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BUREAU OF SHIPS

RADIO AND SOUND BULLETIN

No. 7

	Page
Some notes on new standard radio receiving equipment	1
Method of reporting failures in radio and sound equipment	13
Cross index of Army and Navy type vacuum tubes	19
Modification of model TBP, TBY, and TBY-1 ultra-portable equipment	25
Use of shielded phone cords and high impedance head telephone receivers	27
Fuse failures in TAJ-6, TAJ-7, TAJ-9, and TAJ-10 transmitting equipment	28
The Forum:	
Use of fire pump as emergency cooling water supply	29
Technical papers	30

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RADIO AND SOUND BULLETIN

NAVY DEPARTMENT,
BUREAU OF SHIPS,
July 1, 1942.

SOME NOTES ON NEW STANDARD RADIO RECEIVING EQUIPMENTS

INTRODUCTION

In the July 1941 issue of the Bureau of Ships Radio and Sound Bulletin, an article was presented, describing a new series of radio receiving equipments which should be issued to the Service by the time or shortly after this article appears in print. These equipments are designated as the Models RBA, RBB, and RBC Radio Receiving Equipments. At the time of the writing of the previous article, the preliminary models of these new equipments were undergoing exhaustive type tests at the Naval Research Laboratory.

Subsequent to the publication of the July 1941 issue of the Bureau of Ships Radio and Sound Bulletin, certain features of these equipments have been modified. In connection with the development of a new line of radio equipments it is not uncommon for the equipments, as delivered to the Service, to differ somewhat from the models initially furnished. Consequently, the Model RBA, RBB, RBC equipments which will ultimately be delivered to the Service will differ in certain details from the models described in the previous article.

In order that some understanding may be had as to why this is so, an attempt will be made in this article to describe the method of procurement of a new standard line of radio equipments from the time they are contracted for until the design is finally completed and equipments produced and issued to the Service. In addition, an attempt will be made to enumerate the design features of the Models RBA, RBB, and RBC equipments that have been changed or modified with respect to the descriptions published in the July 1941 issue of this publication, and to explain the reason for such changes.

DESIGN PROCEDURES

Newest standard radio equipments are engineered from performance specifications prepared by the Bureau, the actual physical design work being done by the commercial company obtaining the contract for the equipments.

The development of such equipment is therefore predicated on the designer's interpretation of the performance requirements of the governing specifications. From these interpretations, and from mental pictures formed from them, the designer prepares preliminary manufacturing drawings or sketches, from which a preliminary model is constructed. It would be contrary to all experience for a designer to evolve an equipment design that, in its initial conception, would be devoid of any electrical or mechanical defects or deficiencies. Consequently, as a means for safeguarding the interests of both the Navy and the manufacturer, and prior to the manufacture of the equipment on a production basis, the preliminary model is submitted to a Naval testing establishment, usually the Naval Research Laboratory, for type tests, to determine the suitability of the design for the purpose intended. While the preliminary model may not be exactly identical with the ultimate production equipments, it is a primary requisite for qualification for type tests that its electrical and mechanical features be representative of the corresponding features of the production equipments.

The purpose of the type tests is to determine the suitability of the equipment for use in the Naval Service. Two factors which determine such suitability are as follows:

> (*a*) The degree of compliance with the requirements of the specifications.
>
> (*b*) The extent to which any of the design features have been rendered either obsolete or inadequate by the advances of the art and changes in the requirements of the service, in the interim between preparation of the original specifications, the date of contract and the date of submission of the preliminary model to the Naval testing establishment.

As previously mentioned, it is not uncommon for a preliminary model to fail to comply with all of the requirements of the governing specifications, owing to certain defects of mechanical or electrical design, or performance. It is the manufacturer's obligation to correct these defects in order that they will not be reflected in the production equipments. In many instances they are of minor importance. Such defects are those which occur in the natural course of events; they may be the result of inadequate or careless design; or they may be the result of misinterpretation of the specification requirements. Whatever may be the contributing factors, such defects are usually amenable to correction by modification of the final manufacturing drawings, and do not involve the expenditure of time or money or additional development for their correction. It may be said that, in general, difficulties of this character are usually the result of minor details which are overlooked by the designer whose attention is directed and confined to the more important aspects of the whole problem. Not infrequently, it develops during the conduct of the tests that,

while the performance of the preliminary model may satisfy the specification requirements, it does not offer sufficient tolerance to take care of normal manufacturing variations encountered in attempting to duplicate the particular performance characteristics in production equipment. When such defects are evident it becomes necessary for the manufacturer to devise a means for their correction. The necessary correctives may often require the expenditure of additional developmental efforts, but usually such development can be completed before production actually gets under way.

The development of a new line of radio receiving equipments is an undertaking of major proportions. There is frequently a lapse of time of at least 18 months from the time the contract is placed until production is started. During this time a preliminary model must be developed and constructed by the manufacturer, and then type tested. Concurrently, the manufacturer prepares as many of his manufacturing drawings as possible. After the preliminary model has been approved the manufacturer completes his manufacturing drawings and places his orders for raw materials and component parts. During this time, advances in the art and changes in the requirements of the Service may make it desirable, if not mandatory, to make certain modifications in the design, construction and performance of the equipment.

Certain modifications were effected in the preliminary models of the RBA, RBB, RBC equipments, as the tests progressed, so that the equipments could be kept abreast of the advances of the art and changes in the service requirements. It was also necessary to correct certain obvious defects and to effect coordination of design between the three models of equipments, since they were developed by different manufacturers. Such modifications were accompanied by progressive testing of the models by the Laboratory in order to ascertain that the desired improvements were actually effected by the modifications, and to further assure that the modifications did not in any manner affect other desired characteristics as required by the governing specifications.

These modifications in the preliminary models of the RBA, RBB, and RBC equipments were diversified and have resulted in important changes in the characteristics previously described. Therefore, they will be discussed in some detail.

MODIFICATIONS COMMON TO MODELS, RBA, RBB, AND RBC EQUIPMENTS

1. Illumination and Readability of Dials.

In the preliminary models of all three equipments as initially submitted, the illumination of the main tuning dials was afforded by dial lamps mounted on either side of the dial apertures and arranged to project through the panels and into recesses in the dial window housings. These lamps were accessible upon the removal of the dial window housings, which were attached to the front panels by means of two thumb screws. Illumination of the dials as afforded by this arrangement proved to be entirely unsatisfactory owing to the presence of excessive glare and objectionable shadows. The latter were due to the dial masks and the piano wire indexes, which were mounted in front of the tuning dials. It was found, after some experimentation, that the desired character of illumination (illumination without glare or shadows) could be provided by mounting the dial lamps in back of the panels in such a manner that the light rays are directed between the dials and the dial masks. While such a mounting resulted in the dial lamps becoming inaccessible from the front of the panel, advantages secured from this modification more than outweighed the slight inconvenience of dial lamp replacement. The modification made it possible to reduce the size of the dial window housings; to streamline their designs and thus obtain greater dial visibility; to provide for greater clearances between the dial window housings and adjacent panel-mounted controls or devices; and finally to permit the permanent mounting of the dial window housing by means of conventional screws. The illumination of the tuning dials is further enhanced through the use of dials finished in buff with all scale markings and characters black. This color combination, as has been mentioned, is also extended to include the dials of all indicating instruments.

2. Marking of dial masks.

An innovation has been introduced in the marking of the dial masks for all three equipments. The frequency markings for the bands are arranged to read from right to left, rather than in the conventional left to right order. This method of marking was adopted to provide for continuous numerical increase of indicated frequencies with a clockwise rotation of the band-change switch control knob. It also affords consistency in the markings of the dial masks with respect to the end frequency markings on the tuning dials. In the production equipments, therefore, all controls will operate in clockwise direction for numerical increases, or increases in other control effects. This particular feature is stressed as an important improvement, because, while it is not conventional, it reduces possibility of errors in band switching and tuning adjustments to a minimum.

3. Interconnecting cable assembly.

There will be introduced to the service, upon receipt of the production Models RBA, RBB, and RBC Equipments, a new interconnecting cable design unlike cables furnished with other standard radio receiving equipments. This cable will be entirely metal clad. It will consist of a flexible conduit, surrounded with a metallic braid with

both the conduit and the outer braid suitably plated to prevent corrosion. Its construction is such that it is entirely watertight and does not require the use of rubber to provide this quality. The wires in the cable are simply drawn through the conduit as individual conductors, and terminate at plug receptacles attached to each end of the cable. This assembly feature is of particular interest and importance because it permits damaged or broken conductors to be individually replaced. A broken conductor in cables furnished with other types of Naval radio receiving equipments usually results in the scrapping of the complete cable, with the possible exception of the plug receptacles. The plug receptacles are also of unconventional design, in that the loosening of two knurled and threaded collars permits the plug receptacles to divide into halves which can then be separated from the cable sheath. The soldered leads and their connections are then exposed to full view for inspection or servicing. The plug receptacles in their assembly condition are sprayproof and require no washers, gaskets, or other devices for the attainment of this characteristic. Although the cable assembly is flexible, it is not subject to twist. For this reason, the plug receptacles cannot be keyed to the ends of the cable. Accordingly, the plug receptacles are mounted so that they may rotate about the cable sheath. This rotation can be restricted to a certain degree by tightening the knurled and threaded collars which secure the plug receptacles against ferrules on the ends of the cable sheath. The friction afforded by the contacting surfaces retains the plug in any position to which it is adjusted.

4. Mounting of power and R. F. input receptacles.

In the production Model RBA Equipments the connection of the interconnecting power cable and the r. f. input transmission line will be made at adjacently mounted receptacles at the upper righthand corner of the receiver cabinet as viewed when facing the front of the receiver. In the production Models RBB and RBC Equipments the interconnecting power cable will connect to a receptacle mounted in a similar manner as for the Model RBA Equipment. The concentric transmission line will connect to a concentric jack mounted in a housing which will project through the upper left-hand rear corner of the cabinet as viewed from the front of the panel, in such a manner that the concentric plug on the end of the concentric transmission line will rest, in its connected position, in a horizontal position and at right angles to the power receptacle. It will be recommended in the instruction books for all three equipments that their respective interconnecting power cables and concentric transmission lines be placed side by side and in contact with one another throughout the maximum possible portions of their lengths, as governed by individual installation requirements, and then bonded, by means of metallic clamps, to the top of the operating table as close as possible to the receiver cabinet bases. This is necessary to avoid Radar interference.

MODIFICATIONS APPLICABLE ONLY TO MODEL RBA EQUIPMENT

1. Arrangement and addition of controls.

The arrangement of the controls and devices on the front operating panel of the receiver unit of the Model RBA Equipment has been considerably improved. These improvements include the following:

(*a*) The calibration chart holder has been moved to the left of the band switch control knob and between the output meter and its associated range switch. (The band switch control knob is located directly below the main tuning dial window housing.)

(*b*) In the space originally occupied by the calibration chart holder, there is mounted a new control identified as INPUT CPLG. (input coupling; the function of this control will be described later) and the type nameplate, which originally occupied the space directly below the main tuning control knob. The nameplate is mounted to the right of the INPUT CPLG. control knob, which in turn, is located directly above and in line with the ANT. COMP. (antenna compensator) control.

(*c*) The vernier tuning dial, which is driven by the main tuning control knob, is provided with a housing which completely encloses the vernier dial except for a small aperture which exposes a portion of the dial scale for reading purposes. This housing has made it possible for the vernier dial to be finished, and its scale marked, to match the main tuning dial. It also provides protection to the dial against damage from scratches, etc.

(*d*) The two toggle switches to the left and right of the main tuning control knob have been dropped to a lower level and spaced further apart without otherwise altering their panel relationship with one another. This modification permitted the further improvement of moving the manual GAIN control and the OUTPUT LEVEL control further to the left and right, respectively, to provide greater clearances for the operation of the main tuning control without interference with the adjustments of either the manual GAIN or OUTPUT LEVEL controls. In their new positions these controls will be located at approximately their original levels above the base of the equipment, but with their vertical axis centered between the centers of two toggle switches. With the positions of the switches at the left- and right-hand side of the panel lowered with respect to their original positions, ample clearances are provided for manipulation of the manual GAIN and OUTPUT LEVEL controls without interference with nearby toggle switches. This condition did not prevail with the control arrangement on the preliminary Model RBA Equipment as originally submitted for test.

In the initial design of the preliminary model of this equipment, a coaxial jack was provided at the rear of the receiver and opposite the power input receptacle for the connection of either an antenna adapter connection plug or a coaxial transmission line connector plug. The coaxial jack was then, in turn, connected to either high impedance taps on the secondary windings of the r. f. input transformers or to low-impedance primary windings of these transformers through adjustable links which were adjusted on installation of the complete equipment to accommodate the requirements of the particular conditions. The links permitted the connection of an antenna to the high-impedance portion of the secondary windings of the r. f. input transformers; or the connection of a low-impedance coaxial transmission line across the low-impedance primary windings of these transformers. The r. f. input transformer affected by either form of input connection is selected by the band selector switch. The link arrangement provided in addition a means for inserting other circuit elements to permit the operation of two receivers on a common antenna without serious loading of the input circuit of one by the other.

A variable air dielectric capacitor, controllable from the front panel and designated as ANT. COMP. (antenna compensator), was parallel connected across the secondary winding of the selected r. f. input transformer. It was provided to resonate the input circuits, the characteristics of which will differ among different installations. Its adjustment was required but once for each band for optimum (as contradistinct from maximum) response over the frequency range covered by the selected band. The ANT. COMP. would have to be adjusted at each frequency if maximum response at the selected frequency was to obtain. The adjustment of the ANT. COMP. for optimum conditions was required each time any band was selected.

The results of the type tests, at the Naval Research Laboratory, demonstrated that the input circuit arrangements provided in the preliminary model were not adequate to meet the rigorous requirements of the Naval Service. The arrangement was deficient to the extent that no satisfactory means were afforded for quickly transferring from an antenna to a coaxial transmission line, or vice versa; the range of the ANT. COMP. was not sufficient to compensate for the extreme variations in antenna capacitances which might be encountered under normal operating conditions.

In order to overcome the objectionable features of the input circuit arrangement in the preliminary models and to provide an input circuit design sufficiently flexible to meet all contingencies demanded by war-time operating conditions, the Laboratory, in cooperation with the manufacturer, evolved the following circuit arrangements, which will be included in the ultimate production equipments.

(a) A new control, designated as INPUT CPLG. (input coupling) was added to the front panel. This control is a five-position switch, the function of which is to provide means for selecting any one of five sizes of capacitors independently of band selection. This control, together with the ANT. COMP. and the coaxial input jack, are contained in a common shield enclosure mounted at the rear of the chassis and of such dimensions as to provide space for the installation by the Navy of r. f. filters for eliminating Radar interferences should future requirements make the use of such filters necessary.

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(b) In operation the INPUT CPLG. switch will insert in series with the high potential side of a high impedance primary winding of the r. f. input transformer (selected by the band selector switch) and the coaxial jack, one of five sizes of capacitors. The sizes of capacitors employed with this switch are such that the ANT. COMP., acting in conjunction with the INPUT CPLG. control, will permit antenna circuit trimming at any frequency within the range of the equipment when the receiver is connected to either coaxial transmission lines or antenna. These two controls will permit the use of an antenna having a capacitance of any value from fifty to four thousand (50 to 4000) micromicrofarads.

(c) The circuit arrangement just described will permit rapid switching of the receiver for optimum operation on antennas having widely different characteristics, or from directly connected antennas to those fed through transmission lines.

2. Elimination of microphonics.

It is common knowledge that in a tuned radio frequency receiver, employing only r. f. amplification at the received signal frequency, the amount of r. f. gain that can be used with stability is limited, so that it is necessary to employ a high gain audio amplifier following the detector. Because of this high audio gain such a receiver is likely to be microphonic unless highly precautionary measures are taken to preclude this condition.

With receivers of the superheterodyne type the total gain or amplification is divided into three different groups of frequencies, so that the gain or amplification in any one frequency subdivision—that is, radio, intermediate, and audio frequency—is nominal. However, with receivers of the tuned radio frequency type, only two steps of amplification are present; that is, radio frequency and audio frequency gain.

In the design of any amplifier, it is a matter of practical knowledge that there is a limit to the total amplification that can be obtained and controlled at any given frequency. Beyond this, overall regeneration occurs with resultant instability or even oscillations. This condition is more serious with respect to continuously variable circuits, such as those employed in a tuned radio frequency receiver, than with an intermediate frequency amplifier of a superheterodyne receiver. In the first case, the circuit elements are of necessity large and well spaced, with certain common paths for spurious currents such as the shafts of the main tuning capacitors, etc., all of which introduce certain degrees of feedback or regeneration. However, in an intermediate frequency amplifier, the elements may be kept small and closely spaced. As a practical matter, it is very difficult to use more than three stages of efficient radio frequency amplification as is used in the Model RBA equipments. Because of this fact, it is necessary to employ more audio frequency amplification than is usual with receivers of the superheterodyne type in order to obtain the required overall gain.

It is also a practical fact that most microphonic conditions occur in the detector tubes or circuits associated therewith. Where a small amount of audio frequency gain is employed, these microphonics are innocuous and do not become apparent in the receiver output. However, where high gain audio amplifiers are necessary as in a tuned radio frequency receiver of the RBA type, a relatively insignificant amount of microphonic disturbances assumes large proportions.

It was found in the preliminary model of the RBA receivers that both the detector tube and the variable capacitor plates associated with the beat frequency oscillator were contributing factors in a serious microphonic condition. These difficulties will be corrected in the production equipments by three different design changes. The first will be the employment of relatively soft copper in lieu of hard brass plates for at least the oscillator section of the main tuning capacitors. A second will be the individual shock mounting of the detector tube socket and the employment of a less microphonic detector tube. The detector is a Type 6J5 and it should be said here that only tubes designed and produced since 1941 should be used for replacement purposes. Tubes manufactured prior to 1941 are likely to be extremely microphonic. The remaining microphonic condition was eliminated by the simple expedient of varying both the audio and radio frequency gain by a common control. This is a dual control mounted on the front panel and operable from a common control knob. The dual control is circuitally arranged to control with one section the gain of the r. f. amplifier stages, and with the other section the signal level applied to the signal grid of the first a. f. amplifier tube.

The design of the resistance tapers in the individual sections are such that, as the control knob is rotated in a counterclockwise direction, a reduction in a. f. signal level is effected with no apparent reduction in r. f. gain over approximately 30% of the angular movement of the control; and, as the control is rotated through the remaining 70% of its travel, the r. f. gain is reduced with no appreciable reduction in a. f. signal level. With this arrangement the a. f. signal level, and consequently the amplification of microphonic noises, is kept reduced for all normal operation, since the total available gain in these receivers can seldom be used due to local noise levels, static, etc. The total range in reduction of a. f. signal level afforded by the dual control will be approximately 22 decibels, while the total reduction in r. f. gain will be greater than 100 decibels.

3. Inverse Feedback.

The production Model RBA Equipments will incorporate inverse feed back in the audio system, designed to maintain the output voltage practically constant for any variation in load from one pair up to at least 20 pairs of standard 600 ohms head telephones. This output circuit will permit phones to be plugged into the output without appreciable change in level of those already in use. These characteristics will be similar to those of the Models RBB and RBC Equipments. The introduction of inverse feed-back in the audio amplifier made it necessary to add one stage of a. f. amplification in addition to those provided in the preliminary model, so as to compensate for the loss of gain introduced by this feature. Inverse feed-back is applied between the second a. f. amplifier and power amplifier tubes.

4. Output Limiter.

The output limiter circuit in the production Model RBA Equipment will be very much different from that employed in the preliminary model. In the original model output limiting was effected in the conventional manner previously employed in other Navy standard receivers through the use of a separate output limiter tube. This tube was a type 6H6, dual diode, which was circuitally connected as a full wave rectifier. In operation rectification took place in this tube when a certain value of signal level was reached as determined by the cathode bias on this tube. This rectification caused a load to be applied on the output transformer which, in turn, was reflected into the plate circuit of the output tube with the net result that the voltage appearing across the headphone circuit was held relatively constant for wide variations in signal input. In the revised output limiter circuit limiting is accomplished by making use of plate and screen grid saturation. It is applied to the first and second a. f. amplifier tubes and thus limits the voltage applied at the grid of the output tube. As no separate tube is employed for the output limiter, the tube socket originally provided for the separate output limiter tube has been utilized for the extra stage of a. f. amplification made necessary by the introduction of inverse feed-back.

MODIFICATIONS APPLICABLE ONLY TO MODELS RBB AND RBC EQUIPMENTS

1. Arrangement and Addition of Controls.

The production models RBB and RBC equipments will incorporate noise limiter and carrier operated noise silencer circuits which were not contemplated in the original development of the preliminary models of these equipments. One of the preliminary models was modified to include these circuits in order that tests could be conducted to determine their performance characteristics. In addition to the inclusion of these new circuits, the circuit arrangement for the reception transfer switch was altered to modify the functions of this switch to accommodate the noise silencer circuit and changes effected in the operation of the automatic volume control. These modifications

made it necessary to completely rearrange the controls on the I. F./A. F. unit of the models RBB and RBC equipments. This arrangement was necessary to permit the inclusion of new controls and control nomenclature and to eliminate others. The following modifications were made in the control arrangement of the I. F./A. F. units of these equipments:

(*a*) The front panels of the I. F./A. F. units will be devoid of all engraving. A completely reversed photo-etched aluminum panel will cover the front panel areas below the meters, except for a border on all sides. This border will be finished with Navy Standard black wrinkle to match the panels of the companion PRESELECTOR units and will include the panel securing thumb screws. In this manner the photo-etched panel will be independent of any manipulation of the panel securing thumb screws and, accordingly, will be free from damage from such manipulations.

(*b*) The meter designations will be located directly below the instrument cases and in line at the top of the photo-etched panel.

(*c*) Below the instruments, and in the second row from the top of the panels, there will be mounted in a left to right order a ZERO SET control for the INPUT METER, a range switch for the OUTPUT METER, and a pilot light.

(*d*) Directly below these controls there will be mounted as a third line of controls in a left to right order a RADIO SELECTIVITY control, an OUTPUT LEVEL control, and a noise SILENCER control.

(*e*) As a fourth line of controls the panel will carry in a left to right order a NOISE LIMITER on-off switch, a FREQUENCY VERNIER control, and a manual GAIN control.

(*f*) As a last row of controls or devices there will be mounted in a left to right order and near the bottom of the panel a PHONE jack, a POWER on-off toggle switch, a RECEPTION transfer switch, and an AUDIO SELECTIVITY (broad-sharp) toggle switch.

(*g*) Attention is invited to the following additions and omissions of controls and devices that will be incorporated in the production equipments.

Additions	*Omissions*
Input meter ZERO SET control	A. V. C. switch[1]
NOISE SILENCER control	
NOISE LIMITER switch	

2. Circuit Modifications.

The production Model RBB and RBC equipments will each contain a carrier operated noise SILENCER which will be operable only when the receivers are adjusted for the reception of voice or other modulated c. w. signals. This device is most useful when several receivers are used with loud speakers for guard purposes, since it eliminates the continuous and annoying back-ground noise present in all sensitive receivers. With this device the output circuits of the receivers are substantially silenced or "squelched" until a signal is received. It is usable, however, only when guarding modulated cir-

[1] A RECEPTION transfer switch will appear on the production equipments, but its circuit functions will have been so greatly modified with respect to those of the preliminary model as originally submitted that it may be considered as a new control with the original RECEPTION switch as an omission.

cuits. The SILENCER circuit operates to suppress all noise outputs at least twenty (20) decibels below the output level for which the receiver is adjusted until an r. f. carrier voltage acts on the receiver input circuits. In the presence of an r. f. carrier voltage the "silencing" action is released and the signal arrives at the output at the level to which the OUTPUT LEVEL control had been previously adjusted.

Inasmuch as the carrier operated noise SILENCER is usable only for the reception of m. c. w. signals, it is rendered operative or inoperative by an additional position of the RECEPTION control, titled MOD–AVC–SIL. A panel control, marked SILENCER, is provided for adjusting its signal threshold at which the noise SILENCER becomes effective. This is necessary in order that the threshold of operation of the device can be adjusted with respect to the external noise level affecting the receiver.

The NOISE LIMITER in the preliminary model, and associated with the receiver detector tube, did not provide satisfactory performance. It was of the shunt, as contradistinct from the series type. The series type of limiter has been found to be more effective than the shunt type limiter, and, therefore, it will be employed in the production equipments. The function of the NOISE LIMITER is to reduce or limit surges or peaks of noise voltages to a predetermined level before such voltages are passed to the audio amplifier as audio components. The limiter will be effective with the receiver adjusted to the reception of either c. w. or m. c. w. signals modulated at least 30 percent. A panel marked switch renders this circuit operative or inoperative as desired.

In the preliminary models of the RBB and RBC equipments the manual GAIN control was effective at all times. It was found desirable during the conduct of the tests to render this control inoperative when the A. V. C. was operative. This is automatically accomplished by operation of the RECEPTION switch when thrown to the A. V. C. positions. Under these conditions the control of the signal level at the head phones will be governed only by the adjustment of the OUTPUT LEVEL control. Consequently, full advantage of the A. V. C. characteristics can be obtained under all signal or noise conditions as the gain of the receivers is automatically controlled or reduced in accordance with any existing noise level.

The output limiter of these receivers has been modified to provide a greater range of control than was provided on the preliminary models. This range has been extended so that the output level may be reduced to less than sixty microwatts without reducing the limiting characteristic over a wide variation of radio frequency input levels.

METHOD OF REPORTING FAILURES IN RADIO AND SOUND EQUIPMENT

Circular letter 40, together with all revisions thereof, has been cancelled and material formerly contained therein, "Reports of Failures of Component Parts of Radio and Underwater Sound Equipment," has been incorporated in Chapter 31 (mimeographed form) of the "Manual of Engineering Instructions." Recent changes made in the subject material are considered to be of sufficient moment to give to the Naval Service in this issue of the "Bulletin." All ships and stations should refer to this article and to the latest revision of Chapter 31 for method of reporting radio and sound equipment failures; a supply of the necessary forms, NBS-383, may be obtained from the Bureau of Ships.

In providing and maintaining the subject equipments for the Naval Service, the Bureau of Ships needs to be informed as to the failures that occur in the respective component parts that go to make up such equipments. Such information is necessary for both economical and technical reasons; economical with respect to obtaining adjustments under terms of contractor's guarantee for such items that fail, and technical with respect to enabling the Bureau to effect improvements in such parts as are subject to failure.

It has been the practice of the Bureau of Ships, in the purchase of complete radio and underwater sound apparatus in most cases to include in the contract for complete equipment a guarantee, which will be referred to herein as a "Special" guarantee, covering the design, material, workmanship, and manufacture of the equipment and component parts thereof. This has been found necessary because it is often difficult to determine the existence of unsatisfactory design, material, workmanship, or manufacture of component parts until subject to service conditions for a period of several years. Weaknesses in certain parts cannot always be determined during material acceptance tests, and it is mainly through eventual service use and cooperation of personnel ashore and afloat that failures are brought to the attention of this Bureau.

Where these "Special" guarantees do exist, the practice has been established of having the terms of the guarantee printed in the instruction books. Such guarantees are in general, but not always, written on the basis of applicability for a period of two years of service, but not extending over a total period of more than five years from the date of acceptance by the Navy. In some contracts, shorter periods have been specified; i. e., one year of service and two years total. The date of acceptance of many new equipments by the Inspector of Naval Material will appear on a small nameplate mounted on the main unit of the equipment. The specified service and total periods are automatically extended by whatever time the equipment fails to give the required performance due to any defect covered by the guarantee or lack of suitable replacement parts.

For the purpose of guarantee adjustment, the date placed in service is considered to be the date the equipment was accepted by the vessel or activity concerned and actually made available for service use. For other than portable equipment this will be after installation. For portable equipment it will be the date when first set up for operation by a service activity, as contradistinct from inspection activities.

To obtain the maximum protection and effectiveness under the terms of the contractual guarantee, it is essential that all component part failures be reported promptly. The activity directly concerned with the enforcement of the guarantee protection, and the obtaining of suitable adjustments, is the Office of the Inspector of Naval Material at the plant of the contractor for the complete equipment (as contradistinct from the manufacturer of component units, items, or parts). Lacking a Resident Inspector at such plant, the report should be submitted to the Office of the Inspector of Naval Material for the Inspection District in which the plant is located.

To permit the Inspector to act promptly and effectively, it is not only essential that he be immediately informed of any failures that occur in equipments within the guarantee period, but that he also be in possession of complete information as to the conditions surrounding the failure, particularly stressing details necessary to facilitate proper corrective action.

As to the technical aspect, it is equally important that the Bureau be promptly informed of all failures of component parts and deficiencies, *whether subject to contractual adjustments or not.* In general, new equipments or types of equipments are continually in the process of manufacture, or specifications are being prepared for their manufacture. Accordingly, prompt failure reports enable the Bureau to take immediate action to correct similar deficiencies in such equipments before acceptance by the Navy. The conditions surrounding failures can not be too highly stressed, particularly conditions of shock, unusual temperature, or excessive humidity.

Upon reporting the failure and the physical replacement of the defective item or part from the spares or other source, the defective item or part should be retained until the vessel or activity is advised by the Inspector of Naval Material concerned as to the desired disposition. In many cases, the contractor may desire the return of such items or

parts for investigation. A defective item or part, upon being replaced by the contractor under guarantee, becomes technically his property, and, if not desired by him, may be disposed of by the vessel or the activity concerned without survey or accounting. Defective items or parts which are *not* covered by a guarantee, due to expiration of the guarantee period, or for other reasons (for example, categories (*c*) and (*d*) below), shall be held by the ship or station for a sufficient period of time to allow for receipt of further instructions from the Bureau in the event that special disposition is desired. If such instructions are not received within a period of thirty days, plus time required for transportation of mail in both directions, the defective item or part may be disposed of in accordance with existing instructions.

It will be noted by reference to guarantee clauses (appearing in the instruction books) *that not only are all items or parts of the original equipments guaranteed, but also any replacements. Accordingly, these items or parts should be treated exactly as original equipments as to recording the dates of acceptance, periods of service, and procedure of reporting failures thereof. The date of acceptance for a replacement part is the date given on the inspector's report of material shipped.*

In considering failures and submitting reports thereon, all items or parts connected with radio and underwater sound installations shall be considered in five categories:

(*a*) All types of vacuum tubes.

(*b*) Items or parts contained in or supplied as spares or replacements for complete equipments manufactured by commercial companies and covered by a guarantee.

(*c*) Items or parts contained in or supplied as spares or replacements for complete equipments manufactured by commercial companies not covered by "Special" guarantees.

(*d*) Items or parts contained in equipments manufactured by Government activities and consequently not covered by any guarantee.

(*e*) Items or parts not contained in or furnished as a part of complete equipments, but furnished as installation and operating appurtenances.

Failure of items or parts under paragraph (a) shall be reported until further notice on Form NBS-304 (N Eng 204) in accordance with instructions contained in Chapter 31 (mimeographed form) of the "Manual of Engineering Instructions."

Failure of items or parts under paragraphs (*b*), (*c*) and (*d*) should be reported on Form NBS-383, in accordance with the instructions contained herein.

Failures of items or parts under paragraph (*e*) need not be reported unless the number of failures appears to be excessive, in which case the reports may be made by letter to the Bureau of Ships.

Form NBS 383 has been prepared to permit the reporting of component item or part failure with the minimum of clerical effort.

As soon as possible after a failure has occurred, an individual *set* of forms for *each* item under category of paragraphs (*b*), (*c*), and (*d*) shall be filled out and copies forwarded without forwarding letters as follows:

(*a*) Three (3) copies to the Inspector of Naval Material concerned. In general, and unless otherwise specified, these reports will be sent to the Naval Inspector or Resident Inspector of Naval Material responsible for tests and acceptance of the complete equipment who is in the best position to effect any necessary action under the terms of the guarantee. Instruction books for equipment will indicate the particular Inspection Office involved for a specific model of equipment.

(*b*) Four (4) copies to the Bureau of Ships, as indicated on bottom of form.

(*c*) One (1) copy to be retained in the files of activity or vessel.

The report numbers used shall be maintained in consecutive order for each ship or station concerned.

The requirements of the above paragraphs, regarding the use of Form NBS-383 will not apply to equipments or component parts purchased on Bureau of Aeronautics appropriations; that is, equipment normally installed in aircraft. Failures of such equipment or component parts will be reported on Bureau of Aeronautics Form N. Aero 4112 (Report of Unsatisfactory or Defective Material), in accordance with instructions issued by the Bureau of Aeronautics, and shall include the pertinent information required by Bureau of Ships Form NBS-383. *A Copy of the Aeronautics form shall be sent direct to the Bureau of Ships.*

The Inspector of Naval Material, upon receipt of his copy of Form NBS-383 will take the necessary action to obtain an adjustment under the guarantee. The Inspector of Naval Material concerned, by forwarding Form INM7 marked "Preliminary" or "Final" will advise both the activity or vessel concerned and the Bureau of the action taken or the need for additional information. The Inspector of Naval Material, upon receipt of Bureau of Aeronautics Form N. Aero 4112 in connection with failures of defects occurring in equipment covered by Bureau of Aeronautics appropriations, will take the necessary action to obtain an adjustment under the guarantee and, by forwarding copy of Inspector's Action Report (Form INM7), will advise the activity or vessel concerned, the Naval Aircraft Factory, the Bureau of Ships, and the Bureau of Aeronautics of action taken, or the need for additional information.

In cases where Forms NBS-383 and N. Aero 4112 are forwarded to the Inspector of Naval Material covering materials on which the guarantee has expired, the Inspector will stamp across the face of each copy of the incoming report the words "Guarantee Expired" in order to minimize clerical work, and will forward one copy to the ship or

station concerned, and one to the Bureau concerned. In the event that less than three copies of the failure report are received, the Inspector shall fill out Form INM7 for distribution as indicated above.

The proper submission of a failure report will automatically initiate action to obtain a replacement part where the date and cause of failure are within the scope of the contractual guarantee. In all other cases, exclusive of equipment maintained by the Bureau of Aeronautics, the reporting activity must submit a requisition for the replacement part desired. In the event that an item not covered by a guarantee can be repaired and the services of Navy Yard or tender forces are required, the usual work request should be submitted. Where equipment maintained by the Bureau of Aeronautics is involved and the particular item is beyond the scope of the guarantee, any necessary replacement parts or repairs shall be obtained in accordance with instructions issued by the Bureau of Aeronautics.

From a long term survey of the Bureau records, it appears that many of the failure reports submitted are incomplete as to information. In order to give the Service some idea of proper procedure, the following break-down is made of the items required on Form NBS-383:

Item No.	*Information required*
Serial No.	Serial of *this* report; strict adherence to this system important.
U. S.	Ship or Station.
Date	Date of this report.
1. Name of item or part failing	Give nearest integral component, not major unit.
Navy Type No.	If a voltmeter, "Voltmeter, Navy Type CZZ-22XXX," to be given in this space.
Date of Failure	This is important in determining responsibility for replacement guarantee.
2. Model	"ZZZ" or "ZZY-3"—SUFFIX NUMBER IS IMPORTANT.
Serial No.	Of equipment.
3. Contractor	Westinghouse, or RCA, etc.
Contract No.	Obvious.
4. Navy Type	Of major unit, as "52XXX," if transmitter unit.
5. Date accepted by INSMAT	In new equipment will be found on nameplate. These dates must be included.
Date placed in Service	In new installations should be found on nameplate stamped in by ship or station on date equipment is placed in service.
6. Guaranteed for ______ years of service, from acceptance ______ year(s) of service.	Will be found in instruction book—as "5" and "2" and "1," and so forth.

Item No.	*Information required*
7. Navy Type	Of item or part failing. Found in instruction book or on part.
I. B. part or symbol	As listed in instruction book. Please check carefully.
Serial No.	Of item or part. If given, will be found stamped on item or part.
8. Commercial Identification	Give manufacturer's drawing number, manufacturer's type number.
9. Rating	Electrical units or mechanical description of part failing.
10. If replacement item, state date ______ accepted by INSMAT ______ date placed in service.	Particularly important—if failure of this component has occurred before and the present item is a replacement, its guarantee dates from acceptance individually, instead of acceptance of Naval unit in which installed. This date of acceptance will be found in the Inspector's report (from INSMAT, forwarding such replacement part or item).
11. Was replacement part on hand?	Refers to spares—if item is not replaceable under guarantee, suitable action must be initiated by reporting activity to obtain replacement through usual channel.
12. Nature of casualty.	Self-explanatory.
13. Conditions surrounding failure	"Normal operation", or number of hours sustained operation, conditions preceding failure, especially conditions of high humidity and so forth.

The submission of failure reports, with proper attention to detail in filling out the form, will be beneficial to all concerned with design and production or operation and maintenance of equipment, with a minimum of clerical work on the part of the reporting activity. It is therefore requested that these reports be completed as soon as possible in line with the foregoing requirements. It is further requested that all reporting activities endeavour to submit clearly written, or typed, reports in all cases. Some carbon copies have been received which are so faint as to be illegible.

CROSS INDEX OF ARMY AND NAVY TYPE VACUUM TUBES

Vacuum tubes conforming to specification RE 13A 600 will be marked in accordance with the following examples: U. S. Navy Type CHS-6A6, U. S. Navy Type CG-207, U. S. Navy Type CRC-6F8-G, etc. wherein CHS, CG, CRC, etc. designate the manufacturer as heretofore.

Navy vacuum tubes shall be referred to by Navy Type Numbers. For example, a specific tube should be referred to as Navy Type CHS-6A6, or if it carries a serial number, as Navy Type CG-207, Serial 1234. A specific tube without Navy designation should be referred to as, for example, Sylvania Type 6A6, or if it carries a serial number, as General Electric Type 207, Serial 1234.

This system of type numbers is not only helpful to engineers and radiomen who are generally more familiar with the commercial designations than with the old Navy Type Numbers, but also is of considerable benefit to Supply Officers and stockmen who consolidate their stocks of Navy Type numbered tubes and commercial type numbered tubes into one integrated group to avoid situations wherein the filling of a request for Navy Type tubes might be delayed due to depleted stock without the stockmen being aware that an available stock of a commercial equivalent could be issued in lieu thereof.

Another advantage of the system of designating Navy vacuum tubes by commercial type numbers lies in the fact that in an emergency, an Army vacuum tube or a commercial vacuum tube (bearing a commercial number similar to the new Navy number) may often be obtained from an Army supply depot or a local commercial establishment, as the case may be, and that tube used as a temporary replacement for the Navy Type of tube.

The Army type is to be preferred over a commercial type as the general run of commercial vacuum tubes may not have the longevity or uniformity of characteristics required by Government specifications. However, either type should permit satisfactory operation until Navy types can be obtained. Army specifications on vacuum tubes are in general similar to those of the Navy, but may differ in some details. In the case of commercial tubes, wherever possible, tubes manufactured by concerns that are known to have manufactured that type under Navy specifications should be obtained. The similarity between commercial type numbers, commercial equivalents and the new Navy type numbers is not to be construed as the basis for obtaining or using such tubes except in the case of emergency. Tables I and II are a cross index of Army and Navy Vacuum Tubes. A dash in the place of either the Navy or U. S. Army tube designation indicates the absence of an equivalent substitute.

There are a few types of tubes which were developed especially for Naval use which do not have standardized commercial type numbers or VT designations. As indicated in Table I such tubes will continue to be marked with the old 5-digit Navy type numbers of which the first two digits are always "38".

The manufacturer's code letters, assigned by the Bureau to date to manufacturers now supplying Navy vacuum tubes used in Radio and Underwater Sound equipment are as follows:

CDU	Allen B. DuMont Laboratories, Inc.
CEL	Electrons, Inc.
CEP	Amperex Electronic Products Company.
CEQ	Continental Electric Co.
CFT	Federal Telegraph Company.
CG	General Electric Company.
CHS	Hygrade Sylvania Corporation.
CHY	Hytron Corporation.
CIM	Eitel-McCullough, Inc.
CKH	Heinz & Kaufman, Ltd.
CKR	Ken-Rad Tube and Lamp Corporation.
CNU	National Union Radio Corporation.
CRC	RCA Manufacturing Company (Radiotron Division).
CRP	Raytheon Production Corporation.
CTL	Tung-Sol Lamp Works, Inc.
CTY	Taylor Tubes, Inc.
CUE	United Electronics Company.
CW	Western Electric Company.
CWL	Westinghouse Lamp Company.

These code letters indicate that the tube has been type approved by the Bureau.

The data contained in Tables I and II are available in chart form as Bureau of Ships drawing RE 38A 153B.

TABLE I.—*Listing by Navy Type Number*

Navy type number	Commercial number	Signal Corps designation	Navy type number	Commercial number	Signal Corps designation
01-A	01-A	VT-30	6L7	6L7	VT-87
—	1A5-GT	VT-124	—	6L7-G	VT-87-A
—	1A7-GT	VT-147	6N7	6N7	VT-96
1B4-P	1B4-P	—	—	6Q7	VT-92
—	1C5-GT	VT-125	6Q7-G	6Q7-G	—
1C6	1C6	—	6R7	6R7	VT-88
1D5-G	1D5-G	—	6R7-G	6R7-G	VT-88-A
—	1D8-GT	VT-148	—	6R7-GT	VT-88-B
1E1	1E1	—	6SA7	6SA7	VT-150
—	1E5-GP	VT-170	—	6SC7	VT-105
1E7-G	1E7-G	—	6SF5	6SF5	—
1F7-G	1F7-G	—	6SG7	6SG7	VT-211
—	1H5-GT	VT-223	6SJ7	6SJ7	VT-116
1H6-G	1H6-G	—	—	6SJ7	VT-116-B
1J6-GX	1J6GX	—	6SK7	6SK7	VT-117
—	1LC6	VT-178	6SL7-GT	6SL7-GT	VT-229
—	1LE3	VT-239	6SN7-GT	6SN7-GT	VT-231
—	1LH4	VT-177	6SQ7	6SQ7	VT-103
—	1LN5	VT-179	6SR7	6SR7	VT-233
—	1N5-GT	VT-146	—	6SS7	VT-199
—	1R5	VT-171	—	6ST7	VT-205
—	1R5 (loctal base)	VT-171-A	—	6U5/6G5	VT-98.
—	1S4	VT-210	—	6V6	VT-107
—	1S5	VT-172	6V6-GT	6V6-GT	VT-107-A
—	1T4	VT-173	—	6V6-G	VT-107-B
2A3	2A3	VT-95	—	6W5-G	VT-196
2A5	2A5	—	—	6X5	VT-126
2B7	2B7	—	—	6X5-G	VT-126-A
2X2	2X2/879	VT-119	6X5-GT	6X5-GT	VT-126-B
—	3A8-GT	VT-149	6Y6-G	6Y6-G	VT-168-A
—	3LF4	VT-180	6ZY5-G	6ZY5-G	—
—	3Q4	VT-264	—	7A4	VT-192
—	3Q5-GT	VT-221	—	7B8	VT-208
—	3S4	VT-174	—	7C7	VT-193
4A1	4A1	—	—	7E6	VT-188
—	5T4	VT-114	—	7F7	VT-189
5U4-G	5U4-G	VT-244	—	7H7	VT-190
—	5V4-G	VT-206-A	—	7J7	VT-194
—	5W4	VT-97	—	7Z4	VT-181
—	5Y3-GT	VT-197-A	10 [2]	10	VT-25 [2]
5Z3	5Z3	VT-145	—	10 (spl.)	VT-25-A [2]
—	5Z4	VT-74	12A6	12A6	VT-134
6A6	6A6	—	—	12AH7-GT	VT-207
6A7	6A7	6A7	—	12C8 (spl.)	VT-153
—	6A8-G	VT-151	—	12C8	VT-169
—	6A8-GT	VT-151-B	12H6	12H6	VT-214
6AB7	6AB7/1853	VT-176	12J5-GT	12J5-GT	VT-135
6AC7	6AC7/1852	VT-112	—	12J5	VT-135-A
6AG7	6AG7	VT-247	12K8	12K8	VT-132 [2]
6B7	6B7	VT-68	12SA7	12SA7	VT-161
—	6B8	VT-93	—	12SC7	VT-268
—	6B8-G	VT-93-A	12SF7	12SF7	—
6C5	6C5	VT-65	—	12SG7	VT-209
6C5-G	6C5-G	VT-65-A	12SJ7	12SJ7	VT-162
6C6	6C6	—	12SK7	12SK7	VT-131
6C8-G	6C8-G	VT-163	12SQ7	12SQ7	VT-104
6D6	6D6	VT-69	12SR7	12SR7	VT-133
6E5	6E5	VT-215	19	19	—
6F6	6F6	VT-66	22	22	VT-26
6F6-G	6F6-G	VT-66-A	24-A	24-A	VT-28
6F7	6F7	VT-70	—	25L6	VT-201
6F8-G	6F8-G	VT-99	25L6-GT	25L6-GT	VT-201-C
—	6G6-G	VT-198-A	25Z5	25Z5	—
6H6	6H6	VT-90	27	27	VT-29
6J5	6J5	VT-94	30	30	VT-27
—	6J5-G	VT-94-A	—	30 (spl.)	VT-67 [2]
6J5-GT	6J5-GT	VT-94-D	31	31	VT-31
6J7	6J7	VT-91	32	32	VT-44
6J7-G	6J7-G	—	33	33	VT-33
—	6J7-GT	VT-91-A	34	34	VT-54
6K6-GT	6K6-GT	VT-152	35	35/51	VT-35
—	6K6-G	VT-152-A	36	36	VT-36
6K7	6K7	VT-86	37	37	VT-37
6K7-G	6K7-G	VT-86-A	38	38	VT-38
—	6K7-GT	VT-86-B	39	39/44	VT-49
6K8	6K8	VT-167	40	40	VT-40
—	6K8-G	VT-167-A	41	41	VT-48
—	6L5-G	VT-213-A	42	42	—
6L6	6L6	VT-115	45	45	VT-45
6L6-G	6L6-G	VT-115-A	—	46	VT-63

[2] Micanol or ceramic base on Government Type, but not on Commercial Equivalent.

TABLE I.—*Listing by Navy Type Number*—Continued

Navy type number	Commercial number	Signal Corps designation	Navy type number	Commercial number	Signal Corps designation
47	47	VT-47	886	886	
50	50	VT-50	893	893	
	51 (35/51)	VT-35	921	921	
53	53			923	VT-252
56	56	VT-56	954	954	VT-120
57	57	VT-57	955	955	VT-121
58	58	VT-58	956	956	VT-238
59	59			957	VT-237
71-A	71-A		958-A	958	VT-212
75	75	VT-75	959	959	
76	76	VT-76		1201	VT-241
77	77	VT-77		1203-A	VT-243
78	78	VT-78	38278	1278	
80	80	VT-80		1291	VT-182
81	81			1294	VT-183
82	82			1299	VT-185
83	83	VT-83		1613	VT-175
84	84/6Z4	VT-84	1616	1616	VT-266
85	85			1619	VT-164
89 [2]	89	VT-89	1624	1624	VT-165
112-A	112-A		1625	1625	VT-136
203-A	203-A		1626	1626	VT-137
204-A	204-A	VT-22.	1629	1629	VT-138
207	207	VT-34.	1630	1630 (A-5588)	VT-128
211	211	VT-4-B	1635	1635	
	211 (spl.)	VT-4-C	2050	2050	VT-245
217-C	217-C		2051	2051	VT-109
	575-A	VT-187		KR-7184	VT-227
	585	VT-50	8005	8005	
	586	VT-50		8007 (Std. 807 specify)	
	800	VT-64		8012	VT-228
801	801-A, 801	VT-62	8013	8013	
803	803	VT-106	8016	8016	
805	805	VT-143	8020	8020 (GL-451)	
807	807 (Mod)	VT-100-A[1]	8021	8021 (WE-705-A)	
807	807	VT-100		9002	VT-202
808	808			9003	VT-203
809	809			Eimac 100TH	VT-218
811	811	VT-217		Eimac 250TH	VT-220
812	812			Eimac 250TL	VT-130
813	813	VT-144		Eimac 304TL	VT-129
814	814	VT-154		Eimac 450TH	VT-108
815	815		38405	EL-1C	
	816	VT-216	38404	EL-3C	
826	826		38401	EL-302.5	
829	829		38402	EL-5B2.5	
	832	VT-118	38403	EL-5B-HD	
833-A	833-A		38674-A	EL-6C	
836	836		38897	GE-16X897	
837	837	VT-101	38674	GE-45X674	
838	838			HK-24-G	VT-204
	841	VT-51		HY-615	VT-235
842	842	VT-72		CK-1005	VT-195
843	843	VT-73		CK-1006	VT-249
845	845	VT-43	38222	RK-22	
846	846		38233	RK-33	
849	849			RK-34	VT-224
850	850	VT-60	38275	VR-75-30	VT-260
851	851	VT-41	38290	VR-90-30	VT-184
852	852		38205	VR-105-30	VT-200
857-B	857-B		38250	VR-150-30	VT-139
858	858		38111-A		
860	860	VT-17	38112	WE-212-E	
861	861	VT-19	38015	WE-215-A	VT-5
862	862		38282	WE-282-B	
864	864	VT-24		WE-307-A	VT-225
865	865	VT-55	38412	WE-312-A	
866-A	866-A/866	VT-46-A	316-A	316-A	VT-191
868	868			WE-371-A	VT-166
869-A	869-A	VT-39	38116	WL-289416-D	
870-A	870-A			WL-531	VT-141
871	871			WX-12	VT-7
872-A	872-A	VT-42-A	38220	ZB-120	
874	874				VT-1
876	876			E1148 Hytron	VT-232
878	878		38142	45 (spl.)	VT-52
884	884	VT-222			

[1] For Navy Replacements. Either the VT-100 or the VT-100-A will replace the Navy 807.

TABLE II.—*Listing by Signal Corps VT designation*

Signal Corps designation	Commercial number	Navy type number
VT-1		
VT-2		
VT-4-B	211	211
VT-4-C	211 Special	
VT-5	WE-215-A	38015
VT-6		
VT-7	WX-12	
VT-8	UV-204	
VT-17	860	860
VT-19	861	861
VT-22	204-A	204-A
VT-24	864	864
VT-25	10	10
VT-25-A	10 Special	
VT-26	22	22
VT-27	30	30
VT-28	24-A	24-A
VT-29	27	27
VT-30	01-A	01-A
VT-31	31	31
VT-33	33	33
VT-34	207	207
VT-35	35/51	35
VT-36	36	36
VT-37	37	37
VT-38	38	38
VT-39	UV-869	
VT-39-A	869-A	869-A
VT-40	40	40
VT-41	851	851
VT-42-A	872-A	872-A
VT-43	845	845
VT-44	32	32
VT-45	45	45
VT-46	866	866
VT-46-A	866-A/866	866-A/866
VT-47	47	47
VT-48	41	41
VT-49	39/44	39
VT-50	50, 585, 586	50
VT-51	841	
VT-52	45 Special	
VT-54	34	34
VT-55	865	865
VT-56	56	56
VT-57	57	57
VT-58	58	58
VT-60	850	850
VT-62	801-A 801	801
VT-63	46	
VT-64	800	
VT-65	6C5	
VT-65-A	6C5-G	
VT-66	6F6	6F6
VT-66-A	6F6-G	6F6-G
VT-67 [2]	30 Special	
VT-68	6B7	6B7
VT-69	6D6	6D6
VT-70	6F7	6F7
VT-72	842	842
VT-73	843	843
VT-74	5Z4	
VT-75	75	75
VT-76	76	76
VT-77	77	77
VT-78	78	78
VT-80	80	80
VT-83	83	83
VT-84	84/6Z4	84
VT-86	6K7	6K7
VT-86-A	6K7-G	6K7-G
VT-86-B	6K7-GT	
VT-87	6L7	6L7
VT-87-A	6L7-G	6L7-G
VT-88	6R7	6R7
VT-88-A	6R7-G	6R7-G
VT-88-B	6R7-GT	
VT-89	89	89 [2]
VT-90	6H6	6H6
VT-91	6J7	6J7
VT-91-A	6J7-GT	
VT-92	6Q7	
VT-92-A	6Q7-G	6Q7-G
VT-93	6B8	
VT-93-A	6B8-G	
VT-94	6J5	6J5
VT-94-A	6J5-G	
VT-94-D	6J5-GT	6J5-GT
VT-95	2A3	2A3
VT-96	6N7	6N7
VT-97	5W4	
VT-98	6U5/6G5	
VT-99	6F8-G	6F8-G
VT-100 [1]	807	807
VT-100-A [1]	807 (Mod)	807
VT-101	837	837
VT-103	6SQ7	6SQ7
VT-104	12SQ7	12SQ7
VT-105	6SC7	
VT-106	803	803
VT-107	6V6	
VT-107-A	6V6-GT	6V6-GT
VT-107-B	6V6-G	
VT-108	Eimac 450TH	
VT-109	2051	2051
VT-112	6AC7/1852	6AC7
VT-114	5T4	
VT-115	6L6	6L6
VT-115-A	6L6-G	6L6-G
VT-116	6SJ7	6SJ7
VT-116-B	6SJ7 (micanol or ceramic base).	
VT-117	6SK7	6SK7
VT-118	832	
VT-119	2X2/879	2X2
VT-120	954	954
VT-121	955	955
VT-124	1A5-GT	
VT-125	1C5-GT	
VT-126	6X5	
VT-126-A	6X5-G	
VT-126-B	6X5-GT	6X5-GT
VT-129	Eimac 304TL	
VT-130	Eimac 250TL	
VT-131	12SK7	12SK7
VT-132 [2]	12K8	12K8
VT-133	12SR7	12SR7
VT-134	12A6	12A6
VT-135	12J5-GT	12J5-GT
VT-135-A	12J5	
VT-136	1625	1625
VT-137	1626	1626
VT-138	1629	1629
VT-139	VR-150-30	38250
VT-141	WL-531	
VT-143	805	805
VT-144	813	813
VT-145	5Z3	5Z3
VT-146	1N5-GT	
VT-147	1A7-GT	
VT-148	1D8-GT	
VT-149	3A8-GT	
VT-150	6SA7	6SA7
VT-151	6A8-G	
VT-151-B	6A8-GT	
VT-152	6K6-GT	6K6-GT
VT-152-A	6K6-G	
VT-153	(12C8 Special)	
VT-154	814	814
VT-155	SCL Special	
VT-156	SCL Special	
VT-157	SCL Special	
VT-158	SCL Special	
VT-159	SCL Special	
VT-160	SCL Special	
VT-161	12SA7	12SA7
VT-162	12SJ7	12SJ7
VT-163	6C8-G	6C8-G
VT-164	1619	
VT-165	1624	1624

[1] For Navy Replacements. Either the VT-100 or the VT-100-A will replace the Navy 807.
[2] Micanol or ceramic base on Government Type, but not on Commercial Equivalent.

TABLE II.—*Listing by Signal Corps VT designation*—Continued

Signal Corps designation	Commercial number	Navy type number	Signal Corps designation	Commercial number	Navy type number
VT-166	WE-371-A		VT-208	7B8	
VT-167	6K8	6K8	VT-209	12SG7	
VT-167-A	6K8-G		VT-210	1S4	
VT-168-A	6Y6-G	6Y6-G	VT-211	6SG7	6SG7
VT-169	12C8		VT-212	958	958-A
VT-170	1E5-GP		VT-213-A	6L5-G	
VT-171	1R5		VT-214	12H6	12H6
VT-171-A	1R5 (loctal base)		VT-215	6E5	6E5
VT-172	1S5		VT-216	816	
VT-173	1T4		VT-217	811	811
VT-174	3S4		VT-218	Eimac 100TH	
VT-175	1613		VT-220	Eimac 250TH	
VT-176	6AB7/1853	6AB7	VT-221	3Q5-GT	
VT-177	1LH4		VT-222	884	884
VT-178	1LC6		VT-223	1H5-GT	
VT-179	1LN5		VT-224	RK-34	
VT-180	3LF4		VT-225	307-A	
VT-181	7Z4		VT-227	KR-7184	
VT-182	1291		VT-228	8012	
VT-183	1294		VT-229	6SL7-GT	6SL7-GT
VT-184	VR-90-30	38290	VT-231	6SN7-GT	6SN7-GT
VT-185	1299		VT-232	E1148 Hytron	
VT-187	575-A		VT-233	6SR7	6SR7
VT-188	7E6		VT-234	HY-114	
VT-189	7F7		VT-235	HY-615	
VT-190	7H7		VT-236	836	836
VT-191	316-A	316-A	VT-237	957	957
VT-192	7A4		VT-238	956	956
VT-193	7C7		VT-239	1LE3	
VT-194	7J7		VT-241	1201	
VT-195	CK-1005		VT-243	1203-A	
VT-196	6W5G		VT-244	5U4-G	5U4-G
VT-197-A	5Y3-GT		VT-245	2050	2050
VT-198-A	6G6-G		VT-246	918	
VT-199	6SS7		VT-247	6AG7	6AG7
VT-200	VR-105-30	38205	VT-249	CK-1006	
VT-201	25L6		VT-252	923	
VT-201-C	25L6-GT		VT-254	Eimac 304TH	
VT-202	9002		VT-259	829	829
VT-203	9003		VT-260	VR-75-30	38275
VT-204	HK-24-G		VT-264	304	
VT-205	6ST7		VT-266	1616	1616
VT-206-A	5V4-G		VT-268	12SC7	
VT-207	12AH7-GT				

MODIFICATION OF MODEL TBP, TBY AND TBY-1 ULTRA-PORTABLE EQUIPMENT

MODIFICATION TO PERMIT USE OF TYPE 958A TUBES

It has been found that large scale production of type 958 tubes satisfactory for use in the transmitter section of Model TBP, TBY and TBY-1 equipments, is very difficult. A similar type of tube recently developed, the 958-A, is considerably easier to manufacture and has improved emission and life characteristics. Since existing manufacturing facilities for the type 958 cannot satisfy the Navy's urgent demand for suitable tubes for the TBP, TBY and TBY-1, it has been found necessary to alter these equipments to permit use of the more readily available type 958-A. Manufacture of old type 958 tubes in limited quantities will be continued to satisfy immediate needs of the service.

The type 958-A will be entirely satisfactory for replacement of the type 958 tube (V2) in the receiver section of unmodified TBP, TBY and TBY-1 equipments. However, in order to utilize the type 958-A tubes in the transmitter section (V3, V4), it is necessary to modify these equipments by replacing the present receive-transmit transfer relay with a new transfer relay, Navy type CRY-29156, having an additional set of contacts. Inasmuch as the new type 958-A tube has one undesirable characteristic when used in the transmitter section, that of continuing oscillation even after filament potential is removed, the additional relay contacts are necessary to remove potential from the plates of the tubes in the transmitter section when the relay is in the "receive" position.

The contractor is now preparing modification kits, containing the relay and instructions for its installation, for all equipments not modified prior to leaving the factory. All TBP equipments, all TBY equipments, and TBY-1 equipments, serial numbers 1 to 409 inclusive, will require modification. The kits will be shipped by approximately September 15, 1942, to Navy Yards Brooklyn, Norfolk, Mare Island, and Pearl Harbor, and to Marine Corps Quartermaster Depots, Philadelphia and San Francisco, for installation by laboratory personnel. In order to obviate the need for continued production of old type 958 tubes, it is desired that the equipments indicated be made available to any of these six activities for modification as soon as they can be spared.

Examination of the relay employed will yield adequate indication of whether a particular equipment encountered has been modified; the old type relay bears no type number, while the new type relay carries the designation CRY-29156 clearly visible from the top of the equipment with the cover open.

MODIFICATION TO PERMIT USE OF TYPE 19018-A AND LATER BATTERY PACKS

It has been found that due to a discrepancy in design, Model TBY-1 transmitter-receiver units, Navy type CAY-43007, serial numbers 1 to 610 (approx.), will not accommodate the Navy type 19018-A or later battery pack. This deficiency is in the construction of the base of the aluminum case of the TBY-1 transmitter receiver units only, and is not found in model TBP or TBY equipments. In most instances, the well formed by this base is from $\frac{1}{64}$ inch to $\frac{3}{64}$ inch undersize, sufficient to obstruct insertion of Navy type 19018-A battery pack. This undesirable condition can be corrected by minor modification, in the field, of the Model TBY-1 transmitter-receiver unit case in accordance with instructions given below. In order to ascertain the need for modification, the under side of each Model TBY-1 transmitter-receiver unit bearing a serial number lower than 610 should be examined to determine the presence of a $\frac{1}{2}$ inch by 1 inch by $\frac{1}{32}$ inch aluminum shim (painted olive green) spot-welded to the inside right-hand lip of the case. This shim was originally incorporated to eliminate the possibility of strain on the connector plug should undersize batteries be used; it is not now necessary, inasmuch as type 19018-A and later batteries incorporated a "floating" socket to preclude plug strain. Units not incorporating the shim will not require modification.

Method of modification:

(a) With a screw driver, pry up one corner of the aluminum shim.
(b) With a pair of pliers, remove the shim.
(c) With a file, dress off the remaining weld spots to obtain a smooth surface.
(d) With a file, clean out the excess weld from each corner of the case.
(e) Apply olive green lacquer, if obtainable, to spots showing aluminum.

This modification should be made immediately, in order that type 19018-A and later batteries may be utilized.

USE OF SHIELDED PHONE CORDS AND HIGH IMPEDANCE HEAD TELEPHONE RECEIVERS

For a number of years the Bureau of Ships has been standardizing on an output impedance of 600 ohms for all Navy type radio receiving equipments.

Aside from certain other motivations, one important reason in attempting to standardize on but one type of headphones was to eliminate the need for the previously employed high impedance headphones of the 49003 type. A further purpose of this standardization was to eliminate the use of shielded headphone cords, jack boxes, plugs, etc.

The efforts of the Bureau towards standardization in this field has been somewhat nullified by the growing needs of the Naval Establishment for additional receiving equipment. In order to supply this excessive demand, the Bureau was forced to procure in considerable number certain types of commercial communications receivers which, while designed for high impedance headphones, do not require, in most cases, shielded phone cords.

Keeping the above considerations in mind, it would be expected that there will be a certain demand, not large, for both high impedance headphones and for shielded phone cords. In spite of this, however, the issues of 49003 high impedance head phones and shielded phone cords have continued excessively high. Thus, 20 percent of all requests for headphones have been for the high impedance type, while 30 percent of all requests for headphone cords, both single and double, have been for the shielded type.

The reason for this high demand for items which are not considered standard is difficult to explain. It may be assumed, therefore, that in many cases the requests are for replacements of a type which is not required. This demand may also be due to a lack of appreciation of the facts given above.

In order to assist the Bureau in maintaining standardization on low impedance headphones and unshielded phone cords as far as practicable, the service is requested to survey the equipment before requisitioning nonstandard items and to refrain from ordering high impedance headphones and shielded phone cords unless they are definitely required for specific applications.

FUSE FAILURE IN TAJ-6, TAJ-7, TAJ-9 AND TAJ-10 TRANSMITTING EQUIPMENT

The attention of the Bureau has been directed to an unusual operating condition existing in Models TAJ-6, TAJ-7, TAJ-9, and TAJ-10 transmitting equipments, when the fuse located in the 1500 volt D. C. positive supply lead opens. Reference to the schematic diagram in an instruction book for one of the above models will be of assistance in understanding the conditions.

It may be seen that a single combined bleeder is used for the 1500 and 3000 volt circuits of the main high voltage generator. Failure of the fuse in the 1500 volt lead leaves the bleeder circuit energized; so long as the 3000 volt circuit is intact, the intermediate power amplifier plate circuit remains energized, but at a value of potential much lower than normal. Thus the failure of this fuse does not place the transmitter entirely out of commission, but allows its operation at reduced power output. The power amplifier may not load properly, or may give other indication of lack of excitation. Because of the transmitter's continued functioning, however, failure of a generator fuse may remain unsuspected.

This fuse failure is not readily traceable through observation of the front panel instruments. To test for the open fuse, the following procedure is suggested:

(a) Remove power from the transmitter.

(b) With an ohmmeter, measure the resistance between terminal 19 (terminal 3-3 in TAJ-10) and ground.

(c) If a reading of more than 200 ohms is obtained, the fuse in the 1500 volt supply lead located in the high voltage generator terminal box should be examined.

Supplement No. 1 to the instruction book for Model TAJ-6 equipment has been prepared and issued by the contractor to cover the location of the trouble indicated above.

THE FORUM

AN INFORMAL DISCUSSION OF COMMUNICATION MATERIAL MATTERS OF INTEREST TO THE SERVICE

The discussions contributed to this section of the Bulletin are of great value to the Bureau. Most of the contributions in the past have been very thorough, indicating considerable time and thought on the part of the author. The Bureau realizes that the requirements of wartime service leave little time for carrying out research projects or for preparing reports. Nevertheless, the observations of personnel on the performance of Radio and Sound equipment under wartime operating conditions are of great importance.

It is hoped, therefore, that suggestions, comments, experiences, difficulties, and other matters of interest will continue to be sent in by the service. They may be prepared as briefly and informally as necessary. They should be addressed to the Bureau of Ships via the commanding officer.

USE OF FIRE PUMP AS EMERGENCY COOLING WATER SUPPLY

The following extract from a report by the Officer-in-Charge of the Annapolis Radio Station is quoted as a matter of general interest in its direct application and its further suggestion of initiative to maintain continuous station operation:

"New metal tanks for the cooling water system at Building No. 60 were recently installed at this station to replace the wooden tanks used for the past two years. To connect these new tanks into the system would have usually required the shutting down of all transmitters at Building No. 60 for approximately 45 minutes. This shutdown was avoided successfully by connecting the gasoline trailer pump used for fire protection to the cooling water supply line with the suction taken from one of the new metal tanks being installed. This emergency hook-up gave excellent satisfaction for the period required to disconnect the old tanks from the system and to connect the new tanks into the system.

"The possibility of using fire equipment to supply cooling water to radio transmitters in case the permanently installed systems are damaged by bomb or otherwise should be of interest to other high power radio stations."

TECHNICAL PAPERS

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