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NRL Instruction Book No. 28
Copy No. 5

INSTRUCTION MANUAL FOR RADIO CONTROL HUT

RADIO DIVISION

GEN-SE-0005-94

May 1960

U. S. NAVAL RESEARCH LABORATORY
Washington, D.C.

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FOR

RADIO CONTROL HUT

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WASHINGTON, D. C.

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TABLE OF CONTENTS

SECRET

TABLE O

4. LI

5. IN
5.1
5.2
5.3
5.4

6. PO
6.1
6.2
6.3
6.4

7. OP
7.1
7.2

8. TRA
8.1
8.2
8.3
8.4
8.5
8.6
8.7

9. MAI
9.1

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TABLE OF CONTENTS (Contd.) Page Number

LIST OF FIGURES

LIST OF TABLES

SECRET

1. INTR

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1. INTRODUCTION

This Instruction Manual is part of a group of Manuals covering the radio and electronic equipment for the ground facilities involved in connection with certain earth-encircling satellites. These satellites are designed to emit continuous radio signals for tracking and, upon "command" from a ground-based transmitter, to emit certain data-carrying signals. All the ground equipment for both reception and control purposes is housed in a group of similar "huts" and is identical for all installations except that the recording facilities are not provided with command transmitters and the command facilities omit certain recording and timing equipment not required for control purposes. The antenna equipment for both facilities is identical.

The basic facilities are covered in detail by NRL Instruction Book No. 25* of April 1960, which specifically covers all details of the huts, their placement and the assembly of their radio equipment including the antennas. Being primarily concerned with the Receiving Huts, it contains no information on the transmitting equipment involved in a Control Hut. Similarly, the information in IB 25 on the Data and Time Recording equipment is not pertinent to a Control Hut installation which omits these items. Accordingly IB 25 should be considered as a part of these Instructions which cover the Command Transmitting Equipment and, together with the commercial Instruction Books for the transmitters and Army Technical Manual TM 11-856A covering the Receivers, should be used in the assembly, installation and maintenance of the Control Hut and its equipment.

2. GENERAL DESCRIPTION

The Radio Control Hut proper is identical with the Receiving Huts, as are the types and arrangement of the antennas. As installed, it will appear as shown in Figure 1 of IB 25. However, because of the addition of the transmitting equipment and the omission of Recording and Timing equipment, the interior

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* Instructions for Assembly, Installation and Maintenance of Radio Receiving Huts.

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Figure 1 - Interior of Control Hut

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arrangement differs somewhat from that of the Receiving Huts. Figure 1 is a drawing showing the arrangement of the various equipments.

Fundamentally, the hut contains the following pieces of electronic equipment:

(a) Two identical 200-watt VHF transmitters (Collins type 242F-2 modified)
(b) One Modulation Timer Unit (NRL design and manufacture)
(c) One VHF receiving equipment for Channel A signal reception.
(d) One VHF receiving equipment for Channel B signal reception.

Suitable switching means are provided: (a) to permit either transmitter to be controlled by the Modulation Timer, (b) to switch either transmitter to a transmitting/receiving antenna, (c) to switch the transmitting/receiving antenna to either transmitter or the Channel B receiver.

Two directional antenna systems are provided atop the hut which are identical with those described in IB 25. These are mounted on a common shaft rotatable from within the hut, the upper one being a two-bay Yagi used exclusively for the reception of the tracking signal and the lower one being a four-bay Yagi that is used both for transmission and, when not so employed, for the reception of the Data signals. In addition, a twenty-five-foot vertical antenna is provided for mounting adjacent to the hut for the reception of Time or other communication signals. It is also described in detail in IB 25.

3. DETAILED DESCRIPTION

3.1 GENERAL

The Radio Control Hut (see Figure 1) covered by this handbook is planned as a complete ground station for the purpose of turning on a data link between an orbiting satellite and a receiving hut located at the same or some other site. The equipment required to accomplish its purpose consists

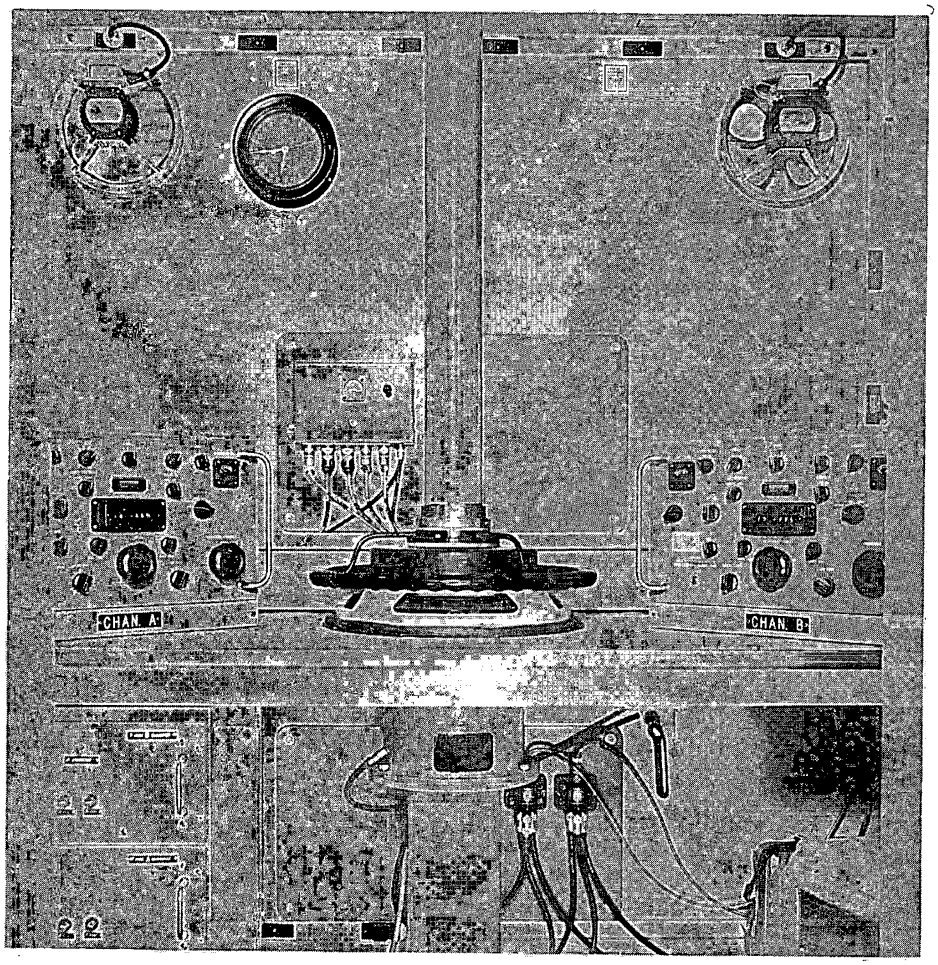

Figure 2 - Control Hut Operating Table

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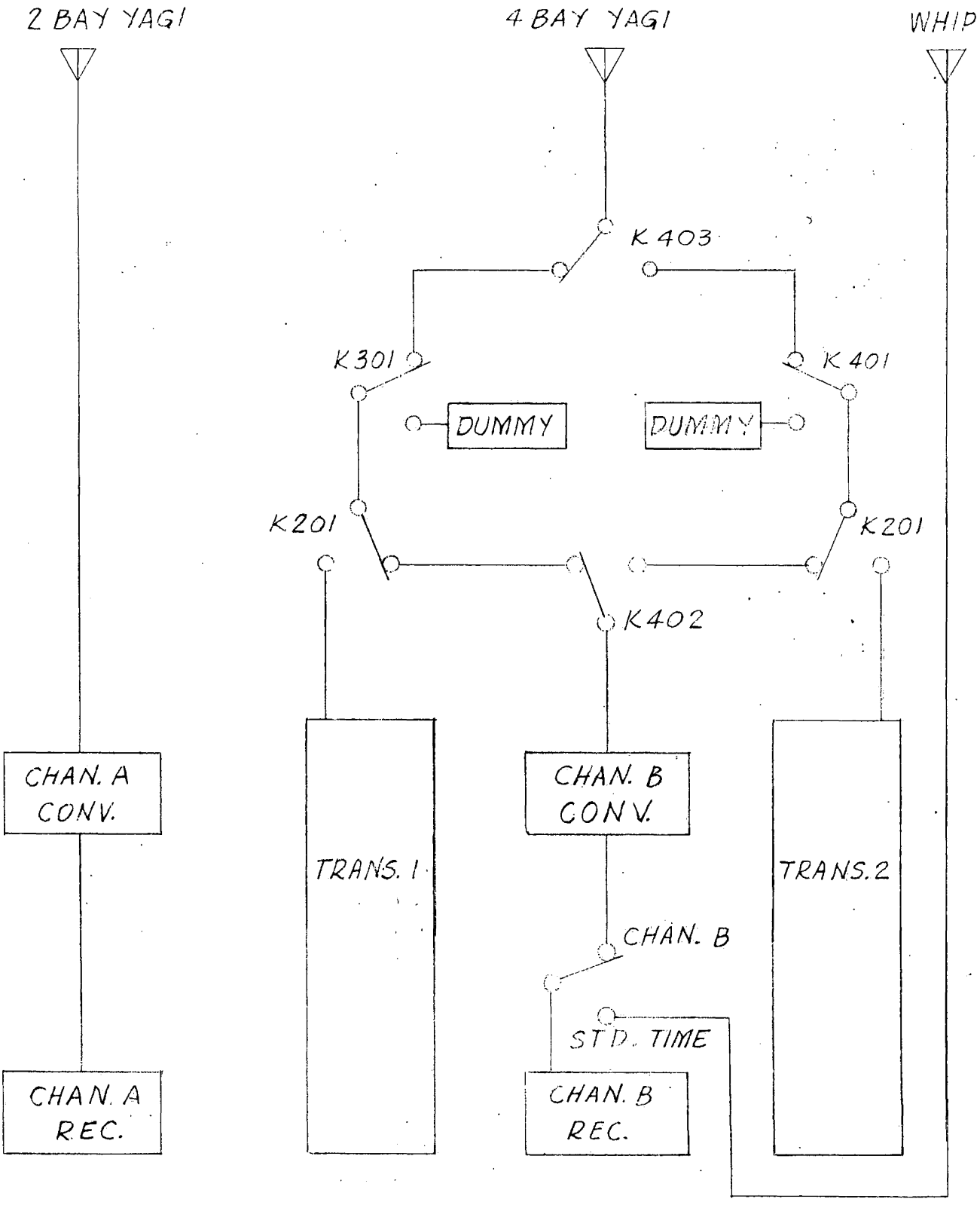

Figure 3 - Control Hut R.F. Switching

of two converter-receiver units and their individual antennas, two VHF transmitters, one for operation and an identical one for emergency use, and a modulation-timer unit for control of the transmitters.

The receiver-converter units are labeled Channel A and Channel B (Figure 2). Channel A converter has been pre-tuned to one of the satellite frequencies. Channel A converter is connected to the two-bay Yagi antenna at the top of the mast and together with its high-frequency receiver forms the complete satellite-locating system.

Channel B converter is tuned to the second satellite frequency and shares the lower four-bay Yagi antenna with the transmitters.

3.2 RECEIVING CHANNEL A

Channel A consists of a converter and a high-frequency receiver. The converter changes the first VHF satellite frequency to the range of its high-frequency receiver. The converter is located below the operating table. See Figure 2. The Channel A Receiver is on the operating bench above the converters.

3.3 RECEIVING CHANNEL B

Channel B is similar to Channel A in that it consists of a converter and high-frequency receiver. The Channel B converter is pre-tuned to the second satellite frequency. It is located below the operating bench on the left side. Channel B is connected to the four-bay Yagi antenna through a switching system. See Figure 3. This system provides for sharing of the four-bay transmitting antenna between the transmitters and the Channel B receiver. The Channel B receiver can be switched to either the converter or a high-frequency whip antenna by a control on the front panel of the converter.

3.4 RECEIVER MONITORING PROVISIONS

The R-390A/URR receivers both contain two separate and distinc audio systems. One, designated as the LINE AUDIO, has its output terminals on one of the two terminal boards on the rear of the receivers (terminals 10 and 13). Its gain is controlled by the LINE GAIN control near the upper left

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In the installation, provisions have been made for three methods of monitoring:

(a) By individual loud speakers, one connected to each of the LINE AUDIO outputs of the respective receivers.

(b) By split headphones, one earpiece being connected to each of the LOCAL OUTPUTS of the respective receivers, permitting one operator to monitor both receivers.

(c) By individual headsets plugged into the telephone jacks of the respective receivers, should two operators be on watch.

3.41 Arrangement

The two loud speakers are mounted on the rear bulkhead of the hut, one above each receiver with which it is associated, being permanently wired to the LINE AUDIO terminals of the respective receivers. Each speaker unit contains its own transformer for matching the voice coil to the 600-ohm output of the LINE AUDIO amplifier.

Also mounted on the rear bulkhead of the hut between the two receivers, is a small STEREOPHONE HEADSET UNIT with two output jacks for receiving the plug from the split-phone headset. These two jacks are wired in parallel but with their "hot" terminals reversed. Most headsets, particularly after being worn for a while, are more comfortable in a certain position. By providing two reversed output jacks it is possible for an operator to have the left ear guarding the left-hand receiver and vice versa merely by choosing the proper jack into which to plug his phones.

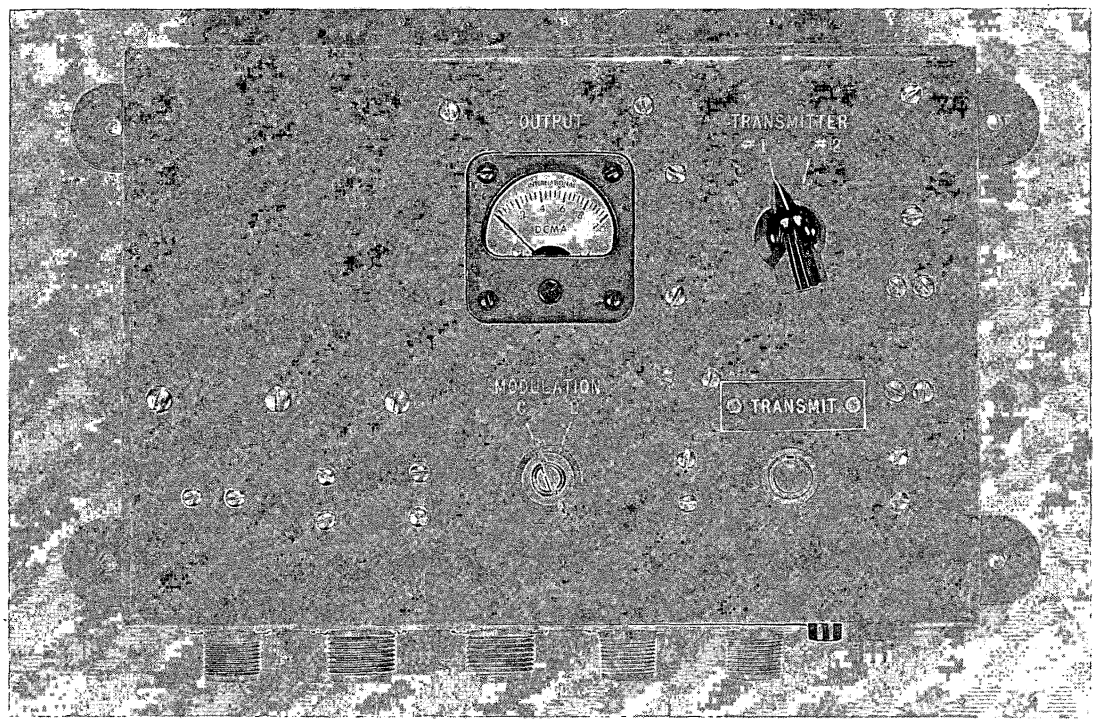

Figure 4 - Modulation Timer Unit - Front View

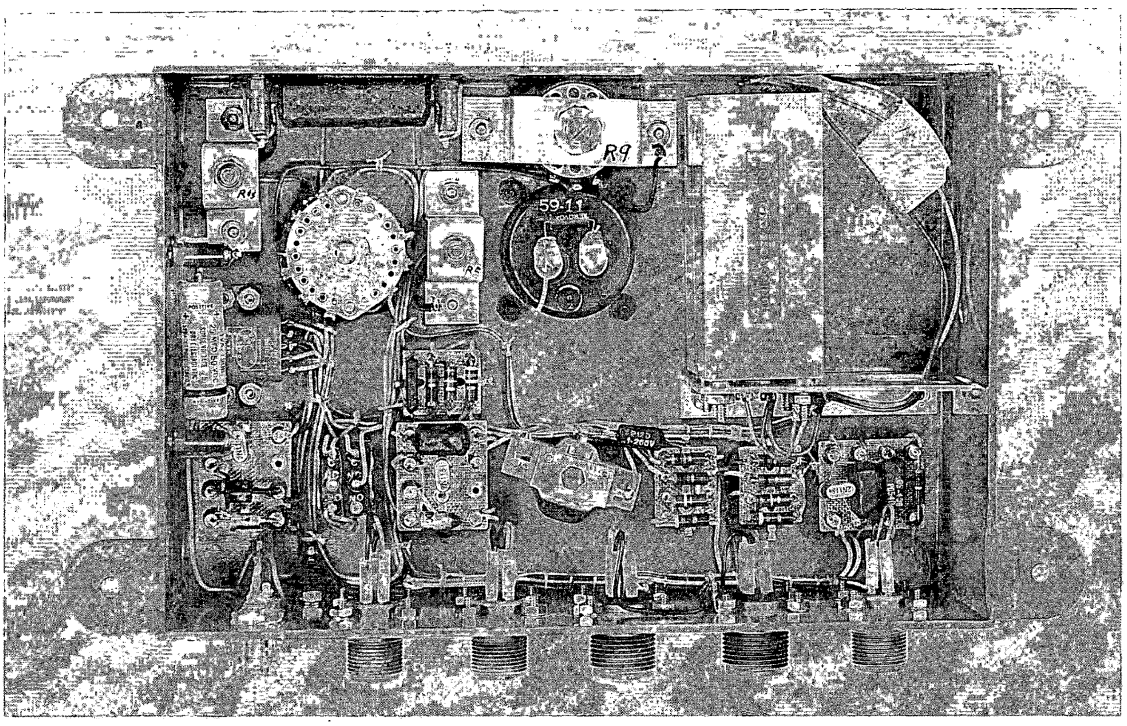

Figure 5 - Modulation Timer Unit - Back View

A pair of Koss type SP-3 Stereo headphones is supplied with the hut. These phones are of low (4-ohm) impedance. In order to match them to the 600-ohm output of the LOCAL AUDIO amplifier, two matching transformers are contained within the STEREOPHONE HEADSET UNIT.

The inputs to the STEREOPHONE HEADSET UNIT are permanently wired to terminals 7 and 8 on the rear terminal boards of the respective receivers.

For dual-watch monitoring, two pairs of standard 600-ohm headsets (not supplied with the hut) should be plugged into the phone jacks on the panels of the respective receivers.

3.5 MODULATION TIMER UNIT

The Modulation Timer, Figures 4 and 5, is a remote control for the VHF 242F-2 transmitters. It is located on the bulkhead at the operator's position and connected to the transmitters by suitable cables.

The Unit contains a precision tone oscillator, C, and has provision for adding and selecting a second tone, D. An output indicator on the front panel reads rectified transmitter output when the Antenna Meter Local-Remote Switch, S404, located on the back panel of the transmitter is thrown to remote. A timer circuit for controlling the transmitter in use is located in this unit. The red TRANSMIT button on the front panel initiates the timing cycle. The circuit automatically controls the length of the cycle and thereby the length of time the transmitter is turned on.

The transmitter selector switch provides for switching of all modulation and control circuits required in shifting operation from one transmitter to the other. It does not turn on the transmitters. When using the modulation timer unit, it must be assumed that the transmitters required have been turned on and adjusted according to the operating procedure outlined. See 6.4.

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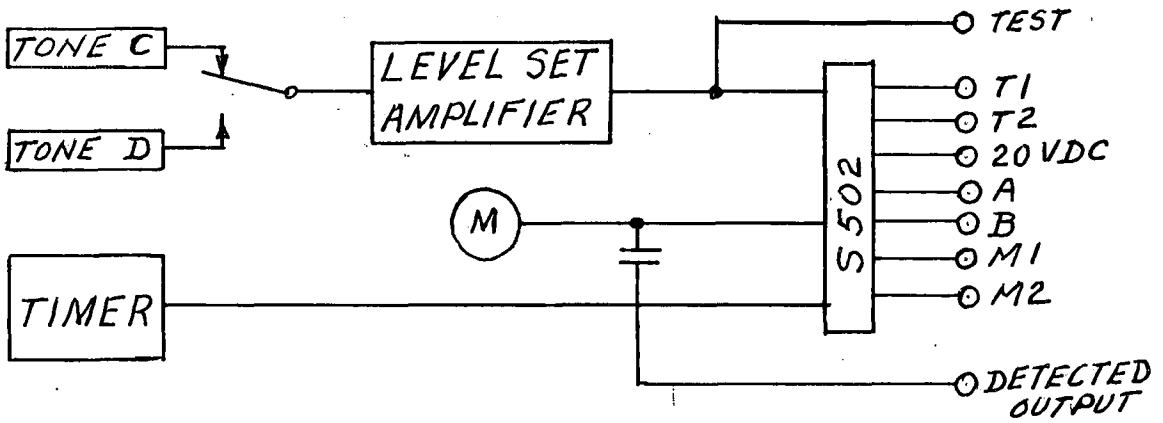
3.6 MODULATION TIMER CIRCUITRY

The schematic for the Modulation Timer Unit is shown on Figure 6. A block diagram of the Modulation Timer Unit is shown in Figure 7.



Figusre 7 - Block Diagram of Modulation Timer Unit.

3.61 Precision Frequency Oscillator

The precision frequency oscillator is a sealed unit consisting of an electronic tuning fork, two transistors connected as an oscillator and an emitter follower used as an output coupling stage.

A small signal current in the drive coil excites the tuning fork which in turn induces a signal in the pickup coil. This induced signal is coupled through Q501 to Q502 (Figure 6), where it is amplified and fed back in proper phase and amplitude to the drive coil to sustain oscillations. The phase and amplitude relationship of the induced pickup signal resemble a very high Q resonance curve, thus the only signal capable of passing through the fork corresponds to the natural resonant frequency of the fork.

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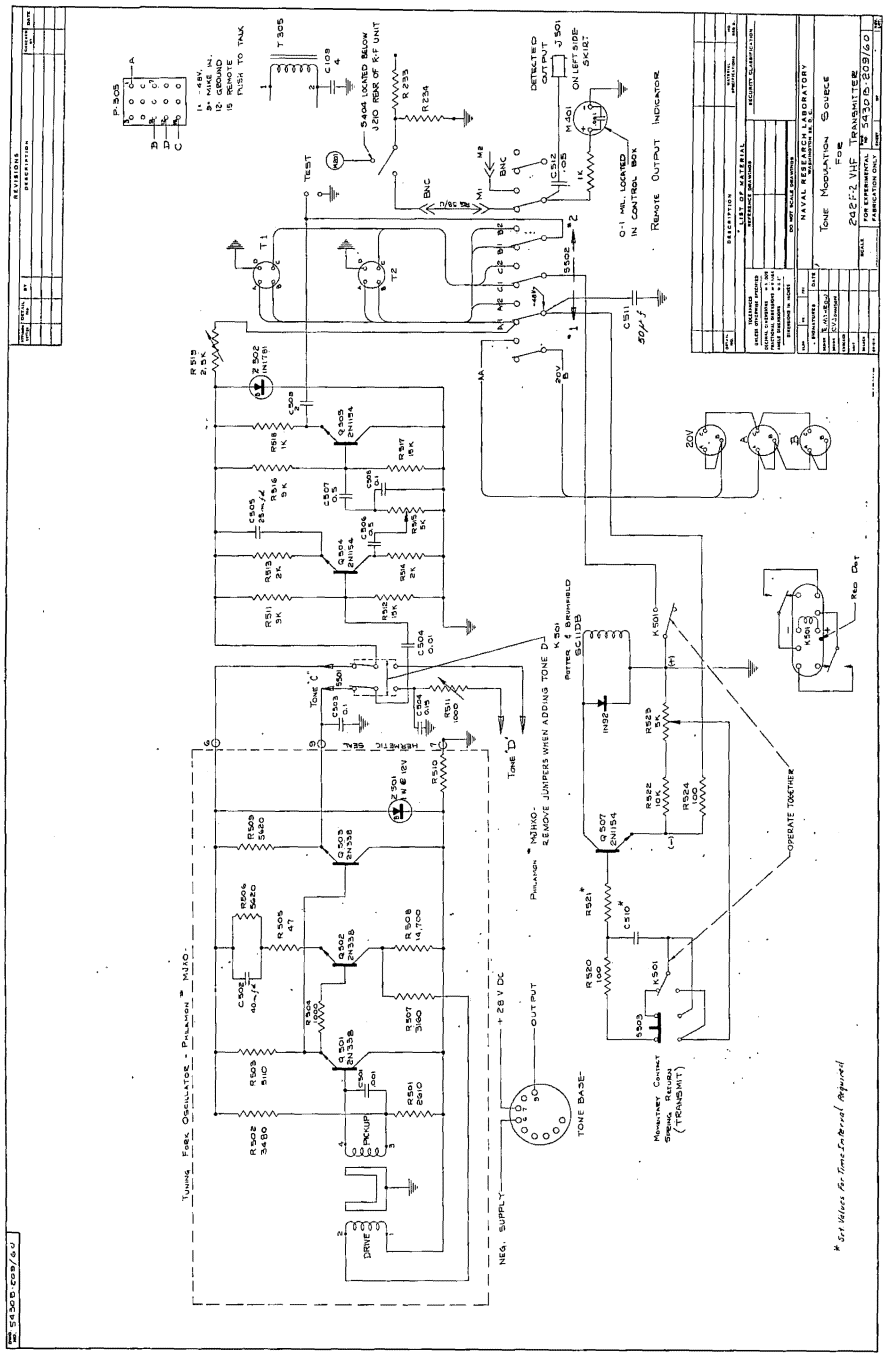

Figure 6 - Modulation Timer Schematic

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The third transistor within the oscillator case, Q503, is an emitter follower used as an output transformer which minimizes the effect of a fairly low impedance load on the oscillator circuit.

The tuning fork oscillator is designed to operate from a 28-volt dc source. It contains the dropping resistor R510 and the Zener regulator Z501, within the case. These establish the 12-volt regulated dc necessary for stable operation.

Three terminals are used for the input and output of the tuning fork oscillator. Pin 7 is the B+ input. Pin 9 is the ac output and Pin 6 is common B- and ac. There are no circuit grounds within the case. This allows external connection of B+ to ground at terminal 7.

Provision has been made to add a second tone to the system should other control later be desired. Switching of tones would be accomplished by a key-locked switch S501. S501 would switch the 28-volt source voltage as well as the ac signal between tones. Since the output of each precision tone source is not necessarily the same between units, an equalizing resistor must be used in the tone lead of the oscillator having the higher output voltage.

The harmonic content of the precision tone source is fairly high, causing distorted waveform. Some improvement in waveform is accomplished by use of a filter capacitor, C503, across the output of the unit.

3.62 Level Set Amplifier

The output of the tone oscillator feeds through S501 to the transistor amplifier Q504 and emitter follower Q505. The output level control R515 is located between Q504 and Q505. The output level of the amplifier is determined by the input requirements of T305 in the transmitter. (See Figure 7-14A in 242F-2 Instructions). The modulation meter in the transmitter, M301, will read 250 milliamperes at full modulation. To obtain

this level with the transmitter remote potentiometer R301 set at midpoint requires a modulation timer amplifier output of 0.141 volts. This is best measured by an oscilloscope or a Ballantine meter connected to the test point (red).

The emitter follower, Q505, serves as an impedance transformer between the amplifier, Q504, and the 82-ohm input to the transmitter.

3.63 Timer

The Timer Unit consists of a dc transistor amplifier with relay K501 in the collector circuit. See Figure 6. The current through the transistor, and therefore through the relay, is controlled by the potential at the base of the transistor. The base of the transistor is connected to the supply voltage through R521 and C510 by closing S503. The relay is thrown for the time interval required to charge C510 through R521 and the transistor base emitter circuit. The voltage applied to C510 and therefore the time interval required to charge C510 is controlled by the setting of R523. The time interval is set and requires no adjustment.

Pushing S503 (TRANSMIT) starts current flowing through the collector of Q507 and closes relay K501. One contact of K501 serves as an interlock to lock in K501 for the duration of the time interval. This eliminates the requirement of holding S503 closed. At the end of the time interval, K501 opens and the interlock contact returns to its normally closed position. In this position, 100 ohms is shunted across C510 to completely discharge it.

During the time that K501 is closed, the working contact closes terminal 15 of P-305 in the transmitter to ground. This is the transmitter Push to Talk circuit and operates the transmitter Plate-On relay.

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3.64 Transmitter Selector Switch

The selection of either transmitter, No. 1 or 2, is made by switch S502 located on the front of the Modulation Timer Unit and labeled Transmitter. S502 performs all the switching required to control either transmitter once the transmitters have been adjusted. Functions of the switch are given in Table I.

TABLE I

FUNCTIONS OF TRANSMITTER SELECTOR SWITCH S502

Contact	Function
1	20-volt dc from Trans. No. 2
2	-48-volt dc Input
3	Control - Push to Talk
4	Tone - Output
5	Remote R-F Power Indicator
6	Spare

3.65 Test Points

There are two test points installed in the Modulation Timer Unit; namely, Test and Detected Output. The two pin jacks labeled Test make available the tone modulation at the output of the tone amplifier for level and waveform checking of the generated tone. The detected output jack J501 is a BNC fitting located on the left flange which connects to the remote power indication circuit. Although the remote power indicator is a measure of rectified rf and uses a dc meter, the circuit is a straight-forward detector and detected tone is available at the Modulation Timer Unit. This is brought out on J501 for viewing on an oscilloscope if desired.

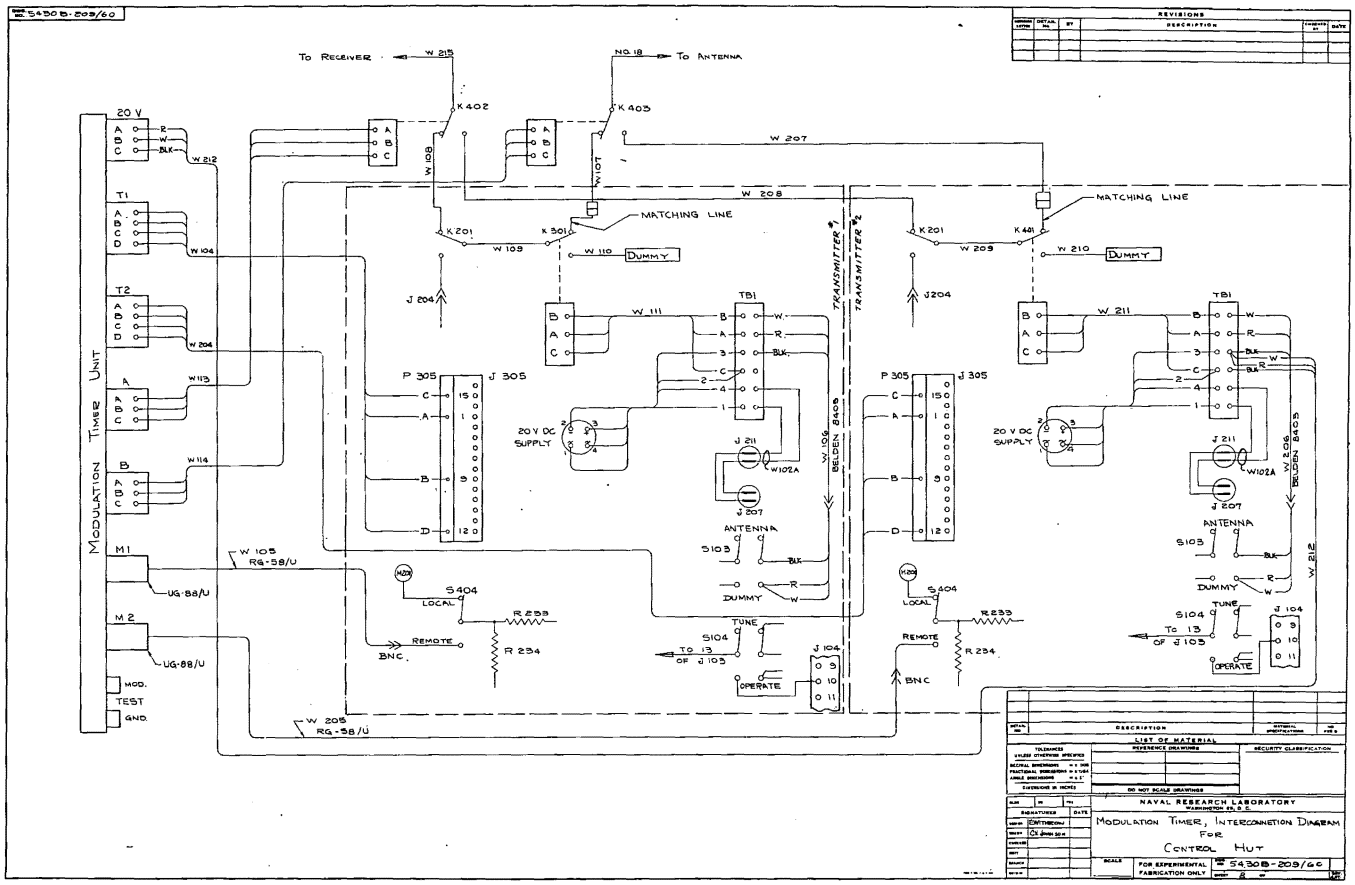

Figure 8 - Hut Cabling Diagram

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3.7 ANTENNAS

3.71 Two-Bay Array

A two-bay Yagi array is mounted at the top of a rotatable mast. See Figure 7 in IB 25. This unit is selected for optimum operation on Channel A and is used for location of the satellite. The feed cable for the two-bay array enters the rotatable mast through the top fitting located about half way up the mast. The cable leaves the mast below the operating table and connects directly to the Channel A converter.

The beamwidth of the two-bay array is about 30° in azimuth and 50° in the vertical plane. It is pointed at 15° elevation for improved overhead coverage. The gain is approximately 12 decibels.

3.72 Four-Bay Array

A four-bay Yagi array is mounted midway up the rotatable mast. See Figure 7, IB 25. This unit is selected for optimum operation on Channel B and the transmitter frequency. Two antennas are provided for this position. The Taco will be initially installed. It is peaked for Channel B. An additional length of transmission line has been added to W107, see Figure 8, and W207, which must be used when the Taco is installed. The additional length of line provides a more favorable match to the transmitters.

The Taco antenna has an azimuth beamwidth of about 20° and a vertical beamwidth of 50°. It also is pointed at 15° elevation for improved overhead coverage.

A Telrex four-bay array is supplied as an emergency spare. It will be installed in an emergency and then by direction.

The Telrex antenna has an azimuth beamwidth of about 17° and a vertical beamwidth of about 36°, thus giving it a gain of 17 decibels. This is three decibels above the Taco and is fully realized since the impedance match is superior to that of the Taco at the Transmitter frequency.

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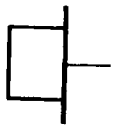

3.73 Whip Antenna

A high-frequency whip antenna is provided for reception of time signals. This is a twenty-five-foot whip erected above a ground screen.

The base of the element connects to a matching transformer housed in a watertight compartment, see Figures 9, 10, 11 in IB 25. A selector switch, Figure 10, IB 25, determines the mode of operation of the whip. The first position is marked Below 10 Mc and is a direct connection to the whip. The next three positions are marked 10, 15 and 20 Mc and indicate the transformer in use for optimum operation at that particular frequency. See Figure 9 for Whip Antenna Schematic.

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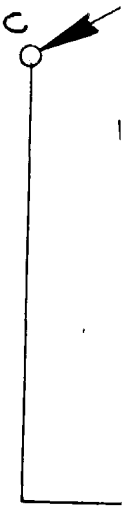

3.8 TRANSMITTING EQUIPMENT

3.81 General

The transmitting equipment is basically the Collins VHF transmitter 242F-2. This is a crystal controlled 200-watt transmitter which has been set up for precision tone amplitude modulated cw operation. Two complete transmitters are installed in closed racks together with auxiliary operating units. See Figures 10 and 11.

3.82 Blower Unit

A 150-cfm fan operating from the 115-volt line is located at the base of the transmitter rack and is used to circulate air through the cabinet. The fan is wired immediately following the transmitter input power jack. Air will therefore circulate through the transmitter cabinet when the external transmitter switch located in conduit at bottom and in front of cabinet is on. The air enters at the bottom rear of the rack and exits through a louver, Figure 12, in the bulkhead near the top of the rack. This louver must, therefore, be open when the transmitter is on.

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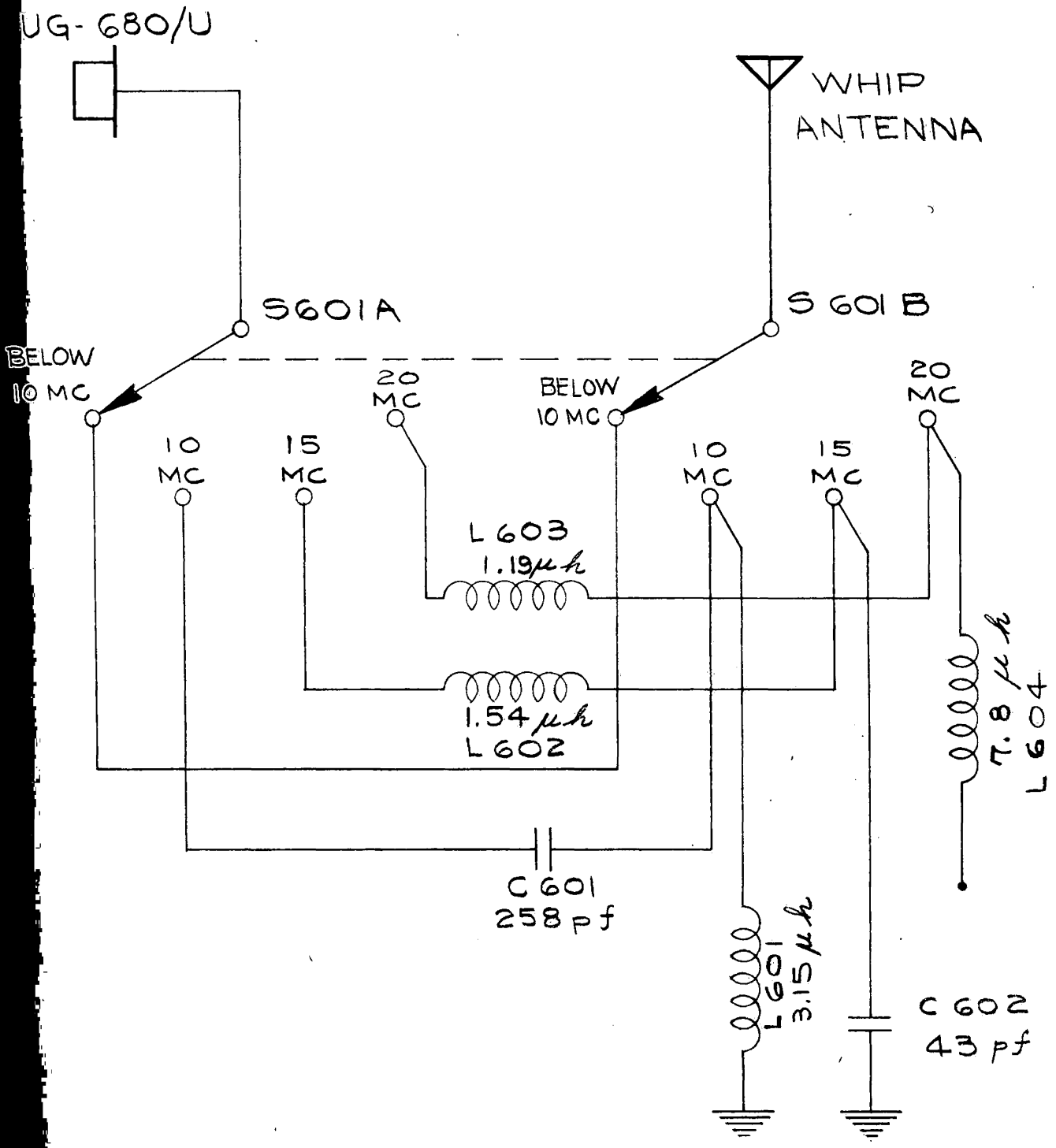

Figure 9 - Whip Antenna Schematic

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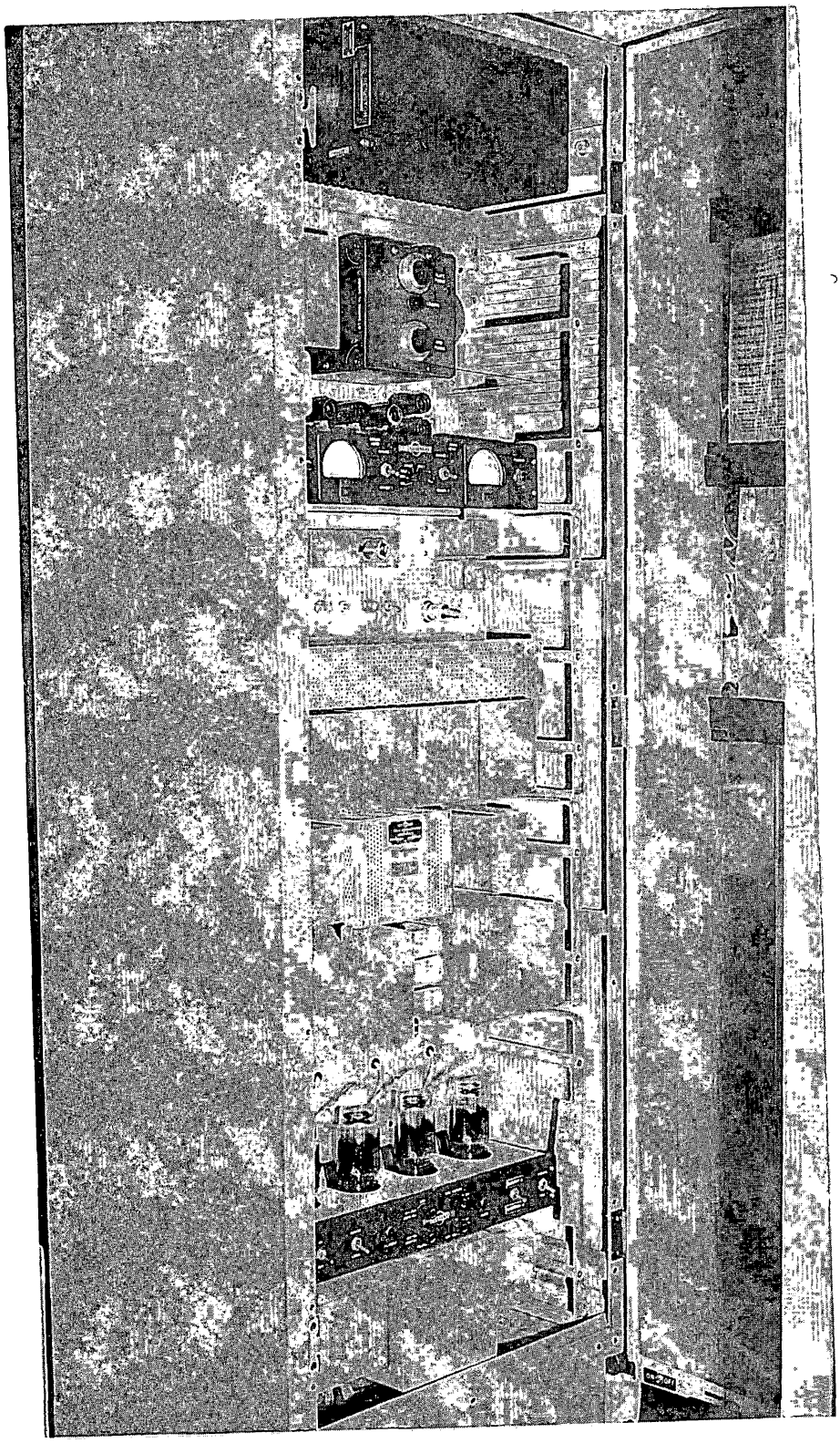

Figure 10 - Transmitter Rack - Front View

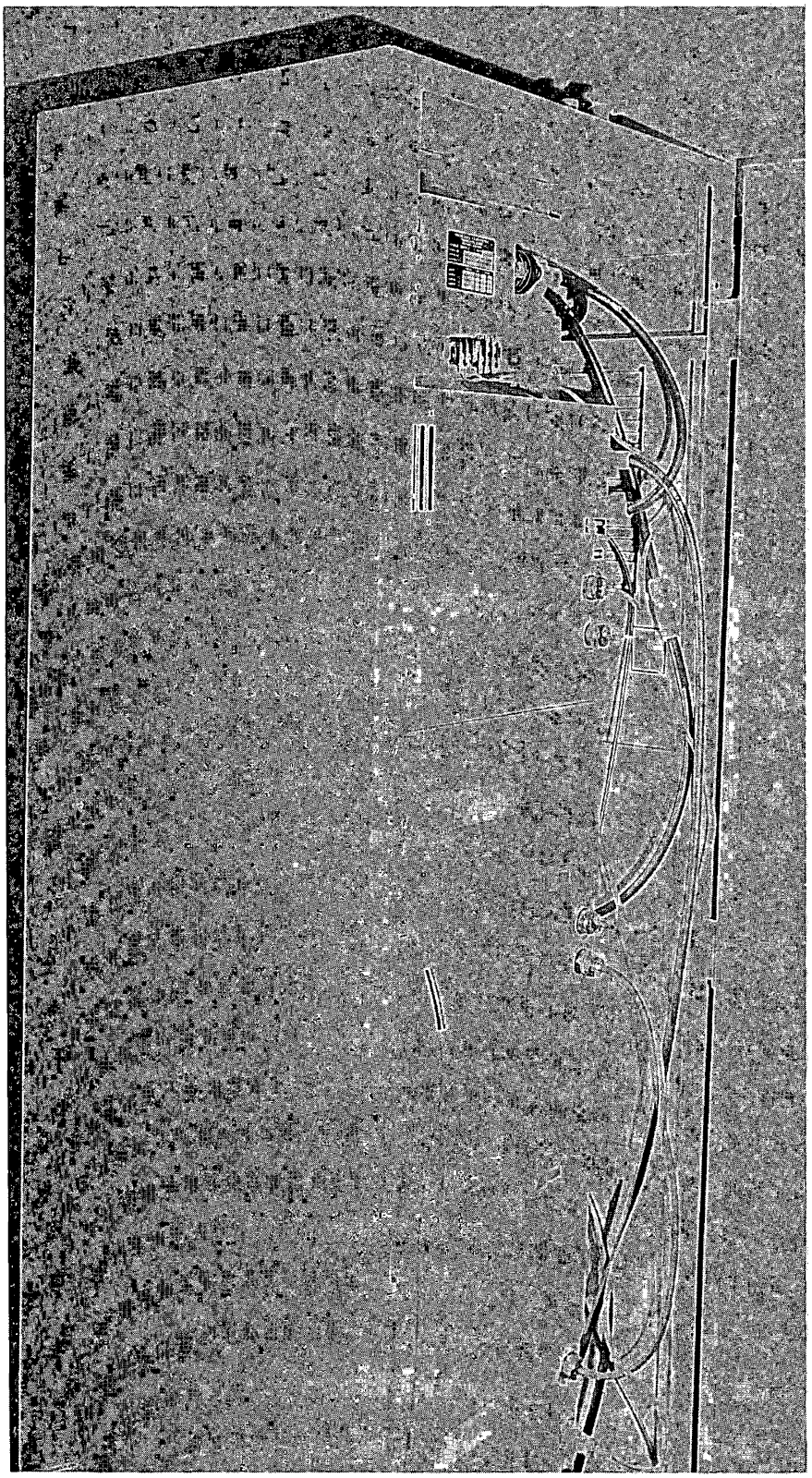

Figure 11 - Transmitter Rack - Back View

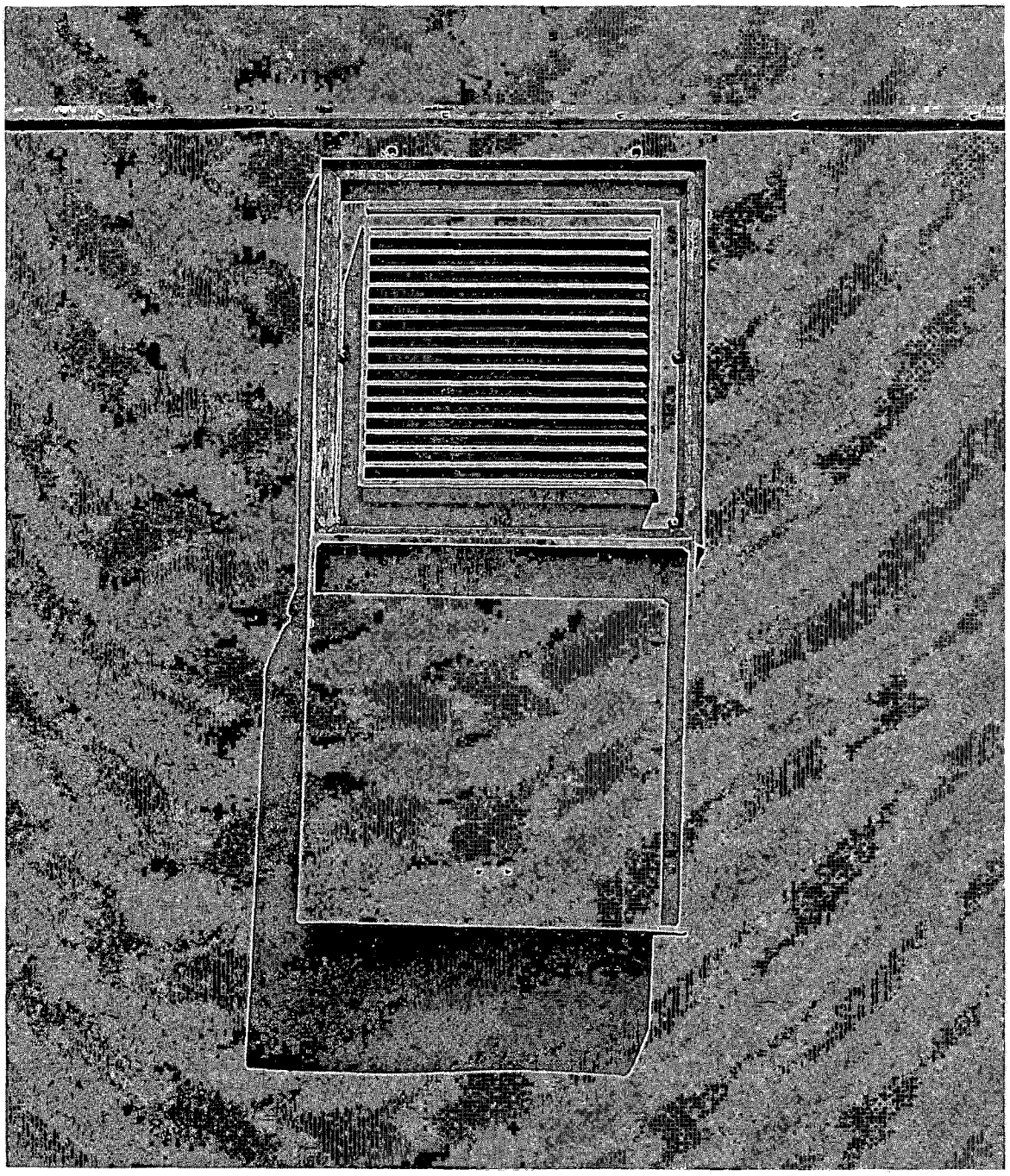

Figure 12 - Transmitter Louver

3.83 VHF 242F-2 Transmitter

The four units of the 242F-2 transmitter are located directly above the blower unit in this order: Rectifier and Control Unit, Filter and Bias Supply Unit, Modulator Unit and R-F Unit. This order of arrangement is normal for this transmitter. For a detailed description of the four units, reference should be made to the 242F-2 Instruction Book which is supplied. Minor modifications to the transmitter proper made necessary by application in this system, will be discussed in Section 8.

3.84 Dummy Load

A dummy load capable of absorbing the full power output of the transmitter is mounted above the R-F Unit facing the front of the rack. This is connected to the Dummy-Antenna Relay by a short length of r-f cable. The Dummy receives the full power of the transmitter when the Antenna-Dummy Switch located on the transmitter control panel, S103, is thrown to Dummy.

3.85 20-Volt DC Supply

A 20-volt dc supply is mounted above the R-F Unit facing the rear of the rack. Both the input and output of the 20-volt dc supply are connected to terminal board TB1 which is on the panel. The primary of the supply is connected to J211 (see Figure 8) and is therefore energized when the transmitter is turned on.

The 20-volt dc is used as a control voltage for the Dummy-Antenna Relay located on the 20-volt dc Supply panel. The antenna and receiver transfer switches located on the bulkhead below the operating table (see Figure 2) also receive control voltage from the supply in the No. 2 transmitter rack.

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3.86 Antenna-Dummy Relay

The Antenna-Dummy Relay switches the output of the transmitter either to the four-bay antenna or the Dummy. It is located on the 20-volt dc supply panel directly above TB1. All tuning and adjustments of the transmitter should be done with the transmitter connected to Dummy. This is insured by wiring the control for the Antenna-Dummy relay through S103 (see 8.4).

3.87 Antenna Transfer Relay K403

The Antenna Transfer Relay K403, see Figure 8, is made necessary by the addition of the second transmitter. It is located on the bulkhead below the operating table and is used to connect Transmitter No. 1 or Transmitter No. 2 to the four-bay antenna. K403 is normally closed for Transmitter No. 1. K403 throws to Transmitter No. 2 by means of the transmitter selector switch S502 providing Transmitter No. 2 is energized. K403 receives its control voltage from the 20-volt dc supply in Transmitter No. 2 rack. The 20 volts is available only when Transmitter No. 2 is on.

3.88 Receiver Transfer Relay K402

The Receiver Transfer Relay K402 is made necessary by the addition of the second transmitter. Since the Channel B antenna is used for both transmitting and receiving, the received signal must pass through the transmitter switching system to get to the receiver. See Figure 3. K402 must therefore follow K403 and the control for K403 is wired in parallel with the control for K402. See A and B, Figure 6.

3.89 Power Circuits

A power wiring diagram for the control hut is shown in Figure 13. The primary power for the hut comes in as three-wire 120-240 volts with the center line ground. The 240 volts is used for the hut heater only and is controlled by a switch in the distribution box. The 240-volt conduit runs along the right bulkhead just above the floor. Two outlets for heaters are locat under the operating table.

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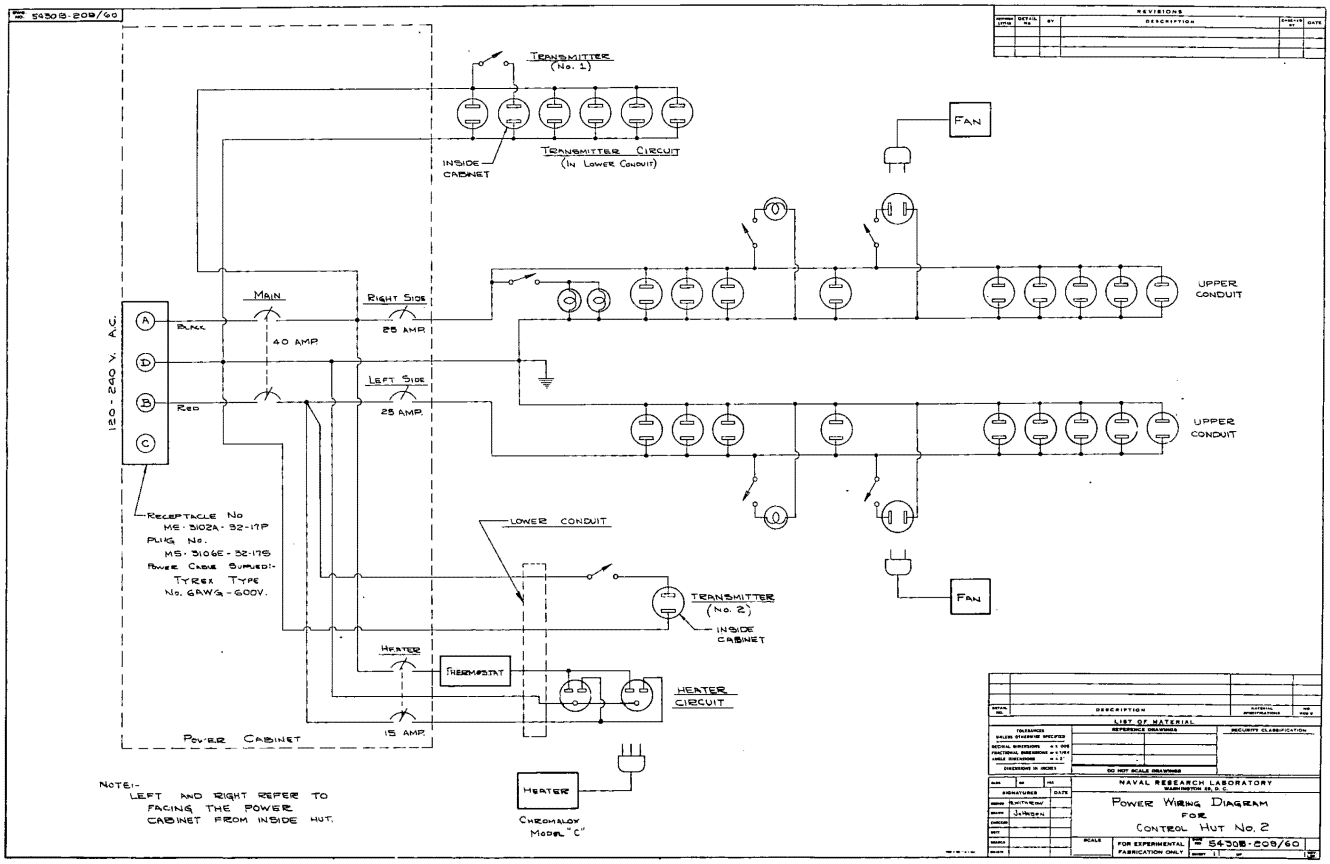

Figure 13 - Power Wiring Diagram

Power for Transmitter No. 1 is taken from the A bus and ground. It runs in the lower conduit along the left bulkhead. A switch located just outside the transmitter rack controls one outlet located in the conduit within the transmitter rack. Additional outlets along the conduit are energized when the main breaker is closed.

Power for Transmitter No. 2 is taken from the B line, thus balancing the load when both transmitters are operating. A switch located in the lower conduit just outside the Transmitter No. 2 cabinet controls one outlet located in the conduit within the cabinet.

The lighting and general-use power circuits run in the upper conduits along each bulkhead with individual switches for the lights and fans.

The main power cable feeding the hut plugs into a receptacle on the exterior of the hut to the left of the door. It is necessary that the proper arrangement of the feeders be maintained when connecting this primary power. If by any chance the wires are reversed, irreparable damage can result to the equipment. See IB 25, paragraphs 8.55 and 9.1.

3.9 TUBES AND SEMICONDUCTOR DEVICES EMPLOYED

The tubes and semiconductor devices employed in the Control Hut may be obtained for the several equipments as follows:

R-390A Receiver	IB 25, Table 8
Converter and Converter Power Unit	IB 25, Table 8
Transmitter *	242F-2 IB Table 1-4A
Modulation Timer Unit	Figure 6 herein

* V-301 and V-302 are omitted.

4.

SHI

Item	
1	Ant
2	Ant
3	Ant OPE
4	Ante
5	Ante
6	Ante
7	Ante
8	Cro
9	Cro
10	Cro
11	Whi
12	Whi
13	Whi
14	Ante
15	Radi
16	Radi
17	Conv
18	Conv
19*	Tran
20*	Tran
21*	Blow (bott
22*	Blow (bott
23	242F
24	242F
25	242F
26	242F

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4. LIST OF MATERIAL

SHIPPED IN OR WITH CRAIG HELIHUT MODEL 150 Serial #2

Item	Description	Quantity
1	Antennas (Channel A) 10-Element Yagi	2
2	Antennas (Channel B) 10-Element Yagi	4
3	Antennas (Channel B) 10-Element Yagi (marked "DO NOT OPEN - FOR EMERGENCY USE ONLY")	4
4	Antenna Mast - Lower Section	1
5	Antenna Mast - Middle Section	1
6	Antenna Mast - Upper Section	1
7	Antenna Mast Jib Pole	1
8	Cross Arm - Upper - Complete	1
9	Cross Arm - Lower - Middle Section	1
10	Cross Arm - Lower - End Sections	2
11	Whip Antenna in 3 Sections each approximately 7 feet long	1
12	Whip Antenna Mounting Base with Insulator	1
13	Whip Antenna Mounting Legs	4
14	Antenna Parts Box (See itemized list for contents)	1
15	Radio Receiver - Type R-390A/URR - Serial #43	1
16	Radio Receiver - Type R-390A/URR - Serial #255	1
17	Converter Assembly (Channel A) Serials # 2A, 2B	1
18	Converter Assembly (Channel B) Serials #2C, 2D	1
19*	Transmitter Cabinet No. 1 (in front of Switch Box)	1
20*	Transmitter Cabinet No. 2	1
21*	Blower, McLean Eng. Labs., 2E300A, #24987 (bottom of No. 1 Transmitter Cabinet)	1
22*	Blower, McLean Eng. Labs., 2E300A, #24988 (bottom of No. 2 Transmitter Cabinet)	1
23	242F-2 Transmitter R-F Unit, No. 183	1
24	242F-2 Transmitter R-F Unit, No. 185	1
25	242F-2 Transmitter Modulator Unit, No. 183	1
26	242F-2 Transmitter Modulator Unit, No. 185	1

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Item	Description	Quantity
27	242F-2 Transmitter Filter and Bias Unit, No. 163	1
28	242F-2 Transmitter Filter and Bias Unit, No. 164	1
29	242F-2 Transmitter Rect. and Control Unit, No. 183	1
30	242F-2 Transmitter Rect. and Control Unit, No. 185	1
31	Dummy Antenna, Load Resistor, M. C. Jones Electronics Co. Model 636NC, NRL No. 02843	1
32	Dummy Antenna, Load Resistor, M. C. Jones Electronics Co. Model 636NC, NRL No. 02844	1
33	20-volt dc Supply Panel (for Transmitter No. 1)	1
34	20-volt dc Supply Panel (for Transmitter No. 2)	1
35*	Switch, Coax. (Antenna Transfer) Part #CS319 Ser. No. 11031 (on bulkhead beneath table)	1
36*	Switch, Coax. (Receiver Transfer) Part #CS319 Ser No. 11029 (on bulkhead beneath table)	1
37*	Modulation Timer Unit (on bulkhead above table)	1
38	Clock - Navy Standard (8-day)	1
39	Power Cable - Tyrex 3-wire #6 AWG 600 volt	140 Feet
40	Power Cable Connector - MS-3106E-32-17S	1
41	R-F Cables (#10, 11, 12, 13, 14, 18, 19, 37)	1 Set
42	Chairs - Posture Type	2
43	Heater, Electric, 3 kw - Chromalox (mounting base attached to deck under table)	1
44	Instruction Books (See itemized list for contents)	1 Set
45	Spare Tubes, Fuses, etc. (See itemized list for contents)	1 Set
46	Channel A Equipment Rack	1
47	Channel B Equipment Rack	1
48*	Converter Rack	1
49*	Exhaust Fans - Rotron	2
50*	Thermostat - Chromalox	1
51*	Antenna Drive System - Complete with gearing, handwheel, azimuth scale, etc.	1

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Item

52*
53*
54

* Thes

NOTE:
Cabinet
24, 26,
Transm

CONTEN

1
2
3
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5
6
7

Item	Description	Quantity
52*	Loud Speakers, 4"	2
53*	Stereophone Headset Unit, Koss T-1	1
54	Stereophone Headset, Koss SP-3	1

* These items were shipped in place and not packed separately.

NOTE: Items 23, 25, 27, 29, 31 and 33, when assembled in Transmitter Cabinet No. 1 (Item 19), constitute Transmitter No. 1. Similarly, Items 24, 26, 28, 30, 32 and 34, when assembled in Item 20, constitute Transmitter No. 2.

CONTENTS OF ANTENNA PARTS BOX (Item 14 above)

1 Tool box (see list of contents of tool box below)
2 Safety belt and strap
3 Block and tackle
4 Sling
5 Box of 18 stakes
6 Coil of wire, 600 feet of #12 bare copper
7 Cardboard box containing:
- (a) Bag #1 3/8-16 x 1 3/4" long bolts, 28 enclosed
- (b) Bag #2 3/8-16 x 1 1/4" long bolts, 30 enclosed
- (c) Bag #3 1/2-13 x 1 1/2" long bolts, 28 enclosed
- (d) Box of 10-32 x 1/2" long binder head machine screws
- (e) Envelope containing 16 ground lugs
- (f) Electrical tape, 3/4" wide, 4 rolls
- (g) Tube Dow Corning Silicone
- (h) Tubes of grease (2)
- (i) Tube of caulking compound

CONTENTS OF TOOL BOX (Part of Item 14 above)

Crescent wrench 12"	Allen wrench, hex, 5/16" flats (2)
Crescent wrench 10"	Allen wrench, hex, 3/16" flats (2)
Crescent wrench 8"	Allen wrench, hex, 1/8" flats (2)
Box wrench 7/8"-3/4"	Wrench, Spintite, hex, 7/16" flats
Box wrench 11/16" - 5/8"	Pliers
Box wrench 9/16" - 1/2"	Carpenters hammer
Screwdriver 8"	Brake adjusting tool
Screwdriver 4"	Flashlight
Screwdriver 2"	Alemite grease gun
Screwdriver, Phillips head 3"	Caulking gun
Screw starter 6"	Crimping tool for wire lugs
Screw starter 3"	

CONTENTS OF INSTRUCTION BOOK ENVELOPE (Item 44 above)

Equipment	Instruction Book, Drawing Etc.
Radio Receiver	Technical Manual TM 11-856A for R-390A/URR
Transmitter	Instruction Book for VHF Transmitter, Collins Type 242F-2, 1955 Revision. (Two copies)
Yagi Antenna	TACO Form 1609, "Coaxial Stacking Lines" (1 sheet)

LIST OF

Tube Typ

OA2
OA3
1N63
1N92
1N1781
2N1154
3B25
3TF7
4X150A
5Y3
6AK5W
6AK6
6BA6W

LIST OF S

Item

Fuse 20A,
Fuse 10A,
Fuse 5A, (
Fuse 3A, (
Fuse 1A, (
Fuse 0.25A
Fuse 3A sl
Fuse 3A, 8
Lamp, dial
Lamp, glov
Tuning For
Philamon L

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LIST OF SPARE TUBES AND SEMICONDUCTOR DEVICES (Item 45 above)

Tube Type	No. of Spares	Tube Type	No. of Spares
OA2	2	6BQ7A	2
OA3	2	6C4	2
1N63	2	6CB6	2
1N92	2	6DC6	2
1N1781	2	6SJ7	2
2N1154	2	6Y6	2
3B25	2	12AT7	2
3TF7	4	26Z5W	2
4X150A	6	417A	2
5Y3	2	811A	2
6AK5W	2	5686	3
6AK6	2	5814A	4
6BA6W	3	6146	2

LIST OF SPARE FUSES AND MISCELLANEOUS ITEMS (Part of Item 45 above)

Item	For Use In	No. of Spares
Fuse 20A, (1 1/4")	Transmitter	4
Fuse 10A, (1 1/4")	Transmitter	20
Fuse 5A, (1 1/4")	Transmitter	10
Fuse 3A, (1 1/4")	Transmitter	10
Fuse 1A, (1 1/4")	Transmitter	10
Fuse 0.25A, (1 1/4")	Transmitter	10
Fuse 3A slow blow, (1 1/4")	Receivers	5
Fuse 3A, 8AG-3 (1")	Converters	5
Lamp, dial, 6.3v	Receivers	1
Lamp, glow	Receivers	1
Tuning Fork Oscillator, Philamon Labs.	Modulation Timer Unit	1

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5. INSTALLATION

5.1 GENERAL

The Control Hut is similar in many respects to the Receiving Huts associated with it. All items such as site selection and preparation and installation of receiving equipment will be the same as described in Section 8 of the Receiving Hut Manual, NRL IB 25. Included here is additional information pertaining to the additional equipment which makes this a control hut.

5.2 UNPACKING UNITS

The order of unpacking receiving equipment is given in the Receiving Hut Manual. The following order is recommended for unpacking the additional transmitting equipment.

Blower Unit (May be shipped installed in transmitter cabinet)
Rectifier and Power Supply
Filter and Bias Supply
Modulator Unit
R-F Unit
Dummy Load
20-Volt DC Supply Panel

The order given above is the order of arrangement of the separate units in the transmitting racks starting with the bottom unit.

5.3 ASSEMBLY IN RACKS

The blower unit is mounted at the bottom of the transmitter rack. The grille over the entrance of the blower is first removed and laid aside. The blower is then installed from the back or operating table side of the rack and fastened in place with its mounting screws. The grille is then replaced and fastened with its acorn-head nuts.

The next units to be placed in the rack are the Rectifier and Power Supply, Filter and Bias Supply, Modulation Unit and the R-F Unit. Each of these units mounts in the rack from the front or door side of the hut in the order named, starting from the bottom. See Figure 10. The order of installation must be followed since the wiring harness which interconnects these four units has its plugs assembled in this order. See Figure 7 - 12 in 242F-2 Instructions.

The Dummy is located at the top of the rack on the front side such that the input connector is towards the left. Do not tighten bolts until all are started and then only after pushing the panel as far to the right as the mounting slots will allow. If this is not done, considerable difficulty will be encountered in connecting the input cable. Tighten all mounting bolts.

The 20-volt dc supply panel mounts on the same level as the Dummy but is installed from the back of the rack. This panel mounts on stand-off spacers to allow for wiring clearance. Three spacers are first loosely attached to the rack on the left side. The panel is then slid under the heads of the bolts with the transformer to the left. A single spacer and bolt are then placed in position on the opposite side. The panel will remain in this position while the remaining spacers and bolts are installed and all tightened.

5.4 INTERCONNECTION OF UNITS

The interconnection of the receiving units is explained in the Receiving Hut Instruction Book No. 25. Additional cabling is required for the added transmitting equipment. Reference to 242F-2 Instructions, Figure 7-12, , and Figure 14 herein should be made while following the cable installation table given below. All cables listed should be installed (if not shipped connected), checked for correct position and tight connections.

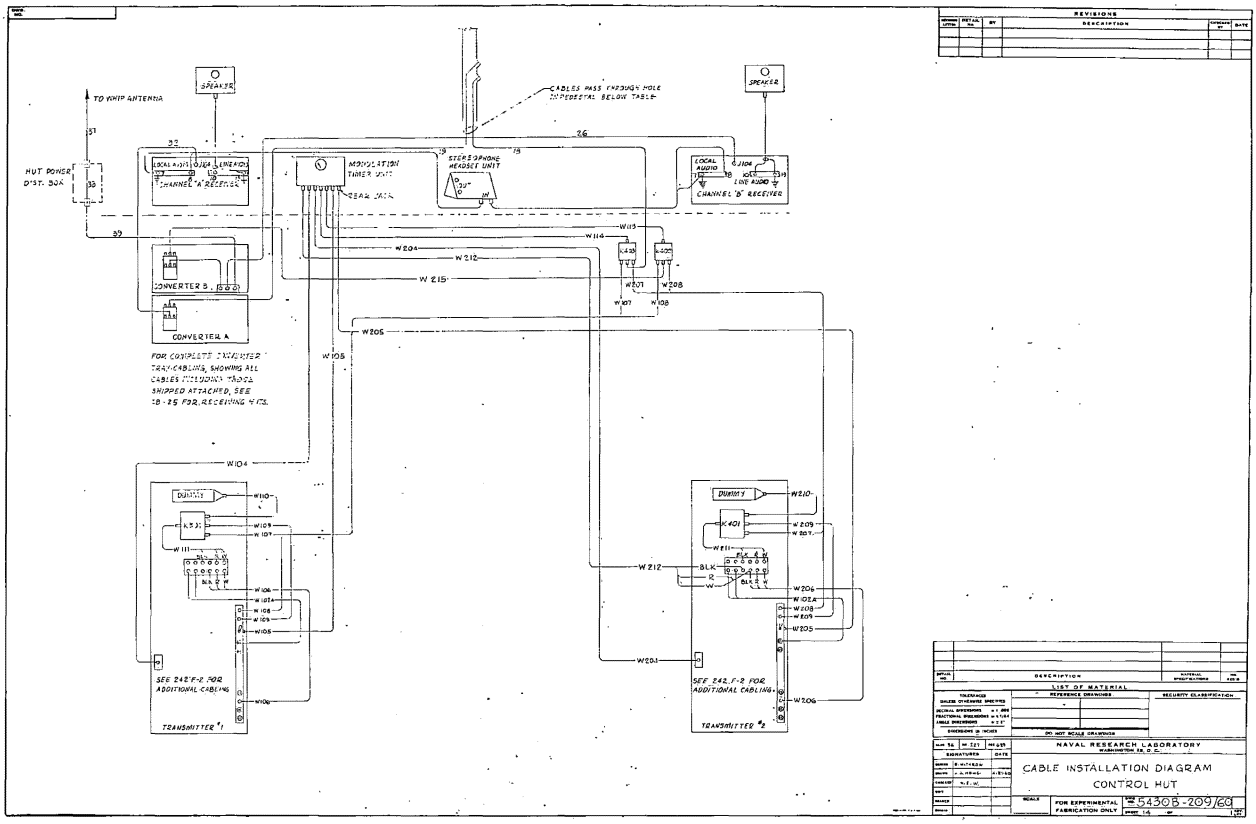

Figure 14 - Cable Installation Diagram

Cable
W100
W101
W102
W102A
W103
W104
W105
W106
W107
W108
W109
W110
W111
W113
W114
W100
W101
W102
W102A
W103
W204

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TABLE 2

CABLE INSTALLATION

Cable	Cable Connects From	To
W100	J101 (Trans. 1)	115-v outlet in conduit passing through racks.
W101	J102 (Trans. 1)	J304 (Trans. 1)
W102	J303 (Trans. 1)	J207 (Trans. 1)
W102A	TB1 (Trans. 1)	J211 (Trans. 1)
W103	See 242F-2 Inst. Figure 2-6.	
W104	T1 of Mod. Timer Unit	J305 of Trans. 1
W105	M1 of Mod. Timer Unit	BNC Fitting right rear flange of R-F Unit, Trans. 1
W106	S103 (Trans. 1)	TB1
W107	K301 (Trans. 1)	K403 (under table)
W108	K201 (Trans. 1)	K402 (under table)
W109	K301 (Trans. 1)	K201 (Trans. 1)
W110	K301 (Trans. 1)	Dummy (Trans. 1)
W111	K301 (Trans. 1)	TB1 (Trans. 1)
W113	"A" on Mod. Timer Unit	K402
W114	"B" on Mod. Timer Unit	K403
W100	J101 (Trans. ~~1~~ 2)	115-v outlet in conduit passing through rack.
W101	J102 (Trans. ~~1~~ 2)	J304 (Trans. 2)
W102	J303 (Trans. ~~1~~ 2)	J207 (Trans. 2)
W102A	TB1 (Trans. ~~1~~ 2)	J211 (Trans. 2)
W103	See 242F-2 Figure 2-6	
W204	T2 of Mod. Timer Unit	J305 of Trans. 2

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TABLE 2 (Contd.)

Cable	Cable Connects From	To
W205	M2 of Mod. Timer Unit	BNC Fitting right rear flange R-F Unit Trans. 2
W206	S103 (Trans. 2)	TB1
W207	K401 (Trans. 2)	K403
W208	K201 (Trans. 2)	K402
W209	K401 (Trans. 2)	K201 (Trans. 2)
W210	K401 (Trans. 2)	Dummy (Trans. 2)
W211	K401 (Trans. 2)	TB1 (Trans. 2)
W212	20-v of Mod. Timer Unit	TB1 (Trans. 2)
W215	Converter "B" Input	K402

Note: Generally, the 100 series go with Transmitter No. 1 and the 200 series with Transmitter No. 2. W100 through W103 carry the same number in both racks.

6. POST-INSTALLATION CHECKOUT

6.1 THE POWER SYSTEM

The power, being a three-wire 120/240 volt system, always introduces the hazard of an error having been made either in the connection to the power plug connecting to the hut or in the connections of the line to the power source. Such an error would result in 240 volts being applied to certain units of the equipment, all of which are intended for 120 volt operation, possibly resulting in burn-outs in certain of their components. Therefore, before turning on any piece of equipment in the hut, check the power connections in accordance with Section 9 of IB 25.

6.2 THE RECEIVING EQUIPMENT

The receiving equipment, being identical with that installed in the receiving huts should be checked out in accordance with paragraph 9.3 of IB 25.

6.3 THE TRANSMITTING EQUIPMENT - GENERAL

Both transmitters were carefully adjusted just prior to shipment. TABLE 3 is a tabulation of the meter readings obtained after their adjustment and represent optimum values. However, there can be no assurance that derangements might not have occurred during shipment and installation, so that both transmitters should be carefully checked and readjusted where necessary. Furthermore, it should be realized that the values shown in TABLE 3 were obtained on a line voltage of 120, and observed values might be expected to deviate somewhat with higher or lower line voltage. Also, ageing or changes in tubes might be expected to affect the values shown. In general, with two exceptions, the exact metered values for the various stages are not rigorous and may vary as much as plus or minus 20% without affecting the satisfactory operation of the transmitters. The two exceptions are the Screen and Cathode currents of the Power Amplifier tubes. The Cathode Currents should never be allowed to exceed 220 MA per tube and the antenna coupling should be held to an adjustment that will maintain these currents at or below this value, even at a sacrifice of some antenna current. Similarly, the Screen current should be kept as low as possible, in no case in excess of 1.0. A better value is 0.6.

6.4 THE TRANSMITTERS AND MODULATION TIMER UNIT

To assure ventilation of the transmitter cabinets during operation, the covers of the louvers on the outisde of the huts adjacent to the transmitters should be opened (see Figure 12); the operation of the blowers in the transmitter cabinets should be confirmed when the master power switch is closed.

The two identical transmitters should be checked out (and adjusted if necessary) individually. Start with TRANSMITTER No. 1 and proceed as follows:

1. Place the TRANSMITTER SELECTOR switch on the MODULATION TIMER UNIT on Transmitter No. 1.

2. Assuring that the master power switch on the bulkhead just in front of the transmitter cabinet and above the deck is OFF, put the following toggle switches on the transmitter in the positions shown below:

CHANNEL switch (on R-F Unit) on CHANNEL 1
ANTENNA-DUMMY switch (on Power Unit) on DUMMY
TUNE-OPERATE switch (on Power Unit) on TUNE
LOCAL-REMOTE switch (on rear of R-F Unit) on LOCAL
POWER switch (on Power Unit) to ON

3. Throw the Master power switch ON.

4. Allow the equipment to run 10 or 15 minutes to warm up.

5. Switch TUNING METER to OSC. If meter reads .05 or more the crystal is operating.

6. Switch TUNING METER to TRIPLER and with a screw driver or "wand", adjust the two studs to the right of the first tube for maximum meter reading, adjusting upper stud first.

7. Switch TUNING METER to DOUBLER and adjust next two studs for maximum meter reading, again adjusting upper stud first.

8. Switch TUNING METER to DRIVER and do the same with the next two studs.

9. Switch TUNING METER to GRID #1 and adjust single right hand stud for maximum meter reading. (The two PA grids are in parallel, so this adjusts both).

10. Turn small LOADING knob on PA box hard clockwise for loosest coupling.

11. Adjust GRID TUNING control for maximum current in Grids 1 and 2.

12. Switch TUNING METER to ANT. and adjust PLATE TUNING for maximum meter reading.

13. Throw right hand toggle switch on POWER PANEL to OPERATE.

14. Check MOD meter and adjust middle pot on the MODULATOR UNIT until meter reads 250.

15. Touch up GRID TUNING for maximum current in Grids 1 and 2.

16. Watching CATHODE METER on either Cathode carefully, readjust PLATE TUNING for the lowest dip in the meter reading.

17. Adjust BALANCE pot (extreme right of R-F panel) until both Cathodes show the same current.

18. Watching the CATHODE meter, very slowly turn the LOADING knob counterclockwise until the Cathode currents read 220 MA (no higher). Touch up the PLATE TUNING as you do this. The optimum adjustment is when the Cathode current dips to 220 MA as the PLATE TUNING and LOADING are adjusted.

19. If necessary, readjust the modulation pot until the MOD meter reads 250 (95% modulation).

20. Switch to CHANNEL 2 (the spare cyrstal). All meter readings should be substantially the same as for CHANNEL 1.

21. Throw the LOCAL-REMOTE switch (on the rear of the R-F Unit) to REMOTE. This transfers the transmitter output current in the DUMMY to the meter on the MODULATION TIMER UNIT. It should read steadily at or above half scale.

22. Shut down the Transmitter temporarily by throwing the POWER switch OFF.

23. Going to the rear of the cabinet, remove the two coaxial cables nearest the panel from the coax transfer switch (above the R-F Unit) and replace the DUMMY cable on the terminal originally occupied by the ANTENNA cable.

24. Throw the ANTENNA-DUMMY switch to ANTENNA.

25. Restart the transmitter.

26. When the power contactors can be heard to close, there should be no PA cathode or antenna current as the TIMER unit has now taken over, holding open the plate contactors until the red TRANSMIT button on the MODULATION TIMER unit is pushed.

27. Push this button (repeating several times for your assurance). On each "push" the meter should read momentarily indicating the pre-timed transmission, although the power is going to the DUMMY by virtue of the transfer switch cables having been reversed. You should also hear the momentary modulation hum from the transmitter. This indicates that the MODULATION TIMER UNIT is in satisfactory operation.

28. Shut down the transmitter, this time by the MASTER switch.

29. Replace the two coaxial cables on the coax switch on the rear of the transmitter in the proper places. Check against Figure 14.

30. Throw the CHANNEL switch (on the R-F Unit) to CHANNEL 1.

If all the above checks have been satisfactory, TRANSMITTER No. 1 is ready for operation and may be secured.

Now place the TRANSMITTER SELECTOR switch on the MODULATION TIMER UNIT on TRANSMITTER No. 2 and proceed to check out this transmitter exactly as you did with TRANSMITTER No. 1, going through steps 2 to 30 inclusive.

When this transmitter checks out satisfactorily, it may be secured. Both transmitters and the MODULATION TIMER UNIT, i.e., the complete transmitting facilities, are now ready for operation.

NOTE: The tuning instructions presented in simplified tabular form in items 5 to 20 inclusive will permit the adjustment of the transmitters "from scratch" although for greater detail the manufacturer's Instruction Book should be consulted. However, unless some unforeseen derangement has occurred, it is not expected that the various tuning controls should require more than a slight "touching up".

TABLE 3

TYPICAL TRANSMITTER METER READINGS

Function	Transmitter No. 1	Transmitter No. 2
OSC	.07	.09
TRIPLER	.24	.38
DOUBLER	.59	.83
DRIVER	.32	.31
GRID # 1	.25	.48
GRID # 2	.34	.50
SCREEN	.92	.66
ANT.	.60	.58
HI VOLTS	1060	1080
MOD.	250	250
BIAS	43	44
LO VOLTS	270	270
CATH # 1	217	219
CATH # 2	217	219
GRID TUNING	1396	1184
PLATE TUNING	1094	1033

7. OPERATION

7.1 THE RECEIVING EQUIPMENT

The operation of the receiving equipment is well covered by IB 25 except for the facilities for monitoring both equipments simultaneously, and need not be repeated here. As in the case of the receiving locations, you will be advised by special instructions and orders the exact receiver settings for the two channels and other pertinent data on tracking procedures, etc.

7.11 Dual-Channel Monitoring

In operation, the output level of the two loud speakers should be adjusted by the respective LINE GAIN controls on the receivers. To turn the speakers OFF merely turn these two controls to zero (hard counterclockwise).

The level of the signals (or noise) in the split phones is controlled by the respective LOCAL GAIN controls of the two receivers.

Similarly these LOCAL GAIN controls will also adjust the level of the signals in the respective headsets when a dual watch is employed.

The split phones supplied (Koss SP-3 Stereophones) have an impedance of only four ohms and are to be used only when plugged into the Stereophone Headset Unit which contains a suitable impedance-matching transformer.

7.2 THE TRANSMITTING EQUIPMENT

The transmitting equipment is, of course, employed only when a "Command" is to be given to any particular satellite. The details of the transmission of such commands will be made the subject of special instructions and orders as in the case of the Operating Procedures for the Receiving Huts.

When such commands are anticipated by the receipt of specific orders, the following procedure should be followed:

1. At a suitable time prior to "Command", keeping in mind that a warm-up period of at least 15 minutes should be allowed, start both transmitters by throwing their respective Master Power Switches ON. Be sure the ventilating louvers for both cabinets are open (Figure 12).

2. Set the TRANSMITTER SELECTOR switch on the MODULATION TIMER UNIT to TRANSMITTER No. 1.

3. At the Command time, push the red TRANSMIT button watching the meter to assure that it momentarily reads approximately half scale.

4. Should it fail to read, indicating that the signal was not transmitted, quickly throw to TRANSMITTER No. 2 and repeat.

5. After the Command has been effected, shut down both transmitters unless an additional Command is anticipated within a reasonable time.

8. TRANSMITTER MODIFICATIONS

8.1 GENERAL

Both of the transmitters installed have been modified slightly in order to reduce the possibility of error in switch setting and to conform to operating procedure. The modifications made and the resulting changes in wiring from that shown on Figure 7 - 14A of the 242F-2 Instruction Book are described below.

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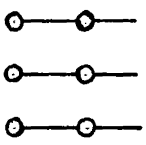
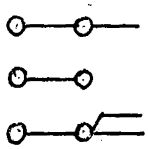
8.2 MIKE-REMOTE SWITCH S302

The transmitter will be modulated by a precision tone only. This tone is introduced through T305, the Modulator input transformer. The audio preamplifier is not required and is therefore removed from the circuitry by removing the wire connected to the common or blade contact and reconnecting this wire to the remote terminal.

S302 (original)



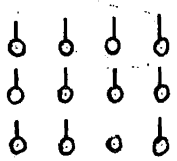
S302 (modified)



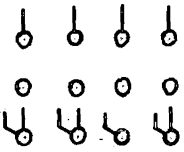
8.3 REMOTE-LOCAL SWITCH

Although the transmitter is controlled by the Modulation-Timer Unit located external to the transmitter rack, the transmitter is operated as in local control. The local-remote switch is therefore wired for local operation only. This is accomplished by individually removing the wires from the center or blade contacts of S102 one at a time and reconnecting them to the local terminal of S102.

S102 (original)



S102 (modified)



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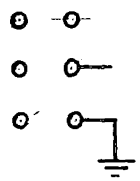
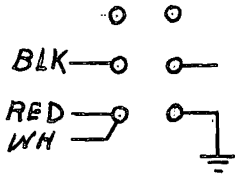
8.4 ON-PUSH TO TALK SWITCH (S103)

The On-Push to Talk Switch wiring has been slightly modified to provide an interlock-circuit. The positive lead to the Antenna-Dummy R-F Relay is run through a spare contact of S103 to insure that the transmitter is operating into the Dummy while the transmitter is being adjusted. The labeling of the On-Push to Talk switch has been changed to Dummy and Antenna in the same order. Thus Dummy position corresponds to the original On and Antenna corresponds to the original Push to Talk.

S103 (original)



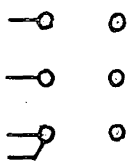
S103 (modified)



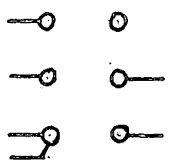
8.5 TUNE-OPERATE SWITCH S104

The spare contact on S104 has been connected as an interlock to prevent the application of modulation when the transmitter is in the tune condition. This is accomplished by inserting the switch spare contacts in series with the modulation ground lead at pin 10 of J104.

S104 (original)



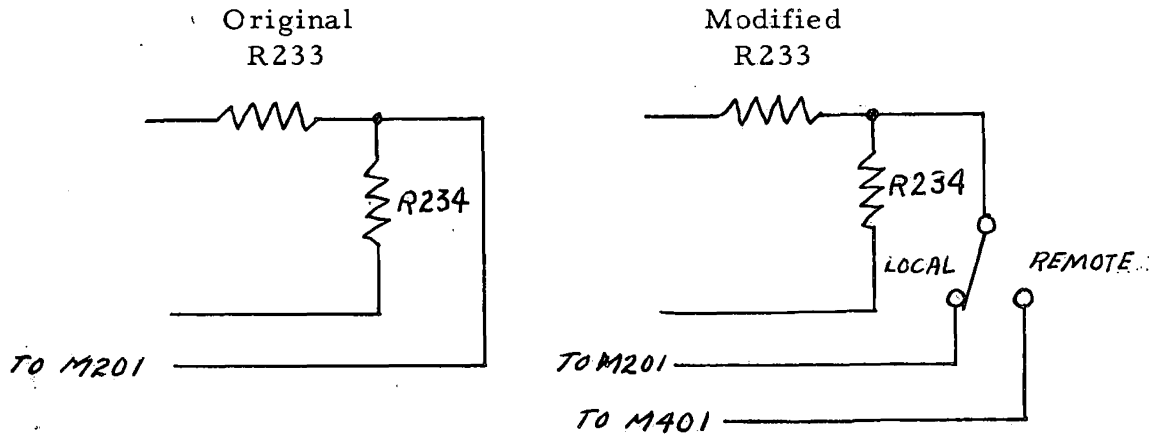
S104 (modified)



~~SECRET~~

8.6 ANTENNA METER SWITCH

An antenna meter switch has been installed in the rear panel of the R-F Unit and labeled S404, Local-Remote. The purpose of this switch is to provide a visual indication of transmitter operation at the operating bench. The antenna meter switch is in the lead which originally connected the Meter Selector Switch to the junction of R233 and R234. Throwing S404 to Local connects the rectified r-f signal to M201 in the Transmitter Rack. Throwing S404 to Remote connects the rectified r-f signal to the meter at the operator's position (M401).



8.7 POWER OUTLET J211

An additional power outlet J211 is installed on the back panel of the R-F Unit. J211 is wired in parallel with J207 and is therefore energized whenever the transmitter is energized by throwing S101 to ON. J211 provides primary power for the 20-volt dc supply.

~~SECRET~~

9. MAINTENANCE

9.1 GENERAL

The general maintenance of the Control Hut should follow instructions on maintenance as outlined in NRL Instruction Book No. 25, Section 13.

Maintenance of the receivers and transmitters is covered in their respective instruction books supplied.