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Ships 232A

UNCLASSIFIED

~~CONFIDENTIAL~~
(NON-REGISTERED)

Radio Equipment Model B.N.

INSTRUCTION BOOK

for

RADIO EQUIPMENT NAVY MODEL BN

FARNSWORTH TELEVISION & RADIO CORPORATION
FORT WAYNE, INDIANA

NAVY DEPARTMENT — BUREAU OF SHIPS

3

Contracts: NXss-27551
NXsr-35824

Approved 15 September 1944

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/s/ J. B. DOW
By direction

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RECORD OF CORRECTIONS MADE

CHANGE NO.	DATE	SIGNATURE OF OFFICER MAKING CORRECTION

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CONTRACTUAL GUARANTEE

The equipment including all parts and spare parts, except vacuum tubes, batteries, rubber and material normally consumed in operation, is guaranteed for a period of one year from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship or manufacture will be repaired or replaced, f.o.b. any point within the continental limits of the United States designated by the Government, without delay and at no expense to the Government; provided that such guarantee will not obligate the Contractor to make repair or replacement of any such defective items unless the defect appears within the aforementioned period and the Contractor is notified thereof in writing within a reasonable time and the defect is not the result of normal expected shelf life deterioration.

To the extent the equipment, including all parts and spare parts, as defined above, is of the Contractor's design or is of a design selected by the Contractor, it is also guaranteed, subject to the foregoing conditions, against defects in design with the understanding that if ten per cent (10%) or more of any such said item, but not less than two of any such item, of the total quantity comprising such item furnished under the contract, are found to be defective as to design, such item will be conclusively presumed to be of defective design and subject to one hundred per cent (100%) correction or replacement by a suitably redesigned item.

All such defective items will be subject to ultimate return to the Contractor. In view of the fact that normal activities of the Naval Service may result in the use of equipment in such remote portions of the world or under such conditions as to preclude the return of the defective items for repair or replacement without jeopardizing the integrity of Naval communications, the exigencies of the Service, therefore, may necessitate expeditious repair of such items in order to prevent extended interruption of communications. In such cases the return of the defective items for examination by the Contractor prior to repair or replacement will not be mandatory. The report of a responsible authority, including details of the conditions surrounding the failure, will be acceptable as a basis for affecting expeditious adjustment under the provisions of this contractual guarantee.

The above one year period will not include any portion of the time the equipment fails to perform satisfactorily due to any such defects, and any items repaired or replaced by the Contractor will be guaranteed anew under this provision.

REPORT OF FAILURES

Report of failure of any part of this equipment, during its service life, shall be made to the Bureau of Ships in accordance with current instructions. The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see Chapter 67 of the "Bureau of Ships Manual," or superseding instructions.

INSTALLATION RECORD

Contacts: NXss—27551 Date of Contracts: 15 April 1943
NXsr—35824 13 August 1943

Serial number of equipment____________________

Date of acceptance by the Navy____________________

Date of delivery to contract destination____________________

Date of completion of installation____________________

Date placed in service____________________

Blank spaces in this table shall be filled in at the time of installation.

PROCUREMENT OF PARTS

All requests or requisitions for replacement material should include the following data:

1. Navy stock number or, when ordering from an Army supply depot, the Army stock number.
2. Name of part.

If the Navy stock number has not been assigned, the requisitions should specify the following:

1. Equipment model designation.
2. Name of part and complete description.
3. Manufacturer's designation.
4. Contractor's drawing and part number.
5. AWS, JAN, or Navy Type designation.

SAFETY

THE ATTENTION OF OFFICERS AND OPERATING PERSONNEL IS DIRECTED TO BUREAU OF SHIPS MANUAL OF ENGINEERING INSTRUCTIONS CHAPTER 67 OR SUBSEQUENT REVISIONS THEREOF ON THE SUBJECT OF RADIO-SAFETY PRECAUTIONS TO BE OBSERVED.

WHILE EVERY PRACTICABLE SAFETY PRECAUTION HAS BEEN INCORPORATED IN THIS EQUIPMENT, THE FOLLOWING RULES MUST BE STRICTLY OBSERVED:

KEEP AWAY FROM LIVE CIRCUITS. Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casualties always remove power and discharge and ground circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE. Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS. Do not depend upon door switches or interlocks for protection but always shut down motor generators or other power equipment. Under no circumstances should any access gate, door or safety interlock switch be removed, short circuited, or tampered with in any way, by other than authorized maintenance personnel, no should reliance be placed upon the interlock switches for removing voltages from the equipment.

RESUSCITATION

"AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR, OR SONAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY."


DANGER
HIGH VOLTAGE
5000VOLTS
Don't Look Now, But the Power IS on!
HE THOUGHT THE POWER WAS OFF
-BEAVER-

DESTRUCTION OF ABANDONED MATERIEL IN THE COMBAT ZONE

In case it should become necessary to prevent the capture of this equipment, and when ordered to do so, DESTROY IT SO THAT NO PART OF IT CAN BE SALVAGED, RECOGNIZED, OR USED BY THE ENEMY. BURN ALL PAPERS AND BOOKS.

Means:

1. Explosives, when provided.
2. Hammers, axes, sledges, machetes, or whatever heavy object is readily available.
3. Burning by means of incendiaries such as gasoline, oil, paper, or wood.
4. Grenades and shots from available firearms.
5. Burying all debris, or disposing of it in streams or other bodies of water, where possible and when time permits.

Procedure:

1. Obliterate all identifying marks. Destroy nameplates and circuit labels.
2. Demolish all panels, castings, switch and instrument boards.
3. Destroy all controls, switches, relays, connections and meters.
4. Rip out all wiring and cut interconnections of electrical equipment. Smash gas, oil, and water cooling systems in gas engine generators, etc.
5. Smash every electrical or mechanical part, whether rotating, moving or fixed.
6. Break up all operating instruments such as keys, phones, microphones, etc.
7. Destroy all classes of carrying cases, straps, containers, etc.
8. Bury or scatter all debris.

DESTROY EVERYTHING!

Equipment. The cabinet is made from heavy steel and welded together, completely enclosed except for the open front end. The sides are not removable; this type of construction eliminates the use of frames. Both sides are louvered and screened for ventilation. Each side is equipped with a runner and track arrangement, permitting easy access and withdrawal of the Model BN Radio Equipment chassis. STOP assemblies are provided, one on each side, to prevent the chassis from being removed completely from cabinet. The bottom of the cabinet has four large shock mounts.

Overall size: Height 14⅜ inches, Width 20$\frac{1}{16}$ inches, Length 17$\frac{7}{16}$ inches, Weight (uncrated) 55 pounds. Refer to dimensional outline drawing, Figure 1-2, Page 1-2.

d. MODULATOR AND I-F TO VIDEO CONVERTER, NAVY TYPE CFN–43ACB.—This is the foundation unit incorporating the Model BN Radio Equipment chassis and front panel, the modulator and receiver intermediate-frequency to video sections, receiver gating circuit, receiver tuning indicator, interlock, blower-motor, and all power supplies. Power input is 105 to 125 volts, 50 to 425-cycles a-c (at 115/1/60 approximately 225 watts). This unit furnishes power to Transmitter R-F Oscillator, Navy Type CFN–52ACQ, and R-F to I-F Converter, Navy Type CFN–46ACW, has video output for visual indicator. Input impedance is 75 ohms (Sync. In); output impedance is 50 ohms (Video Out). Weight uncrated is 86 pounds. For dimensions, refer to Figure 7-6, Pages 7-11, 7-12. This section is designated in the photograph in Figure 1-3, Page 1-4. A bottom view showing the parts and wiring is shown in Figure 1-4, Page 1-5.

e. R-F TO I-F CONVERTER, NAVY TYPE CFN–46ACW (shown in Figure 7-6, Pages 7-11, 7-12) mounts on the Modulator and I-F to Video Converter, Navy Type CFN–43ACB from which it derives its power. Also it includes receiver tuning controls and delivers intermediate-frequency signal to the input of the modulator and the I-F to Video Converter, Navy Type CFN-43ACB. Input impedance is 50 ohms (Receiver Antenna). Output impedance is 1500 ohms. Weight is 7 pounds.

f. TRANSMITTER R-F OSCILLATOR, NAVY TYPE CFN-52ACQ (shown in Figure 7-7, Pages 7-13, 7-14), mounts on the modulator and I-F to Video Converter, Navy Type CFN–43ACB, from which it derives its power and modulation. Connects to transmitter tuning controls on type CFN–43ACB. Input impedance is determined by operating conditions. Output impedance is 50 ohms (Transmitter Antenna). Weight is 8 pounds.

7. POWER SUPPLY.

a. Model BN Radio Equipment operates from any 105 to 125 volts, 50 to 425-cycle a-c power supply. This permits its use on the standard 60 and 400-cycle frequencies. The equipment is shipped for use with 115 volts, a-c operation. Operation below 110 or above 120 volts a-c necessitates changing only one connecting lead on the power transformer.

8. FREQUENCY.

a. The Transmitter R-F Oscillator Unit, Navy Type CFN–52ACQ, and R-F to I-F Converter Unit, Navy Type CFN–46ACW, of the Navy Model BN Equipment can each be tuned to any predetermined frequency in the 157 to 187 megacycle band.

9. VACUUM TUBES.

a. The vacuum tubes used in the Model BN Equipment and their location are indicated in the photograph, Model BN Equipment top view, without cabinet, Figure 1-3, Page 1-4, which also shows the major sections of the equipment. The location of the related tube sockets are shown in the photograph of the Model BN, bottom view, Figure 1-4, Page 1-5.

b. The Vacuum tubes employed in and included with the Navy Model BN Radio Equipment are as follows:

One—Type 6J6 used as—
  1st r-f amplifier (V1)
One—Type 6SH7 used as—
  2nd r-f amplifier (V2)
One—Type 9006 used as—
  1st detector (V3)
One—Type 6J5 used as—
  Oscillator (Receiver) (V4)
Nine—Type 6AC7 used as—
  1st i-f amplifier (V5)
  2nd i-f amplifier (V6)
  3rd i-f amplifier (V7)
  4th i-f amplifier (V8)
  5th i-f amplifier (V9)
  Pulse amplifier and limiter (V15)
  Multivibrator input (V16)
  Multivibrator output (V17)
  1st video amplifier (V13)
Three—Type 6H6 used as—
  Gate pulse limiter (V10)
  2nd detector and tuning indicator (V11)
  Diode limiters (V22)
One—Type 6E5 used as—
  Tuning indicator (V12)
One—Type 6AG7 used as—
  2nd Video Amplifier (V14)
Two—Type 6SN7GT used as—
  Pulse shaper and clipper (V18)
  Gate pulse generator (V21)
Two—Type 6L6G used as—
  Driver (V19)
  Modulator (V20)
One—Type 3B24 used as—
  High voltage rectifier (V24)
One—Type 5U4G used as—
  300 volt rectifier (V25)
One—Type 15E used as—
  Oscillator (Transmitter r-f) (V23)

VACUUM TUBE LOCATION

c. R-F to I-F Converter—Navy Type CFN–46ACW

Symbol	*Type*	*Function*
V1	6J6	1st r-f amplifer
V2	6SH7	2nd r-f amplifier
V3	9006	1st detector
V4	6J5	Oscillator (Receiver)

d. Modulator and I-F to Video Converter (Navy Type CFN–43ACB)

(I-F to Video Converter Section of Receiver)

V5	6AC7	1st i-f amplifier
V6	6AC7	2nd i-f amplifier
V7	6AC7	3rd i-f amplifier
V8	6AC7	4th i-f amplifier
V9	6AC7	5th i-f amplifier
V10	6H6	Gate pulse limiter
V11	6H6	2nd detector and tuning indicator
V12	6E5	Tuning indicator
V13	6AC7	1st video amplifier
V14	6AG7	2nd video amplifier

(Modulator Section of Transmitter)

V15	6AC7	Pulse amplifier and limiter
V16	6AC7	Multivibrator input
V17	6AC7	Multivibrator output
V18	6SN7GT	Pulse shaper and clipper
V19	6L6G	Driver
V20	6L6G	Modulator
V21	6SN7GT	Gate pulse generator
V22	6H6	Diode limiters

(Power Supply)

V24	3B24	High voltage rectifier
V25	5U4G	300 volt rectifier

e. Transmitter R-F Oscillator—Navy Type CFN–52ACQ

V23	15E	Oscillator (Transmitter r-f)

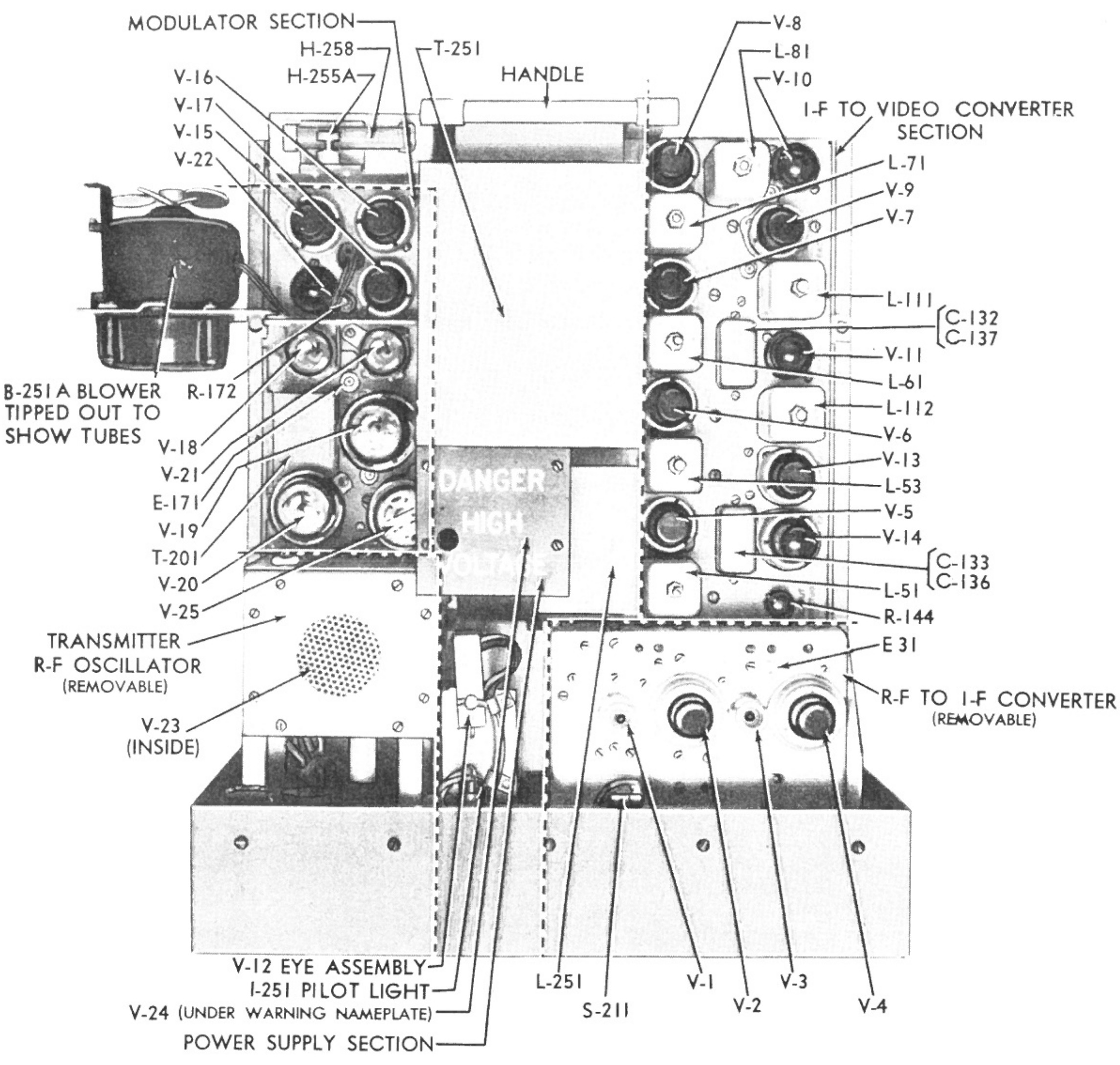


Figure 1-3—Model BN Equipment Removed from Cabinet Top View

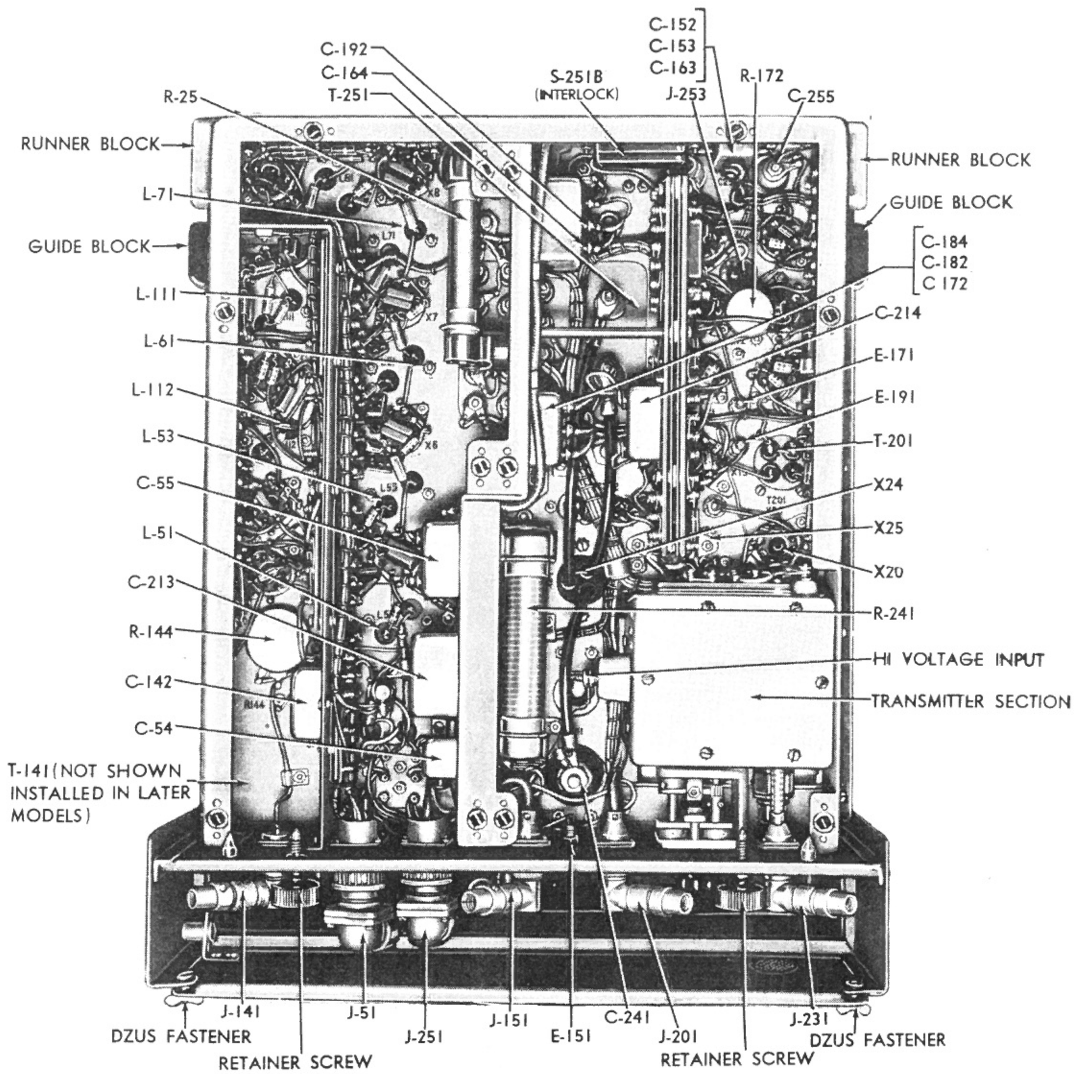


Figure 1-4—Model BN Equipment Bottom View Cover Removed

TABLE OF MAIN COMPONENTS

Quantity	Numerical Series of Reference Symbols	Name of Unit	Navy Type Designation	Overall Dimensions Uncrated H	Uncrated W	Uncrated D	Crated H	Crated W	Crated D	Volume Uncrated	Volume Crated	Weight Uncrated	Weight Crated
*1		Navy Model BN Radio Equipment	CFN-46ACW CFN-43ACB CFN-52ACQ	14 3/8	20 1/16	20 11/16						156	
*1		Equip. Spares	— —	9	18	12	20 1/8	26 1/2	42			40	304
*1		Duplexer	CTZ-50ACW	4 5/8	21	4 3/4						18	
1		Tender Spares	— —	15	24	18	17 1/4	29 1/2	22 3/4			92	210
1		Stock Spares	— —	15 1/2	24 1/4	18 1/4	17 1/4	29 1/2	22 3/4			95	155
1		Ex. Equip. Spares	— —	9	18	12	11 1/4	23 1/2	16 11/16			40	70

* Shipped in one crate

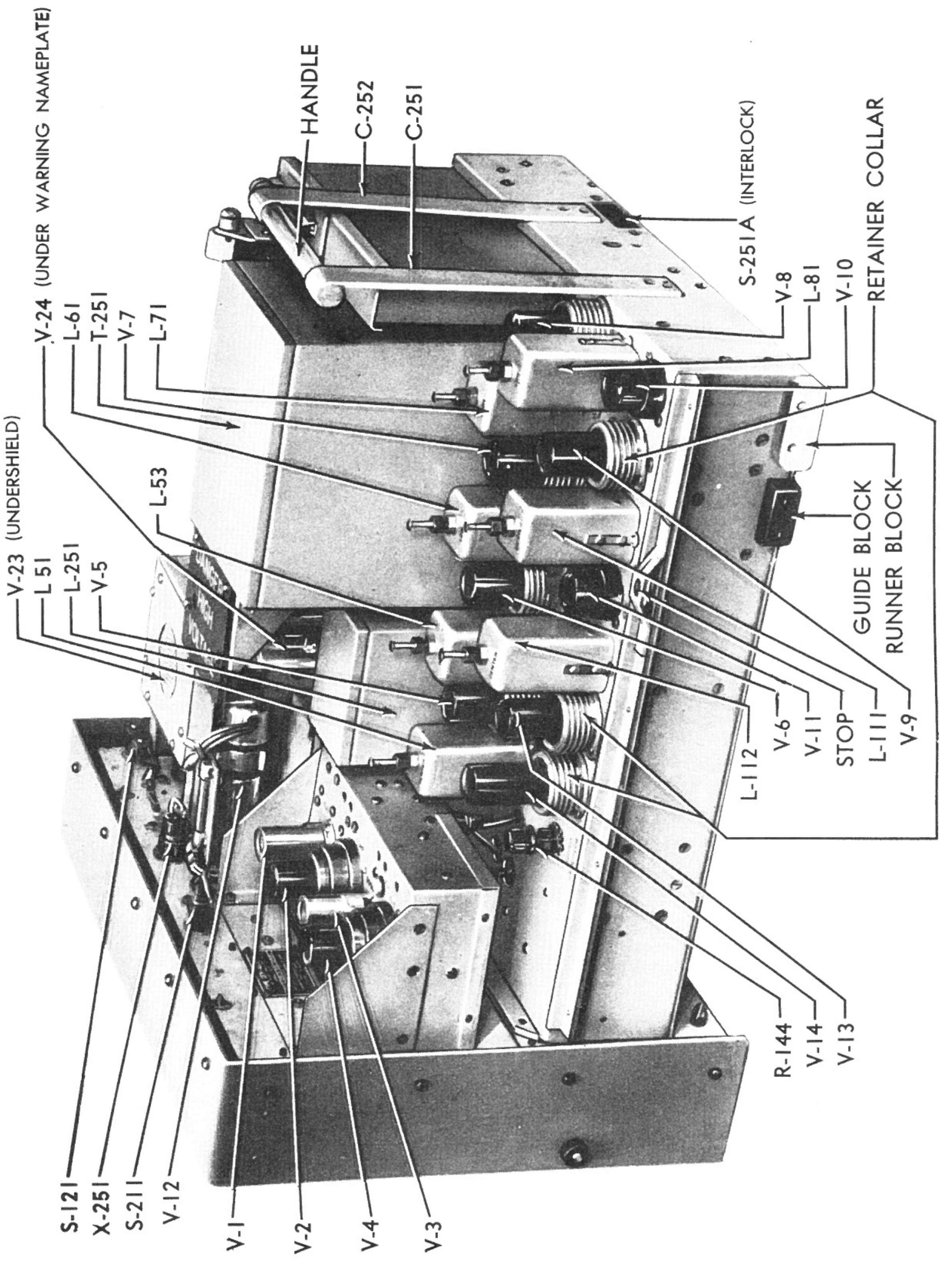


Figure 2-1—Navy Model BN Radio Equipment Oblique View

SECTION II

INSTALLATION AND ADJUSTMENT

1. UNPACKING BN RADIO EQUIPMENT.

a. In the unpacking and handling of the BN Radio Equipment during process of installation, care should be exercised to prevent damage to equipment. The following precautions should be observed:

(1) Keep boxes and crates containing equipment in the upright position at all times. The upright position is indicated by an arrow pointing upward, stenciled on each shipping container.

(2) Observe weights marked on shipping containers. As the BN Radio Equipment weighs approximately 300 pounds when packed, adequate transporting and lifting gear and sufficient handling personnel should be available to prevent equipment from being subjected to unwarranted shock.

(3) Remove nails from shipping container with a nail puller; do not use a hammer or pinch bar for this purpose.

b. Any components or wiring which may have been displaced during shipment should be replaced in their proper locations. The BN Radio Equipment, Duplexing Unit, Navy Type CTZ–50ACW, and the equipment spare parts will be shipped in the same shipping container.

c. The BN Radio Equipment is shipped from the factory completely wired and adjusted for the specified voltage (see Paragraph 7, Page 2-2), ready for installation. Therefore, the only installation connections which will be necessary will be those for the incoming power lines, antennas, and the connections necessary for the DUPLEXER unit.

d. The various units should be carefully unpacked and all wrappings removed in the following sequence:

(1) Remove the stapled steel bands from the packing box.

(2) Remove the waterproof envelope, containing the packing list, from the side of the packing box.

(3) Remove the cover from the packing box.

(4) Remove the Duplexing Unit from the packing box.

(5) Remove the special pads around the Duplexer.

(6) Remove the blocking, extracting nails carefully.

(7) Remove the moisture vapor barrier bag containing the Spare Parts Equipment.

(8) Open the moisture vapor barrier bag surrounding the BN Equipment.

(9) Remove the bags containing Dehydrating Agent from equipment.

(10) Remove the diagrams (Installation and Service) and Instruction Books from the equipment.

(11) Remove the washer, lockwasher, and nut from the bolts before attempting to remove the BN Equipment from the box.

(12) Remove the fiberboard cover surrounding the equipment.

(13) Remove the complete BN Equipment from the box.

(14) Remove the two large power and remote-control plugs.

(15) Remove the potentiometer tied to the equipment. This is the receiver remote gain-control.

(16) Remove the five coaxial adapter and plug assemblies.

2. INSTALLATION.

a. The major units comprising a complete installation include the following (excluding spare parts):

(1) One—Navy Model BN Radio Equipment.

(2) One—Duplexing Unit, Navy Type CTZ–50ACW.

(3) One—Antenna Equipment, Navy Type CTZ–66–ACG or CTZ–66–AFJ.

b. Accessories furnished with BN Radio Equipment and Remote Control components—comprised of:

(1) One—Potentiometer Receiver Gain Control [3,500 ohms (R–51)*].

(2) Five—Plugs, Navy Type C**–49195—Receiver Output (Video Out), Receiver (Antenna), Transmitter Sync (Sync-In), Transmitter (Antenna), External Pulse (Pulse Out).

(3) Five—Adapter Plugs, Navy Type C**–49192, used with each 90 degree angle Adapter.

(4) One—Plug Assembly, Navy Type AN–3108–16–10P(R–51)*, three-contact Remote Control.

(5) One—Plug Assembly, Navy Type AN–3108–16–11S (P–251)*, two-contact Power Unit (115 volt a-c input).

c. Suitable quantities of flexible cable are issued by the Navy installation office to meet the requirements of each particular installation. The kinds of cables and their location in the installation are shown in the cabling diagram, Figure 7-3 on Pages 7-5, 7-6.

3. LOCATION OF EQUIPMENT.

a. The Navy Model BN Radio Equipment should be installed near the Radar Equipment so that the interconnecting cables will be reasonably short and so that the panel is readily seen by either the active or stand-by

** Manufacturer optional.
* Refer to Figure 7-1, Pages 7-1, 7-2.

operators from their positions. The latter consideration is not essential for proper operation but is preferred if a choice of several locations exists.

(1) The equipment shall be adequately protected from bomb splinters, shell fragments, and weather.

(2) The BN equipment should be reasonably near the observing position of the associated equipment with which it operates so that the operator can see the screen of the associated equipment while adjusting the controls of the BN. If this arrangement cannot be provided, a location with convenient access should be chosen as near as practicable.

(3) Have the length of cable from the equipment to the antenna as short as possible to avoid unnecessary energy losses.

4. CLEARANCE.

a. The overall dimensions of the BN cabinet and the minimum clearance requirements are shown in Figure 7-4, Pages 7-7, 7-8. Since the cabinet is mounted on rubber shock insulators of great resilience, space should be allowed for necessary motion with shock.

b. A clearance of 30 inches is recommended in front of the equipment so that the chassis can be removed for service when necessary. Mechanically, 17 inches is sufficient space for chassis removal, but this does not allow space for a man. Since the Model BN radio chassis is particularly heavy (101 lbs.), it is essential that space is available to allow a positive hold on the unit.

c. The recommended clearance allows a man to stand in front of the equipment and grasp the chassis with one hand on either side. In this position chassis withdrawal is easily accomplished. If the front clearance is diminished to the point where it is no longer possible for a man to stand in front of the equipment, two men are necessary, one on either side; and the operation becomes somewhat awkward. However, if the space available does not allow the full clearance, this latter method of chassis removal is satisfactory. An absolute minimum of 17 inches must be observed in any event.

5. HANDLING BN CHASSIS.

a. To remove the Navy Model BN chassis from its cabinet, proceed in the following manner:

(1) Unfasten the hinged doors (held in place by four DZUS fasteners) on front of cabinet.

(2) Next, release (by turning counter-clockwise) the four RETAINING SCREWS, (finger grip controls, located on the front panel). Two of these retaining screws are located along the top of the front panel, the other two along the bottom of the panel.

(3) Grip the wraparound firmly with both hands, at the same time withdrawing* the Model BN chassis from the cabinet. Stop Assemblies (one located on each side of BN cabinet) will prevent the chassis from being removed completely from the cabinet.

(4) Grip the HANDLE of each Stop Assembly, lifting upward sufficiently to allow unimpeded complete removal of the BN chassis from its cabinet.

***NOTE**

It is suggested sufficient handling personnel be available to prevent the equipment from being subjected to unwarranted shock or damage.

Place the equipment on a bench or other flat surface; remove the wraparound by freeing the thirteen 8–32 round-head screws securing the wraparound to the chassis.

Because of the weight of this chassis, it is desirable to have two persons available, one on each side, as the unit is removed completely from the case.

To return the chassis to the cabinet, reverse the above procedure.

6. MOUNTING.

a. When the location for the equipment is accurately chosen, a rectangle should be marked on the shelf in the space to be occupied by the BN Radio Equipment. The dimensions of this rectangle should conform to the exact dimensions of the flexible shock mounting.

b. The location of the mounting holes should then be marked with reference to the dimensions given in Figure 7-4, Pages 7-7, 7-8. The shock mounting should then be bolted to its shelf. The cabinet should be electrically grounded. If the shelf is metal and electrically connected to the ship, the cabinet can be conveniently grounded by means of a flexible copper strap from the cabinet to one of the mounting bolts. All the contact surfaces involved on the bolt head, the nut, the mounting, and the shelf must be clean to insure good contact.

c. Sufficient cable length on each cable should be provided to allow withdrawal of the BN radio chassis approximately 10 inches, or to the STOP position, for servicing.

7. POWER SUPPLY FREQUENCY AND TYPE OF BLOWER-MOTOR.

a. The BN equipment is designed to operate from a 105–125 volt, 50–400-cycle single phase a-c power source.

b. The blower-motor in the equipment is for 60-cycle operation. If used with Radar provided with 400-cycle power supply,

(1) Remove the 60-cycle blower-motor.

(2) Replace by a 400-cycle blower-motor taken from the equipment's spare parts.

(3) The 60-cycle motor removed shall be exchanged for a 400-cycle motor in the stock or tender spare parts.

(4) The 400-cycle motors in the equipment's spare parts of all the BN radio equipments which are to operate in conjunction with Radar equipments other than those which operate from a 400-cycle source shall be exchanged for 60-cycle motors in the stock or tender spare parts.

8. CABLE INSTALLATION.

a. The cables constituting the external connections of the equipment are shown in Figure 7-3, Pages 7-5, 7-6. The type numbers of the cables are shown on the drawing. The plugs and cables which are used with the Model BN Radio Equipment are prepared as outlined in this section, Installation and Adjustment.

b. In arranging the installation each cable should be brought to its termination on the panel in a manner which will not interfere with controls or other cable terminations.

c. In all plug-and-cable assembly operations extreme care must be exercised at every step. A poor job of soldering, an improper assembly of a plug, a cut in the insulation, or a "*nick*" in a conductor might cause equipment failure.

d. Allow ample slack in all cables at the BN cabinet to permit full freedom of motion on the shock mounting. Reference is made to the cabling diagram shown in Figure 7-3, Pages 7-5, 7-6 as illustrating this point. Attach all plugs to the cables before the cables are put in place.

e. The reason for this procedure is that the attachment of some of these plugs is a delicate operation, and may have to be repeated once or twice with a spoilage of a short length of the cable. If the cable were already firmly secured to bulkheads, there might be a pull on the flexible mounting due to the short lengths, and a loosening and refastening of a considerable length of cable would be required.

f. Experience in cabling and plug attachment has brought out the following points to which attention should be paid in all installations.

(1) Each AN–RG–10/U cable bend shall have a radius of at least four inches.

NOTE

AN–RG–10/U is now the standard Navy Type Number for the coaxial conductor formerly referred to as Navy Type CASSF–50–1A and British Type PT–5.

(2) Antenna connections which involve ultra-high-frequency currents must use Polyethylene insulated cable throughout. Type AN–RG–10/U is suitable and also has the advantage of armor for protection against mechanical damage. Types AN–RG–10/U, AN–RG–8/U, CASSF–50–1A, and the British PT–5 are similar except that the AN–RG–8/U and PT–5 do not have armor. Cables with other dielectric materials are not suitable for these ultra-high frequencies.

(3) The woven-wire armor (provided on most cables for mechanical protection but serving no electrical function) should be cut off, taped, and left on open circuit at the first supporting clamp near the BN equipment mounting. Removal of this armor prevents its complicating the attachment of the plugs to the cables.

(4) The connector plugs are supplied fully assembled, and it is usually necessary to take them apart in order to attach the cables. If not familiar with the work, it is well to make written notes during all disassembling operations so that the connector can be correctly reassembled. Also, reference is made to Figures 2-6 to 2-8, inclusive.

(5) Insulating coverings should be removed without "*nicking*" or otherwise damaging the braided shielding or other conductors in the cable.

(6) Carefully remove any spatterings of solder or shreds of wire on insulation and the inner portions of all connectors to prevent trouble after the cable has been put into service.

(7) Take care, especially on short cable lengths, to give the plug its correct axial orientation on the cable during the assembly. Excessive twisting of the cable in order to line up plugs on the two ends of a cable can be avoided by proper advance planning.

(8) On completing the assembly of each plug, short-circuit together all conductors and shielding at the far end of the cable. Check for low resistance with an ohmmeter across each pair of all these electrical elements at the plug. Then remove the short-circuits at the far end and check for high resistance at the plug.

g. Plug Type AN–3108–16–10P and Cable Clamp Type AN–3057–B are assembled on Remote Control Cable, Type MCOP–4 as follows:

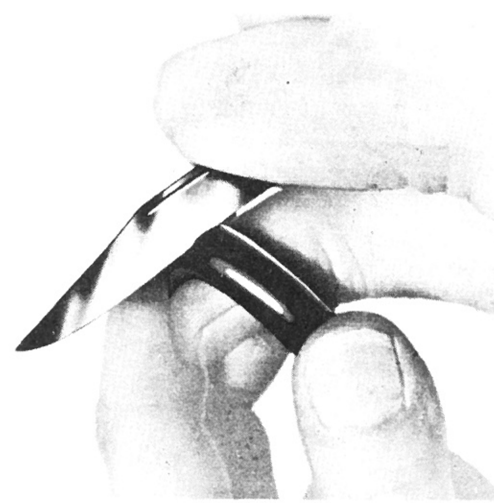


Figure 2-2—Cutting Rubber Cover

(1) Figure 2-2—Illustrates the method of cutting the outside rubber covering. The cut should be made one inch from the end. Bend the cable as shown and, using a sharp knife, cut on the outside of the bent portion, going all around the cable. It will be necessary to observe some caution in doing this so as not to cut into the insulated wires directly below.

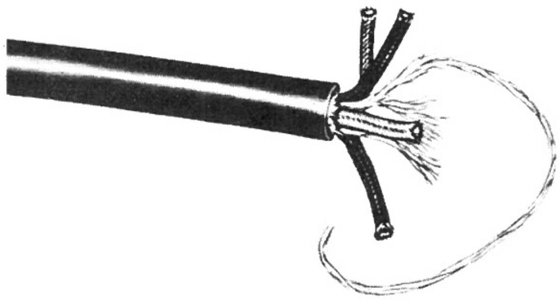


Figure 2-3—Cutting Jute and Cord Fillers

(2) Figure 2-3—Shows the four insulated wires and jute and cord fillers. Cut the jute and cord fillers and the brown colored insulated wire off even with the shoulder of the outer rubber covering.

Figure 2-4—Cable with Three Inner Conductors

(3) Figure 2-4—Illustrates how the cable should look at this time, showing the remaining three inner conductors.

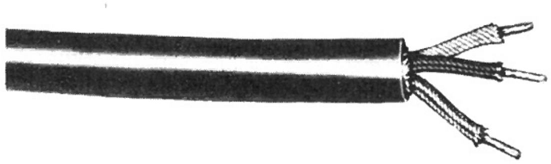


Figure 2-5—Cable with One-fourth Inch Insulation Removed

(4) Remove about one-fourth inch of the insulation covering each of these three wires, clean and tin the ends. The cable now appears as shown in Figure 2-5.

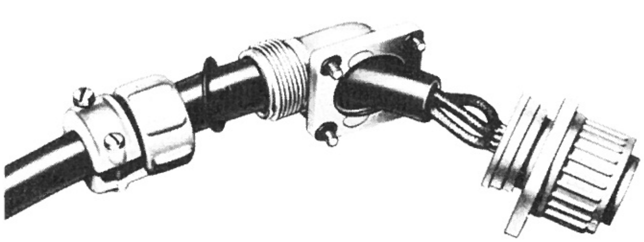


Figure 2-6—Remote Control Plug

(5) Disassemble the plug, Type AN–3108–16–10P, remove the four machine screws holding the plug body and elbow together, being careful not to lose the four small black washers. Then assemble the cable clamp, black washer, and elbow on the cable as shown in Figure 2-6.

(6) Insert the tinned end of the red wire in the contact marked "A" in the plug body and solder.

(7) Insert the tinned end of the yellow wire in the contact marked "B" in the plug body and solder.

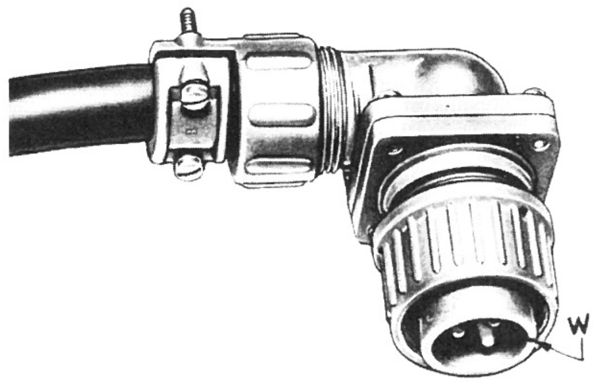


Figure 2-7—Elbow and Plug Body of Type AN-3108-16-10P Joined Together

(8) Insert the tinned end of the black wire in the contact marked "C" in the plug body and solder.

(9) Screw the cable clamp firmly into the elbow; fasten the elbow and plug body together with the four machine screws, making sure that the locating slot in the plug body is positioned as indicated by the letter "W" in Figure 2-7.

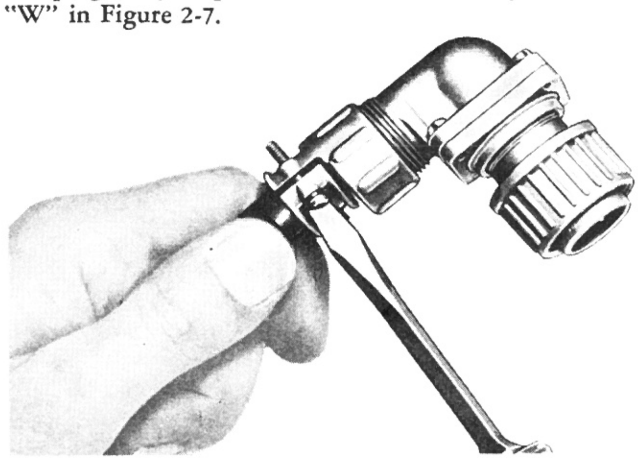


Figure 2-8—Tightening Two Screws in Cable Clamp

(10) Tighten the two machine screws in the cable clamp, as shown in Figure 2-8. This completes the assembly of this plug.

b. Plug, Type AN–3108–16–11S and Cable Clamp, Type AN–3057–B are assembled on Power Cable, Type DCOP–2 as follows:

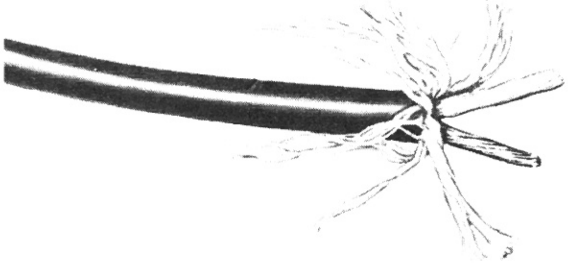


Figure 2-9—Cable with Covering Cut One Inch From End

(1) Cut through the rubber covering one-inch from the end as illustrated in Figure 2-2. The cable will then appear as shown in Figure 2-9.

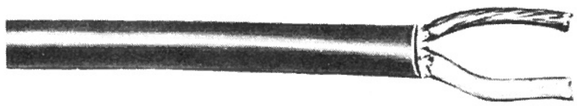


Figure 2-10—Cable with Thread Binder and Jute Filler Cords Cut

(2) Cut off the thread binder and the jute filler cords even with the shoulder of the outer rubber covering. The cable will then be as shown in Figure 2-10.

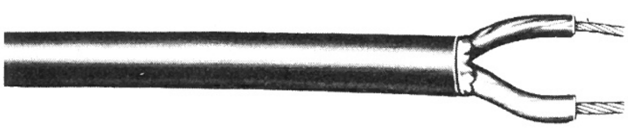


Figure 2-11—Cable Cleaned and Tinned

(3) Remove one-fourth inch of the insulation from the ends of the two inner conductors, clean, and tin. The cable as it now appears is shown in Figure 2-11.

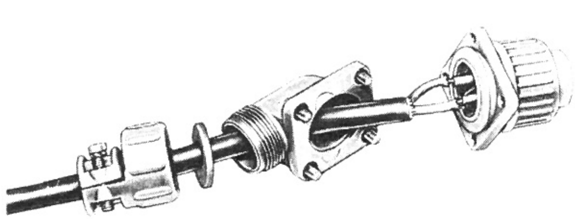


Figure 2-12—Power Plug

(4) Disassemble Plug, Type AN–3108–16–11S in the same manner as Type AN–3108–16–10P shown in Figure 2-6. Then assemble the cable clamp, black washer, and elbow on the end of the power cable as shown in Figure 2-12.

(5) Insert the tinned end of the white wire in the contact marked "A" in the plug body and solder.

(6) Insert the tinned end of the black wire in the contact marked "B" in the plug body and solder.

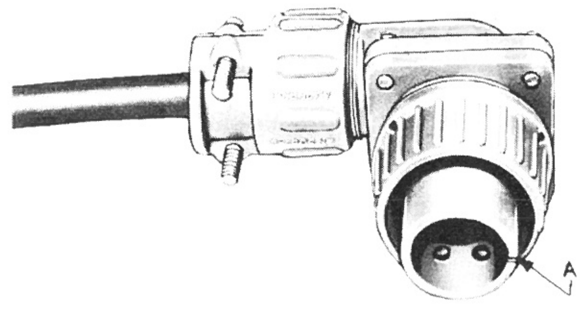


Figure 2-13—Elbow and Plug Body of Type AN-3108-16-11S Joined

(7) Screw the cable clamp into the elbow and fasten the elbow and plug body together with the four machine screws, making sure the locating notch or groove is positioned as shown by "A" in Figure 2-13.

(8) Tighten the two machine screws in the cable clamp as shown in Figure 2-8, Page 2-4.

i. The plug, Navy Type C**—49195, and adapter, Navy Type C**—49192 are assembled to the cable, Type AN–RG–10/U or its equivalent. This cable, plug, and adapter are used for connections to the following receptacles: Receiver Antenna (RCVR), Transmitter Antenna (TRANS), Synchronizing Pulse Input (SYNC. IN), Video Output (VIDEO OUT), Blanking Pulse Output (PULSE OUT).

Figure 2-14—Cable with One and One-eighth Inches Rubber Covering Removed

(1) If armored cable is used, remove armor for the required distance as explained in paragraph f(3), page 2-3. Using the same method as illustrated in Figure 2-2, Page 2-3, remove one and one-eighth inches of the rubber covering, being careful not to cut into the shield wires directly below. The cable now will look as shown in Figure 2-14.

(2) Unbraid the shielding wires for a distance of one-half inch from the end and cut off evenly as shown in Figure 2-15, Page 2-6. This will expose an additional synthetic covering over the inner conductor. Remove three-eighths of an inch of this by cutting around with a sharp knife and pulling the piece off. The end of the cable should now appear as in Figure 2-16, Page 2-6.

** Manufacturer optional.

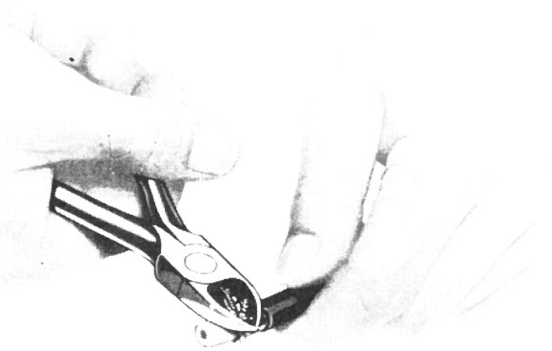


Figure 2-15—Cutting Shielding Wires

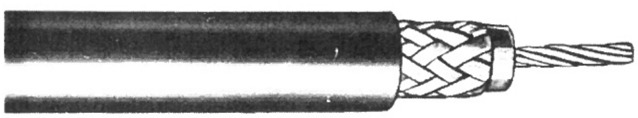


Figure 2-16—Cable with Synthetic Covering of Inner Conductor Removed

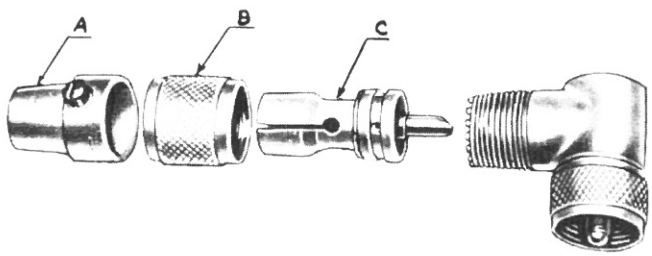


Figure 2-17—Plug Parts and Adapter

(3) Referring to Figure 2-17, it will be seen that the plug parts have been designated as follows: Plug Shell "A," Locking Ring "B," Plug Body "C." Care should be taken to see that the shell "A" and locking ring "B" are fitted over the cable in the proper order and with each in the proper direction. Begin by putting the shell on, narrow end first. Examination of the locking ring will reveal that one end has an internal shoulder. This end goes on first and therefore comes up against the wide end of the plug shell on the cable. These parts must be on the cable before it is inserted into the plug body. Corrugations of threaded form in the plug body make it possible now to screw this part onto the cable.

(4) The shield of the cable should now be soldered to the plug body, designated as "C" in Figure 2-17. The solder should be applied through the four holes in the waist of the plug body, taking care that no solder creeps up on either shoulder of the plug body. This is shown in Figure 2-18.

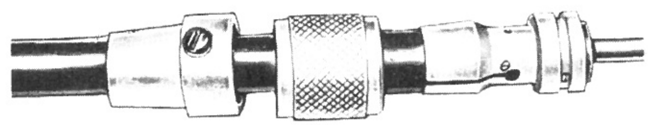


Figure 2-18—Plug Parts Assembled on Coaxial Cable

Figure 2-18—how the plug parts should be assembled on the coaxial cable.

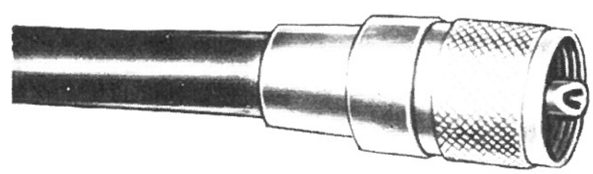


Figure 2-19—Plug and Cable with Set Screw in Plug Shell Tightened

Figure 2-19—completed plug and cable, after set screw in plug shell has been tightened.

(5) Finish the assembly of this plug by pulling the locking ring and the plug shell in place as shown in Figure 2-19 and tighten the set screw in the plug shell.

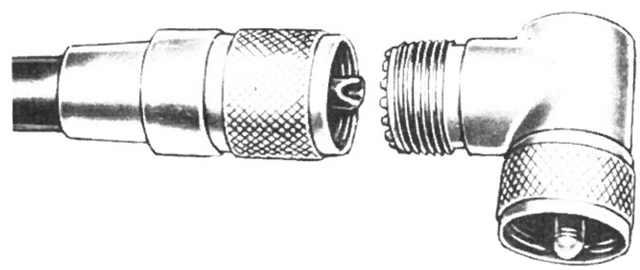


Figure 2-20—Plug, Cable and Adapter Previous to Joining

Figure 2-20 — completed plug and cable with the Adapter Type C**–49192 ready to be screwed together.

(6) The assembly is completed by screwing the plug to the adapter as shown in Figure 2-20.

** Manufacturer optional.

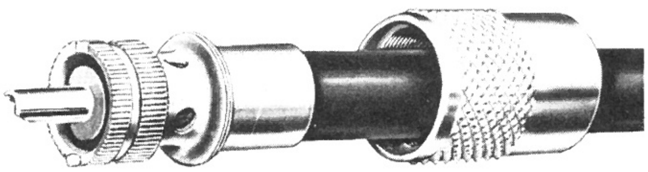


Figure 2-21—Assembling Plug

j. The plug Navy Type C**–49190 is different from the three piece plug Type C**–49195 in the fact that it is a two piece connector and has no set screw.

(1) The two piece connector is assembled onto the coaxial cable in a manner similar to that of the three piece plug.

(2) The coaxial cable is prepared exactly as outlined on Pages 2-5 and 2-6, the only difference being that the plug shell is tightened by its own threads in lieu of a set screw as in plug Navy Type C**–49195.

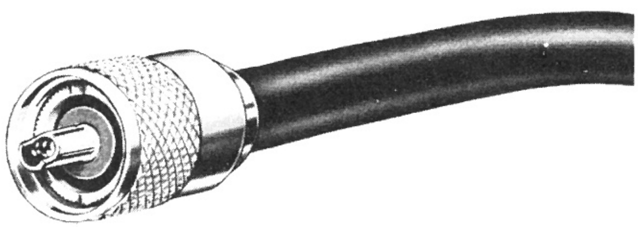


Figure 2-22—Plug Assembled on Coaxial Cable

(3) Figure 2-22 shows the completed two piece plug assembled into the coaxial cable after the plug shell has been tightened.

9. DUPLEXING UNIT.

a. INTRODUCTION.

(1) The Duplexing Unit Navy Type CTZ–50ACW is a device which permits a single antenna to be used for both transmitting and receiving in connection with associated radio equipment. Refer to Duplexing Unit Navy Type CTZ–50ACW dimensional outline photograph, Page 2-8, Figure 2-23.

(2) Duplexing Unit Navy Type 50AFH* has been specifically designed for use with the Model BN and similar type equipments. However, Duplexing Type CTZ–50ACW (supplied with Model BN equipment) may be used should the Type 50AFH not be available.

b. CHOICE OF LOCATION.

(1) The approximate overall dimensions of the duplexer are 21 inches long, four and five-eighths inches wide, and four and three-fourths inches high. Any location permitting space for the duplexer itself and accessibility to the four receptacles, two adjusting knobs and dials will be suitable. The adjusting knobs must be accessible to the operating personnel, and the dials must be seen for readings to be taken. The receptacle must be accessible in order to make the cable connections and to permit use of the special "TEST" terminal. Allowance for the bending of cables should be made therefore at all the four receptacles. Another factor in the choice of location of the duplexer is that the panel of the radio receiver should be visible to the person adjusting the duplexer. A very important consideration is that the lengths of the cables between the duplexer and the Model BN equipment should be kept as short as possible to avoid unnecessary power losses.

c. MOUNTING.

(1) The duplexer may be mounted in any position near the associated radio equipment. Three holes for mounting the duplexer case are provided—the single hole in the bracket at one end and two holes in the bracket at the other end. Bolts of one-fourth inch diameter should be used through these holes.

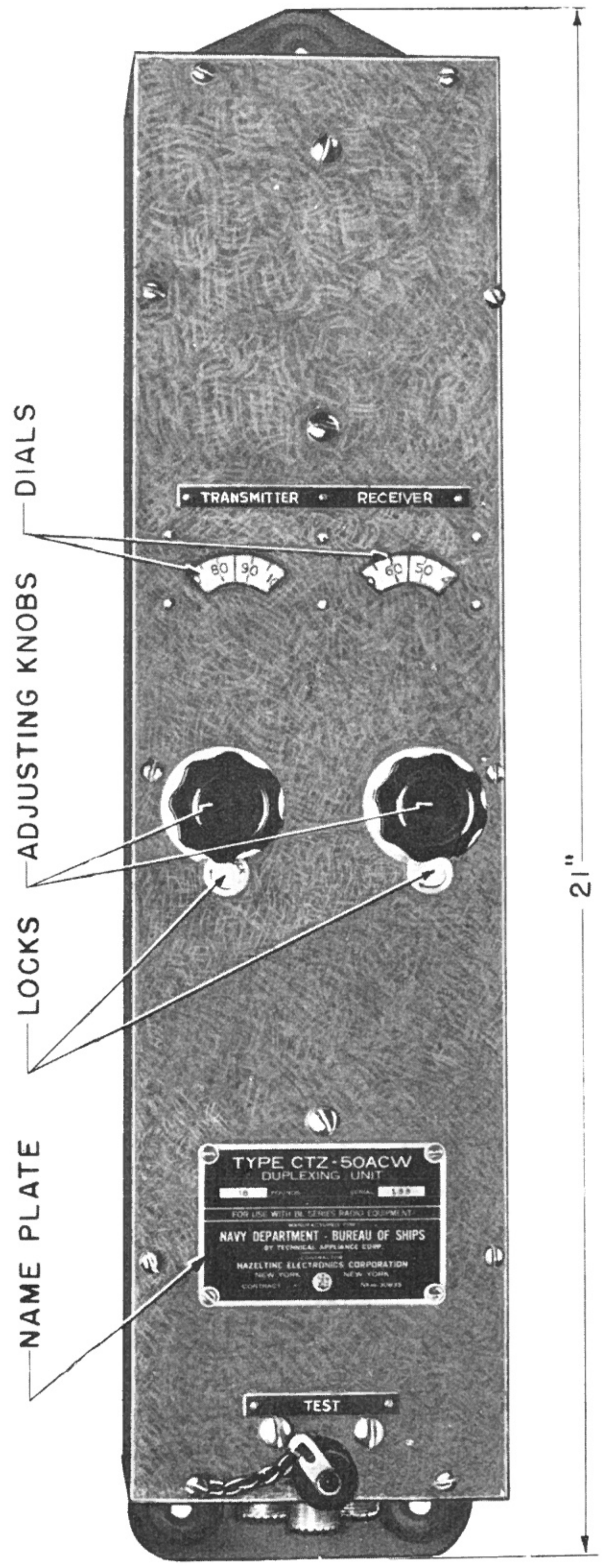
d. CONNECTIONS.

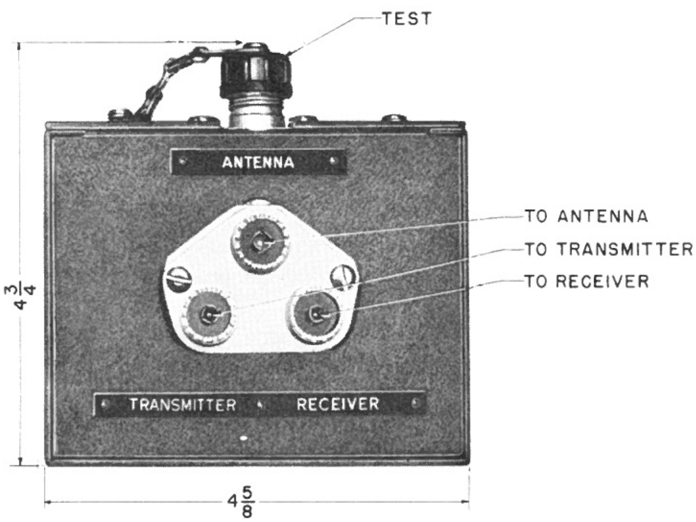
(1) The duplexer is supplied with three plugs Type C**–49195, which are ready to be attached to cable, Navy Type AN–RG–10/U for making the antenna, transmitter, and receiver connections. Refer to CABLE INSTALLATION, Paragraph 8, Pages 2-3 to 2-7.

e. TESTING.

(1) The central terminals of the three main receptacles are connected together as far as a direct-current test is concerned, and are insulated from the outer terminals and the case. A completed installation, with the three cables connected to the duplexer but disconnected at their other ends, should therefore show very high resistance between the central and outer conductors at any one of the remote ends of these three cables. This is a check against short-circuits. As a check for continuity, one of the remote cable ends should be shorted, after which very low resistance should be found at the other two cable ends.

** Manufacturer optional.
* These instructions are intended for both types.





SPACE REQUIREMENTS

SPACE PROVISIONS MUST ALLOW FOR:

1. BENDING OF CABLES AT "TRANSMITTER", "RECEIVER", "ANTENNA", AND "TEST" JACKS
2. OPERATING PERSONNEL TO TURN ADJUSTING KNOBS AND READ DIALS.

Figure 2-23—Duplexing Unit Navy Type CTZ-50ACW dimensional outline photograph—Top and Front Views

10. ANTENNA ASSEMBLY TYPE CTZ-66AFJ.

a. INTRODUCTION.

(1) This antenna is suitable for use on all sizes of naval vessels where space aloft is limited. This antenna has a height of about 18 inches (excluding the pipe on which it is mounted) and a diameter of 20 inches at the widest point. The weight is about eight pounds.

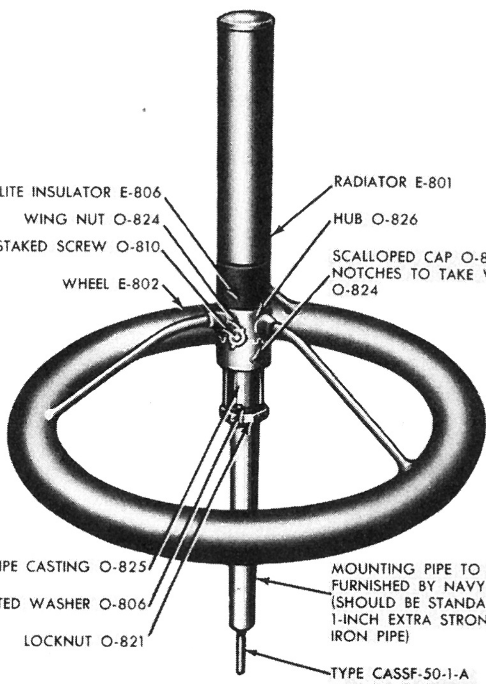


Figure 2-24—Antenna Assembly Navy Type CTZ-66AFJ

(2) This antenna is essentially a vertical radiator, sending out vertically-polarized waves. Below this radiator are a bakelite insulator and a horizontal wheel. The wheel furnishes a ground plane with respect to which the radiator operates. The antenna concentrates the energy toward the horizon to a fair extent. In the horizontal plane the antenna has a circular radiation pattern so that the efficiency in all directions is uniform unless disturbed by the presence of nearby metal structures. (See Selection of Antenna Location, Page 2-12.)

b. MAJOR PARTS AND ACCESSORIES.

(1) Five antenna assemblies of Navy Type CTZ-66AFJ are shipped in a wooden case. Each assembly is enclosed in a corrugated carton containing the following items in separate fillers:

Item No.	*Description*
1	Wheel with pipe casting and scalloped cap attached.
2	Radiator with bakelite insulator, two gasket washers, spacer, plain washer, castellated nut, and cotter pin, assembled on a square piece of plywood.
3	One small envelope containing one 1-inch lock nut, one serrated washer, one extra cotter pin, and one insulating bushing.
4	Wrench to fit castellated nut.
5	One instruction book.

(2) The pipe on which the antenna is mounted and the connecting cable are not supplied as parts of the antenna and must be obtained at the point of installation.

(3) The appearance and construction of the antenna are shown in Figures 2-24 and 2-32.

c. UNPACKING AND DISASSEMBLING.

(1) In unpacking the antenna, carefully remove everything from the cardboard fillers protecting Items 1 and 2. In opening the envelope, Item 3, make sure not to mislay or drop any of the small parts. Do not lose Item 4, which is the wrench to be used in tightening the castellated nut, as explained in a later section of these instructions.

(2) It will be necessary to disassemble Items 1 and 2 before putting together the complete antenna assembly. To disassemble Item 1, first rest the wheel (E 802) on a flat surface. Next unscrew the wing nut (O 824) on the staked screw (O 810) until it is entirely clear of the scallops of cap (O 801). Then hold pipe casting (O 825) in one hand and unscrew the scalloped cap (O 801) with the other hand, releasing these two parts from the hub (O 826). Be careful not to drop and lose the pipe casting and scalloped cap during this operation. Make sure that gasket washer (O 822) is over the guide pins (O 819) and (O 819A), which project from the base of the hub next to the pipe casting.

(3) Be especially careful in disassembling Item 2 not to damage any of the parts enclosed in a paper tube projecting from the square of plywood. Rest Item 2 horizontally on a flat surface. Remove the paper tube. Then remove the cotter pin (O 818), and unscrew the castellated nut (O 812). This releases the washer (O 814), the spacer fitting (O-815), the bakelite insulator (E 806), and the gasket washers (O 807) and (O 808). Then slide—do not twist—the plywood mounting off the connector (E 803) until it clears the end of the banana plug (P 802). [Turning the plywood in the first part of this operation would bend and distort the jumper (E 804).] The bakelite insulator (E 806) and possibly the gasket washers (O 807) and (O 808) (both of these washers are to be found between insulator and radiator) will then come off. Do not let the bakelite insulator roll away.

(4) Put the gasket washer (O 807) in place on the radiator, and gasket washer (O 808) in place on the hub, as shown in Figure 2-32.

(5) Inspect the jack (J 801), which consists of a split cylinder. Check the fit of this jack over the pin of the plug (P 801), which is gripped by the chuck jaw (O 802) in the pipe casting (O 825). If the fit is loose, pinch the sides of the jack slightly with a pair of pliers. Avoid closing the two sides too much.

(6) The various parts of the antenna are now ready for assembly. Do not take anything aloft until required at a later stage of the job.

d. ATTACHMENT OF RADIATOR TO HUB.

(1) Have the wheel (E 802) lying on a flat surface, with the spokes going up to the hub. Hold the radiator in one hand and place the bakelite insulator (E 806) over the gasket washer (O 807), at the same time seeing that the screw (O 811) goes between the two guide pins (O 820). The radiator and bakelite insulator must now be held together as one part so that neither turns. Now examine the jumper (E 804) and the banana plug (P 802) to see that the banana plug is directly opposite the screw (O 811-A). Put the connector (E 803) through the center hole in the hub (O 826) and fit the banana plug (P 802) into the small hole of the hub, at the same time looking between insulator spacer and hub to make sure that screw (O 811 A) enters between the guide pins (O 820 A) projecting from the top of the hub.

(2) The bakelite insulator is now temporarily held in place. To check the last operation it is necessary to raise the wheel (E 802) from the flat surface on which it has been lying and to look into the bottom of the hub to see if the tip of the banana plug shows, as indicated at point P in Figure 2-32.

(3) With the wheel now raised, the insulating bushing (E 807) may be placed over the connector (E 803) until the shoulders of the bushing are flush against the hub casting. The neck of the insulating bushing will now be in the center hole of the hub, and the bushing will serve its purpose of preventing a short-circuit between the hub casting and the connector. Next slide the spacer fitting (O815) over the connector and up to the insulating bushing, then slide the washer (O 814) up to the spacer fitting, and finally screw on the castellated nut (O 812).

(4) To make sure that the castellated nut is on tight, use the half-inch wrench (Item 4, Page 2-9) and tighten the nut till the gasket washers (O 807) and (O 808) begin to bulge out. The next operation is to insert the cotter pin, and it should be noted that the hole through the jack is at the end of the slot which divides the two sides of the jack. Therefore turn the castellated nut, if necessary, a little tighter until the next groove in the head of the nut lines up with the slot of the jack. Then insert the cotter pin and spread it. This operation completes the assembly of the radiator, insulator, and wheel.

e. REMOVAL OF PLUG FROM PIPE CASTING.

(1) The next step is to loosen the three chuck screws (O 809) slightly, in order to release the plug (P 801) from the grip of the chuck. The plug may then be removed from the under side of the opening in the pipe casting.

f. ASSEMBLY OF CHUCK IN PIPE CASTING IF REQUIRED.

(1) Should the chuck come apart in this process, adhere to the following in putting it together again.

(a) Holding one chuck jaw (O 802) upside-down on a hard flat surface, insert the horizontal pin of the second chuck jaw into the corresponding hole of the first.

(b) Place the spring (O 803) into the groove provided for it in the chuck jaws as shown in Figure 2-32, Page 2-13, and hold these three parts together with a finger.

(c) Then insert the free part of the spring in the groove of the third chuck jaw and fix the groove pin of this part into its corresponding hole.

(d) Make sure that all three jaws are properly aligned; that is, the bottom and top of the chuck as now assembled must both be even.

(e) Lift the assembled chuck, keeping it firmly together, and place it into the top hollow of the pipe casting (O 825) so that the holes for the chuck screws in the chuck are aligned with the holes for these screws in the pipe casting.

(f) Place the chuck washer (O 804) over the chuck, and insert the chuck screws, making sure that a lock washer (O 816) is on each screw as shown in Figure 2-32, Page 2-13.

(g) Turn down each chuck screw far enough to hold the chuck firmly in the pipe casting, but not more than this. Enough opening of the chuck should be left for the plug (P 801) to be inserted later.

g. ATTACHMENT OF PLUG (P 801) TO CABLE.

(1) The next step is to attach the plug (P 801) to the flexible coaxial cable. This antenna is designed for use with Navy Type AN–RG–10/U coaxial cable, which is composed of a core of stranded copper wire surrounded by a high-frequency light-colored flexible insulator material called Polyethylene. Figure 2-25, Page 2-11, shows a cross-section of this cable. The high-frequency insulation is encased in a shielding copper braid, which in turn is covered with a black synthetic rubber-like protective material sometimes called Vinylite. On the outside is a woven wire armor. This cable is similar to the British PT-5, except for the addition of the armor.

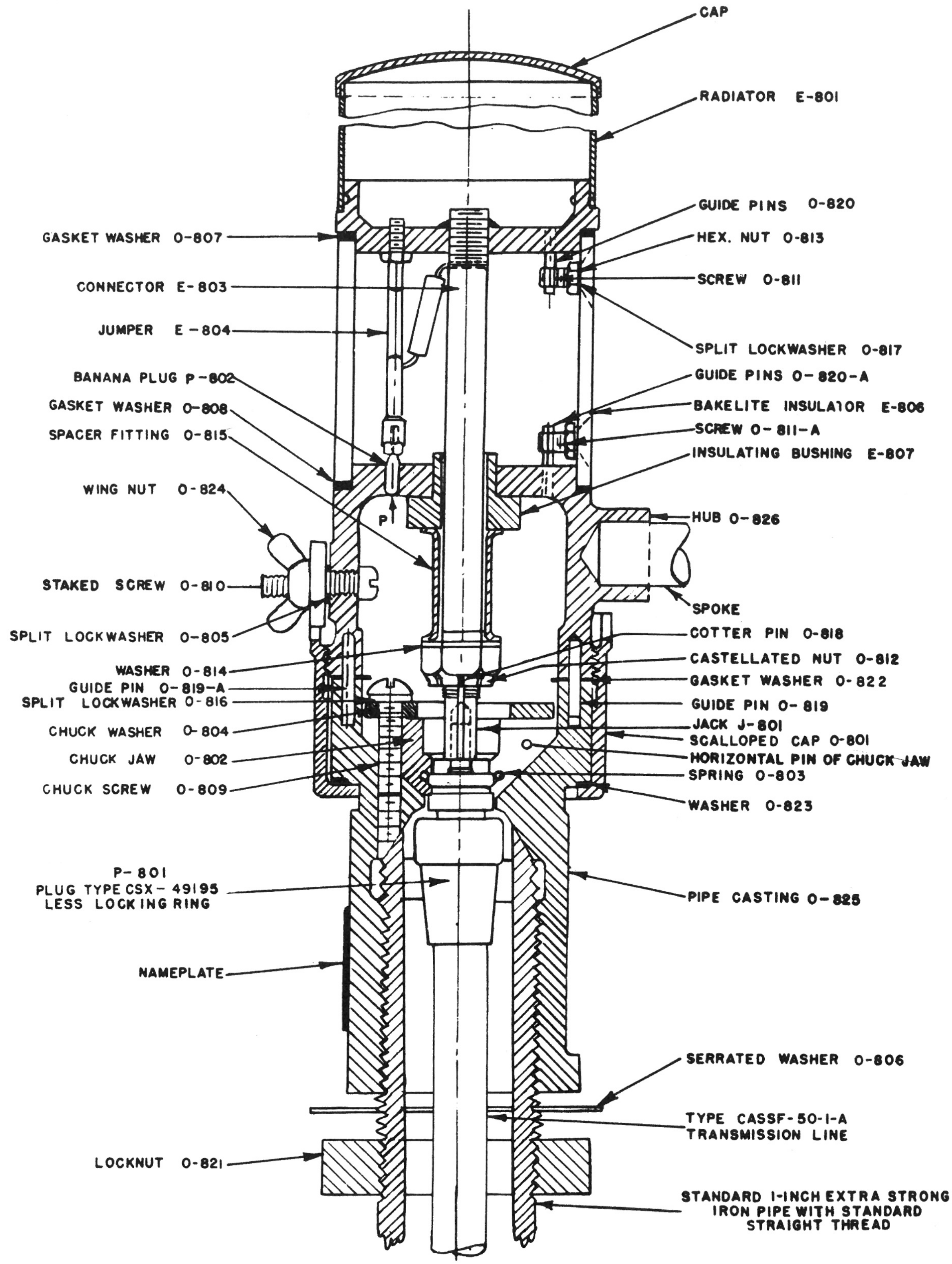


Figure 2-32 —Construction of Antenna Navy Type CTZ-66AFJ (*a*) FIRST METHOD.

1. If the cable is free where it comes out of the bottom of the mounting pipe, it can of course be turned inside the pipe. The assembly in this case starts with having the cable in the pipe, with the plug a few inches above the top of the pipe. Then insert the plug into the chuck jaw (O 802) and secure the plug in place by tightening the three chuck screws (O 809).

2. The next step is to screw the pipe casting onto the mounting pipe. During this operation, the cable will turn inside the pipe; and this action must be accommodated without damage to the cable. After the pipe casting is firmly screwed onto the pipe, bring up the lock nut (O 821). Then turn up the teeth of the serrated washer (O 806) on both sides of the small stop block which is part of the pipe casting. Bend all the remaining teeth of this lockwasher down around the nut (O 821).

(*b*) SECOND METHOD.

1. If the cable cannot be turned inside the mounting pipe, the first method cannot be used. In this case the chuck screws must be set up in two stages, as will be seen from the detailed directions in the following paragraphs.

2. As before, have the cable in the pipe with the plug a short distance above the top of the pipe. The pipe casting should now be held so that its internally threaded portion is near the top end of the mounting pipe, and the plug should then be pushed up into the pipe casting. The three chuck screws (O 809) should be loosened if necessary to permit the plug to be thrust up as far as it will go. Then tighten the screws just enough so that the plug cannot be withdrawn from the chuck. At this time the chuck jaws should not grip tightly, but the pipe casting should be allowed to turn without twisting the transmission line.

3. The pipe casting should then be placed on the mounting pipe and carefully rotated until the threads engage. Then tighten the pipe casting on the pipe. Watch the plug (P 801) while turning the pipe casting. Plug (P 801) must not turn. If it starts turning, jar it with the fingers so as to free it from being turned by the chuck jaws.

4. After the pipe casting is secure on the pipe, the locknut (O 821) must be turned up tight against the bottom of the pipe casting. The teeth of the serrated washer (O 806) will protrude beyond the edge of the nut. Bend two of the teeth upward, one on each side of the small stop block which is part of the pipe casting. Bend the remaining teeth down around the locknut. Then tighten the chuck screws (O 809) inside the hub so that the chuck jaws (O 802) firmly clamp the plug (P 801). This is important in order to get a good electrical connection on the ground side of the circuit.

j. ATTACHMENT OF WHEEL AND RADIATOR TO PIPE CASTING.

(1) Apply a small amount of lubrication on the upper side of the brass washer (O 823) in order to permit easy turning of the scalloped cap (O 801), which has a shoulder bearing against this washer. Use only a very small amount of oil or grease.

(2) Then loosen the wing nut (O 824) until it is one-fourth-inch away from the hub. (The screw on which the wing nut turns has a flattened end so that the wing nut cannot come off.) Make sure that gasket washer (O 822) is over the guide pins (O 819) and (O 819 A), which project from the bottom of the hub. Carefully align the assembly of the radiator (E 801) and the wheel (E 802) so that these pins will enter the two holes in the top of the pipe casting. Now look between the bottom of the hub (O 826) and the top of the pipe casting (O 825) to make sure that the jack (J 801) slips over the pin of the plug (P 801). This is important for obtaining a good electrical connection on the high side of the circuit. Then lower the assembly of the wheel and the radiator into place.

(3) Lift the scalloped cap (O 801) and screw it onto the hub until the scalloped cap is as tight as it can be turned by hand. Then, taking care not to strip the inner threads of the cap, tighten it with a pipe wrench, at the same time holding the pipe casting (O 825) if necessary to prevent it from rotating. Then further tighten the scalloped cap slightly on the hub so as to permit the wing nut (O 824) to be screwed firmly in place into one of the 12 notches cut into the cap.

(4) This completes the antenna installations, except for testing.

(5) As suggested by the instructions on the two methods of assembling the plug, pipe casting, and hub, the securing of the cable run should preferably be the final step in the antenna installation. This order of assembly will allow a desirable freedom of cable movement while the antenna is being mounted.

k. TESTING.

(1) The only simple electrical test on the completely assembled antenna is to check with an ohmmeter at the bottom end of the cable. Since the antenna itself offers very little resistance to direct current, the ohmmeter reading will be low. A high reading indicates a faulty installation.

(2) The order of assembly as given in these instructions should be followed rigidly to prevent a short-circuit, which would impair the performance of the antenna and yet not be revealed by the direct-current test. Make sure in assembling the connector (E 803) into the hub (O 826) that the insulator bushing (E 807) goes over the connector first and then the spacer fitting (O 815). Over this is placed the washer (O 814), and then the castellated nut (O 812), which is held in place by the cotter pin (O 818).

l. MAINTENANCE.

(1) The maintenance requirements of this antenna are simple. The outside of the bakelite insulator (E 806) should be kept clean to prevent the accumulation of soot and dirt which would be harmful when soaked with salt water.

(2) The insulator is wax-impregnated and must not be painted. But the rest of the antenna can be painted as required, and no special precautions need be observed in this work.

11. ANTENNA ASSEMBLY TYPE CTZ-66ACG.

a. INTRODUCTION.

(1) The antenna Type CTZ–66ACG is suitable for use on small and medium naval vessels where space aloft is limited. This antenna has a height of only about 20 inches (excluding the mounting pipe) and a diameter of only about 19 inches at the widest point. The weight is about five pounds.

b. MAJOR PARTS AND ACCESSORIES.

(1) The antenna assembly Type CTZ–66ACG is shipped in one cardboard carton containing the following items:

Quantity	*Description*
1	Steering wheel.
1	Radiating rod.
1	Lock nut.
1	Lockwasher.
1	Instruction book.

(2) The required mounting pipe and connecting cable are not supplied as parts of the antenna. These must be obtained at the point of installation.

c. GENERAL DESCRIPTION.

(1) The appearance and construction of this antenna are shown in Figures 2-33 and 2-34. The radiating conductor is a vertical rod (E 701), which sends out vertically polarized waves. At the bottom it is insulated from a fixed wheel structure which establishes a plane of ground potential for a limited distance. A central hub structure supports the rod and wheel and is screwed onto a mounting pipe. This pipe also encloses the transmission line from the radio equipment.

(2) The rod (E 701) of the antenna attaches at the bottom to a cylindrical insulator (E 702) which is about an inch high. This assembly of rod and insulator is attached to the hub of the wheel through a threaded flanged coupling (O 701). A terminal which is electrically connected to the rod extends down thru the insulator to contact by means of a jack (J 701) with a plug (P 701) at the top end of the transmission line. This provides a connection from the rod to the central lead of the transmission line. Connection is made from the outer lead of the transmission line to the hub of the wheel, which makes direct contact to the spokes and rim.

(3) The wheel portion of the antenna furnishes a ground plane so that the behavior of the antenna is a good deal like that of a vertical antenna above a real ground. This antenna provides low-angle radiation, acting to concentrate the energy toward the horizon like a simple vertical dipole. In the horizontal plane the antenna has a circular radiation pattern so that the radiating efficiency in the various directions of azimuth is uniform unless it is disturbed by the presence of nearby metal structures.

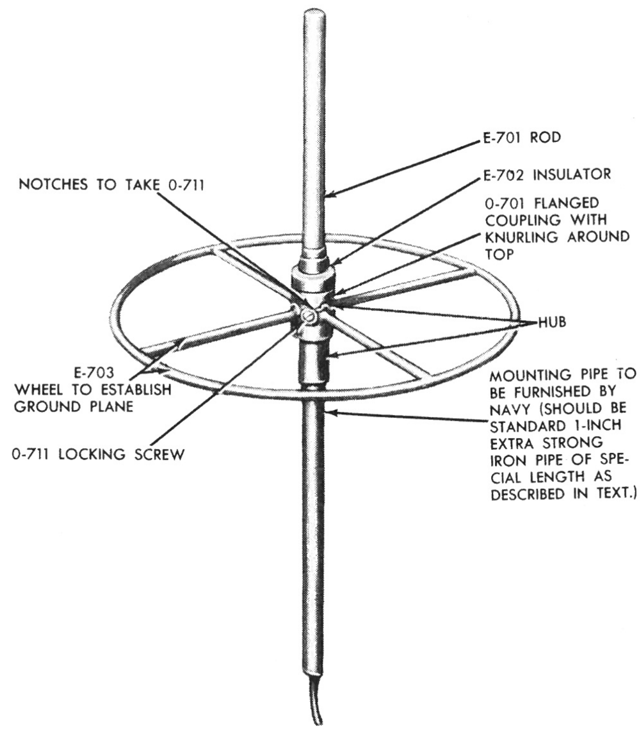


Figure 2-33—Antenna Assembly Navy Type CTZ-66ACG

d. SELECTION OF ANTENNA LOCATION.
(Refer to Page 2-14, Paragraph 10 b.)

e. UNPACKING.

(1) In unpacking the antenna remove everything from the carton and slip the rod (E 701) out of its cylindrical cardboard cover. Take care in handling this rod to avoid damaging the insulator (E 702) and the projecting jack (J 701) at the bottom end. Inspect this jack to see that its two portions form a symmetrical split cylinder. Check the fit of this jack over the pin of the plug (P 701) at the top end of the transmission line. If it fits loosely, pinch the sides of the jack slightly with a pair of pliers. Take care to avoid closing the two sides too much.

f. ATTACHMENT OF PLUG P-701* TO CABLE. *(Refer to instructions in Paragraph 10g, on Pages 2-10 to 2-12 inclusive.)*

g. MOUNTING.

(1) The antenna is to be supported on standard one-inch extra strong iron pipe which must be obtained at the point of installation. As already mentioned, this should have a length of approximately 14 or 49 inches above the nearest point of support, this distance being measured on the mounting pipe in the clear before the antenna is attached. A suitable arrangement for attaching the mounting pipe to the yardarm of a vessel is shown in Figure 2-31, Page 2-12.

(2) The top end of the mounting pipe must have a standard straight pipe thread for at least two and a half inches. It is desirable that the mounting pipe also have at its top end a long conical taper of 30 degrees so as to press against a corresponding surface inside the hub, as shown in Figure 2-34. This gives a firmer installation.

(3) At this point screw the lock nut (O 713) on the mounting pipe, and then put on the lockwasher (O 714). These are then ready for use later.

(4) The assembly of the plug (P 701), the hub, and the mounting pipe can be made in either of two methods depending on whether the cable can be rotated inside the mounting pipe.

(a) FIRST METHOD.

1. If the cable is free where it comes out of the bottom of the mounting pipe, it can of course be turned inside the mounting pipe. The assembly in this case starts with having the cable in the pipe with the plug a few inches above the top of the pipe. Then insert the plug into the chuck of the hub and secure the plug in place by tightening the three chuck screws (O 705), (O 706), and (O 707).

2. The next step is to screw the wheel onto the mounting pipe. During this operation, the cable will turn inside the pipe; and this action must be accommodated without damage to the cable. After the hub is firmly screwed on the pipe, bring up the lock nut (O 713). Then turn up the teeth of the lockwasher (O 714) on both sides of the small stop block which is part of the hub. Bend all the remaining teeth of this lockwasher down around the nut (O 713).

(b) SECOND METHOD.

1. If the cable cannot be turned inside the pipe, the first method cannot be used. In this case the chuck screws must be set up in two stages, as will be seen from the detailed directions in the following paragraphs.

2. As before, have the cable in the pipe with the plug a short distance above the top of the pipe. The wheel of the antenna should now be held so that the internally threaded portion of its hub is near the top end of the mounting pipe, and the plug should then be pushed up into the hub. The three chuck screws (O 705), (O 706), and (O 707) within the hub should be loosened if necessary to permit the plug to be thrust up as far as it will go. Then tighten the screws partway until the plug is held so that it cannot be withdrawn from the three chuck wedges (O 708), (O 709), and (O 710). However, at this time the chuck wedges should not grip tightly; they should allow the wheel to be turned without twisting the transmission line.

3. The wheel should then be placed on the mounting pipe and rotated carefully until the threads engage. Then tighten the wheel on the pipe. Watch the plug (P-701) while turning the wheel. Plug (P 701) must not turn; if it starts turning, jar it with the fingers so as to free it from being turned by the chuck wedges.

4. After the wheel is secure on the pipe, the lock nut (O 713) must be turned up tight against the bottom of the hub. The teeth of the serrated lockwasher (O 714) will protrude beyond the edge of the nut. Bend two of the teeth upward, one on each side of the small stop block which is part of the hub. Bend the remaining teeth down around the nut itself. Then tighten the chuck screws (O 705), (O 706), and (O 707) inside the hub so that the chuck wedges (O 708), (O 709), and (O 710) firmly clamp the plug (P 701). This is important in order to get a good electrical connection on the ground side of the circuit.

(5) Mount the antenna rod as follows:

(a) Apply a small amount of lubrication on the upper side of the brass washer (O 718) in order to permit easy turning of the flanged coupling (O 701) which has a shoulder bearing against this washer. Use only a very small amount of oil or grease.

(b) Then loosen the locking screw (O 711), having a large head, and back it off until the head is some distance from the hub. Do not take this screw out because it might fall and be lost. Take the antenna rod (E 701) and carefully put it in place so that its jack (J 701) slips over the pin of the plug (P 701) in the center of the hub. This is important for obtaining a good electrical connection on the high side of the circuit. Then screw the flanged coupling (O 701), located at the lower end of the rod, to the hub until it is as tight as it can be turned by hand. In all the tightening of O 701, hold the rod (E 701) to prevent it from rotating while the coupling (O 701) is being tightened. If care is not taken about this, the jack (J 701) may be sprung open and electrical contact lost. Now notice that a small amount of additional tightening of the flanged coupling (O 701) will permit the locking screw (O 711) to enter one of the rounded notches which are cut into the lower edge of the flanged coupling. This additional tightening should be performed, again holding rod (E 701). Then put screw (O 711) all the way in and tighten it firmly. This completes the antenna installation, except for testing.

* P 701 and P 801 are both Navy Type C**49195.

(6) As suggested by the discussion of the two methods of assembling the plug, pipe, and wheel, the securing of the cable run should preferably be left as the last part of the antenna installation. This affords a desirable freedom of cable movement during the mounting of the antenna.

h. TESTING.

(1) Electrical tests on the completely assembled antenna should be made with an ohmmeter, as follows:

(a) Short circuit the bottom end of the cable. Very low resistance should then be found between the rod and wheel portions of the antenna. Care should be taken to secure good electrical contacts with both the rod and the wheel. In making this test it will be necessary to scratch away a little of the paint, using a sharp test probe. Select a point in the center of a smooth surface away from any edges, and remove the paint from only a very small spot.

(b) Change the conditions at the bottom end of the cable so as to have an open circuit here. Very high resistance should then be found between the rod and wheel portions of the antenna.

(2) If either of these tests shows a faulty condition, report the matter promptly to the proper authority.

i. MAINTENANCE.

(1) The maintenance requirements of this antenna are simple. The insulator (E 702) at the hub of the wheel should be given a periodic visual inspection to determine whether it has any cracks which would permit water to get inside the hub. If cracked, the insulator should be replaced. To accomplish this remove the rod (E 701) from the hub by loosening the locking screw (O 711) and the flanged coupling (O 701). Cotter pin (O 704) and nut (O 703) are then removed from jack (J 701) so that the cracked insulator can be removed and a new one put in place. The nut (O 703) is then put back on and tightened and the cotter pin put in place. The rod is then replaced.

(2) The antenna can be painted whenever desired, and no special precautions have to be observed in this work.

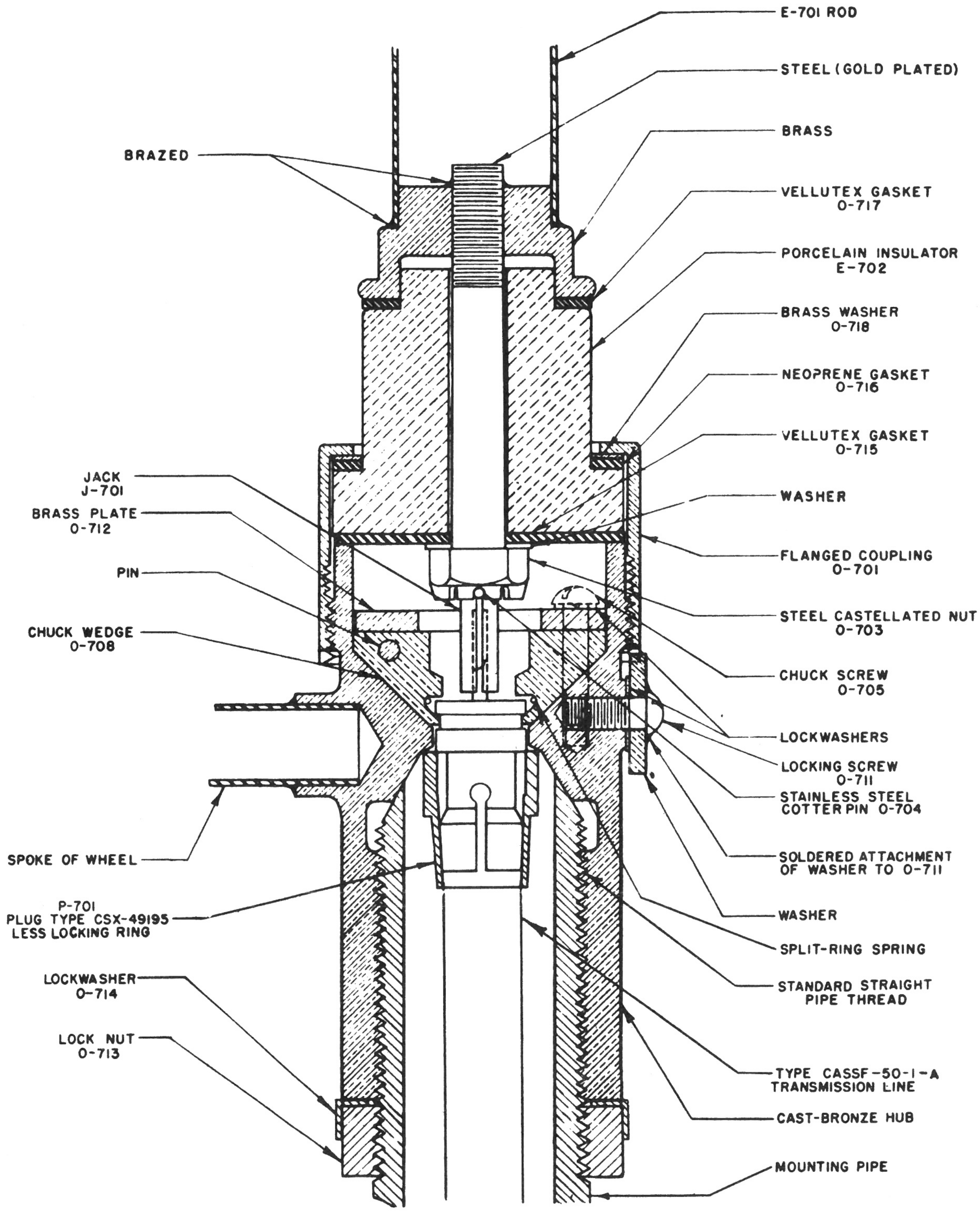


Figure 2-34 —Details of central portion of Antenna Navy Type CTZ-66ACG

12. RECEIVER ADJUSTMENTS.

a. INTRODUCTION.

Upon completion of installation and before operation is undertaken, the equipment must be checked and adjusted properly. The following procedure is based on the assumption that the installation is completed in all respects. It is applicable where no previous adjustments have been made (newly installed equipment, major service work has been undertaken) or where the equipment has been out of service for an extended period of time. The controls are indicated on Figures 7-6 and 4-1, Pages 7-11, 7-12 and 4-1 respectively either by schematic symbols or by the actual names as used on the nameplates of the individual controls. In addition to the controls shown, there are two other controls, namely, the INTERROGATION switch (S51) and the RECEIVER GAIN control (R51), both of which are located at the Radar equipment and serve as remote controls for the BN equipment.

b. WAVEMETER OSCILLATOR.—The equipment required to make adjustments on the receiver will be a Model OAP Wavemeter Oscillator and an auxiliary gain control [IF THE GAIN CONTROL (R51) and INTERROGATION switch (S51) are located at a distance from the receiver] and a short length of hook-up wire.

c. Before proceeding with adjustments, it is recommended that the adjustor study the Instruction Book for the Model OAP Wavemeter Oscillator and become familiar with its operation.

d. Connect the coaxial cable W201, shown on Pages 6 and 7 in the Preliminary Instructions for the Model OAP Wavemeter Oscillator, to the output jack of the Wavemeter and the other end to the ANTENNA jack (J11) of the receiver which is on the front panel of the BN equipment.

e. With the wavemeter power switch in the "OFF" position insert the power plug of the OAP Wavemeter Oscillator into convenience outlet (on front of BN equipment) of from 110 to 120 volts, 50 to 70 cycles.

f. If the GAIN control (R51) and the INTERROGATION switch (S51) are at some distance from the point where the receiver is installed, the auxiliary gain control and switch may be interconnected to the REMOTE CONTROL jack (J51). The AUXILIARY GAIN control (R201) is shown on Pages 6 and 7 in the Preliminary Instruction Book for the Model OAP Wavemeter Oscillator and is packed within the top lid of the wavemeter. Since this gain control is of a higher resistance than the GAIN control (R51) of the BN equipment, a different setting of the auxiliary control will have to be made to correspond to that of the normal gain control. Adjust the gain control clockwise to the maximum gain position.

g. The auxiliary interrogation switch is merely the connecting of terminal C of the REMOTE CONTROL Jack (J51) of the BN equipment to ground. This corresponds to the "OPERATE" position of the normal remote interrogation switch.

h. Turn all switches on the front panel of the BN equipment to their "OFF" positions and, after connecting POWER plug (P251) to the jack (J251), insert the cable into any 115 volt, 50 to 425 cycle a-c outlet.

i. TUNING.

(1) Before turning the power on, be sure all connections are made properly. Then switch power on to the BN equipment and also the Model OAP Wavemeter Oscillator. Allow the equipment to warm up thoroughly for at least five minutes.

(2) When the equipment is warmed up, adjust the Wavemeter Oscillator in accordance with the Instruction Book for the Model OAP Wavemeter Oscillator to the desired frequency.

(3) It will be noted in Section IV that the receiver is a superheterodyne in which the four tuning controls are separately tuned. The frequency of the Local Oscillator is required to be 30 megacycles lower than the signal frequency so as to convert the signal frequency to that of the intermediate-frequency amplifier which is 30 megacycles.

(4) Starting with the "OSC" control of the receiver, adjust each of the four tuning controls until the dark sector at the bottom of the VISUAL TUNING indicator (V12) is as narrow as possible. If the sector of the VISUAL TUNING indicator narrows completely, reduce the receiver gain, by means of the RECEIVER GAIN Control (R51), until some of the dark area is restored and a definite indication of a maximum signal is obtained.

(5) In all tuning operations on the receiver, care must be taken to avoid setting the controls at some spurious response. The remedy for mistuning is to check the setting of "OSC" control by turning it from one end of the band to the other in search of another response. Two responses may be found. The one occurring at the lowest frequency setting of the "OSC" control (the lowest number on the counter-dial) is the correct response and corresponds to the signal frequency minus the intermediate-frequency of 30 megacycles.

(6) The other response, which is the incorrect response, corresponds to the signal frequency minus one-half the intermediate-frequency of 30 megacycles which produces an intermediate-frequency of 15 megacycles. This contains harmonics, the second harmonic of which is 30 megacycles and would be amplified in the normal manner. The image frequency corresponds to the signal frequency plus the intermediate-frequency of 30 megacy-

cles. With the i-f frequency used in this equipment and the relative high selectivity, it is impossible to tune in on the image unless the input from the Wavemeter Oscillator is abnormally high or the gain control is not properly adjusted as previously outlined in the operation above.

(7) Now adjust the RECEIVER GAIN control (R51) until the visual tuning eye of the receiver is almost closed. That is, until the dark sector at the bottom of the TUNING EYE is very narrow.

(8) Once more adjust the Oscillator of the Wavemeter Oscillator to tune it exactly to the desired Wavemeter setting and again adjust all of the tuning controls for the smallest dark sector of the receiver visual tuning indicator.

(9) The receiver is now tuned and ready for use.

13. MODULATOR ADJUSTMENTS.

a. The modulator in the Model BN Equipment, if it has not incurred any damage enroute to its point of installation, should be in the proper operating condition and should require no adjustments after installation, aside from any needed on the front panel control, "GATE WIDTH" (R214).

b. Information on the GATE WIDTH control circuit and how it operates is given on Pages 4-14 and 4-15. This control in the gating circuit varies the positive gate pulse width from 250 microseconds to 1500 microseconds. This is the gate pulse which controls the length of time the receiver is made to operate immediately following each pulse from the transmitter. Since this is the only control to adjust if the equipment is in the proper operating condition, it is only necessary to adjust this control to obtain the width of the gate pulse, or receiver operating time, which corresponds to the Radar indicator sweep.

NOTE

It will be possible on some sets to set this control for too wide a pulse in which case the gate pulse generator will deliver alternate long and short gate pulses or actually count down 2-1 and deliver a gate pulse for every second trigger pulse. This will only happen if the "RECEIVER GATING WIDTH" Control is turned so far in a clockwise direction as to cause the Gate Pulse Generator to attempt to deliver pulses over 1700 microseconds in width, which is much longer than what is required for proper operation of the equipment. To insure proper adjustment the Receiver Gating Width Control should first be turned fully counterclockwise. Then rotate the control clockwise until the Receiver is gated for the desired width as seen on the indicator scope.

14. TRANSMITTER ADJUSTMENTS.

a. INTRODUCTION.

(1) Tuning the BN transmitter is relatively simple. However, care must be used to insure maximum power output on the desired frequency. If at all possible, the transmitter should be tuned up to maximum output on the desired frequency into a 50 ohm pure resistive load. Then the output coupling control is locked in position and not changed further unless frequency is to be changed. The regular antenna is then connected and the transmitter frequency control is tuned to bring the transmitter back to the desired frequency. In the detailed procedure which follows, use of the 50 ohm resistor load and a duplexer is assumed. If either of these is not available, merely omit the parts referring to them.

b. FREQUENCY CHECK.

(1) Connect a "T" connector* to the transmitter antenna jack (J231) on the model BN Equipment. Connect a Model OAP Wavemeter Oscillator to the "test" side of the "T" connector. Connect a pure resistance load of 50 ohms to the other side of the "T" connector.

*NOTE

A "T" connector is supplied with the Model OAP Wavemeter Oscillator. Connect the Model OAP Wavemeter Oscillator power cord to a 115 volt, 50 to 70 cycle a-c outlet.

c. Turn on power switch of Model OAP Wavemeter. Also turn on power switch of the BN equipment. Allow Model OAP Wavemeter Oscillator to warm up for at least 15 minutes before using it.

d. With connection as outlined above, set the wavemeter oscillator to the desired frequency as outlined in the Instruction Book accompanying the wavemeter oscillator. Then tune the transmitter frequency control, knob (E236A), until the wavemeter indicates that the transmitter is operating on the desired frequency.

e. TUNING.—Now adjust the Transmitter OUTPUT COUPLING loop, knob (E236C), to obtain maximum power output. This will be indicated by the smallest shadow angle obtainable on the Wavemeter Oscillator TUNING INDICATOR EYE tube. It will be necessary to readjust the transmitter frequency control during this operation to bring the transmitter back to the desired frequency, since adjustment of the Transmitter OUTPUT COUPLING will affect the transmitter frequency. Lock the transmitter OUTPUT COUPLING control in this position and do not readjust it during the balance of the tuning procedure.

f. If a Duplexer is to be used, it will now be necessary to tune up the receiver before proceeding further with the transmitter tuning. Connect the oscillator of the

Wavemeter Oscillator directly to the RECEIVER ANTENNA JACK (J11) on the model BN equipment and tune up the receiver in the manner described under the receiver section.

g. CONNECTING DUPLEXER AND ANTENNA.—Existing connections to the Transmitter and Receiver are removed and the Duplexer and Antenna connected up as described in the Installation Section.

h. Connect the oscillator of the Wavemeter Oscillator to the TEST JACK on the Duplexer. Then, with the oscillator in operation for tuning the receiver, adjust the TRANSMITTER side of the Duplexer to give maximum input to the receiver tuning indicator eye tube. Adjust the receiver ANTENNA TUNING knob only, to keep the receiver antenna circuit in resonance with the signal frequency as the Duplexer is adjusted.

i. Connect the wavemeter of the Wavemeter Oscillator to the TEST JACK, turn on the KEYER switch, and tune the RECEIVER side of the Duplexer for maximum transmitter output as indicated by the smallest shadow angle on the wavemeter TUNING INDICATOR eye tube. Adjust the TRANSMITTER TUNING control during adjustment of the Duplexer to keep the transmitter at the correct frequency.

j. Retune both the Transmitter and the Receiver sides of the Duplexer to correct for any effects that one may have had on the other. The Transmitter, Receiver, and Duplexer are now tuned to the correct frequency and matched for maximum transmitter power output and maximum receiver sensitivity. The Model OAP Wavemeter Oscillator may be removed, and the Model BN Equipment is ready for use.

k. 50 OHM PURE RESISTANCE.—A close approach to a 50 ohm pure resistance can be made by connecting a one watt insulated carbon resistor to a plug, Navy Type C**–49195. The resistor should preferably be of the axial lead type and mounted inside the plug with the shortest leads possible. To test this resistor, connect it to the transmitter through a short length of 50 ohm cable, Navy Type CASSF–50–1. Tune transmitter to a given frequency and lock all dials. Then use a cable between the transmitter and resistor. Recheck the transmitter frequency; and if no change has occurred, the resistor is very close to a 50 ohm pure resistor. Checking with several different length cables will make a more complete verification possible.

l. If tuning without the use of the 50 ohm pure resistor is necessary, tune the Receiver, then tune the Transmitter as described previously. The receiver side of the Duplexer will have to be tuned at the same time, thus making simultaneous adjustment of three controls necessary to obtain maximum power output at the required frequency.

m. If a Duplexer is not available for use with the Navy Model BN Radio Equipment, tuning may be done using the regular antenna in place of the 50 ohm load.

**Manufacturer optional.

WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS: SEE PAGE X. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE SUPPLY ON. DO NOT DEPEND ON INTERLOCK FOR PROTECTION BUT ALWAYS SHUT OFF POWER AND OPEN THE MAIN SWITCH IN THE SUPPLY LINE TO EQUIPMENT.

of the transpondor receiver will pass a signal of suitable strength, at a frequency relatively far removed from the exact BN operating frequency. That is, the signal will begin to pass at a frequency near the outer end of the receiver's broad selectivity curve and will continue to pass until the transpondor has turned past the BN transmitter frequency by an equal frequency interval. Note the points A and A′ on Figure 3-3, Page 3-2.

d. As the transpondor moves away from the interrogating source, the signal strength drops; and therefore the receiver on the transpondor will not detect a signal except in the more sensitive condition which is nearer the peak of the curve. (Note points B and B′ on Figure 3-3.) Hence the keying time becomes reduced since the distance between the points of signal passing is reduced. At extreme range, therefore, the transpondor will operate for only a fraction of a second, transmitting only a very short burst of reply pulses.

e. The pulses transmitted by the transpondor are received and detected in the BN equipment and displayed on an oscilloscope as has been explained. At close ranges the frequency band over which the transpondor is capable of being keyed by the BN signal may be greater than the overall bandwidth of the BN receiver. At such ranges the time interval during which the IFF signal is displayed is dependent on the BN receiver bandwidth.

f. For example, if the bandwidth is three megacycles, the IFF signal is at such ranges displayed during a time interval of $\frac{3}{30} \times 2.5$ seconds or 0.27 second. At extreme ranges the transpondor is capable of being keyed over a frequency band shorter than the receiver bandwidth, and at these ranges the duration of the display of the IFF signal is governed by the frequency band over which the transpondor is keyed. In either case the IFF signal appears on the scope not as a continuous signal like the Radar echo, but in flashes.

g. The pulse amplitude decreases as the range increases; but because of BN receiver's saturation characteristic (clipping action), all signals appear of the same height on the scope until the range approaches the magnitude at which the received signal is below the saturation limit. The amplitude then approaches the noise level, even falls below, and finally disappears altogether.

h. Tests indicate that, if BN and transpondor equipments are in normal operating condition, the transpondor will continue to receive interrogation pulses and key beyond the range at which the BN is capable of receiving receptable signals. Consequently, when received pulses at the scope are seen to grow weaker with distance, it will be understood that the loss of strength is due to the distance covered by the re-transmitted pulse of the transpondor.

. Should the BN transmitter or receiver become mistuned, or the transmitter power be reduced, there will be a loss of signal strength throughout the entire system. Therefore, if, during operation, the received reply signal at the scope from the transpondor is seen to disappear suddenly, it can be assumed that the operation has ceased because insufficient signal strength is obtained at the transpondor receiver. No amount of increased BN receiver sensitivity will bring in a reply signal, since no reply signal exists.

j. Mistuning may also give false indication of distance since the reply pulse from the transpondor may be of a frequency only partially, or not at all, within the BN receiver pass band. Thus the signal will appear on the scope for the length of time that it takes the transpondor to sweep over that portion.

k. However, the apparent disappearance of the signal does not exclude the possibility that a weak signal may exist. A weak signal may be recognized even though well below the noise level. This is possible because of the coding of the reply pulses which will cause the trace of the cathode ray tube to flicker at the point where the reply pulse is usually received. The flicker appears as a vertical displacement of the noise pattern or as a change in noise amplitude at the reply pulse position.

5. CODING.

a. The signal which the transpondor returns depends on a code which may be changed at will by a knob. The coding on the Model ABK equipment is so arranged that the returning signal appears as a repeating code combination consisting of any arrangement of the following codes, as shown in Figure 3-4.

(1) narrow (N) pulses having a duration of about seven microseconds.

(2) wide (W) pulses having a duration of about 21 microseconds.

(3) omitted (–) pulses, or quiet periods between transmitted pulses.

b. One component of a complete code is displayed during each sweep of the transpondor. Thus a code consisting of two N's followed by two W's will be repeated completely every four sweeps of the transpondor. The display of such a code will consume approximately 12 seconds.

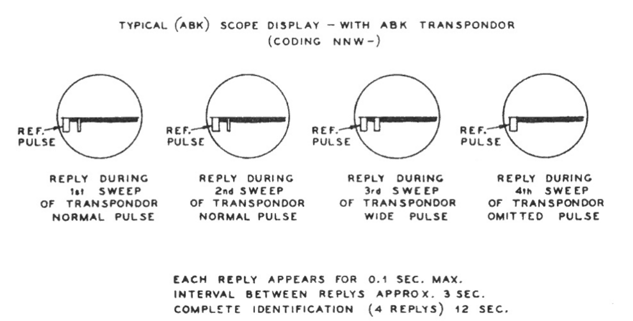


Figure 3-4—Typical (ABK) Scope Display—Coding

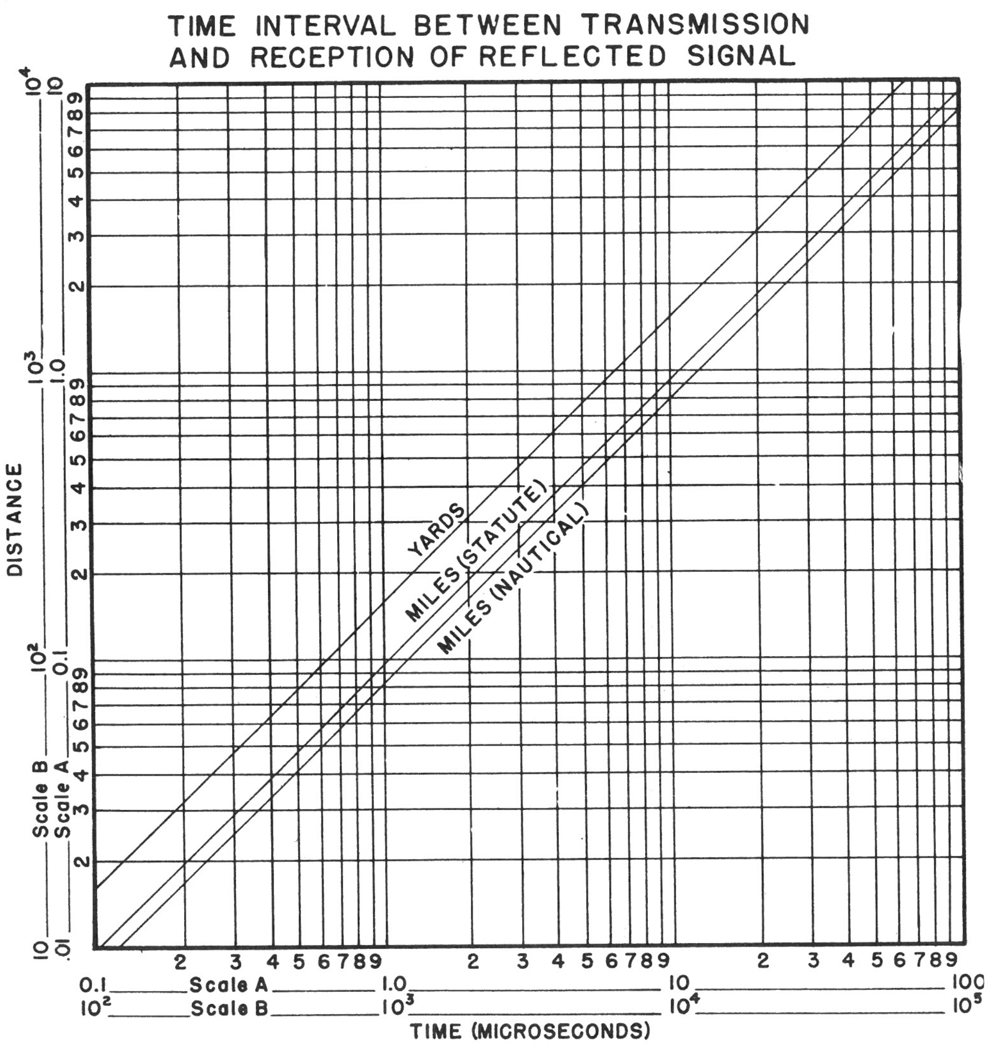
c. In addition to the above codes, an emergency signal, consisting of very wide (80 microsecond) pulses sent out successively, regardless of the setting of the code-selector switch, is provided. The coding device is always in operation and is not dependent upon the received signal for operation.

d. The coding on other model transpondors may or may not correspond to the above arrangement since it is for a specific model (ABK) and is given only to help clarify the discussion.

e. The chart, Figure 3-5, is intended to help determine quickly either the time interval between transmission and reception of the reflected signal or the distance to the reflecting object. This chart gives only approximate values of these elements.

f. In using the chart, the scale A of the X axis should be versus scale A of the Y axis; likewise with the B scales. This applies to using the Miles scale. To determine the Yards distance, Scale A of the Time axis should be versus Scale B of the Distance axis.

g. It will be well to remember that the Y axis is the distance to the reflecting object and not the overall distance, or equivalent to one-half of the values given under the Velocity of Propagation Chart on Figure 3-5.



Y AXIS – DISTANCE TO REFLECTING OBJECT
X AXIS – TIME REQUIRED

VELOCITY OF PROPAGATION (FREE SPACE)
985 FT. (OVERALL DISTANCE) PER MICROSECOND 328 YDS. (OVERALL DISTANCE) PER MICROSECOND .187 MILES (STATUTE) (OVERALL DISTANCE)/MICROSECOND .162 MILES (NAUTICAL) (OVERALL DISTANCE)/MICROSECOND

Figure 3-5—Time Interval Between Transmission and Reception of Reflected Signal

SECTION IV

THEORY OF OPERATION

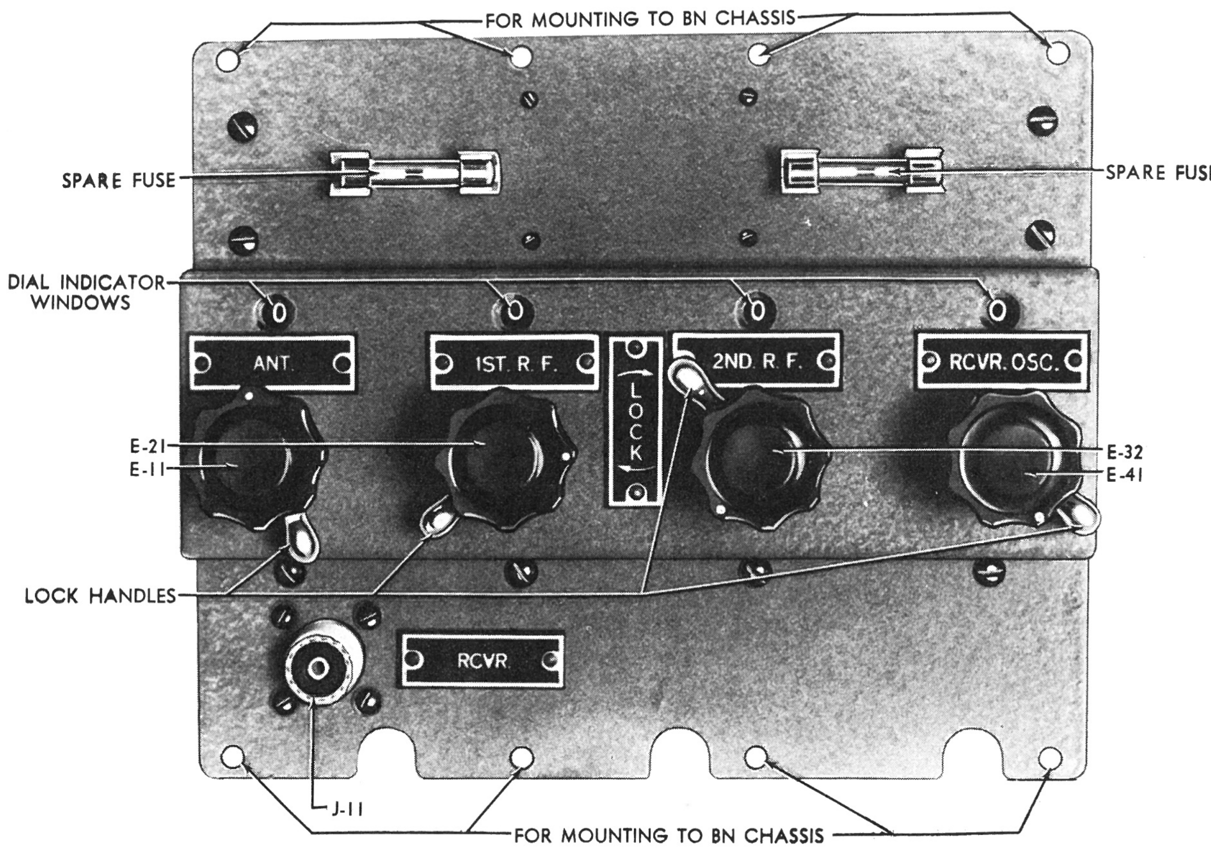


Figure 4-1—R-F to I-F Converter Navy Type CFN-46ACW Front View

1. RECEIVER.

a. FUNCTION.

(1) The function of the BN receiver is to convert radio-frequency identification signals, which are returned by Mark III IFF transpondors, to video signals. These transpondors are carried by friendly craft and function when interrogated by signals from Model BN Radio Equipment.

b. GENERAL DESCRIPTION.

(1) The radio-frequency section of the receiver (R-F to I-F Converter, Navy Type CFN–46ACW) is accommodated on a separate small chassis, mounted on the front panel of the Model BN Radio Equipment and facilitating easy removal by means of eight mounting screws located on the front panel and by unsoldering four electrical connections at the rear of the chassis. A photograph of the front panel is shown in Figure 4-1; Figure 4-2, Page 4-2, shows a bottom view of the chassis which contains the first radio-frequency amplifier (V–1), second radio-frequency amplifier (V–2), first detector diode (V–3), and local oscillator (V–4).

(2) The intermediate-frequency amplifier, second detector, and video stages are located on the right-hand side of the Modulator and I-F to Video Converter Chassis (Figure 1-3, Page 1-4). The first intermediate-frequency

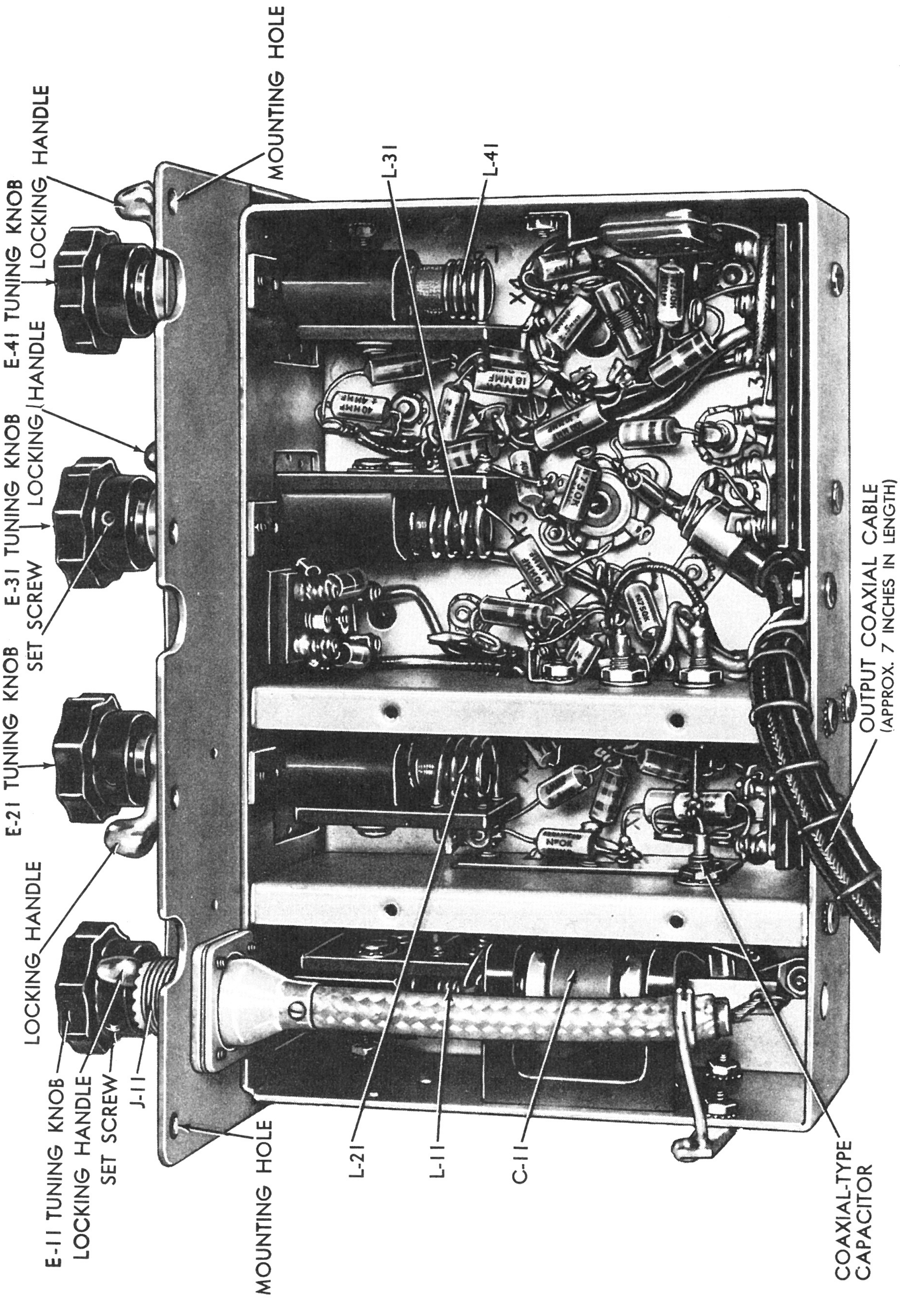


Figure 4-2—R-F to I-F Converter Navy Type CFN-46ACW Bottom View

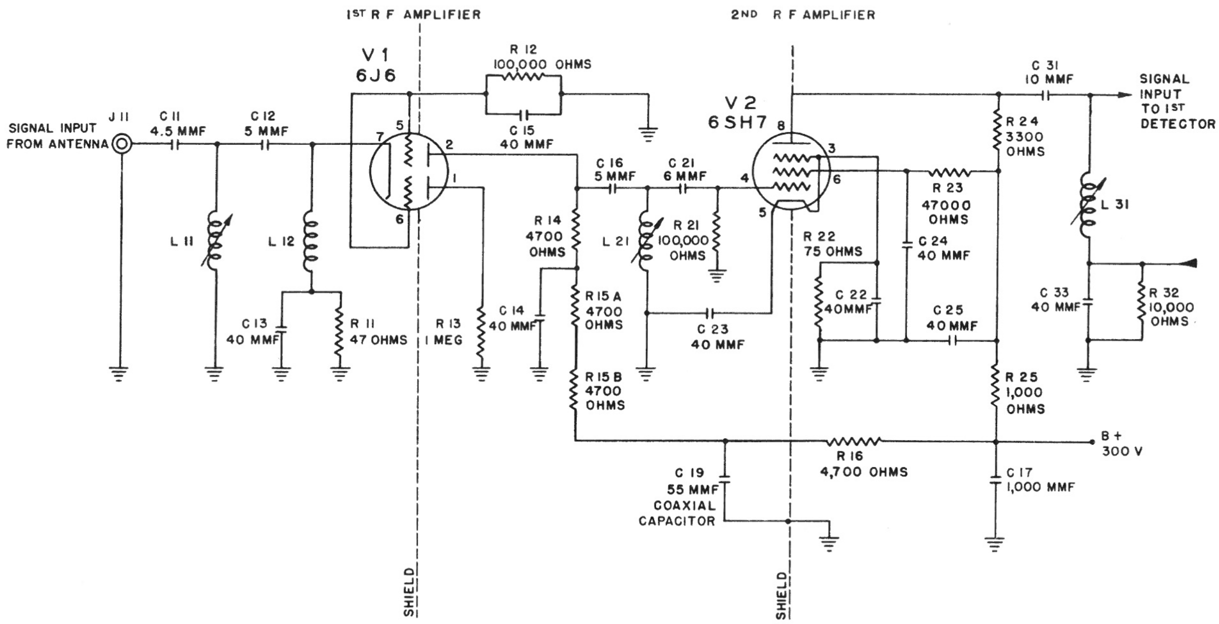


Figure 4-5—Schematic Circuit of Radio-Frequency Stages

3. The capacitors C11 and C12 and the inductor L11 (See Figure 4-5) comprise the antenna coupler, which transforms the input impedance of the First Radio-frequency Amplifier (V1) to terminate the transmission line in its characteristic impedance. C11 is a high voltage capacitor, and considerable voltage from the transmitter will be developed across it when tuning up the duplexer.

4. The capacitance of the tuned circuit in these impedance coupled networks consists chiefly of the input and output capacitances of the tubes, the distributed capacitance of the coil, and capacitance of the associated wiring.

5. The tuned circuit inductor (L11) is tuned by a silver sleeve within its winding. The inductance decreases as the sleeve is inserted into the winding. The sleeve is equivalent to a short-circuited secondary, which, when brought near the primary, has the same effect as short-circuiting some of the turns on it, reducing the inductance. It is well to note that the effect of this sleeve in the magnetic field of the coil is opposite to that of a powdered-iron slug, which increases the inductance.

6. When the silver sleeve is displaced the maximum distance from the coil, the inductance is maximum and the tuned circuit resonates at the low frequency end of the tuning range (lowest frequency to be covered by this equipment is 157 megacycles). As the silver sleeve is inserted into the coil, the inductance decreases and the resonant frequency of the tuned circuit increases. This continues as the sleeve is further inserted until the sleeve is completely engaged, when the inductance of the coil will be minimum. Then the tuned circuit resonates to the upper frequency limit of the receiver (highest frequency to be covered by this equipment is 187 megacycles). The rotation of the tuning controls is such that as the dial readings increase from zero to nine, the frequency is increased from 157 to 187 megacycles.

7. Since the input impedance of a cathode-driven amplifier is approximately equal to 2/Gm for the tube, and since impedance is coupled across the tuning inductor (L11) by the coupling capacitor (C12), the tuning inductor (L11) is shunted by an impedance of relatively low value and L11 will tune quite broadly.

8. The first stage of the radio-frequency amplifier employs one section of 6J6 dual triode (V1) as a grounded grid cathode-driven amplifier. The choice of the triode results from the fact that a triode is less noisy than a pentode of comparable transconductance.

9. Because of the high interelectrode capacitance between the grid and the plate of the triode, this type tube would not function properly at high radio-frequencies in a conventional grounded grid cathode coupled circuit. The choice of the grounded grid cathode driven circuit results from the fact that in this type of circuit the control grid is grounded insofar as radio frequency is concerned and acts as a shield between the input, the cathode, the output, and the plate. This results in a low interelectrode capacitance between the input and output circuits.

10. The construction of the 6J6 is such that there is less direct capacitance between the plate of triode number 1 and the cathode than between the plate of triode number 2 and the cathode. Advantage is taken of this fact by using triode number 1, terminal numbers 2, 5, and 7, as the radio-frequency amplifier, to secure improved performance.

11. Figure 4-5, Page 4-5, shows the control grid of both triodes, terminals 5 and 6, connected to ground through a 100,000 ohms resistor (R12) and by-passed by a 40 micromicrofarad capacitor (C–15). The purpose of this circuit can be explained best by considering what takes place when the transmitter is in operation. When the transmitter is fired, a high r-f voltage exists between the cathode and grid and is sufficient to drive grid No. 5 positive during a positive pulse of a cycle.

12. Now control grid No. 6 also is connected to control grid No. 5; and, since there is no plate voltage on its associated plate, element No. 1, the control grid of triode No. 2, acts as a diode and draws considerably more current. If the parallel combination of R12 and C15 in series with the control grids were omitted, the tube would absorb considerable power from the transmitter and loss of radiated power would result. By inserting the resistor in series with the control grids and by-passing the grids to ground, the grids draw current thru the resistor R12 during the first few cycles of a pulse of r.f. charging up the capacitor (C15). The capacitor (C15) keeps this charge during the pulse interval. The average d-c voltage developed across this resistor is a negative voltage on the control grids and biases, the triode section No. 1, elements 2, 5, and 6, beyond cut-off. The input impedances of the tube during this interval can be represented by very high resistance. The antenna coupler under this condition presents a very high resistance to the transmission line, and very little power is absorbed.

13. The values of R12 and C15 circuits are selected so that the capacitor will discharge 90% in six microseconds after the termination of the transmitter pulse. Self-bias for this tube is obtained of R11 by-passed by C13 in series with the cathode coupling coil (L12).

14. The heaters for this tube are operated above r-f ground potential at approximately the same r-f potential as the cathode by the use of the small inductors (L13) and (L14). This facilitates two purposes: (a) reduces the r-f voltage between the heater and cathode to a practical minimum when the transmitter is fired; (b) the inherent capacitance between the heater and cathode for this tube is approximately three micromicrofarad and is of poor power factor (high dielectric loss). This capacitance would appear across the tuning inductor (L11) limited by the coupling capacitor (C12) if the heaters were operated at ground potential and would: 1. reduce the tuning range of the inductor (L11); 2. reduce gain; and 3. change alignment of inductor (L11), since this capacitance (heater to cathode) varies during the useful life of the tube.

15. A shield is provided between the input and output impedance of the first radio-frequency amplifier to reduce the coupling to a minimum, necessary to assure reliable operation. The tube shield for the 6J6 serves both to shield at radio-frequency and to hold the tube in place.

16. The plate circuit of the first stage is coupled to the grid of the following stage by means of the coupling network (C16, C21, and L21). R14 is the plate load resistor and is decoupled by C14. R21 is the grid coupling resistor for the Second Radio-frequency Amplifier (V2).

(b) SECOND TUNED RADIO-FREQUENCY STAGE (V2).

1. The second stage of the radio-frequency amplifier employs a 6SH7 tube (V2) in a pentode grounded-cathode amplifier circuit. That is, the cathode is operated at radio-frequency ground potential, the conventional method. L31 is the tuned circuit for the second tuned radio-frequency amplifier.

2. The schematic circuit of the second radio-frequency amplifier stage is given in Figure 4-5, Page 4-5.

3. It should be noted that two separate cathode connection pins, Nos. 3 and 5, are used on the 6SH7 tube. This feature is utilized to reduce to a minimum the cathode lead inductance common to both input and output circuits, that is, inductance through which both input and output high-frequency currents flow. At the frequencies handled by this receiver, this reduction of common inductance is important in terms of stage performance in that it reduces tube loading loss on the tuned circuits. For this reason the original wiring at the cathode terminal of the socket should be preserved in repair work. Although terminals 3 and 5 both connect to the cathode, the original circuit connections to each should be maintained carefully. By examination of Figure 4-5, Page 4-5, it should be noted that all output-circuit by-pass capacitors are returned to cathode lead No. 3, while cathode lead No. 5 is by-passed to the input circuit by the use of the small capacitor (C23). This reduces to a practical minimum the inductance common to the input and output circuits.

4. The self bias for this tube is obtained by the use of R22, by-passed by C22. R23 and C24 are the screen series resistor and screen by-pass capacitor respectively. R24 is the plate load resistor, and C25 is the plate load capacitor.

5 R25 is a filter resistor, used to reduce the coupling between the output of the second radio-frequency amplifier and other associated circuits. The purpose of the small feed-thru capacitor (C19) also is to reduce interstage coupling. A shield is provided between the input and output circuits of this stage to reduce the coupling to a minimum.

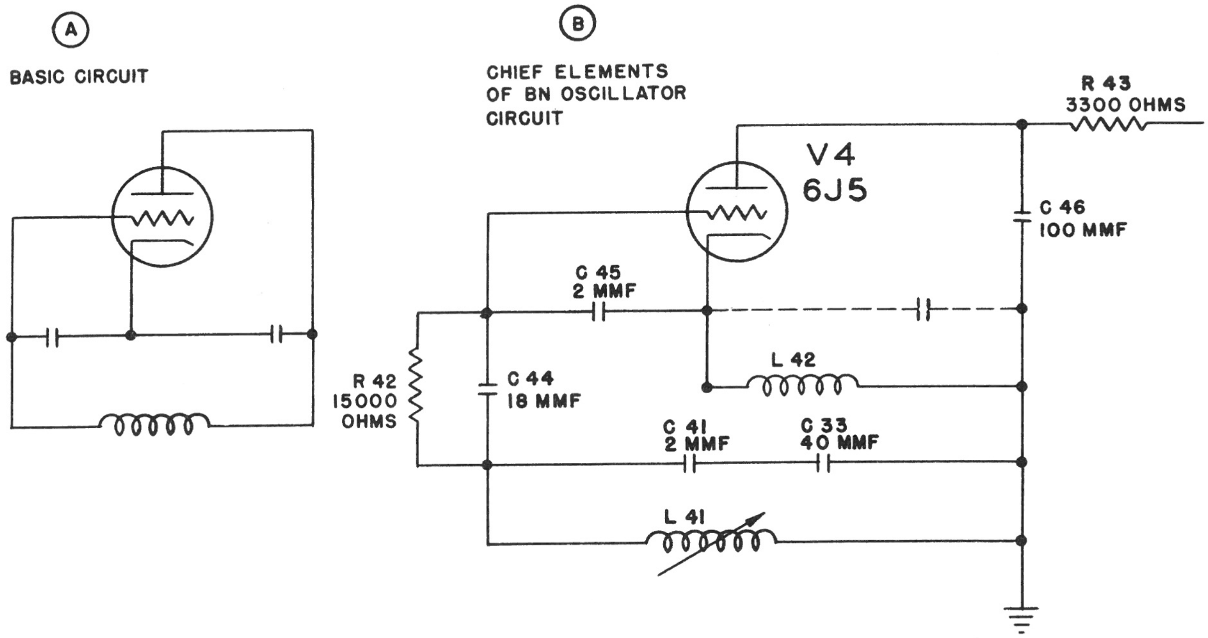


Figure 4-6—Principle of Local Oscillator

6. R15A, R15B, and R16 comprise the plate series resistors and are used to adjust the voltage to the first radio-frequency amplifier tube below the rated maximum value.

7. C17 is provided in the radio-frequency chassis to by-pass currents of the intermediate frequency, which may be coupled to the radio-frequency chassis through the interconnection leads.

8. The output of the second radio-frequency amplifier is coupled to the first detector diode plate and to the inductor (L31) through the capacitor (C31).

9. The socket for the 6SH7 amplifier (V2) is provided with a knurled type of retainer. The purpose of this is to cut through the black paint on the tube shell and make the low impedance ground connection which is required for high-frequency operation. The retainer also serves to hold the tube in place.

e. LOCAL OSCILLATOR (V4).

(1) A 6J5 triode is employed in a Colpitts circuit to supply the source of radio-frequency voltage. This voltage is supplied to the first detector, where it is mixed with the amplified incoming radio-frequency signal from the amplifier described in the previous section to form an intermediate frequency by heterodyne action, which will be explained later under section "First Detector (V3)." This is the operation of a conventional superheterodyne receiver.

(2) In this receiver, the frequency of the Local Oscillator is to be lower than that of the signal being received. Since the intermediate frequency is 30 megacycles, the range which the oscillator must cover to accommodate signals from 157 to 187 megacycles extends from 127 to 157 megacycles.

(3) The circuit is of the Colpitts type, of which the basic form is shown in Figure 4-6. It will be seen that the inductance is connected from the grid to the plate and that there is capacitance to each of these elements from the cathode. Any voltage appearing in the output circuit of this stage (between plate and cathode) will produce a voltage of opposite phase between the grid and the cathode. This is the condition required for self-oscillation; hence the stage oscillates, producing a continuous high-frequency voltage across the inductor. A detailed explanation of this type of oscillator circuit may be found in any textbook on thermionic vacuum-tube circuits.

(4) In Figure 4-6B (Chief Elements of the BN Oscillator Circuit) is shown the actual circuit of the Local Oscillator, which differs from the Basic Circuit in certain respects. In Figure 4-6A (Basic Circuit), a capacitor is shown from the cathode to the plate. This provides no path for the cathode current. Figure 4-6B differs at this point by substituting for this capacitor an inductor (L42) shown shunted by a capacitor, dotted to indicate that it is of distributed capacitance. Now a capacitor and inductor in parallel act as an inductor below their resonant frequency and as a capacitor above it. The size of L42, therefore, has been chosen to resonate with the distributed capacity at a frequency below that of the oscillator and is, therefore, capacitive at its frequency.

(5) The frequency of the basic circuit is approximately the resonant frequency of the two series capacitors (acting as one capacitor) in parallel with the inductor. In Figure 4-6 this is still the case, except that the capacitors C41 of two mmfd., C44 of 18 mmfd., C33 of 40 mmfd., and C46 of 100 mmfd. have been added. C41 serves to bring the oscillator frequency range to the

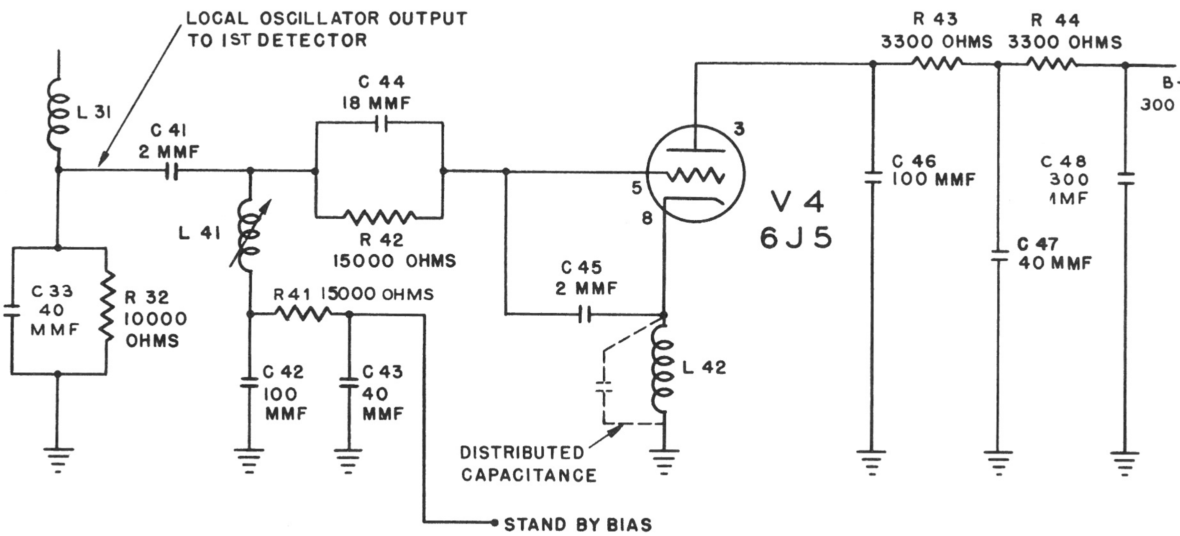


Figure 4-7—Local Oscillator Schematic

desired location and also to apply the oscillator voltage to the circuit of the first detector tube (V3). (Refer to Figure 4-7.)

(6) The grid and plate capacitor, (C44) and (C46), in Figure 4-6A are so large that they effectively are short circuits at the oscillator frequency. Therefore, it is obvious that the circuit of Figure 4-6B, Page 4-7, used in this equipment is of the same type as the basic Colpitts circuit shown in Figure 4-6A.

(7) The frequency of the Local Oscillator is adjusted to the desired frequency by varying the inductance of L41 in the same manner as for the radio-frequency inductors (L11 and L21), described under radio-frequency amplifier stages.

(8) The socket for the 6J5 Oscillator (V4) is provided with a knurled type of retainer. The purpose of this is to cut through the black paint on the rim of the shell and make the low impedance connection which is required for high-frequency operation. The retainer also serves to hold the tube in place under conditions of mechanical vibration and gunfire shock.

(9) Figure 4-7 shows the complete circuit. Capacitor C41 is used to feed oscillator voltage to the first detector circuit. C44 is the grid coupling capacitor, and the grid leak for the oscillator is R42. C45 is the cathode to the grid coupling capacitor, while the cathode inductor L42 serves to perform the function as previously described in detail. Capacitor C46 is the plate radio-frequency by-pass, while R43, C47, and C48 comprise the radio-frequency filter, which serves to prevent Oscillator voltage from entering the plate supply. The inductor L41 is not directly grounded as described herein but is by-passed instead by capacitor C42. R41 and C43 serve as filter for the stand-by bias.

f. FIRST DETECTOR (V3).

(1) The amplified radio-frequency signals from the second r-f amplifier (V2) and the radio-frequency voltage supplied by the local oscillator (V4) which is 30 megacycles lower than the former, are mixed in this stage by heterodyne action. The cathode circuit of this stage then contains the signal and the oscillator frequencies as well as the sum and difference of the two frequencies. The desired signal, the intermediate frequency of 30 megacycles, is selected by means of a parallel tuned circuit connected in the cathode of the detector (V3), and the unwanted signals are rejected.

(2) The schematic circuit for the first detector and method of operation is shown in Figure 4-8, Page 4-9. The signal input to the first detector from the second radio-frequency amplifier is through the 10 micromicrofarads capacitor (C31) to the plate of the diode tube (V3). The oscillator input to the first detector is through the two micromicrofarads capacitor (C41) and is supplied to the plate of the 9006 through L31.

(3) Figure 4-9, Page 4-9, A through D, shows the wave forms diagrammatically. The wave form for the signal frequency is shown in Figure 4-9A, Page 4-9. The wave form for the oscillator input, which has a frequency of 30 megacycles lower than the signal frequency, is shown in Figure 4-9B, Page 4-9.

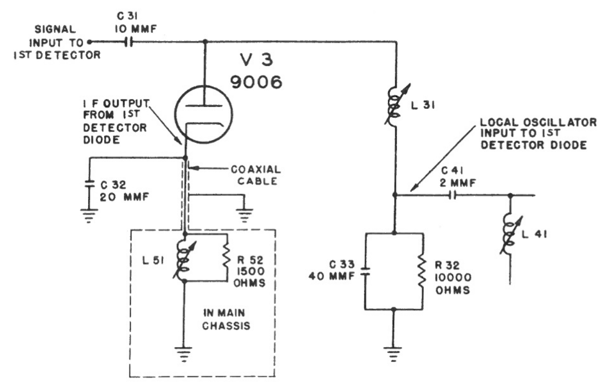


Figure 4-8—First Detector Schematic

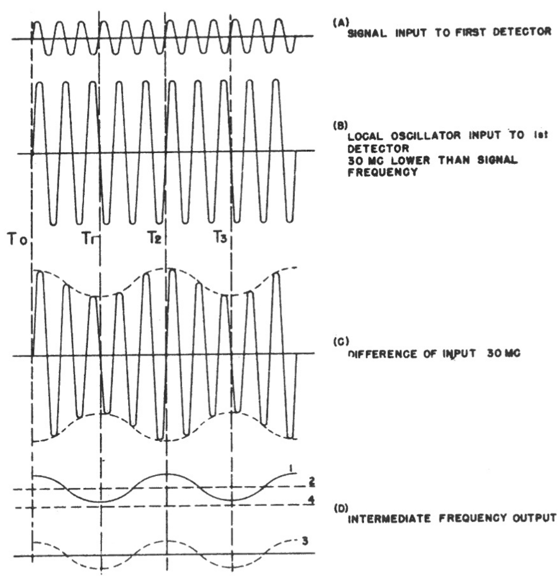


Figure 4-9—First Detector Operation

(4) At certain times, such as T_0 and T_2 in Figure 4-9C, the two high-frequency inputs to the First Detector are in phase, and their effects add on the plate of the tube. After a number of cycles, the relation between the two inputs departs from the in-phase condition and gradually comes to a complete out-of-phase condition. This is the situation at times T_1 and T_3 in the diagram. In this way the high-frequency voltages applied to the plate of the First Detector has a waxing and waning envelope, which is shown by the dotted lines in Figure 4-9C.

(5) Since electrons can pass in a diode only from the cathode to the plate, not from the plate to the cathode, only the positive halves of the high-frequency waves on the plate of the diode produce a flow of current. These cause electrons to pass from the cathode to the plate, and flow through the circuit elements in Figure 4-8, including the tuned coil (L51) and a damping resistor (R52) in the input circuit of the first intermediate-frequency stage. A voltage wave, such as shown by curve 1 in Figure 4-9D, thereby is created between the cathode and ground of V3, and also applied to the grid of the First Intermediate-frequency Stage (V5).

(6) The individual positive halves of the high-frequency cycles are by-passed through C32, but their average effect remains. The wave form of curve 1, Figure 4-9D, therefore has a fundamental frequency of 30 megacycles, the intermediate frequency of the receiver. In this circuit the harmonics of 30 megacycles are attenuated, leaving a sine wave of the intermediate frequency, which is shown as curve 3, Figure 4-9D.

(7) In case no signal is received at the antenna, there is no signal input into the First Detector, leaving only the oscillator input. The envelope shown in Figure 4-9C then disappears. The only output of the First Detector in this case is a direct current as shown by the dotted line curve 4 in Figure 4-9D. There is no 30 megacycle signal then existing across the inductor L51 in the grid circuit of the first intermediate-frequency stage. Thus no effect is produced in the remainder of the receiver.

(8) The amplitude of the oscillator voltage in the input of the Intermediate-frequency Amplifier, indicated as "I-F Output from First Detector Diode" in Figure 4-8, is minimized by the tuned circuit in the Intermediate-frequency Amplifier input, consisting of the resonating capacitor (C32) and inductor (L51), which has a low impedance at the oscillator frequency, since it is tuned to the intermediate frequency.

(9) The tube shield for the 9006 serves a dual purpose, to shield a radio frequency and to hold the tube in place.

g. INTERMEDIATE-FREQUENCY AMPLIFIER (V5 to V9, INCLUSIVE).

(1) This section of the receiver amplifies the intermediate-frequency voltage delivered by the First Detector and provides the intermediate-fequency selectivity of over three megacycles bandwidth. The overall response of this circuit is a curve of steep sides and flat top.

(2) The complete schematic diagram of the five-stage Intermediate-frequency Amplifier is given in Figure 4-10, Page 4-10.

(3) The intermediate-frequency signal derived from the First Detector (V3) is applied to the intermediate-frequency amplifier through the coaxial lead from the cathode of the First Detector (V3) to the grid of the First Intermediate-frequency Amplifier (V5).

(4) Since, as described in Section I, General Description, Page 1-1, the transpondor frequency varies, the length of time during which the BN receiver will respond depends upon its bandwidth. For example, if its bandwidth were one-tenth of the range covered by the trans-

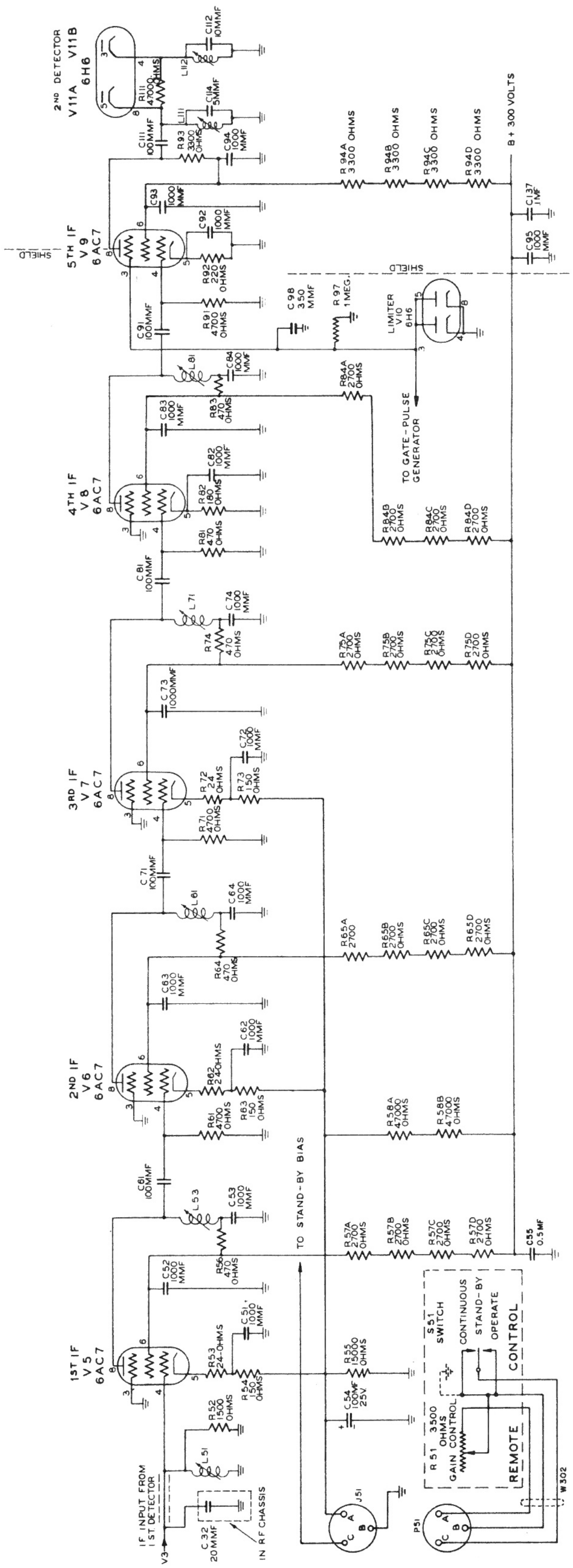


Figure 4-10—Intermediate Amplifier Schematic Circuit

pondor, it would respond during one-tenth of the three-second interval. For this reason the intermediate-frequency response characteristic is made substantially flat over a range of from 28 to 32 megacycles. This is accomplished by:

(a) Shunting the tuned circuits with suitable resistors, and

(b) Resonating the individual inductors (L51, L53, L61, L71, L81, and L111) at different frequencies within the range of the intermediate frequency.

(5) The capacitance of the tuned circuit in these impedance coupled networks consists chiefly of the input and output capacitances of the tubes, the distributed capacitances of the coils, and the capacitances associated with the wiring.

(6) Each inductor is tuned by moving a silver plated brass slug, positioned within its winding, to vary its inductance. The inductance is decreased and increased in the same manner as for the radio-frequency circuits. When the adjustment screws are tuned clockwise, the brass slugs advance down into the coil. This decreases the inductance and therefore increases the resonant frequency. The opposite action takes place when the screw is turned counterclockwise. Detailed alignment procedure is given in the Maintenance section.

(7) The first and sixth inductors (L51 and L111) are resonated to the intermediate frequency of 30 megacycles, L53 and L71 are resonated to 32 megacycles, and L61 and L81 are resonated to 28 megacycles. L51 is damped by the resistor R52, which has a resistance of 1500 ohms. L111 is damped by the plate coupling resistor R93, which has a resistance of 3300 ohms, and also by the second detector diode load resistor thru the diode. L53, L61, L71, and L81 are damped by the grid coupling resistors R61, R71, R81, and R91, respectively, each of which has a resistance of 4700 ohms.

(8) The coupling capacitors C61, C71, C81, C91, and C111, connected between the plate of the tube and the control grid of the following tube, isolate the plate potential from the grid potential. C52 serves as screen by-pass for the first intermediate-frequency amplifier (V5), while R56 and C53 comprise the radio-frequency filter and plate by-pass, respectively. R57a, R57b, R57c, and R57d comprise the plate series resistors that are used to reduce the plate voltage to the desired value. C48, C95, and C137 are intermediate-frequency by-passes and reduce coupling between the input and output stages of the intermediate-frequency amplifier.

(9) The impedances connected in the elements of the remaining four intermediate-frequency tubes (V6, V7, V8, and V9) are the same as for the first amplifier (V5) except that the control grid of the Fourth and Fifth Intermediate-frequency Amplifiers (V8 and V9), operates with self-bias in a conventional manner. The capacitor C98 on the suppressor grid of V9 is a radio-frequency by-pass.

(10) This receiver has no automatic volume control in either the radio-frequency or intermediate-frequency sections. The only gain control provision is the manual gain control (R51) which is located in the remote control box interconnected to the equipment.

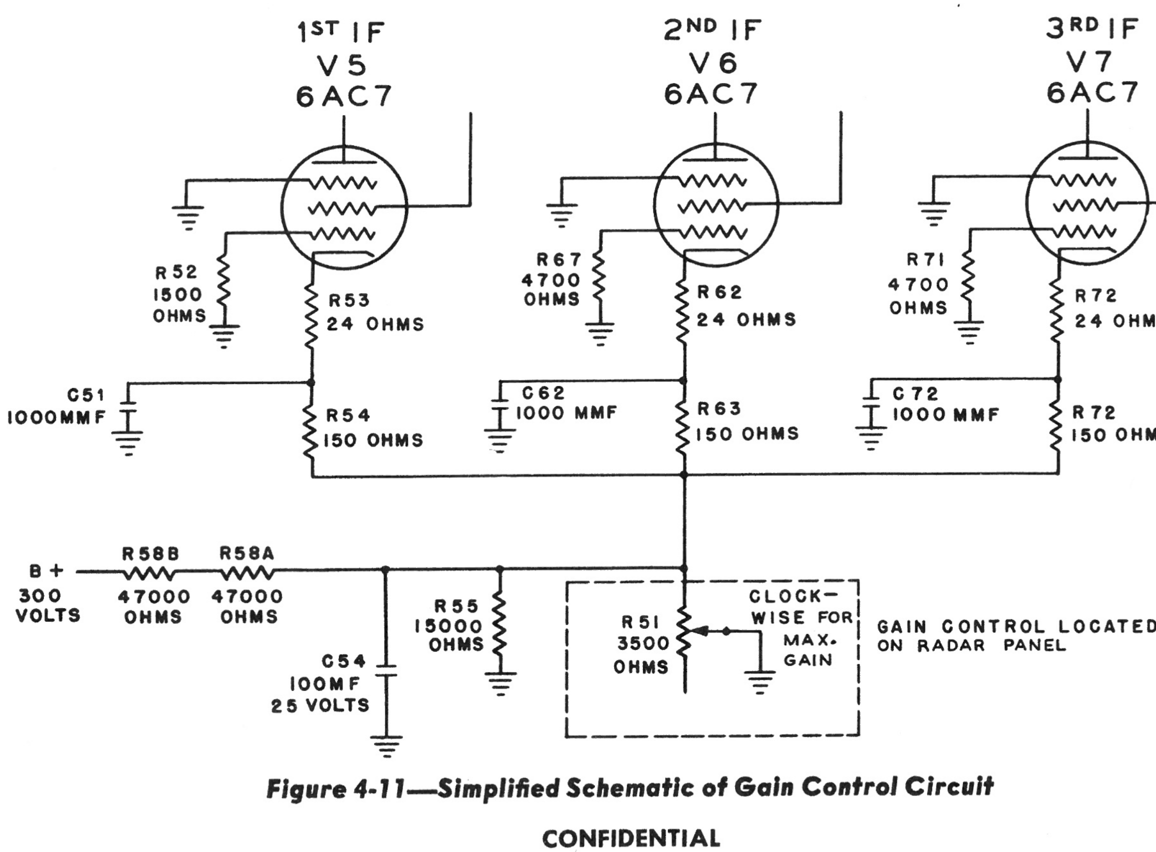


Figure 4-11—Simplified Schematic of Gain Control Circuit

(11) The functioning of the Gate-Pulse Limiter (V10) will be described under Receiver Gating Circuit (V9, V10, V21A, and V21B), Page 4-14.

b. RECEIVER GAIN CONTROL CIRCUIT.

(1) The sensitivity of the receiver may be controlled manually by this circuit. Adjustment of the gain control (R51) in a clockwise direction from its maximum counterclockwise setting results in an increase in receiver gain. This can be verified by noting the increase in amplitude of the thermal noise as viewed on the Radar indicator as the gain control potentiometer is advanced from its maximum counterclockwise position.

(2) The schematic circuit and chief elements of the Receiver Gain Control are shown in Figure 4-11, Page 4-11. Shown in this schematic are the first three intermediate-frequency amplifier tubes (V5, V6, and V7) with the gain control (R51). The gain control consists of a 3500 ohm potentiometer with a carbon resistance element, the resistance of which varies substantially logarithmically with counterclockwise rotation. It is connected in series with the fixed cathode resistors of the first three intermediate-frequency amplifier tubes.

(3) The voltage drop across the total resistance in series with each cathode is a negative bias on the control grids with respect to the cathode. Since the resistance increases as the gain control is increased in a counterclockwise direction, the bias increases. This reduces the plate current and the amplification. Conversely, when the gain control is increased in a clockwise direction, these three cathodes become less positive with respect to ground, the grids become less negative with respect to the cathodes, plate current increases, and the amplification increases.

(4) One of the fixed resistors in each of the three cathodes (R53, R62, and R72) are unby-passed. The use of these unby-passed resistors is to minimize the change in input resistance and capacitance as the gain control is changed, minimizing in turn any related change in tuning and bandwidth in the intermediate-frequency amplifier.

(5) The plate and screen grid for each of these tubes are supplied through approximately 10,000 ohms resistance. When the gain control is adjusted to maximum sensitivity, that is, with the gain control adjusted to the maximum clockwise position, the cathode voltage is at a minimum, the plate and screen current is at a maximum, and the voltage drop in the plate and screen series resistors is at a maximum. This results in an operating voltage of approximately 150 volts under this condition.

(6) With a gain control in the maximum counterclockwise position, its resistance is greatest. Thus the maximum voltage will be impressed on the cathodes or maximum bias applied to the control grids, the tubes will pass minimum plate and screen current, and the drop in the 10,000 ohms series resistors will be at a minimum. The plate and screen voltage measured under this condition is equal approximately to the voltage supply of 300 volts.

(7) A small d-c current is bled through the gain control from the low voltage power supply, through resistors R58A and R58B, to increase the cathode voltage when the gain control is in the maximum counterclockwise position, and thereby increases the attenuation.

(8) The 100 microfarad electrolytic capacitor (C54) is provided across the gain control to prevent hum modulation of the carrier and motor-boating for any setting of the gain control; while R55, which is connected in shunt with the electrolytic capacitor (C54), limits the d-c voltage across this capacitor when the REMOTE CONTROL plug is removed from the front panel of the equipment.

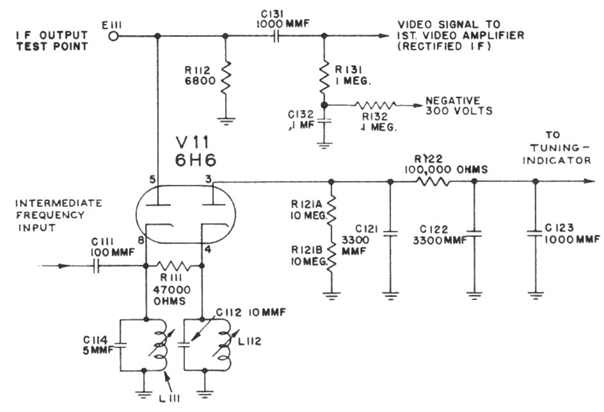


Figure 4-12—Schematic Circuit of Second Detector

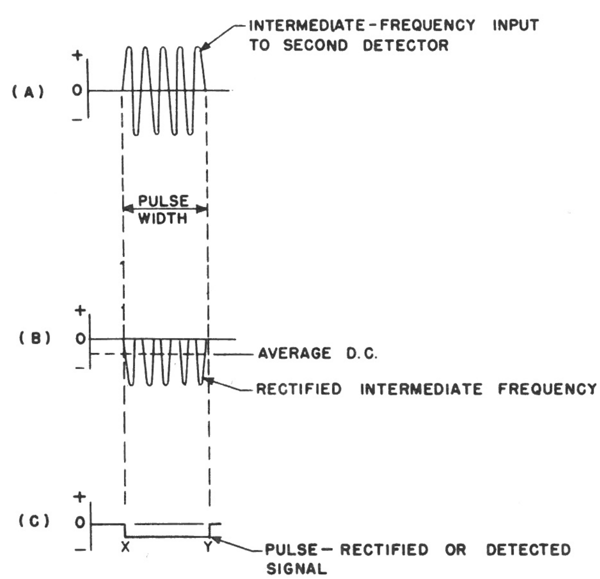


Figure 4-13—Method of Operation of the Receiver Second Detector

i. SECOND DETECTOR (V11).

(1) This stage converts the intermediate-frequency amplifier output signals into video-frequency signals, replicas of the envelopes of the intermediate-frequency signals. The video signals then are fed to, and further amplified by, the video amplifier.

(2) This receiver uses the 6H6 (V11) dual diode tube as the Second Detector. The schematic circuit is shown in Figure 4-12, Page 4-12. One cathode and plate (terminals 5 and 8) of the tube constitute the detector for the intermediate frequency; the other cathode and plate (terminals 3 and 4) are the detector to operate the tuning indicator of the receiver.

(3) It will be noted that the intermediate-frequency input to the detector is applied between the cathode and ground of the 6H6. The plate of the detector, element No. 5, is connected to ground through the diode load receiver (R112). The presence of an intermediate-frequency signal on the detector causes current to flow from ground through the diode load resistor (R112) to the plate and then to the cathode only during the negative cycles of the intermediate frequency. Hence, rectification takes place. Therefore, the rectified intermediate frequency is a negative voltage with respect to ground on the plate, element No. 5, of the detector.

(4) Curve A of Figure 4-13, Page 4-12, shows diagrammatically a pulse signal at intermediate frequency. Curve B shows the output of the diodes. The positive peaks of the wave are not passed by the diodes. Curve C shows the average d-c pulse delivered by each plate.

(5) The input of the detector consists of pulses of the intermediate-frequency signal. This input is applied through capacitor C111 to the cathode, terminal 8, and also through resistor R111 to the other cathode, terminal 4. The cathode, terminal 8, and its associated plate, terminal 5, supply the rectified signal output; and the circuit for these elements is broadly tuned by the diode inductor L111. This inductor is damped by the plate coupling resistor (R93) of the preceding intermediate-frequency amplifier and by the load resistor (R112) through the diode. Cathode 4 and its associated plate, terminal 3, supply rectified negative voltage to the tuning indicator.

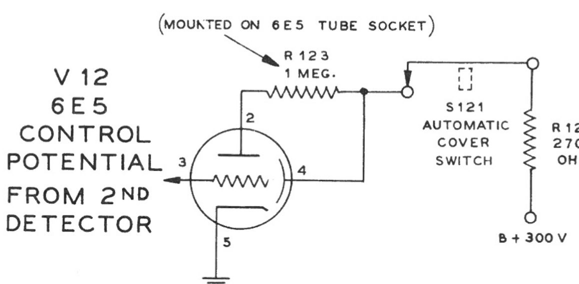


Figure 4-14—Schematic of Tuning Indicator

j. VISUAL TUNING INDICATOR (V12).

(1) The Tuning Indicator provides an indication when the receiver is tuned precisely to the frequency of the signal being received.

(2) The receiver uses the 6E5 tube (V12) as a Visual Tuning Indicator, as shown in the schematic circuit, Figure 4-14. The circuit of the tuning indicator is conventional. The only novel feature is the provision of the switch (S121), by means of which the plate potential is removed automatically from the indicator when its operation is not needed. The push button switch is mounted on the front panel of the equipment; when the front cover is closed, it strikes the push button and opens the circuit. Since the receiver will require tuning only infrequently, the cover over the front panel generally will be closed and also the plate potential for the indicator will be switched off most of the time. This prolongs the life of the tuning indicator tube, the fluorescent surface of which is subject to exhaustion in use.

(3) A signal in the intermediate-frequency amplifier results in a negative potential on the control grid of the tuning-indicator tube. When there is more signal, resulting in more negative control potential, the dark sector of the indicator tube becomes narrower. Tuning adjustments for inductors in the r-f sub-chassis are made, therefore, to get as narrow a dark sector as possible.

(4) The circuit containing tuning inductor (L112) for the Visual Tuning Indicator is sharply tuned to the center of the i-f band (30 megacycles). No damping resistor is used in shunt with this inductor. Therefore, the positive potential impressed on the grid of the tuning eye is a maximum, and the tuning eye sector indicates sharpest tuning when the tuning inductors of the r-f sub-chassis and particularly the local oscillator tuning inductor are tuned so as to provide maximum potential at the center of the i-f band. When the signal for tuning the BN is derived from an OAP wavemeter, the latter is set to the frequency of the transmitter of the BN. By using the tuning eye to indicate the position of maximum tuning, an indication is obtained when the tuning inductors of the r-f sub-chassis are so set that the frequency of the transmitter is at the center of the frequency characteristic curve of the receiver. The transmitter and receiver frequencies then are centered, and the time of display of the IFF signal is a maximum at extreme range.

CAUTION

The tuning of the BN receiver by referring to the echo received by the BN equipment without an OAP wavemeter should be discouraged because such tuning does not lead to centering of the transmitter and receiver frequencies. In this case the tuning is accomplished by varying the tuning inductors in the r-f sub chassis until the echo signal of the oscillator is a maximum. No circuit sharply tuned to the center of the i-f band appears in the normal path for signals flowing through the receiver. Therefore, the inductors in the r-f sub chassis are, in using this method, tuned to values such that the frequency of the receiver is centered on one or the other of the peaks of the receiver response curve. The frequencies of these peaks are not at the center of the response curve; and, therefore, the receiver frequency is not centered with the transmitter frequency, and the display of the IFF signal is impaired. At extreme ranges the eccentricity of the transmitter and receiver signals results in the failure to receive the transferred signal, although the latter is triggered and the sensitivity of the receiver is sufficiently good to receive the transpondor reply.

(5) A filter is provided, consisting of the resistor R122 and capacitor C121, C122, and C123 (See Figure 4-12, Page 4-12), which averages the pulses delivered by the detector, leaving the resultant steady d-c applied to the tuning indicator. The diode load resistors for the tuning-indicator rectifier are R121A and R121B.

(6) The plate limiting resistor (R123) is located on the socket for the 6E5 tube. R124 is the plate series resistor to drop the voltage to a safe value.

k. RECEIVER GATING CIRCUIT (V9, V10, V21A, AND V21B).

(1) With switch S211 "ON," this circuit furnishes a positive gate pulse to the suppressor grid, terminal No. 3 of the last Intermediate-frequency Amplifier Stage (V9), the potential of which is normally negative, permitting the stage to operate at normal gain starting at the leading edge of the pulse being furnished by the Radar pulse generator, and such operation then continuing until the end of the gate pulse. At this time the suppressor swings back to its normal negative potential, reducing the gain of the receiver by approximately 60 decibels; and no thermal noise or pulses will be received on the Radar indicator between the pulses.

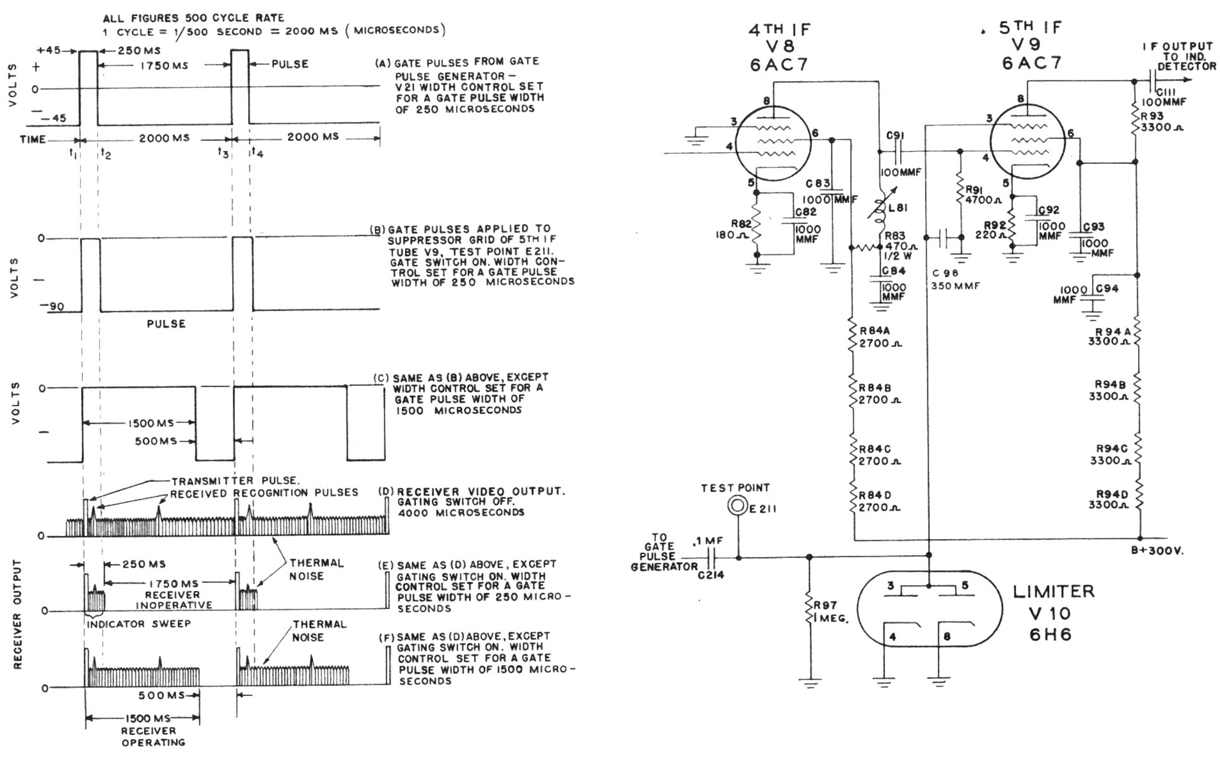


Figure 4-15—Schematic Circuit and Operation of Gating Circuit

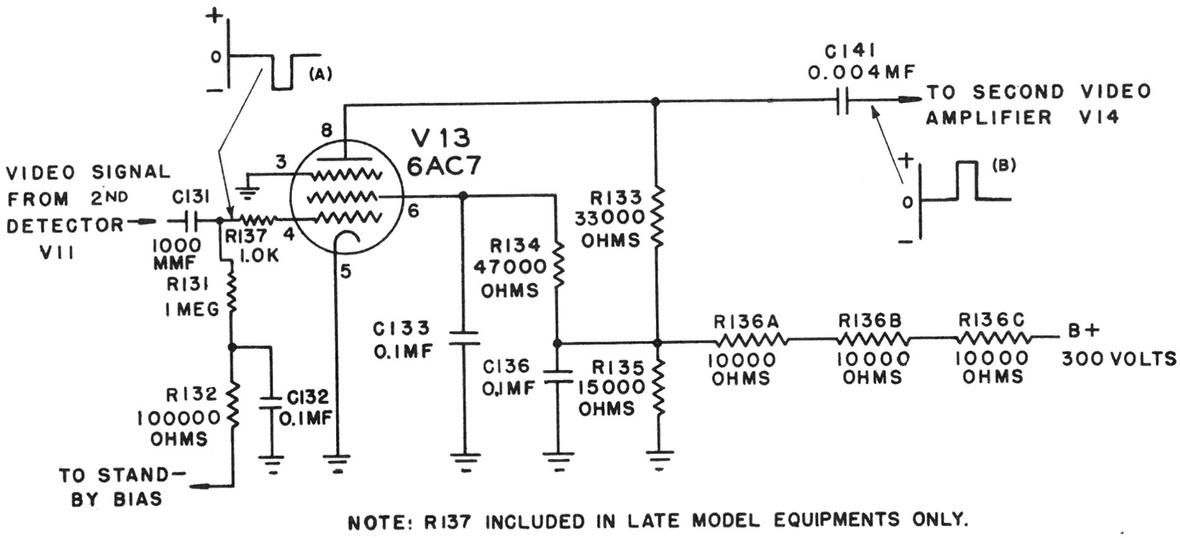


Figure 4-16—First Video Amplifier Schematic

(2) The width of the positive gate pulse, which may be varied from 250 to 1500 microseconds, is controlled by the width control, which is located on the front panel of the equipment and identified by a name plate.

(3) The schematic circuit and method of operating the gating circuits for the receiver is shown in Figure 4-15, Page 4-14. The gating circuit consists of the gate pulse generator (V21A and V21B), limiter (V10), and the fifth intermediate-frequency tube (V9). The gate pulse generator (V21A) and (V21B) employs a 6SN7-GT dual-triode in a conventional cathode-coupled multivibrator circuit. It is described in detail later under Gate Pulse Generator section, Page 4-22. This generator, normally blocked, is initiated by the modulator pulse on its control-grid terminal, number 1, (V21A). The width of the output positive pulse is controlled by the capacitor (C212), the fixed resistor (R213), and the potentiometer (R214). A test point (E211) is provided at the output of the gate pulse generator.

(4) Curve A, Figure 4-15, Page 4-14, shows the positive gate pulse diagrammatically. This may be measured at test point E211 with an oscilloscope. Curve B shows the negative pulse, which is applied to the suppressor grid of the fifth intermediate-frequency tube (V9). Curve C shows the negative pulse with the width controls set for a gate pulse width of 1500 microseconds.

(5) Now, when the positive gate pulses, between t_1 and t_2 on Curve A, are supplied by the gate pulse generator (V21), the limiter (V10) becomes conductive, since its plates become positive, and charges up the capacitor (C214). The capacitor keeps this charge throughout each pulse since it has a large value of capacitance and can discharge only slowly through the one megohm resistor (R97). Hence, the potential applied to the suppressor grid of tube V9 is shown by Curve B. The suppressor grid assumes a potential of minus 90 volts during the interval t_2 to t_3 which cuts off the tube, reducing the gain of the fifth intermediate-frequency stage by about 60 decibels.

(6) Curve D shows the receiver output signal with the gating switch in the "OFF" position and a transmitter pulse along with two recognition pulses from transpondors located at two different distances from the BN equipment.

(7) Curve E shows the same condition except that the gating switch is turned on and the width control set for a gate pulse width of 250 microseconds.

(8) Curve F shows the same condition as for Curve D, except that the gating switch is turned on and the width control set for a gate pulse width of 1500 microseconds.

(9) Ordinarily the sweep on the Radar indicator, on which this receiver signal is viewed in normal service, is only a few hundred microseconds. Therefore, the display will be much shorter than that shown, a typical example being with a 250 microsecond sweep, as shown in Curve E.

l. VIDEO AMPLIFIERS—general.

(1) The video amplifier has an overall characteristic which is essentially flat from 100 cycles to 200,000 cycles.

(2) This wide range is necessary because of the nature of the signal to be amplified. The desired signal usually consists of widely separated pulses of substantially rectangular wave form and short duration.

(3) It can be shown that a wave having a rectangular wave form contains a large number of harmonics. Hence, the amplifier must be capable of transmitting harmonics of the highest pulse repetition rate if the wave form of the pulse is to be amplified without distortion.

(4) The video amplifier also must polarize and limit the amplitude of the pulse so that suitable characteristics are obtained for application to the Radar indicator.

m. FIRST VIDEO AMPLIFIER (V13).

(1) A 6AC7 tube is employed as a video voltage amplifier. The amplitude of the video output voltage of the first video amplifier must be limited to a value not to exceed the point at which grid current occurs in the following stage so that suitable characteristics will be obtained for application to the Radar scope. The schematic circuit of the first video amplifier is shown in Figure 4-16, Page 4-15, together with diagrammatic wave forms A and B. The video signal from the second detector (V11) shown in Figure 4-13, Page 4-12 is applied to the first video amplifier grid through the coupling grid capacitor (C131).

(2) A video signal of the type shown diagrammatically in Figure 4-13 is a typical video signal applied to the first video amplifier (V13). Prior to application of a video signal to the control grid of V13, terminal No. 4; the current through the plate resistor (R133) maintains the plate, terminal No. 8, at about 15 volts. At point X on Figure 4-13 the voltage on the control grid, terminal No. 4, suddenly is increased from zero to minus four volts. This causes the plate current to decrease through R133, allowing the plate voltage to rise to a maximum value determined by the voltage across C137, approximately 50 volts. Since the time constant of C131 and R131 is 1000 microseconds, the capacitor (C131) discharges only slightly from point X to point Y, which represents a pulse of approximately 10 microseconds. At point Y, Figure 4-13, the negative voltage suddenly falls to zero, the plate current increases through R133 and the plate voltage again falls to 15 volts. Therefore, when a four volt negative pulse is impressed on the input or grid circuit, it results in a positive pulse on the output or plate circuit of the same duration but of larger amplitude. Since the plate voltage changed from 15 volts to 50 volts, the amplitude of the pulse in the plate circuit is 35 volts and the gain is 35/4 or 8-3/4.

(3) The operating voltage of the plate and screen are so chosen that the plate current is cut off for any voltage higher than minus four volts on the control grid. The first video tube, therefore, operates as a voltage amplifier and limiter, the limiting taking place when pulses of four volts negative or more are impressed on the control grid. This limits the positive output pulse in the plate circuit to 35 volts. The cathode of the tube is operated at ground potential so that the only bias on the control grid, terminal No. 4, is a small negative potential which is due to the contact potential or space charge potential of the tube. R135, R136A, R136B, and R136C is the bleeder circuit and is used to adjust the plate voltage to the desired value. C136 is the bleeder by-pass. R134 is the screen dropping resistor and is used to adjust the screen voltage to the desired value. C133 is the screen by-pass. The desired value referred to is the value at which cut off will occur with minus four volts on the grid. The positive output pulses developed across the plate load resistor (R133) are coupled to the control grid of the second video amplifier through the coupling capacitor (C141).

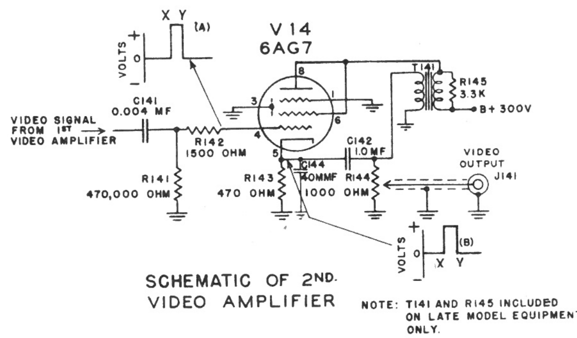


Figure 4-17—Schematic of Second Video Amplifier

n. SECOND VIDEO AMPLIFIER (V14).

(1) The second video amplifier employs a 6AG7 tube (V14) as a power amplifier. This stage utilizes the cathode follower circuit and performs the function of a step-down transformer. That is, it transforms high voltages across high resistance to lower voltages across low resistance. The cathode follower amplifier differs from the conventional type of amplifier in that the output load resistor is removed from between the d-c supply voltage and tube plate and connected between the cathode and ground. The output signal then appears between the cathode and ground. This automatically increases the grid input signals required for a given output since the voltage developed in the cathode is in opposition to or bucks the input voltage.

(2) The advantage in using this type of amplifier lies in its low output impedance, which equals the reciprocal of the tube transconductance or approximately 100 ohms. It therefore is capable of delivering voltage to loads down to 50 ohms or less with high fidelity as to frequency.

(3) The schematic circuit of the second video amplifier is shown in Figure 4-17, together with diagrammatic wave forms A and B. With no signal on the control grid of terminal No. 4 the plate and screen currents of approximately 22 mils total flows through the cathode load resistor (R143) and produces a bias of approximately 10 volts negative on the control grid of terminal No. 4. At point X on Figure 4-17 the control grid suddenly increases from zero to + 35 volts, which causes the plate and screen current to increase through the cathode load resistor (R143), which is a positive voltage across the cathode load resistor as shown by wave form B,

of the multivibrator itself to a maximum of five hundred pulses per second. Therefore, should the input sync pulse rate exceed five hundred pulses per second, the multivibrator automatically will "count-down" or "divide" by skipping the proper number of excess pulses to limit its output to five hundred per second. R172 is the potentiometer used for setting the limit of the repetition rate at 500 pulses per second. Each time the multivibrator operates, it delivers an output pulse to the element number 1 grid of V18A. One half of V22 is used as a diode on the grid of V17 in such a manner as to prevent the grid from being driven negative.

(3) The pulse shaper (V18A) and the pulse clipper (V18B) serve to amplify and shape the pulse from the multivibrator before applying it to the driver. Circuit constants have been chosen to limit the pulse width between five and nine microseconds.

(4) The driver (V19) serves to further amplify the pulse and to furnish sufficient driving power to drive the grid of the modulator. The pulse out of the plate is negative, but the transformer (T201) reverses the pulse polarity to positive. The transients shown on the sketch are due to this transformer but do not affect the operation of the circuit.

(5) The modulator (V20) is in the filament-to-ground circuit of the transmitter radio-frequency oscillator (V23). The modulator grid is normally biased to cutoff, and thus its plate-to-ground voltage also serves to bias the transmitter radio-frequency oscillator (V23) to cutoff. Whenever the positive pulse is delivered to the grid of V20 from T201, the plate-to-ground voltage is reduced to such an extent that the transmitter radio-frequency oscillator (V23) oscillates and delivers radio-frequency power to the antenna. As soon as the positive pulse is removed from the grid of V20, V23 again is biased to cutoff and ceases to oscillate.

(6) The gate pulse generator (V21) is a type of multivibrator that delivers a rectangular-shaped pulse from its output whenever it is triggered. The width of this pulse is controllable between 250 and 1500 microseconds. The pulse to trigger V21 is derived from the multivibrator output. One half of V22 is used to prevent the No. 1 grid of V21 from being driven excessively negative. The output pulse of V21 is used to "gate" the receiver i-f amplifier. By means of this "gate pulse," the receiver is made to operate for a definite period of time, during and immediately following each pulse from the transmitter, and then is rendered inoperative until the next pulse from the generator.

e. CIRCUIT OPERATION—Detailed.—The following is a detailed stage-by-stage description of the operation of the modulator section.

(1) The function of the pulse amplifier and limiter (V15) stage (Figure 4-19) is the providing of a substantially uniform pulse output for purposes of triggering the following multivibrator, although the input may be in the form of a positive pulse, substantially rectangular, and variable between the following limits:

1. Amplitude, from five to 150 volts.

2. Width, from 1/4 to 20 microseconds.

3. Repetition rate, from 50 to 3600 pulses per second.

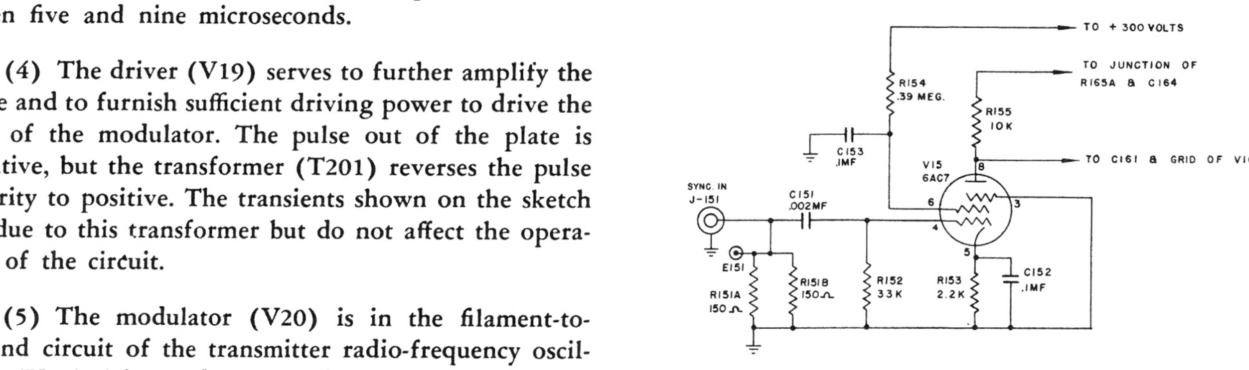


Figure 4-19—Pulse Amplifier and Limiter (V15)

(a) The pulse 1, shown applied to the grid of V15 on Figure 4-18, Page 4-18, is an example of a pulse of about 20 volts amplitude, four microseconds in width, and at a repetition rate of 800 pulses per second. The output pulse 2 is the result. Circuit constants are chosen so that the amplitude of the output pulse is limited to the maximum negative value shown. The gain of the stage is sufficient to obtain the maximum negative value with an input pulse of less than five volts. The time constant of R152-C151 is short enough for voltage from grid to ground, to decay to zero, between pulses at the highest repetition rate of 3600 pulses per second.

(2) The purpose of the multivibrator (V16 and V17) stage is to limit the repetition of the transmitter radio-frequency oscillator to a maximum rate of 500 pulses per second for input sync pulse rates between 500 and 3600 pulses per second. The way in which this is accomplished is best explained by reference to Figures 4-20 and 4-21, Pages 4-20 and 4-21.

(*a*) When there is no input sync pulse, V17 is normally cut off as a result of the current passed through the cathode resistor (R173) by way of the cathode bleeder resistors (R174A, R174B, and R174C); and its plate voltage therefore is at its highest point since no current is flowing through its plate resistor (R175). This condition is represented at point A on Figure 4-21, Page 4-21.

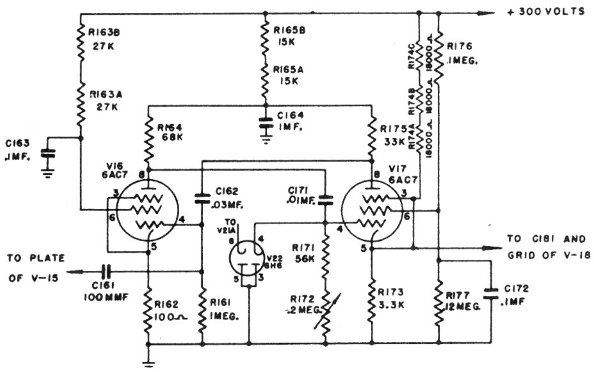


Figure 4-20—Multivibrator (V16 and V17)

(*b*) However, V16 is not cut off; and normally plate current flows through V16 and its plate resistor R164, and the voltage drop of R164 reduces the plate voltage. In this condition V16 is ready to amplify any sync pulse that may be applied to its grid.

(*c*) At point B, Figure 4-21, a negative pulse is applied to the V16 grid. This cuts off the plate current and permits the plate voltage to rise. The rise of the V16 plate voltage is coupled to the V17 grid by means of the coupling capacitor (C171), and the V17 grid thereby is driven in a positive direction above cutoff so that plate current flows in V17. This plate current flows through the V17 plate resistor (R175), and the plate voltage thereby is driven downward or in a negative direction. Since the V17 plate is coupled back to the V16 grid through the coupling capacitor (C162), the V16 grid is driven still more negative. These actions therefore reinforce each other, and the actions occur as shown at point B on Figure 4-21, Page 4-21, and are completed within three to four microseconds following the application of the beginning, or the leading, edge of the sync pulse. The pulse on the cathode of V17, used as the output pulse, rises to its maximum value within one microsecond of the application of the sync pulse leading edge.

(*d*) Immediately following the application of the sync pulse as shown at point B on Figure 4-21, Page 4-21, the conditions of V16 and V17 are interchanged; that is, V16 now is cut off and V17 is conducting. In this condition, V16 is incapable of amplifying any more negative sync pulses as the grid already is far below cutoff. Such sync pulses are indicated between points B and C on the grid voltage curve of V16 on Figure 4-21, Page 4-21. A small amount of such sync pulses is, however, coupled to the V16 plate and the V17 grid by virtue of the interelectrode capacitances of the tubes and can be seen in the pictures shown on Figure 4-18. They do not have any effect on the operation of the circuit.

(*e*) Now the V16 grid voltage cannot remain negative below cutoff, and it immediately starts rising along an exponential curve determined by the time constants of the coupling condensers (C162 and C171) and their respective grid leak resistors (R161, R171, and R172). R172 is a potentiometer (located on the chassis next to V17) so that the time required for the voltage on the V16 grid to rise can be adjusted in order to set the maximum rate at which the multivibrator can be triggered.

(*f*) As soon as the V16 grid voltage rises sufficiently so that plate current starts to flow again in V16, action takes place which is exactly opposite to that at point B on Figure 4-21, Page 4-21, and is shown at point C. Here the V16 grid voltage amplitude is drifting in a positive direction; and, as soon as plate current starts to flow into V16, its plate voltage is driven in a negative direction. Since the V16 plate is coupled to the V17 grid, the V17 grid voltage is driven negative, which allow the V17 plate voltage to go in a positive direction; and since the V17 plate is coupled back to the V16 grid, the V16 grid voltage is driven still more positively so that all these actions again are mutually reinforcing and continue until V17 is cut off.

(*g*) One half of V22, a 6H6 diode, is connected from the grid of V17 to ground, with the cathode of the diode connected to the V17 grid so that this grid cannot be driven far negative at point C on Figure 4-21, Page 4-21, as the V16 grid was at point B. This insures that the conditions existing at A of Figure 4-21 are reestablished as soon as possible following point C so that the multivibrator will be ready to be triggered by the first sync pulse following point C, as shown at point D.

(*h*) As the input sync pulse rate is varied, the time between points B and C of Figure 4-21 will remain constant, while the time between points C and D will vary. Actually, as the sync pulse rate is increased gradually, point D will approach point C, with point C remaining fixed. When point D comes very close to point C, point C will move slightly toward point A, as if being pushed by point D; but as the input pulse rate is further increased, pulse No. 4 on Figure 4-21 that had been triggering the multivibrator at point D, will fail to trigger. Point C then moves slightly to the right and thus the region between points B and C expands to include pulse No. 4. The region between points C and D then suddenly expands until point D comes to rest under pulse No. 5, where it remains until the input sync pulse rate is further increased, thus shortening the time between pulses 1 and 5 until 5 reaches point C where the same action again takes place. The action is exactly opposite when the input sync pulse rate is decreased.

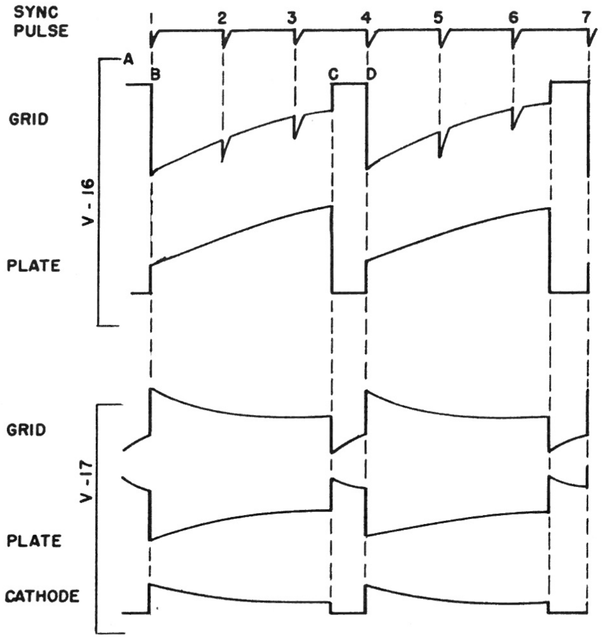


Figure 4-21—Multivibrator Pulse Shapes

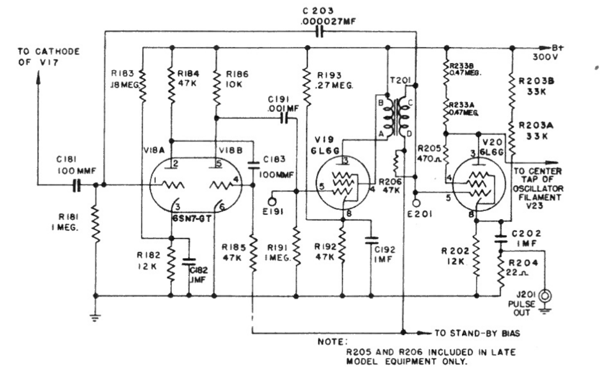


Figure 4-22—Pulse Shaper, Pulse Clipper, Driver and Modulator Schematic

(i) Whenever the input rate is so low that the separation between any two sync pulses exceeds the separation between points B and C, the multivibrator is triggered by every sync pulse and is said to be "driving direct." When it is being triggered by every second pulse, it is said to be "counting down" at a two to one rate. Figure 4-21 is drawn for a count down rate of three to one. The pulse shapes shown on Figure 4-18, Page 4-18, are for a count down rate of two to one.

(j) The output pulse of the multivibrator, from the cathode of V17, is capacity coupled to the following stage (V18A) by means of C181.

(3) The pulse shaper, pulse clipper, and driver (V18 and V19) function is to take the output pulse of the multivibrator from the cathode of V17, amplify and shape it to a pulse that is essentially rectangular, between five and nine microseconds in width and about 180 volts in amplitude. This pulse then is applied to the grid of the modulator (V20), which in turn permits the transmitter radio-frequency oscillator to oscillate for the duration of the modulator pulse.

(a) Pulse number 6 on Figure 4-18, Page 4-18, shows the shape of the pulse on the grid of the pulse shaper (V18A), Pin No. 1. This grid normally is biased almost to cutoff with respect to its cathode. The shape of the pulse is affected by a certain amount of voltage coupled back from the modulator grid (V20) by means of C203. The action of this capacitor will be explained further in a later paragraph, *(b)*.

(b) The output pulse of V18A is shown at No. 7 of Figure 4-18, Page 4-18 and is approximately 30 microseconds in width at the base. This pulse is shortened before applying it to the grid of the pulse clipper (V18B), Pin 4, by means of the short time constant of the coupling capacitor and grid leak resistor combination, C183 and R185. The differentiating action of this capacitor-resistor combination shortens the pulse to about 11 microseconds at the base. However, V18B begins to conduct plate current about two microseconds before the end of this pulse, and therefore the plate starts in a negative direction at this point. The output pulse of V18B, No. 9 of Figure 4-18, Page 4-18, thereby is limited to a width of about nine microseconds. Note that the values of C183 and R185, as well as the plate resistor (R184), are the primary factors governing the width of the output pulse of V18D.

(c) From the plate of V18B, the pulse is coupled by means of C191 to the grid of the driver (V19). The grid of this tube is biased normally nearly to cutoff with respect to its cathode. The grid is driven in a positive direction by over 70 volts, as shown on No. 10 of Figure 4-18, Page 4-18. This results in a large surge of plate current through the primary of the pulse transformer (T201), and the plate of V19 is driven in a negative direction by over 100 volts, as shown on No. 11 of Figure 4-18, Page 4-18. The transients on this pulse are discussed in a later paragraph.

(d) By means of the transformer (T201) the pulse on the plate of V19 is inverted to a positive pulse, and the voltage is increased by the turns ratio of the transformer. This pulse, over 180 volts positive, is applied to the grid of the modulator (V20) and is shown on No. 12 of Figure 4-18, Page 4-18.

(e) The modulator tube (V20) is the filament-to-ground circuit of the transmitter radio-frequency oscillator, as shown on Figure 4-22. The screen grid is connected to the plate so that the tube operates as a triode. The grid normally is biased to cutoff so that practically no plate current is allowed to flow, and the

plate voltage thereby is quite high (about 300 volts), which provides sufficient bias for the transmitter oscillator tube (V23) to cut it off and prevent it from oscillating. As soon as the modulator pulse is applied to the grid of V20, the plate voltage goes in a negative direction until the voltage from plate to ground becomes low enough for the transmitter radio-frequency oscillator (V23) to start conducting plate current and start oscillating. As soon as V23 conducts plate current, the plate voltage of V20 rises about 200 volts above its normal value and remains there for the duration of the modulator pulse. At the end of the modulator pulse, the modulator grid (V20) suddenly is driven below cutoff, and V20 ceases to conduct plate current. Therefore, the oscillator tube stops oscillating. The plate voltage of V20 then decays to its normal value in readiness for the next succeeding modulator pulse. This pulse shape is shown at No. 13, Figure 4-18, Page 4-18.

(f) No. 14, Figure 4-18, is the pulse across the 22-ohm resistor (R204), which is in series with the cathode by-pass condenser (C202) of V20. This pulse is fed to the "PULSE OUT" jack (J201) on the front panel. Since voltage appears across this resistor only when V20 is conducting plate current, the shape of this pulse is indicative of the plate current of the modulator (V20), and also of the Transmitter Radio-frequency Oscillator (V23) throughout the duration of the modulator pulse. When the modulator pulse is first applied to the V20 grid, the pulse across R204 rises approximately six volts, showing that plate current is flowing now through both V23 and V20. However, V23 does not commence to oscillate until about one microsecond later. As soon as V23 oscillates, the pulse across R204 rises to about 25 volts and remains there for the remainder of the modulator pulse, after which it decays immediately to nearly zero. This action accounts for the step in the pulse as seen on No. 14 of Figure 4-18.

(g) Pulse No. 11, Figure 4-18, Page 4-18, has large transients present. These are caused by the sudden starting and stopping of current through the primary of T201. The primary of T201, of course, is inductive and has across it certain small capacitances, such as the plate-to-ground capacitance of V19 and stray wiring capacitances. This inductance and capacitance combination comprises a tuned circuit which is shocked into oscillation at both the beginning and the end of the modulator pulse. The transients at the beginning of the pulse die out rapidly because of the load of the plate circuit of V19, which now is conducting plate current, and also to the load of the grid of V20 as reflected over into the primary of T201 by the inductive coupling between the two windings. The transients at the end of the modulator, however, last for a much longer time, about 14 microseconds, because both the plate loading effect of V19 and the reflected grid load of V20 are now absent.

(h) The feedback capacitor (C203) prevents the transients on the primary of T201 from having any deleterious effect. Without C203, these transients combine with stray feedback effects from V19 and V20 back to V18A to produce a series of several modulator pulses each time that the multivibrator is triggered. That is, under this condition, each time the multivibrator is triggered and feeds a pulse to V18A, a string of perhaps a dozen or more identical pulses are fed to the modulator grid (V20). The feedback capacitor (C203) prevents this from occurring by coupling back to the grid of V18A a negative voltage from the trailing edge of the pulse on the modulator grid, No. 12 of Figure 4-18. This drives the grid of V18A below cutoff at the end of the pulse and thus prevents the transients fed back to this grid through stray capacities from being amplified by V18A. C203 has further beneficial effects by helping to give a sharp fall to the trailing edge of the modulator pulse and thus improve the overall shape. It also contributes to a sharp rise of the leading edge of the modulator pulse by feeding back a positive pulse to V18A at this point. The three tube combination of V18A, V18B, and V19 does not break into self sustained oscillations due to the feedback of C203 because both V18A and V19 are biased close to cutoff.

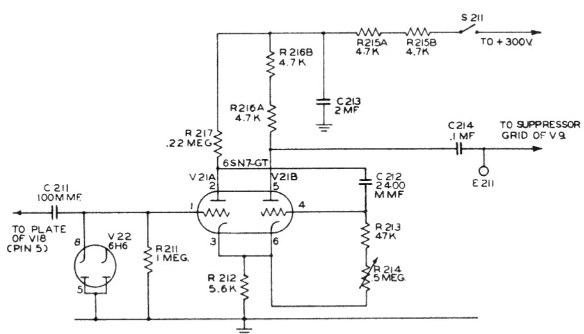


Figure 4-23—Gate Pulse Generator

(4) The schematic of the Gate Pulse Generator, the last stage, is shown in Figure 4-23, and the pulse shapes are shown on Figure 4-24.

(a) Prior to the application of a trigger pulse to the No. 1 grid of V21, the stage is in a quiescent condition, as shown at A on Figure 4-24, Page 4-23. Since the No. 4 grid is connected to the No. 6 cathode through resistors (R213 and R214), there is no bias between the No. 4 grid and the No. 6 cathode. Plate current, therefore, flows through this half of the tube and through the cathode resistor (R212), the plate load resistors (R216A, and R216B) and through the decoupling resistors (R215A and R215B). The current through the cathode resistor (R212) is sufficient to develop cutoff bias for the other half of the tube; that is, since grid No. 1 is connected to

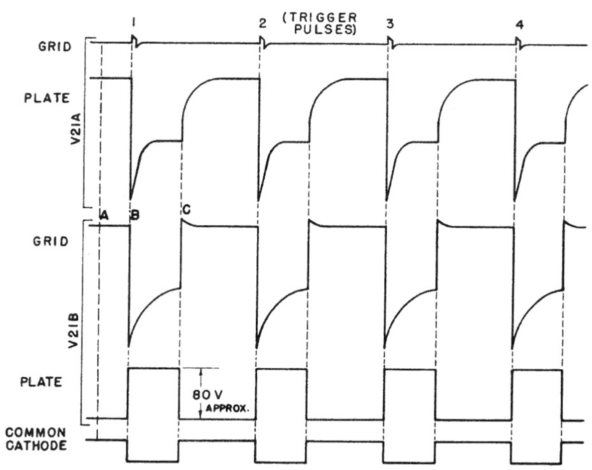


Figure 4-24—Gate Pulse Generator Pulse Shape

ground through the grid leak resistor R211, it is maintained at negative cutoff bias with respect to the cathode No. 3. The current through the plate resistors maintains the plate No. 5 about 83 volts below the voltage on C213. Since no plate current flows in the other half of the tube (plate No. 2), there is no current through R217; and plate No. 2 is at its maximum voltage, about 217 volts above ground.

(b) At point B on Figure 4-24, trigger pulse No. 1, derived from the output of V18B, is applied to the No. 1 grid of V21. This pulse drives the grid sufficiently in a positive direction so that the cutoff bias is overcome and plate current now flows through this half of the tube and through the plate load resistor (R217). The voltage drop developed across R217 because of this current drives the plate of V21A in a negative direction about 140 volts. The plate of V21A is coupled to the grid of V21B through the coupling capacitor (C212), and the grid is driven negative about 125 volts at point B on Figure 4-24. Therefore the plate current through V21B suddenly is cut off completely, allowing the plate voltage to rise to a maximum value determined by the voltage across C213. Since the high plate current in V21B (about 12.3 milliamperes) has ceased to flow, the voltage across the cathode resistor (R212) falls to a lower value determined by the current now flowing in V21A. This drop in voltage across this resistor is in such a direction as to remove most of the bias from between the grid and cathode of V21A, thereby reinforcing the action of the trigger pulse in causing current to flow in V21A. All the actions taking place at point B on Figure 4-24, therefore, are mutually reinforcing and take place in less than five microseconds from the start of the trigger pulse.

(c) The rise of the plate voltage of V21B is the start of the gate pulse and serves to gate or to turn on the intermediate-frequency amplifier of the receiver. This plate voltage remains at its maximum value as long as the grid of V21B remains below cutoff. The V21B grid voltage starts rising again immediately following point B of Figure 4-24. The rate at which it rises is determined by the time constant of the C212, R213, and R214 combination. Since R214 is a potentiometer, this rate, and hence the time of rise, can be adjusted. As soon as the V21B grid voltage has risen far enough to allow V21B to conduct, plate current action occurs at point C of Figure 4-24, which is the reverse of that taking place at point B. That is, plate current through V21B causes the cathode of V21A to be driven in a positive direction, which increases the bias between the V21A grid and cathode, causing the V21A plate current to decrease. This current decrease causes a rise in the V21A plate voltage, which is coupled through C212 to the grid of V21B. This in turn causes more plate current to flow in V21B, and therefore all the actions again are mutually reinforcing. The result is that the conditions existing before the application of the sync pulse are rapidly reestablished, the gate pulse is terminated abruptly, and the receiver intermediate-frequency amplifier is turned off. When the No. 2 trigger pulse is applied to the grid of V21A, the entire sequence is repeated. Thus a gate pulse is provided, starting with each trigger pulse and lasting for a definite time. This time, and hence the width, of the gate pulse is under the control of the operator by means of R214, which is brought out on the front panel.

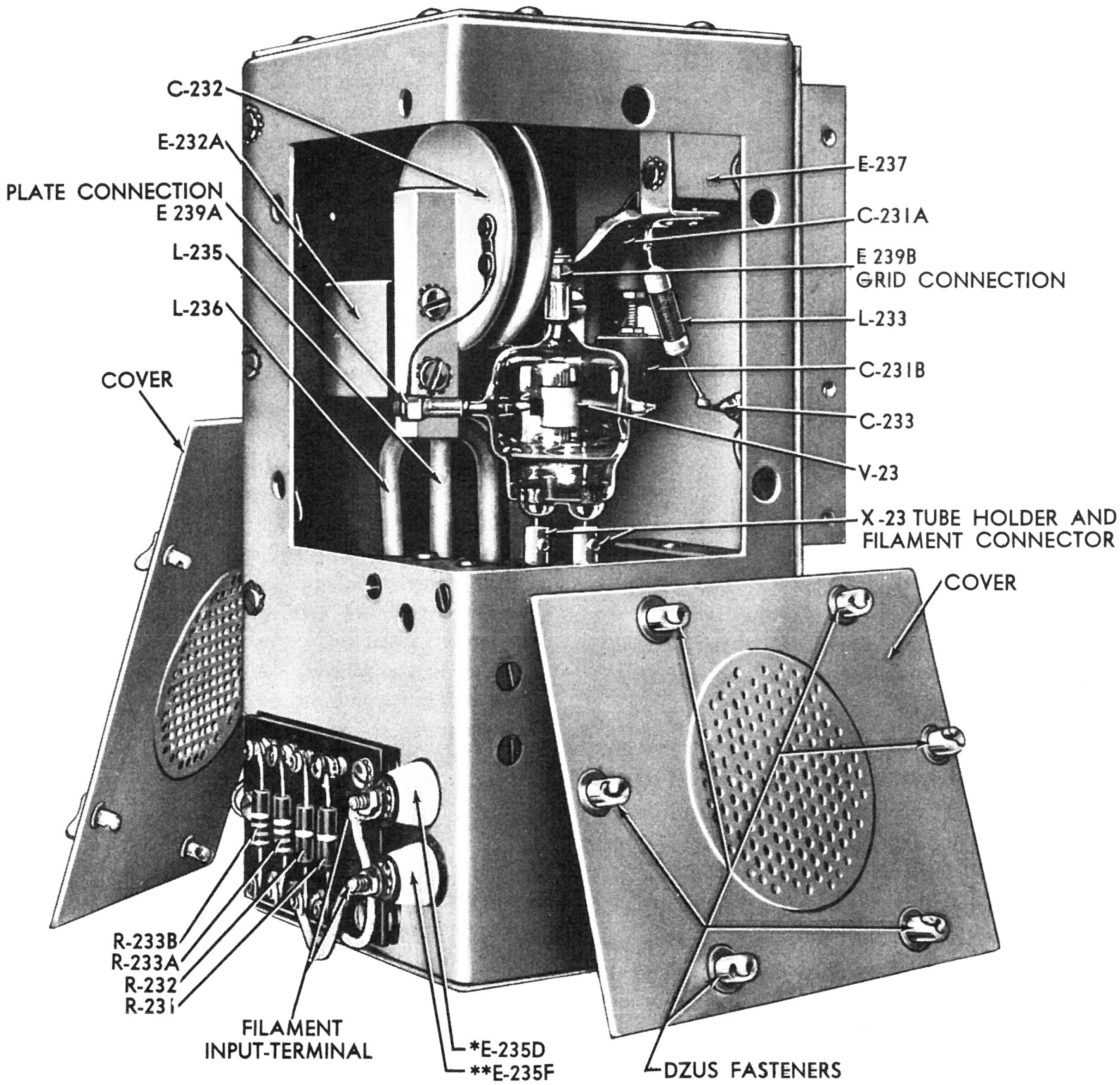
(d) The purpose of the diode (half of V22) on the grid of V21A is to prevent the grid from being driven excessively negative by the negative overshoot of the trigger pulse which would otherwise occur and interfere with the triggering action of the gate pulse generator.

3. TRANSMITTER.

a. FUNCTION.—The Transmitter R-F Oscillator, Type CFN–52ACQ provides the pulses of radio-frequency energy which are transmitted into space.

b. GENERAL DESCRIPTION—PHYSICAL.—The transmitter is housed in a compact compartment measuring only 4⅝ inches wide by 4 inches deep by 9 inches high. Figure 4-25, Page 4-24, shows a general view of this unit with the tube access door removed. These doors are provided with Dzus fasteners to facilitate easy removal.

c. The frequency of this transmitter is controlled by a rugged tank line supported by a large "U" shaped insulator near the top and by two cylindrical standoff



1030 *TWO PIECE INSULATOR, EXTERNAL SECTION (INTERNAL SECTION (E-235C)
**TWO PIECE INSULATOR, EXTERNAL SECTION (INTERNAL SECTION (E 235E)

Figure 4-25—Transmitter R-F Oscillator Navy Type CFN-52ACQ Side View

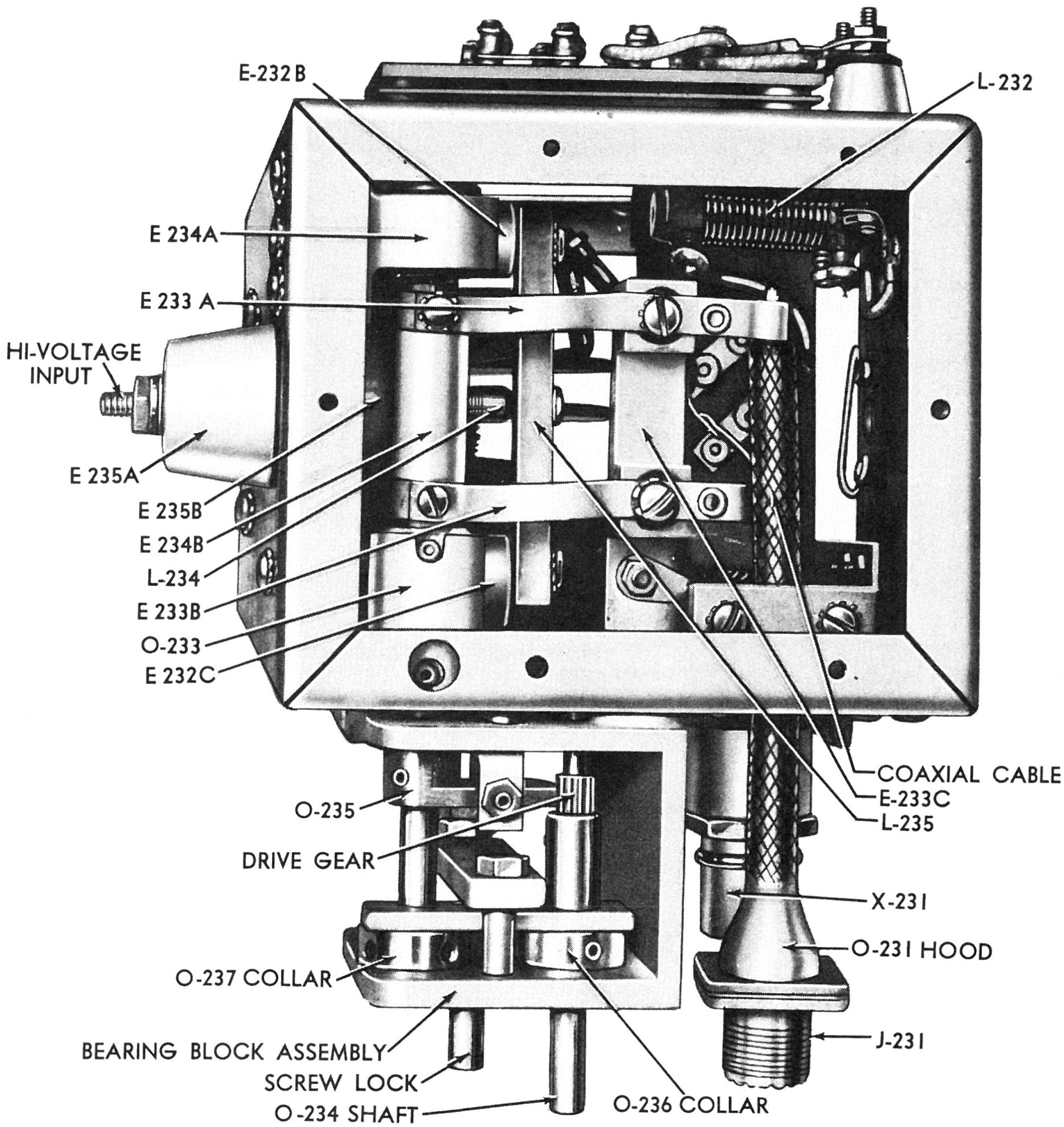


Figure 4-26—Transmitter R-F Oscillator Navy Type CFN-52ACQ Bottom View

insulators at the bottom. This circuit is tuned by a "pie plate" capacitor which can be seen at the top of the unit in Figure 4-25, Page 4-24. The shaft for this capacitor is connected to a front panel control by means of a flexible, ceramic-insulated coupling. A counter mechanism is actuated by the front panel control so that the operator has an idea of the approximate frequency to which the transmitter is set. A lock on this capacitor actually grips the threaded shaft holding the movable "pie plate" so that, when locked, this capacitor retains its set capacity. This lock is also connected to the front panel control by means of a flexible ceramic-insulated coupling.

d. The type 15E oscillator tube is mounted by its filament pins in a special socket. The filament pins are held securely in this socket by means of a set screw on each contact. One contact of this socket is fastened securely to the ceramic socket base. The other contact is mounted so that it is free to move slightly in order to accommodate variations in tube filament pin spacing. The grid and plate connections are made by spring grip connectors with flexible strip leads. Thus the tube actually is rigidly mounted at only one place so that vibrations will not strain the lead seals.

e. Figure 4-26, Page 4-25, shows a view of the bottom of the transmitter with the bottom cover removed. The bushing on the left hand side is the high voltage input terminal. At the left, just inside the compartment, can be seen the bottom of the output coupling loop and the strip type connectors which carry radio-frequency power from the coupling loop to the output cable and receptacle. Under these connectors can be seen the bottom of the transmitter tank line. The position of the output loop is variable with respect to this tank line so as to be able to match various loads. This output loop position is controlled by the shafts protruding from the gear box mounted at the bottom of the transmitter unit. These shafts, as well as the output receptacle, protrude through the front panel when the transmitter unit is installed in the BN equipment. This can be seen in Figure 4-26. Just above the radio-frequency output receptacle is a neon indicator lamp which is connected to a small pick-up loop inside the transmitter. The purpose of this lamp is to indicate operation of the transmitter.

f. ELECTRICAL.—The transmitter oscillator consists of a type 15E triode (V23) in a modified Colpitts oscillator circuit, as shown in Figure 4-27, Page 4-27. A parallel transmission line (L235) is used for the oscillator tank circuit. This is tuned by capacitor C232 from a control on the front panel. One end of this tank is connected to the plate of the oscillator tube (V23). The other end connects to the grid of V23 through the coupling capacitors C231A and C231B. These two capacitors are connected in series to increase the breakdown potential of the combination. The center of the tank is connected through a radio-frequency choke (L234) to the high voltage plate supply which is at a potential of approximately 5300 volts above ground.

g. The grid return for V23 is through radio-frequency choke (L233) and bias resistor (R234) to ground. Resistor R234 is located on the outside of the transmitter housing to keep it away from the heat of the vacuum tube inside. Capacitor C233 serves the dual purpose of bringing this grid return lead through the wall of the transmitter housing and at the same time grounding it for radio-frequency currents.

h. The radio-frequency output circuit consists of a pick-up loop (L236) connected through a short length of solid dielectric, 50 ohm coaxial cable to the transmitter antenna receptacle (J231). The position of the output loop (L236) is a variable with respect to the oscillator tank line (L235). This variation in coupling permits matching the transmission line to the transmitter to assure maximum transfer of energy even if the antenna mismatches the transmission line by a ratio of as much as three to one.

i. The radio-frequency monitor consists of a neon lamp (L231) connected to a pick-up loop (L237) inside the transmitter compartment. Physically this pick-up loop consists of a support bracket and the leads from the lamp socket. (The neon lamp is not intended for us as a tuning indicator but merely to show whether o not the transmitter is operating.)

j. The filaments of the oscillator tube (V23) are connected to a 5.4 volt winding on the power transformer (T251) through radio-frequency chokes (L231) and (L232). The purpose of these chokes is to permit the filament to seek a radio-frequency potential which gives the best efficiency to the oscillator.

k. An electrical center of the filament winding is obtained by means of resistors R231 and R232. This center point is connected to low voltage B-positive through resistors R233A and R233B, having a total resistance of approximately one megohm. The center point of the filament also is connected to the plate of the 6L6G modulator tube (V20). The cathode of V20 is connected to a voltage divider comprising R202 to ground and R203A and R203B in series to the low voltage power supply, which delivers 300 volts. This results in a normal voltage of approximately 50 volts above ground on the cathode of V20. Since the grid of V20 is returned to ground, this tube normally is biased to cutoff unless there is a positive signal on its grid.

l. CIRCUIT OPERATION—detailed.

(1) The cathode return for the transmitter oscillator tube (V23) is through resistors R233A, R233B, and the low voltage plate supply to ground. The modulator tube (V20) is in parallel with the above combination. With no signal on the grid of the modulator tube (V20), the plate resistance of the tube is very high since the grid is biased normally to a value below cutoff. Hence the modulator tube in this condition has practically no effect on the oscillator tube (V23). The oscillator cathode is at a potential of approximately 300 volts above ground.

(2) Since the grid of the oscillator tube is returned to ground, a negative bias of 300 volts is on the grid of V23. This bias is sufficient to cut off the plate current on this tube. Furthermore, as a result of the high value of resistance in the cathode circuit from R233A and R233B, if V23 does pass any plate current, it will build up additional bias voltage across these two resistors which thus will limit the plate current to a very small value, much too small to permit oscillation.

(3) When a positive signal is applied to the grid of V20, the plate resistance of this tube is reduced to a low value. This low value resistance, which is between the cathode of V23 and ground, reduces the voltage on the cathode of V23 to the order of 50 volts, thus reducing the grid bias on V23 and allowing this tube to oscillate. As soon as V23 starts to oscillate, it draws a rather high plate current, which is in the order of one ampere for the duration of the pulse. Since the plate resistance of V20 is in the order of several hundred ohms, the plate current of V23 produces a voltage drop across V20 in the order of 500 volts. This acts as cathode bias on the oscillator tube and supplies a part of the total grid bias voltage. The remainder of the grid bias voltage is supplied by grid leak resistor (R234).

(4) As soon as the pulse on the grid of the modulator tube (V20) ceases, the plate resistance of this tube immediately rises to a very high value. This causes the voltage across V20 to start to increase, but it does not increase greatly because the current is limited by the increasing resistance of the modulator tube. Thus V23 stops oscillating because sufficient current to sustain oscillations is not available. The voltage across the modulator tube (V20) drops along a capacitor discharge curve to the idling value, and the circuit again is ready to receive another pulse. The time required for the voltage on V20 to drop immediately after the pulse depends upon the capacity in the circuit and will vary between equipments. However, the time is well under that required for a repetition rate of 600 pulses per second.

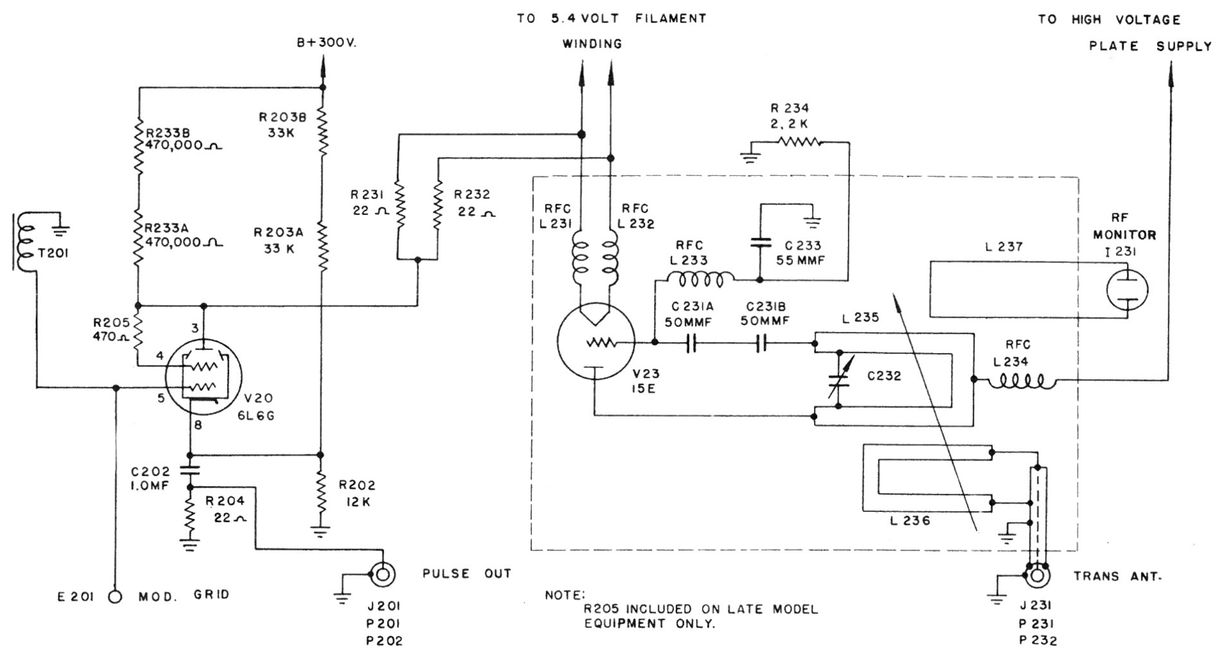


Figure 4-27—Transmitter Oscillator and Modulator

4. POWER SUPPLY.

a. GENERAL DESCRIPTION.

(1) The BN Equipment is designed to operate on an alternating-current power supply of 115 volts, 50 to 425 cycles per second. A single power transformer converts the input voltage to the necessary plate and filament voltages for the rectifiers and other tubes. This transformer is located near the center of the Modulator and I-F to Video Converter, Navy Type CFN–43ACB. The other power supply components are located on the chassis near the transformer. The power supply schematic is shown in Figure 4-28.

(2) The "POWER INPUT" receptacle (J251) is located in the lower right hand corner of the front panel of the modulator unit. Also on the front panel is located a 115 volt power outlet receptacle into which may be plugged test equipment or an electric soldering iron. This outlet is located on the line side of the power switch and fuses in the set so that a maximum of 15 amperes may be drawn from this outlet, provided the prime power suppy will deliver this much current.

b. DETAILED DESCRIPTION.

(1) The primary circuit of the power transformer (T251) in the BN is connected to the "POWER INPUT" receptacle (J251) through an interlock (S251), fuses, (F251) and (F252), and the main power switch (S252). A receptacle (J253) is connected in parallel with the power transformer primary. The blower motor (B251) is plugged into receptacle J253 by means of plug P253 for power connections. Normally a 60-cycle motor is supplied with this blower. A 400-cycle blower motor provided in the equipment spares can be used when using 400 cycles.

(2) The blower motor, as well as the power transformer, therefore is energized immediately upon closing the main powei switch (S252) provided that the interlock (S251) is closed. The interlock switch is composed of two parts: a two contact female receptacle (S251A) located on the rear skirt of the chassis of the modulator unit, and a two-prong male plug (S251B) located on the case so that the plug engages the receptacle when the modulator unit chassis is pushed all the way into the case. The two prongs of S251B are connected together and thus close the circuit when the plug engages the receptacle.

(3) This interlock operates on one side of the power supply line only, so that the "POWER INPUT" plug (P251) should be connected with its "A" terminal to the "grounded" side of the power line in order that the interlock may be in the "hot" side of the line.

(4) The power transformer primary is tapped to accommodate input voltages as low as 100 volts or as high as 130 volts. These taps are provided for 105, 115,

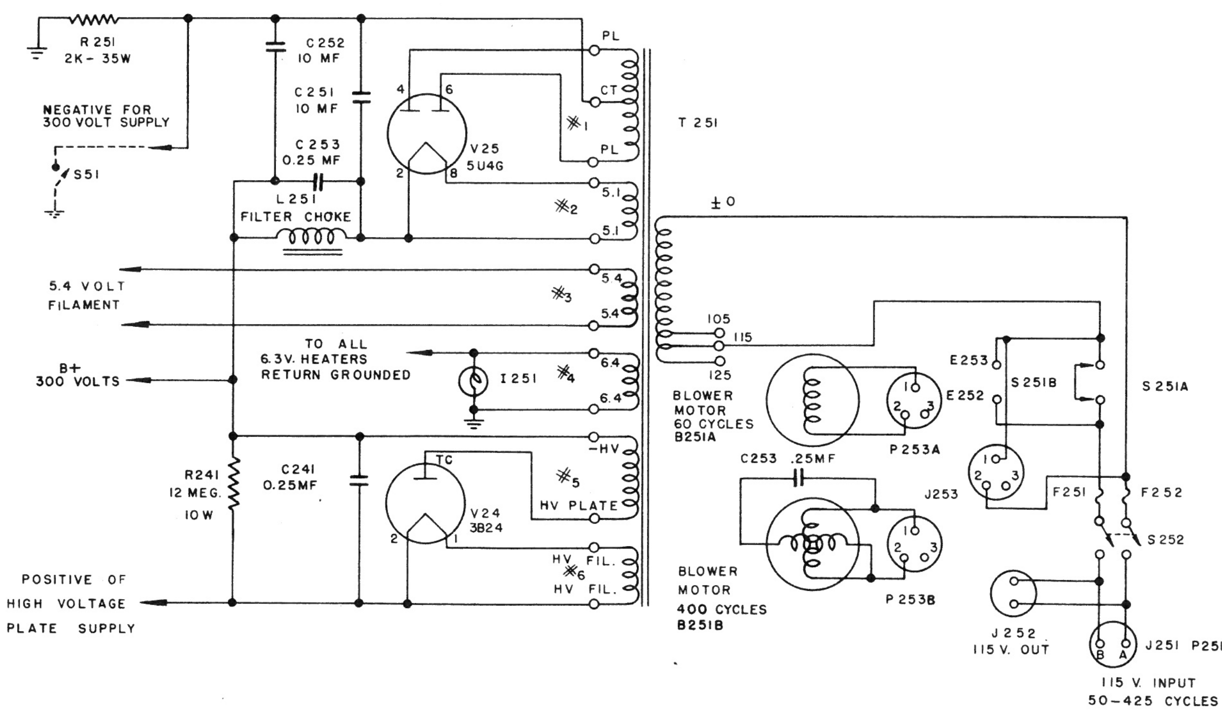


Figure 4-28—Schematic of Power Supply

and 125 volt inputs, and each tap will accommodate a voltage variation of plus or minus five volts from its rated voltage without appreciably affecting the performance of the equipment.

(5) The power transformer is equipped with six separate secondaries, as follows, to supply all voltages required for operation of this set:

(a) SECONDARY No. 1.

300 volt plate winding, center tapped, to supply plate voltages for the low voltage rectifier (V25).

(b) SECONDARY No. 2.

5.1 volt filament winding to supply filament power for the low voltage rectifier (V25).

(c) SECONDARY No. 3.

5.4 volt filament winding to supply filament power for the transmitter oscillator tube (V23).

(d) SECONDARY No. 4.

6.4 volt heater winding to supply heater current for all tubes having an indirectly heated cathode.

(e) SECONDARY No. 5.

High voltage plate winding to supply plate potential for the high voltage rectifier (V24).

(f) SECONDARY No. 6.

2.5 volt filament winding to supply filament current for the high voltage rectifier (V24).

(6) The 300 volt plate supply uses a type 5U4G full wave rectifier tube (V25). The filter for this rectifier consists of two ten microfarad capacitors (C251) and (C252) and an iron core choke (L251) of approximately 4.75 henries inductance shunted with a .25 microfarad capacitor (C253). This latter combination is broadly antiresonant at approximately 140 cycles, so that the 120 cycle ripple on the 60 cycle supply is well filtered. At 400 cycles, even though the filter choke and shunt capacitor combination represents a rather low impedance, the impedance of the 10 microfarad filter capacitors (C251) and (C252) is so very low that good filtering at this frequency still is obtained. No separate bleeder resistor is used on the 300 volt rectifier, since a number of voltage divider circuits in the modulator section provide an effective bleeder for this supply.

(7) The high voltage plate supply uses a type 3B24 half wave rectifier tube (V24). The filter for this rectifier consists of a single 0.25 microfarad capacitor (C241) as it is not essential to obtain a very low ripple content. This capacitor (C241) also acts as a current source for the high current pulses drawn by the transmitter oscillator tube (V23). A 12 megohm bleeder resistor (R241) is provided to discharge capacitor C241 when the equipment is de-energized.

(8) STAND-BY BIAS CIRCUIT.

(a) GENERAL DESCRIPTION.

1. In order that this equipment may be warmed up completely and ready for instant operation without actually operating, a stand-by switch (S51) is provided. The switch itself is not furnished with the equipment, as it generally will be installed in a remote position. The switch required is basically a single pole, single throw switch. The switch generally used is a three position switch in which the center position is open, the lower position is closed momentarily with a spring return, and the upper position is closed with a lock-in action. When switch S51 is closed, it connects the negative of the low voltage plate supply directly to the chassis (ground). When switch S51 is open, it places a 2000 ohm resistor (R251) between the negative of the 300 volt plate supply and chassis. Since the cathodes of all tubes using this plate supply return to the chassis (some through resistors), this arrangement makes resistor R251 carry the total output current of the 300 volt power supply. While this current is reduced from the normal value, it is sufficient to produce a voltage drop across R251 which is in the order of 150 volts. Since the control grids of tubes V4, V13, V18, and V20 are returned directly to the negative of the 300 volt power supply, these tubes have a bias of over 150 volts applied to them. Hence these tubes are biased well beyond cutoff and effectively prevent both the receiver and transmitter from operating. This is explained further in the sections describing the circuits of the above-mentioned tubes.

(b) The schematic of the stand-by bias circuit is shown in Figure 4-29, Page 4-30. The interrogation switch (S51), which is located in the remote control box, has three functions:

1. To turn the transmitter off and on.

2. To stop the local oscillator (V4).

3. Block the video amplifier.

(c) ELECTRICAL.—When the interrogation switch (S51) is in the stand-by position, the total plate current which is still flowing in the receiver is returned through the resistor (R251). Insofar as the ground end of the resistors is concerned it is connected to C plus, while the end connected to the center tap of the 300 volt plate winding is a negative potential, or C minus, the amplitude depending upon the I-R drop in the resistor. For the BN equipment this is approximately minus 150 volts d-c. The voltage from this point is fed to the grid return of the local oscillator (V4) through the filter circuit, which consists of C43 and R41, and to the grid return of the first video amplifier (V13) through the filter resistor (R132). The purpose of the filter circuits is to prevent oscillator voltage from entering the video circuit and

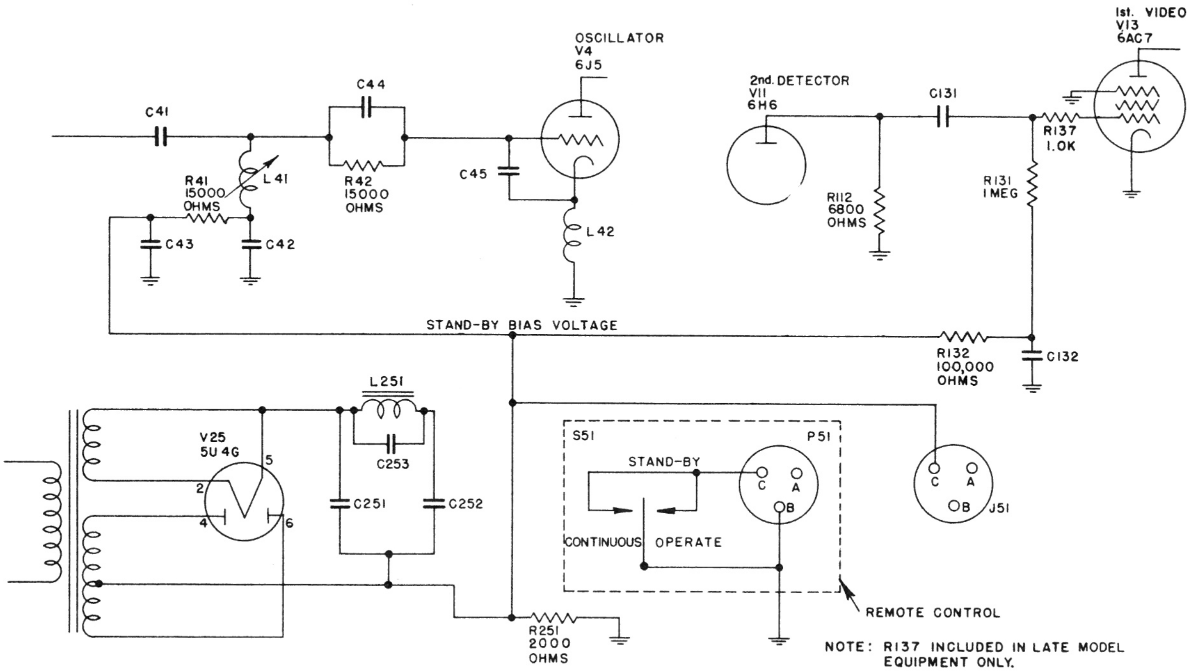


Figure 4-29—Schematic of Stand-by Bias Circuit

to keep the oscillator voltage and video voltage off the interconnection leads. Therefore, when the interrogation switch is in the stand-by position, the grids of the local oscillator and the first video amplifier are biased to minus 120 volts and are cut off.

(d) When the interrogation switch is in the "operate continuous" position, resistor R251 is short circuited and grid returns of the local oscillator and first video amplifier are returned to ground and operate normally.

5. INTERFERENCE RADIATED BY AN ASSOCIATED ABK TRANSPONDOR.

a. Since the Model BN Interrogator-Responsor Equipment is capable only of interrogating and receiving the response from a transpondor, but not capable of answering another Model BN, it is necessary for a craft carrying a Model BN Interrogator-Responsor to carry a transpondor so that other craft interrogating it may receive identifying responses.

b. This associated transpondor, being installed on the same craft as the Model BN, has a similar antenna located in the neighborhood of the Model BN antenna and radiates a signal that interferes with the reception of reply signals by the Model BN from crafts it may be interrogating.

c. The receiver in the Model ABK equipment utilizes a super regenerative circuit, the detector of which radiates an interference signal (as well as recognition pulses) as the transpondor sweeps the band. The interference signal from the ABK is modulated by the quench frequency, 300 kilocycles, and by thermal and tube noise. The ABK equipment radiates this signal regardless of whether the equipment is interrogated by a BN equipment or not.

d. The ABK equipment is provided with a suppressor circuit by means of which the radiation of interference may be suppressed for 300 microseconds after a short suppressor pulse which is supplied to the ABK equipment from the "PULSE OUT" Jack (J201) of the BN equipment. The suppressor pulse from the BN equipment occurs at the same time as the BN transmitter pulse and is of the same pulse repetition rate.

e. NATURE OF THE RADIATED SIGNAL.

(1) The ABK interference signal consists of triangular pulses of about one microsecond in duration at the base and a repetition rate of 300 kilocycles per second. These pulses appear on the Radar indicator as unsynchronized railing pulses, and, since there are only about 3 microseconds between pulses (300KC), it will not be possible to distinguish between peaks. Since it requires approximately 2½ seconds for the ABK Transpondor to sweep across the band once and return to the starting point, it is obvious that the transpondor will be tuned to the fixed challenging frequency of the BN once every 2½ seconds. Accordingly, ABK interference will be received at the same interval. Since the ABK sweeps 30 megacycles

every 2½ seconds, the duration of the received signal will depend on the bandwidth of the BN receiver. Now the band width of the BN receivers is at least five mc. for 10% response (20 db. down) so that the duration of the received interference will be 5/30 of 2½ seconds or 0.416 seconds (or 416,000 microseconds). On the return sweep, the BN receiver will pick up the ABK for about 0.1 second and will be hardly usable.

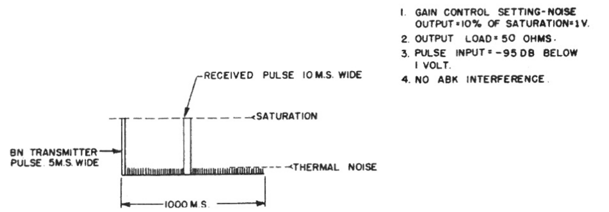


Figure 4-30—Signal Received with ABK Turned Off

(2) Figure 4-30 shows a weak pulse modulated signal received with the ABK turned off. The received pulse was 95 db. below one volt, just sufficient to produce maximum output. The pulse at the leading edge of the diagram represents the BN transmitter pulse.

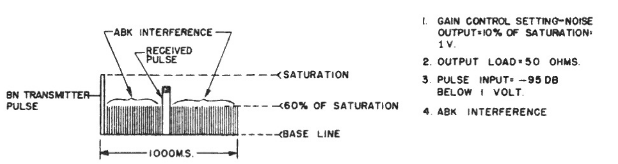


Figure 4-31—Operation with ABK Turned On and −95 Db. Signal

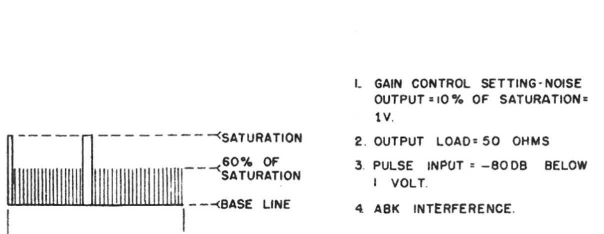


Figure 4-32—Operation with ABK Turned On and −80 Db. Signal

(3) Figures 4-31 and 4-32 show the effect of ABK interference. The antennas for the ABK and BN were 10 feet apart, and for this condition the peak ABK interference at the BN receiver was 50 db. below one volt.

(4) Figure 4-31 shows the operation when the ABK is turned on and is in tune with the BN. The weak pulse modulated signal received was 95 db. below one volt.

(5) Figure 4-32 shows the same operation except that the received pulse modulated signal was 80 db. below one volt.

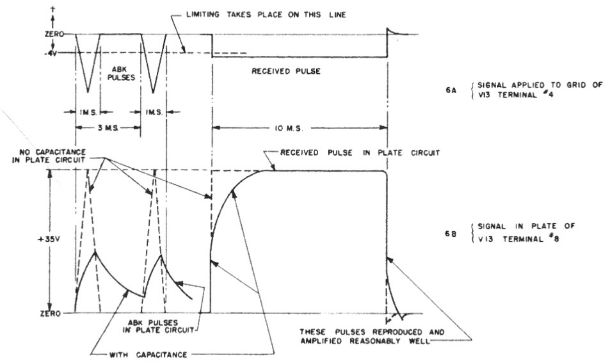


Figure 4-33—Detector Discrimination Against ABK Interference

(6) As shown in Figure 4-32 the 80 db. below one volt pulse-modulated signal is more than sufficient to produce a display corresponding to maximum output, (i.e., saturate the second video tube) with the gain control set for thermal noise output 10% of maximum output. Therefore the ABK interference which is 50 db. below one volt should also be sufficient to produce maximum output. However, the actual display of the ABK interference as shown in Figure 4-32 is at 60% of maximum output. This discriminatory action can best be explained by considering the difference in characters of the ABK interference and the desired pulses. Figure 4-33, 6A shows diagrammatically these signals which are applied to the first detector grid.

(7) The capacitance associated with the plate circuit of V–13, including tube and wiring capacitance, measures about 40 mmfd.; thus the time constant of the plate circuit (RC) is .00000132 seconds or 1.32 microseconds.

(8) Since it will require 1.32 microseconds to charge up the 40 mmfd. capacitance 60% and since the pulse duration of the ABK interference is only about one microsecond at the base, the voltage on the grid of the second video tube V14 will rise to about 50% of the maximum amplitude which it would reach without the presence of the capacitance. The short ABK interference pulses are attenuated. The five microsecond pulse or wider are reproduced reasonably well because in five the voltage on the grid of V14 rises to full value. Figure 4-33, 6B shows the same pulses as for Figure 4-33, 6A after amplification and limiting by the first video amplifier.

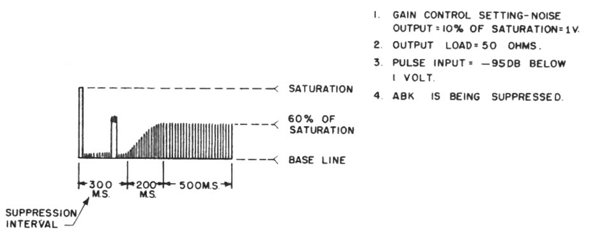


Figure 4-34—Pulse Received 200 Microseconds After Suppressor Interval

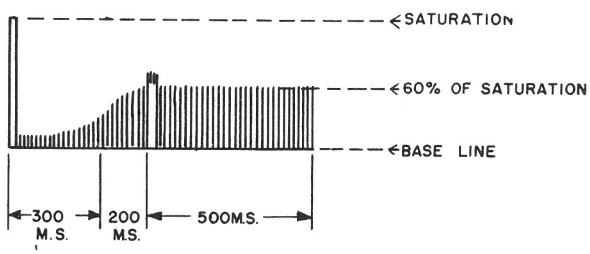


Figure 4-35—Pulse Received 500 Microseconds After Suppressor Interval

(9) When the ABK is suppressed as previously explained, the ABK will be sufficiently suppressed to prevent radiation for about 300 microseconds after the short suppressor pulse supplied by the BN. During the suppression interval, no ABK interference will appear in the BN output. Figure 4-34, Page 4-32, shows a weak pulse modulated signal received during the suppression interval. The received pulse was –95 db. below one volt, which is –45 db. below the ABK interference.

(10) Figure 4-34 shows the same received pulse received at a time corresponding to 200 microseconds after the suppressor interval, and Figure 4-35 shows it when received 500 microseconds after the suppressor interval.

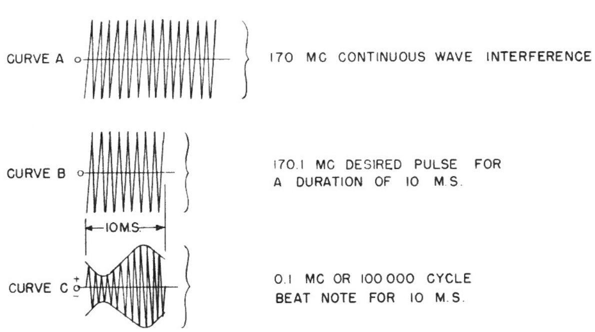


Figure 4-36—Beat Envelope

(11) Before the ABK is suppressed, the interference signal has a large d-c component at the second detector load resistor (R112). A d-c voltage therefore exists across the coupling capacitor (C131) to the first video grid V13, terminal No. 4. The time constant of the grid coupling circuit (R131 and C131) is 1000 microseconds, and the tube is operated without bias. When the ABK is suppressed, the coupling capacitor is discharged rapidly by grid current; and the first video amplifier recovers sensitivity rapidly as shown in Figure 4-34.

(12) The large ABK signal interferes with the BN for approximately 0.5 second when no suppressor is used. It will increase the average cathode current of the second video power amplifier cathode follower, raising the cathode voltage. The output coupling capacitor (C142) is made small enough so that this circuit discharges rapidly, and the tube is operated close enough to class A so that the increase in bias as a result of ABK interference does not cut off the tube.

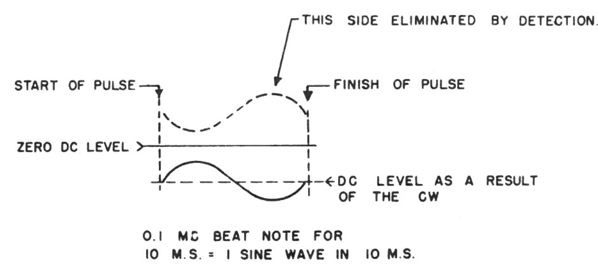


Figure 4-37—Beat Note After Detection by Second Detector

f. ACTION WHEN C-W INTERFERENCE IS PRESENT.

(1) When c-w (continuous-wave) interference is present, the interference and the desired pulse (received pulse) combine to form a beat envelope, see Figure 4-36. The receiver is tuned to 170.1 mc. for this explanation.

(2) One half of the beat note shown in Figure 4-36 still remains after detection by the second detector V 11A. This signal may be represented by Figure 4-37.

(3) This rectified signal then contains a d-c component and an a-c component. The d-c component represents the rectified c-w interference and the a-c component the beat frequency of the desired pulse and the interfering c-w signal. This beat note will be amplified by the video amplifier. Since the beat note is a 100,000-cycle a-c voltage, it will not produce a positive pulse in the output of the receiver. See Figure 4-38.

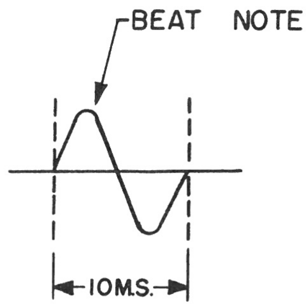


Figure 4-38—Beat Frequency Between C-W and Desired Pulse

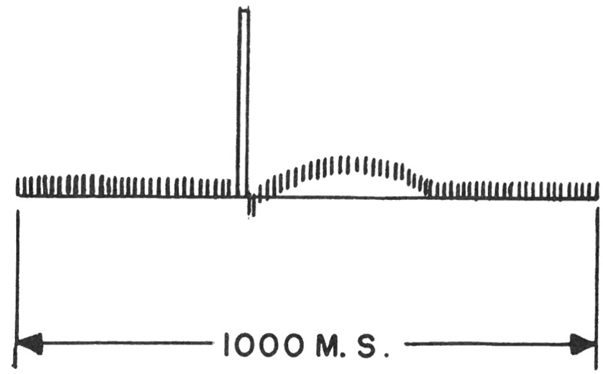


Figure 4-41—Result of Reducing C-W to –80 Db.

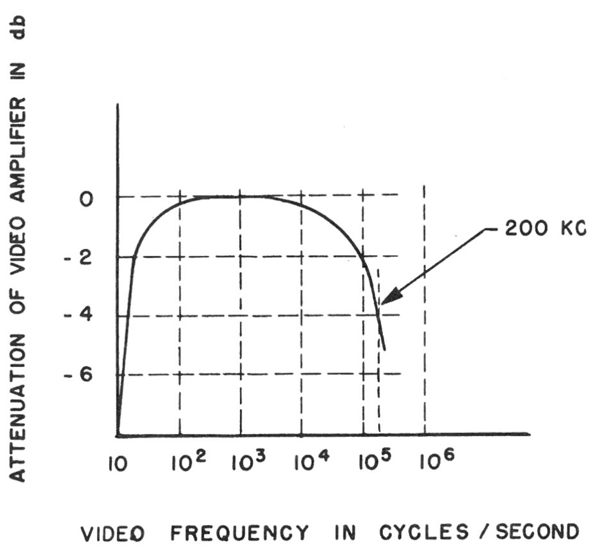


Figure 4-39—Overall Frequency Characteristics of Video Amplifier

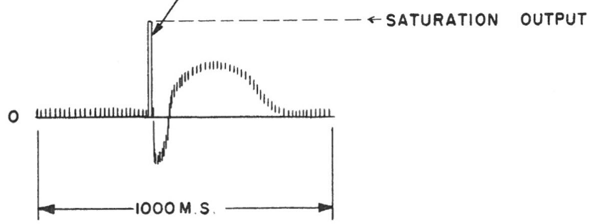


Figure 4-40—Result of C-W Overloading I-F Amplifier

(4) The cutoff frequency of the video amplifier is approximately 200 kc. If the frequency difference (the beat note) between the pulse carrier and the c-w interference exceeds the video amplifier cutoff frequency, the beat note is not passed by the video amplifier. The overall frequency characteristics of the video amplifier is shown in Figure 4-39.

(5) Figure 4-40 shows what happens if the c-w is permitted to overload the i-f amplifier and a strong pulse is received. The sensitivity control of the receiver may be reduced in the presence of a strong c-w signal to minimize distortion.

(6) Figure 4-41 shows what happens if the c-w interference is reduced to –80 db., other conditions the same as for Figure 4-40.

(7) Now if we consider the fact that the response of the ABK recognition pulses lie in the BN receiver pass band for about 0.4 second in each sweep of the frequency band, 157 mc. to 187 mc., the beat of this response with an interfering c-w signal will lie in the video pass band for only about .04 second or 1/10 as long, and hence is of little importance and is too fast to see on the Radar indicator.

(8) In general the desired pulse will reach the Radar indicator and be reproduced reasonably well if the pulse signal is six db. stronger than the c-w interference, providing of course that the c-w signal does not overload the i-f amplifier. With the gain control set for a thermal noise output of 10% of saturation, the i-f amplifier will start to overload on a c-w signal of –70 db.

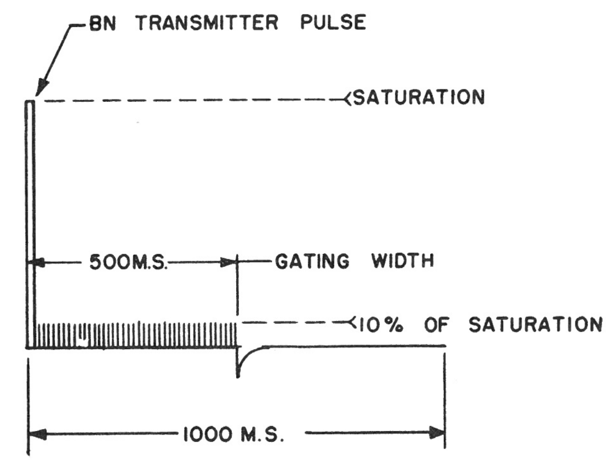


Figure 4-42—Display with Gating and with Thermal Noise Output of 10% of Maximum Output

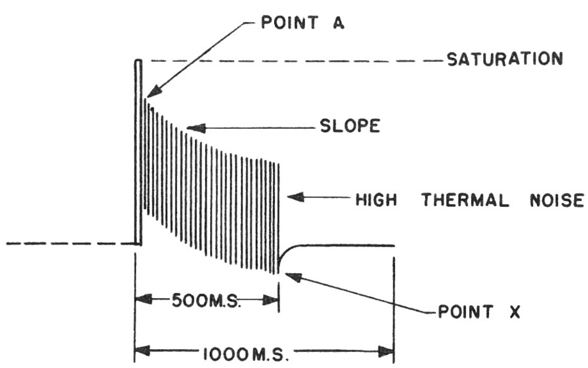


Figure 4-43—Display with Gating and with Thermal Noise Output of 50% of Maximum Output

g. ACTION WHEN GATING CIRCUIT IS USED.

(1) When the gating circuit is used and the receiver sensitivity control is adjusted to give at thermal noise output of 10% of saturation output, the display on the Radar indicator for the BN receiver will be as shown in Figure 4-42.

(2) If the receiver sensitivity control is adjusted for a thermal noise output of about 50% of maximum output, the display will appear as shown in Figure 4-43.

(3) The reason for the slope in the thermal noise is as follows: during the quiescent period, between gating pulses, the fifth i-f amplifier is cut off; hence no signal and thermal noise is passed into the second detector and video amplifier. The coupling capacitors in the input and output circuits of the first video amplifier (V13) will assume a charge corresponding to the grid voltage and plate voltage respectively.

(4) Now its grid voltage is substantially zero and the plate voltage is about 15 volts with the fifth i-f amplifier blocked.

(5) At the start of the gating pulse, the fifth i-f amplifier suddenly begins to deliver thermal noise voltage to the second detector, which in turn drives the first video grid negative, resulting in a display of thermal noise on the output of the second video stage displaced in a positive direction per point A of Figure 4-43. The coupling capacitors start to charge, the decay of the thermal noise pattern continues until the coupling capacitors in the video amplifier assume the average d-c potential of the video signal, and the thermal noise pattern returns from its displaced position to normal. (Fig. 4-43, X.)

(6) The negative overshoot in Figure 4-43, point X, is the transient which occurs when the fifth i-f amplifier suddenly is blocked.

6. TUNING MECHANISM.

a. GENERAL DESCRIPTION.—PHYSICAL.—The tuning mechanism, shown in Figures 4-44 to 4-49, Page 4-35, consists essentially of a Geneva movement, a dial, and a means of converting the rotary movement of the tuning shafts into an axial movement for actuating the tuning components.

b. The Geneva movement is provided with a stop that is an integral part of the ratchet wheel. This stop permits a rotary movement of approximately nine and three quarters turns.

c. The tuning shaft is attached to the main shaft, which drives the tuning components and a ratchet wheel which is secured to an auxiliary shaft above the main shaft. The ratchet wheel is driven by a small cam on the main shaft.

d. A black, laminated, cloth base phenolic dial is mounted on the front end of the auxiliary shaft. This dial is calibrated from zero to nine inclusive with luminous characters which are readily discernible regardless of outside illumination. These calibrations are read through indented "peep" holes in the receiver front panel.

e. ACTION.—For each complete revolution of the tuning shaft the dial moves one calibration, the numbers increasing as the shaft is rotated clockwise. This action is effected by a small projection on the cam engaging a notch in the ratchet wheel on each revolution of the cam. When the projection is not engaged in the notch, the ratchet wheel is locked in position by an inverted arc on its periphery which fits closely the circular contour of the cam.

f. The main shaft is reamed out from the rear to permit an in and out movement of a slotted shaft. (In the receiver this is the lead screw of the tuning slug

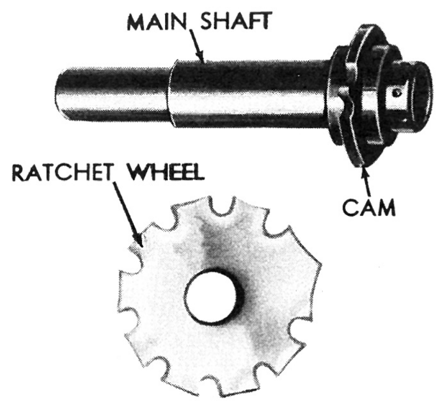


Figure 4-44—Tuning Mechanism

Geneva Movement and Tuning Shaft

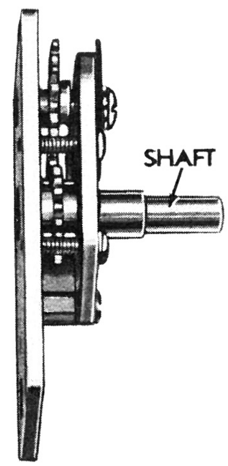


Figure 4-47—Transmitter Tuning Mechanism Side View

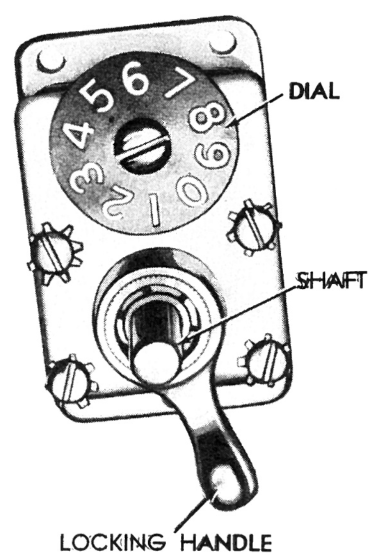


Figure 4-45—Tuning Mechanism Front View

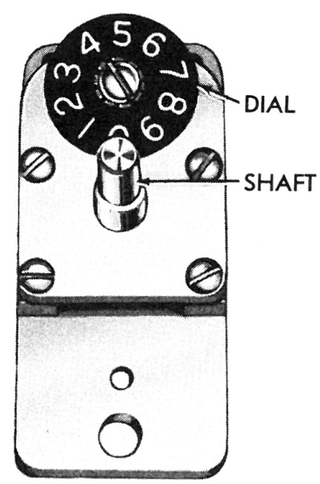


Figure 4-48—Transmitter Tuning Mechanism Front View

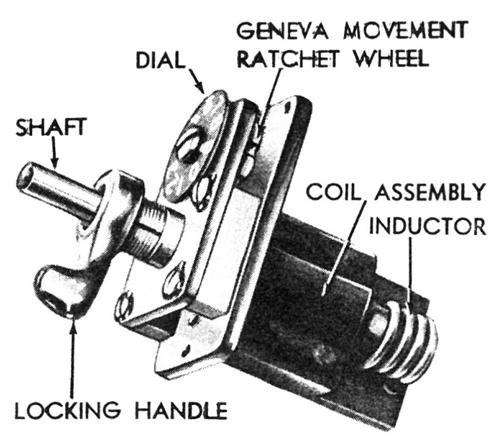


Figure 4-46—Tuning Mechanism Side View

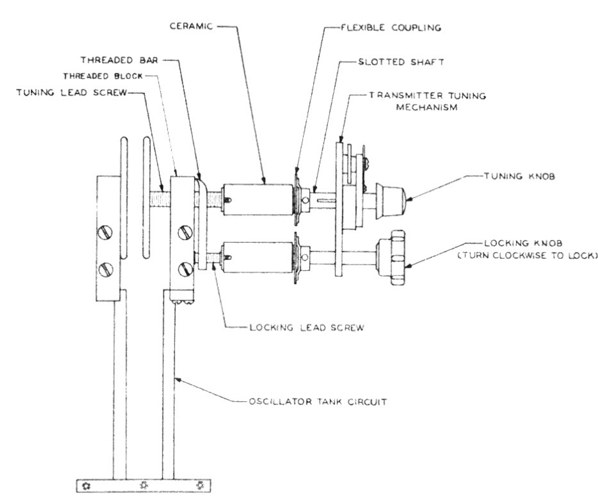


Figure 4-49—Locking Mechanism Transmitter

assembly.) A small pin is centered across this opening in the shaft at the rear edges. This pin rides in the slot in the tuning shaft or lead screw, causing them to follow the rotary movement of the main shaft.

g. In the transmitter section, the tuning shaft is connected by a flexible coupling to a lead screw which turns in a threaded block on the plate line assembly, causing an in or out movement according to the direction of rotation.

h. In the receiver, the lead screw of the tuning slug assembly is slotted. The pin in the main shaft engages in this slot. The in and out movement of the tuning slug assembly is produced by the rotary movement of the lead screw in the threaded portion of the phenolic mounting block of the tuning coil assembly.

7. LOCKING MECHANISM.

a. Locking action in the receiver tuning mechanism (see Page 4-35) is accomplished by forcing the tapered surface on the handle against the tapered surface on the split bushing that is secured to the front plate of the tuning mechanism. This action causes the split bushing to bind on the main shaft, giving the required locking effect. To lock, turn the handle clockwise; for unlocking, turn the handle counterclockwise, as shown on the nameplate.

b. Locking action in the transmitter section (See Figure 4-49, Page 4-35) is accomplished by the outward movement at the bottom of a bar, threaded to accept the lead screw of the transmitter tuning component. When this bar is moved outward, it produces a binding action on the threads of the lead screw, giving the required locking effect. This outward movement of the bar is actuated by the rotation of a lead screw inserted into a threaded hole in the bottom of the bar. This lead screw is connected to a knob directly below the tuning control, through a flexible coupling and a shaft. For locking, turn the knob clockwise; for unlocking, turn the knob counterclockwise.

c. All controls must be unlocked before the tuning mechanisms are operated. This is particularly true of the transmitter tuning mechanism, as the binding action would produce an undue strain on the ceramic portion of the flexible coupling.

SECTION V

MAINTENANCE

1. INTRODUCTION.

a. Maintenance, in a very general and broad sense, is insuring the continued normal operation of the equipment through proper servicing. It is intended to detect slow changes in the characteristics of the circuits, to indicate the need for adjustments and repair in advance of possible failure, and also to effect the necessary repairs in the event of actual failure.

b. In servicing equipment the procedure should not be haphazard, but should be conducted in a predetermined orderly manner. With this thought in mind there should be a definite point by point check of every possible place or source of trouble which may cause marked variation in operation or no operation at all.

c. A schematic diagram of the Model BN Radio Equipment is shown in Figure 7-1, Pages 7-1, 7-2, and the wiring diagram in Figure 7-2, Pages 7-3, 7-4.

d. A photograph of Model BN Radio Equipment (rear oblique view) is shown on Page 2-0.

2. TEST CHART.

a. A chart showing d-c voltages on each tube in the unit, as well as signal voltages at various points, is supplied with this instruction book. This chart should be consulted whenever a failure occurs. Voltages should be measured with a meter having a resistance of at least 20,000 ohms per volt. An oscilloscope is a practical necessity for observation and measurement of wave shapes at various points.

b. The service problems on this receiver are the same as for any other receiver using the superheterodyne principle.

c. A definite but general procedure to follow would be the checking of the given causes for the following troubles, remembering that the circumstances are not entirely complete.

(1) Entire unit dead

(*a*) Power switch "OFF"
(*b*) No connection to power line outlet
(*c*) Line voltage absent or low
(*d*) Fuses blown
(*e*) Broken interlock wire
(*f*) Defective rectifier
(*g*) Short on voltage supply
(*h*) Defective component

(2) Operation below normal (according to either Radar or separate indicator)

(*a*) Low line voltage
(*b*) Gain control at minimum
(*c*) Remote control circuit open
(*d*) Local or external interference
(*e*) Poor connection to antenna
(*f*) Broken or shorted transmission line to Radar
(*g*) Receiver defective
(*h*) Transmitter defective
(*i*) Modulator defective
(*j*) Power supply defective
(*k*) Defective gain control
(*l*) Defective stand-by switch

d. Since this is pulse-type equipment operating at very high carrier frequencies, it is quite evident that the characteristics of any one equipment will differ somewhat from those of another. The information presented in this section is somewhat general in that it gives average data and is applicable to all BN equipments.

3. PERIODIC CHECK-UP.

a. A periodic check should be made of the equipment to insure dependable operation. If, at any time, it is necessary to operate this unit in an exposed position, steps should be taken to clearly mark the equipment as dangerous and to keep personnel from touching any of the circuits. Almost all defects can be investigated with an ohmmeter, and this method of analysis should be used at all times in preference to test made under operating conditions.

b. Notes should be taken of all waveforms, resistance values, and available voltages. These notes should be recorded and arranged to permit easy comparison of measurements of any one quantity taken at various times. Records should also be kept on the replacement of tubes or other components. With such records it will be possible to detect slow progressive drifts in operation performance which may lead to trouble. Steps can then be taken to prevent any failures. Thus the data, if taken this way on equipment that has been operating properly, may be used for checking purposes in place of some of the general data given in this section of the instruction book.

4. MEASUREMENTS.

a. Personnel must often rely on measurements of resistance and voltage by indirect methods to locate trouble. Navy regulations forbid personnel to measure potentials in excess of 500 volts or to tamper with safety interlock switches under any circumstances. Therefore, most maintenance and servicing data, especially on the transmitter, need to be taken by indirect methods, using continuity tests and resistance measurements. On the receiver, however, available voltage and resistance measurements can be taken, but it is necessary in making voltage measurements to observe precautions in some cases to prevent the presence of measuring leads from upsetting the high-frequency circuits.

b. WHEN PERFORMING OHMMETER ANALYSIS, always be sure that all power is off; otherwise faulty readings will be obtained and damage to the measuring instrument is very likely to occur. It is important that the correct scale is chosen to measure a particular resistor so that a readable deflection will be obtained. A meter sensitivity of 20,000 ohms per volt is recommended. The schematic should be referred to constantly so that the presence of shunting circuits will be realized. In many instances it will be necessary to open such circuits to obtain a correct reading.

c. Also as a safety precaution when making measurements, be sure to remove any charge that might be, or suspected to be, left in the high voltage capacitor, by shorting the terminal to ground. Use a well insulated and dry screwdriver and proceed by touching ground, or the chassis, first; and then complete the short circuit by contacting the terminal. Remove the high voltage rectifier cap. Proceed accordingly with measurements.

d. The following tables of resistance and voltage measurements are of an average BN equipment and should be used for reference purposes when making periodic checks and locating faulty components. Variations in values of any particular equipment from those given should not be great. Once an equipment has been determined to be operating correctly, its resistance and voltage measurements can be used with more preciseness than the following tables which are only average values; however, both should be the same values.

e. The schematic diagram, Figure 7-1, pages 7-1, 7-2, should always be referred to when taking measurements. Figure 5-1 illustrates tube socket terminal numbering.

5. RESISTANCE VALUE AT TUBE SOCKET.

(Refer to schematic diagram, Figure 7-1, and measure resistance from points given under "Pin No." and "Test Conditions.")

CAUTION

BE SURE ALL VOLTAGES ARE REMOVED. SHORT HIGH VOLTAGE CAPACITOR TO GROUND TO REMOVE ANY CHARGE LEFT.

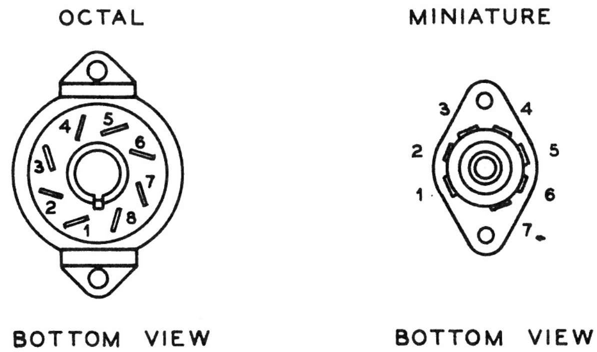


Figure 5-1—Tube Socket Terminal Numbering

NOTE

All plugs (external connections) must be removed before resistance tests are made.

Receiver—6J6 (V-1)

Pin No.	*Test Conditions*	*R Ohms*	*Components Involved*
1	Plate T2 to Gnd	1 Meg	R13
2	Plate T1 to Gnd	32.2 K	C16, R14, C14, R15A, R15B, C19, R16, Group A
2	Plate T1 to B+	18.8 K	R14, R15A, R15B, R16
3	Heater to Gnd	Small	L13, C18, Group B
4	Heater to Gnd	Small	L14
5	Grid T1 to Gnd	100 K	R12, C15
6	Grid T2 to Gnd	100 K	R12, C15
7	Cathode to Gnd	47	C12, L12, C13, R11

Receiver—6SH7 (V-2)

1	Shell	0	
2	Heater to Gnd	Small	C26, L22, Group B
3	Cathode and Suppressor to Gnd	75	R22, C22, C23
4	Grid to Gnd	100 K	R21, C21
5	Cathode and Suppressor to Gnd	75	R22, C22, C23
6	Screen to Gnd	61.4 K	C24,R23,C25,R25,Group A
6	Screen to B+	48 K	R23, R25
7	Heater to Gnd	0	
8	Plate to Gnd	17.7 K	R24, R25, C25, Group A
8	Plate to B+	4.3 K	R24, R25

Receiver—9006 (V-3)

1			
2			
3	Heater to Gnd	0	
4	Heater to Gnd	Small	C34, L32, Group B
5	Plate to Gnd	10 K	L31, C33, R32, C41, C31
6			
7	Cathode to Gnd	Small	R52, C32, R31, L51

Receiver—6J5 (V-4)

1	Shell	0	
2	Heater to Gnd	0	
3	Plate to Gnd	20 K	C46, R43, C47, R44, Group A
3	Plate to B+	6.6 K	R43, R44
4			
5	Grid to Gnd	32 K	C44, R42, C41, C42, L41, R41, C43, C45, R251
6			
7	Heater to Gnd	Small	C49, L43, Group B
8	Cathode to Gnd	Small	L42

Note: Small means less than one ohm.

Receiver—6AC7 (V-5)

Pin No.	*Test Conditions*	*R Ohms*	*Components Involved*
1	Shell	0	
2	Heater	0	
3	Suppressor	0	
4	Grid to Gnd	Small	L51, R52
*5	Cathode to Gnd	174	R53, C51, R54
5	Cathode to B+	23 K	R53, R54, R55, C54, R58A, R58B, Group A
6	Screen to Gnd	24.2 K	C52, R57A, R57B, R57C, R57D, Group A
6	Screen to B+	10.8 K	R57A, R57B, R57C, R57D
7	Heater to Gnd	Small	C56, L54, Group B
8	Plate to Gnd	24.7 K	L53, C61, C53, C52, R56, R57A, R57B, R57C, R57D, Group A
8	Plate to B+	11.3 K	L53, R56, R57A, R57B, R57C, R57D

Receiver—6AC7 (V-6)

1	Shell	0	
2	Heater	0	
3	Suppressor	0	
4	Grid to Gnd	4.7 K	R61, C61
*5	Cathode to Gnd	174	R62, C62, R63
5	Cathode to B+	23 K	R62, R63, R55, C54, R58A, R58B, Group A
6	Screen to Gnd	24.2 K	C63, R65A, R65B, R65C, R65D, Group A
6	Screen to B+	10.8 K	C63, R65A, R65B, R65C, R65D, Group A
7	Heater to Gnd	Small	C65, L62, Group B
8	Plate to Gnd	24.7 K	L61, C71, C64, R64, R65A, R65B,R65C,R65D,Group A
8	Plate to B+	11.3 K	L61, R64, R65A, R65B, R65C, R65D

Receiver—6AC7 (V-7)

1	Shell	0	
2	Heater to Gnd	0	
3	Suppressor to Gnd	0	
4	Grid to Gnd	4.7	R71, C71,
*5	Cathode to Gnd	174	R72, C72, R73
5	Cathode to B+	23 K	R72, R73, R55, C54, R58A, R58B, Group A
6	Screen to Gnd	24.2 K	C73 R75A, R75B, R75C, R75D, Group A
6	Screen to B+	10.8 K	R75A, R75B, R75C, R75D
7	Heater to Gnd	Small	C75, L72, Group B
8	Plate to Gnd	24.7 K	C81, L71, C74, R74, R75A, R75B, R75C, R75D, Group A
8	Plate to B+	11.3 K	L71, R74, R75A, R75B, R75C, R75D

Receiver—6AC7 (V-8)

1	Shell	0	
2	Heater	0	
3	Suppressor	0	
4	Grid to Gnd	4.7 K	R81, C81
5	Cathode to Gnd	180	R82, C82
6	Screen to Gnd	24.2 K	C83, R84A, R84B, R84C, R84D, Group A
6	Screen to B+	10.8 K	R84A, R84B, R84C, R84D
7	Heater to Gnd	Small	C85, L82, Group B
8	Plate to Gnd	24.7 K	C91, L81, C84, R83, R84A, R84B, R84C, R84D, Group A
8	Plate to B+	11.3 K	L81, R83, R84A, R84B, R84C, R84D

*Ground Terminal A of J51

Receiver—6AC7 (V-9)

Pin No.	*Test Conditions*	*R Ohms*	*Components Involved*
1	Shell	0	
2	Heater to Gnd	0	
3	Suppressor to Gnd	1 meg.	R97, C98
4	Grid to Gnd	4.7 K	R91, C91
5	Cathode to Gnd	220	R92, C92
6	Screen to Gnd	26.6 K	C93, C94, R94A, R94B, R94C, R94D, Group A
6	Screen to B+	13.2 K	R94A, R94B, R94C, R94D
7	Heater to Gnd	Small	C96, L91, Group B
8	Plate to Gnd	29.9 K	C111, R93, C93, C94, R94A, R94B, R94C, R94D, Group A
8	Plate to B+	16.5 K	R93, R94A, R94B, R94C, R94D

Receiver—6H6 (V-10)

1	Shell	0	
2	Heater to Gnd	Small	Group B
3	Plate to Gnd	1 meg.	R97, C98
4	Cathode to Gnd	0	
5	Plate to Gnd	1 meg.	R97, C98
6	No Connection		
7	Heater to Gnd	0	
8	Cathode to Gnd	0	

Receiver—6H6 (V-11)

1	Shell	0	
2	Heater to Gnd	Small	C113, L113, Group B
3	Plate to Gnd	20 meg.	R121A, R121B, C121, L111, C114
4	Cathode to Gnd	Small	L112, C112
5	Plate to Gnd	6.8 K	R112
6			
7	Heater to Gnd	0	
8	Cathode to Gnd	Small	L111, C114

Receiver—6E5 (V-12)

1	Heater to Gnd	Small	Group B
2	Plate to Gnd (S121 closed)	1 meg.	R123, R124, Group A
3	Grid to Gnd	20 meg.	C122, C123, R122, C121, R121A, R121B
4	Target to Gnd (S121 closed)	16.1 K	R124, Group A
5	Cathode to Gnd	0	
6	Heater to Gnd	0	

Receiver—6AC7 (V-13)

1	Shell	0	
2	Heater to Gnd	0	
3	Suppressor to Gnd	0	
4	Grid to Gnd	1.1 meg.	C131, R137, R131, C132, R132, R251
5	Cathode to Gnd	0	
6	Screen to Gnd	58.5 K	C133, R134, R135, R136A, R136B, R136C, Group A
6	Screen to B+	61.7 K	R134, R135, R136A, R136B, R136C, Group A
7	Heater to Gnd	Small	C138, L131, Group B
8	Plate to Gnd	44.5 K	R134, C133, R133, R135, R136A, R136B, R136C, C136, Group A
8	Plate to B+	47.7 K	R133, R135, R136A, R136B, R136C, Group A

Note: Small means less than one ohm.

Receiver—6AG7 (V-14)

Pin No.	*Test Conditions*	*R Ohms*	*Components Involved*
1	Shell	0	
2	Heater to Gnd	0	
3	Interlead Shield to Gnd	0	
4	Grid to Gnd	471.5 K	R142, C141, R141
5	Cathode to Gnd	470	R143, C144, C142
6	Screen to Gnd	13.4 K	Group A
6	Screen to B+	20	T141 Primary
7	Heater to Gnd	Small	L141, Group B
8	Plate to Gnd	13.4 K	Group A
8	Plate to B+	20	T141 Primary

Modulator—6AC7 (V-15)

1	Shell to Gnd	0	
2	Heater to Gnd	Small	Group B
3	Suppressor to Gnd	0	
4	Control Grid to Gnd	33 K	R152, C151
5	Cathode to Gnd	2.2 K	R153, C152
6	Screen to Gnd	400 K	R154, C153, Group A
6	Screen to B+	390 K	R154
7	Heater to Gnd	0	
8	Plate to Gnd	53 K	R155, R165A, R165B, C161, C164, C171, Group A
8	Plate to B+	40 K	R155, R165A, R165B

Modulator—6AC7 (V-16)

1	Shell to Gnd	0	
2	Heater to Gnd	0	
3	Suppressor to Gnd	100	R162
4	Control Grid to Gnd	1 meg.	R161, C161
5	Cathode to Gnd	100	R162
6	Screen to Gnd	67.4 K	R163A, R163B, C163, Group A
6	Screen to B+	54 K	R163A, R163B
7	Heater to Gnd	Small	Group B
8	Plate to Gnd	111.4 K	R164, R165A, R165B, C171, C164, Group A
8	Plate to B+	98 K	R164, R165A, R165B

Modulator—6AC7 (V-17)

1	Shell to Gnd	0	
2	Heater to Gnd	0	
3	Suppressor to Gnd		Same as E171
4	Control Grid to Gnd (Variable)	56K to 256K	R171
5	Cathode to Gnd		Same as E171
6	Screen to Gnd	58.6 K	R177, C172, R176, Group A
6	Screen to B+	57.4 K	R177, R176, Group A
7	Heater to Gnd	Small	Group B
8	Plate to Gnd	76.4 K	R175, R165A, R165B, C164, C161, C171, Group A
8	Plate to B+	63 K	R175, R165A, R165 B

Modulator—6SN7GT (V-18)

Pin No.	*Test Conditions*	*R Ohms*	*Components Involved*
1	Grid 2 to Gnd	1 meg.	R181, C181
2	Plate 2 to Gnd	60.4 K	R184, R183, Group A
2	Plate 2 to B+	47 K	R184
3	Cathode 2 to Gnd	11.3 K	R182, C182, R183, Group A
3	Cathode 2 to B+	23 K	R182, R183
4	Grid 1 to Gnd	49 K	R185, R251, C183, C184, C124
5	Plate 1 to Gnd	23.4 K	R186, C211, C191, Group A
5	Plate 1 to B+	10 K	R186
6	Cathode 1 to Gnd	0	
7	Heater to Gnd	0	
8	Heater to Gnd	Small	Group B

Modulator—6L6G (V-19)

1	To Gnd (no element)	0	
2	Heater to Gnd	0	
3	Plate to Gnd (S191 open)	Infinite	
3	Plate to Gnd (S191 closed)	13.4 K	Group A, Primary T201
3	Plate to B+	20	
3	Plate to B+ (S191 closed)	20	T201 Primary
4	Screen to Gnd (S191 open)	Infinite	
4	Screen to Gnd (S191 closed)	13.4 K	Group A
4	Screen to B+ (S191 open)	Infinite	
4	Screen to B+ (S191 closed)	0	
5	Grid		Same as E191
6	To Gnd (no element)	0	
7	Heater to Gnd	Small	Group B
8	Cathode to Gnd	40.2 K	R192, C192, R193, Group A
8	Cathode to B+	49.6 K	R192, R193, Group A

Modulator—6L6G (V-20)

1	To Gnd (no element)		
2	Heater to Gnd	0	
3	Plate to Gnd	950 K	R233A, R233B, Group A
3	Plate to B+	940 K	R233A, R233B
4	Screen to Gnd	950 K	R233A, R233B, R205, Group A
4	Screen to B+	940 K	R233A, R233B, R205
5	Grid	—	Same as E201
6	(No element)		
7	Heater	Small	Group B
8	Cathode to Gnd	10.5 K	R202, R203A, R203B, Group A
8	Cathode to B+	19.4 K	R202, R203A, R203B, Group A

Note: Small means less than one ohm.

Modulator—6SN7GT (V-21)

Pin No.	Test Conditions	R Ohms	Components Involved
1	Grid 2 to Gnd	1 meg.	R211, C211
2	Plate 2 to Gnd (S211 open)	Infinite	
2	Plate 2 to B+ (S211 open)	Infinite	
2	Plate 2 to Gnd (S211 closed)	242.8 K	R217, R215A, R215B, C212, C213, C214, Group A
2	Plate 2 to B+ (S211 closed)	229.4 K	R217, R215A, R215B
3	Cathode 2 to Gnd	5.6 K	R212
4	Grid 1 to Gnd	52.6 K to 552.6 K	Pot. R214, R213, R212, C212
			R213, R212
5	Plate 1 to Gnd	32.2 K	C214, C213, C212, R216A, R215A, R216B, R215B, Group A
5	Plate 1 to B+	18.8 K	R216A, R215A, R216B, R215B
6	Cathode 1 to Gnd	5.6 K	Same as 3
7	Heater to Gnd	0	
8	Heater to Gnd	Small	Group B

Modulator—6H6 (V-22)

1	Shell to Gnd	0	
2	Heater to Gnd	0	
3	Plate 2 to Gnd	0	
4	Same as No. 4 of V17	—	
5	Plate 1 to Gnd	—	Same as 3
6	(No element)	—	
7	Heater to Gnd	Small	Group B
8	Same as No. 1 of V21	—	

Transmitter—15E (V-23)

See Fig. 4-25	Plate to Gnd	12 meg.	R241, C241, C231, L234, L235, Group A
	Grid to Gnd	2.2 K	L233, C233, R234
	Filament to Gnd	.95 meg.	R233A, R233B, L232, R231, R232, L231, Group A

Note: Small means less than one ohm.

6. RESISTANCE VALUES AT JACKS AND TEST POINTS.

(Refer to schematic diagram, Figure 7-1, Pages 7-1, 7-2, and make measurements according to the given test conditions.)

Jack or Test Point	Test Conditions	R Ohms	Components Involved
J11	Jack to Gnd	Infinite	C11
E31	Point to Gnd	100 K	R31, C32, R52, L51
J51	Terminal A to Gnd	13.2 K*	C54, R55, R58A, R58B, Group A
J51	Terminal B to Gnd	0	
J51	Terminal C to Ground	2K	R251, C124, C251, C252
E111	Point to Gnd	6.8 K	R112
J141	Jack to Gnd	Variable 0 to 1 K	Pot. R144, C142
J151	Jack to Gnd	75	R151A, R151B
E151	Point to Gnd	75	R151A, R151B
E171	Point to Gnd	3.15 K	R173, C181, R174A, R174B, R174C, Group A
E171	Point to B+	14.7 K	R173, R174A, R174B, R174C, Group A
E191	Point to Gnd	1.0 meg.	R191, C191
E201	Point to Gnd	2 K	T201, R251, C129
J201	Jack to Gnd	22	R204, C202
E211	Point to Gnd	1 meg.	R97, C98, C214

*Because of electrolytic capacitor (C54) in circuit, observe resistance with each polarity of ohmmeter and use higher value.

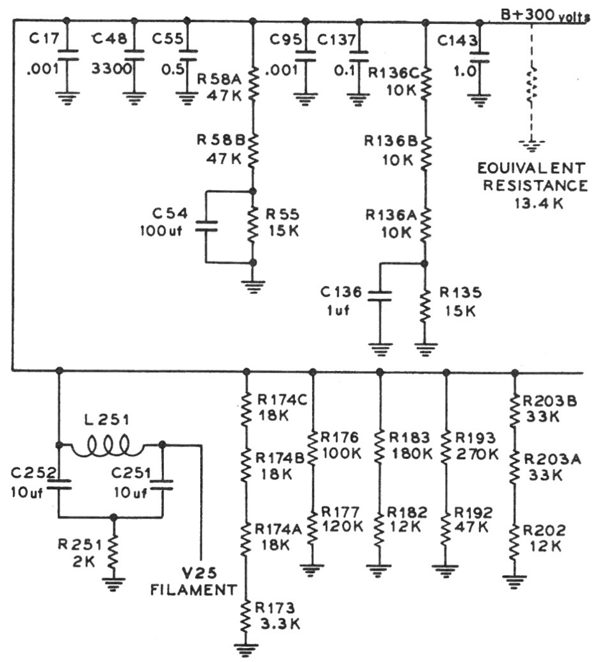


Figure 5-2—Resistance Value of Group A

The Group A, mentioned in the Measurement of Resistance, is the combination of resistors and capacitors from the main B+ bus to ground. This resistance as measured between B+ to ground is the equivalent resistance of 13,400 (13.4K) ohms. The main B+ bus is a red lead.

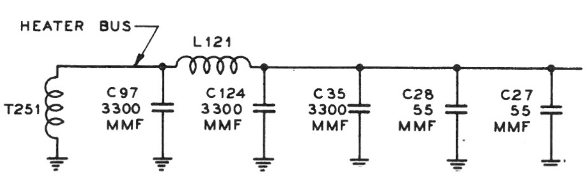


Figure 5-3—Resistance Value of Group B

Group B is the combination of capacitors from the main filament supply to ground, series choke, and the six volt winding of transformer T251. This combination has a very low resistance to ground.

OPERATING CONDITIONS: A-C SUPPLY 115 VOLTS—60 CYCLES

Tube No.	Tube Type	Function	Oper. Condition	E Plate	Pin No.	E Screen	Pin No.	E Cathode	Pin No.	E Filament
V1	6J6	1st r-f amplifier		110 v.	2	—	—	0.4 v.	7	6.3 v.
V2	6SH7	2nd r-f amplifier		240 v.	8	135 v.	6	0.8 v.	5	6.3 v.
V3	9006	1st detector		0.8 v.	5	—	—	0.0 v.	7	6.3 v.
V4	6J5	Oscillator (Receiver)		205 v.	3	—	—	0.0 v.	8	6.3 v.
V5	6AC7	1st i-f amplifier		155 v.	8	160 v.	6	2.4 v.	5	6.4 v.
V6	6AC7	2nd i-f amplifier		155 v.	8	160 v.	6	2.4 v.	5	6.4 v.
V7	6AC7	3rd i-f amplifier		155 v.	8	160 v.	6	2.4 v.	5	6.4 v.
V8	6AC7	4th i-f amplifier		150 v.	8	155 v.	6	2.1 v.	5	6.4 v.
V9	6AC7	5th i-f amplifier		95 v.	8	140 v.	6	2.3 v.	5	6.4 v.
V10	6H6	Gate pulse limiter		0.6 v.	3–5	—	—	0.0 v.	4–8	6.4 v.
V11	6H6	2nd detector and tuning indicator		0.7 v.	3	—	—	0.0 v.	4	6.4 v.
V11	6H6	2nd detector and tuning indicator		0.8 v.	5	—	—	0.0 v.	8	6.4 v.
V12	6E5	Tuning indicator		55 v.	2	—	—	0.0 v.	5	6.4 v.
V13	6AC7	1st video amplifier		30 v.	8	45 v.	6	0.0 v.	5	6.5 v.
V14	6AG7	2nd video amplifier		285 v.	8	285 v.	6	11.0 v.	5	6.5 v.
V15	6AC7	Pulse amplifier and limiter	Keyer Off	150 v.	8	150 v.	6	4.1 v.	5	6.5 v.
V16	6AC7	Multivibrator input	Keyer Off	9.0 v.	8	70 v.	6	0.6 v.	5	6.5 v.
V17	6AC7	Multivibrator output	Keyer Off	165 v.	8	155 v.	6	17.0 v.	5	6.5 v.
V18	6SN7GT	Pulse shaper and clipper	Keyer Off	260 v.	2	—	—	20.0 v.	3	6.5 v.
V18	6SN7GT	Pulse shaper and clipper	Keyer Off	150 v.	5	—	—	0.0 v.	6	6.5 v.
V19	6L6	Driver		285 v.	3	285 v.	4	45.0 v.	8	6.5 v.
V20	6L6	Modulator		275 v.	3	275 v.	4	45.0 v.	8	6.5 v.
V21	6SN7GT	Gate pulse generator		190 v.	2	—	—	45.0 v.	3	6.5 v.
V21	6SN7GT	Gate pulse generator		130 v.	5	—	—	45.0 v.	6	6.5 v.
V22	6H6	Diode limiters		0	3–5	—	—	0.4 v.	4–8	6.5 v.
V23	15E	Oscillator (Transmitter r-f)		**5300 v.		SEE CAUTION				*5.4 v.
V24	3B24	High voltage rectifier		*—		SEE CAUTION				**2.5 v.
V25	5U4G	300 volt rectifier		300 a-cv.	4–6	—	—	—	—	5.1 v.

ALL D-C MEASUREMENTS MADE WITH 20,000 OHMS-PER-VOLT METER

NOTE*

Measured on terminal board outside of oscillator case.

NOTE**

Measured with V24 in socket (for this test only). Plate connection must be left off to avoid high voltage.

CAUTION

V24 must be out of socket for all tests to remove high voltage. (See **)

NOTE

Refer to opposite page for overall operating conditions and positions of switches. All measurements are made between the point indicated and ground.

Figure 5-4—Model BN Test Data

7. MEASUREMENT OF DIRECT-CURRENT VOLTAGES.

a. The preceding voltage measurements are to be taken as those of an average BN equipment, and values given may vary from those taken of any particular equipment. Voltage measurements should be under the following conditions and taken at least every two weeks.

(1) Have the chassis on a bench, all tubes in place and all covers removed to get at the tube sockets.

WARNING

The vacuum tubes used, particularly those of the metal variety, may reach extreme temperatures after prolonged operation and can cause painful burns. When removing such tubes, the hand should be protected with a piece of cloth or glove.

(2) Have a ground on the chassis, remove the cable from J11, and short this point to chassis ground.

(3) Have the proper a-c power on the unit.

(4) Use a direct-current voltmeter of at least 20,000 ohms per volt. Observe voltage between the chassis and points indicated.

(5) Take all voltage readings with pins of J51 shorted together, "KEYER" switch "ON," and "GATING" switch "ON."

(6) Compare voltage readings taken with MODEL BN TEST DATA, Figure 5-4 on Page 5-6, and note differences. After BN equipment indicates that it is functioning normally, record its voltage readings for future use, saving the average readings for reference purposes only.

WARNING

No attempt should be made to measure the high voltage (5300 volts) points, i.e., E235A, C241, R241.

8. GENERAL SERVICING.

a. INSERTING AND REMOVING TUBES.

(1) The majority of vacuum tubes used are of octal base variety. This type of tube base has provision for eight prongs, although the full number are not always used. These prongs are arranged in a ring around a central key which engages a keyway in the octal socket so that the tube cannot be inserted incorrectly. The key contacts the socket surface before the prongs, making it possible to locate the tube without actually looking at the socket.

(2) When inserting a tube, the key is inserted in the keyway of the socket and rotated until the tube drops in place. It is then pressed in firmly, as far as it will go. To withdraw the tube, a slight rocking motion is necessary in order to prevent a sudden release of the socket contacts which may cause damage to the tube or injury to the hand if a near-by projection is struck. The tubes are accessible by withdrawing the chassis from the cabinet sufficiently to reach the tubes which are to be checked or replaced.

9. LUBRICATION.

a. Proper lubrication* is very important in the maintenance of equipment. Lack of lubrication and the presence of foreign matter on switches, contacts, bearings, controls, and mechanisms causes considerable difficulty. Whether the equipment is used continually or only occasionally, it should be lubricated periodically where needed.

b. The small number and nature of the moving parts in the BN Radio Equipment make the lubrication requirements simple. The only lubricants needed are SAE No. 10 OIL and MOBILGREASE ZERO or equivalents.

c. The wearing surfaces of the mechanical STOP LOCK assembly should be lubricated sparingly in order to keep the lubricant away from electrical apparatus. The same precaution must be observed when lubricating the gears and threads of the TUNING MECHANISM of the Transmitter Unit. No other parts of the equipment should be lubricated.*

d. The chassis slides must be OPERATED WITHOUT LUBRICANT; because, if a lubricant is used, it will come off on the hands and clothes when the chassis is removed from the cabinet. With these factors in mind, slides and rails are heavily cadmium plated so that a hard, clean surface which needs no lubrication is produced. The cadmium surface is not polished as it is most often in ornamental work.

e. DO NOT LUBRICATE the tuning capacitors, the potentiometers, the panel bushings, or the mechanical service. Lubrication of such components can cause faulty operation by destroying ground contact. Where radio equipment operates at high frequencies, solid grounds are of great importance and contribute to the stability of the equipment.

f. All tube retainers on the BN equipment should have anti-seize compound (Farnsworth part 2058–001) applied to them to prevent the "freezing" of the assembly. This should be done as soon as retainers appear dry and should be applied to all new ones when installed.

*Refer to LUBRICATION CHARTS, Figures 5-10, 5-11, 5-12, 5-13, Pages 5-19 to 5-22.

g. ELECTRIC MOTORS, such as blower motor, (B251), demand the usual attention to their bearings; however, no attempt should be made to adjust and clean such items unless one is skilled in this type work. The blower and motor should be lubricated with a fine grade, low temperature lubricant as described below, periodically or as required, depending on the duty cycle and climatic conditions of operation.

h. The blower unit may fail to rotate at extremely low temperatures as a result of oil congealing and bearings tightening up, but this will not harm the equipment nor the blower and is permissible. A reduced flow of air from the blower (determined by placing hand close to louvers on left side of cabinet) indicates the blower is clogged with dust. necessitating immediate cleaning of the blades and throat of the blower.

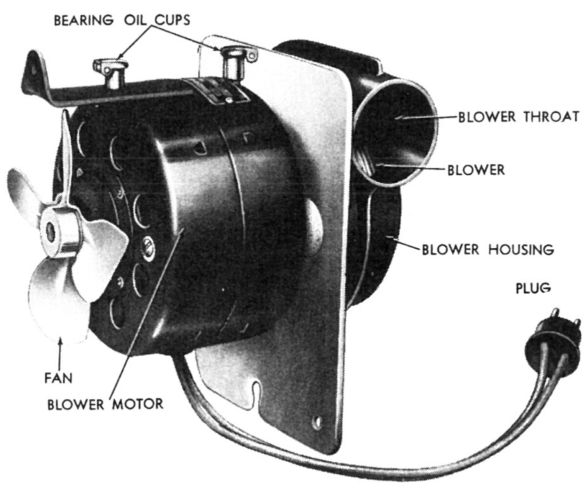


Figure 5-5—Model BN Radio Equipment 60-Cycle

i. THE 60-CYCLE BLOWER MOTOR† (Smith Company) should be lubricated with SAE No. 10 OIL, of which 10 to 15 drops every month is sufficient under constant running condition. If it is on an intermittent duty cycle, 10 to 15 drops of oil every two or three months will be adequate.

j. THE 400-CYCLE BLOWER MOTOR (Westinghouse) does not require lubrication more than once a year. The motor is capable of continuous service for that length of time. At the end of one year, the blower motor should be replaced by one of the spares. The removed motor should then be disassembled and the bearings lubricated.*

†Refer to Figure 5-5, also Figure 5-12.

*Refer to Figure 5-6, also Figure 5-10.

k. To disassemble the motor remove the blower cover and three stud nuts, lockwashers, and studs.*

CAUTION

Care must be taken so that the wound stator stays in the capacitor end bracket and that the leads are not damaged or pulled loose. Cocking of the brackets must be avoided since this will cause binding in the bracket fits and make the disassembly more difficult. Loosen the two set screws in the fan and remove it from the shaft, and then remove the rotor from the fan end bracket. Do not remove the bearings from the shaft. Lubricate* the bearings with a small amount of light grease* pushed into the gap between the inner race and the bearing shield of the face of the bearing farthest from the rotor core.

After re-assembly, the blower should be rotated very slowly while feeling for *spots* in the complete revolution where the rotor seems to stick slightly. Such *spots* indicate that the bearings are binding and must be relieved or an early failure may result.

10. RECEIVER.

a. It is impossible to anticipate all types and combinations of circumstances which will cause faulty operation of the equipment. However, the following are a few of the more general and probable causes for trouble.

(1) No output of any kind.

- *(a)* Power switch not "ON."
- *(b)* No connection to power line outlet.
- *(c)* Line voltage low or absent.
- *(d)* Fuses blown.
- *(e)* Remote control plug (P51) not connected.
- *(f)* Interrogation switch (S51) in "STAND-BY" position.
- *(g)* Gain control at minimum sensitivity position.
- *(h)* Remote control plug (P51) external circuit open.
- *(i)* Video output control (R144) reduced to zero output.
- *(j)* Defective vacuum tube (See Paragraph 11, Page 5-10).
- *(k)* No plate voltage.
- *(l)* No filament voltage.
- *(m)* Defective component.

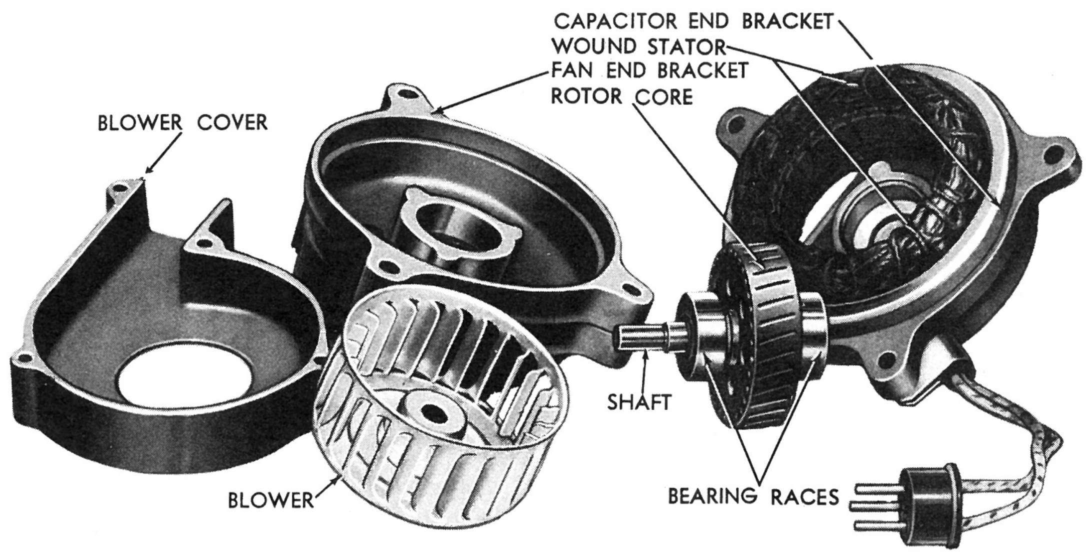


Figure 5-6—Model BN Radio Equipment 400-Cycle Blower Motor Disassembled View

(2) Low output.

(*a*) Low line voltage.
(*b*) Receiver antenna transmission line open.
(*c*) Duplexer not properly tuned or open.
(*d*) Interference from unwanted signals which overload receiver.
(*e*) The four tuners of the radio-frequency chassis not adjusted to correct frequency. (See detailed description on adjusting receiver, Pages 2-19 to 2-20, Adjustments, Section II).
(*f*) Tube retainers for the two metal tubes V2 and V4 on the radio-frequency chassis loose and not making good contact. (See instructions on replacing tubes, Page 5-10 of this section).
(*g*) Video output control (R144) reduced.
(*h*) Intermediate-frequency portion of receiver detuned. (See receiver alignment instructions, Page 5-15, this section).
(*i*) Same as (1-*j*).
(*j*) Defective resistor or capacitor.
(*k*) Broken connection.

(3) Unstable operation.

(*a*) Unstable line voltage.
(*b*) Interference from unwanted signals.
(*c*) Loose remote control plug (P51).
(*d*) Defective gain control (R51).
(*e*) Same as (2-*f*).
(*f*) Same as (1-*f*).
(*g*) Poor connection.

b. In view of the high frequencies and the high amplification used, replacement of defective component parts must be done with care. Only the proper replacement parts should be used since substitutions generally prove unsatisfactory. The physical dress of parts and wiring was carefully considered in the original design and should be duplicated as closely as possible. The exact point of grounding a capacitor, for example, should be duplicated, as well as all lead lengths.

c. If, at any time, service work required soldering or unsoldering of leads or small impedances on the terminals of the type 6J6 or 9006 tube socket in the receiver, great care must be exercised to prevent damage to it. When removing leads, do not strain the socket terminals. The necessarily small lugs are easily broken.

d. To prevent strain, heat the terminal quickly and straighten the hooked lead before withdrawing it. Do not hold the iron against the terminal while straightening the lead; but rather do it in steps, applying only enough heat each time to cause fusing, and reheating when the solder cools. Careful handling will make complete socket replacement unnecessary.

e. When the receiver operation is faulty, the vacuum tubes should be checked unless indications point to some other specific component. Experience has shown that the majority of failures are because of defective vacuum tubes.

f. Trial by replacement as a method of locating the faulty tube is generally preferable to testing the tubes in a conventional vacuum tube tester and accepting its indication as final. A tube which tests as defective should be rejected. However, tubes tested as satisfactory may not operate properly when actually installed in the receiver.

g. Defects, such as intermittent or noisy operation and certain inter-electrode shorts or opens, usually will not be indicated on the tube tester but will have serious effects on the operation of the receiver. These suggestions apply particularly to frequency instability of the receiver when all tuned circuit connections appear to be good.

11. REPLACING TUBES (V1 TO V14, INCLUSIVE) IN RECEIVER.

a. To replace the first r-f amplifier tube (V1) or the first detector diode tube (V3) the tube shields must be removed first. To remove the tube shields from the miniature tubes, press down lightly on the tube shield and rotate counterclockwise, then remove the shield. Remove the tube by pulling it straight out. Note the position of the pins so that when the new tube is inserted proper orientation will be more easily accomplished. No key is provided; hence, care must be used when inserting the tube. It is not possible to insert the tube in the incorrect position, but it may be difficult to locate the pins properly.

b. Care must be used in removing or inserting the miniature type tubes because any pressure on the terminal wires is borne by the glass seals. Undue pressure may chip or crack the glass or bend the tube contacts so as to damage the socket upon insertion. It should be noted here that the tube shield for the 9006 is considerably shorter than the tube shield for the 6J6 type tube. Be sure to replace the shortest tube shield on the 9006 tube.

c. To replace the tubes, which are held in place by the spun aluminum retainer, on the main chassis deck of the receiver, it is only necessary to remove the retainer by means of the tool, insert the new tube in place, replace and tighten the retainer. It is not necessary to clean the paint from the rim of the shell.

d. When it is necessary to put in new retainers, or when old retainers show signs of the lubrication becoming dry, anti-seize compound (Farnsworth Part 2058–001) should be applied.

e. The VISUAL TUNING INDICATOR tube (V12) has its base, which supports the socket, clamped on a bracket behind the front panel by means of a wing nut. To remove the tube, loosen the wing nut, swing back the bracket to the left of the tube and remove the tube socket from the bracket, and then remove the tube from the socket. Insert the new tube in the socket and reassemble.

12. REPLACING AND TRIMMING RADIO-FREQUENCY TUNERS (L11, L21, L31, AND L41).

a. Should it be necessary to replace a radio-frequency tuner, there is a series of steps to follow in servicing. When a new tuner assembly is installed, or if there has been any other major disturbance of the circuit, each tuner as a whole should cover the entire frequency range of the BN equipment in approximately four to eight (approximately eight for L41) revolutions of the tuning knob, the remainder of the available travel being equally distributed between the upper and lower ends of the tuning range.

13. REMOVING BN CHASSIS FROM CABINET.

a. Remove* the Navy Model BN equipment from its cabinet in the following manner:

(1) Unfasten the hinged doors (held in place by four "Dzus" fasteners) on front of cabinet.

(2) Next, release (by turning counterclockwise) the four retaining screws (finger grip controls, located on the front panel); two of these retaining screws are located along the top of the front panel, the other two along the bottom of the panel.

(3) Grip the wrap-around firmly with both hands at the same time, withdrawing* the Model BN Chassis from the cabinet. Stop assemblies (one located on each side of BN cabinet) will prevent the chassis from being removed completely from the cabinet.

(4) Grip the "HANDLE" of each stop assembly, lifting upward sufficiently to allow unimpeded complete removal of the BN chassis from its cabinet.

***NOTE**

It is suggested sufficient handling personnel be available to prevent the equipment from being subjected to unwarranted shock or damage.

b. Place the equipment on a bench or other flat surface, remove the wrap-around by freeing the thirteen 8–32 round-head screws securing the wrap-around to the chassis. Next, remove the bottom dust cover of the receiver main chassis. DO NOT REMOVE THE COVER MARKED 5000 VOLTS. Unsolder the intermediate-frequency interconnection coaxial lead in the bottom of the main chassis which is connected to the first intermediate-frequency inductor and ground.

c. Remove the eight screws which mount the panel of the radio-frequency chassis to the front panel of the main chassis. Withdraw the radio-frequency chassis through the panel of the main chassis as far as the interconnection leads (four power leads) will permit. Remove the bottom cover of the radio-frequency chassis.

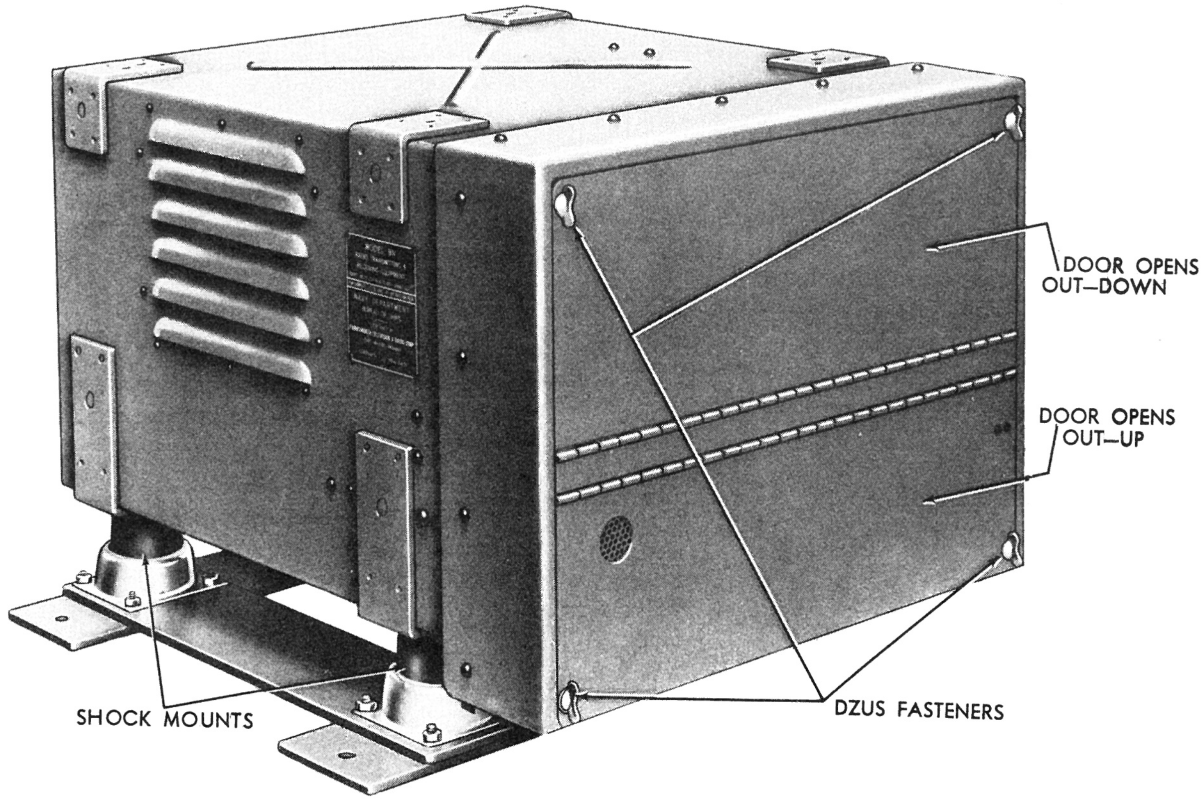


Figure 5-7—Model BN Radio Equipment Cabinet

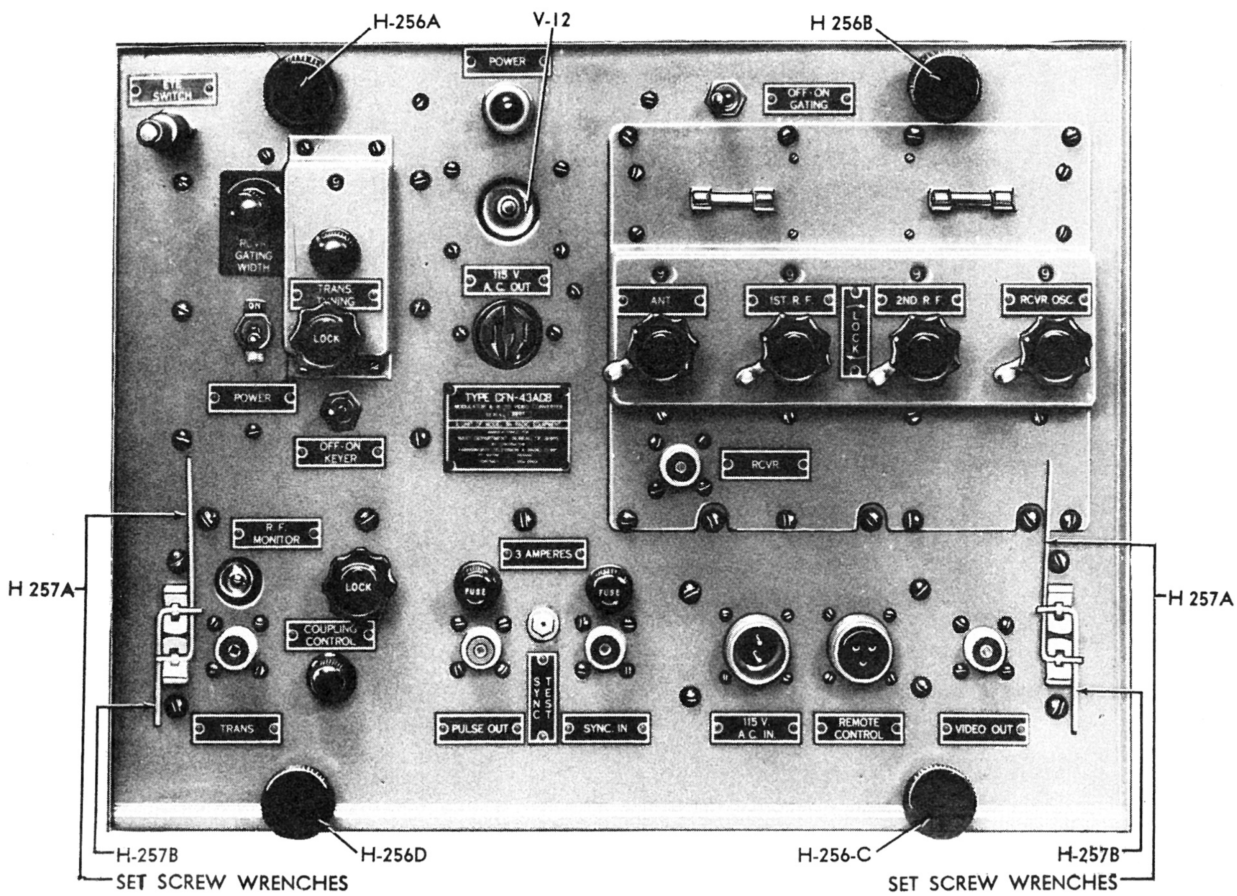


Figure 5-8—Model BN Radio Equipment Front Panel

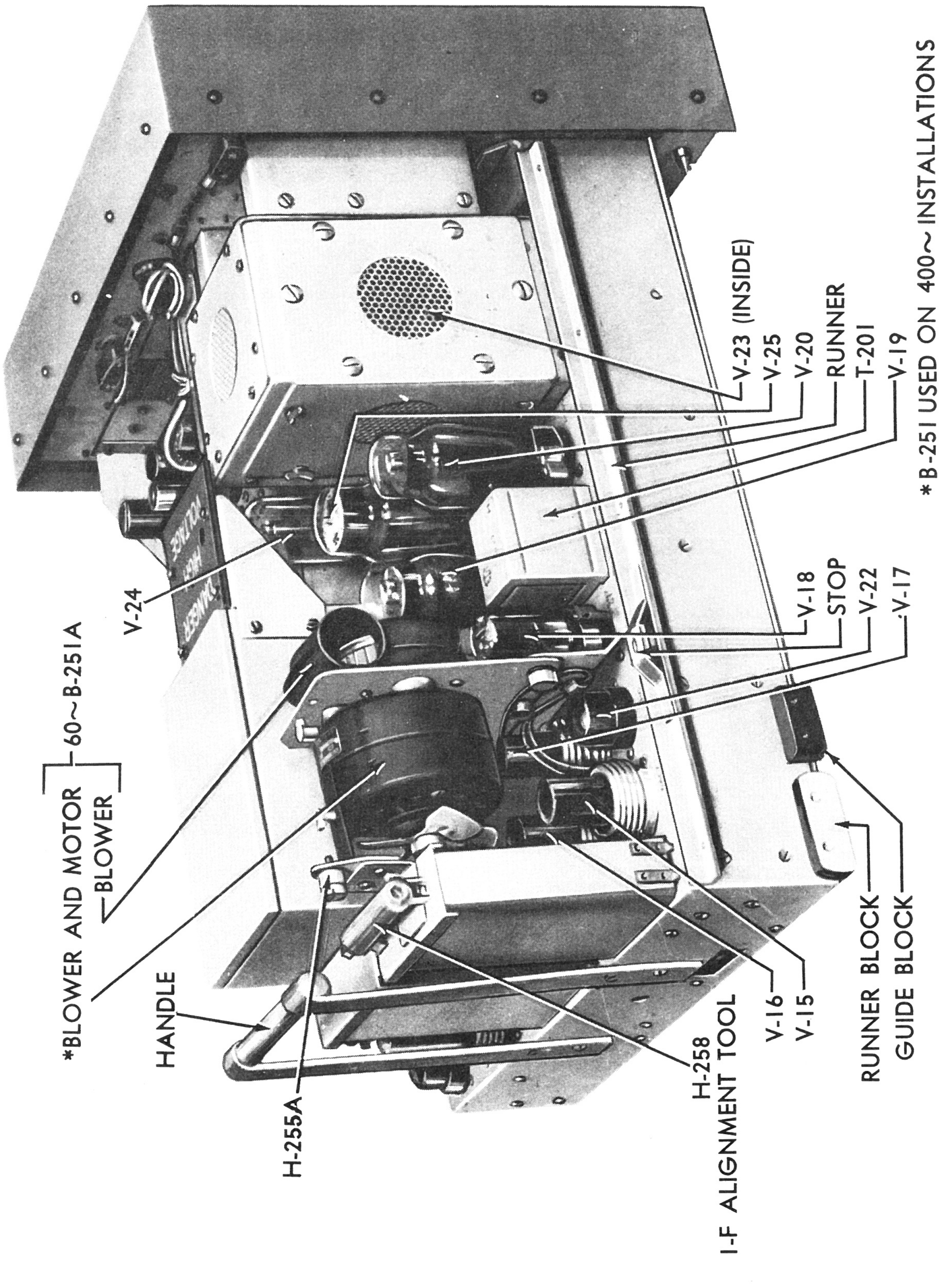


Figure 5-9—Model BN Radio Equipment Left Oblique View

14. COIL ASSEMBLY.

a. To replace the coil assembly, proceed by assembling the new coil assembly to the mounting plate, but do not tighten screws. Center the drive bearing about the slotted lead screw of the silver sleeve and then tighten both screws.

NOTE

Should the coil fail to cover frequency only, it does not need to be replaced. Refer to paragraph *f.* below for information on trimming.

b. With the tuning mechanism removed from the slotted lead screw of the silver sleeve, adjust the lead screw so that the end of the silver sleeve is in line with the center of the wire lead extending through the terminal board eyelet farthest from the mounting block. Assemble the mounting plate to the panel of the radio-frequency chassis.

c. Next, rotating the knob of the tuning mechanism to the maximum clockwise position (*right*), adjust the counter dial so that it will read "9" in the mounted position. The tuning knob will be three-quarters of a turn clockwise past "9" for this adjustment.

d. In assembling the tuning mechanism to the mounting plate, first insert the torque pin of the drive shaft into the slotted lead screw to the nearest turn and then hold the spacers in place and replace the four mounting screws. Replace the cover.

e. Screw on the locking mechanism and fasten the knobs to the shafts.

f. TRIMMING RADIO-FREQUENCY COIL ASSEMBLIES (ANT. 1ST RF, 2ND RF) requires a signal generator (continuous-wave or tone-modulated) capable of supplying a frequency of from 157 to 187 megacycles with an output of about one volt. The frequency calibration must be accurate and the signal generator must be capable of being attenuated to one-tenth of a volt output.

g. A response indicator is also necessary, and this may be a direct-current microammeter with a full scale range of less than 250 microamperes. Assuming the signal generator internal impedance is less than 50 ohms, a 47 ohm carbon resistor in series with the input connector should be used as a *dummy* antenna.

h. Remove the local oscillator (V4) from its socket in the radio-frequency chassis. Connect the output lead (antenna) of the signal generator to one end of the 47 ohm resistor. Connect the other end of the resistor to the center conductor of the receiver antenna jack (J11). Attach the ground lead of the signal generator to any convenient ground on the radio-frequency chassis.

i. Connect the positive terminal of the microammeter (response indicator) to the intermediate-frequency input test jack (E31). Connect the negative terminal to any convenient ground point on the radio-frequency chassis. It should be noted that with respect to the operation of the response indicator connected this way the first detector diode (V3) serves as the rectifier of the test signal and the multiplier for the response indicator is the 100,000 ohms resistor (R31) in the radio-frequency chassis. Hence, the coaxial lead must be opened as previously stated.

j. Check all connections made. Assuming the connections have been properly made, apply power to the signal generator and BN equipment. After the equipment has warmed up, apply a test signal of 187 megacycles.

k. In making any adjustments of the receiver tuners or the signal generator, which are to be observed as amplitude changes on the response indicator, care must be exercised to keep the signal level below the point of receiver overload (grid current in the radio-frequency amplifier tubes). When the input from the signal generator is equal to or greater than that which causes overload, and when observations of amplitude changes are made while tuning or adjusting, loss of accuracy will result; because the exact point of maximum amplitude is flattened out and appears very broad. The point at which overload starts is readily determined by slowly increasing the signal into the receiver from a low value to the point where the deflection on the response indicator ceases to increase noticeably with an increase of signal.

l. Adjust the three knobs for maximum output on the response indicator. Adjust the 2nd RF tuner first, then the 1st RF, and finally the "ANT." When the tuners are adjusted for maximum output, the counter dials for the respective tuners should read:

ANT	*1st RF*	*2nd RF*
8	6.5	6.5

m. If the counter dial reads higher than these figures, decrease the inherent inductance of the coil by spreading out the turns of the winding; if the counters read lower, increase the inductance by adjusting the turns closer together. When adjusting the turns of the coil, the silver sleeve should be completely engaged in the coil to help support the form. Always keep the first turn of the winding adjusted in line with the eyelet supporting it. If the turns of the winding must be moved, do not move the turn at the open end of the form but move those turns which are adjacent to the bakelite block on the tuner assembly. Use the blade of a screwdriver or long nose pliers to do this.

n. After the adjustment of turns on any one of three windings, readjust all tuners for maximum output on the response indicator. When tuning, it will be noted that the "1st RF" and "2nd RF" tune sharp, while the "ANT" tunes broad. This broad tuning is characteristic of this grounded grid antenna input circuit. With care the "ANT" can be seen to tune through each test frequency, sharper at the high frequency end of the band than at the low frequency end. The adjustments at the high frequency end of the band completed, proceed to check the coverage at the low frequency end of the band.

o. Apply a test signal of 147 megacycles and adjust all three tuning knobs counterclockwise until the counter dials read "2." Then adjust the three knobs for maximum output. Adjust the "2nd RF" first, then the "1st RF," and finally the "ANT." When the tuners are adjusted for maximum output, the counter dials for their respective tuners should read:

ANT	between	1 and 2
1st RF	between	1 and 2
2nd RF	between	1 and 2

p. The "ANT," "1st RF," and "2nd RF" circuits are now adjusted and ready for use.

15. TRIMMING OSCILLATOR UNIT (L–41).

a. The counter dial for the "OSC" should read "8" provided that the R-F Chassis, including L–41, has been adjusted as recommended on Page 5-13.

b. If the dial reads higher, then decrease the inherent inductance of the oscillator coil by spreading out the turns; if lower, increase the inductance by adjusting the turns closer together. Always have the silver sleeve completely engaged in the coil to help support the form whenever adjusting turns. After the adjustment of turns on the "OSC" inductor, adjust all tuners for maximum response on the visual tuning indicator (V12) (narrowest dark sector).

c. The adjustment at the high frequency end of the band completed, adjust the wavemeter oscillator to 157 megacycles. Adjust all four tuning knobs counterclockwise until counter dials read "2"; then starting with the "OSC" knob, adjust each of the tuners for maximum response (narrowest dark sector on V12). When "OSC" coil assembly is adjusted for maximum response on the correct peak, the "OSC" counter dial should read between "0" and "2." The radio-frequency chassis is now in the proper operating condition.

16. BANDWIDTH MEASUREMENT.

a. A continuous-wave or tone-modulated signal generator will be required which will be capable of supplying a frequency of from 26 to 34 megacycles and with an output of at least 10,000 microvolts or 40 db. below one volt. The attenuator in its output must be of the low impedance type (less than 100 ohms) capable of attenuation to 100 microvolts or 80 db. below one volt. The frequency calibration should be accurately known or verified. A convenient response indicator for determining amplitude is a direct-current microammeter with a full scale range of any value less than 250 microamperes.

b. A 12,000 ohm carbon resistor-multiplier will be needed for the 250 microampere meter. If a 100 microampere meter is used, a 30,000 ohm resistor is the requirement. The adjustment tool is conveniently located on the chassis at the rear of the blower motor.

c. The alignment of the intermediate-frequency amplifier may be checked by taking an overall selectivity curve. The bandwidth at six decibels down or 50% response from that at the center frequency of 30 megacycles should be at least 4.0 megacycles. The bandwidth at 20 decibels down or 10% of the response at 30 megacycles should be less than six megacycles. The selectivity curve with the gain control of the receiver at its maximum clockwise position (maximum gain) should be similar to that at reduced gain (providing the presence of high thermal noise as read by the response indicator is taken into account). The maximum overall gain should be 500 microvolts for a 50% deflection of the response indicator. This figure does not represent the actual voltage gain since a 100,000 ohm carbon resistor is connected in series with the intermediate-frequency amplifier input test jack (E31); hence it gives a figure of merit.

d. Connect the signal generator (ungrounded terminal) to the i-f input test point marked E31, located on top of the R-F to I-F Convertor Sub-chassis, and connect the outer conductor of the signal generator lead (ground) to any convenient ground near the i-f test point. Keep this lead as short as possible. The placement of the signal generator and its ouput lead should be such as to avoid coupling between the input and output of the intermediate-frequency amplifier.

e. Connect one end of the multiplier resistor directly to the i-f output test point (E-111), which is located next to the sixth i-f inductor assembly. Connect the other end of the resistor to a lead not longer than six inches in length. Connect the open end of this lead to the negative terminal of the microammeter. Connect the positive terminal of the microammeter to any convenient ground point and the chassis by means of a lead not longer than three inches in length. With these connections made, remove the local oscillator (V4) from the radio-frequency chassis and then apply power to the BN equipment and signal generator.

f. After a 10-minute warm-up period, adjust the GAIN CONTROL (R51) for a bias voltage of six volts as measured from terminal "B" to ground on the GAIN CONTROL jack (J51). Then apply a test signal of 30 megacycles and adjust the output of the signal generator to obtain a 50% or 1/2 full scale deflection on the microammeter and note the reading of the attenuator on the signal generator. Increase the output of the signal generator to two times the reading obtained or six db. (the microammeter probably will read off scale for this adjustment if the frequency of the signal generator is left set at 30 megacycles).

g. Starting at 30 megacycles, carefully adjust the frequency of the signal generator to a lower frequency until the microammeter again reads 50% or 1/2 full scale deflection, and note the frequency of the signal generator for this adjustment.

h. The bandwidth at 20 db. down or response 10% may be obtained by repeating operations above with one exception. Instead of increasing the output of the signal generator to two times the reading obtained or six db., increase it to 10 times or 20 db. If the total bandwidth thus obtained is greater than six megacycles, realignment may be desirable.

17. ALIGNMENT.

a. The BN receiver has been carefully aligned at the factory and should not ordinarily require realignment. Replacement of tubes associated with the intermediate-frequency amplifier should not disturb the alignment materially. Before any realignment is undertaken, therefore, a check of the intermediate-frequency amplifier should be made in order to indicate whether the alignment is at fault.

b. To align the intermediate-frequency amplifier, the lock nuts on the single screw adjustment on the top of each inductor shield must first be released. Each stage is tuned by means of the single screw adjustment.

c. During the alignment procedure, the output of the signal generator must be adjusted to keep a peak reading of about 1/2 full scale deflection on the output indicator (microammeter). If as the alignment proceeds the deflection becomes greater than this, reduce the output of the signal generator.

d. The frequency to which the signal generator must be set for adjusting each inductor is:

Inductor	*Code*	*Frequency in Megacycles*
1st IF	Center**	30
2nd IF	High	32
3rd IF	Low	28
4th IF	High	32
5th IF	Low	28
6th IF	Center	30
Indicator Coil	Center	(See Note)

NOTE

The indicator coil is adjusted for the narrowest dark sector on the visual tuning indicator (V12) with the signal generator set at 30 megacycles.

At the completion of the alignment tighten the lock nuts sufficiently to prevent adjustment of the alignment screws by hand. Replace the intermediate-frequency adjustment tool in a holder in the BN equipment.

18. MODULATOR.

a. If the equipment has been checked thoroughly periodically, as suggested in the introduction of this section, and a record kept of all such checks, there will be enough information to readily show whether the modulator is functioning with full efficiency or not. There will be other indications of defective operation of the modulator.

b. A brief listing of possible troubles and causes, aside from those causes of power failure, which occur ahead of the modulator input follows.

(1) No operation.

(a) Power failure.
(b) Keyer switch "OFF."
(c) Defective tube.
(d) Defective component.
(e) Open connection.

(2) Intermittent operation.

(a) Power supply erratic.
(b) Defective tube.
(c) Defective component.
(d) Loose connection.
(e) Erratic synchronization of input pulses.
(f) Input pulse amplitude too low.
(g) Erratic multivibrator frequency.

**The tops of the corresponding i-f inductor cans in the equipment are labeled as indicated in this column.

(3) R-F Output too low.

(*a*) Low amplitude of pulse output.
(*b*) Low repetition rate of pulse output.
(*c*) Transmitter (See Paragraph 3, Section IV).
(*d*) Defective modulator tube (V20).

(4) R-F Output (average) too high.

(*a*) Repetition rate high.
(*b*) Pulses too wide.
(*c*) Multiple pulses.

(5) Narrow or wide pulses.

(*a*) R-F feedback from transmitter.
(*b*) Defective tube.
(*c*) Defective component.
(*d*) Poor connection.

(6) Multiple Pulses.

(*a*) Defective condenser (C203).
(*b*) R-F feedback from transmitter.
(*c*) Transmitter not "ON."
(*d*) Defective tube.

(7) Erratic synchronization or irregular spacing.

(*a*) Radar input pulses erratic.
(*b*) Pulse input too low.
(*c*) Defective multivibrator.
(*d*) R-F feedback.
(*e*) Defective tube.

c. The best way of determining the source of trouble will be a point-by-point check, working from the modulator tube (V20) on back toward the input, or (V15). The pulse shapes and amplitudes should be checked, using an oscilloscope whose sweep is synchronized with synchronizing pulse input from the Radar to the BN. The various voltages on tube pins should be checked, using a high impedance (20,000 ohms per volt) voltmeter. The notes taken should be compared with the general data given in this book (Pulse shapes, Figure 4-18, Page 4-18; voltages, Page 5-6) or checked against the previously made periodical checks that were made under operating conditions.

d. When checks are made on the modulator section, the transmitter must be operating into either an antenna or a *dummy* load. Because the transmitter is operating, all precautions possible must be taken to prevent coming into contact with the high voltage (5300 VOLTS) when these checks are in progress. Refer to safety precautions, Page x.

e. Test equipment, which is specifically designed to test pulse type equipment such as the BN Radio Equipment, the modulator section in particular, is a SYNC PULSE and SERVO-SWEEP Generator. In general, the equipment comprises a group of major units adapted to produce special signals for application to apparatus under test.

f. In brief, it contains as one of the major units its own sync pulse generator, the pulses of which are variable both in amplitude and in repetition and can be delivered to the BN in place of the Radar sync pulses. The sweep generator provides a very fast sweep for the oscilloscope by which the shape of pulses can be observed. The scope is also contained in this equipment and is synchronized with the sync pulses. The sweep durations available are 50, 200, and 1000 microseconds. Thus with this equipment the pulse shapes, amplitudes, and repetition rate may be determined.

g. With a conventional commercial oscilloscope incorporating a saw-tooth sweep, only the amplitude and repetition rate of the pulses may be determined since it is not provided, as is the Servo-Sweep Generator, with a very fast sweep.

19. REPETITION RATE.

a. The misadjustment of the repetition rate of the multivibrator may be the cause of intermittent operation, too high or too low r-f power (average) output, and/or erratic synchronization. Therefore it is imperative that the repetition rate be correctly set to limit the multivibrator output to 500 pulses per second.

b. If a SYNC PULSE and SERVO-SWEEP Generator is available, the repetition rate, or count down ratio, may be checked very rapidly. Because of the operating features of this equipment, only one lead should be connected from the scope to test point (E171) on the BN Radio Equipment, provided the BN is in operation and the test equipment has its sync pulse output connected to SYNC IN on the front panel of the BN equipment.

c. The output pulse of the multivibrator from test point (E171), together with traces apparently horizontal and on different levels, will appear on the scope. These traces indicate the repetition rate or count down ratio. Should the count down ratio be one to one (driving direct), there will appear on the scope just the single trace. If three traces are apparent, then the count down ratio would be three to one, or for every 1500 sync pulses the multivibrator output under proper operation would be 500 pulses per second. Thus the count down ratio will be "the number of horizontal traces (as they appear on the scope) to one."

d. The repetition rate of the sync pulse generator should be set to 500, which shall be the maximum limit of the multivibrator. Now, the repetition rate control (R172) should be adjusted from its maximum resistance, or full counterclockwise point, to a value where it starts to count down at exactly, or slightly under, 500 pulses per second rate. This point may be checked by then varying the input sync pulse rate and noting whether the circuit counts down at the repetition rate of 500.

At any rate over 500, but less than 1000, the scope should indicate a two to one count down. Thus the count down ratio will be according to the multiple of 500. If the scope shows that the count down starts at exactly, or slightly under, 500 pulses per second when the input repetition is varied, then the repetition rate of the multivibrator is correctly set.

e. A conventional scope of the commercial type requires somewhat of a different method to check the repetition rate since there is no provision of a very fast sweep for it. Also the input sync pulses to the BN from the Radar equipment will have to be used. The repetition rate of these input sync pulses will have to be known.

f. With the "KEYER" switch on the front panel "OFF," connect a lead from the test point (E171) to the horizontal input of the scope. The SYNC TEST point on the BN front panel should be connected to the vertical input. The Horizontal Amplifier Timing switch of the scope should be in the "OFF" position since in this position the input pin jacks are connected to the deflecting plates.

g. The scope display will show the initial wide pulse with other very narrow pulses appearing within the wide pulse, all rising vertically above the reference trace. The count down ratio in this case will be indicated by the number of very narrow pulses, being one less than the ratio. Thus if the initial wide pulse is shown with three very narrow pulses, the count down will be four to one. Therefore, knowing the input sync pulse rate, R172 can be adjusted to show the proper number of pulses, indicating the correct count down ratio, or repetition rate, which will make the multivibrator output a 500 pulse per second rate or less.

20. GATE PULSE GENERATOR.

a. Should the Radar scope, or the separate Indicator scope, show the sweep trace of the BN Receiver as being either too short or too long, it may be readily adjusted by the front panel control (R214) on the BN. Refer to instructions in Section II, Page 2-20, Paragraph 13.

WARNING

High voltage (5300 volts) is used in the operation of the transmitter, and maintenance work shall be done only in accordance with regulations concerning the use of voltages over 500 volts.

21. MAINTENANCE TEST SCHEDULE.

a. In general, it can be determined whether servicing will be required by adhering to a rigid maintenance test schedule as outlined below.

(1) HOURLY.

(a) Check for indication of transmitter pulse on Radar indicator.

(2) WEEKLY.

(a) Wipe complete equipment with dry cloth. Check frequency. Check transmitter output, pulse shapes, and repetition rate.

(3) MONTHLY.

(a) Remove the equipment from the cabinet; make a visual check of the stop assembly, guide block and runner, and track of the cabinet and chassis; check the interlock and locating pin; wipe dust from the blower, tubes, chassis, and cabinet; make certain all tubes are seated properly in their sockets; and wipe off the front panel.

(b) Connect the equipment for test.

(c) Notes should be taken of all waveforms, pulse voltages, resistance values, and available a-c and d-c voltages in the data book that is used for that purpose.

(d) Records should be kept of replacements of all tubes or other components.

(e) Check pulse shapes, referring to Figure 4-18, Page 4-18: Sync-In, E151, Pulse 1; Multivibrator Output, E171, Pulse 5; Driver Grid, E191, Pulse 10; Modulator Grid, E201, Pulse 12; Pulse Out, Pulse 14; Gate Pulse, E211, Pulse 17.

(f) Make voltage measurements as outlined in Paragraph 7, Page 5-7.

(g) Test all tubes, replacing weak or bad tubes with new ones if a tester is available.

(h) Check all solder connections. Resolder any loose or broken connections.

(i) Lubricate bearings, controls, and other mechanisms, whether the equipment is used continually or only occasionally.

(j) Do not lubricate the tuning capacitors, potentiometers, panel bushings, guide block and runner, or track assembly.

(k) Lubricate the 60-cycle blower motor (Smith Company) with 10 to 15 drops of oil (SAE #10).

(4) QUARTERLY.

(a) After every three months of operation, the chassis should be removed from the cabinet, carefully

inspected, and cleaned. Accumulated dust, particularly on and near high-voltage parts, should be blown out or wiped off with a cloth moistened in carbon tetrachloride.

(b) Electrical connections should be tightened and all traces of dust and corrosion removed from switches, plugs, jacks, and other contact making surfaces.

(c) Inspect, clean, and tighten all knobs.

(5) ANNUAL.

(a) The 400-cycle blower motor (Westinghouse) requires only annual lubrication. This unit is capable of continuous service for that length of time. At the end of this time the complete blower should be replaced by one of the spare units. The removed motor should then be disassembled and the bearings lubricated.

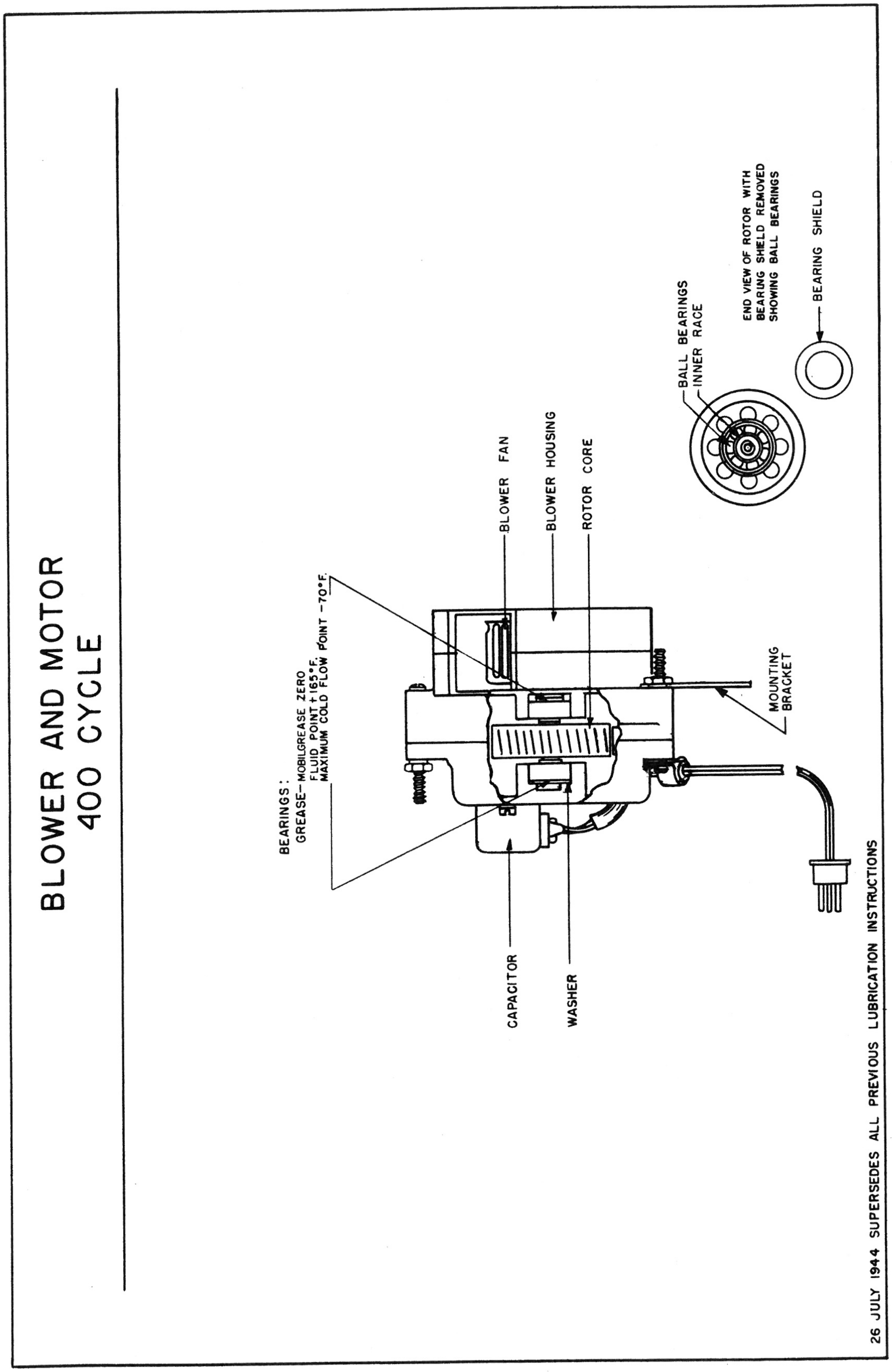


Figure 5-10—Lubrication Chart

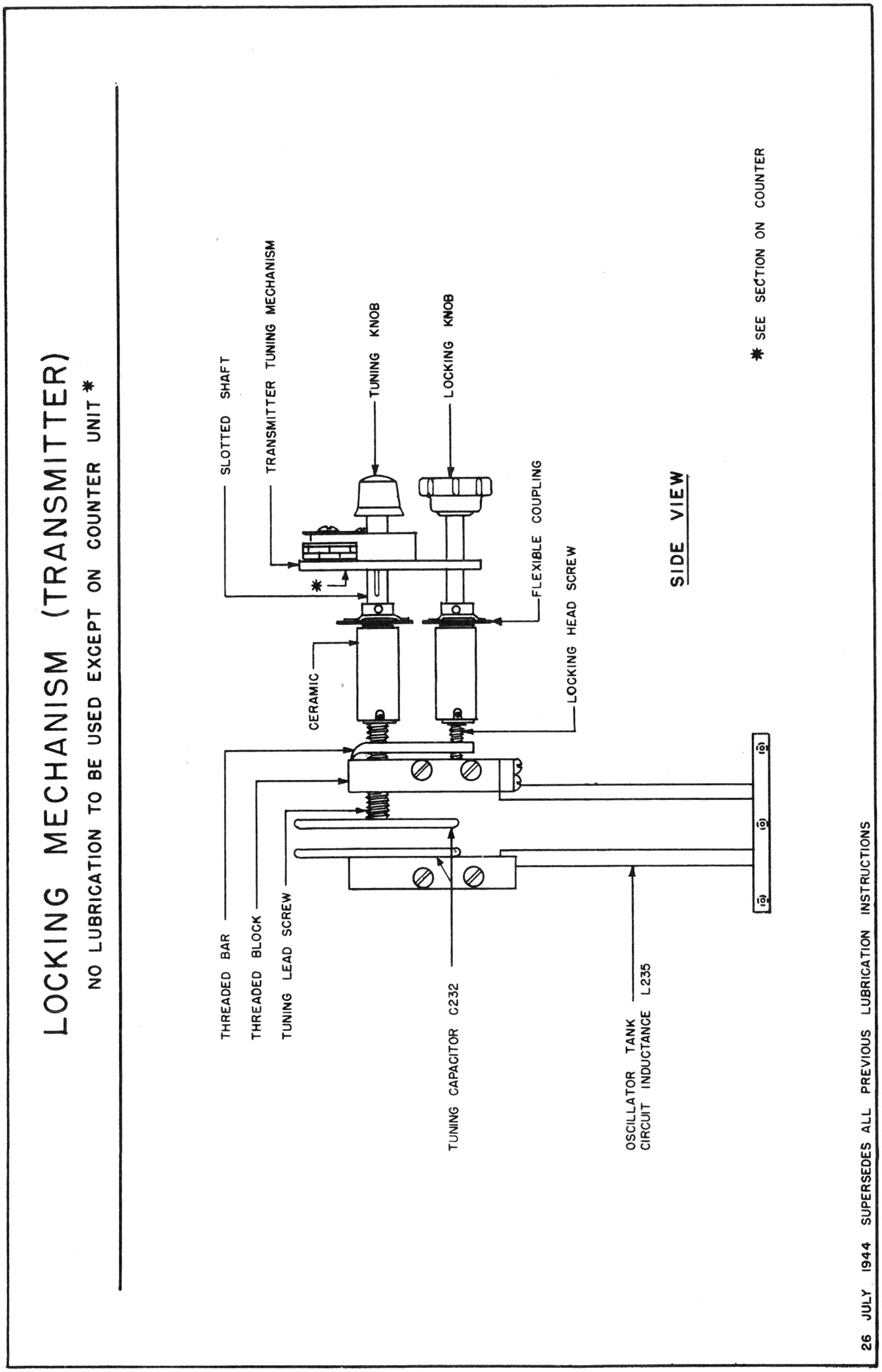


Figure 5-11—Lubrication Chart

TABLE 1
LIST OF MAJOR UNITS
FOR MODEL BN RADIO EQUIPMENT

Quantity	Symbol Group	Navy Type Designation	Name of Major Unit	Assembly Drawing Number
1	250-269	CFN-10233	Cabinet	300871
1	51-259 less 230-239	CFN-43ACB	Power Supply and I-F to Video Converter	300755
1	11-49	CFN-46ACW	R-F to I-F Converter	300736
1	230-239	CFN-52ACQ	Transmitter R-F Oscillator	300735

AUXILIARY EQUIPMENT WHICH MAY BE USED

Quantity	Symbol Group	Navy Type Designation	Name of Major Unit	Assembly Drawing Number
	—	CTZ-50ABS	Duplexing Unit	—
	—	CTZ-50ACW	Duplexing Unit	—
	—	CTZ-66ACG	Antenna Assembly	—
	—	CTZ-66AFJ	Antenna Assembly	—

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Tender	Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(B) MOTORS													
B251A	Blower and motor 60-cycles	115 volt, 60-cycle shaded pole induction motor, speed 3,150 rpm ±5%. Torrington #000 blower wheel	10509	17M10 (INT.) for motor	2			300503 P-1	1	1	1	0	B251A	1	21.19
B251B	Blower and motor 400-cycles	115 volt, 400-cycle capacitor induction motor, speed 6,850 rpm ±5%. Torrington #000 blower wheel	10510	17M10 (INT.) for motor	3		Blower and mounting assembly per contractor's drawing 300521 G-1 supplied in spare parts.	300521 P-2	2	4	4	1	B251B	0	42.27
		(C) CAPACITORS													
									3				Not used		
C11	Antenna input coupling capacitor	Capacitor, ceramic, 4.5 mmfd 0.5 mmfd. 5,000 V. D.C. working, zero temp. coefficient. 11,000 V. D.C. test			4	Type 852	Capacitor and mounting per contractor's drawing 300483 G-1 supplied in spare parts.	300394 P-1	4	3	3	1	C11	1	2.46
C12	1st R.F. grid coupling capacitor	Capacitor, ceramic, 5 mmfd ±10% 500 V. D.C. working. Zero temp. coef.		A.S.A. C75/000	5	NP0K5 ±.5		300442 P-1	5	5	5	1	C12, C16, C114	3	.17
C13	1st R.F. Cathode resistor bypass capacitor	Capacitor, ceramic, 40 mmfd ±10% 500 V. D.C. working −750 mmfd/mmfd °C x 10^{-6} temp. coefficient.	482953	A.S.A. C75/000	5	N750K40 ±4		300442 P-2	6	38	38	8	C13, C14, C15, C18, C22, C23, C24, C25, C26, C33, C34, C43, C47, C49, C144	15	.06
C14	1st R.F. plate filter capacitor	Same as C13													
C15	1st R.F. grid bypass capacitor	Same as C13													
C16	1st R.F. plate coupling capacitor	Same as C12													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(C) CAPACITORS (Continued)													
C17	1st R.F. plate supply bypass capacitor	Capacitor, mica, 1,000 mmfd ±20%, 500 volts D.C. working	CM30-B102M	A.S.A. C75.3-1942	7, 8			300445 P-4	7	27	27	6	C17, C51, C52, C53, C56, C62, C63, C64, C65, C72, C73, C74, C75, C82, C83, C84, C85, C92, C93, C94, C95, C96, C113, C123, C131, C138, C191	27	.17
C18	1st R.F. heater bypass capacitor	Same as C13													
C19	1st R.F. plate filter capacitor	Capacitor, coaxial ceramic, 55 mmfd ±10%, 500 volts D.C. working	482000		4	817-001		300393 P-1	8	10	10	2	C19, C27, C28, C233	4	.22
C21	2nd R.F. grid coupling capacitor	Capacitor, ceramic, 6 mmfd ±10%, 500 volts D.C. Zero temperature coefficient			5	NP0K6 ±.6		300442 P-4	9	3	3	1	C21	1	.14
C22	2nd R.F. cathode resistor bypass capacitor	Same as C13													
C23	2nd R.F. cathode bypass capacitor	Same as C13													
C24	2nd R.F. screen bypass capacitor	Same as C13													
C25	2nd R.F. plate filter capacitor	Same as C13													
C26	2nd R.F. heater bypass capacitor	Same as C13													
C27	1st R.F. heater bypass capacitor	Same as C19													
C28	2nd R.F. heater bypass capacitor	Same as C19													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(C) CAPACITORS (Continued)													
									10				Not used		
C31	2nd R.F. plate coupling capacitor	Capacitor, ceramic, 10 mmfd ±10%, 500 volt, D.C. working. Zero temp. coefficient	481886	A.S.A. 75/000	5	NP0K10 ±1		300442 P-5	11	5	5	1	C31, C112	2	.07
C32	1st I.F. tuning capacitor	Capacitor, ceramic, 20 mmfd ±10%, 500 volts, D.C. working, −750 mmfd / mmfd/°C x 10^{-6} temp. coefficient		A.S.A. 75/000	5	N750K20 ±2		300442 P-6	12	3	3	1	C32	1	.06
C33	R.F. oscillator output coupling capacitor	Same as C13													
C34	1st detector heater bypass capacitor	Same as C13													
C35	R.F. section heater bypass capacitor	Capacitor, mica, 3,300 mmfd ±20%, 500 volts D.C. working	CM30B-332M	A.S.A. C75.3-1942	7, 8			300445 P-1	13	6	6	2	C35, C48, C97, C121, C122, C124	6	.20
									14				Not used		
									15				Not used		
C41	Receiver oscillator output coupling capacitor	Capacitor, ceramic, 2 mmfd ±25%, 500 volts D.C. working. Zero temp. coefficient	CC21CG-020D	A.S.A. 75/000	5	NP0K2 ±.5		300442 P-7	16	5	5	1	C41, C45	2	.17
C42	Receiver oscillator grid filter capacitor	Capacitor, ceramic, 100 mmfd ±10%, 500 volts D.C. working, ±750 mmfd / mmfd/°C x 10^{-6} temp. coefficient	481959	A.S.A. 75/000	5	N750K100 ±10		300442 P-8	17	18	18	4	C42, C46, C61, C71, C81, C91, C111	7	.05
C43	Receiver oscillator grid filter capacitor	Same as C13													
C44	Receiver oscillator grid coupling capacitor	Capacitor, ceramic, 18 mmfd ±5%, 500 volts D.C. working, −470 mmfd / mmfd / °C x 10^{-6} temp. coefficient		A.S.A. 75/000	5	N470K18 ±.9		300442 P-9	18	3	3	1	C44	1	.09

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(C) CAPACITORS (Continued)													
C45	Receiver oscillator feed back capacitor	Same as C41													
C46	Receiver oscillator plate bypass capacitor	Same as C42													
C47	Receiver oscillator plate filter capacitor	Same as C13													
C48	Plate supply bypass capacitor	Same as C35													
C49	Receiver oscillator heater bypass capacitor	Same as C13													
C51	1st I.F. cathode bypass capacitor	Same as C17													
C52	1st I.F. screen bypass capacitor	Same as C17													
C53	1st I.F. plate filter capacitor	Same as C17													
C54	I.F. cathode bypass capacitor	Capacitor, dry electrolytic, 100 mfd +100% −10% 25 volts working −40 volts max. surg. range −40° C to 85° terminals on side	482957	RE 13A 549A	6	Type B.S.		300282 P-1	19	5	5	1	C54	1	.70
C55	I.F. section plate bypass capacitor	Capacitor, paper—metal case, 0.5 mfd +20% −10% 600 volts D.C. working top terminals	481002	RE 13A 488E	19, 34			300447 P-1	20	3	3	1	C55	1	.91
C56	1st I.F. heater bypass capacitor	Same as C17													
C61	2nd I.F. grid coupling capacitor	Same as C42													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	SPARE PARTS Quantities Stock	SPARE PARTS Quantities Tender	SPARE PARTS Quantities Equip.	SPARE PARTS All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(C) CAPACITORS (Continued)													
C62	2nd I.F. cathode bypass capacitor	Same as C17													
C63	2nd I.F. screen bypass capacitor	Same as C17													
C64	2nd I.F. plate filter capacitor	Same as C17													
C65	2nd I.F. heater bypass capacitor	Same as C17													
C71	3rd I.F. grid coupling capacitor	Same as C42													
C72	3rd I.F. cathode bypass capacitor	Same as C17													
C73	3rd I.F. screen bypass capacitor	Same as C17													
C74	3rd I.F. plate bypass capacitor	Same as C17													
C75	3rd I.F. heater bypass capacitor	Same as C17													
C81	4th I.F. grid coupling capacitor	Same as C42													
C82	4th I.F. cathode bypass capacitor	Same as C17													
C83	4th I.F. screen bypass capacitor	Same as C17													
C84	4th I.F. plate filter capacitor	Same as C17													
C85	4th I.F. heater bypass capacitor	Same as C17													
C91	5th I.F. grid coupling capacitor	Same as C42													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(C) CAPACITORS (Continued)													
C92	5th I.F. cathode bypass capacitor	Same as C17													
C93	5th I.F. screen bypass capacitor	Same as C17													
C94	5th I.F. plate filter capacitor	Same as C17													
C95	I.F. section plate supply bypass capacitor	Same as C17													
C96	5th I.F. heater bypass capacitor	Same as C17													
C97	I.F. section heater bypass capacitor	Same as C35													
C98	5th I.F. suppressor bypass capacitor	Capacitor, ceramic, 350 mmfd ±10%, 500 volts D.C. working −750 mmfd/mmfd/°C x 10^{-6} temp. coefficient	482954	A.S.A. 75/000	5	N750M350 35		300442 P-10	21	3	3	1	C98	1	.09
C111	2nd det. coupling capacitor	Same as C42													
C112	Tuning indicator detector tuning capacitor	Same as C31													
C113	2nd det. heater bypass capacitor	Same as C17													
C114	2nd detector tuning capacitor	Same as C12													
C121	Tuning indicator grid filter cap.	Same as C35													
C122	Tuning indicator grid filter capacitor	Same as C35													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(C) CAPACITORS (Continued)													
C123	Tuning indicator grid bypass capacitor	Same as C17													
C124	R.F. section heater supply bypass capacitor	Same as C35													
C131	1st video coupling capacitor	Same as C17													
C132	1st video grid filter capacitor	Capacitor, paper—metal case 2 x 0.1 mfd +20% −10% 600 volts D.C. working—bottom terminals. (Unit includes C137)	48703-A	RE 13A 488E	19, 34			300447 P-2	22	5	5	1	(C132-C137) (C133-C136)	2	.97
C133	1st video screen bypass capacitor	Same as C132. (Unit included C136)													
C136	1st video plate filter capacitor	Part of unit containing C133													
C137	I.F. section plate supply bypass capacitor	Part of unit containing C132													
C138	1st video heater bypass capacitor	Same as C17													
C141	2nd video grid coupling capacitor	Capacitor, paper—molded case .004 mfd ±20% 600 volts D.C. working	182958	RE 13A 488E	7,8			300446 P-1	23	3	3	1	C141	1	.23
C142	2nd video output coupling capacitor	Capacitor, paper—metal case 1.0 mfd +20% −10% 600 volts D.C. working, side terminals	48600-A	RE 13A 488E	19, 34			300447 P-5	24	3	3	1	C142	1	1.06
C144	2nd video cathode bypass capacitor	Same as C13													
									25				Not used		
C151	Sync. amp. grid coupling capacitor	Capacitor, mica, 2,000 mmfd ±10%, 500 volts D.C. working	CM-30-B-202K	A.S.A. C75.3-1942	7, 8			300445 P-2	26	1	1	1	C151	1	.15

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(C) CAPACITORS (Continued)													
C152	Sync. amp. cathode bypass capacitor	Capacitor, paper—metal case 3 x .1 mfd +20% −10% 600 volts D.C. working. Top terminals. (Unit includes C153 & C163)	48849-A	RE 13A 488E	19, 34			300447 P-6	27	5	5	1	(C152-C153-C163) (C172-C182-C184)	2	1.08
C153	Sync. amp. screen bypass capacitor	Part of unit containing C152													
C161	Sync. amp. plate coupling capacitor	Capacitor, mica, 100 mmfd ±20%, 500 volts D.C. working	CM20-B101M	A.S.A. C75.3-1942	7, 8			300445 P-3	28	4	4	1	C161, C181, C183, C211	4	.06
C162	Multivibrator input grid coupling capacitor	Capacitor, paper—molded case .03 mfd ±20% 600 volts D.C. working	481025-A	RE 13A 488E	8			300446 P-2	29	3	3	1	C162	1	.14
C163	Multivibrator input screen bypass capacitor	Part of unit containing C152													
C164	Multivibrator plate filter capacitor	Capacitor, paper—metal case 2 x 1.0 mfd +20% −10% 600 volts D.C. working. Top terminals. (Unit includes C192)			19, 34			300447 P-7	30	3	3	1	(C164-C192)	1	1.37
C171	Multivibrator output grid coupling capacitor	Capacitor, paper—molded case 0.1 mfd ±20% 600 volts D.C. working	481729	RE 13A 488E	7, 8			300446 P-3	31	3	3	1	C171	1	.19
C172	Multivibrator output screen bypass capacitor	Same as C152. (Unit includes C182 & C184)													
C181	Pulse shaper grid coupling capacitor	Same as C161													
C182	Pulse shaper cathode bypass capacitor	Part of unit containing C172													
C183	Pulse clipper grid coupling capacitor	Same as C161													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(C) CAPACITORS (Continued)													
C184	Pulse clipper grid return bypass capacitor	Part of unit containing C172													
C191	Driver grid coupling capacitor	Same as C17													
C192	Driver cathode bypass capacitor	Part of unit containing C164													
									32				Not used		
									33				Not used		
C202	Modulation cathode bypass capacitor	Capacitor, paper—metal case 1.0 mfd +20% −10% 600 volts D.C. working, bottom terminals	482946	RE 13A 488E	19, 34			300447 P-9	34	3	3	1	C202	1	1.06
C203	Pulse amplifier feedback capacitor	Capacitor, mica, 27 mmfd ±10% 500 volts D.C. working	CM20-B270K	A.S.A. C75.3-1942	7, 8			300445 P-5	35	1	1	1	C203	1	.08
									36				Not used		
C211	Gate pulse generator input grid coupling capacitor	Same as C161													
C212	Gate pulse generator output grid coupling capacitor	Capacitor, mica, 2,400 mmfd ±5% 500 volts D.C. working	CM30-B242J	A.S.A. C75.3-1942	7, 8			300445 P-6	37	1	1	1	C212	1	.18
C213	Gate pulse generator plate filter capacitor	Capacitor, paper—metal case 2.0 mfd +20% −10% 600 volts D.C. working, bottom terminals		RE 13A 488E	19, 34			300447 P-10	38	3	3	1	C213	1	1.30
C214	Gating generator output plate coupling capacitor	Capacitor, paper—metal case 0.1 mfd. +20% −10% 600 volts D.C. working, top terminals	481001	RE 13A 488E	19, 34			300447 P-11	39	3	3	1	C214	1	.82

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No	Quantities Stock	Tender	Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(E) MISCELLANEOUS ELECTRICAL PARTS (Continued)													
E211	Test point for gating pulse	Same as E31													
E212	Knob for R214	Same as E141													
E231	Transmitter tuning assembly	Complete tuning assembly per contractor's reference drawing			1	300077 G-1		300077 G-1	50				E231	1	
E232A	Support insulator for L235	Ceramic insulator. Material to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A.W.S. C75.1-1943	30			300094 P-1	51	3	3	1	E232A	1	.86
E232B	Support insulator for L235	Ceramic insulator. Material to be grade L-5 or L-6 per specification. Glazed and wax impregnated. ⅜" dia. by 1½" long. #6-32 x ⅜" deep. Tapped hole each end		A.W.S. C75.1-1943	30			2044-351	52	5	5	1	E232A, E232C	2	.09
E232C	Support insulator for L235	Same as E232B													
E233A	Connector for L236	Flexible strip connector beryllium copper silver plated						300433 G-1	53	1	1	0	E233A	1	.29
E233B	Connector for L236	Flexible strip connector beryllium copper silver plated						300433 G-2	54	1	1	0	E233B	1	.29
E233C	Insulator for supporting E233A and E233B	Ceramic insulator. Material to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A.W.S. C75.1-1943	30			300115 P-1	55	3	3	1	E233C	1	.76
E234A	Bearing insulator for L236	Ceramic insulator. Material to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A.W.S. C75.1-1943	30			300048 P-1	56	3	3	1	E234A	1	.55
E234B	Spacing insulator for L236	Ceramic post insulator mat'l to be grade L-5 or L-6 per specification. ⅜" dia. by 1" long. #6-32 x ⅜" deep tap each end. Glazed and wax impregnated		A.W.S. C75.1-1943	30			2044-331	57	3	3	1	E234B	1	.08

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No	SPARE PARTS Quantities Stock	SPARE PARTS Quantities Tender	SPARE PARTS Quantities Equip.	SPARE PARTS All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(E) MISCELLANEOUS ELECTRICAL PARTS (Continued)													
E235A	Feed thru insulator for H.V. lead	Ceramic feed thru insulator. Material to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A.W.S. C75.1-1943	30			300993-2	58	3	3	1	E235A	1	.13
E235B	Feed thru insulator for H.V. lead	Ceramic feed thru insulator. Material to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A. W. S. C75.1-1943	30			300993-1	59	3	3	1	E235B	1	.13
E235C	Feed thru insulator for filament lead	Ceramic feed thru insulator. Material to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A. W. S. C75.1-1943	30			2045-152	60	5	5	1	E235C, E235E	2	.08
E235D	Feed thru insulator for filament lead	Ceramic feed thru insulator. Material to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A. W. S. C75.1-1943	30			2045-156	61	5	5	1	E235D, E235F	2	.07
E235E	Feed thru insulator for filament lead	Same as E235C													
E235F	Feed thru insulator for filament lead	Same as E235D													
E236A	Knob for tuning C232	Same as E141													
E236B	Knob for locking C232	1⅛" diameter fluted knob, black phenolic body, brass insert for ¼" shaft. "Lock" with clockwise arrow engraved and filled with white on face of knob. Two #8-32 tapped holes for set screws. Supplied less set screws		17P4 (INT)	32			300522 P-1	62	8	8	0	E236B, E236D	2	.30
E236C	Knob for adjusting L236	Same as E141													
E236D	Knob for locking L236	Same as E236B													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

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		(E) MISCELLANEOUS ELECTRICAL PARTS (Continued)													
E237	Support insulator for C231	Ceramic insulator material to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A. W. S. C75.1-1943	30			300111 P-1	63	3	3	1	E237	1	.38
E238	Support insulator for L237	Ceramic insulator material to be grade L-5 or L-6 per specification. Glazed and wax impregnated. 3/8" dia. by 1/2" long. #6-32 x 5/32" deep. Tapped hole each end		A. W. S. C75.1-1943	30			2044-301	64	3	3	1	E238	1	.07
E239A	Plate clip for V23	Clip for .098 dia. pin beryllium copper strip lead 2 5/8" long			1	300096 G-1		300096 G-1	65	5	5	1	E239A	1	1.37
E239B	Grid clip for V23	Clip for .098 dia. pin beryllium copper strip lead 2 1/8" long			1	300096 G-2		300096 G-2	66	5	5	1	E239B	1	1.36
E241	Plate clip for V24	Clip for 3/8" dia. tube cap with 2" braid lead and #10 shakeproof terminal lug			1	300438 G-1		300138 G-1	67	5	5	1	E241	1	13
E242A	Support insulator for R241	Metal based ceramic insulator metal part cadmium plated ceramic to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A. W. S. C75.1-1943	1	300355 G-1		300355 G-1	68	3	3	1	E212A	1	.65
E242B	Support insulator for R241	Phenolic insulator 1" diameter by 3/4" long. Material type FBG per spec.		17P4 (INT)	1	300309 P-1		300309 P-1	69	8	8	2	E242B, E251A, E251B	3	.30
E251A	Support insulator for R251	Same as E242B													
E251B	Support insulator for R251	Same as E242B													
E252	Terminal for shorting interlock	Part of keyer terminal board													
E253	Terminal for shorting interlock	Part of keyer terminal board													

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		(F) FUSES													
F251	Line fuse	Fuse, cartridge type, 4 amps. 125 volts 1¼" overall length, ferrules ¼" dia.	Type GT-4	17F2 (INT)	10	Type 3AG		300409 P-2	70A	100	100	20	F251, F252, F253, F254	2	.03
F252	Line fuse	Same as F251													
F253	Spare fuse	Same as F251													
F254	Spare fuse	Same as F251													
F255	Line fuse holder	Fuse holder, for type 3AG fuse			10	Type HKM		300162 P-1	71	1	1	1	F255, F256	2	.20
F256	Line fuse holder	Same as F255													
		(H) HARDWARE													
H11	Spring for L11	Steel spring. #10 gage (.024) music wire cadmium plated			39			300327 P-1	72	4	4	0	H11, H21, H31, H41	4	.02
H12	Retainer for H11	Steel "U" plate. Mtg. hole spaced ¾" centers. Cadmium plated						300420 P-1	73	4	4	0	H12, H22, H32, H42	4	.05
H13A	Set screw for E11	#8-32 x 3/16" long socket set screw, cup point cadmium plated			35			2041-142	74	0	0	12	H13A, H13B, H23A, H23B, H33A, H33B, H43A, H43B, H237A, H237B, H237E, H237F	12	.03
H14	Tube shield base for V1	Base for .810 I.D. tube shield. Mtg. holes ⅞" centers. Steel, cadmium plated			26	1022		300778 P-2	75	3	3	0	H14, H34	2	.10
H15	Tube shield for V1	Tube shield .810 I.D. by 1 9/16" long. Steel, cadmium plated			26	8674		300387 P-1	76	2	2	1	H15	1	.09
H21	Spring for L21	Same as H11													
H22	Retainer for H21	Same as H12													
H23A	Set screw for E21	Same as H13A													
H23B	Set screw for E21	Same as H13A													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

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		(H) HARDWARE (Continued)													
H24	Grounding ring for V2	Stainless steel ring 1½—20 thd. Three .110 dia. holes on 1.312 dia. circle spaced 120° apart			40			300453 P-1	77	3	3	1	H24, H44	2	.51
H31	Spring for L31	Same as H11													
H32	Retainer for H31	Same as H12													
H33A	Set screw for E32	Same as H13A													
H33B	Set screw for E32	Same as H13A													
H34	Tube shield base for V3	Same as H14													
H35	Tube shield for V3	Tube shield .810 I. D. by 1⅜" long steel cadmium plated			26	8660		300388 P-1	78	2	2	1	H35	1	.04
H41	Spring for L41	Same as H11													
H42	Retainer for H41	Same as H12													
H43A	Set screw for E41	Same as H13A													
H43B	Set screw for E41	Same as H13A													
H44	Grounding ring for V4	Same as H24													
H51	Retainer base for V5	Tube retainer base. Mounting holes spaced 1½" centers			31			300173 P-1	79	13	13	3	H51, H61, H71, H81, H91, H131, H141, H151, H161, H171	10	.02
H52	Retainer collar for V5	Retainer tube collar to fit item H51A			31			300172 P-1	80	13	13	3	H52, H62, H72, H82, H92, H132, H142 H152, H162, H172	10	.06
H61	Retainer base for V6	Same as H51													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(H) HARDWARE (Continued)													
H232A	Set screw for O232A	#6-32 x 1/8" long socket set screw, cup point cadmium plated			35			2041-131	88	0	0	16	H232A, H232B, H232C, H232D, H233A, H233B, H233C, H233D, H234A, H234B, H234C, H234D, H235A, H235B, H235C, H235D	16	.04
H232B	Set screw for O232A	Same as H232A													
H232C	Set screw for O232A	Same as H232A													
H232D	Set screw for O232A	Same as H232A													
H233A	Set screw for O232B	Same as H232A													
H233B	Set screw for O232B	Same as H232A													
H233C	Set screw for O232B	Same as H232A													
H233D	Set screw for O232B	Same as H232A													
H234A	Set screw for O233	Same as H232A													
H234B	Set screw for O233	Same as H232A													
H234C	Set screw for O233	Same as H232A													
H234D	Set screw for O233	Same as H232A													
H235A	Set screw for O234	Same as H232A													
H235B	Set screw for O234	Same as H232A													
H235C	Set screw for O235	Same as H232A													
H235D	Set screw for O235	Same as H232A													
H236A	Set screw for O236	#6-32 x 3/16" long socket set screw cup point, cadmium plated			35			2041-132	89	0	0	4	H236A, H236B, H236C, H236D	4	.03
H236B	Set screw for O236	Same as H236A													
H236C	Set screw for O237	Same as H236A													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(I) INDICATORS													
I231	R. F. monitor	Lampglobe—Neon ¼ watt 105/125 volts	VG-7		9	T4¼-105/125 V.		300407 P-1	102	10	10	2	I231	1	.39
I251	Power pilot lamp	Lamp globe 6-8 volts .25 amp. bayonet base	TB-11		9	Mazda #44		300406 P-1	103	10	10	2	I261	1	.04
		(J) RECEPTACLES													
J11	Rcvr. ant. input receptacle	Receptacle, coaxial, single conductor, female	49194	RE 49F 167	11	49194		300106 P-1	104	1	1	0	J11, J141, J151, J201, J231	5	1.23
J51	Remote control receptacle	Receptacle, three contact, female	AN-3102-16-10S		12	AN-3102-16-10S		300164 P-1	105	1	1	0	J51	1	1.16
J141	Video output receptacle	Same as J11													
J151	Sync. input receptacle	Same as J11													
J201	Pulse output receptacle	Same as J11													
J231	Trans. ant. output receptacle	Same as J11													
J251	115 V. input receptacle	Receptacle—two contact—male	AN-3102-16-11P		12	AN-3102-16-11P		300164 P-2	106	1	1	0	J251	1	.93
J252	115 V. output receptacle	Receptacle—two contact—female	49952		12	MIP-6IF		300605 P-1	107	1	1	0	J252	1	.11
J253	Blower motor power receptacle	Receptacle—3 contact—for .093 pins—⅝" dia.	49264		12	78-S3S		300606 P-2	108	1	1	0	J253	1	.06
		(L) INDUCTORS													
L11	Antenna tuning	Inductance—ant., 3½ turns #16 A.W.G. silver coated wire, .401 dia.			1	300297 G-1		300297 G-1	109	1	1	0	L11	1	2.80
L12	1st R.F. cathode choke	R.F. choke—36 turns #28 double vinyl acetal insulated wire ¼" dia.	47921		1	300452 G-1		300452 G-1	110	9	9	2	L12, L54, L62, L72, L82, L91, L113, L131, L141	9	.66

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Tender	Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(L) INDUCTORS (Continued)													
L13	1st R.F. heater choke	R.F. choke—18 turns #28 A.W.G. double vinyl acetal insulated wire —¼″ dia.	47922		1	300452 G-2		300452 G-2	111	5	5	1	L13, L14, L22, L32, L43	5	66
L14	1st R.F. heater choke	Same as L13													
L21	1st R.F. tuning	Inductance—R.F. tuner—3½ turns #14 A.W.G. silver coated wire .401 dia.			1	300297 G-2		300297 G-2	112	1	1	0	L21	1	2.80
L22	2nd R.F. heater choke	Same as L13													
L31	2nd R.F. tuning	Inductance R.F. tuner—3½ turns #14 A.W.G. silver coated wire .401 dia.			1	300297 G-3		300297 G-3	113	1	1	0	L31	1	2.80
L32	1st detector heater choke	Same as L13													
L41	Rcvr. oscillator tuning	Inductance-oscillator 4½ turns #16 A.W.G. silver coated wire .401 dia.			1	300297 G-4		300297 G-4	114	1	1	0	L41	1	2.80
L42	Rcvr. oscillator cathode coil	Coil–7 turns #26 A.W.G. double vinyl acetal insulated wire ¼″ dia.			1	300493 G-1		300493 G-1	115	1	1	1	L42	1	.81
L43	Rcvr. oscillator heater choke	Same as L13													
L51	1st I.F. grid tuning	I.F. coil—6½ turns #24 A.W.G. enamel wire ½″ dia. Can marked "input center"			1	300308 G-3		300308 G-3	116	1	1	0	L51	1	3.71
L53	1st I.F. plate tuning	I.F. coil 12½ turns #24 A.W.G. enamel wire ½″ dia. Can marked "high"			1	300308 G-2		300308 G-2	117	1	1	0	L53, L71	2	3.71
L54	1st I.F. heater choke	Same as L12													
L61	2nd I.F. plate tuning	I.F. coil 13½ turns #24 A.W.G. enamel wire ½″ dia. Can marked "low"			1	300308 G-1		300308 G-1	118	1	1	0	L61	1	3.71

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(L) INDUCTORS (Continued)													
L62	2nd I.F. heater choke	Same as L12													
L71	3rd I.F. plate tuning	Same as L53													
L72	3rd I.F. heater choke	Same as L12													
L81	4th I.F. plate tuning	I.F. coil 13½ turns #24 A.W.G. enamel wire ½" dia. Can marked "low"			1	300472 G-1		300472 G-1	119	1	1	0	L81	1	3.71
L82	4th I.F. heater choke	Same as L12													
L91	5th I.F. heater choke	Same as L12													
L111	2nd detector tuning	I.F. coil 14½ turns #24 A.W.G. enamel wire ½" dia. Can marked "center"			1	300472 G-2		300472 G-2	120	1	1	0	L111	1	3.71
L112	Tuning indicator detector tuning	I.F. coil 14½ turns #24 A.W.G. enamel wire ½" dia. Can marked "center"			1	300308 G-4		300308 G-4	121	1	1	0	L112	1	3.71
L113	2nd detector heater choke	Same as L12													
L121	R.F. section heater choke	R.F. choke—37 turns, #24 A.W.G. double vinyl acetal enamel wire, ⅜" dia.	47919		1	300314 G-1		300314 G-1	122	1	1	1	L121	1	.83
L131	1st video heater choke	Same as L12													
L141	2nd video heater choke	Same as L12													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(L) INDUCTORS (Continued)													
L231	Oscillator filament choke	R.F. choke—16 turns, #16 A.W.G. double vinyl acetal enamel wire, ⅜″ dia.	47920		1	300314 G-2		300314 G-2	123	2	2	1	L231, L232	2	.83
L232	Oscillator filament choke	Same as L231													
L233	Oscillator grid choke	R.F. choke 20 turns #30 A.W.G. double vinyl acetal enamel wire, ¼″ dia.	47918		1	300340 G-1		300340 G-1	124	2	2	1	L233, L234	2	1.00
L234	Oscillator plate choke	Same as L233													
L235	Oscillator tank inductance	Inductance—parallel line rod type			1	300078 G-1		300078 G-1	125				L235	1	
L236	Oscillator output coupling loop	Inductance—parallel line rod type			1	300057 G-1		300057 G-1	126				L236	1	
L237	R.F. monitor pick-up loop	Inductance formed in part by structural members							127					1	
L251	L.V. plate supply filter	Reactor—4.75 henries (min.) at 150 MA. D. C. at 10 volts R.M.S. 60 cycles D.C. resistance 80 ohms ±15% to carry 180 MA. D.C. continuously	301964	RE 13A 553B RE 13A 554D	13	466-001-161		300360 P-1	128	1	1	0	L251	1	10.93
		(O) MECHANICAL PARTS													
O12	Hood for J11	Hood to fit over Navy receptacle 49194. Mtg. holes on 23/32″ x 23/32″ centers. Silver plated.	49193	RE 49F 167	11	49193		300106 P-2	130	1	1	0	O12, O201, O231	3	1.23
O11	Counter assembly for L11	Counter assembly with dial indicating 0 to 9			1	300517 G-1		300517 G-1	129	4	4	0	O11, O21, O31, O41	4	2.99
O21	Counter assembly for L21	Same as O11													
O31	Counter assembly for L31	Same as O11													

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(O) MECHANICAL PARTS (Continued)													
O41	Counter assembly for L41	Same as O11													
O151	Hood for J151	Hood to fit over Navy receptacle type 49194. Mtg. holes on 23/32" x 23/32" centers. Silver plated with 1/4" dia. hole on conical section.	49193		11			300516 P-1	131	1	1	0	O151	1	.26
O201	Hood for J201	Same as O12													
O231	Hood for J231	Same as O12													
O232A	Insulated shaft coupling for C232	Flexible shaft coupling for 1/4" shafts. Ceramic insulation to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A.W.S. C75.1-1943	1	300249 G-1		300249 G-1	132	5	5	1	O232A, O232B	2	.90
O232B	Insulated shaft coupling for C232	Same as O232A													
O233	Insulated coupling for L236 control shaft	Ceramic shaft coupling for 1/4" dia. shafts. Ceramic material to be grade L-5 or L-6 per specification. Glazed and wax impregnated		A.W.S. C75.1-1943	1	300339 G-1		300339 G-1	133	3	3	1	O233	1	.63
O234	Control shaft for L236	3/8" dia. shaft cut to 1/4" on one end, 1 15/16" long. Brass nickel plated			41			300300 P-1	134				O234	1	
O235	Gear segment for L236	11/16" Segment of 1 3/4" pitch dia. 48 pitch 14 1/2" pressure angle gear with hub drilled for 1/4" shaft. Brass cadmium plated			42			300073 P-1	135				O235	1	
O236	Collar for O234	3/4" O.D. x 1/4" thick collar for 3/8" dia. shaft. Tapped holes for #6-32 set screws. Steel cadmium plated			41			300302 P-2	136				O236	1	
O237	Collar for O234	3/4" O.D. x 1/4" thick collar for 1/4" dia. shaft. Tapped holes for #6-32 set screws. Steel cadmium plated			43			300302 P-1	137				O237	1	

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(O) MECHANICAL PARTS (Continued)													
O238	Counter assembly for C232	Counter assembly with dial indicating 0 to 9			1	300428 G-1		300428 G-1	138	1	1	0	O238	1	1.40
		(P) PLUGS													
P11	Rcvr. ant. input plug	Plug—coaxial, single contact, 13/16" dia.	49195	RE 49F 167	11	49195		300105 P-1	139	10	10	2	P11, P141, P151, P201, P231	5	1.45
P12	Rcvr. ant. input plug	Plug—adapter—90° angle, coaxial, single contact	49192	RE 49F 168	11	49192		300105 P-2	140	10	10	2	P12, P142, P152, P202, P232	5	1.47
P51	Remote control plug	Plug—3 contacts, male, with cable clamp			1	300462 G-1		300462 G-1	141	2	2	1	P51	1	1.77
P141	Video output plug	Same as P11	49195												
P142	Video output plug	Same as P12	49192												
P151	Sync. input plug	Same as P11	49195												
P152	Sync. input plug	Same as P12	49192												
P201	Pulse output plug	Same as P11	49195												
P202	Pulse output plug	Same as P12	49192												
P231	Trans. ant. output plug	Same as P11	49195												
P232	Trans ant. output plug	Same as P12	49192												
P251	115 volt input plug	Plug—2 contact, female—115 v. in with cable clamp			1	300462 G-2		300462 G-2	142	2	2	1	P251	1	1.90

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(P) PLUGS (Continued)													
P253A	Plug for B251A	Plug—3 prong .093 pins, 5/8" diam.	49265		12	71-3S		300606 P-1	143	2	2	0	P253A, P253B	2	.06
P253B	Plug for B251B	Same as P253A													
		(R) RESISTORS													
R11	1st R.F. cathode bias resistor	Resistor, composition, 47 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-009	144	5	5	1	R11	1	.02
R12	1st R.F. grid bias resistor	Resistor, composition, 0.1 megohm, ±10%, ½ watt	63360	RE 13A 340C	14			2024-049	145	15	15	3	R12, R21, R31	3	.02
R13	1st R.F. plate resistor	Resistor, composition, 1.0 megohm, ±10%, ½ watt	63360	RE 13A 340C	14			2024-061	146	30	30	6	R13, R123, R161, R181, R191, R211	6	.02
R14	1st R.F. plate load resistor	Resistor, composition, 4,700 ohms, ±10%, 1 watt, slug type (solid molded carbon-composition, insulated)	63288	RE 13A 340C	15			2027-033	147	5	5	1	R14	1	.03
R15A	1st R.F. plate filter resistor	Resistor, composition, 4,700 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-033	148	35	35	7	R15A, R15B, R16, R215A, R215B, R216A, R216B	7	.03
R15B	1st R.V. plate filter resistor	Same as R15A	63288												
R16	1st R.F. plate filter resistor	Same as R15A	63288												
									149				Not used		
R21	2nd R.F. grid bias resistor	Same as R12	63360												
R22	2nd R.F. cathode bias resistor	Resistor, composition, 75 ohms, ±5%, ½ watt	63355	RE 13A 340C	14			2023-022	150	5	5	1	R22	1	.05
R23	2nd R.F. screen dropping resistor	Resistor, composition, 47,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-045	151	35	35	7	R23, R58A, R58B, R134, R184, R185, R213, R206	8	.03

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R24	2nd R.F. load resistor	Resistor, composition, 3,300 ohms, ±10%, 1 watt, slug type (solid molded carbon, composition insulated)	63288	RE 13A 340C	15			2027-031	152	10	10	2	R24, R93	2	.03
R25	2nd R.F. plate filter resistor	Resistor, composition, 1,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-025	153	5	5	1	R25	1	.03
									154				Not used		
R31	I.F. test point isolating resistor	Same as R12	63360												
R32	1st detector plate resistor	Resistor, composition, 10,000 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-037	155	5	5	1	R32	1	.02
R41	Receiver oscillator grid filter resistor	Resistor, composition, 15,000 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-039	156	10	10	2	R41, R42	2	.02
R42	Receiver oscillator grid leak resistor	Same as R41	63360												
R43	Receiver oscillator plate filter resistor	Resistor, composition, 3,300 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-031	157	35	35	7	R43, R44, R94A, R94B, R94C, R94D, R145	7	.03
R44	Receiver oscillator plate filter resistor	Same as R43	63288												
									158				Not used		
R51	Receiver gain control potentiometer (I.F. bias)	Potentiometer, 3,500 ohms, ±20%	633217	RE 13A 492C	18	Series 35		300176 P-1	159	5	5	1	R51	1	.28
R52	1st I.F. grid loading resistor	Resistor, composition, 1,500 ohms, ±10%, ½ watt, slug type (solid molded carbon composition insulated)	63360	RE 13A 340C	15			2024-027	160	5	5	1	R52	1	.02
R53	1st I.F. degeneration resistor	Resistor, composition, 24 ohms, ±5%, ½ watt	63355	RE 13A 340C	14			2023-010	161	15	15	3	R53, R62, R72	3	.04
R54	1st I.F. cathode bias resistor	Resistor, composition, 150 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-015	162	25	25	5	R54, R63, R73, R151A, R151B	5	.03

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R55	I.F. cathode bias resistor	Resistor, composition, 15,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-039	163	20	20	4	R55, R135, R165A, R165B	4	.03
R56	1st I.F. plate filter resistor	Resistor, composition, 470 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-021	164	25	25	5	R56, R64, R74, R83, R205	5	.02
R57A	1st I.F. screen filter resistor	Resistor, composition, 2,700 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-030	165	85	85	17	R57A, R57B, R57C, R57D, R65A, R65B, R65C, R65D, R75A, R75B, R75C, R75D, R84A, R84B, R84C, R84D, R124	17	.03
R57B	1st I.F. screen filter resistor	Same as 57A	63288												
R57C	1st I.F. screen filter resistor	Same as R57A	63288												
R57D	1st I.F. screen filter resistor	Same as R57A	63288												
R58A	I.F. bias bleeder resistor	Same as R23	63288												
R58B	I.F. bias bleeder resistor	Same as R23	63288												
R61	2nd I.F. grid loading resistor	Resistor, composition, 4,700 ohms, ±10%, ½ watt, slug type (solid molded carbon-composition insulated)	63360	RE 13A 340C	15			2024-033	166	20	20	4	R61, R71, R81, R91	4	.02
R62	2nd I.F. degeneration resistor	Same as R53	63355												
R63	2nd I.F. cathode bias resistor	Same as R54	63288												
R64	2nd I.F. plate filter resistor	Same as R56	63360												

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Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R65A	2nd I.F. screen filter resistor	Same as R57A	63288												
R65B	2nd I.F. screen filter resistor	Same as R57A	63288												
R65C	2nd I.F. screen filter resistor	Same as R57A	63288												
R65D	2nd I.F. screen filter resistor	Same as R57A	63288												
R71	3rd I.F. grid loading resistor	Same as R61	63360												
R72	3rd I.F. degeneration resistor	Same as R53	63355												
R73	3rd I.F. cathode bias resistor	Same as R54	63288												
R74	3rd I.F. plate filter resistor	Same as R56	63360												
R75A	3rd I.F. screen filter resistor	Same as R57A	63288												
R75B	3rd I.F. screen filter resistor	Same as R57A	63288												
R75C	3rd I.F. screen filter resistor	Same as R57A	63288												
R75D	3rd I.F. screen filter resistor	Same as R57A	63288												
R81	4th I.F. grid loading resistor	Same as R61	63360												
R82	4th I.F. cathode bias resistor	Resistor, composition, 180 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-016	167	5	5	1	R82	1	.03
R83	4th I.F. plate filter resistor	Same as R56	63360												

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Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R84A	4th I. F. screen filter resistor	Same as R57A	63288												
R84B	4th I. F. screen filter resistor	Same as R57A	63288												
R84C	4th I.F. screen filter resistor	Same as R57A	63288												
R84D	4th I.F. screen filter resistor	Same as R57A	63288												
R91	5th I.F. grid loading resistor	Same as R61	63360												
R92	5th I.F. cathode bias resistor	Resistor, composition, 220 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-017	168	5	5	1	R92	1	.03
R93	5th I.F. plate load resistor	Same as R24	63288												
R94A	5th I.F. screen filter resistor	Same as R43	63288												
R94B	5th I.F. screen filter resistor	Same as R43	63288												
R94C	5th I.F. screen filter resistor	Same as R43	63288												
R94D	5th I.F. screen filter resistor	Same as R43	63288												
R97	5th I.F. suppressor bias resistor	Resistor, composition, 1.0 megohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-061	169	10	10	2	R97, R131	2	.03
R111	Tuning eye detector input resistor	Resistor, composition, 47,000 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-045	170	10	10	2	R111, R192	2	.02
R112	2nd detector plate load resistor	Resistor, composition, 6,800 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-035	171	5	5	1	R112	1	.02
R121A	Tuning eye detector plate load res.	Resistor, composition, 10 megohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-073	172	10	10	2	R121A, R121B	2	.03

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R121B	Tuning eye detector plate load resistor	Same as R121A	63288												
R122	Tuning eye grid filter resistor	Resistor, composition, 0.1 megohm, ±10%, 1 watt	63288	RE 13A 340C	16			2027-049	173	15	15	3	R122, R132, R176	3	.03
R123	Tuning eye plate load resistor	Same as R13	63360												
R124	Tuning eye plate voltage dropping resistor	Same as R57A	63288												
									174				Not used		
R131	1st video grid leak resistor	Same as R97	63288												
R132	1st video grid filter resistor	Same as R122	63288												
R133	1st video plate load resistor	Resistor, composition, 33,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-043	175	20	20	4	R133, R175, R203A, R203B	4	.03
R134	1st video screen filter resistor	Same as R23	63288												
R135	1st video plate voltage divider resistor	Same as R55	63288												
R136A	1st video plate voltage divider resistor	Resistor, composition, 10,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-037	176	20	20	4	R136A, R136B, R136C, R155	4	.03
R136B	1st video plate voltage divider resistor	Same as R136A	63288												
R136C	1st video plate voltage divider resistor	Same as R136A	63288												

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R137	1st video grid filter resistor	Resistor, composition, 1,000 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-025	177	5	5	1	R137	1	.02
R141	2nd video grid leak resistor	Resistor, composition, 0.47 megohm, ±10%, ½ watt	63360	RE 13A 340C	14			2024-057	178	5	5	1	R141	1	.02
R142	2nd video grid limiting resistor	Resistor, composition, 1,500 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-027	179	5	5	1	R142	1	.02
R143	2nd video cathode bias resistor	Resistor, composition, 470 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-021	180	5	5	1	R143	1	.03
R144	Video output amplitude control potentiometer	Potentiometer—1,000 ohms, ±10%, 4 watt, wire wound	633218	RE-13A-492C	18	Series 25		300175 P-1	181	5	5	1	R144	1	.46
R145	Video transformer damping resistor	Same as R43	63288												
									182				Not used		
R151A	Pulse input loading resistor	Same as R54	63288												
R151B	Pulse input loading resistor	Same as R54	63288												
R152	Pulse amplifier grid leak resistor	Resistor, composition, 33,000 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-043	183	5	5	1	R152	1	.02
R153	Pulse amplifier cathode bias resistor	Resistor, composition, 2,200 ohms, ±10%, ½ watt	63360	RE-13A-340C	14			2024-029	184	5	5	1	R153	1	.02
R154	Pulse amplifier screen dropping resistor	Resistor, composition, 0.39 megohm, ±10%, 1 watt	63288	RE 13A 340C	16			2027-056	185	5	5	1	R154	1	.03
R155	Pulse amplifier plate load resistor	Same as R136A	63288												
R161	Multivibrator input grid leak resistor	Same as R13	63360												

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R162	Multivibrator input cathode bias resistor	Resistor, composition, 100 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-013	186	5	5	1	R162	1	.02
R163A	Multivibrator input screen dropping resistor	Resistor, composition, 27,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-042	187	10	10	2	R163A, R163B	2	.03
R163B	Multivibrator input screen dropping resistor	Same as R163A	63288												
R164	Multivibrator input plate load resistor	Resistor, composition, 68,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-047	188	5	5	1	R164	1	.03
R165A	Multivibrator plate filter resistor	Same as R55	63288												
R165B	Multivibrator plate filter resistor	Same as R55	63288												
R171	Multivibrator output grid leak resistor	Resistor, composition, 56,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-046	189	5	5	1	R171	1	.03
R172	Multivibrator frequency control potentiometer	Potentiometer, composition, 0.2 megohms, ±10%	633219	RE 13A 492C	18	Series 35		300333 P-1	190	5	5	1	R172	1	.30
R173	Multivibrator output cathode load resistor	Resistor, composition, 3,300 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-031	191	5	5	1	R173	1	.02
R174A	Multivibrator output cathode bias dropping resistor	Resistor, composition, 18,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-040	192	15	15	3	R174A, R174B, R174C	3	.03
R174B	Multivibrator output cathode bias dropping resistor	Same as R174A	63288												
R174C	Multivibrator output cathode bias dropping resistor	Same as R174A	63288												

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R175	Multivibrator output plate load resistor	Same as R133	63288												
R176	Multivibrator output screen dropping resistor	Same as R122	63288												
R177	Multivibrator screen bleeder resistor	Resistor, composition, 0.12 megohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-050	193	5	5	1	R177	1	.03
R181	Pulse shaper grid leak resistor	Same as R13	63360												
R182	Pulse shaper cathode bias bleeder resistor	Resistor, composition, 12,000 ohms, ±10%, ½ watt	63360	RE 13A 340C	14			2024-038	194	5	5	1	R182	1	.02
R183	Pulse shaper cathode bias dropping resistor	Resistor, composition, 0.18 megohm, ±10%, 1 watt	63288	RE 13A 340C	16			2027-052	195	5	5	1	R183	1	03
R184	Pulse shaper plate load resistor	Same as R23	63288												
R185	Pulse clipper grid leak resistor	Same as R23	63288												
R186	Pulse clipper plate load resistor	Resistor, 10,000 ohms, ±10%, 10 watt wire wound, non-inductive	633221		19	10 NI "Koolohm"		300403 P-1	196	5	5	1	R186	1	41
R191	Driver grid leak resistor	Same as R13	63360												
R192	Driver cathode bias bleeder resistor	Same as R111	63360												
R193	Driver cathode bias dropping resistor	Resistor, composition, 0.27 megohm, ±10%, 1 watt	63288	RE 13A 340C	16			2027-051	197	5	5	1	R193	1	.03
R202	Modulator cathode bias bleeder resistor	Resistor, composition, 12,000 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-038	198	5	5	1	R202	1	.03

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R203A	Modulator cathode bias dropping resistor	Same as R133	63288												
R203B	Modulator cathode bias dropping resistor	Same as R133	63288												
R204	Pulse output voltage supply resistor	Resistor, composition, 22 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-005	203	15	15	3	R204, R231, R232	3	.03
R205	Modulator plate to screen suppressor resistor	Same as R56	63360												
R206	Pulse transformer damping resistor.	Same as R23	63288												
R211	Gate pulse generator input grid leak resistor	Same as R13	63360												
R212	Gate pulse generator input cathode bias resistor	Resistor, composition, 5,600 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-034	200	5	5	1	R212	1	.03
R213	Gate pulse generator output grid leak resistor	Same as R23	63288												
R214	Gate pulse width control potentiometer	Potentiometer, composition, 0.5 megohm, ±10%	633220	RE 13A 492C	18	Series 35		300332 P-1	201	5	5	1	R214	1	.32
R215A	Gate pulse generator plate filter resistor	Same as R15A	63288												
R215B	Gate pulse generator plate filter resistor	Same as R15A	63288												
R216A	Gate pulse generator output plate load resistor	Same as R15A	63288												
R216B	Gate pulse generator output plate load resistor	Same as R15A	63288												

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS: Item No.	Quantities: Stock	Quantities: Tender	Quantities: Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(R) RESISTORS (Continued)													
R217	Gate pulse generator input plate load resistor	Resistor, composition, 0.22 megohm, ±10%, 1 watt	63288	RE 13A 340C	16			2027-053	202	5	5	1	R217	1	.03
R231	Oscillator filament center tapping resistor	Same as R204	63288												
R232	Oscillator filament center tapping resistor	Same as R204	63288												
R233A	Oscillator cathode bias resistor	Resistor, composition, 0.47 megohm, ±10%, 1 watt	63288	RE 13A 340C	16			2027-057	204	10	10	2	R233A, R233B	2	.03
R233B	Oscillator cathode bias resistor	Same as R233A	63288												
R234	Oscillator grid leak resistor	Resistor, composition, 2,200 ohms, ±10%, 1 watt	63288	RE 13A 340C	16			2027-029	205	5	5	1	R234	1	.03
R241	H. V. plate supply bleeder resistor	Resistor, 12 megohms, 10 watt	633178		19	"Megomax" Type 1		300357 P-1	206	5	5	1	R241	1	17.78
R251	Standby bias resistor	Resistor, 2,000 ohms, 35 watt, wirewound, grade 1, class 1, style D	63079-F	RE 13A 372	19	"Koolohm" No. 35F		300365 P-1	207	5	5	1	R251	1	2.67
									208				Not used		
		(S) SWITCHES													
S51	Standby switch	(not furnished)													
S121	Tuning indicator on-off switch	Switch-plunger type, S.P.S.T., normally closed 3 amp. 125 volt	24562	RE 24AA 118A	9	GA13A1		300161 P-1	209	3	3	1	S121	1	.34
S191	Keyer on-off switch	Switch, S.P.S.T., toggle, 3 amp. 250 volt		RE 24AA 118A	21	#8908 K137		300270 P-1	210	5	5	1	S191, S211	2	.41
S211	Rcvr. gating on-off switch	Same as S191													
S251A	Interlock switch	Switch, interlock type female, 10 amp. 125 volt, 5 amp. 250 volt	24430		20	#4600B	Female part only	300159 P-2	211	3	3	1	S251A	1	.79
S251B	Interlock switch	Switch, interlock type male, 10 amp. 125 volt, 5 amp. 250 volt	24551		20	#4600A	Male part only	300159 P-1	212	3	3	1	S251B	1	.40

TABLE II—PARTS AND SPARE PARTS LIST BY SYMBOL NUMBERS

Symbol	Function	Description	Navy Type Number	Navy Drawing or Specification	Mfr.	Mfr's. Desig.	Special Rating or Modification	Contractor's Drawing No.	SPARE PARTS Item No.	Quantities Stock	Quantities Tender	Quantities Equip.	All Symbol Designations Involved	Total Per Equip.	Unit Cost
		(S) SWITCHES (Continued)													
S252	Main power switch	Switch, toggle, D.P.S.T., 3 amp. 250 volt, 6 amp. 125 volt		RE 24AA 118A	21	#8908 K138		300160 P-1	213	3	3	1	S252	1	.62
									214				Not used		
		(T) TRANSFORMERS													
T141	Video transformer	Transformer, pulse, primary 225 turns 70 mh @ 1000 cycles; secondary 450 turns 260 mh minimum @ 1000 cycles, 1500 volt insulation	302043	RE 13A 553B	13	467-001-228		300362 P-1	215	1	1	0	T141, T201	2	12.08
T201	Modulator driver transformer	Same as T141													
T251	Power transformer	Transformer, power, primary 125 volts tapped at 105 and 115 volts, 50 to 425 cycles. Secondaries: 5.1 v. at 3.0 amp. 325-0-325 v. at 0.175 amp., 5.4 v. at 8 amp., 6.4 v. at 10.3 amp., 2.5 v. at 3.0 amp., 4500 v. at .005 amp., 2.5 v. and 4500 volt windings insulated for 6000 volts. All other winding insulated for 1500 volts	301201	RE 13A 553	13, 55	463-001-224 74695		300359 P-1	216	1	1	0	T251	1	42.78
									217				Not used		
		(V) VACUUM TUBES													
V1	1st R.F. amplifier tube	Type 6J6 vacuum tube	JAN-6J6	JAN-1A	29	JAN-6J6		300232 P-1	218	0	0	3	V1	1	1.63
V2	2nd R.F. amplifier tube	Type 6SH7 vacuum tube	JAN-6SH7	JAN-1A	29	JAN-6SH7		300233 P-1	219	0	0	1	V2	1	.47
V3	1st detector tube	Type 9006 vacuum tube	JAN-9006	JAN-1A	29	JAN-9006		300234 P-1	220	0	0	3	V3	1	1.45
V4	Receiver oscillator tube	Type 6J5 vacuum tube	JAN-6J5	JAN-1A	29, 44	JAN-6J5		300235 P-1	221	0	0	1	V4	1	.35
V5	1st I.F. amplifier tube	Type 6AC7 vacuum tube	JAN-6AC7	JAN-1A	29	JAN-6AC7		300236 P-1	222	0	0	9	V5, V6, V7, V8, V9, V13, V15, V16, V17	9	.71

TABLE III—COLOR CODES

RESISTOR COLOR CODE—Radio Manufacturers Association Standard

Standardizing coding for resistance value identification is confined to ten colors and figures plus the tolerance colors gold and silver, as shown in the following chart:

COLOR CODE CHART—RESISTORS
Figure 6-1

Color	Significant Figure	Decimal Multiplier	Tolerance	Power of 10
Black	0	1		10^0
Brown	1	10		10^1
Red	2	100		10^2
Orange	3	1000		10^3
Yellow	4	10000		10^4
Green	5	100000		10^5
Blue	6	1000000		10^6
Violet	7	10000000		10^7
Gray	8	100000000		10^8
White	9	1000000000		10^9
Gold	—	0.1	5%	10^{-1}
Silver	—	0.01	10%	10^{-2}
No Color	—		20%	

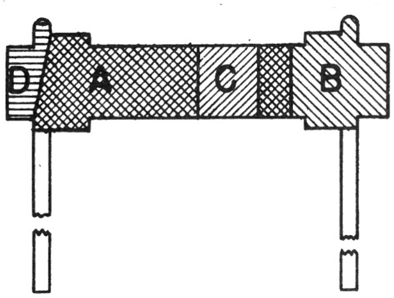

Figure 6-2—Radial Lead Resistors.

The body (A) of the resistor is colored to represent the first figure of the resistance value. One end (B) of the resistor is colored to represent the second figure. A band, or dot (C) of color representing the number of ciphers following the first two figures, is located within the body color. See Figure 6-2.

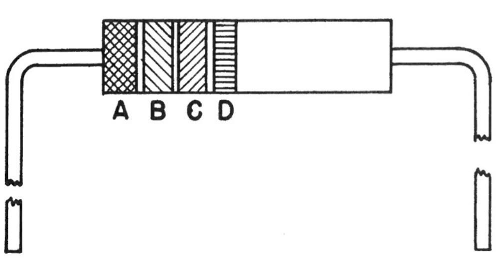

Figure 6-3—Axial Lead Resistors.

Standard fixed composition resistors with axial leads will have bands of color around the body of the resistor to indicate the nominal resistance value. Three or more bands of color provide the indications. See Figure 6-3.

The color (D) appearing on the body of the axial lead resistor and on the end of the radial lead type, is used to indicate tolerance value. See Figure 6-4.

RADIAL-AXIAL LEAD RESISTOR CHART
Figure 6-4

Radial Leads	Axial Leads	Color
Body A	Band A	Indicates first significant figure of resistance value in ohms
End B	Band B	Indicates second significant figure
Band C or Dot	Band C	Indicates decimal multiplier
Band D	Band D	If any, indicates tolerance in percent about nominal resistance value. If no color appears in this position, tolerance is 20%

MICA CONDENSER COLOR CODE

Radio Manufacturers Association Standard
See Figure 6-5

Mica condensers which are not stamped with capacity values may usually be identified according to the following color code. The capacity value in micromicrofarads is indicated by a row of three dots colored. If only one row of three colored markers appears on the capacitor, the voltage rating is 500 volts and the usual tolerance being ± 20%.

The first dot is colored to indicate the first significant figure of the capacitance, the second dot indicates the second significant figure, and the third dot indicates the number of zeros.

In case there are more than two significant figures in capacitance value the method is changed somewhat. In this case the first dot on the trade-mark side indicates the first significant figure, the second dot indicates the second significant figure, and the third dot is left uncolored to indicate that the other dots are on the reverse side of the capacitor.

Here the left hand dot indicates the third significant figure, while the right hand dot indicates the number of zeros.

If two rows of three colored markers appear on the capacitor, then the top row represents the significant figures, read from left to right; the bottom row indicates the decimal multiplier, tolerance, and voltage rating, read from right to left. (This is not the case in the American War Standards.) Capacitance is in micromicrofarads.

If the capacitor is approximately circular two groups of colored bands are used, one group made up of wide bands and the other of narrow bands. When the capacitor is viewed with the wide bands on the right, the wide bands indicate the significant figures read from left to right; the narrow bands indicate the decimal multiplier, tolerance, and voltage rating, from right to left respectively.

COLOR CODE CHART—CONDENSERS
(RMA Standard)
Figure 6-5

Color	Significant Figure	Decimal Multiplier	Tolerance %	Voltage Rating (Volts)
Black	0	1	—	——
Brown	1	10	1	100
Red	2	100	2	200
Orange	3	1000	3	300
Yellow	4	10000	4	400
Green	5	100000	5	500
Blue	6	1000000	6	600
Violet	7	10000000	7	700
Gray	8	100000000	8	800
White	9	1000000000	9	900
Gold	—		5	1000
Silver	—		10	2000
No Color	—		20	500

MICA CONDENSER COLOR CODE

American War Standard. See Figure 6-7

American Standard Association C75.3-1942

These standards cover physical dimensions, capacitance values, color coding, characteristics, and test procedures and requirements for a range of fixed mica-dielectric capacitors. There are many additional sizes and shapes which are not covered by these standards.

There is a comprehensive type-numbering system which identifies each capacitor, but where marking of the type designation is not permitted by space or existing molds, the capacitance, characteristic, and tolerance may be indicated by color coding.

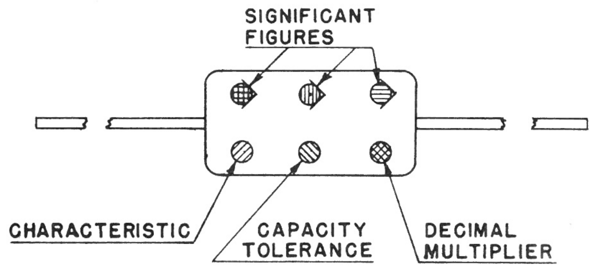

Figure 6-6—Condenser Marking.

COLOR CODE CHART—CONDENSERS
(A. W. S.)
Figure 6-7

Color	Significant Figure	Decimal Multiplier	Tolerance	Characteristic
Black	0	1		A
Brown	1	10		B
Red	2	100	2% (G)	C
Orange	3	1000		D
Yellow	4			E
Green	5			F
Blue	6			G
Violet	7			
Gray	8			
White	9			
Gold	—	0.1	5% (J)	
Silver	—	0.01	10% (K)	
Black	—		20% (M)	

The top row of three dots, in this system, still represents the significant figures, read from left to right, as stated previously. The bottom row of dots is the one which differs which can be noted on Figure 6-6.

CHARACTERISTIC CHART—CONDENSERS
(A. W. S.)
Figure 6-8

Characteristic	Q	Temp. Co-efficient Parts/Million/Deg. C.	Max. Capacitance Drift	Verification of Characteristic by Produc. Test
A	Not Specified	Not Specified	Not Specified	Not Required
B	(As specified in following paragraph)	Not Specified	Not Specified	Not Required
C		—200 to 200	0.5 per cent	Not Required
D		—100 to 100	0.2 per cent	Not Required
E		0 to 100	0.05 per cent	Not Required
F		0 to 50	0.025 per cent	Required
G		0 to −50	0.025 per cent	Required

Q or the figure of merit for capacitors of characteristics other than A and for which current ratings are not listed will be in accordance with American War Standards, ASA C75.3.

TABLE IV—LIST OF MANUFACTURERS

Code Number	Mfr's Prefix Letters	Name of Manufacturer	Mailing Address
1	CFN	Farnsworth Television & Radio Corp.	3700 Pontiac Street Fort Wayne, Indiana
2		F. A. Smith Corporation	P. O. Box 509 Rochester, New York
3	CAY	Westinghouse Electric & Manufacturing Co.	2519 Wilkens Avenue Baltimore, Maryland
4	CBN	Centralab	900 East Keefe Avenue Milwaukee, Wisconsin
5	CER	Erie Resistor Corporation	644 West 12th Street Erie, Pennsylvania
6	CMA	P. R. Mallory & Company	1941 Thomas Street Indianapolis, Indiana
7	CSL	Solar Manufacturing Corporation	588 Avenue A Bayonne, New Jersey
8	CMR	Micamold Radio Corporation	1087-1095 Flushing Ave. Brooklyn, New York
9	CG	General Electric Company	Schenectady, New York
10	CFA	Bussman Mfg. Company	2538 W. University St. St. Louis, Missouri
11	CSX	Selectar Manufacturing Corporation	21-10 49th Avenue Long Island City, N. Y.
12	CPH	American Phenolic Corporation	1250 West Van Buren St. Chicago, Illinois
13	CJE	Jefferson Electric Company	910-25th Avenue Bellwood, Illinois
14		Option of following suppliers:	
	CBZ	Allen-Bradley Company	118 W. Greenfield Ave. Milwaukee, Wisconsin
	CCC	Continental Carbon Company	100 East 42nd Street New York, N. Y.
	CER	Erie Resistor Corporation	644 West 12th Street Erie, Pennsylvania
	CIR	International Resistance Corporation	401 N. Broad Street Philadelphia, Pennsylvania
	CPQ	Speer Resistor Corporation	Theresia Street St. Mary's, Pennsylvania
	CSA	Stackpole Carbon Company	1942 Tannery Street St. Mary's, Pennsylvania
15	CER	Erie Resistor Corporation	644 West 12th Street Erie, Pennsylvania
16		Option of following suppliers:	
	CBZ	Allen-Bradley Company	118 W. Greenfield Avenue Milwaukee, Wisconsin
	CPQ	Speer Resistor Corporation	Theresia Street St. Mary's, Pennsylvania
	CER	Erie Resistor Corporation	644 West 12th Street Erie, Pennsylvania
	CSA	Stackpole Carbon Company	1942 Tannery Street St. Mary's, Pennsylvania
17	CSH	H. B. Sherman Company	1934 Sperry Street Battle Creek, Michigan

Code Number	Mfr's Prefix Letters	Name of Manufacturer	Mailing Address
18	CTC	Chicago Telephone Supply Company	Elkhart, Indiana
19	CSF	Sprague Specialties Company	N. Adams, Massachusetts
20		Bryant Electric Company	Bridgeport, Connecticut
21	CAE	Cutler Hammer Inc.	1333 W. St. Paul Avenue Milwaukee, Wisconsin
22	CIM	Eitel-McCullough	San Bruno, California
23	CFT	Federal Telephone & Radio Corp.	200 Mount Pleasant Ave. Newark, New Jersey
24		Graybar Electric Company	5830 Calumet Avenue Hammond, Indiana
25	CEJ	E. F. Johnson	Waseca, Minnesota
26	CMG	Cinch Manufacturing Company	2339 W. Van Buren St. Chicago, Illinois
27		H. A. Douglas Manufacturing Company	Bronson, Michigan
28		Dial Light Company of America	90 West Street New York, N. Y.
29	CRC	RCA Mfg. Company (Radiotron Div.)	Harrison, New Jersey
30	CDP	General Ceramics Company	Keasbey, New Jersey
31		Plume & Atwood	Waterbury, Connecticut
32		Kurz Kasch	1417 S. Broadway Dayton, Ohio
33		J. E. Waterfield	Attleboro, Massachusetts
34	CD	Cornell-Dubilier Corporation	1000 Hamilton Blvd. South Plainfield, N. J.
35		Set Screw & Manufacturing Company	2708 Diversey Avenue Chicago, Illinois
36		Indianapolis Screw Products Company	621 N. Noble Street Indianapolis, Indiana
37		Central Screw Products Company	3511 Shield Avenue Chicago, Illinois
38		Standard Pressed Steel Company	P. O. Box 732 Jenkintown, Pennsylvania
39		Reliable Spring & Forms Company	3167 Fulton Road Cleveland, Ohio
40		Beaver Machine Company	W. Belden & Simonds Sts. Syracuse, N. Y.
41		American Screw Products Company	Providence, Rhode Island
42		Chicago Gear Works	440 N. Oakley Blvd. Chicago, Illinois
43		Milled Screw Products	2016 West Lake Street Chicago, Illinois
44	CKR	Kenrad Tube & Lamp Corporation	Owensboro, Kentucky
45	CTL	Tung-Sol Lamp Works, Inc.	1936 Woodford Plainsville, Conn.
46	CHS	Sylvania Electric Products	Emporium, Pennsylvania
47		Dayton Machine Company	Dayton, Ohio

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