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NRL Instruction Book No. 37

Cy. 22

# RADIO HUT COMMAND SYSTEM UPDATING

[UNCLASSIFIED TITLE]



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U. S. NAVAL RESEARCH LABORATORY
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## 1. INTRODUCTION

This Instruction Manual is part of a group of Manuals covering the 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, when commanded by the ground-based transmitter can select various types of data to be transmitted.

The ground facilities have undergone a number of updatings since their inception. NRL Instruction Book No. 25, Addendum 2, describes two huts, namely a Primary Hut and a Secondary Hut, which are presently in active service. A Command System is installed in the Primary Hut at the Command Stations only. For most information concerning power, the receiving installation, and switching and recording, reference should be made to NRL IB25, Addendum 2.

Formal instructions have not been promulgated for the command system presently in operation. Recent extensions of the overall program have required a complete revision of the Command facilities. These instructions are provided for the installation and operation of the newest facilities.

The work of updating a Primary Hut for command purposes consists primarily in substituting a new Modulation Timer Unit and new wiring for the Transmitter Control Panel.

## 2. GENERAL DESCRIPTION

These instructions are for an updating of the Primary Hut when located at a command station. Figure 1 shows an exterior view of a Primary Hut with its two arrays of Yagi antennas. The lower array is used for both command and acquisition. It has a beamwidth approximately the same as the upper data-collection array and rotates with it on a common mast.

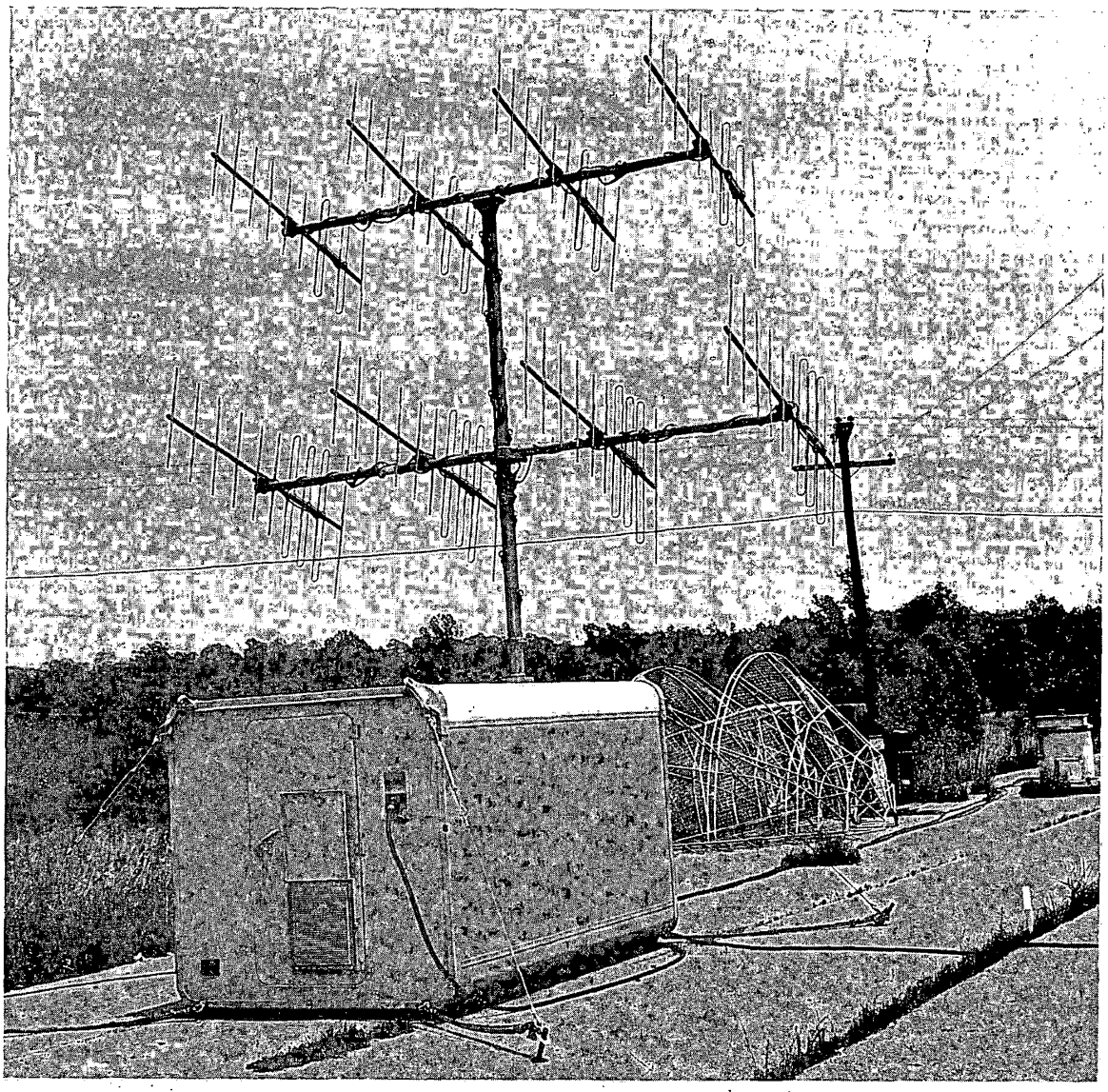

Figure 1 - Command hut showing Yagi antenna system

The basic hut equipment consists of:

a. Complete receiving and recording units with complementary patching and provision for time accuracy of operation (see NRL IB 25, Addendum 2).

b. Two identical 50-watt transmitters (Collins 242F-5CL).

c. One Modulation Timer Unit (NRL design and manufacture) hereafter designated MTU.

Suitable switching means are provided:

a. To permit either transmitter to be controlled by the MTU.

b. To switch either transmitter to the transmitting/receiving antenna or to a dummy load.

c. To switch the transmitting/receiving antenna to either the selected transmitter output or to the Channel A converter.

## 3. DETAILED DESCRIPTION

### 3.1 ANTENNAS

#### 3.1.1 Upper Mast Array

The Yagi array arranged on the upper arm of the rotatable mast is selected for optimum operation on receiving Channels B and C. The array has a beamwidth in the horizontal plane of approximately 20 degrees and a gain of 16 decibels. The array is elevated 15 degrees above the horizon to improve the vertical coverage of the system.

The feed cable for the upper array enters the mast through the topmost fitting located immediately below the lower crossarm.

The cable passes through the mast and emerges at the base beneath the operating table. It is connected through a test coupler to the Channel B and C converter (see Figure 2).

3.1.2 Lower Mast Array

The lower Yagi array is selected for optimum performance on both the Control and Channel A frequencies. The array has a beamwidth in the horizontal plane of approximately 20 degrees, to agree with the upper array, and a gain of 16 decibels. It is also pointed at an elevation angle of 15 degrees for improved vertical coverage.

The feed cable for this array enters the mast through the middle of three fittings located immediately below the lower crossarm. The cable passes through the mast emerging at the base beneath the operating table. This cable is detachable at the base of the mast for shipping purposes. From the junction it passes along the baseboard in a conduit to the Transmitter Control Panel where it connects to the Antenna-Dummy Relay.

3.2 TRANSMITTERS

Two identical VHF transmitters, Collins 242F-5CL, are installed in the transmitter rack (Figures 3 and 4). This is a crystal controlled 50-watt transmitter which has been set up for precision tone amplitude modulated CW operation. The unit at the top of the rack is designated as transmitter X and the unit in the middle of the rack is designated as transmitter Y. Either transmitter can be selected for a particular operation in which case the second unit would be considered as on standby.

The 242F-5CL is capable of operating on either of four closely spaced carrier frequencies. Two carrier frequencies are presently in use and are designated as Channel 1 and Channel 2. The selection of the proper channel is done remotely at the MTU.

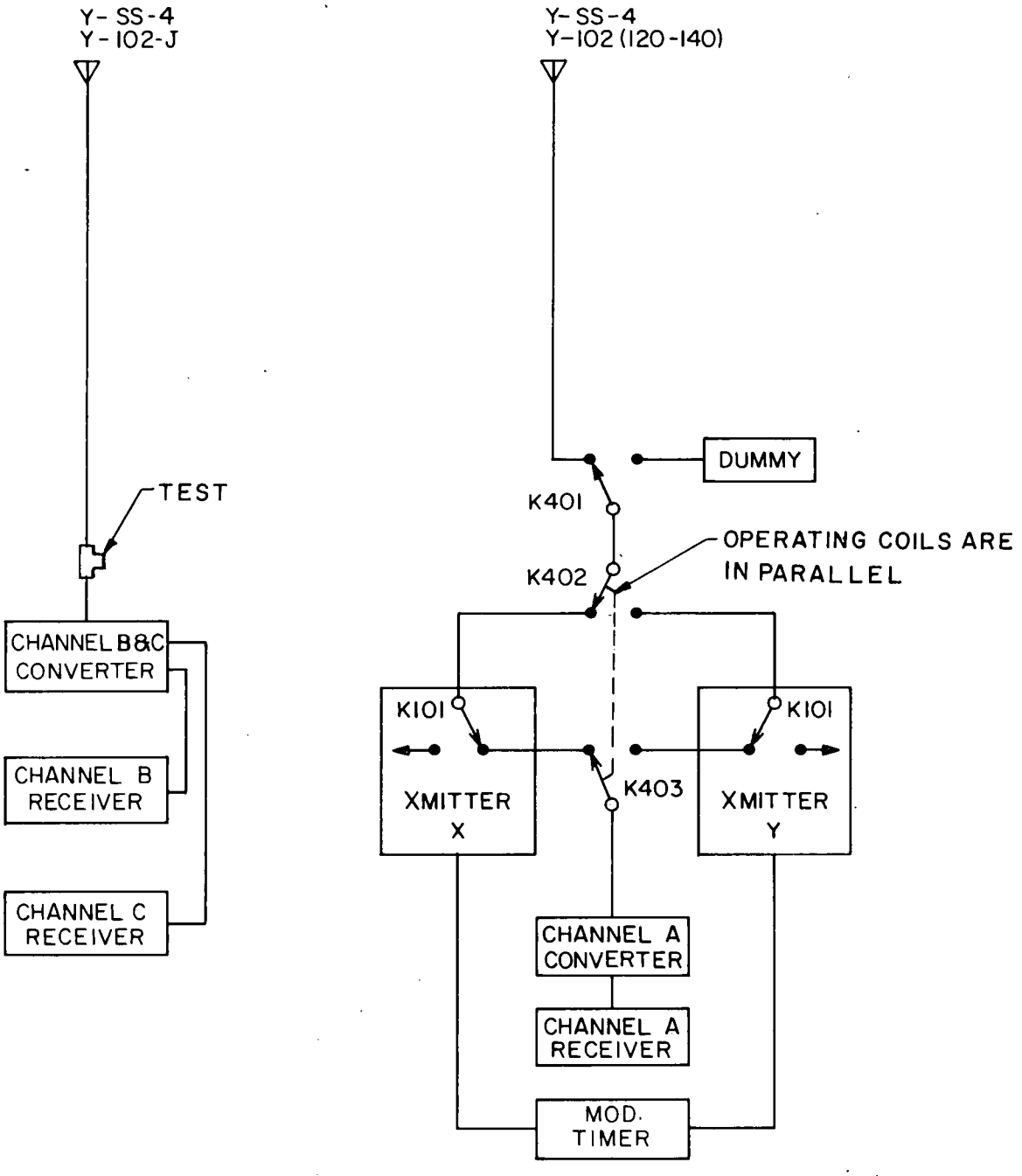


Figure 2 - Command hut – simplified RF cabling diagram

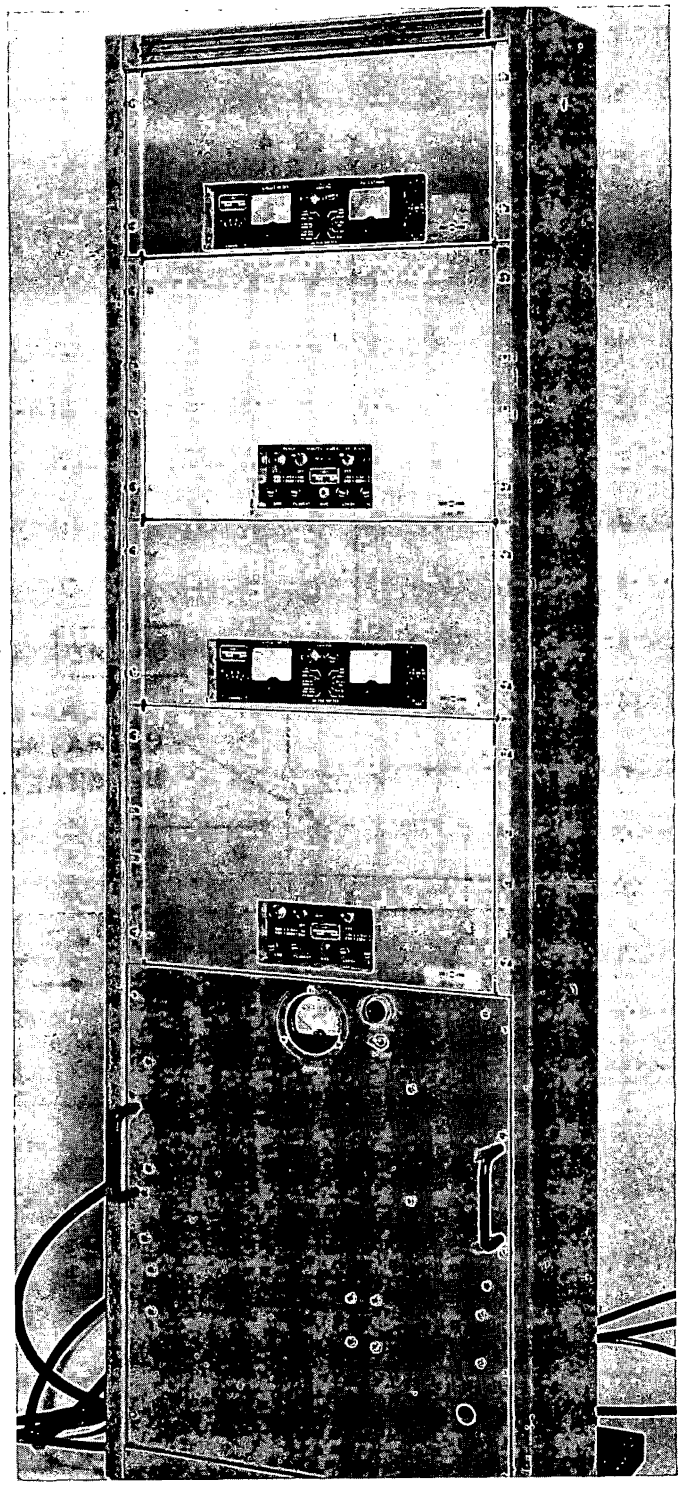

Figure 3 - Transmitter rack - front view

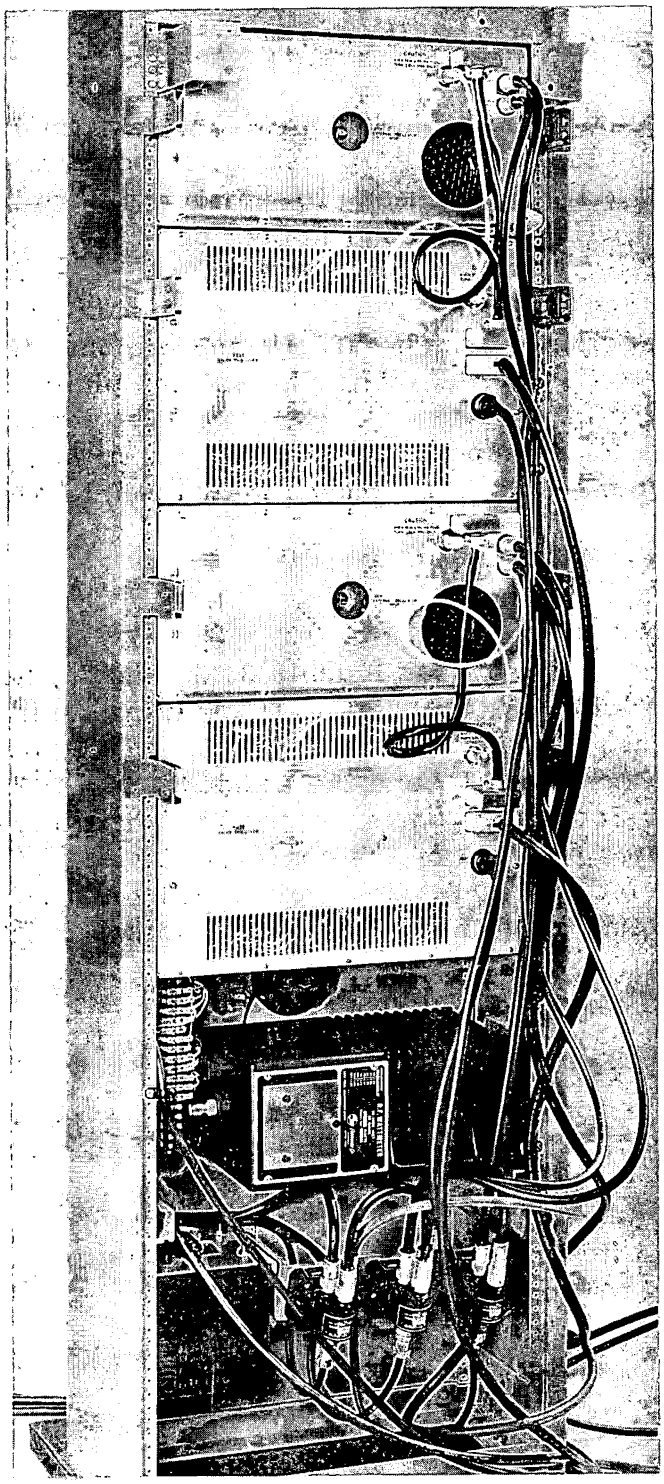

Figure 4 - Transmitter rack - back view

A detailed description of the two units which compose one transmitter can be found in the 242F-5CL instruction book which is supplied. Only minor modifications have been made to the transmitters for application in this system. These will be discussed in Section 6.

The transmitters are arranged for operation locally, at the transmitter rack, or remotely, at the MTU. For remote operation the transmitter Local-Remote switch must be on Remote and the plate switch OFF.

Modulation is supplied to the transmitter rack by the MTU for local operation at the rack. It is removed only when turned off at the MTU.

## 3.3 CONTROL PANEL

The Control Panel (see Figures 3, 4, and 5), hereafter designated as TCP, is located at the bottom of the transmitter rack and is used as a convenient mounting location for the dummy load, rf relays, and as a tie point between the MTU and the transmitters. NOTE: In the Transmitter Instruction Book, components in the RF Unit are identified by numbers in the 100 series prefixed by the conventional letter (such as C101) and those in the Modulator-Power Supply Unit by numbers in the 200 series. This system is continued herein and extended as follows:

300 series numbers refer to items in the MTU,
400 series numbers refer to items on the TCP.

The meter on the front panel shows the level of rf power entering the dummy load. The Antenna-Switch and its indicator are for switching between the dummy load and antenna.

The fuse for the 28-volt dc control supply is mounted in the lower right section for accessibility.

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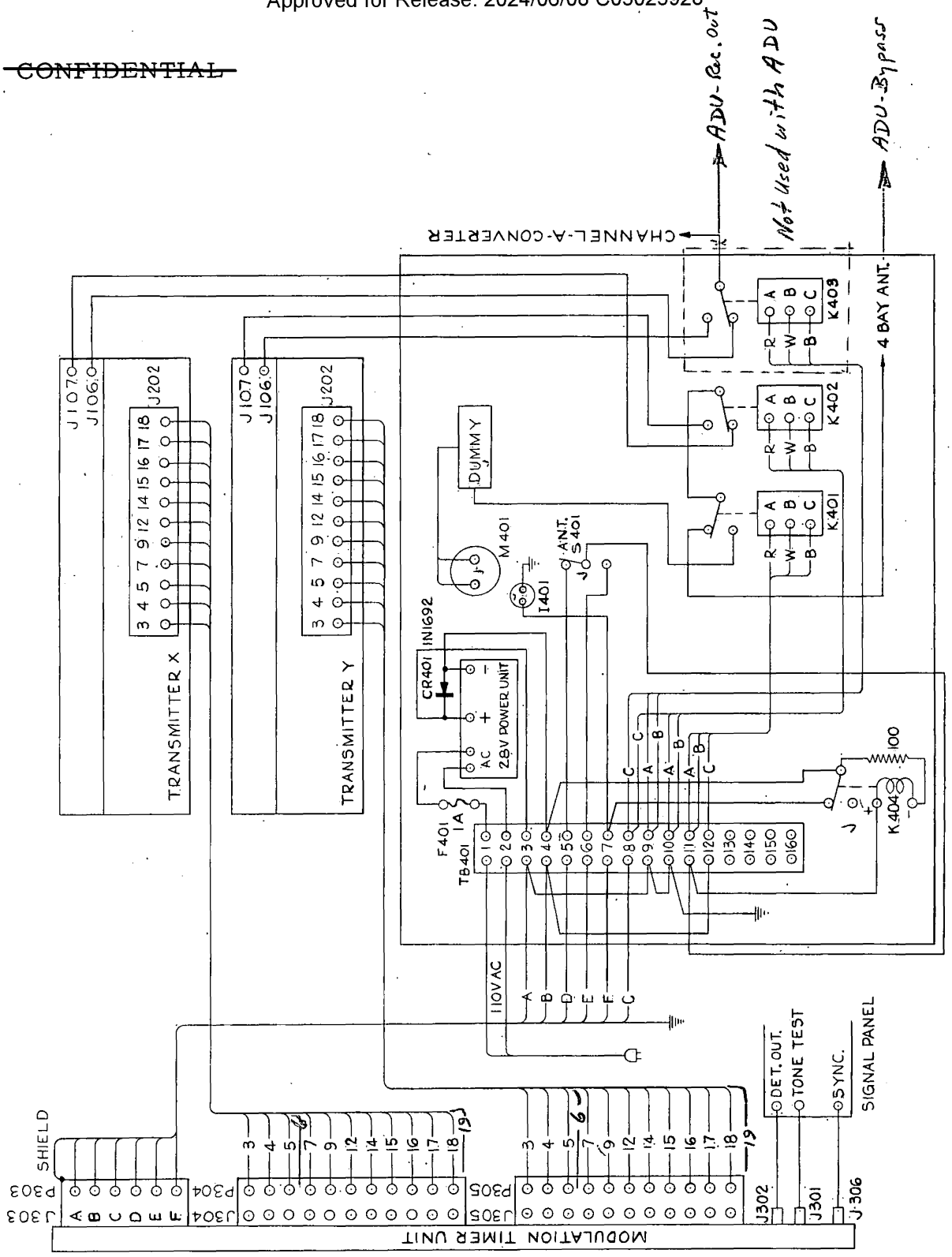


Figure 5 - Transmitter control panel wiring



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### 3.3.1 Dummy Load

A dummy load, capable of absorbing the full power output of the transmitter, is mounted on the TCP (see Figure 4). This is connected to the Antenna-Dummy Relay by a short length of rf cable.

The dummy load is selected manually by two-way operating switches, one on the MTU and one on the TCP, labeled Antenna. The position of the Antenna-Dummy Switch is indicated by a red light on both the TCP and on the MTU. The red light is "on" for connection of the transmitter to the antenna, indicating the possibility of radiating should the transmitter be keyed. The red light also indicates connection of the Channel A converter through the transmitter transmit-receive relay to the antenna and must be on for acquisition purposes.

Table 1 shows the light indication for guide reference.

TABLE 1

ANTENNA SWITCHING PATTERN

| Operation | Antenna Switch Indicator Lights |
|---|---|
| Tune or test transmitter on dummy | OUT |
| Receive or transmit | ON |

The meter on the TCP is associated with the dummy load and indicates power entering the dummy load. It serves as a check principally for transmitter tuning purposes.

### 3.3.2 28-Volt DC Supply

A 28-volt dc regulated supply is mounted below the dummy on the rear of the TCP. Both the input and output of this supply

are connected to the terminal board TB-401 which is located just above the supply (Figure 4). The power cord for this supply connects from the terminal board to a wall outlet located behind the transmitter rack. This series of power outlets also provides the power for the transmitters. The 28-volt dc supply will therefore be turned on whenever the transmitter master switch located in the hut power distribution box is turned on.

The 28-volt dc supply is used as control voltage for the three rf relays, and as the power supply for the MTU.

3.3.3 Antenna-Dummy Relay

The Antenna-Dummy Relay, K401, switches the output of the selected transmitter either to the lower antenna or to the dummy. The two controls for this relay are explained in 3.3.1.

All tuning and adjustments of the transmitters should be performed with the transmitter connected to the dummy load.

3.3.4 Antenna Transfer Relay

The Antenna Transfer Relay, K402, is made necessary by the addition of the second transmitter. It is the middle relay on the relay mounting bracket. K402 connects Transmitter X or Transmitter Y to K401. K402 is normally closed for Transmitter X. It is controlled by the Transmitter Selector switch, S314, located in the MTU.

3.3.5 Receiver Transfer Relay

The Receiver Transfer Relay, K403, is also made necessary by the addition of the second transmitter. It is located on the right of K402, Figure 4. The transmitting antenna is used also for Channel A reception. The received signal must pass through the transmit/receive switch of the selected transmitter before reaching the receiving Channel A converter. K403 must therefore follow K402 and both are controlled by the transmitter selector switch, S314, located in the MTU.

### 3.3.6 Power Circuits

The power wiring diagram for the Primary Hut is shown in IB 25, Addendum 2, Figure 41. The primary power comes in as three-wire 115-230 volts with the neutral center line on ground. It is imperative that the proper arrangement of the feeders be maintained when connecting the primary power. A chance reversal of the wires can result in irreparable damage to the equipment. The 230 volts is used for the hut heater and is controlled by a switch in the distribution box.

All power for the transmitter rack, which includes the two transmitters and the 28-volt dc supply, is taken from the distribution box in a special conduit (not shown in IB 25, Addendum 2, Figure 41) which runs along the right bulkhead near the ceiling and contains six outlets directly behind the transmitter rack. One switch, located in the distribution box, controls this power. Throwing one switch will therefore energize the command system providing the local individual power switches are left turned on.

## 3.4 MODULATION TIMER UNIT

### 3.4.1 General

A new MTU, designed and manufactured at NRL, is required for the current updating. This unit is 3-1/2 inches high by 8-1/4 inches deep and fits into the same space as the unit which it replaces. Figures 6, 7, and 8 show three views of the unit. Figure 9 is the schematic drawing of the MTU. It will be noted that all operating controls are on the front panel and all cable connections are at the back.

Table 2 shows the functions of the MTU front panel controls.

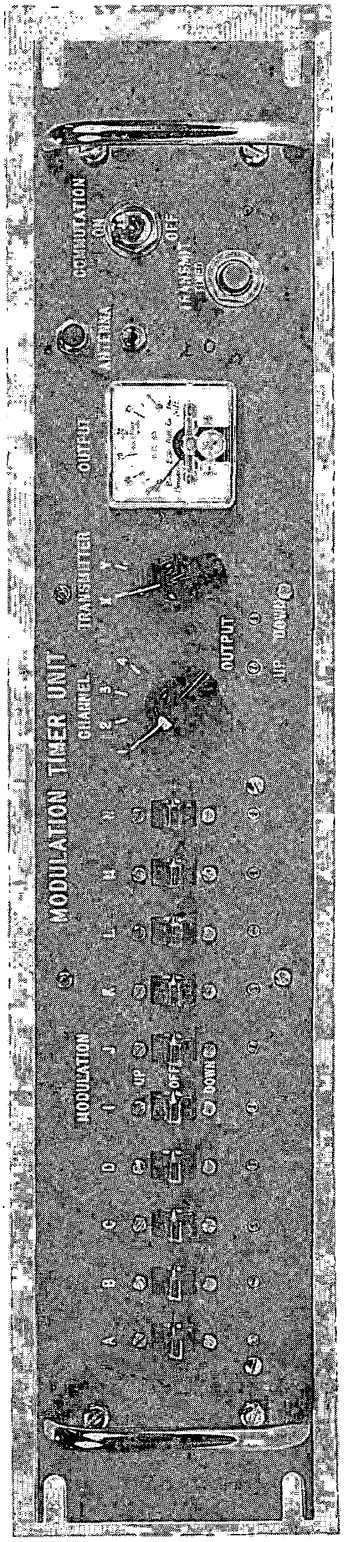


Figure 6 - Modulation timer unit - front view

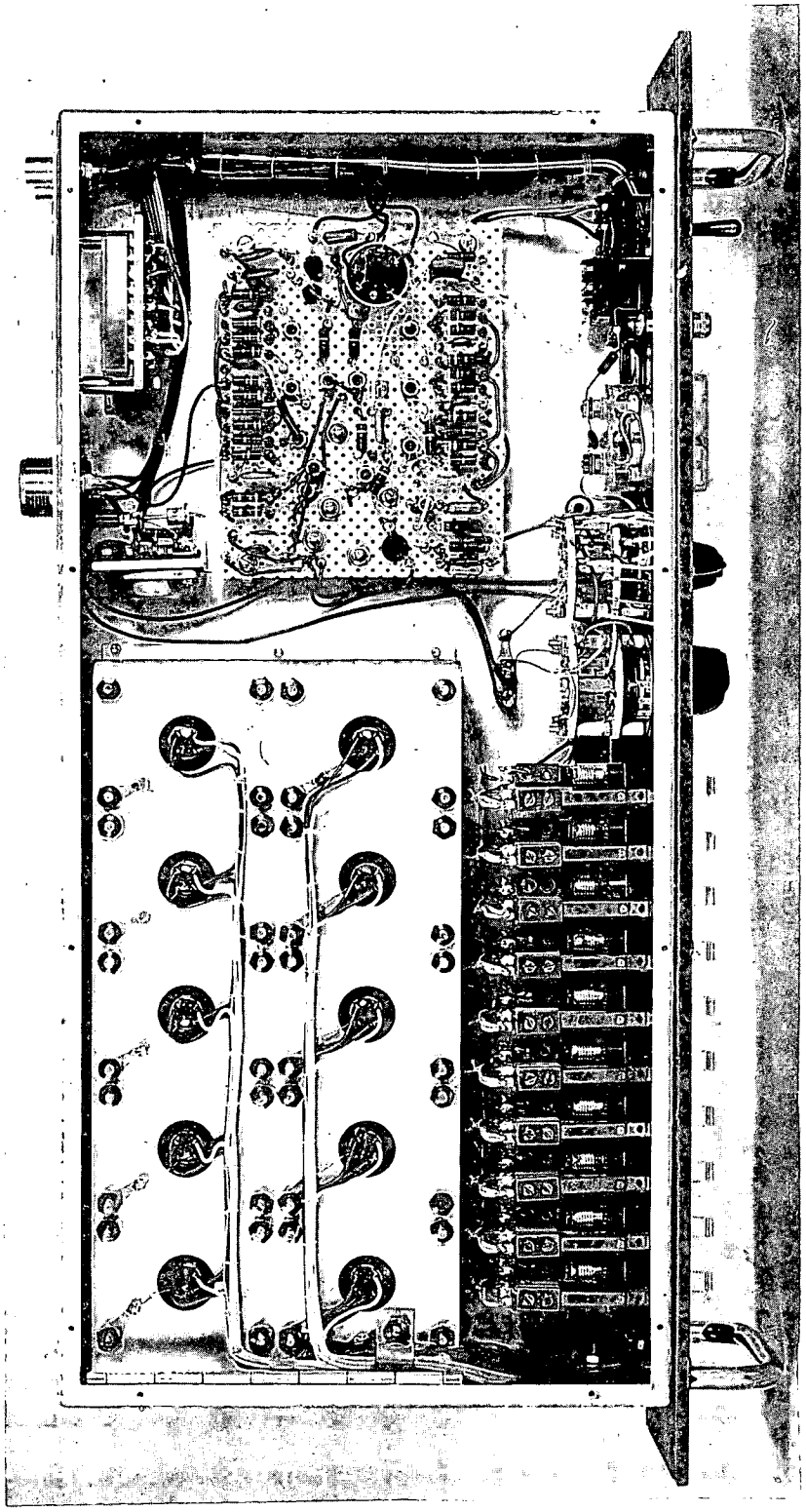

Figure 7 - Modulation timer unit - top view


Figure 8 - Modulation timer unit - back view

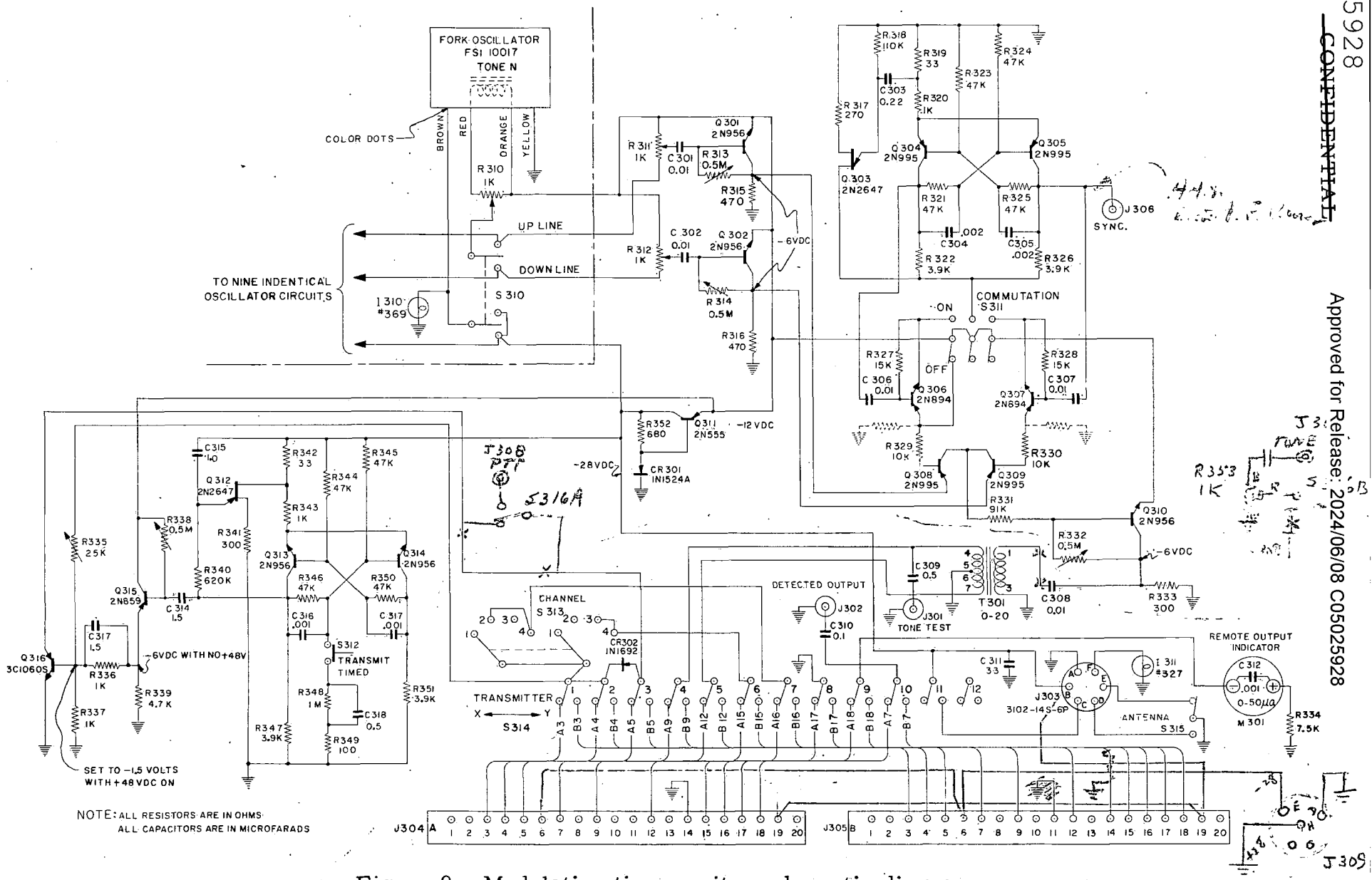


Figure 9 - Modulation timer unit - schematic diagram

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TABLE 2
MTU SWITCHES AND ASSOCIATED RELAYS

| Switch Identification MTU Panel | MTU Schematic | Switch Function | Associated Relay |
|---|---|---|---|
| Modulation A-D, I-N | S301 to S310 | To select modulation frequency | None |
| Channel | S313 | To select transmitter crystal | K103, K104, K105 in each transmitter |
| Transmitter | S314 | To select transmitter X or Y | K402 and K403 on TCP* |
| Antenna | S315** | (1) To select antenna or dummy as transmitter load<br>(2) To indicate, by light on MTU and TCP, when K401 is on antenna position | K401 and K404 on TCP |
| Transmit Timed | S312 | To key transmitter | K101 and K204 in selected transmitter |
| Commutation | S311 | To apply two tones alternately or single tone | None |

* TCP - Transmitter Control Panel
** S401 on TCP performs identical functions



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The MTU has circuits for performing three principal functions:

a. To select and control the transmitter.

b. To provide an automatic timer on the length of the transmission.

c. To provide selected modulation for modulating the carrier.

3.4.2 Tone Oscillators

The modulator circuit contains ten electrically driven transistorized tuning-fork oscillators, any one of which may be selected by a switch to modulate the carrier. In addition, a commutation circuit is included, which permits time sharing of two modulation tones successively and repeatedly during the transmission period.

Each of the ten identical three-position switches (marked A to D and I to N) turns on and connects one of the tone oscillators to a circuit to provide the modulation frequency of that particular tone.

The two basic modes supplying modulation for the transmitter are:

a. Any one tone continuously.

b. Any two tones commutated.

Mode a. is obtained by selecting a single tone in the UP position of the tone selection switch and by placing the Commutation switch in the OFF position. Note that a single tone switch in the DOWN position will not provide modulation with the Commutation switch in the OFF position.

Mode b. is obtained by selecting a single tone in the UP position and a second tone in the DOWN position and by placing the Commutation switch in the ON position. The two tones will then by supplied to the transmitter with a 50 percent duty cycle for each tone.

The center position of the tone selector switches is the OFF position. All tones not required at a particular time must be in the OFF position. This is particularly necessary when the transmitter is being tuned.

Placing two tones simultaneously either in the UP or DOWN position will result in modulation by both tones plus a beat note. This may or may not be successful in executing a command and would be used only in the emergency that either the UP or the DOWN channel has failed.

The row of small holes under the modulation switches are provided to permit access (by a special screwdriver) to the control potentiometers to adjust the output of each of the ten oscillators to the desired value, as will be later specified. The two right-hand holes are for the adjustment of these outputs when the switches are in the UP or the DOWN position, as indicated by the panel marking. See Section 5.3 (i) for adjustment of the output UP and DOWN level controls.

Figure 9 shows the individual and the UP or DOWN line controls effectively in series. This arrangement is chosen for more universal control of the modulation level. The Modulation Switching Pattern is summarized in Table 3.

TABLE 3

MODULATION SWITCHING PATTERN

| Modulation Desired | Modulation Sw. For Desired Tone | Commutation Switch | All Other Modulation Switches |
|---|---|---|---|
| Any one tone, continuously | UP | OFF | OFF |
| Any two tones, commutated | One UP, Other DOWN | ON | OFF |

3.4.3 Commutation of Modulation

To provide for a much larger number of commands than the ten available by the separate use of ten tones, provision for time sharing two oscillators by rapidly switching from one to the other repeatedly during the duration of a transmission has been incorporated into the MTU. To employ this facility, three conditions must be met:

a. The commutation switch at the far right of the panel must be ON.

b. The switch for one of the selected tones must be UP.

c. The switch for the other selected tone must be DOWN.

If the two tones are A and B, the modulation will vary from frequency A to B at a rapid rate.

Commutation is accomplished by connecting the two tones desired one to the UP line and the second to the DOWN line (see Figure 9). These tones pass through the output level set controls,

R311 and R312, to their respective amplifiers, Q301 and Q302.

The outputs of Q301 and Q302 are connected to the emitters of Q308 and Q309 which serve as switches to alternately pass the UP line and the DOWN line signals to the final output amplifier Q310. Switching is accomplished by controlling the bias of Q308 and Q309. Q308 and Q309 operate either at saturation or in cutoff, depending on whether the associated Trigistor, Q306 or Q307, is conducting or non-conducting.

The Trigistor is a PNPN device which can be triggered into saturation by a positive pulse into the base, or triggered from saturation to cutoff by a negative pulse into the base. When "on", the voltage drop, collector to emitter, is approximately 0.8 volt. When "off", the Trigistor has a very high impedance with low leakage current.

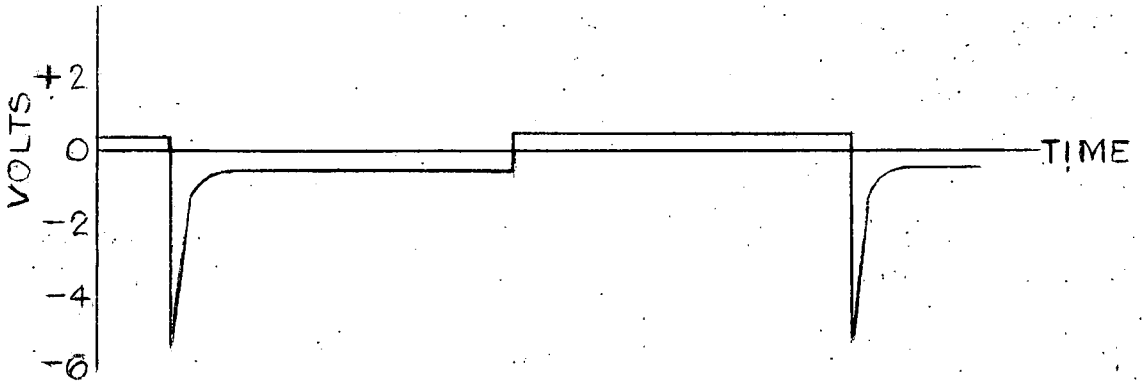
Q306 and Q307 are used to open and close the bias circuits of Q308 and Q309 in response to pulses received from the hybrid timing circuit consisting of Q303, Q304, and Q305.

The hybrid timing circuit consists of a symmetrical multivibrator which is synchronized by a pulse generated by the relaxation oscillator, Q303. The relaxation oscillator frequency is controlled by C303 and R318. For a given value of C, R can have a very broad variation in value and is used to set the frequency of the multivibrator.

The square wave output of the multivibrator is differentiated by C306, R327 and C307, R328 to supply the triggering pulses to the Trigistors. The pulses are about plus and minus 5 volts and appear as shown in Figure 10.

Figure 10

COMMUTATOR TRIGGERING PULSES




The commutation of modulation is selected by S311. With S311 in the ON position, supply voltage is applied to the multivibrator and the Trigistors. In the OFF position, negative supply voltage is applied to the switching transistor, Q308, which controls the flow of signal in the UP line. The UP line amplifier is therefore continuously connected to the output amplifier when S311 is OFF. This continuous signal availability is used in two particular cases. First, it is very convenient for setting up and adjusting the oscillator output levels. Second, it is necessary when a single tone is required for continuous modulation of the carrier.

### 3.4.4 Output Amplifier

The Output Amplifier (Q310) accepts tone signals passed by the switching transistors, amplifies them, and passes them into the output transformer, T301. A Tone Test point is connected to one side of the 600-ohm secondary of T301 for tone checking purposes.

### 3.4.5 Transmitter Selector Switch

The Transmitter Selector Switch, S314, is used to switch all remote wiring between the MTU and the two identical Transmitters.

### 3.4.6 Channel Switch

The Channel Switch is used to select the desired rf channel for the transmitter in use as determined by the Transmitter Selector Switch. Each transmitter has four possible rf channels of which only Channel 1 and Channel 2 are presently required. The Channel Selector Switch is so wired that it can accommodate the third and fourth channels whenever this becomes necessary. Reference should be made to the 242F-5CL instruction book for multiple channel operation of the transmitter.

### 3.4.7 Transmitter Timing

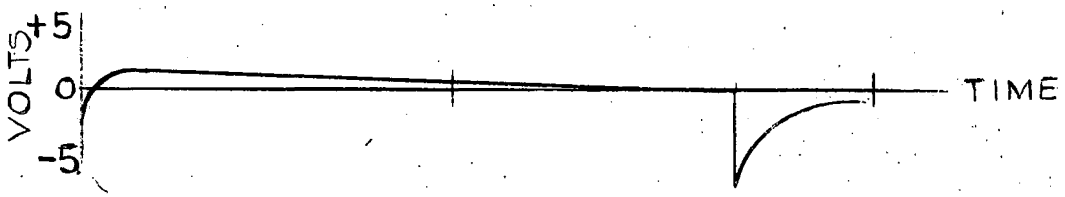
The transmitter timing circuit is used to limit the time of transmission of a given command to the time required for its execution. The timing control circuitry (see Figure 9) consists of a power Trigistor (Q316), a buffer amplifier (Q315), and a hybrid timing circuit (Q312, Q313, and Q314). Q316 is in series with the transmitter plate control relay and is turned on by a positive pulse into the base. It is turned off by a negative pulse into the base.

The positive and negative pulses are generated by the "one shot" hybrid timing circuit. They appear as shown in Figure 11. Q314 is off in the quiescent state and Q313 is on. Closing the TRANSMIT switch, S312, applies a positive pulse to the base of Q314, triggering the circuit such that Q314 is on and Q313 is off. At the end of the timing interval the unijunction transistor Q312 will fire and cause the circuit to revert to its quiescent state. C315 and R340 set the time interval which controls the length of period of the "one shot," and therefore of the transmission.

The output of Q313 is a square wave. This is differentiated by C310 and R346 to generate the positive and negative pulses which control Q316. See Figure 11.

Figure 11

TRANSMITTER TIMER TRIGGERING PULSES




### 3.4.8 Regulated Voltage Divider

The MTU is powered by the 28-volt dc supply located in the TCP. This voltage enters the MTU on pins A and B of J303. It will be noted (Figure 9) that all the circuits do not operate from 28 volts. Q311 is used together with CR301 to reduce the supply voltage to 12 volts for about half the circuitry. The zener regulator, CR301, holds the base of Q311 at minus 12 volts. The dc output of Q311 is minus 12 volts less the small emitter-to-base voltage drop of Q311.

### 3.4.9 Diode Transient Protection

The diode CR302 is connected effectively across pins 4 and 5 of J304. This is inserted to protect Q316 from voltage transients which are set up by the transmitter plate relay.

# 4. INSTALLATION

## 4.1 GENERAL

Installation for this updating consists of:

a. Removing the present MTU and replacing it with a new one supplied by the Naval Research Laboratory (NRL).

b. Installing Fuse Holder in the TCP.

c. Removing the present wiring on the TCP and replacing it with the new wiring supplied by NRL in accordance with Figure 5.

## 4.2 MODULATION TIMER UNIT

The MTU is designed for direct replacement of the unit presently installed. Installation consists of removing the present unit and mechanically installing the new one.

In addition to the existing cables which will be connected according to Figures 5 and 9, one additional cable must be connected from J306 to the oscilloscope. This can be run directly to the signal panel for patching to the scope or it can be run through the patch panel and then to the signal panel. The method of installing this cable will depend on the availability of space on the signal panel. This is a convenience connection and not critical to the system operation.

## 4.3 TRANSMITTER CONTROL PANEL

The TCP wiring has been changed to accommodate a new fuse for the 28-volt dc regulated supply, the two-way Antenna Control Switch, S401, and relay K404, which is an auxiliary unit used to indicate the condition of K401.

K404, F401 fuse holder and a complete wiring harness have been supplied.

Remove all wiring from the TCP. Remove TB401. Mount K404 on the underside of the angle bracket which supports TB401 and at an elevation such that the relay spans terminals 5 to 8. The relay should be mounted on stand-off pillars with its flat side adjacent to the back of TB401. (See Figure 12.)

Drill for and mount the fuse holder for F401 above the 28-volt dc supply mounting bracket (Figure 12). Install a one-ampere slo-blow fuse in the fuse holder.

Remount TB401 with the terminal numbering plate on the underside such that the numbers are visible on the left side of TB401 when viewing it from the rear of the TCP.

Wire the TCP according to Figure 5. Particular attention should be given to the installing of control cables for K401, K402, and K403. The location of these cables has been changed on TB401 from the present wiring. The wiring of the six-conductor power and relay control cable has also been changed and must be carefully installed according to Figure 5.

## 5. INSTALLATION CHECKOUT

### 5.1 POWER

Before turning on the main power be certain that the transmitters and the 28-volt dc power supply cables are plugged into 115-volt ac outlets.

### 5.2 TRANSMITTERS

Both transmitters have been recently in use and are assumed to be in good operating condition. The transmitters will

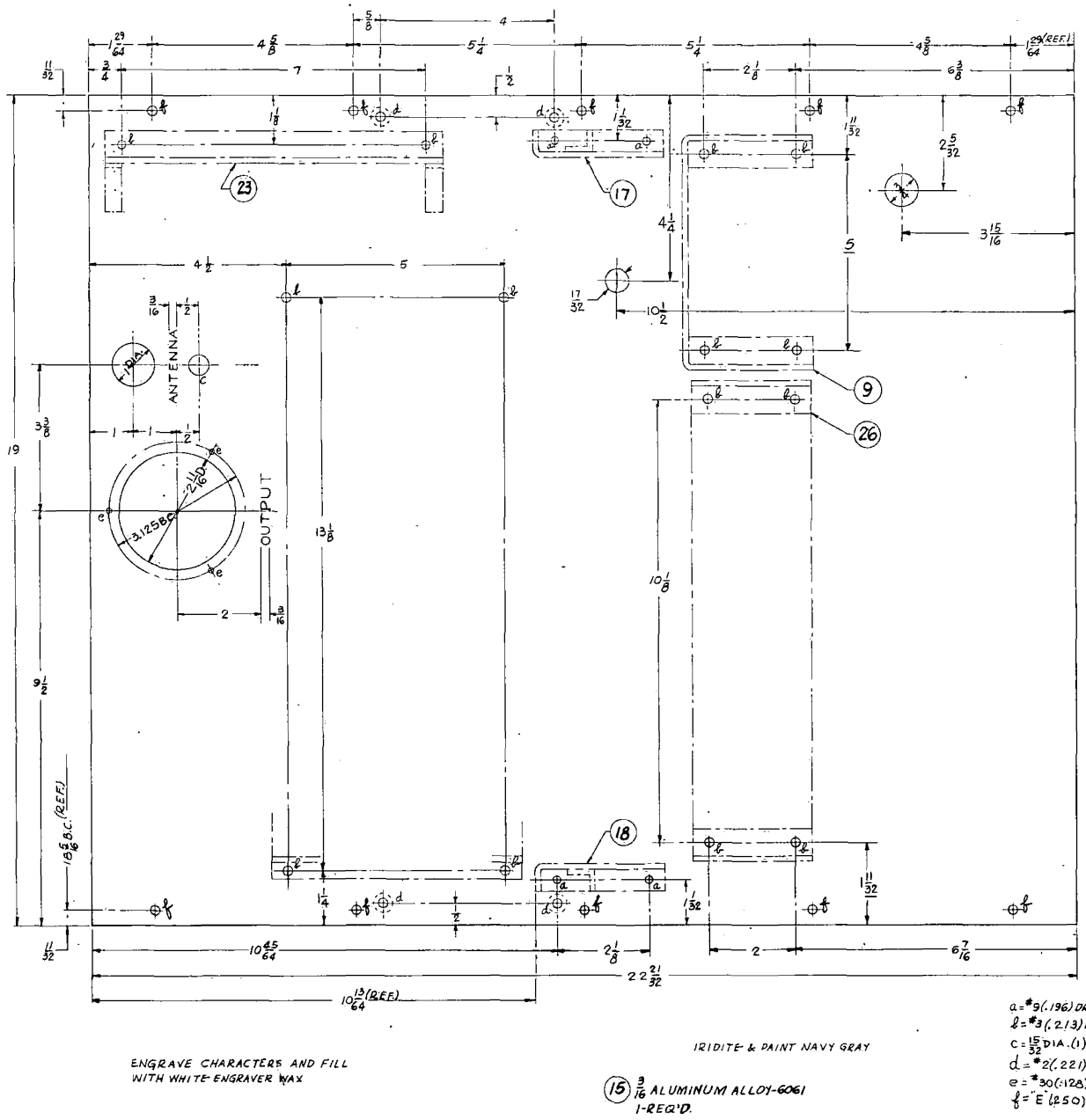



Figure 12 - Transmitter control panel detail

therefore need little more than "touching up" to assure that all circuits are operating satisfactorily. Obtain a copy of the Collins Instruction Book 520-5922-00 covering these transmitters which have been supplied.

Power for the Transmitter Rack is obtained from an individual circuit running from the Power Panel at the door of the hut. It is controlled by a separate switch marked TRANSMITTERS. When this is thrown ON, power is applied to all units in the Transmitter Rack, providing, of course, the individual transmitter power switches are ON. This includes the 28-volt dc power unit.

a. Set the TRANSMITTER switch on the MODULATION TIMER UNIT to Transmitter X. Place all Modulation Switches in the center OFF position. use of CHANNEL 3.

b. Apply power to Transmitter X only. This is the top unit. Keep Transmitter Y off.

c. Be sure the ANTENNA switch is thrown correctly and indicates connection to DUMMY (Indicator Light OUT) and that the LOCAL REMOTE switch is on REMOTE.

d. After you hear the time delay relay actuate, throw the LOCAL-REMOTE switch to LOCAL, watching the Cathode Current meter. If this meter reads less than 115 ma, the PA tube is not being overloaded and it is safe to proceed.

e. Now proceed to run the dial switch associated with the CIRCUIT METER through its range, starting with the PA BIAS position and proceeding clockwise. Refer to Tables 2-3 and 2-4 of the Collins Instruction Book and check each reading against the Book value.

f. If all readings check within the limits given in the Book, the power output is 50 watts and the PA Cathode Current

is not in excess of 115 ma, the adjustments of Transmitter X may be considered satisfactory except for the final setting of the modulation percentage.

g. If any of the readings appear abnormal, proceed to touch up the tuning in accordance with SECTION II of the Collins Instruction Book.

h. After Transmitter X is considered entirely satisfactory, leave it running (in order to set the modulation later) and throw to Transmitter Y on the Modulation Timer Unit.

i. Apply power to Transmitter Y and proceed to check it in exactly the same manner that was followed with the other transmitter.

j. When this has been found, or put, in satisfactory operating condition, you are ready to check the Modulation Timer Unit and set the modulation percentage.

NOTE: There is a power output meter on the Transmitter Control Panel and a position on the CIRCUIT METER that also reads power output. These two meters may not agree. The meter on the Transmitter Control Panel has been included as a check on the FILTER COUPLER UNIT only. It will normally be found to read LOW and should be considered as relative power only.

## 5.3 THE MODULATION TIMER UNIT

The MTU will be used as the source oscillator for setting the modulation level into the transmitter. The adjustment of the MTU and the transmitter modulation level will therefore be considered together.

Energize the oscilloscope and connect one trace to the Tone Test BNC fitting on the Signal Panel. Set its vertical gain to permit a reading of 0.35 volt peak-to-peak signal with good accuracy and the sweep for a moderately high tone frequency.

On the left of the MTU panel will be found ten modulation switches and beneath each one an adjustment screw. Adjustment screws set the output level of each individual tone. The switches are used both for turning on a particular tone and for connecting this tone either to the UP line or the DOWN line.

The following discussion is very similar to paragraph 2.4.4 (Audio Adjustments) as found in the transmitter instruction book and should be considered as a supplement for, and complementary to, section 2.4.4 thereof.

Paragraph 2.4.4, Audio Adjustments, should read as given below:

a. Connect a vtvm to J206 for measuring negative bias voltage. Turn MIKE GAIN (R212) and REMOTE GAIN (R215) fully counter-clockwise. Adjust BAL (R216) until oscillation, as shown on the vtvm, ceases. Set this control in the center of the range over which there is no oscillation and lock control. If there is no oscillation evident at any setting, set the control to midrange and lock.

b. Set the MOD EQU control (R116) on the rf unit to midrange.

c. The table shown below will be used for reference in this and succeeding paragraphs. These levels correspond to required levels in paragraph 2.4.4 of the transmitter instruction book.

Table 4

MTU SIGNAL OUTPUT LEVELS

| Level | | Output Volts (rms) | 1/2 Output Volts (rms) | 1/2 Output Volts (peak-to-peak) |
|---|---|---|---|---|
| $c^1$ | -30dbm | .025 | .0125 | .035 |
| $d^1$ | -20dbm | .077 | .038 | .11 |
| $e^1$ | -20dbm | .077 | .038 | .11 |
| $f^1$ | -10dbm | .245 | .125 | .350 |

On the MTU, set the modulation switch A in the UP position. Turn the commutation switch OFF. Connect either a vtvm or an oscilloscope to the Tone Test point J301. Obtain a transmitter input level of -30dbm. At this point, determine that the full range of -30dbm to -10dbm is obtainable by setting only the UP output level potentiometer (R311, near the center of the MTU panel). If this is not possible, find an adjustment of the potentiometer under switch A, (R301), which will make this possible. Set the UP output level to -20dbm (0.11v p-p at J301). Each oscillator (A through N) should now be adjusted by setting the individual gain controls to give an output at J301 of 0.11 volt peak-to-peak. Note that this adjustment is made with only one oscillator on at a time in the UP position and the commutation switch in the OFF position. Return to switch A and set UP level to -30dbm (0.035 p-p at J301).

d. Turn REMOTE GAIN (R215) to maximum. Attach a vtvm to J206. Adjust MOD LIM (R227) until a slight bias voltage is developed at J206. 0,2

e. Increase the UP output gain (R311) of the ~~MTU~~ to obtain a level of -20dbm at J301 and record the bias voltage at J206. 3.4

f. The level set in step e. is the remote line input operating level.

g. Increase the UP output gain to a level of -10dbm and adjust MOD EQU control on the rf unit for an indication of 95 percent modulation of 50 watts rf power. Reduce the UP output level to -20dbm. The audio compressor circuit in the modulator power supply will control the modulating voltage to within 3db for 10db change in modulation level.

h. Since the oscillators are already connected, this step is superfluous.

i. To set the commutation level, place the commutation switch ON. Connect the SYNC (J306) to an oscilloscope. Place one oscillator such as A in the UP position and a second oscillator such as B in the DOWN position. Adjust the DOWN Gain Control (R312) until the two output levels are equal. Do not at this point disturb the individual level settings.

j. The adjustments given above set up the MTU for operation either with a single tone (one oscillator in UP position), or with two tones commutated (one oscillator in the UP position and a second oscillator in the DOWN position) with the commutation switch ON.

## 6. TRANSMITTER MODIFICATIONS

### 6.1 GENERAL

The transmitters require slight modifications in order to permit use with the MTU. These modifications have been made to each transmitter, but are set down here for completeness of these instructions. Reference should be made to Figure 8-1 of the VHF Transmitter 242F-5CL Instruction Book. It is recommended that Figure 8-1 be marked according to the following changes.

### 6.2 DETECTED SIGNAL AUDIO

Detected Audio is brought out of the transmitter on pin 7 of J202. This is accomplished as follows:

a. Lift the lead from pin 7 of J202 and tape it. Connect a jumper from pin 7 of J202 to pin 7 of J204.

b. Lift center of shielded wire from AGC Box entry at C165. Extend the wire to reach TP101 on the AGC Box and sleeve the junction of the wires. Solder the end of the extension to TP101.

### 6.3 FILAMENT CONTROL

The jumper marked "Z" has been added according to NOTE 6 on Figure 8-1 of the transmitter instruction book.

### 6.4 TRANSMITTER LOAD INTERLOCK

In order to prevent the application of plate power until K402 connects a load to the transmitter selected by ~~S314~~ S301 the following changes must be made:

a. Lift the lead going to ground from S203 and connect it to B11 of S202. This effectively removes the ground from B12 of S202, connects B11 to B12 and to ON and PTT of S203.

7. OPERATION

The transmitting equipment is 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.

A word of caution here, however, concerns the multiple mode capability of the MTU. Certain settings of the MTU controls will be used for a given mission. These will be different for different missions and must be accurately set up on the MTU. In particular, a single-tone transmission requires one tone set in the UP position with the Commutation Switch OFF. A two-tone transmission requires one tone to be set in the UP position and the second tone in the DOWN position with the Commutation Switch ON.

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

a. At a suitable time prior to "Command," keeping in mind that a warmup period of at least 15 minutes should be allowed, start both transmitters by throwing their respective Master Power Switches ON.

b. Set the Modulation Switch or switches as required.

c. Set the Channel Switch.

d. Select Transmitter X.

e. Turn Antenna Switch to ON (a red light will come on).

f. Set the "Commutation" switch to agree with b. (See Table 3.)

g. At the command time, push the Transmit button and observe the meter to assure that it momentarily reads approximately half scale.

h. Should the meter fail to read, quickly throw to Transmitter Y and repeat g.

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

## 8. MAINTENANCE

### 8.1 TRANSMITTERS

Maintenance of the transmitters is covered in Instruction Book 520-5922-00.

### 8.2 MODULATION TIMER UNIT

All MTU units have been checked prior to shipment and operating difficulty is not expected under normal conditions.

A number of variable resistors are employed for class A operation of the various amplifiers and setting the bias of the transmitter keying Trigistor. All amplifiers are operated with -6 volts dc at the collector. (See Figure 9.) This is obtained by adjusting the bias by means of a variable resistor between the collector and base of the ~~transmitter~~ resistor. Small variations from -6 volts dc will not materially affect operation. These voltages can be checked at routine maintenance or in case of failure.

A sketch of the variable resistor location on the MTU subpanel is shown below. It is shown as viewed from the top of the MTU with the dust cover removed.

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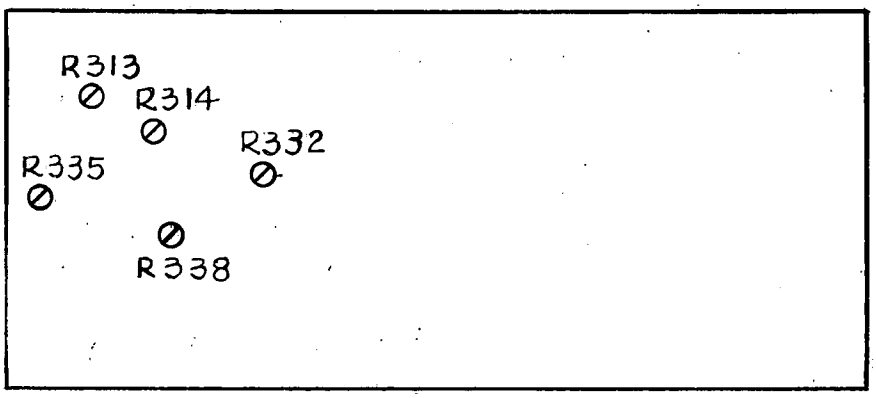
FIGURE 13

VARIABLE RESISTOR LOCATION ON MTU SUBCHASSIS




R335 controls the bias level at the base of Q316. Since R335 is connected to +48 volts, supplied by the transmitter, it is possible by reducing R335 to cancel the negative voltage developed across R337 by the emitter current of Q315. R335 is adjusted until the base of Q316 is at a level of -1.5 volts dc.

The signal level at various points through the MTU is given below. These are typical readings. The important level is at J301 which has been explained in detail in section 5.3.

TABLE 5

MTU CIRCUIT SIGNAL LEVEL READINGS (TYPICAL)

| Transistor Collector | Voltage Peak to Peak |
|---|---|
| Q301 | 2.2 " " " |
| Q308 | 2.2 " " " |
| Q310 | 1.7 " " " |
| Transformer | |
| T301 - Pin 1 | 0.45 " " " |
| Tone Test Point J301 | 0.11 " " " |



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