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TECHNICAL MANUAL

FOR

ANTENNA COUPLER GROUP AN/SRA-34(V)

CHAPTER C
ANTENNA COUPLER
CU-1169/SRC-16

DEPARTMENT OF THE NAVY
NAVAL SHIP SYSTEMS COMMAND

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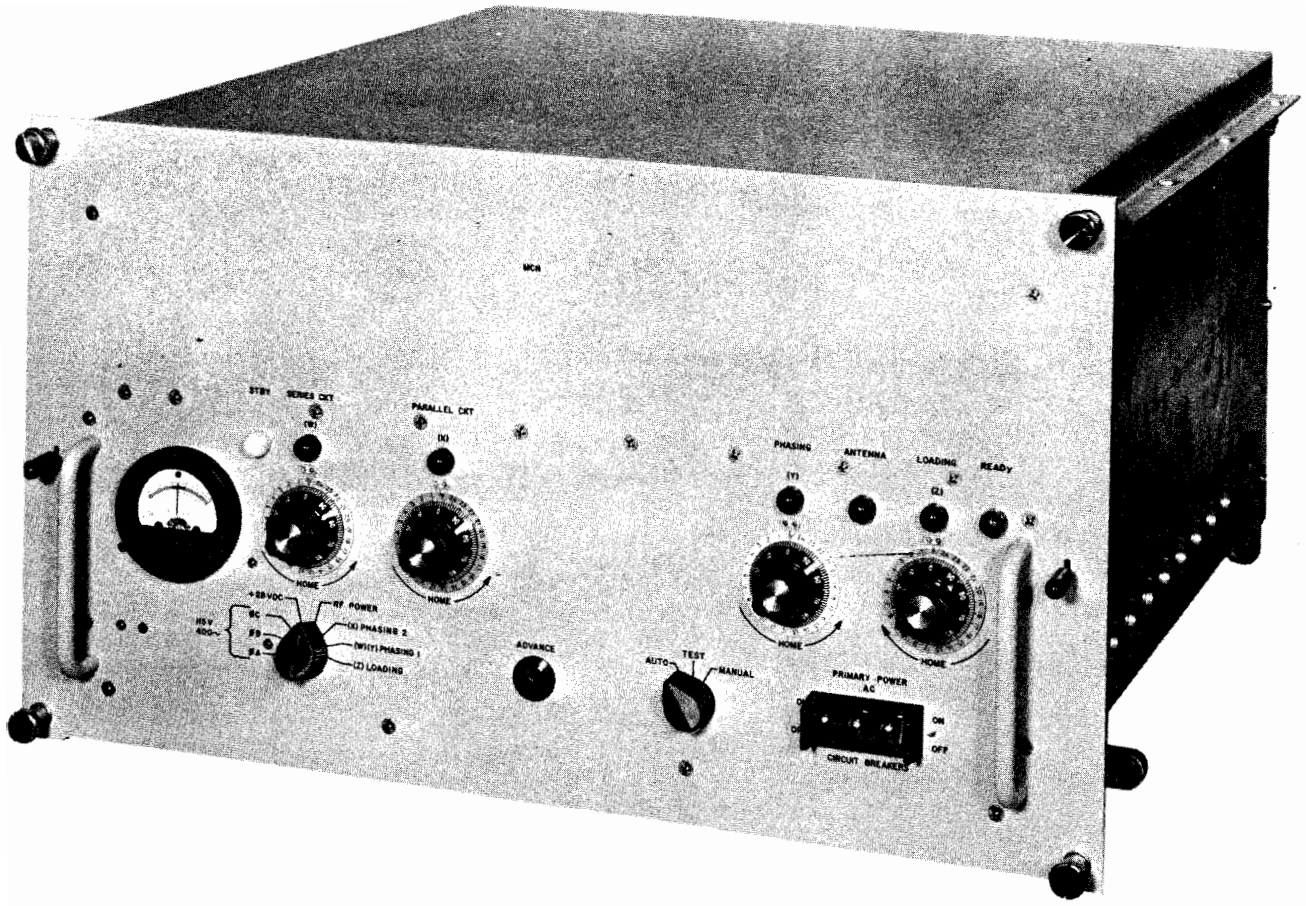

Figure 1-1. Antenna Coupler CU-1169/SRC-16

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SECTION 1

GENERAL INFORMATION

1-1. SCOPE.

This chapter of the technical manual describes Antenna Coupler CU-1169/SRC-16. The chapter contains general information, operating instructions, troubleshooting procedures, and maintenance procedures. This chapter of the technical manual is in effect upon receipt. Extracts from this publication may be made to facilitate the preparation of other Department of Defense publications.

1-2. ASSOCIATED PUBLICATIONS.

The technical manual for Electronic Circuit Plug-in Unit Test Set AN/URM-158 contains the functional description and troubleshooting procedures for the following assemblies of the antenna coupler: power supply, electronic control amplifiers, antenna coupler servo control, and antenna coupler control. Reference is made to this manual at appropriate points throughout this chapter. The maintenance standards book for Antenna Coupler Group AN/SRA-34 includes the preventive maintenance procedures for Antenna Coupler CU-1169/SRC-16. Parts list information is included in chapter F of this technical manual.

1-3. GENERAL DESCRIPTION.

Antenna Coupler CU-1169/SRC-16 is shown in figure 1-1. The CU-1169/SRC-16 is an automatically tuned antenna multicoupler which provides sufficient frequency selectivity and isolation to permit up to eight receiver and/or transmitter combinations to operate simultaneously into a single 2- to 6-mc broadband antenna. Antenna Coupler CU-1169/SRC-16 operates over the frequency range of 2.000 mc to 5.999 mc and tunes automatically in response to control line information and rf energy supplied by associated equipment such as Radio Set AN/SRC-23(V). The CU-1169/SRC-16 tuning normally is completed within 30 seconds after initiation, although tuning time up to 1 minute, maximum, may sometimes be required.

1-4. REFERENCE DATA.

Frequency range	2.000 mc to 6.000 mc.
Input impedance	50 ohms nominal.
Antenna vswr (tuning range)	4 to 1 (50 ohms) maximum.
Correct vswr (at power amplifier output)	1.33 to 1 (50 ohms) maximum.
Rf input power	6000 watts pep., 3000 watts average continuous, maximum. 100-watt average forward power required for automatic tuning and constant surveillance of antenna.
Efficiency	60 percent minimum.
Phase shift	1 degree in 22 milliseconds, maximum.
Isolation, input to output	45 db minimum with channel frequencies separated 15 percent or more.
Isolation between inputs	50 db minimum with channel frequencies separated 15 percent or more.
Total distortion and noise	Not less than 120 db below the applied signal.
Control line inputs	Operate high power, reciever tune, and tune activate ground-on-line control signals are supplied by associated equipments.
Control line outputs	Tune complete, carrier insert, and alarm ground-on-line control signals are supplied by antenna coupler.
Primary input voltage	115 volts ±10 percent, 400 cps, 3-phase delta.
Primary input power	100 watts maximum.
Type of service	Continuous, unattended, remote.
Ambient temperature	0 to 50 °C (32 to 122 °F).
Ambient humidity	Up to 100-percent relative humidity.

Size	22-7/8 inches wide, 21-3/4 inches deep, 13-1/2 inches high.
Weight	140 pounds.
Mounting	Mounts in antenna coupler cabinet CY-4032/SRA-34(V).
Cooling.	Forced-air cooling is required and is supplied by a central blower in cabinet CY-4032/SRA-34(V).

1-5. PREPARATION FOR RESHIPMENT.

When the antenna coupler is prepared for shipment, it should be securely crated in a fabricated wooden case capable of withstanding the handling normally encountered in transit. Special packaging is not required except to protect the front panel controls and connectors protruding from the bottom of the unit. When technical manuals are shipped with the equipment, mark the packing case containing the manuals with the words TECHNICAL MANUALS INSIDE.

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SECTION 2

INSTALLATION

2-1. UNPACKING AND HANDLING.

Antenna Coupler CU-1169/SRC-16 is packed in accordance with the best-known commercial practices. Normal care should be exercised in handling and unpacking the shipping container. After unpacking all units, perform the inspection checks of paragraph 2-4.

2-2. POWER REQUIREMENTS AND DISTRIBUTION.

Antenna Coupler CU-1169/SRC-16 requires a 115-volt, 400-cps, 3-phase delta-connected power source capable of delivering 100 watts. Provisions for adequate power are normally made by the installing activity. Power is supplied through Electrical Equipment Cabinet CY-4032/SRA-34(V) in which the antenna coupler is installed.

If primary power is disrupted for maintenance or other purposes, make certain that the phase sequence is restored as shown on the primary power distribution diagram in the installation section of chapter A. Proper phase sequence can be determined with a phase sequence indicator or by observing that the cabinet blowers are rotating in the direction indicated by the arrow on the blower case. If phase sequence is incorrect, reverse any two of the primary power leads entering the cabinet.

2-3. INSTALLATION REQUIREMENTS.

Make certain that the CU-1169/SRC-16 is secured in the cabinet slides and that it slides freely in both directions. Antenna Coupler CU-1169/SRC-16 should slide completely into the cabinet without the use of force. Forcing or slamming the couplers into the cabinet will damage the rf and control connectors. Examine the connectors at the bottom of the antenna coupler and on the cabinet shelves for deformation or misalignment.

a. INSTALLATION OF ANTENNA COUPLER CU-1169/SRC-16. - To install Antenna Coupler CU-1169/SRC-16 in Electrical Equipment Cabinet CY-4032/SRA-34(V), perform these steps in order. Mounting hardware is shown in figure 2-1.

(1) Extend cabinet slides until they lock in place.

(2) Place antenna coupler on cabinet slides, and engage two mitered retaining studs (B) on each side with grooves on antenna coupler sides (C).

(3) Push antenna coupler toward rear of cabinet (unit will move about 3 inches), and lock in place with two captive fasteners (D).

(4) Remove O-ring moisture seal washers from plastic envelope fastened to handle of coupler, and place these rings over rf connectors on bottom of unit so that they rest against the shoulders on these connectors.

(5) Release cabinet slide lock (A), and push antenna coupler firmly into the cabinet.

(6) Press in and turn clockwise four thumbscrews (see figure 3-1) to secure antenna coupler in place.

b. REMOVAL OF ANTENNA COUPLER CU-1169/SRC-16. - To remove Antenna Coupler CU-1169/SRC-16 from Electrical Equipment Cabinet CY-4032/SRA-34(V), perform these steps in order. Mounting hardware is shown in figure 2-1.

(1) Turn four thumbscrews counterclockwise (see figure 3-1) until thumbscrews are loose.

(2) Push up on two thumb-latch levers (see figure 3-1), and pull antenna coupler from cabinet as far as it will come.

CAUTION

If antenna coupler is to be operated in the extended position, be sure to connect the auxiliary blower and jumper cables according to the instructions in paragraph 5-2.

(3) Remove O-ring moisture seals from rf connectors, and place them aside until coupler is to be re-installed in cabinet.

(4) Turn two captive fasteners (D) counterclockwise as far as they will go.

(5) Pull antenna coupler about 4 inches further from cabinet, and lift coupler from cabinet slides.

2-4. INSPECTION.

After the installing activity has completed installation of the equipment, perform the following mechanical checks.

a. Operate all front panel controls. Turn all tuning knobs through their full range of travel. Operation must be uniform and smooth.

b. Remove dust cover at top of unit. Check all subassemblies for secure mounting.

c. Check rf assemblies for secure mounting.

d. Inspect unit for obvious damage, particularly to the rf and control connectors at the bottom of the unit.

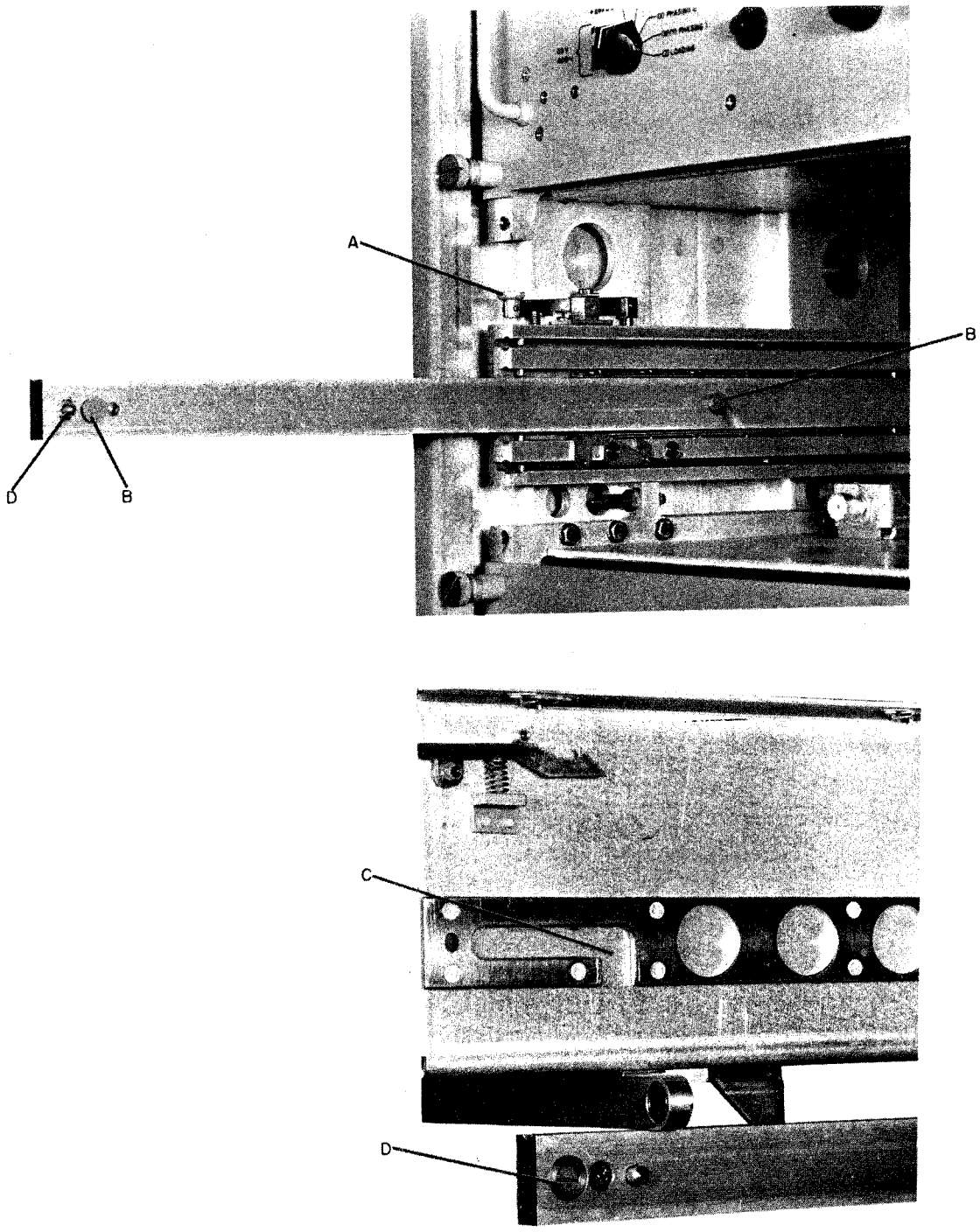

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Figure 2-1. Antenna Coupler, Installation and Mounting Hardware

SECTION 3

OPERATION

3-1. FUNCTIONAL OPERATION.

Antenna Coupler CU-1169/SRC-16 operates automatically in response to control signals provided by associated equipment such as Radio Set AN/SRC-23(V). Front panel controls and indicators are provided for maintenance and emergency operation and for visual observation of correct operation.

Refer to the block diagram, figure 4-1. The antenna coupler is an rf tuning device composed of inductors and variable capacitors. When a radio channel is placed in operation, rf energy is supplied to the input of the antenna coupler. The phasing-loading discriminator and the phasing discriminator sense inaccuracies in the adjustment of the variable elements and, through a control circuit, cause servo motors to run. The servo motors are connected to the variable elements and drive them toward a point where the discriminators are able to sense no remaining tuning error.

The CU-1169/SRC-16 operates over the frequency range from 2.000 mc to 5.999 mc and has the capability of correctly tuning up to eight channels (each with its own antenna coupler), operating any combination of transmitters and receivers, into a common broadband antenna. The only restriction is that adjacent frequencies must be separated by at least 15 percent.

3-2. DESCRIPTION OF CONTROLS AND INDICATORS.

Table 3-1 lists the functions of antenna coupler controls and indicators. Refer to figure 3-1 for location of controls and indicators.

3-3. NORMAL OPERATING PROCEDURES.

Under normal circumstances, operation of Antenna Coupler CU-1169/SRC-16 is fully automatic and is controlled by control signals originating in the components of Radio Set AN/SRC-23(V). To energize the antenna couplers for operation, move the antenna coupler cabinet CIRCUIT BREAKER to the ON position. Move the POWER circuit breaker bar on each antenna coupler to the ON position. Check for approximately 115 volts on antenna coupler test meter when test selector switch is set to 115-volt, 400-cps ØA, ØB, and ØC. Check all three phases, and note that test meter indications are approximately equal for each phase. Finally, move the AUTO-TEST-MANUAL switch to the AUTO position. The equipment now is prepared for automatic operation. Cabinet doors may be closed, and no further attention is required. Make sure cabinet blowers are operating before closing cabinet doors and leaving the area.

TABLE 3-1. CONTROLS AND INDICATORS

CONTROL OR INDICATOR	FUNCTION
POWER ON circuit breakers	Protects 3-phase input power, and serves as off-on switch.
AUTO-TEST-MANUAL switch	
AUTO position	Enables antenna coupler to tune automatically in response to control information supplied by system.
TEST position	Used for maintenance only. Allows each tuning step to operate normally, but prevents the antenna coupler from advancing to the next tuning position until the ADVANCE pushbutton is operated.
MANUAL position	Prevents the antenna coupler from tuning automatically. Each tuning step must be performed manually, and indications must be derived from the test meter.

TABLE 3-1. (Continued)

CONTROL OR INDICATOR	FUNCTION
ADVANCE pushbutton	Advances antenna coupler tuning to the next step when the AUTO-TEST-MANUAL switch is in the TEST or MANUAL position and proper tuning sequence is followed.
Test selector switch	Selects the antenna coupler function to be monitored by test meter M1. Also causes the indicator light corresponding to the circuit being monitored to light with increased brilliance. Applies to the (X), (W), (Y), and (Z) positions only.
Test meter M1	Indicates voltage, rf power, or go-no-go status of the function selected by the test selector switch.
STBY indicator	Lights when antenna coupler is in the standby condition (ready for tuning).
SERIES CKT (W) tuning knob	For maintenance and emergency operation only. Knob is connected to variable capacitor C5 in series circuit.
SERIES CKT (W) indicator	Lights when series circuit is selected for tuning. Lights with increased brilliance when test selector is set to (W) (Y) PHASING 1 position.
PARALLEL CKT (X) tuning knob	For maintenance and emergency operation only. Knob is connected to variable capacitor C2 in parallel circuit.
PARALLEL CKT (X) indicator	Lights when parallel circuit is selected for tuning. Lights with increased brilliance when test selector is set to (X) PHASING 2 position.
PHASING (Y) tuning knob	For maintenance and emergency operation only. Knob is connected to variable capacitor C3 in phasing circuit.
PHASING (Y) indicator	Lights when phasing circuit is selected for tuning. Lights with increased brilliance when test selector is set to (W) (Y) PHASING 1 position.
LOADING (Z) tuning knob	For maintenance and emergency operation only. Knob is connected to variable capacitor C4 in loading circuit.
LOADING (Z) indicator	Lights when loading circuit is selected for tuning. Lights with increased brilliance when test selector is set to (Z) LOADING position.
ANTENNA indicator	Lights when loading and phasing circuits are tuning the broadband antenna.
READY indicator	Lights when the antenna coupler is completely tuned and ready for operation.

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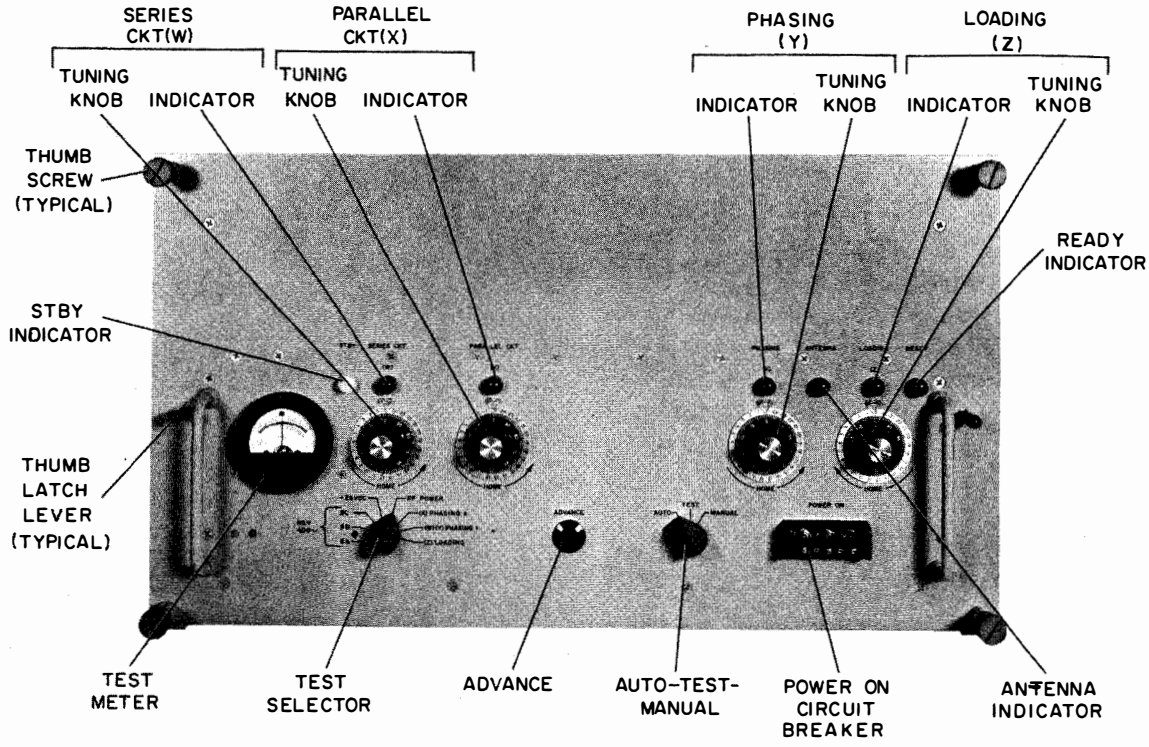

Figure 3-1. Antenna Coupler CU-1169/SRC-16, Controls and Indicators

3-4. EMERGENCY OPERATING PROCEDURES.

a. AUTOMATIC TUNING FAILURE. - If any antenna coupler fails to tune automatically after the transmitter control TUNE - OPERATE pushbutton is pressed, perform the following steps:

(1) Move the antenna coupler AUTO-TEST-MANUAL switch to TEST and the test selector to (W) (Y) PHASING 1 (see figure 3-1). Press the ADVANCE pushbutton. If rf level is high enough, series circuit should tune, and test meter should indicate no error when tuning is completed. (Zero error is indicated when test meter pointer rests in the green area of the meter scale.)

CAUTION

Correct tuning points are indicated only when the test meter needle moves in the same direction the tuning knob is turned. Tuning on false tuning points will result in antenna coupler damage.

(2) Move the test selector to (X) PHASING 2, and press the ADVANCE pushbutton. The parallel circuit should tune, and the test meter should indicate no error when tuning is completed. (Zero tuning error is indicated when test meter pointer rests between 0 and -35 on meter scale.) If error is indicated, turn the PARALLEL CKT (X) tuning knob slightly to return the test meter pointer to within the proper limits. Be certain to tune on the correct tuning point. Refer to the caution following paragraph 3-4a(1).

(3) Move the test selector to (W) (Y) PHASING 1, and press the ADVANCE pushbutton. The phasing circuit should tune, and the test meter should indicate no error when tuning is completed. (Zero tuning error is indicated when test meter pointer rests in the green area of the meter scale.) Be certain to tune on the correct tuning point. Refer to the caution, paragraph 3-4a(1).

(4) Press the ADVANCE pushbutton and, when tuning is completed, check both the (Z) LOADING and the (W) (Y) PHASING 1 test selector positions for tuning error. Correct manually if necessary. Be certain to tune on the correct tuning point. Refer to the caution, paragraph 3-4a(1).

(5) Press the ADVANCE pushbutton. If READY indicator is illuminated, antenna coupler is tuned and ready for operation.

If any of the preceding steps cannot be performed, follow the procedure of paragraph 3-4b below for manual tuning.

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b. COMPLETE TUNING FAILURE. - In the event that an antenna coupler will not tune according to the above procedure, the following manual tuning steps can be performed. The antenna coupler must be supplied with primary power, and all control lines must be intact and delivering correct information.

(1) Move all four tuning knobs in the direction indicated by the HOME arrows on the antenna coupler front panel until the home stop is reached. Move the antenna coupler AUTO-TEST-MANUAL switch to MANUAL.

Note

If operating frequency is between 2.000 mc and 2.200 mc, turn the LOADING (Z) tuning knob to 12.00 before proceeding.

(2) Move test selector to (W) (Y) PHASING 1, and press the ADVANCE pushbutton. Turn the SERIES CKT (W) tuning knob away from home (clockwise) until the correct tuning point is found and the test meter needle is centered in the green area of test meter scale.

CAUTION

Correct tuning points are indicated only when the test meter needle moves in the same direction the tuning knob is turned. Tuning on false tuning points will result in antenna coupler damage.

(3) Move the test selector to (X) PHASING 2, and press the ADVANCE pushbutton. Turn the PARALLEL CKT (X) tuning knob away from home (clockwise) until the correct tuning point is found and the test meter needle rests between 0 and -35 on the meter scale. Be certain to tune on the correct tuning point. Refer to the caution, paragraph 3-4b(2).

(4) Move the test selector to (W) (Y) PHASING 1, and press the ADVANCE pushbutton. Turn the PHASING (Y) tuning knob away from home (clockwise) until the correct tuning point is found and the test meter needle is centered in the green scale area. Be certain to tune on the correct tuning point. Refer to the caution, paragraph 3-4b(2).

(5) Move the test selector to (Z) LOADING. Do not press the ADVANCE pushbutton. Turn the LOADING (Z) tuning knob away from home (counter-clockwise) until the correct tuning point is found and the test meter needle is centered in the green scale area. Be certain to tune on the correct tuning point. Refer to the caution, paragraph 3-4b(2).

(6) Move the test selector to (W) (Y) PHASING 1. Do not press the ADVANCE pushbutton. Turn the PHASING (Y) tuning knob in the opposite direction indicated by the test meter until the correct tuning point is found and the test meter needle is centered in the green scale area. Be certain to tune on the correct tuning point. Refer to the caution, paragraph 3-4b(2).

(7) Since the PHASING and LOADING controls interact, repeat paragraph 3-4b(4) and (5) a number of times until no error is indicated. With the test meter set to the correct position, always turn the tuning knobs opposite the direction indicated by the test meter to ensure tuning on the correct tuning point. (Refer to the caution, paragraph 3-4b(2).) If the antenna coupler is to be used with a receiver, omit paragraph 3-4b(8).

(8) Press the ADVANCE pushbutton. The ANTENNA indicator should light. Repeat paragraphs 3-4b(4), (5), and (6) until no tuning error is indicated. Be certain to tune on the correct tuning point. Refer to the caution, paragraph 3-4b(2).

(9) Press the ADVANCE pushbutton. The READY indicator should light. The antenna coupler is tuned and ready for operation.

c. PRESET TUNING PROCEDURE. - To tune antenna couplers using logged preset tuning information, perform the following steps:

(1) Move the antenna coupler AUTO-TEST-MANUAL switch to MANUAL.

(2) Set SERIES CKT (W) tuning knob to a predetermined setting according to previously logged tuning information. See example, table 3-2. Place radio channel in OPR. Press antenna coupler ADVANCE pushbutton. If the antenna coupler is to be used with a transmitter, more accurate tuning may be desired. Move the test selector to (W) (Y) PHASING 1, and manually adjust the SERIES CKT (W) tuning knob until the test meter pointer rests in the green area of meter scale. Be certain to tune on the correct tuning point.

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CAUTION

Correct tuning points are indicated only when the test meter needle moves in the same direction the tuning knob is turned. Tuning on false tuning points will result in antenna coupler damage.

(3) Set PARALLEL CKT (X) tuning knob to predetermined setting according to previously logged tuning information. Press the antenna coupler ADVANCE pushbutton. If the antenna coupler is to be used with a transmitter, more accurate tuning may be desired. Turn PHASING (Y) tuning knob in the HOME direction until limit is reached. Move test selector to (X) PHASING 2, and manually adjust PARALLEL CKT (X) tuning knob until test meter pointer rests between 0 and -35 on the meter scale. Be certain to tune on the correct tuning point. Refer to the caution, paragraph 3-4c(2).

(4) Set PHASING (Y) and LOADING (Z) tuning knobs to predetermined setting according to previously logged tuning information. Press antenna coupler

TABLE 3-2. ANTENNA COUPLER FREQUENCY LOGGING CHART, TYPICAL

Antenna coupler subassembly number_____

Antenna coupler unit number_____

Antenna coupler MCN number_____

FREQUENCY (mc)	SERIES CIRCUIT (W)	PARALLEL CIRCUIT (X)	PHASING (Y)	LOADING (Z)

NOTES: 1. Record frequency to nearest kilocycle when antenna coupler has been tuned with AUTO-TEST-MANUAL switch in MANUAL position. Take readings just after paragraph 3-4b(6).
2. PARALLEL CIRCUIT (X) tuning is critical. Record knob setting with care.
3. PHASING (Y) and LOADING (Z) knob readings will change with changing antenna conditions. Refer to paragraph 3-4c(5) and (6) above.

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ADVANCE pushbutton twice. ANTENNA indicator should light. If the antenna coupler is to be used with a transmitter, more accurate tuning may be desired. Proceed to paragraph 3-4c(5). If antenna coupler is to be used with a receiver, proceed to paragraph 3-4c(8).

(5) Move test selector to (W)(Y) PHASING 1, and adjust PHASING (Y) tuning knob until test meter pointer rests in the green area of meter scale. Be certain to tune on correct tuning point. Refer to the caution, paragraph 3-4c(2).

(6) Move test selector to (Z) LOADING, and adjust LOADING (Z) tuning knob until test meter pointer rests in the green area of the meter scale. Be certain to tune on correct tuning point. Refer to the caution, paragraph 3-4c(2).

(7) Repeat paragraph 3-4c(5) and (6) until no improvement can be made.

(8) Press the antenna coupler ADVANCE pushbutton. READY indicator should light. The antenna coupler is now ready for use.

SECTION 4

TROUBLESHOOTING

4-1. LOGICAL TROUBLESHOOTING.

a. HISTORICAL DATA AVAILABILITY. - When adequate historical data is not available, troubleshooting procedures should be based on the six logical steps given in system description, section 4 of chapter A, Antenna Coupler Group AN/SRA-34(V).

4-2. OVERALL FUNCTIONAL DESCRIPTION.

The antenna coupler is an automatically tuned antenna multicoupler which provides frequency selectivity and isolation to permit up to eight receiver and/or transmitter combinations to operate simultaneously into a single 2- to 6-mc broadband antenna. Antenna Coupler CU-1169/SRC-16 operates over the frequency range of 2.000 mc to 5.999 mc (2- to 6-mc band) and tunes automatically in response to control line information and rf energy supplied by associated equipment. Refer to the block diagram, figure 4-1, the tuning sequence, figure 4-2, and the schematic diagram, figure 5-18, of the CU-1169/SRC-16.

The transmission line from the power amplifier of the associated transmitter equipment must be a 50-ohm coaxial cable. In order to ensure maximum forward power transfer from the power amplifiers to the antenna, this coaxial cable must be terminated in a load which is 50 ohms resistive. When the antenna-antenna coupler combination is tuned properly, transmission line current and voltage are in phase, and the load is said to be phased properly. When the antenna-antenna coupler combination appears to have an impedance of 50 ohms, it is said to be loaded properly. Loading and phasing of the antenna circuit are accomplished by capacitors C3 and C4 arranged in an L-network which derives its energy from fixed inductor L3. Inductor L3 is coupled loosely to the high-Q parallel resonant circuit made up of variable capacitor C2 and fixed inductor L2.

Variable capacitor C4 varies the impedance level presented to the transmission line, and variable capacitor C3 varies the reactance type (inductive, capacitive, or resistive) presented to the transmission line. These variable elements effectively tune out the reactance and adjust the impedance level of the antenna over a vswr range of 4:1 (50 ohms).

Also, in order to operate in the duplex mode (simultaneous transmit and receive) using a common antenna, the antenna coupler must provide isolation for any receiver tuned to a frequency separated by at least 15 percent from other transmit or receive frequencies. The antenna coupler accomplishes this isolation using a system of low-Q series and high-Q parallel resonant circuits delivering rf power to a lightly coupled transformer secondary which feeds rf power to the antenna.

Refer to the block diagram, figure 4-1. The antenna coupler tunes in three general steps as follows:

a. SERIES CIRCUIT. - The series circuit (C5-L5) tunes to resonance. During tuning, the circuit is loaded with a 50-ohm resistor. After tuning, a resistor is placed in parallel with the circuit to reduce circuit Q.

b. PARALLEL CIRCUIT. - The parallel circuit (C2-L2) tunes to resonance. During tuning, capacitor C3 is shorted so the C2-L2 combination does not react to reflected reactances coupled from the antenna circuit.

c. PHASING CIRCUIT. - Capacitors C3 and C4 load and phase the broadband antenna so that the transmission line from the power amplifier is terminated (effectively) in 50 ohms resistive.

Refer to the block diagram, figure 4-1. The rf transmission line is sampled by a loading-phasing discriminator which reacts to impedances other than 50 ohms resistive. The error signal produced by the phasing portion of this discriminator is a dc voltage. This dc error voltage is converted to a 400-cps square-wave voltage and amplified by a servo amplifier. The servo-amplifier output is used to drive servo motor B5 which adjusts a variable element in the series trap circuit. During this step of antenna coupler tuning, the series trap circuit is loaded with a 50-ohm resistor. Loading information is not needed.

The coupling between L1 and L2 is variable and is controlled by motor B1. Motor B1 runs on position information supplied by a control circuit. The position of the coupling link is determined by the frequency positioning of L1.

When the series circuit is tuned, relay K6 energizes and feeds the rf signal to the parallel circuit. A separate phasing discriminator is used to detect tuning errors, and discriminator output is amplified and used to drive servo motor B2 until capacitor C2 is tuned correctly. Variable capacitor C3 is shorted while the parallel circuit is tuning to prevent false tuning information from being reflected back from the antenna.

When the parallel circuit is tuned, phasing capacitor C3 is run by servo motor B3 until the antenna coupler is tuned into internal 50-ohm dummy load resistor R4. Phasing information is supplied by the phasing discriminator circuit of loading-phasing discriminator assembly A2.

When the phasing discriminator detects zero error, relay K4 energizes, and both phasing and loading capacitors C3 and C4 are run by servo motors B3 and B4 until the transmission line terminal impedance is 50-ohm resistive. When the antenna coupler is completely tuned, loading-phasing discriminator assembly A2 continues to sample the impedance and phase relationships on the transmission line. Any change in antenna characteristics will be reflected to these discriminators, and, if sufficient forward power is available, capacitors C3 and C4 will be driven to

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correct the tuning error. Thus, the antenna is kept under constant surveillance, and the addition of receivers or transmitters to the common antenna will not disrupt the transfer of forward power to the antenna.

The control of the various tuning steps of the antenna coupler is accomplished in antenna coupler control assembly A3. The coupler control assembly operates in response to control information supplied by associated equipments. See table 4-1.

4-3. OVERALL TEST DATA.

a. TEST DATA.

(1) REFERENCE ILLUSTRATIONS.

(a) Overall schematic diagram, figure 5-18.

(b) Block diagram, figure 4-1.

(c) Tuning sequence block diagram, figure 4-2.

(2) TEST EQUIPMENT REQUIRED.

(a) Multimeter AN/USM-116.

(b) Auxiliary blower and extender cable set (supplied with CY-4032/SRA-34(V).

(3) TROUBLE ISOLATION PROCEDURE. - The antenna coupler must be supplied with primary power, and all control lines must be intact and delivering correct information before this procedure can be run.

(a) Refer to paragraph 5-2, and install auxiliary blower and maintenance cable set.

(b) On local frequency control, set XMTR and RCVR FREQ SELECT-MC switches for a 6-mc transmitter and receiver frequency.

(c) Perform the trouble isolation procedures given in table 4-2.

4-4. LOADING-PHASING DISCRIMINATOR ASSEMBLY A2.

a. FUNCTIONAL DESCRIPTION. - Loading-phasing discriminator assembly A2 contains both a loading discriminator and a phasing discriminator. The loading discriminator measures the magnitude of the impedance at the input of the antenna coupler. If the impedance is not 50 ohms, a dc voltage will appear at the output of the discriminator. Impedances lower than 50 ohms develop a negative output voltage while impedances greater than 50 ohms develop a positive output voltage. The phasing discriminator measures the phase difference between the current and voltage on the transmission line. When the transmission line is inductive (voltage leading current), the phasing discriminator develops a positive output voltage. When the transmission line is capacitive (current leading voltage), the phasing discriminator develops a negative output voltage.

(1) LOADING DISCRIMINATOR. - The loading discriminator measures the magnitude of the transmission line voltage and current. When the ratio of voltage to current is 50 ohms, the circuit develops no output voltage. Transformer T1 is electrostatically shielded so that it is only magnetically coupled to the

TABLE 4-1. ANTENNA COUPLER CU-1169/SRC-16, CONTROL LINE FUNCTIONS

CONTROL LINE	COMMAND WHEN GROUNDED	COMMAND WHEN UNGROUNDED
Operate	Initiate tuning from home position	Home, standby.
Tune activate	Retune to a new frequency after a tuning cycle has been initiated.	Transmitter or receiver tuned.
Tune complete	Antenna coupler tuned.	Antenna coupler tuning.
Carrier insert	Key transmitter and power amplifier with carrier inserted.	Remove carrier.
High power	Desensitize servos for high-power operation after coupler is tuned.	Maintain high servo sensitivity for low-power operation after coupler is tuned.
Alarm	No alarm.	Alarm.
Thermal alarm override	Unsafe temperatures inside antenna coupler will not alarm system.	Unsafe temperatures will alarm system normally.
Receive tune	Antenna coupler to be used for receive. No power will be radiated on antenna during tuning.	Antenna coupler will be used for transmit. Final phasing and loading will be done on antenna.

TABLE 4-2. OVERALL TROUBLE ISOLATION PROCEDURE

STEP	TEST PROCEDURE	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
1	Set POWER ON circuit breaker to ON.	Tuning elements (W), (X), (Y), and (Z) turn to home position, and STBY indicator is on.	Proceed to step 2.	If tuning elements fail to turn, check antenna coupler control assembly A3. If STANDBY indicator fails to light, check indicator and lamp and associated circuit.
2	Set AUTO-TEST-MANUAL switch to MANUAL. Press OPERATE-TUNE pushbutton on transmitter control. Press ADVANCE pushbutton.	SERIES CKT indicator is on bright when test selector switch is at (W) (Y) PHASING 1 and on dim in all other switch positions.	Proceed to step 3.	Check indicator lamp, antenna coupler control assembly A3, and associated circuit.
3	Press ADVANCE pushbutton.	PARALLEL CKT indicator is on bright when test selector switch is at (X) PHASING 2 and on dim in all other switch positions.	Proceed to step 4.	Same as step 2.
4	Set test selector switch to (W) (Y) PHASING 1, and press ADVANCE pushbutton.	PHASING indicator is on bright. LOADING indicator is on dim.	Proceed to step 5.	Same as step 2.
5	Set test selector switch to LOADING.	LOADING indicator is on bright. PHASING indicator is on dim.	Proceed to step 6.	Same as step 2.
6	Press ADVANCE pushbutton.	ANTENNA indicator is on bright.	Proceed to step 7.	Same as step 2.
7	Press ADVANCE pushbutton.	READY indicator is on bright.	Proceed to step 8.	Same as step 2.
8	Press ADVANCE pushbutton.	STBY indicator is on bright.	Proceed to step 9.	Same as step 2.
9	a. Set test selector switch to (W) (Y) PHASING 1, and press ADVANCE pushbutton.	More negative than -10 as measured on the front panel test meter.	Proceed to step 10.	Proceed to step 9b.
	b. Connect vtvm between test points J2 and J5 of loading-phasing discriminator A2. (Connect positive vtvm test probe to J2.)	Approximately 0.4 vdc.	Check circuit between A2 and test meter for defective wiring or components.	Check rf power cables for loose connections and loading-phasing discriminator assembly A2 for defective components.

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TABLE 4-2. (Continued)

STEP	TEST PROCEDURE	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
10	a. Set AUTO-TEST-MANUAL switch to TEST.	Tuning element (W) turns cw and reduces discriminator voltage to the green area of meter scale.	Proceed to step 11.	If tuning element (W) turns but does not reduce discriminator voltage to green area of meter scale, check phase sensitive circuit, series tuning circuit, and antenna coupler control assembly A3. If tuning element (W) does not turn, proceed to step 10b.
	b. Connect vtvm to test points J1 and J2 of electronic control amplifier assembly A1.	Not less than 15 vac.	Check servo motor B5 and associated circuit.	Check coupler servo-control assembly A7, electronic control amplifier assembly A1, and associated chassis wiring.
11	Set AUTO-TEST-MANUAL switch to MANUAL and test selector switch to (X) PHASING 2. Press ADVANCE pushbutton.	Large positive discriminator voltage as measured on front panel test meter.	Proceed to step 12.	Check phasing discriminator assembly A5 and associated chassis wiring.
12	a. Set AUTO-TEST-MANUAL switch to TEST.	Tuning element (X) turns cw and reduces discriminator voltage to the green area of meter scale.	Proceed to step 13.	If tuning element (X) does not turn, proceed to step 12b. If tuning element (X) turns but does not reduce discriminator voltage to green area of meter scale, check phase sensitive circuit, parallel tuning circuit, and antenna coupler control assembly A3.
	b. Connect vtvm to test points J1 and J2 of electronic control amplifier assembly A1.	Not less than 15 vac.	Check servo motor B2 and associated circuit.	Check coupler servo-control assembly A7 and associated chassis wiring.
13	Set AUTO-TEST-MANUAL switch to MANUAL and test selector switch to (W) (Y) PHASING 1. Press ADVANCE pushbutton.	Large positive voltage as measured on front panel test meter.	Proceed to step 14.	Check loading-phasing discriminator assembly A2 and associated circuit.
14	a. Set AUTO-TEST-MANUAL switch to TEST. (Tuning element (Y) tunes into 50-ohm load.)	Tuning element (Y) turns to reduce discriminator voltage to the green area of meter scale.	Proceed to step 15.	If tuning element (Y) fails to turn, proceed to step 14b.

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TABLE 4-2. (Continued)

STEP	TEST PROCEDURE	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
14 (Cont)	b. Connect vtvm to test jacks J1 and J2 to electronic control amplifier assembly A1.	Not less than 15 vac.	Check servo motor B3 and associated chassis wiring.	Check coupler servo-control assembly A7 and associated chassis wiring.
15	Set AUTO-TEST-MANUAL switch to MANUAL and test selector switch to (Z) LOADING. Press ADVANCE pushbutton.	Loading discriminator error voltage greater than +10 as measured on the front panel test meter.	Proceed to step 16.	Check loading-phasing discriminator assembly A2 (loading circuit) and associated chassis wiring.
16	a. Set AUTO-TEST-MANUAL switch to TEST.	Tuning elements (Y) and (Z) tune together to reduce discriminator error voltage to green area of meter scale.	Proceed to step 17.	If tuning element (Z) fails to turn, proceed to step 16b.
	b. Connect vtvm to test jacks J1 and J4 of loading-phasing discriminator assembly A2.	Approximately 0.5 vdc.	Proceed to step 16c.	Check loading-phasing discriminator assembly A2 (loading circuit) for defective components.
	c. Connect vtvm between test points J1 and J2 of electronic control amplifier A4. Measure servo excitation voltage.	Not less than 15 vac.	Check servo motor B4 and associated circuit.	Check coupler servo-control assembly A7, electronic control amplifier assembly A4, and associated chassis wiring.
17	Press ADVANCE pushbutton, (tuning elements (Y) and (Z) tune to antenna).	Discriminator voltage is within green area of meter scale. ANTENNA indicator is on.	Proceed to step 18.	Check loading circuit and antenna coupler control assembly A3.
18	Set test selector switch to (W) (Y) PHASING 1.	Discriminator voltage is within green area of meter scale.	Proceed to step 19.	Check phasing circuit and antenna coupler control assembly A3.
19	Press ADVANCE pushbutton.	READY indicator is on.	Proceed to step 20.	Check antenna coupler control assembly A3.
20	Press ADVANCE pushbutton.	All tuning elements return to HOME position. STANDBY indicator is on.	Proceed to step 21.	Check antenna coupler control assembly A3.
21	Press STANDBY pushbutton on transmitter control. Set AUTO-TEST-MANUAL (Cont)	All tuning elements turn and reduce discriminator voltage to green (Cont)	Proceed to step 22.	Check antenna coupler control assembly A3 and associated chassis wiring. If fault (Cont)

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TABLE 4-2. (Continued)

STEP	TEST PROCEDURE	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
21 (Cont)	(Cont) switch to AUTO, and press OPERATE TUNE pushbutton on transmitter control.	(Cont) area of test meter. READY indicator lights when antenna coupler has completed tuning.		(Cont) is not located, repeat steps 1 through 19.
22	Press OPERATE-TUNE pushbutton on transmitter control, and hold one of the tuning element knobs. Observe that antenna coupler faults and returns to standby.	Antenna coupler faults and returns to standby within 1 minute. STBY indicator lights.	Antenna coupler operating properly.	Check 1-minute delay circuit in antenna coupler control assembly A3.

transmission line. The voltage induced in transformer T1 will cause current to flow through potentiometer R9 and resistor R1. Resistor R1 swamps transformer T1 so that the current in phase with the voltage flowing through the parallel circuit is essentially independent of frequency. Diode CR2, capacitor C1, and resistor R2 form a rectifying and filtering network which produces a dc voltage from the rf voltage across resistor R9. Thus, there is produced across resistor R2 a voltage which is proportional to the current flow along the transmission line. Capacitors C5 and C6 form a voltage-dividing network which drops the rf voltage appearing on the transmission line. Inductor L4 compensates for voltage differences occurring with frequency changes. This rf voltage is rectified by diode CR3 and appears across resistor R3 as a dc voltage which is proportional to the amplitude of the voltage on the transmission line.

The dc voltage across resistor R3, resulting from the magnitude of the transmission line voltage, and the dc voltage across resistor R2, resulting from the magnitude of the transmission line current, oppose each other. During manufacture, a known voltage and current (with an impedance of 50 ohms) are introduced to the transmission line, and potentiometer R9 is adjusted for zero voltage at the discriminator output. Thereafter, if the transmission line current or voltage changes so that the impedance is not 50 ohms, a voltage proportional to the change will appear at the loading discriminator output.

(2) PHASING DISCRIMINATOR. - (Refer to figures 4-3 and 5-20.) The phasing discriminator produces a dc output the polarity of which is dependent on the reactance of the transmission line. In a transmission line which appears capacitive, current leads voltage. In a transmission line which appears inductive, current lags voltage. When the transmission line presents no reactance (resistance only), current and voltages are in phase. The phasing discriminator determines the direction and magnitude of any phase difference between transmission line current and voltage and converts such differences into dc voltages.

Transformer T2 is coupled magnetically and electrostatically to the center conductor of the transmission line. The voltages developed at points A and C are always 180 degrees out of phase with each other and are proportional to the transmission line current I_t. The voltage developed at point B is the result of stray capacity between the transformer secondary and primary and is in phase with and proportional to the transmission line voltage. Since the transformer is unloaded, the following phase relationships will exist whenever transmission line current and voltage are in phase: E_{cb} leads E_{bd} by 90 degrees; E_{ab} lags E_b by 90 degrees; and I_t, E_t, and E_{bd} are in phase. Refer to vector diagrams in figure 4-3.

When the phase relationships are as above, and the antenna coupler appears resistive to the transmission line, the dc current (rectified by CR5) through transformer half B-C, through CR5, R8, R7, L2, and back to point B is equal to the dc current (rectified by CR4) through transformer half A-B, through CR4, R5, R6, L2, and back to point B. The dc voltage developed across resistor pairs R5-R6 and R7-R8 is equal but of opposite polarity. Cancellation occurs, and discriminator output is zero. Potentiometer R8 adjusts for slight differences in diode balance. Inductors L5, L6, and L7 present a high impedance to any rf voltage on the dc discriminator output.

Assume that the transmission line appears capacitive and transmission line current leads the transmission line voltage. The voltages present in the phasing discriminator are shown in figure 4-3. Voltage E_{bd} is still in phase with transmission line voltage E_t, and voltage E_{cb} still leads transmission line current I_t by 90 degrees. The vector sums of voltages E_{ab}-E_{bd} and E_{cb}-E_{bd} still produce dc voltages E_{ad} and E_{cb}. However, the amplitudes are no

longer equal, and the dc current through resistors R7-R8 is greater than the current through resistors R5-R6. Under these conditions, a negative dc voltage is developed across capacitor C11 and is taken as the discriminator output.

b. TEST DATA.

(1) REFERENCE ILLUSTRATIONS. - Simplified schematic diagram, figure 4-3, and schematic diagram, figure 5-18.

4-5. PHASING DISCRIMINATOR ASSEMBLY A5.

a. FUNCTIONAL DESCRIPTION. - The operation of phasing discriminator assembly A5 is similar to that described for the phasing portion of loading-phasing discriminator assembly A2. The resistors across which the output voltage is developed are of difference values.

b. TEST DATA.

(1) REFERENCE ILLUSTRATION. - Schematic diagram, figure 5-18.

4-6. ANTENNA COUPLER SERVO-CONTROL ASSEMBLY A7.

a. FUNCTIONAL DESCRIPTION. - The antenna coupler servo-control assembly operates on the dc error signals produced by the phasing and loading discriminators. The assembly produces a 400-cps square-wave output which is applied to the servo amplifier, adjusts the gain of the servo loop to compensate for changing error signal levels, and inserts the necessary lead or lag networks as required for stability or position accuracy. A more detailed description of antenna coupler servo-control assembly A7 is given in the technical manual for Electronic Circuit Plug-in Unit Test Set AN/URM-158.

b. TEST DATA.

(1) REFERENCE ILLUSTRATION. - Schematic diagram, figure 5-22.

(2) TROUBLESHOOTING. - Troubleshooting and adjustment procedures are given in the technical manufal for Electronic Circuit Plug-in Test Set AN/URM-158.

4-7. ELECTRONIC CONTROL AMPLIFIER ASSEMBLIES A1 AND A4.

a. FUNCTIONAL DESCRIPTION. - The dc error voltages originating from the discriminator assemblies is converted to a 400-cps square wave by the chopper in antenna coupler servo-control assembly A7. This 400-cps error signal is then applied to the electronic control amplifier assemblies which amplify the error signal to a level sufficient to drive the control windings of the tuning motors.

This 400-cps signal is either 90 degrees leading or 90 degrees lagging with respect to the chopper driver voltage supply, depending upon whether a negative or positive dc error signal is generated by the discriminator. The chopper ac supply is always 90 degrees out of phase with the 115-volt, 400-cps voltage applied to the reference windings of the tuning motors.

The ac output of the electronic control amplifier is in phase with the input and is, therefore, either +90 degrees or -90 degrees out of phase with the ac voltage applied to the tuning motor reference windings. The electronic control amplifier output is applied to the tuning motor control windings which are in quadrature with the reference windings. Thus, the tuning motor excitation voltage either leads or lags the reference voltage by 90 degrees, depending on the polarity of the dc error signal applied to the chopper by the discriminators. The lead or lag in phase angle determines the direction of rotation of the tuning motors, which, in turn, controls the direction in which the rf tuning elements are driven. A more complete description of electronic control amplifier assemblies A1 and A4 is given in the technical manual for Electronic Circuit Plug-in Test Set AN/URM-158.

b. TEST DATA.

(1) REFERENCE ILLUSTRATION. - Schematic diagram, figure 5-19.

(2) TROUBLESHOOTING. - Troubleshooting and adjustment procedures are given in the technical manual for Electronic Circuit Plug-in Test Set AN/URM-158.

4-8. ANTENNA COUPLER CONTROL ASSEMBLY A3.

a. FUNCTIONAL DESCRIPTION. - The antenna coupler control assembly is a plug-in unit which performs the switching and control functions required by the antenna coupler. The assembly contains a small dc motor which drives a 7-section rotary switch, 25 relays, and 7 silicon controlled rectifiers (scr). Figure 5-21 is a schematic diagram of the unit, and figure 4-2 is a tuning sequence diagram which shows the general steps involved in antenna coupler tuning.

The antenna coupler is programmed in six steps; standby, series circuit tune, parallel circuit tune, phase (50-ohm load), phase load (antenna), and ready. The 12-position rotary switches driven by motor A3B1 stop at even-numbered positions of rotary switch section S7R (reference section). Each time motor A3B1 stops, a tuning function is performed and must be completed before the switch can advance.

Assume the antenna coupler control assembly is at some control position other than HOME. When the radio channel is placed in operation, a ground is placed on the tune-activate line. (Refer to figure 4-2.) This ground is generated in the receiver and transmitter when they are set to a new frequency or when they are cycled from STBY to OPR. A ground on the tune-activate line energizes relay A3K5 and causes motor A3B1 to return to standby (position 12).

The operate line is open circuited when the radio channel is placed in STBY. Note that relay A3K5 is maintained energized until motor A3B1 reaches the standby position.

When motor A3B1 is in the standby position, tuning servo motors B2, B3, B4, and B5 are operated by homing relays A3K1, A3K2, A3K3, and A3K4 until they reach the HOME position, and operate limit switches S7, S9, S11, and S12. While the tuning motors are homing, relay A3K5 remains energized. Relay A3K5 will also be energized if alarm relay A3K10 becomes deenergized. Relay A3K10 can deenergize because of loss of primary power, loss of +28 volts dc from the antenna coupler power supply, more than 1-minute

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