A NEW FORM OF CONSTRUCTION FOR RADIO EQUIPMENT

General Description

In the course of work on Type 980/1 the Type 274/5 Design of Radar Panels has been revised with the following aims :-

(a) To improve certain features of the previous design.

(b) To improve the space factor.

(c) To obtain a basic design of standard panel with greater adaptability. (Circuit or Site).

The method of achieving these aims is described below :-

(a) The telescopic runner system is redesigned to carry heavier loads, it now embodies the lock system and pawl device which holds the jaws open.

The locks are driven by a Bowden "Pull" wire system with spring return so that handle can move with the cradles, this eliminates the small separate plate formerly used supporting the handle.

The panel device takes the form of a spring plunger engaging in a slotted quadrant. (See Fig. 3.).

(b) The space factor has been improved by increasing the width of the Panel (now 22¾") to take four units abreast instead of three (This is an optional feature, where there are limitations in size, the width can be 18" - equivalent to 3 units abreast), so that for the same loss of space at the sides, the Panel holds more units.

The panel has been reduced in height to suit a new method of dealing with incoming cables and interconnections occupying the area usually "wasted" by the resilient mounts. Particulars of the new system are detailed below.

(c) The design now enables panels to be built up like bricks one upon another with provision for interconnections. Each brick contains either a Crocodile type Drawer or a Simple drawer depending on the circuit and its contents. The arrangement allows for either top or bottom cable entries. (See Fig. 1)

Provision for Interconnection and Cable entries
'Cable Front' and 'Cable Entry Compartment'.

Interconnections between panels one above another are run inside the 'Cable Front'. This is a hollow steel trough surrounding the front panels, it contains the panel wiring complete with flexible sheath to the cradles. It can be wired as a unit and fitted to the panel at any convenient stage in the assembly process. It can be disengaged from the panel. This form of construction provides the following important features :-

(a) It embraces all the wiring associated with the panel, as distinct from the cradles.

(b) It can be wired as a unit and fitted to the panel at any convenient stage in the assembly process.

(c) It can be disengaged from the panel for examination after installation.

(d) It forms the "junction box" between panels.

Incoming cables enter the back of the "Cable Entry Compartment" and are clamped and terminated in conventional fashion, all manipulation being done from the front, as there is bound to be limited access to the rear and sides of the Panel during installation. Cross connections between vertical banks of panels are made between the adjacent cable entry compartments. (See Fig. 2).

KEY TO FIG. 3.

1. Upper Resilient Mountings.
2. Air Outlet for Forced cooling system. GR-S Moulding.
3. Cable Entry Box (can be mounted on top or bottom (or both) of Panel).
4. Removable top cover of cable entry box.
5. Front cover of 3. Hinged; carries Controls and Indicators.
6. Securing screws for 5.
7. Release lever of link lock - this holds cradles or "jaws" open.
8. Latch holding upper and lower jaws together.
9. Handle controlling locks in telescopic runner system via "Bowden" cable.
10. Telescopic Runner System with internal locks.
11. Lower Cable Front. Disengaged for connecting up. Partly cut away to show cables.
12. Junction Point between Cable Fronts.
13. One of four studs supporting each Cable Front.
14. Air Inlet for Forced cooling system - identical with 2.
15. Lower Resilient Mountings.
16. Plastic (P.V.C.) Cable sheath on underside of Drawer (Drawer not shown).
17. Plugs coupling signals to units in Drawer (Units not shown).
18. Contact strip to supply upper Panel with L.T. power supplies.
19. Lower Panel. Side cover, runner system and drawer removed.
20. Upper Cable Front. - parts cut away to show cable run.
21. Upper Panel.
22. L.T. Power Supply contact strip to units in cradles.
23. Plugs coupling signals and units in cradles (Units not shown).
24. Non-sag cable sheath to cradles.
25. Cables running inside hollow Cable Front connecting upper and lower panels together electrically.

VIEW SHOWING HOW PANELS CAN BE BUILT UP IN A COMBINATION TO SUIT OPERATIONAL & CIRCUIT REQUIREMENTS

WIDTH IS A MULTIPLE OF RADIO UNITS IN CRADLE,
I.E 3 BERTHS = 18 1/4", 4 BERTHS = 22 3/4"

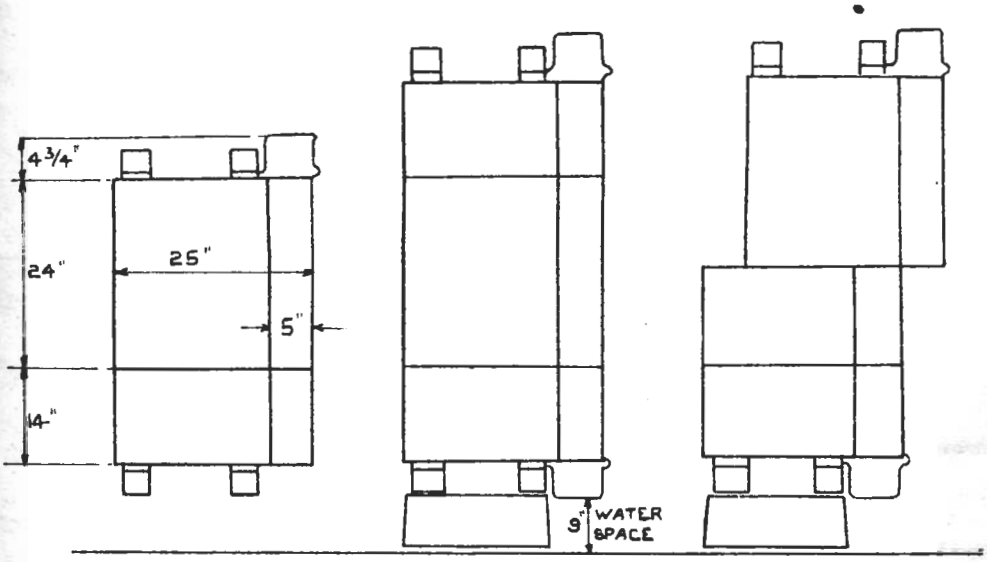


FIG. 1

VIEW ON TOP (OR BOTTOM) OF PANEL SHOWING REAR OF CABLE ENTRY BOX, ANTI-SHOCK MOUNTINGS FLEXIBLE AIR COOLING TRUNKING, INCOMING CABLES

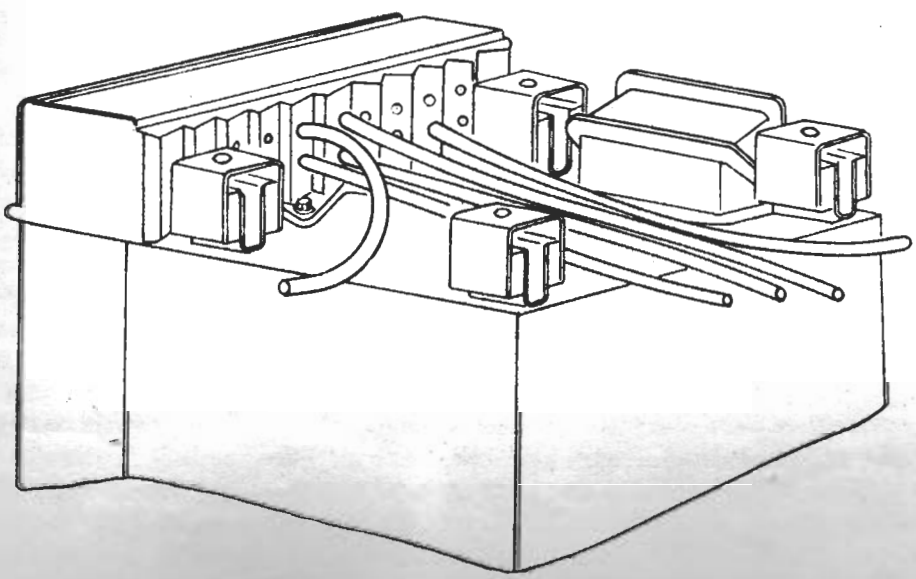
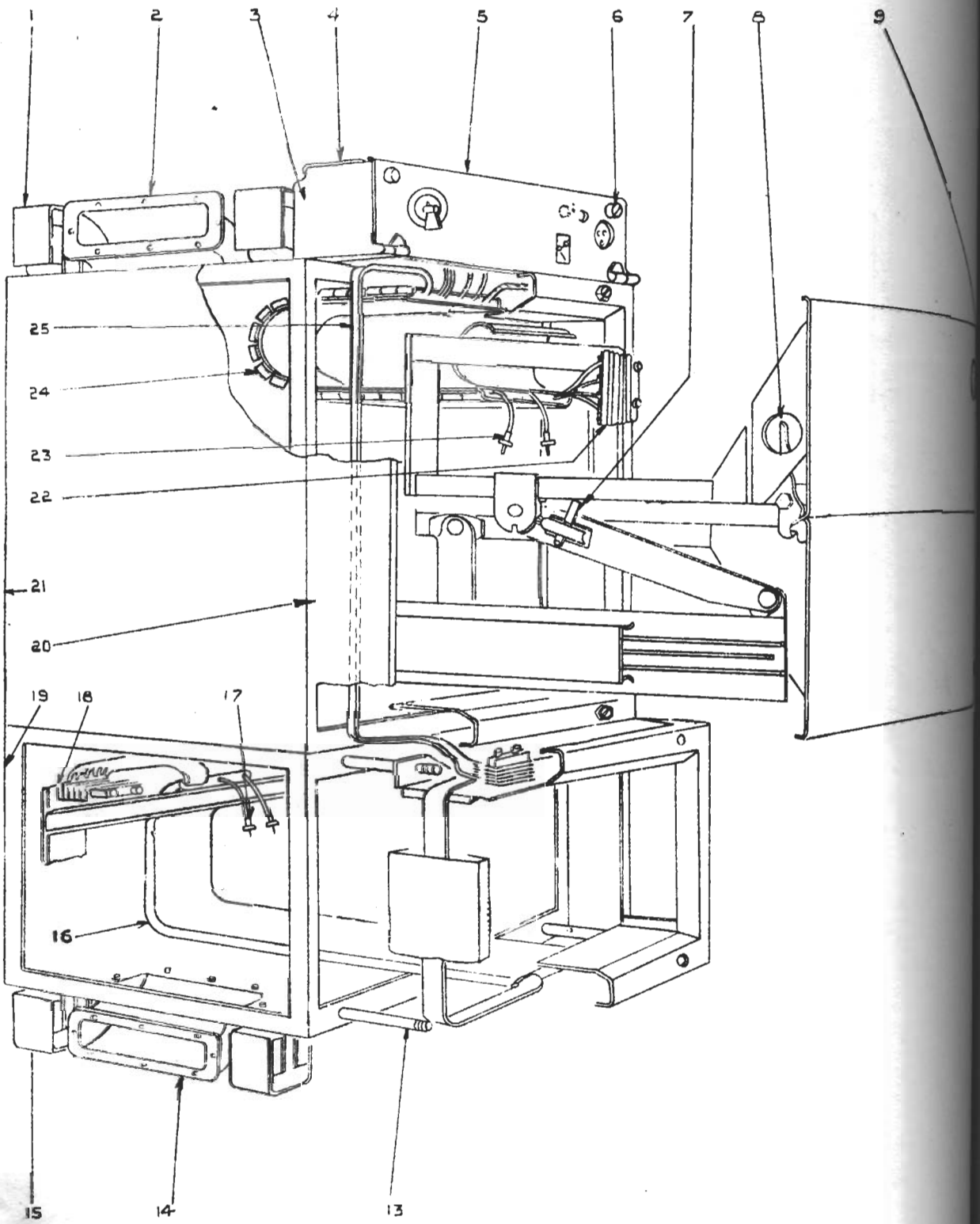


FIG. 2.

PICTORIAL VIEW OF TWO PANELS

UPPER PANEL - WITH CRADLES WITHDRAWN

LOWER PANEL - SIDE COVER RUNNER SYSTEM & SIMPLE DRAWER REMOVED



INSTALLATION SPECIFICATIONS

AND

ESTABLISHMENT LISTS

This article, written by an anonymous long-service civil servant at the behest of certain experienced Signal Officers, purports to describe, and hopes to stimulate an interest in, two publications which are of great importance from all aspects of naval radio but which, in the opinion of the aforesaid Signal Officers, are nothing like so widely known and appreciated as they deserve. There is some justification for this in the case of the specification, since it is a document which is only circulated to those concerned with fitting, as distinct from operating and maintenance. Nevertheless a time may come, even in the career of the most adventurous, when the luck of the draw (officially known as the exigencies of the Service) lands an officer in one of those mysterious appointments ashore in which he will be intimately associated with either the planning, first fitting, or refitting of W/T or Radar gear, and it is in these circumstances, whether employed as a Port W/T or Radar Officer, a Fitting-Out Officer, or other similar job, that a knowledge of the specification technique will smooth the way towards speed and quality in the results of his labours.

The Establishment List is in another category; like the "poor", it is always with us. Not always quite up-to-date, not invariably accurate in every detail, it nevertheless does represent the sum total of current knowledge of the composition of an equipment in terms of its pattern stores. As such it should be always on hand, regularly consulted, its provisions applied and - most important - its defects noted and duly reported to A.S.E.

SPECIFICATIONS

The primary purpose of the Installation Specification (formerly called the Fitting-Out Specification) is to tell the reader all he needs to know about a radio set when called upon to plan the lay-out and to carry out the work of fitting and wiring. It has a secondary function also, deriving from the days when money meant purchasing power, untrammelled by expense or priorities, and this was to serve as a basis for estimating prices and a standard of reference for determining the scope of the contract in case of dispute. This auxiliary purpose has a somewhat unfortunate effect from the point of view of the enthusiastic technically-minded user, since it involves the insertion of a certain amount of matter which a technical officer or rating could very well dispense with. With a little practice, however, he can soon learn to separate the wheat from the chaff and gain sufficient nutriment to justify the attention given. The specification is, therefore, drafted mainly with a view to the needs of dockyards, shipbuilders and Naval Base Staffs, these being the authorities who will be required to do the work. It follows that the contents should be known to Inspecting Officers and Port Radio Officers as and when the occasion arises.

The proper performance of a radio set depends, in the first instance, on the correct design of its constituent parts. Careful fitting is, however, one of the factors contributing to operational success and it is thus an important objective in compiling a specification to ensure that it meets the latest Staff Requirements and up-to-date scientific and technical demands.

The average specification comprises a few pages of textual matter bound with a set of perhaps half-a-dozen drawings. The whole is of foolscap size - like the Bulletin, but there the resemblance ends, as specification covers are entirely devoid of artistic decoration and only official matter-of-fact statements are encouraged in the matter which they enclose. There was a time when every self-respecting specification bore a number in the 9,000 series. There were, it is true, certain disreputable publications with "B" numbers but these were quite definitely of a preliminary nature and were discarded without regrets as soon as they could be replaced by the genuine article,

and it was genuine, for the text was carefully compiled and revised and the drawings were made by well-trained draughtsmen and checked in the most complete manner by lynx-eyed section leaders of vast experience. The 9,000 series, aided by the fact that practically all "types" were two-figure numbers, was suitably exploited to relate the specification number to the type number in such a way that, to the uninitiated, an expert could appear a miracle of memory at very small cost to himself in the way of mental strain. The advance of science, the impact of the war and the introduction of radar, all contributed to make havoc of the complete and orderly presentation of information which had hitherto been the rule. "B" books, hitherto in disrepute, took the stage at an increasing rate; the exception because the rule and now the ever-swelling flood of these documents has entirely drowned their predecessors and effectually prevented any hope of replacement by "standards" for many years to come.

There remains, however, one sample of the 9,000 series which deserves special mention and that is specification No. 9001. This important publication contains, in addition to legalistic matter too dull for frequent repetition, a statement of very general provisions which apply to almost all equipments and lists which provide the key to the whole specification system. Certainly 9001 is worthy of attention, even though, by its very nature, it can never be up-to-date.

To return to the installation specifications proper, (most of which will be "B" books). A convenient starting point is to consider the fitting of a "type", and it may as well be W/T since, after all, Radar is a newcomer and the technique is the same. The Type specification will itself give all essential information, in its test, as to the broad composition of the set, variations of circumstances in which it may be fitted, power supplies required, weights of components, ventilation and the like. It will also give a lead as to the control outputs with which the set will be associated and where to look for details of such outfits. As a rule, the drawings attached will deal with the lay-out, wiring and details of the type itself; this limitation is imposed because the ancillary equipment such as aerial trunks, deck insulators, power outfits etc., are common to many sets and it is thus economical to give each of these its own specification to be used in conjunction with the main specification. The text of the latter explains these matters and provides the required references. The text also serves as a useful repository for any information regarding "tricks" of fitting, where it is felt that difficulty may be encountered.

The drawings are more or less self-explanatory. They usually comprise office plans showing the preferred disposition of the apparatus, complete wiring diagrams and any detailed information which is best shown pictorially.

It is important to note that the specification in the approved authority for determining where the responsibility of the contractor for dockyard begins and ends. In broad terms it is easily stated; the shipyard is responsible for the whole work of fitting and wiring, including the provision of all materials bits and pieces, frameworks, brackets and the like except pattern articles supplied by the Admiralty. These are enumerated in the E. List. The definition of all these items is, of course, a matter of much detail and the specification is the final authority for determination of these details.

How does the specification come into existence? What is the method of its preparation or growth? - these are questions, the answers to which may be of general interest and of some value in understanding the growth of an equipment. Arising from the experimental development work in the laboratory a point is reached at which a preliminary circuit diagram can be produced. At the same time, consideration is being given to power supplies, aerials and aerial connections and when all the facts are known, a complete wiring diagram is prepared. This is the essence of the whole production, since the lay-out cannot be completely decided until the circuits are known. The preliminary circuit diagram is therefore extended into the form of a complete detailed wiring diagram at the earliest possible date. This involves deciding not only the patterns of cables to be used but also such mundane matters as whether two or three conductors can be taken to a particular terminal and if not, what is to be done about it. The answer is probably an intermediate terminal block or junction box, for which, be it noted, provision of adequate quantities will need to be made.

In parallel with the preparation of the wiring diagram, typical lay-outs of offices are planned and, in some cases proved by a mock-up and modified if found necessary. The lay-out and wiring being determined the rest is a straightforward consideration of the possible fitting snags which may be encountered and an attempt to overcome them by the provision of adequate sketches of details.

The installation specifications are distributed over a wide area but owing to the necessity for economy in production, the numbers issued to the various authorities are necessarily less than could be desired. For instance, it is not the practice to distribute to the Signal Officers of ships; the needs of these officers are met by the sections of the instructional handbooks dealing with the work of fitting. But, as copies are issued to all the principal Naval Authorities throughout the world and to all Port W/T and Radar Officers as well as to Warship Production Superintendents and the various shipyard Overseers, it should not be difficult to consult a copy at a time when it is likely to be of value, viz. during or preceding a refit. The distribution of every new specification is promulgated by an A.F.O.

ESTABLISHMENT LISTS

The function of an Establishment List, from the point of view of the user of an equipment, is to provide a detailed list of all the "sea stores" articles in the main and ancillary groups which go to make a complete radio installation. This includes stores which will be carried as spares as well as the working allowance; the list also serves as a useful guide to the spares carried at bases. It is important to note that there is a limitation imposed by the description"sea stores". Broadly speaking this covers all instruments and apparatus purchased by the Admiralty and issued to dockyards and shipbuilders. This almost amounts to the whole of the gear, but not quite; exceptions occur, such as small fittings made by the shipbuilder and certain items which are not "radio" but are, nevertheless, Admiralty pattern articles. Amongst these are junction boxes for permanent wiring, lighting fittings, furniture and what not. There is no real risk of confusion about these matters, because any articles which do not appear in the E. List will be adequately entered for by the installation specification on the Admiralty specifications for the ship.

Another way of looking at an E. List is to regard it as the authority for all dealings with Naval Store Officers, subject, of course, to modifications promulgated by Fleet Orders.

The Establishment List has three main divisions, viz. "Front page allowances", List of Permanent Stores and List of Consumable Stores.

The front page allowances deal with groups and not with individual items of stores. They show what ancillary groups should be associated with the main groups and where to seek the detailed particulars of this ancillary equipment. In short, they "pass the buck" on to other E. Lists.

The permanent stores are those items for which it may be expected that repairs could be effected when damage occurs, presuming that the original value was sufficient to justify returning for repair. Consumable stores are either those which are genuinely "consumed", after a term of service, or for which it is not worth the trouble and expense of returning when demanding a replacement; in other words articles of comparatively small value. Any representative E. List will easily furnish examples of this latter distinction; carbon brushes are an example of the genuinely consumable article and small valve holders of the other category.

The growth of the draft of an E. List should, ideally, be at the same rate as that of the installation specification. In practice this cannot be achieved since it is possible to produce some sort of a preliminary list at a very early stage, based on the experimental designer's forecast of store requirements. This is very necessary as it enables advance provisioning action to be taken for standard stores which are known to be wanted. Of course there will be later additions but where provisioning action is involved the earlier the machinery is set in motion the better. Thus the first preliminary E. List inevitably gets a lap ahead of the specification. Then, as the set develops, it is amended and revised as necessary until finally it is brought into line with the approved specification, inevitably finishing a lap behind.

It should be clear from the foregoing that the Establishment List is the only really authoritative document for defining the equipment, including spares, which makes up a complete outfit for a ship or station. It is, therefore, only by reference to this type of list that the Signal or Radar Officer can know that the radio equipment of his is complete and that he is adequately supplied with spares. Having regard to the responsibility for custody of the permanent equipment which falls to the lot of these officers, it will be readily appreciated that the Establishment Lists, properly used, can be of utmost practical service.

Although the Establishment Lists originate in A.S.E., it is to be noted that distribution is made through the S.N.S.O., Haslemere.

Any demands for E. Lists should therefore be forwarded to S.N.S.O. (H).

STANDARD FREQUENCY TRANSMISSIONS

Standard frequency transmissions are now radiated by the U.S. Bureau of Standards from a station near Washington, and by the British Broadcasting Corporation from a station near London.

Although these transmissions could be used for checking the reference crystals in wavemeters G61, G62 or G73, which crystals are the ships frequency standards, ships staffs have not so far been recommended to take advantage of them.

The reason for this is that the setting and reading accuracy of the interpolating absorption wavemeter in the case of the G61 and G62 and the reading accuracy of the dial in the case of the G73 are by far the most important factors limiting the overall accuracy of these wavemeters, the maximum observed crystal error, even after years of service, being quite negligible in comparison. Checking and adjusting the crystal cannot therefore produce any detectable improvement in the performance of the wavemeter while the adjustment, if not very carefully made, can result in the introduction of a serious error.

Two wavemeters covering the range 15 kc/s to 30 Mc/s are under development as replacements for Wavemeter G73. These will have a dial giving very greatly improved reading accuracy and it is probable that this will improve the overall accuracy to such an extent that it will be worth while to check and adjust the reference crystal at intervals. To give those concerned the opportunity of becoming familiar with them, the latest information about the available transmissions is given below.

THE NATIONAL BUREAU OF STANDARDS TRANSMISSIONS.

(i) These signals are transmitted every day from Washington, D.C. U.S.A. on frequencies of 2·5, 5·0, 10·0 and 15·0 Mc/s. The schedules are subject to change from time to time, but at present they are as shown on Table I, which also indicates the standard audio-frequency tones with which the carriers are modulated.

TABLE I.

Washington WWV Standard-frequency Transmissions.

Frequency Mc/s	Power kW.	Schedule GMT.	Modulation Tones c/s.
2·5	1	2300 - 1300	440
5·0	10	2300 - 1100	440
		1100 - 2300	440 & 4,000
10·0	10	continuously day & night	440 & 4,000
15·0	10	continuously day & night.	440 & 4,000

(ii)/ ....

(ii) The accuracy of the carrier frequencies is better than one part in 10,000,000.

(iii) The 440-c/s tone is the standard keytone for orchestras internationally agreed shortly before the War, and corresponds to the A above middle C. This and the 4,000 c/s tone are accurate to 1 part of 10,000,000.

(iv) In addition to the tones, short pulses marking seconds are being radiated continuously, the minutes being marked by the suppression of each 59th. pulse; that is to say, the first of every series denotes the minute exactly.

(v) The tone modulation is suppressed for an interval of exactly one minute beginning at each hour and at every succeeding 5 minutes, for the purposes of radiating the call-sign and allowing radio-frequency measurements to be made without any interference by the modulating tones. At every hour and half-hour the transmission is announced by R/T, but at all other intervals the call-sign WWV is sent in morse.

THE B.B.C. TRANSMISSIONS.

(i) These are not specially radiated signals, but arrangements have been made to maintain the carrier frequencies of certain B.B.C. broadcast transmitters continuously within one part in a million of the nominal values.

(ii) Again the schedules are subject to variation from time to time, but Table II sets out the transmitters concerned and their hours of service at the time of preparation of this article.

It is to be noted that B.B.C. transmitters are not identified by separate announcements, only the name of the programme is announced and, as there are several B.B.C. transmitters in each H/F broadcasting band, sometimes on nearby frequencies, considerable care is needed to ensure that the standardised transmitter is in fact the one being heard.

TABLE II.

B.B.C. Transmissions stable to one part in a million for frequency.

Frequency.	Call sign.	Schedule GMT.	Direction.
200 kc/s	(B.B.C. "Light Programme")	0800 - 2300	
6·180 Mc/s	GRO	0400 - 1330 1430 - 2215 2230 - 0045	Europe
9·510 Mc/s	GSB	0400 - 0800 1730 - 2100	Near & Middle East & Italy.
		2100 - 0215	South America.
17·810 Mc/s	GSV	0900 - 1415	India.
		0900 - 1515	Africa.

TRAINING RADAR MECHANICS (W/T)

The training of Radio Mechanics has undergone a number of changes. In the early days two varieties were to be found - the Radio Mechanics (R) trained for Radar and (S) for shore station W/T maintenance. Most of these ratings had had previous experience of radio work. In order to improve the standard of maintenance of both Radar and W/T in small ships the category (W) was then introduced. This rating was a Radar Mechanic who had undergone a further short course in small ship W/T equipment. The next step was to provide an outlet to a higher rating. The technical qualification for chief Radio Mechanic was a course covering both Radar and W/T and the Mechanic who successfully completed this was known as a Radio Mechanic (C).

By this time it was becoming apparent with the lower standard of technical attainment reached by ratings in the Telegraphist branch and the increasing variety of W/T apparatus, that further changes had to be made. The category (C) was not meeting the need largely on account of small numbers. The reorganisation that then took place, in the early part of 1944, had led to the present position. A new category (W/T) was introduced, recruited and trained to serve the needs of communications equipment in a way similar to the (R) category already in existence. This latter category was continued and so was that of (W) which was now renamed (WR). Recent Admiralty Fleet Orders have aimed at tidying up the state of affairs thus created. The Radio Mechanics (S) have automatically become (W/T). The Radio Mechanics (C) have become either (R) or (W/T) depending on choice. The Radio Mechanics (W) have been recategorised into (WR). There are, therefore, excluding Mechanics trained and serving in the Fleet Air Arm whose history has not been touched, these three main categories, (W/T), (R), and (WR). Of these, training in the category (WR) has been suspended indefinitely. Indeed, owing to the shortage of Mechanics (W/T) and the surplus of (WR), conversion courses for volunteers from the one into the other have been arranged.

At the present time a limited number of selected volunteers from the higher ratings in the Telegraphist branch have been given the opportunity to transfer to the Radio Mechanic branch in the category (W/T). Transfer depends upon the successful completion of a course.

So far, no mention has been made of the W.R.N.S. Of these there are two categories (WM) for W/T duties and (RR) for Radar duties.

This article and the photographs on Page 73 are concerned with the training of Radio Mechanics (W/T) and (WM) for which H.M.S. MERCURY at Leydene is primarily responsible. The course for Radio Mechanics (W/T) who are drawn either straight from their civil occupations or from volunteers in other branches in the service, consist of two parts - 20 weeks basic training at civilian technical colleges, four weeks at H.M.S. SCOTIA and ten at Leydene. The last two stages are devoted to technical application to current equipment. The W.R.N.S. mechanics (WM) follow a similar scheme which consists of twenty weeks at Technical Colleges and eight weeks at Leydene. The equipment covered by the W.R.N.S. at Leydene is from a more limited selection, to train them for work at maintenance bases.

There are four civilian Technical Colleges where a small naval staff acts as liaison. They are to be found at Aberdeen, Chelsea, Rugby and Walthamstow. Only Chelsea and Walthamstow are used for training W.R.N.S. Mechanics.

The photographs illustrate the practical aspects of the training. In parallel with the practical work a proportion of the time is devoted to lectures. The courses like so many other wartime courses tend to be very crowded both in the number of pupils and in subject matter. In this respect it is realised that they depart from the ideal, which is to provide for a gradual process of assimilation and plenty of practice for each individual. It has been the more limited aim at Leydene to provide the soundest possible foundation, under wartime pressure, upon which a mechanic may build up his skill through later experience.

There is, however, no substitute for adequate time in which to give a sound grasp of the principles of Radio techniques and their application, together with a measure of fitting and workshop skill, to men charged with the upkeep of radio equipment. The realisation of this will undoubtedly shape future schemes, whatever the organisation of the branch or branches concerned.

The photographs are as follows :-

1. Completing first chassis built sets, Walthamstow Technical College.
2. Work in the test shop, H.M. Signal School, Leydene.
3. Instruction on Type 88 RS at H.M.S. "SCOTIA".
4. Maintenance of VH/F equipment, H.M.S. "SCOTIA".
5. Testing circuits in the special circuit laboratory at Rugby Technical College.
6. Testing FH4 aerial at H.M. Signal School, Leydene.
7. Work in the aerial laboratory, Rugby Technical College.
8. Wrens (WM) basic work shop instruction, Walthamstow College.
9. Aerial view of Leydene.
10. Shore station equipment, H.M. Signal School, Leydene.
11. Instruction on American Equipment, H.M. Signal School, Leydene.
12. C.W.S. Instruction, H.M. Signal School, Leydene.
13. Wrens (WM) instruction on H/F D/F, H.M. Signal School, Leydene.
14. Elementary bench work in Aberdeen Technical College.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