H/F COMMUNICATIONS ON SURFACE CRAFT

It is often wrongly assumed that when a ship is transmitting on H/F, that signals are radiating equally in all directions. A moment's thought, taking into account the complicated nature of the ship's structure, and the number of aerial systems which has to be a accommodated, will indicate that as soon as any of the surrounding structures or aerials approaches first resonance at the frequency which it is desired to transmit, then the re-radiation from this structure will modify the polar diagram of the radiator concerned. Even where no other structure is present in the field of the transmitting aerial, its own horizontal polar diagram, unmodified by its surroundings will only be circular if it is vertical. If it has any horizontal component, that is if it slopes from the deck insulator to some point on the mast; its horizontal polar diagram will only be approximately circular while its total length is small compared with the wavelength.

Practical observations taken over a number of years in various classes of ships, show that circular polar diagrams are seldom obtained in sea going vessels at frequencies higher than 2 - 4 Mc/s. The frequencies at which the polar diagram departs seriously from circular will vary considerably from class to class. Probably the simplest case is that of the Submarine. For certain experimental work, it was necessary to take observations of the polar diagrams of a captured German 'U' Boat. The measurements show that a difference of as much as 45 - 1 in the power radiated on the best and worst bearings was obtained. The German Admiralty were well aware of this, and issued instructions to all 'U' Boats that when passing any signals on H/F, the Submarine was to be so aligned as to radiate the maximum power in the direction in which the receiving station lay. So far as can be seen the instructions given to the 'U' Boat, which definitely specified the relative bearing on which transmissions were to be made for certain specified frequencies, were based on the horizontal polar diagram of an average Submarine. In the case of the 'U' Boat polar diagrams already mentioned, observations were taken of the vertical as well as the horizontal pattern. The horizontal polar diagram which is taken at or near sea level does not necessarily give any indication of the vertical polar diagram, i.e. the way in which the aerial radiates at angles above the horizontal. It is quite possible for conditions of minimum radiation in a horizontal direction to correspond with conditions for maximum radiation at an angle above the horizontal.

For short distance communication by ground wave, the horizontal polar diagram is the best guide for determining the bearing on which to transmit. For long distance communication, however, there is a best angle of elevation which is desirable in transmission, and this angle is determined by day to day conditions (which affect the height of the Heaviside layer) and the distance between the transmitting and receiving stations. There are in addition, certain factors depending on the geographical positions of the transmitting and receiving stations which will also affect the conditions required for best communication. It will be seen therefore that the German method of issuing instructions connecting the frequency of transmissions, and the relevant bearing on which to transmit, without reference to the numerous other factors involved, can at best only be considered a partial solution of the problem of communication between Submarines and Shore Stations.

The Submarine has probably a smaller aerial rig and superstructure than any other class of vessel.

If it is desired to extend the considerations of this problem of H/F communication to other classes of surface ships, a number of other factors must be taken into account. Changes of rigging and superstructure are much more likely to occur in surface ships, and any change of this nature is bound to have some effect on the polar diagrams of any associated aerials. Again, in the case of H/F, surface ships usually possess a number of aerials for this band of frequencies. The restricted space and rigging facilities available makes it inevitable that a fairly high degree of coupling exists between the various H/F aerials, rigging and superstructure. It is therefore obvious that the polar diagrams of any one aerial on any one frequency will be affected by the frequency to which the aerial circuits associated with every other aerial are tuned. It will be seen therefore that although there is some reason for basing communication instructions on measurements taken in the simple case of the Submarine, it is quite unlikely that this would be the case for a surface ship of any size.

It would not be impossible, of course, to develop a technique whereby the best relative bearing on which to transmit from a surface craft could be determined. The procedure and equipment required, however, would require such a high degree of skill and involve such a large amount of effort, that the general solution does not enter the realms of practical possibility. It may however be possible in the future to form some simple rules which would be applicable in particular cases or over restricted frequency ranges. A simpler explanatory method involving no complicated apparatus is suggested below, although the probability of its successful use in the general case, is considered extremely remote. It is considered possible, however, that certain conditions may arise where such a procedure might be of value.

SUGGESTED METHOD OF TAKING POLAR-DIAGRAMS

By the reciprocal theorem the characteristics of an aerial are identical whether it is used for transmission or reception. If therefore a receiver connected to the transmitting aerial is capable of receiving on the same frequency the station to which it is desired to transmit, then the transmitter power being sufficient, it should be possible to transmit to it. Alternatively, another station at approximately the same range, using approximately the same frequency may be used to determine the transmission polar diagram and hence the best relative bearing on which to transmit for that particular set of conditions. It is of course necessary when making the observations on the receiver, to switch off the A.V.C. as otherwise a true picture of the variations in field strength will not be obtained. The object of the measurements is to give an indication of the Shape of the polar diagram and so long as the conditions of measurement remain sensibly constant during the taking of any one polar diagram, the absolute order of accuracy of the observations does not matter. The readings at the beginning and end of each swing should coincide and polar diagrams taken at different times with the same physical arrangement of apparatus should be similar in shape. For this reason, any method of observing the signal strength which can be relied upon to remain substantially uniform during the taking of one polar diagram, can be used. A receiver fitted with an S meter, an Avometer connected across the telephone output or an aural estimate of the signal strength could each give the results desired if used with care. Due allowance must be made for any possible variations in received field strength due to changes in propagation conditions

during the period of observations. In applying the results obtained it is, of course, very important to remember the limitations already mentioned and to be quite certain that the results obtained are only applied for the ship conditions (i.e. rig arrangements, tuning or other aerial circuits) for which they were taken.

A simpler alternative procedure than that described in the preceding paragraph would be to arrange for the relative bearing on which the signal is made to be changed if communication is not established during the first transmission. The importance of being able to transmit maximum power or minimum power in selected directions does not need stressing. A knowledge of the H/F radiation patterns will not only result in a greater percentage of transmissions reaching the correct destination, but could at times be used to ensure that these transmissions stood the minimum risk of interception by the enemy.

It is regrettable that no easy general solution of this problem is apparent at the present time, but it is felt that it is desirable to draw the attention of Signal Officers to the fact that such a problem exists. Although with our world wide receiving organisation this problem is not as applicable as it was to the German U-Boats, with their receiving stations all relatively in the same direction, it is worth bearing in mind the fact that when communication with shore stations cannot be established, an alteration in the ships head may do the trick.

PROTECTING DEVICES FOR WIRE AERIALS

At the beginning of the war a number of ships lost their main aerials due to the whip of the mast caused by near misses. Early in 1940 the Protecting Loop was introduced (A.F.O. 1949/40) and this device has since saved a large proportion of "near missed" ships from losing their main aerials. This has been borne out by many action damage reports, particularly those from ships who have been mined, who stated that the Protecting Loop functioned and saved the main aerial.

However, the Protecting Loop principle cannot be applied to vertical (or near vertical) aerials, numbers of which are parted by blast, or sway of the yard, or splinters, because if the loops of adjacent aerials functioned, there would be a considerable chance of the aerials touching one another or some part of the ship's structure. It is therefore under consideration in A.S.E. to provide a spring at the lower end of all vertical and near vertical transmitting and receiving aerials, and development models are in the course of production now. It is anticipated that the spring will take up the movement introduced by sway of the yard, and cushion the effect of blast pressure, but, of course, this is no protection against splinters.

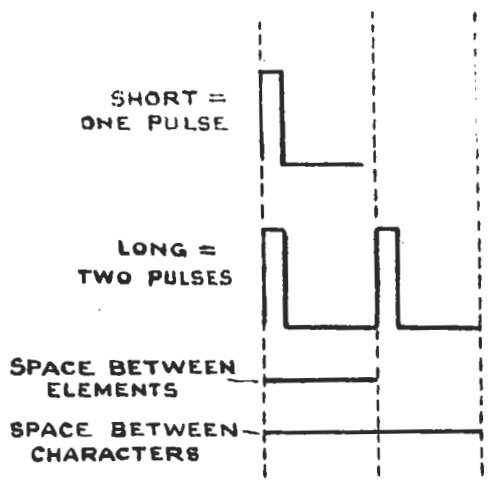
Splinter damage, we hope, will be mitigated by the introduction of the whip aerials which were previously referred to in A.S.E. Bulletin No.4 Page 74, the first of which are being fitted in August 1945.

GERMAN HIGH SPEED W/T EQUIPMENT

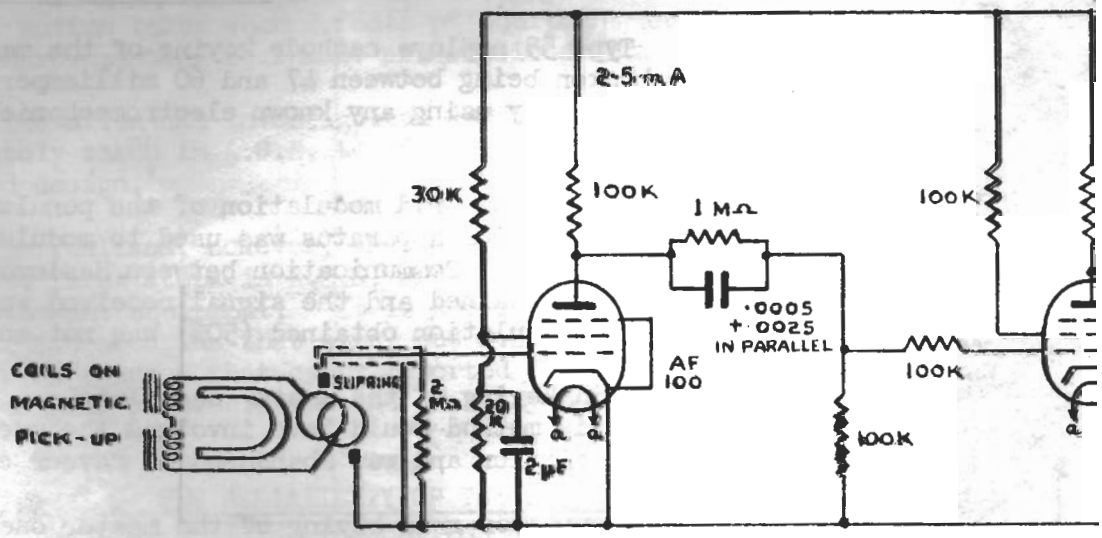
Following the experimental use of high speed transmission from German submarines before the end of the war in Europe, an investigation into the application of the German "Kurier" High Speed Keying Device has been carried out. This unit provides a means of sending a complete "preset" message together with its identification signal in a maximum time not exceeding 0·5 second. The object of this was to enable a U boat to make a report in a period of time which was too short to enable a D/F bearing to be taken. The actual speed of transmission is about 110 words per minute, and whilst it is usually stated that the actual message is limited to 7 letters, this and the speed of transmission, both assumes that letters having morse symbols of average length are used. If, however, carefully selected codes are used, the message can be considerably increased. For instance, as an extreme case, a message consisting of 28 "E's" is within the units capacity.

DESCRIPTION OF KEYING DEVICE.

The Kurier apparatus comprises an electro magnetic pick-up and valve amplifier in one housing, the novel feature being the electro-magnetic pick-up, which rotates at the end of an arm of radius $4\frac{1}{2}$" and sweeps past 110 steel fingers arranged around the circle swept by the pick-up. It is arranged that any finger which is required to transmit a pulse can be set forward, when the gap between the finger and the pick-up armature is reduced from an average width of 0·156" to 0·015". The fingers are arranged so that the first 25 are set forward permanently to give an identification call, followed by a space equal to 4·5 times the distance between fingers, then follow the 85 fingers which can be arranged to form the intelligence to be transmitted, the circle is then completed by a space equal to approximately 7·5 times the spacing between fingers. The arm is driven by a synchronous 50 cycle motor at a speed of 120 r.p.m. corresponding to a transmission time of 0·5 seconds for the complete messages of seven symbols. Character formation differs from the standard arrangement in that pulses only are sent, character formation is as follows :-



The pulses generated by the pick-up are then amplified by a two stage amplifier as shown in the attached circuit diagram to give a peak output of 184 volts. Circuit diagram is given in Figure 1. As used by the Germans, a Rotary switch was utilised to enable the equipment to be switched to either of the two transmitters.

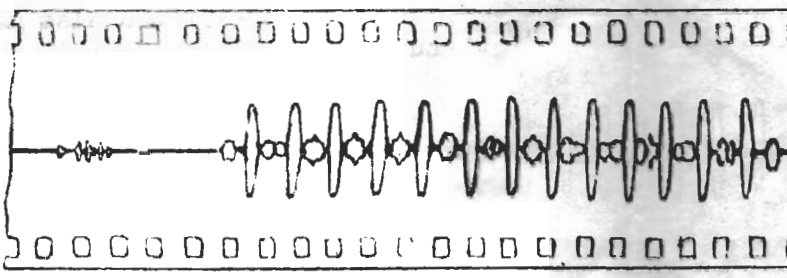


CIRCUIT DIAGRAM OF GEBER AMP

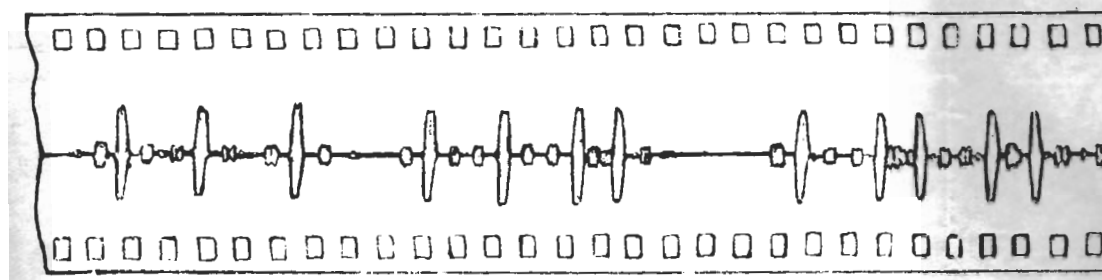
THE POINTS A, B AND C ARE TAKEN TO CONTA

THE NUMBERS REFER TO TERMINALS ON THE
END NEARER THE RECTIFIER.

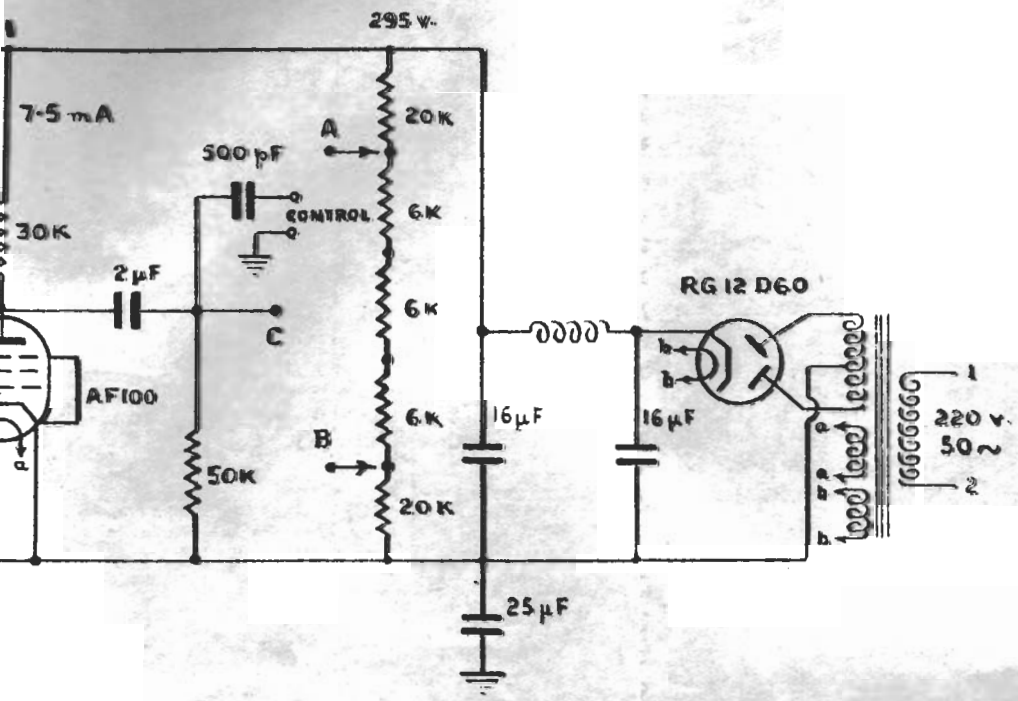
FIG. 1



IDENTIFYING & SYCRONIS



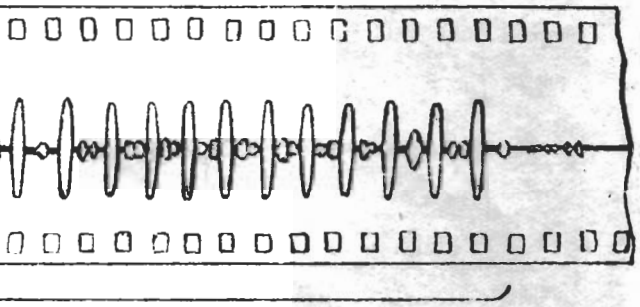
S | U | P



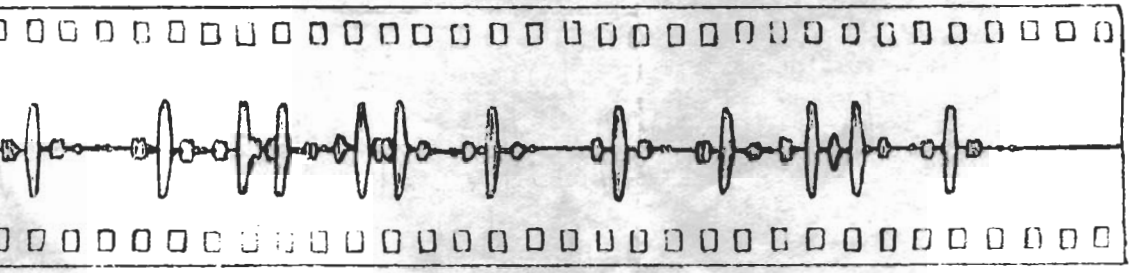
PLIFIER; GEBER SER: Nº 13.

ACTS ON THE ROTARY SWITCH
TERMINAL STRIP NUMBERING FROM THE

.



ING PULSES



P E R

APPLICATION TO TYPE 55.

Type 55 employs cathode keying of the master oscillator, the current to be broken being between 47 and 60 milliamperes at 550 volts, precluding the possibility using any known electromechanical key. Alternative methods are :-

1. Suppressor Grid modulation of the penultimate stage as for R/T. The Kurier apparatus was used to modulate the suppressor grids direct. Communication between Haslemere and H.M.S. FLOWERDOWN was obtained and the signal received was readable, but the depth of modulation obtained (50%) was not considered satisfactory.

2. Grid keying of the master oscillator.
This method would have involved the use of a 3 stage D.C. amplifier and was abandoned in favour of method 3.

3. Suppressor grid keying of the master oscillator. A trial of this method between Haslemere and H.M.S. FLOWERDOWN was very successful, figure 2 gives a photographic record of the received signal. The method employed was to bias back the suppressor grids of the master oscillator until oscillation ceased, this involves an anode current change of only 30%, making absorbing arrangements unnecessary. The bias voltage required varies from 106 volts at 3 Mc/s to 68 volts at 19·5 Mc/s. The low potential end of the Kurier amplifier is not earthed, so that by earthing point B and connecting C (Fig. 1) to the suppressor grids of the master oscillator, the suppressor grids are biassed back to a point where no oscillation takes place at any frequency. This means in effect that the only component necessary for operating Type 55 with Kurier is a 0·001 mfd. condenser to earth the master oscillator suppressor grids.

APPLICATION TO T.C.S.

An effort was also made to apply the unit to a T.C.S. transmitter but was abandoned when it was found that considerable modifications would be necessary to the T.C.S.

RECEPTION.

Reception is done with the aid of a photographic recorder having a film speed of 1380 mms/sec. Fig. 2 shows the record of a complete transmission taking less than $\frac{1}{2}$ second and comprising the 25 identifying and synchronising pulses followed by the word "SUPPER".

THE SHAPE OF W/T THINGS TO COME

This feature in the Communication Section of the A.S.E. Bulletin is intended to inform the Fleet in advance of Fleet Orders of the improvements to existing equipment which are being projected. They are the result of action taken when defects of equipment and/or useful suggestions for improvement of equipment are received from the users.

After consideration and investigation of the reports received, steps are immediately taken in A.S.E. to effect necessary improvement by new or modified design.

It should be realised, however, that a certain time inevitably elapses between the first steps in A.S.E. and the introduction to the Fleet of the improvement equipment. It is not intended to mention here the process which occupies that time, but A.S.E. would, however, like the user to feel assured that every reported defect and/or suggestion receives full consideration and that any necessary action is taken.

IMPROVEMENT IN THE RELIABILITY OF THE POWER SUPPLY OF BATTERY OPERATED TRANSMITTER 4T'S.

Several complaints have been received on the battery power supply of Types 60EQR, 60EMR, and other versions of transmitter 4T operated from batteries.

They were principally confined to defects occurring when operating the transmitter from No. 4 position of the Pattern W782 control switch. This position incorporates the 20 volt battery float charge condition, and possible earthing of transmitter 20 volt circuits together with an opposite polarity earth (usually present) on the ship's D.C. supply mains results in the burning out of the 20 volt keying anti-auxiliary relay bobbins of the transmitter. The battery outfits concerned are BBr and BBq.

A battery outfit BBz has been introduced to supersede BBr and BBq and is now being fitted in new construction ships with Type 60EQR.

Briefly, BBz consists of duplicate 24 volt batteries with their associated charge/discharge equipment. The 24 volt battery consists of 6 volt car type battery units of 144 ampere hour capacity, thus providing two batteries of 144 ampere hour capacity, as opposed to one 210 ampere hour capacity battery as fitted with Outfit BBq and BBr. The 4 volt batteries in BBz consist of two in number Pattern 7541 cells for each battery.

The advantages of battery outfit BBz over both BBr and BBq are :-

(a) Increased reliability for the "emergency" state. Given correct maintenance of batteries, one 24 volt battery and one 4 volt battery of the outfit should always be in the fully charged condition, irrespective of the possible continuous use of the battery operated transmitter.

Note :- From several reports it has been evident that this condition does not always provail with the single battery outfit.

(b) Omission of float charging, thereby removing a possible source of major defects to the transmitter.

(c) No increase in space is required for installation (the duplicate batteries of BBz are accommodated in the same battery cupboard as for BBq and BBr) and a reduction in weight as compared with battery outfit BBq.

A Fleet Order will shortly be promulgated authorising ships concerned to insert an Alteration and Addition item for the fitting of battery outfit BBz in lieu of their present outfit.

PATTERN W6703 MICROPHONE AND TELEPHONE ASSEMBLY.

Several cases of the Patt. 7307 cotton covered telephone and microphone leads of this assembly becoming defective have been reported.

A moulded rubber covered lead is now in production and will shortly be available for supplying to ships concerned for replacing the existing lead in all Patt. W6703 microphone/telephone head-set assemblies.

A Fleet Order authorising ships to demand the new type of lead will be promulgated in the near future.

V.H/F AERIAL SYSTEMS.

The following improvements are being introduced to the aerial outfit and Types 86M and 87M.

(a) Special gland adaptors for replacing the Air Ministry Type adaptors of the modified Air Ministry Type 160 plugs in aerial outfit APH for connecting Patt. 13802 coaxial to the steel tube extension of the aerial unit. Two types are envisaged, one with a gland adaptor and clamp; the other with an improved type of clamp.

(b) An improved Admiralty pattern adaptor to replace the Air Ministry Type 8 to take the Air Ministry plug Type 158 instead of the Air Ministry Type 160 plug. This improves :-

(i) the connection between Patt. 13808 cable of aerial outfit APU and the Patt. 13831 flexible cable.

(ii) the output connection of the Type 87M and the connection of the Patt. 13821 or 13831 flexible cables.

FIGHTER DIRECTION CONTROL OUTFIT KFD/E

Several suggestions have been received from the Fleet for improving the operating facilities of the above outfits.

The following additions and modifications are now in course of development :-

(i) INDEPENDENT VOLUME CONTROL OF TELEPHONE RECEPTION AT REMOTE CONTROL POSITIONS.

(a) The present 6 channel and 12 channel R/T control units are being modified to include a local volume control, and the V.D/P line switch has consequently been removed to provide the necessary space. Switching of the V.D/P line to a selected communication channel will be carried out by an additional switch selector unit sited in the A.D.R. Provision is also made on the switch selector unit for connecting two other lines similar to the V.D/P line, one for M.L.O. requirements in Assault Carriers; the third for any similar future requirements.

(b) Replacement of the W.7546 socket unit by a watertight socket unit with volume control included for fitting the V.D/P line extensions and for similar uses when in exposed positions.

(c) Volume control unit for fitting at all R/T logger positions.

(ii) INTRODUCTION OF AUDIO FREQUENCY AMPLIFIER.

To provide satisfactory loudspeaker reception, loudspeaker amplifiers are in course of development and production and will be incorporated in all future control outfits as required. Retrospective fittings will be implemented as considered necessary.

(iii) RECEPTION OUTPUT EXCHANGE WITHIN THE A.D.R.

To avoid the numerous number of telephone Junction Boxes and associated inter-connection leads, a simple form of exchange will be included in the replacement Fighter Direction Control Outfits.

(iv) Addition of flying control communication requirements into the KFE requirements in future aircraft carriers.

(v) The extension of scrambling facilities by means of a scrambler exchange incorporated into relevant speech control outfits.

(vi) The inclusion at the fighter direction officers' positions in the A.D.R. of a microphone assembly employing a "stand microphone" and possibly a foot operated pressel switch. This will enable R/T operation with both hands free.

(vii) Consideration has been given to the inclusion of inter-communication facilities between remote control positions. This will possibly be included at a later stage, but technical design and production consideration prohibits incorporation into the present development programme.

It is intended that the above features will be introduced into the replacement outfit of KFD/E viz. KFF/G for fitting in future capital ships, cruisers and aircraft carriers. It is hoped to implement certain individual items retrospectively into existing ships and aircraft carriers where the fitting of such items will not entail major alterations to existing equipment. It is anticipated that any full modernisation of ships or aircraft carriers will include the complete replacement of the existing control systems by the more up-to-date W/T and R/T control outfit with their associated "Fighter direction" and "Flying control" R/T Control outfits.

ANY W/T DEFECTS

In spite of the advice and requests in A.S.E. Bulletins No. 1 - March, 1944, page 26, and No. 4 - December, 1944, page 61, A.F.O. 4136/43 and recently published A.F.O.3047/45, very few reports on form S.1183 (on defective W/T apparatus) are being received from sea although evidence from other less detailed, and therefore not so valuable, reports indicate that defects are occurring repeatedly in certain apparatus. From observations made during visits to ships and establishments it appears that among the reasons given for this lack of reports are the following :-

(i) "It reflects on the efficiency of the ship"

(ii) "Don't say anything about it or we may be blamed for not keeping it up to scratch." (prevalent among junior ratings)

(iii) "The defect is so obvious it must have been reported before"

(iv) The rating putting the defect right is much too concerned at the moment in getting the apparatus to function again, and is very satisfied when it is correct, and his natural reaction is to forget it, fail to record it, or consider it not worth while.

(v) "No one will take any notice of our report".

All these point to the fact that the A.S.E. Bulletin articles quoted above HAVE NOT BEEN COMMUNICATED TO THE JUNIOR OFFICERS AND RATINGS RESPONSIBLE FOR THE MAINTENANCE OF W/T APPARATUS, and thus they are not aware of the great importance attached to these reports by A.S.E.

This is very disturbing, and gives rise to doubts on reports received through other channels, gives a false sense of complacency to Designers, Testers, Inspectors and Fitters, and may mean that (under certain conditions) similar defective apparatus will continue to be manufactured and issued to the Fleet.

WE MUST STOP THIS STATE OF AFFAIRS, and get reports from you on Form S.1183 as soon as possible after the defect is apparent or the breakdown occurs.

Our difficulties have been, and continue to be, lack of sufficient information relating to defects both electrical and mechanical in apparatus which for the most part has been manufactured, tested, supplied and fitted under "RUSH" conditions. Rush conditions will not always prevail, but we hope, with your help for great improvements in design, manufacture and test - and trouble-free radio communication.

A.S.E. "Equipment Improvement Committee" (Committee quoted in Bulletin No. 1 - March, 1944, page 26) are not in a very good state of health with regard to W/T apparatus at present and require more and more meat to bite on, their meat is more and more S.1183's and the vendor is you. Please bring this article to the notice of all W/T personnel in accordance with the terms of the note inside the front cover of the Bulletin.

In the early days of the war, a radio system for accurate navigation was conceived by Messrs. Decca Radio and Television Ltd. and, about the middle of the war, development and trials of the system were undertaken jointly by A.S.E. and the Decca Co.

The system employs three C.W. transmitting stations operating in the frequency band 80 to 140 Kc/s and a special three-channel receiver, the output of which operates two meters. At any time a navigator has merely to take the readings of the two meters and pick out the point of intersection of two similarly numbered lines on a chart over-printed with a lattice grid.

Although the transmitters operate on different frequencies, frequency changing arrangements in the receiver are so arranged that the result is equivalent to the two adjacent pairs of the three transmitters operating on two equal frequencies. It is then possible to construct on a chart, between the two pairs of the three transmitters, two families of hyperbolae, which are the loci of points of constant phase difference between the emitted carriers. The indicating meters connected to the output of the receiver are actuated by direct currents, whose magnitude is dependent upon the phase difference between the emitted carriers at the receiving point. By numbering the hyperbolae on the chart in accordance with the meter scales, it is obviously possible, from the meter readings, to determine upon which two hyperbolae the receiver is situated in the two families constructed on the chart. The point of intersection of these two hyperbolae is, of course, the position of the vessel.

Trials quickly showed the possibilities of high accuracy with the system and, after further development, a stage was reached where it was decided that the system should be used for the landings on the Normandy Beaches on "D" Day. The system functioned most successfully during this operation and was used in Mine Sweeper Flotilla Leaders and Navigational Leaders.

Later, when there was no further use for the system with the transmitting stations sited along the English South Coast, it was decided to remove the stations and re-erect them in Belgium, at Bruges, Ghent and Antwerp, in order to provide an accurate navigational aid throughout the River Scheldt at times when visibility would be bad and, without the assistance of a navigational aid, the movements of shipping bringing supplies to Antwerp for the Allied Armies would be held up. The River Scheldt from Flushing to Antwerp is difficult and tortuous and, in many places, the navigable channel is dangerously narrow under conditions of poor visibility.

It was known that the system would give the required navigational assistance from the point of view of accuracy and ease of operation, but quite how to use the system was a difficult problem. Liberty ships etc. coming into the River Scheldt would obviously not be fitted with the necessary receivers, so it was decided to fit six M.L's and attempt to use these to lead vessels up the river, until a battery-operated portable receiver could be produced. This would be carried aboard by a pilot and operated from a simple single wire aerial rigged in any convenient position.

In actual fact there was no call for this system since weather remained unusually good. The River Scheldt is, however, an ideal proving ground for a system of this type and much useful information was obtained during numerous trials carried out in the river. All previous trials lacked a "yard stick" which was of greater accuracy than the system undergoing trial but, in the Scheldt, it was possible in a small craft, to run alongside navigation lights, tide gauges, jetties etc., all of which are charted, and compare the known position

of the craft with the position given by the system. Excellent results were obtained by this method of trial and reports made accordingly back to the Admiralty in London.

It was then decided that the accuracy of the system should be established quantatively and by independent observers, and that the only way in which this could be done satisfactorily was with the co-operation of the Hydrographic Dept. of the Admiralty. Accordingly arrangements were made for the Admiralty Survey Vessel, H.M.S. FRANKLIN, under the command of Commander Irving, to proceed to the Scheldt and carry out trials with the members of A.S.E. staff out there.

Most extensive trials were arranged and carried out with Commander Irving, who arrived in Terneuzen with the report that, on the run from Flushing to Terneuzen, the system was inaccurate by some 30 yards. This statement was most disconcerting, since the run between these two points is open water and was the only portion of the Scheldt devoid of marks and had, therefore, never been tried out. A number of tests showed that the system was accurate immediately one crossed a line east of Terneuzen and inaccurate to the west, i.e. the Flushing side of this line. This, to the relief of all, was subsequently pinned down to the fact that this line was the dividing line between the Belgian and Dutch surveys. The chart was correct in the Dutch portion but discrepancies were present in the Belgian portion which were brought to light by the accuracy of the Navigational System!

Many trials were conducted with the ship-borne A.C. outfit and with the battery-operated portable model, which was even carried up to the tops of navigational lights on the banks of the Scheldt to ensure, beyond doubt, that the equipment was on the exact spot at which a proving "fix" was required.

Commander Irving stated verbally, and in his report, that the accuracy of the system was very high and was not worse than 20 feet in the Scheldt, while the operation of the equipment was as simple as could be desired. He foresaw many applications for the system, amongst which were mine clearance in the North Sea and position fixing for the Admiralty Survey Vessel which operates continuously in the Thames Estuary but is hampered severely by frequent spells of bad visibility. It is hoped that in the near future a chain of transmitting stations will be erected for covering the Thames Estuary for these purposes and, possibly, Harbour Pilotage as well.

Work is proceeding on certain aspects of the system, including maximum useful range, accuracy at long distances, and "land identification". So far, trials have been conducted to 550 miles, at which distance signal strength failed owing to the transmitting aerials being too small for efficiency. The transmitters are now re-erected on the English South Coast, with higher and larger aerials, and trials are to be carried out almost immediately by air, on a round trip via France, Spain, Gibraltar, Portugal and back to the U.K.