Every effort is being made to overcome these and A.F.O.'s introducing them will be published immediately stocks are available.

INTERFERENCE SUPPRESSION - PRESENT POSITION.

Receiver.	Limiter.	Remarks.
B.28	Pattern 56703 - N.L. Design 1.	In production. Introduced by A.F.O. 6064/44.
B.29	Limiter not practicable.	R.I.S.(1) fitted at present. Will probably be unnecessary when Patt. 56152 Filter Unit H/F. Design 12 is introduced.
P.38	Patt. 57380 - N.L. Design 2.	In production. Introduced by A.F.O. 6064/44.
P.104	Limiter incorporated during manufacture.	Receiver P.104 supersedes P.38. Production now starting.
86.M	Patt. 58360 - N.L. Design 6.	Developed. Mechanically designed. Production to be started.
T.B.S.	Patt. 59444 - N.L. Design 7.	Developed. Mechanically designed. Production to be started.
T.C.S.	Patt. 58359 - N.L. Design 5.	Developed. At present being mechanically designed.
C.R.300	Patt. 58358 - N.L. Design 4.	Developed. At present being mechanically designed. Will be incorporated during production in later models.
Patt.4660 S.R.E. Receiver.	Limiter not practical.	Patt. 50152 Filter Unit H/F Design 12 may be satisfactory.
B.40.	Limiter incorporated during manufacture.	Receiver B.40 will supersede B.28 during latter part of 1946.
B.41	Limiter incorporated during manufacture.	Receiver B.41 will supersede B.29 during later part of 1946.

It is proposed to continue to issue brief fitting instructions with the units as this is proving the most satisfactory method of ensuring that both limiter and method of fitting are simultaneously available.

The later designs are slightly more complicated than the earlier types and they are not entirely self-contained, it being necessary to fit some minor components into the receiver circuit separate from the main limiter unit.

TELEVISION

Briefing aircrews on a number of carriers simultaneously presents some problems which television may be able to solve, and a small number of television outfits are therefore being developed and produced for trial.

Experimental and development work on television ceased in the U.K. on the outbreak of hostilities, and with a view to avoiding delay in development of new equipment it was decided to obtain sets built to the same technique as that used by the B.B.C. at Alexandra Palace. It has proved necessary to re-design the equipment from a mechanical aspect to make it suitable for shipboard use, and also to incorporate special filters in the receiver circuit with a view to preventing interference from Radar transmitters.

The vision transmitters have an output of 200 watts, and in the first models will operate on two frequencies in the 40 - 65 Mc/s band; the vision bandwidth is about 5 Mc/s - a band of this width being necessary to cater for the 405 line scan. The speech transmitter is a modified Type 682, having an output of 7 watts, also operating in the 40 - 65 Mc/s band.

One aerial is used for vision and speech, and at first it appeared that it would be necessary to change the aerial if it was desired to change frequency, but laboratory tests show that it is probable that one aerial can be developed to cover the whole band without unacceptable loss.

The vision receiver also follows pre-war practice. The output is fed through suitable amplifiers to enable up to 12 viewing units to be operated. These units give a picture of about 10 inches by 8 inches, which may seem small at first sight, but in fact there is little to choose optically between a small picture which can be viewed from any distance between 3 and 10 feet, and a larger picture from which one must be some greater distance away. In practice, the smaller picture units are more convenient for the restricted space in ships; a large briefing room would be fitted with about 6 of these picture units.

Sound receivers are based on Receiver Outfit CDK suitably modified for the appropriate frequency. The output is fed through normal audio amplifiers and loudspeakers arranged as necessary.

Talk-back facilities are provided from each briefing room, using one of the ship's normal V.H/F. lines. Talk-back is arranged to be received by all ships being briefed, and reproduced over the briefing-room loudspeakers, as well as over the briefing officers' speaker.

The equipment is rather bulky in its present form, and the sizes of the various compartments are as follows:-

Television Equipment Room (contains transmitters and receivers etc.)	15' x 13'.
Television Equipment Room (if receiving equipment only is fitted)	9' x 9'.
Television Camera Room.	12' x 10'.

The limiting distances between various pieces are governed as shown below:-

Television Camera Room to Television Equipment Room.	200'.
Television Equipment Room to Aerial.	150'.

The first transmitter and receiver will be ready for installation about April, and practical trials will take place as soon as possible after that date. The actual time of the trials is governed mainly by the availability of two suitable ships. Technical and practical trials will take about six weeks. It will be necessary to develop a television briefing technique during this period because the lighting required for effective televising is such that the briefing officer has to be in the camera room, which is really a television studio. This fact makes it essential for aircrews in even the briefing ship (which is also the television transmitting ship) to be briefed by wired television.

NEW V.H/F AERIALS

Two new V.H/F. aerials are expected to make their appearance in the Service this year. Both are for fitting at the masthead, and are of bi-conical construction.

Outfit ANC, for use with Types 86M and 87M, is designed to cover the frequency range 100 - 156 Mc/s and for fitting above Radar Types 281BM and BQ, and all Types of 960. At present it will only be fitted in fleet and light fleet carriers in the position occupied (in some ships) by outfit ART. There may be an application for this outfit later on in cruisers and capital ships, fitted above the same types of radar sets.

The aerial is fed by slip rings in the Types 281/960 pedestal and sits above the associated I.F.F. array, and thus occupies a good clear position.

Outfit ANG is designed to cover the frequency range 60 - 95 Mc/s - for Type TBS in ships and Types 682 and 685 in shore stations. It is anticipated that this aerial will be fitted with the second TBS set, to be fitted aft in destroyers.

The performance of both ANC and ANG is expected to be at least not inferior to their equivalent dipole outfits - APH and APU respectively.

The appearance of both is a little alarming, but they should not be taken for prefabricated seagulls' nests.

STOP PRESS

In view of the increasing responsibilities that Navigating Officers are assuming on the application of Radar to Navigation, it is requested that the attention of Navigating Officers be drawn to any information appearing in the Bulletin which is relevant to their duties or likely to be of interest. A.F.O. 5971/44 refers.

EQUIPMENT FREQUENCY CHARTS - ERRATA.

(a) Chart 0 to 1·5 Mc/s. and 1.5 to 30 Mc/s.

TCE is a Transmitter only.

(b) Chart 1·5 to 30 Mc/s.

CR300/1 Top frequency is 25 Mc/s.

55M. Does not go below 1·5 Mc/s.

THE AMERICAN RADAR MAINTENANCE BULLETINS.

The above have arrived at last and have been despatched. If you have an American W.A. set, you should have received your copy by now. It is a mine of information Parts 6 and 7 will be of major interest to you. The former gives a list of modifications authorised to ships and Chapter 7 tells you how they are done. One exception to this is the method of fitting a 12" tube to the VC or VC-1 in the A.D.R., see Part 6, pages VC/VC-1 - 6 - 1. If you have a tube and can fit it, you and the F.D.O. are friends for life. It enables him to plot on the tube itself. Some ships have done this already and are enthusiastic.

WANTED.

Many of our readers will have had an amusing or interesting experience with their radio gear. We would like to hear about it so that we can use it in the Bulletin. DINK will illustrate it, all he wants is the idea. Send it to the Editor.