

## **PART II—RADIO AND SOUND**

### **TYPES AND ALLOCATION OF AIRCRAFT RADIO EQUIPMENT**

In order to acquaint the Service in general with the various types of radio equipment now in use in aircraft, the following article describes the present aircraft radio installations.

Aircraft operating from battleships are provided with a model MJ equipment which is a telegraph transmitter and receiver contained in one case. The transmitter is rated at 15 watts output in the frequency range, 545-585 kilocycles, and at 30 watts output in the range 1,005-1,465 kilocycles. The transmitter-receiver with tubes weighs 37 pounds. Power for operation is obtained from an engine driven direct current generator, double voltage: 14.6 volts, 6 amperes and 500 volts, .325 ampere and weighing 24.5 pounds. The transmitter utilizes a colpitt's circuit with a type 38110 master oscillator tube and two of the same type in parallel for the power amplifier. The receiver, frequency range 500 to 1,465 kilocycles, uses two type 38036 tubes as radio frequency amplifiers and one 38036 as a detector. The audio amplifier is a type 38038 with a type 38037 as an audio oscillator or howler. To provide for transfer from reception on the trailing antenna to reception on the homing loop, a switch marked "ANT-LOOP" is provided on the front of the receiver panel. The fixed loop is located in the wings and so placed that it receives a minimum signal when the plane is headed directly toward or away from the transmitting station. To facilitate tuning the transmitter and receiver to desired frequency, a crystal frequency indicator (C.F.I.) weighing 4.75 pounds is provided as a separate unit. The oscillator uses a type 38037 tube with tuned plate tank circuit and secondary coupling from the tank inductance back to the crystal. This MJ set is designed to mount in the same space as the Navy models MB and MF equipment.

Aircraft operating from 8-inch cruisers and VO-VS planes on carriers are provided with model MF-1 or MF-2 equipments. The transmitter and receiver are contained in the same case in each model, weight 36.75 pounds, and each transmitter is rated at 75 watts. The MF-1 transmitter has a frequency range of 545-995 kilocycles and the MF-2, 545-1,000 kilocycles. Power is furnished from a shunt wound, double voltage (15 and 1,000 volts) direct-current, four-pole, self-excited generator weighing 35 pounds.

The MF-1 transmitter employs a Navy type 38111 as the master oscillator and one as a power amplifier while the MF-2 uses CG 1984 tubes, a similar arrangement. The receivers are nonradiating with tuned r.f. detector and two stages of audio amplification. Type SE 3864 tubes are used in the MF-1 and type 38064 in the MF-2. An "ANT-LOOP" switching arrangement similar to that described under MJ equipment is provided on each of these models. A separate C.F.I. is provided for each equipment; that for model MF-1 having a frequency range 545 to 995 kilocycles, uses two CW 1344 tubes, one as an oscillator and one as an audio amplifier, while the C.F.I. for the MF-2 uses type 38064 tubes. This MF equipment is designed to mount in the same space as the MB and MJ equipments.

Aircraft operating from 6-inch cruisers are provided with MB-2 and MB-3 equipment. The transmitter and receiver are contained in the same case. The MB-2 has a rated output of 30 watts, frequency range 545-995 kilocycles, and weighs 35 pounds. The MB-3 is similar except that the upper frequency limit is 1,000 kilocycles and weight is 35 pounds 12 ounces. Power is obtained from an engine-driven direct-current generator which is shunt wound, double voltage (15-500 volts), four-pole, self-excited and weighs 23 pounds including the filter. The circuits are similar to those previously described (M.O.-P.A.) under the MJ and MF models and employ type CG 2566 in the MB-2 and 38110 tubes in the MB-3. The receivers are identical and of the nonradiating type and consist of one stage of r.f. amplification, regenerative detector, and two stages of a.f. amplification. The MB-2 uses SE 3864 tubes and the MB-3 uses type 38064. The homing device, loop, and Switching arrangement is similar to that in the equipment previously discussed.

At the present time the Bureau of Engineering contemplates replacing all of the above models with a new "universal" transmitter, model GP, which cover a frequency range of 350 to 9,050 kilocycles and an output of 100 to 125 watts. This set will be capable of operation on CW, MCW, and ICW and will be of about the same weight and size as the MF models. The receiver with this equipment will cover a frequency range of 24-13,575 kilocycles using plug-in coils and incorporating automatic volume control.

The fighter planes on carriers are provided with model GF transmitters and model RU-2 receivers. The transmitter comprises an r.f. oscillator, r.f. amplifier, coupling circuit, modulator stage and a tone oscillator. Type 38110-A tubes are used except for the modulator which employs a type 38142. The output is approximately 1.5 watts over a frequency range of 6,200-7,700 kilocycles. The equipment weighs 43 pounds, which includes the transmitter,

other transmitting equipments. For single-seat planes dual coil sets are provided with remote switching so that the pilots of these planes may "throw down" from the high-frequency communication channel to the intermediate frequency-direction finding channel. The RAM receivers cover the ranges 200 to 1,500 kc and 1,500 to 13,575 kc simultaneously in 2 separate receivers operated from a common dynamotor. In order to conserve cockpit space near the operator these receivers, which are of the all-wave superheterodyne type, are split into radio-frequency units and intermediate frequency—audio-frequency units. The radio-frequency units are approximately 8 by 7 by 9 inches and contain all receiver controls on the front panels. Remote controls are provided, however, for quick attachment if conditions do not permit mounting the radio-frequency units convenient to the operator. These receivers will be used with the model GN transmitters as two-channel equipment in liaison airplanes.

## CRYSTAL FREQUENCY INDICATORS

| Model no. | Number on contract | Manufacturer          | Designated for—        | Status                                      |
|-----------|--------------------|-----------------------|------------------------|---|
| LJ.....   | 60                 | Hygrade Sylvania..... | VP.....                | Delivered, being issued with GQ equipments. |
| LJ-1..... | 145                | General Electric..... | VS, VSB, VSQ, VOS..... | Delivery about Aug. 1, 1935.                |
| LM.....   | 200                | Radio Research Co.    | VP, VS, VSB.....       | Delivery about May 1, 1936.                 |

These CFI units cover a frequency range of 195 to 13,600 kc. The LJ has 10 crystals ground to Navy frequencies. Frequency checks may be made against the crystal direct, or at any frequency in the range of the instrument against the heterodyne oscillator which has first been checked against a crystal point and then moved to the desired frequency in accordance with the calibration. The manufacturer is attempting to improve the accuracy of the heterodyne oscillator of the CFI and if successful will eventually modify all the LJs. The LJ-1 has 10 crystals ground to selected frequencies (not necessarily naval) for checking the heterodyne oscillator. With this instrument frequency settings are made against the heterodyne oscillator, this first having been checked against a crystal and a correction applied. The accuracy demonstrated by the instrument in flight tests of the preliminary models was better than 0.025 percent. The LM has but one crystal of the type AT cut and is expected to be provided with a very high-grade heterodyne oscillator. The use of the AT cut crystal will make errors due to change in ambient temperature negligible, since the guaranteed temperature coefficient of this crystal is better than one part in a million per degree centigrade. Frequency settings are made as in the LJ and LJ-1 CFIs.

The above CFI's are all designed for airplane use in conjunction with receiving equipments and transmitting equipment of the GC and GP series. None will be carried with GF series equipments. The procurement of this type of CFI in the future will depend upon developments looking toward better frequency stability of aircraft transmitters and receivers. If necessary to ensure accurate setting of frequencies in an airplane, they will be provided, but, needless to say, it is very desirable to dispense with this class of equipment altogether.

- (4) Emphasize with a distinct hiss all sibilants, such as "s", "c", and "z."
- (5) Emphasize all terminal consonants, such as "t" and "g."
- (6) Speak slowly.

## RADIO AND UNDERWATER SOUND EQUIPMENT— DISTRIBUTION OF INSTRUCTION BOOKS

All radio and sound instruction books, final form, except those for aircraft equipment, which are not shipped with the equipments, will be delivered to the supply officer, Washington Navy Yard. Instruction books for aircraft radio equipment, final form, which are not shipped with the equipments, will be delivered to the supply officer, Naval Aircraft Factory, Philadelphia, Pa.

The Bureau will instruct the supply officer having cognizance of the instruction books, final form, to issue two copies to each ship or activity to replace the instruction books, preliminary form, if supplied with the equipment at time of delivery. Also, the supply officer will be instructed to issue one copy each to those ships and activities which are concerned with the operation and maintenance of the particular type of equipment involved.

Ships and shore activities, upon receipt of instruction books, final form, shall immediately replace the preliminary copies furnished with the equipment and shall *destroy the preliminary books and drawings*. After receipt of instruction books, final form, no further reference shall be made to the preliminary copies, such as when ordering replacement material, servicing, etc. When replacement material is ordered prior to the receipt of instruction books, final form, it should be clearly indicated that data has been obtained from the preliminary copy.

Repair ships, tenders, and shore activities should establish and maintain a permanent file for all instruction books, final form, furnished. This file should be available to all personnel concerned in the operation and maintenance of radio and underwater sound equipment.

Instruction books, final form, covering equipment at shore radio stations will be forwarded to the commandant of the naval district concerned for distribution as follows: 2 copies for each set of equipment at each station, to replace the preliminary copies, and 1 copy for the naval district's central files, referred to in the preceding paragraph.

The above system of distribution applies to all equipment, with the possible exception of special equipment and experimental models, of which the quantities involved are small.

All requests for instruction books shall be made to the Bureau of Engineering.

### **INTERCONNECTING CABLES FOR THE MODEL "DO" SERIES OF DIRECTION FINDERS—FAILURE OF**

Owing to a number of failures of interconnecting cables in the model DO series of direction-finder equipments, the manufacturer has agreed to 100-percent replacements. The new cables will be stocked at Mare Island and New York.

Upon request, defective cables will be replaced by the Bureau without charge to vessels' allotments.

### **ACCEPTANCE OF RADIO EQUIPMENT FROM CONTRACTORS**

In order for the Government to derive the maximum benefit under the contractual guarantees on radio and sound equipment, it is necessary that claims for replacement of defective parts without cost to the Government be submitted within the contract guaranty period.

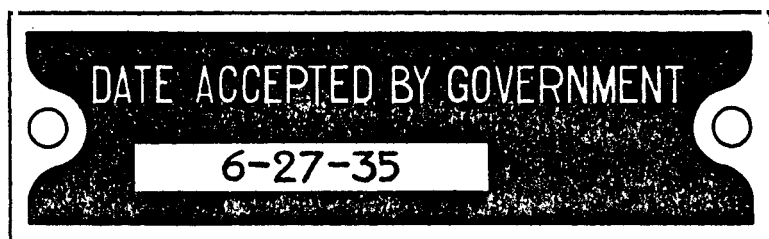


FIGURE 1

In general, the equipment is guaranteed for 1 year of service; that is, 1 year after installation. For new ships, this is interpreted as 1 year from date of commissioning of the vessel. However, the above year must be within a 2-year period after acceptance by the Government. The date of acceptance is available in the records of the Bureau; but in order to assist all concerned, the Westinghouse Electric & Manufacturing Co. has inaugurated a practice of affixing a plate on the inside of equipment manufactured by them showing the date of acceptance by the naval inspector. Figure 1 shows the type of nameplate used.

This information will be available on model TBK, TBK-1, TBK-2, and TAJ-5. All except TBK-3 will be installed on new construction.

It is desired that the service assist the Bureau in obtaining replacement of defective material under contractual guarantees.

# STATUS OF AIRCRAFT RADIO PROCUREMENT

## TRANSMITTERS

| Model no. | Number on contract | Manufacturer              | Nominal power | Frequency range                   | CW and MCW | Voice | Designated for                 | Status                             |
|-----------|--------------------|---------------------------|---------------|-----------------------------------|------------|-------|--------------------------------|------------------------------------|
|           |                    |                           | <i>Watts</i>  | <i>Kilocycles</i>                 |            |       |                                |                                    |
| GO.....   | 69                 | Hygrade-Sylvania.....     | 100           | {4000-13,575.....<br>300-600..... | } Yes      | No    | VP.....                        | Delivered, being issued.           |
| GO-1..... | 25                 | Western Electric.....     | 100           | {4000-13,575.....<br>300-600..... | } Yes      | No    | VP.....                        | Delivery about February 1, 1936.   |
| GO-2..... | 50                 | do.....                   | 125           | {3000-13,575.....<br>300-600..... | } No       | No    | VP.....                        | Delivery about May 1, 1936.        |
| GP.....   | 50                 | RCA Manufacturing Co..... | 100           | 350-9050.....                     | No         | Yes   | {VS, VOS.....<br>VSO, VSB..... | } Delivery about December 1, 1935. |
| GP-1..... | 85                 | Western Electric.....     | 100           | 350-9050.....                     | No         | Yes   | {VS, VOS.....<br>VSO, VSB..... | } Delivery about January 1, 1936.  |
| GP-2..... | 230                | RCA Manufacturing Co..... | 100           | 350-9050.....                     | No         | Yes   | {VS, VOS.....<br>VSO, VSB..... | } Delivery about May 1, 1936.      |
| GN.....   | 16                 | Western Electric.....     | 100           | {1500-9050.....<br>350-1500.....  | } No       | Yes   | VS, VSB.....                   | Delivery about July 1, 1936.       |
| GF-1..... | 203                | Aircraft Radio Corp.....  | 0.3           | 6200-7700.....                    | No         | Yes   | {VF, VB.....<br>VBF, VP.....   | } Delivered, being issued.         |
| GF-2..... | 43                 | do.....                   | 15            | {3000-4525.....<br>6000-9050..... | } No       | Yes   | VB.....                        | Do.                                |
| GF-3..... | 92                 | do.....                   | 15            | {3000-4525.....<br>6000-9050..... | } No       | Yes   | {VF, VB.....<br>VBF, VP.....   | } Delivery about June 1, 1936.     |

The GO series transmitters are the standard type for patrol aircraft. They are double, all-wave transmitters, high and intermediate, with quick switch-over from a common rectifier. The GP series transmitters are the standard type for two-seater scout and observation airplanes and miscellaneous airplanes. They are of the plug-in coil type with six coil ranges covering the band 850 to 9050 kc. Interphone is provided as part of the GP series transmitting equipments. The GN transmitter is a semiexperimental type, an all-wave transmitter, high and intermediate frequency, with quick switch-over from a common rectifier, of the same general shape as the GP transmitter. The GN is an attempt to provide two-channel equipment for certain classes of two-seat planes and will be used with two separate receivers. The GF-1 transmitter is very similar to the GF, with which the service is familiar. The GF-2 and GF-3 transmitters will be standard for single-seat planes, two-seat dive bombers, and patrol airplane intersquadron work. The GF series transmitters are dynamotor operated from the 12-volt direct-current airplane power supply; all others listed above are operated from rectifiers in the radio set which convert the 800-cycle alternating-current airplane generator supply into filament and plate power. All of the above transmitters are of the master oscillator, power-amplifier type, continuously variable. Progress is being made toward attaining better frequency stability of aircraft transmitters under the extreme service conditions encountered.

#### RECEIVERS

| Model no. | Number on contract | Manufacturer                | Type         | Designated for—            | Status   |
|-----------|--------------------|-----------------------------|--------------|----------------------------|--|
| RU-3..... | 242                | Aircraft Radio Corporation. | Tuned R.F.   | RF, VS, VOS, VSO, VSB, VP. | Delivered; being issued.                                   |
| RU-3..... | 203                | .....do.....                | .....do..... | VF, VP.....                | Delivered; being issued with GF-1 transmitters.            |
| RU-4..... | 230                | .....do.....                | .....do..... | VS, VSB.....               | Delivery about May 1, 1936.                                |
| RAM.....  | 16                 | Western Electric.           | Superhet.    | .....do.....               | Delivery about July 1, 1936; for use with GN transmitters. |

The RU-3 receivers are similar to the RU-2, except that CW reception and AVC are both incorporated. The RU-4 receivers are similar to the RU-3s. The frequency range provided is 224 to 13,575 kc, with a tuning condenser ratio of 1.57 to 1, by plug-in coil sets covering the band in 11 ranges. The actual coil sets provided vary with the service for which the receivers are intended. Generally the ranges 224 to 350 kc, 3,000 to 4,525 kc, and 5,200 to 7,700 kc are provided for receivers used with the GF series transmitters, while a complete set of plug-in coils is provided for receivers issued with



receiver, dynamotor, junction box, microphone, control boxes, etc. The RU-2 receiver has a frequency range of 224 to 12,500 kilocycles and uses three type 38039 tubes as radio frequency amplifiers, one type 38036 tube as a detector and one as a heterodyne oscillator, and one 38033 as an audio amplifier. The type CBY 46006 receiver receives modulated or damped wave signals within the two bands 224-350 and 5,400-8,100 kilocycles but it will not receive unmodulated signals. This receiver uses four 38039 tubes as r.f. amplifiers, one type 38037 as a detector, and one type 38038 as an audio amplifier. Power is furnished from a dynamotor of the totally enclosed type having a low-voltage commutator at one end, and a high-voltage commutator at the other end. Input to the low voltage commutator is from a 12-15 volt battery and the output high voltage commutator is from 185-235 depending on the applied low voltage.

The patrol plane equipment in use at present consists of models GH-1 and GI. Model GH, which is similar to GH-1, has been recalled for overhaul at Naval Aircraft Factory, Philadelphia. The model GH-1 equipment covers the frequency bands: 300-600 kilocycles, 4,000-4,525 kilocycles, 8,000-9,050 kilocycles and 12,000 to 13,575 kilocycles. The I.F. receiver covers 200-600 kilocycles and the h.f. receiver covers 3,000-18,500 kilocycles. The C.F.I. covers 200-600 kilocycles and 4,000-4,525 kilocycles. The output of transmitters is 100 watts for CW or MCW telegraph service. This is an alternating current transmitter in three sections; intermediate frequency transmitter, rectifier, and high-frequency transmitter. Power is obtained from a self-excited engine-driven inductor generator delivering 800 cycles at 4,000 revolutions per minute with conversion for plate and filament supply by means of suitable transformers and rectifiers. The alternating current input to the power control unit is approximately 550 watts at 115 volts, 800 cycles. Direct current at approximately 15 volts is also brought into the control unit for control of the generator field excitation, to operate the relays, and for battery charging. Two Navy type 3069 mercury vapor half-wave rectifier tubes are used to give full-wave rectification. The I.F. transmitting unit can be operated between 300-600 kilocycles on either CW or MCW. The circuit is of the master oscillator-power amplifier type using two type 3119 tubes, one in either circuit. The H.F. transmitter does not use crystal control but is of the self-excited master oscillator type. The master oscillator power amplifier tubes are type 3119. The receiving equipment consists of three major units which can be fastened together as one vertical unit or as one horizontal unit. The I.F. intermediate unit covers a range of 200-600 kilocycles and contains the requisite circuits of a Bellini-Tosi direction finder, as well as those of the receiving unit itself.

The tubes required for operation of this unit are type 3222 shield grid tubes, and three type 3864 nonmicrophonic general purpose tubes. The H.F. receiving unit covers the range 3,000-18,500 kilocycles. The circuits of both receivers consist of one shield grid coupling stage, one stage of shield grid tuned r.f. amplification, an autodyne detector, and two stages of transformer coupled a.f. amplification. The direction finder employs two fixed loops placed at right angles to each other which are directly connected to two small coils, also at right angles to each other and wound on a special form similar to a variometer. The rotor of this form, or goniometer as it is called, is connected to a coupling transformer the secondary of which connects to the receiving unit proper. The field, set up inside the goniometer by the two fixed coils, has the same characteristics as the field in which the large loops are located provided the loops are identical in size and that the coils are matched accurately. This equipment weighs about 250 pounds.

The GI aircraft radio equipment installed in patrol planes covers the frequency bands: 300-600 kilocycles, 4,000-4,525 kilocycles, 8,000-9,050 kilocycles, 12,000-13,575 kilocycles. The receiver is capable of receiving CW, ICW, and MCW. The transmitter unit is complete in a frame of rectangular welded steel tubing, and is divided into three sections. The bottom section contains the power transformers, rectifier tubes, switching equipment, meters, and space for stowing coils not in use. The center section, which is divided into two compartments by a vertical shield, contains the radio frequency circuits of the master oscillator, intermediate power amplifier, and parts of the circuits of the power amplifier. The top section contains power amplifier tank inductance, antenna loading units, power and control plugs, and the keying relay. The side shields are made in three sections, and so arranged that any one shield may be removed by sliding the shield forward to the front of the transmitter. The intermediate frequency circuit comprises a CG 1984 master oscillator driving two CG 1984 tubes as power amplifiers. In the H.F. transmitter there are three CG 1984 tubes connected in a master oscillator-intermediate power amplifier-power amplifier circuit. This transmitter is alternating current operated on 800 cycles similar to the power supply of the GH-1 described above. The receiver covers a frequency range of 200-25,000 kilocycles, the direction finder covers a frequency range of 200-600 kilocycles. The C.F.I. furnished may be used in the following two bands 200-600 kilocycles and 4,000-4,525 kilocycles. The receiver uses plug-in coils and consists of two stages of tuned radio frequency amplification using screen grid tubes, a regenerative detector and two stages of transformer coupled audio amplification.

First deliveries have been made of model GM equipments which have provision for transmission on CW or voice with a power of 15 watts and a frequency range of 3,000-4,525 kilocycles and 6,000-9,000 kilocycles. This set will be used with an RU-2 receiver in VF and VB planes. The power supply will be from a dynamotor.

Delivery will commence in about 3 months of model GO equipments which are intended for use in patrol planes. The frequency bands are: 300-600 kilocycles, 4,000-4,525 kilocycles, 8,000-9,050 kilocycles and 12,000-13,575 kilocycles. The set is, in general, similar to the GH-1 equipment and will be used with the model RU-2 receiver. The power will be 100 watts and the set will be alternating current operated on 800 cycles.

### **RADIO IMPROVEMENTS ON SHIPS DURING FISCAL YEAR 1934**

The following excerpts from Bureau of Engineering multiple letters FS/S67 (11-6-W5) of November 20, 1933, and FS/S67 (1-11-W5) of January 18, 1934, addressed to Commandants and Unit Commanders are quoted for the information of the Service.

Accomplishment of the following radio improvements was planned on the indicated vessels in commission. Those projects which remained uncompleted from previous years are restated as new projects. Projects indicated \* are those which have been revised due to more recent information on the status of delivery.

1. \* \* \*

2. In order that all of these improvements may be accomplished with the funds available, it is essential that the forces afloat cooperate to the fullest extent in making the installation of new material, and by reducing to a minimum the maintenance repairs required at navy yards. The Bureau is confident of this cooperation, and upon this basis is making purchases of material in the amounts indicated herein. It may also be observed that experience gained by ships' forces in installation and repair increases familiarity with design and construction, which results in improved operation.

3. The ships concerned are presented another opportunity to further the purchase program of new and modern apparatus by exercising the same care in the removal of apparatus that they show in the installation of new material. Very often the apparatus removed is to be reinstalled in different type vessels. Spare part boxes should be complete upon turning into store unless specific authority has been received from the Bureau to use spares without replacement

#### **CLASSIFICATION OF IMPROVEMENTS**

4. These improvements are not only designed to increase the effi

reliability and economy of operation. This work is considered of equal importance with urgent repairs and is designated as equivalent to repairs.

#### INDIVIDUAL AUTHORIZATION ON FORM N.ENG. 199

5. Individual authorization for each improvement will be issued by the Bureau to the ships and yards concerned on Form N.Eng. 199. No improvement or alteration shall be started until the vessel or yard has received this individual authorization or notice from the Bureau that the form has been issued. In this connection, the Bureau desires that ships follow carefully the printed instructions on this form. If the instructions are followed promptly and correctly it will save paper work, facilitate completion of the Bureau's program, and will result in economy of time and energy for all concerned. Heretofore, ships have in many instances failed to forward the yellow copy upon completion of the project. This prevents the Bureau from completing its records. Numerous cases are on file showing failure of ships to return yellow copies covering 1933 projects.

#### DELIVERY OF MATERIAL

6. The probable dates of delivery of the items of equipment as given under the projects listed hereinafter are tentative and are based upon the best available information at the time this letter is written. However, unforeseen delays in manufacture or shipment may change these dates considerably. Much correspondence will be avoided if inquiries regarding the status of delivery of material are kept at a minimum. In most cases the copy of the Bureau's shipment order will furnish individual vessels with sufficient advance notice in order that adequate preparations for installation may be made.

#### HOW COST CHARGES ARE TO BE MADE BY FORCES AFLOAT

(a) As heretofore, supplies necessary to maintain equipment operative will be chargeable to the appropriation "Engineering, Subhead 1, General Expenses", and to the regular quarterly allotment of the ship concerned; material other than that referred to in subparagraph (c) below, used by repair ships and tenders for work on other vessels, is to be charged to the repair allotments (subhead 1) of the repair ship as granted. Further, all incidental material used by the forces afloat in making installations of radio and sound apparatus (improvements), also will be charged to subhead 1, general expenses.