

CHAPTER 4

FUNCTIONAL DESCRIPTION

4-1. OVER-ALL FUNCTIONAL DESCRIPTION.

Antenna Coupler Group AN/SRA-22 is designed to provide an impedance match between a 50-ohm coaxial transmission line and a wire or whip antenna 35 to 50 feet in length. The antenna coupler group is limited to use with radio equipment operating in the 2- to 32-megacycle frequency range and with transmitter power output of not more than 1000 watts on a short-term duty cycle or 350 watts continuously. Figure 4-1 is a block diagram of the antenna coupler group. Antenna Coupler Group AN/SRA-22 consists of Antenna Coupler CU-714/SRA-22 and Antenna Coupler Control C-2698/SRA-22. The Antenna Coupler AN/SRA-22 consists of Antenna Coupler CU-714/SRA-22, Antenna Coupler Control C-2698/SRA-22 and interconnection terminal board TB-5. The antenna coupler depends entirely on the coupler control sequence to accomplish tuning and loading operation.

Operation of COIL, TAP, and CAPACITOR drives is enabled by holding the TUNE-OPERATE switch in the TUNE position. The coil drive switch in the coupler control unit energizes the coil motor in the antenna coupler unit and drives a variable tapped coil. The variable tapped coil consists of a windup coil in which a silver ribbon is wound from a metal drum onto a ceramic drum. To increase the inductance, the number of turns of the silver ribbon on the ceramic drum is increased; to decrease the inductance, the silver ribbon is wound from the ceramic drum to the metal drum. The tap drive switch in the coupler control unit energizes a second motor in the antenna coupler unit which drives a contact that makes a sliding connection with the ribbon on the ceramic drum. The contact is mounted on a ring assembly which rotates around the coil, using the ribs of the ceramic drum as a helical guide. With the two motors driving the drums and the tap, it is possible to secure a variable inductor having a variable tap position. Using this type of variable inductive element, an extremely wide range of high Q inductance can be obtained without self-resonances. The relative positions of the coil and tap are indicated by position circuits consisting of meters and receiving potentiometers in the coupler control, and sending potentiometers in the antenna coupler unit. The sending potentiometers are connected to the tap and coil drives in such a manner that a voltage is developed which is a function of the coil and tap positions. The relative displacement of sending and receiving potentiometers is compared on panel meters of the coupler control unit. By operating the tap and coil drive switches until the sending potentiometers produce a null or "0" reading on their respective meters, the coil and tap positions can be read out on their receiving potentiometers.

The 12-position CAPACITOR switch in the coupler control unit energizes a third motor which drives a variable vacuum capacitor in the antenna coupler unit to a predetermined position. The variable vacuum capacitor has a range of 5 to 465 picofarads and is placed in shunt or series with the antenna.

Resonance of the antenna system is accomplished when the capacitive current from the tap through the portion of the coil above the tap to the antenna equals the inductive current through the portion of the coil from tap to ground. Proper load impedance is presented to the coaxial transmission line when the coil and capacitor in the antenna coupler unit reduce the phase angle to unity and the tap is at a position on the coil so that the impedance of the antenna system (which may reach several thousand ohms) is transformed to 50 ohms.

In cases where tuning cannot be accomplished by operation of the coil alone, the variable vacuum capacitor is placed either in shunt or in series with the antenna and operated through its range to obtain a tuning point.

4-2. FUNCTIONAL SECTIONS.

a. COUPLER CONTROL C-2698/SRA-22.

(1) TAP AND COIL INDICATORS. - Refer to figure 4-2 for the simplified schematic diagram. The position indicators (TAP AND COIL) consist of receiving potentiometers in the coupler control and sending potentiometers in the antenna coupler. The sending potentiometers are connected to individual tap and coil drives by gears so that tap and coil positions are immediately determined. When resistance settings of potentiometers 2R1 and 1R6, or 2R2 and 1R7 are equal, indicator meters 2M1 or 2M2 will read zero. Diodes 2CR3 and 2CR4 on TAP indicator meter, and diodes 2CR5 and 2CR6 on COIL indicator meter are used to prevent excessive overload current from damaging the meters. Resistors 2R4 on TAP indicator meter and 2R5 on COIL indicator meter provide bias for the diodes. Capacitors 2C8 and 2C9 are used for r-f protection for meters 2M1 and 2M2.

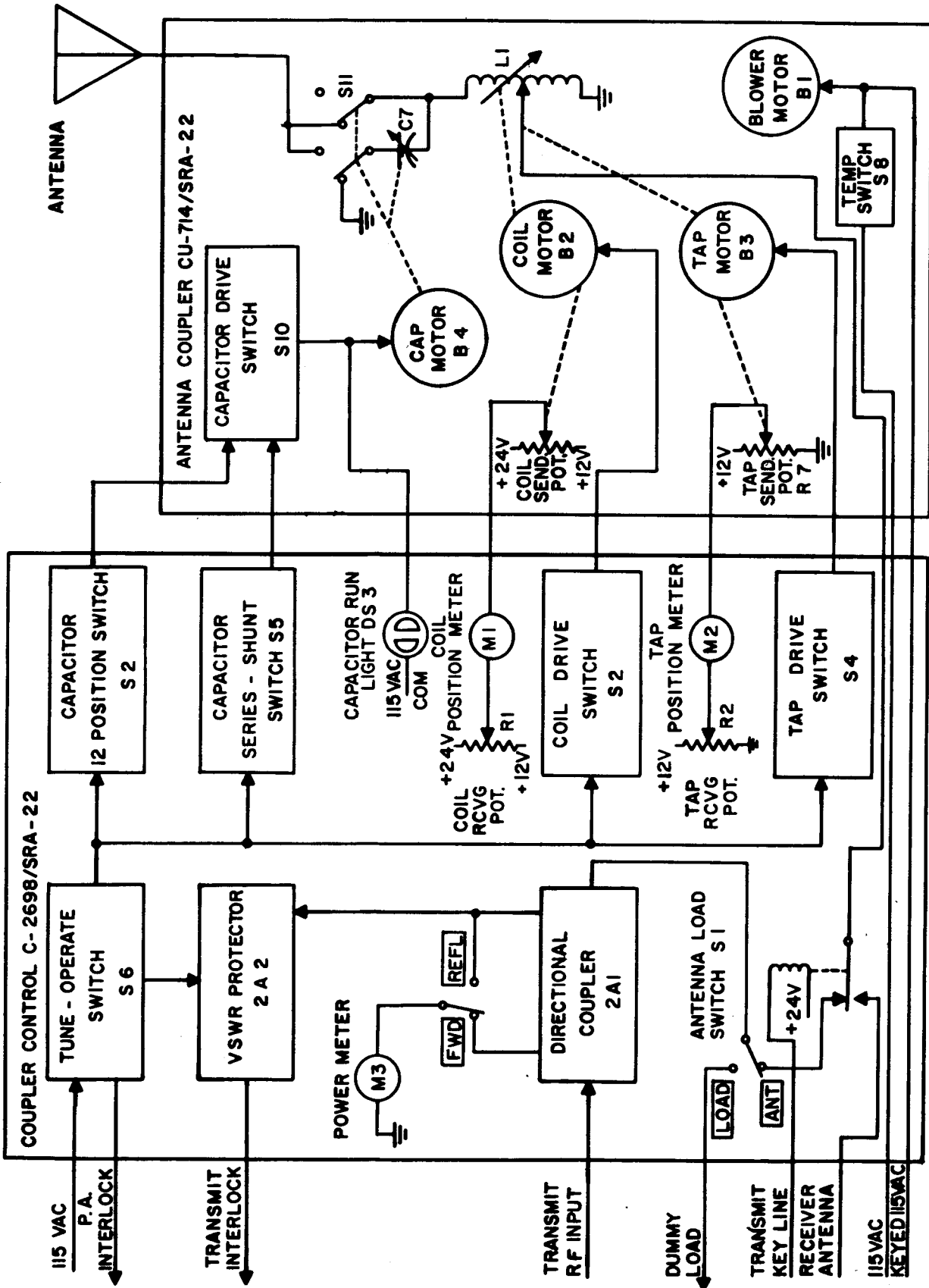


Figure 4-1. Antenna Coupler Group AN/SRA-22, Block Diagram

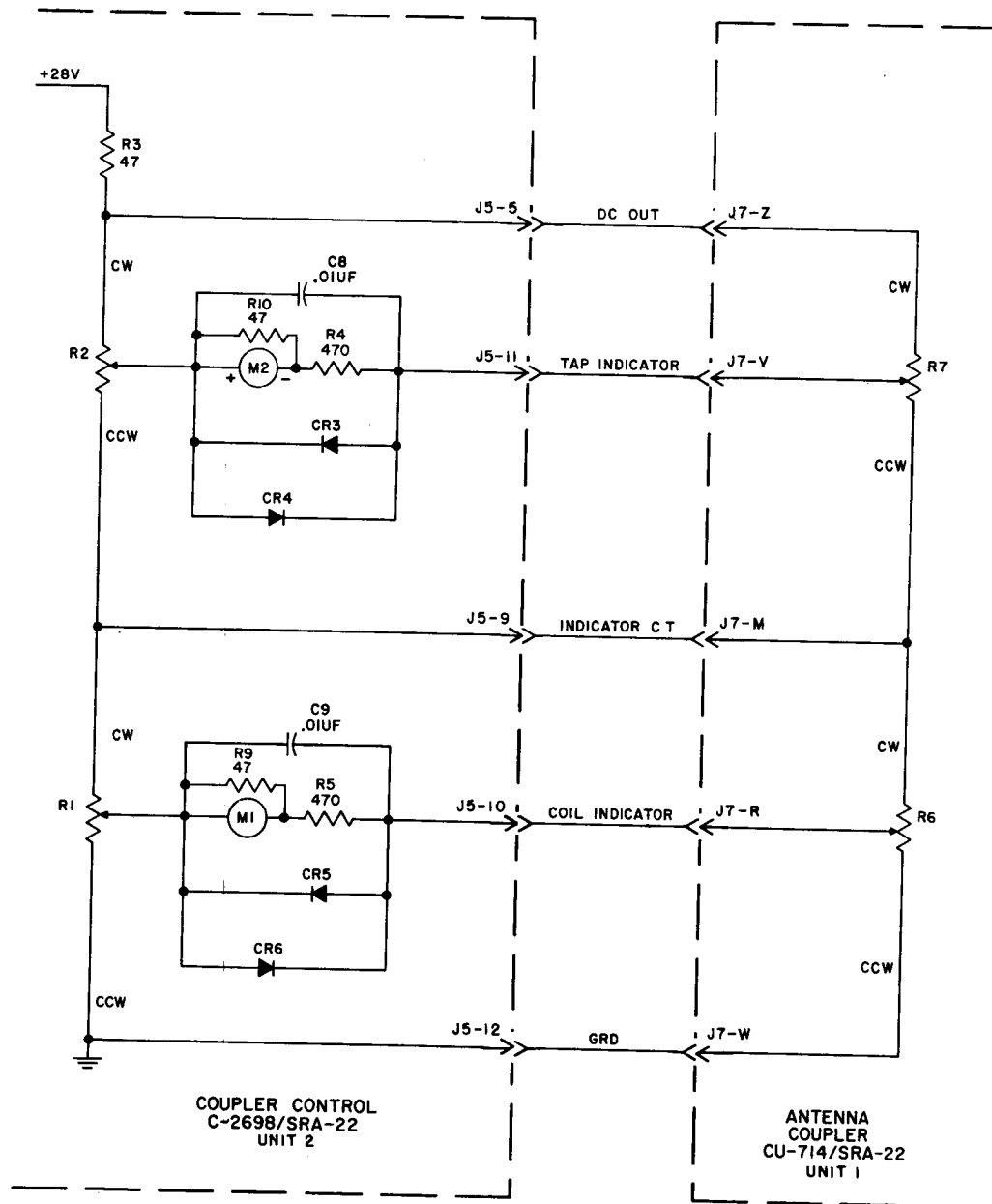


Figure 4-2. TAP and COIL Indicator Meter Circuits, Simplified Schematic Diagram

(2) COIL COARSE TUNE-FINE TUNE. - Refer to figure 4-3 for simplified schematic diagram. When switch 2S3 is set to COARSE TUNE (switch contacts 4 and 9, or 5 and 18), 115 volts ac is applied through contacts 4 and 12 of relay 2K2 to common of switch 2S3, either through contact 5 of switch 2S3 and limit switch 1S12B to terminal 4 of coil motor 1B2 and phase-shifted through capacitor 1C9 to terminal 3, or through contact 9 of switch 2S3 and limit switch 1S12A to terminal 3 of coil motor 1B2 and phase-shifted through capacitor 1C9 to terminal 4. When switch 2S3 is set to FINE TUNE (switch contacts 1 and 6, or 3 and 8), one end of capacitor 2C3 receives a ground through contacts 1 or 3 of switch 2S3. Relay coil 2K2 receives +28 volts through contacts 4 and 12 of relay 2K1, causing relay 2K2 to be energized by the charging current of capacitor 2C3. When capacitor 2C3 is fully charged, relay 2K2 will become de-energized, causing the charge present in 2C3 to be applied through contacts 2 and 11 of relay 2K2 to the coil of relay 2K1, energizing relay 2K1 by discharging capacitor 2C3 through the coil. When contacts 3 and 11 of relay 2K1 complete the circuit, resistor 2R8 accelerates the discharge of capacitor 2C3.

When capacitor 2C3 is discharged, relay 2K1 will become de-energized. Each time relay 2K2 is de-energized, coil motor 1B2 in the antenna coupler unit will have 115 volts ac applied to it in pulses through contacts 6 or 8 of switch 2S3 and the applicable limit switch. The short pulses allow the coil motor to operate for short durations, giving fine-tune control over the coil. Capacitor 2C4, which is across contacts 4 and 12 of relay 2K2, is used as an arc suppressor for the relay contacts.

Operation of the circuit with COIL switch 2S3 on FINE TUNE MIN (contacts 1 and 6) is the same as for FINE TUNE MAX (contacts 3 and 8) except that pulsed 115 volts ac is applied directly to terminal 4 instead of terminal 3 on coil motor 1B2. This causes the coil motor, operating through phase-shift capacitor 1C9, to reverse direction of rotation.

(3) ELECTRICAL LIMIT SWITCHES. - Coil electrical limit switch 1S12 consists of two sets of circuit-opening contacts mechanically driven through a gear train by coil motor 1B2. It is set to interrupt the energizing path of coil motor 1B2 just prior to when the coil reaches its mechanical limits. These limit switches protect the motor from being damaged should control switch 2S3 be held in the energized position after the coil has reached its mechanical limit. To drive the motor off the limit switch, it is necessary only to hold control switch 2S3 in the opposite direction. This will apply the 115 volts ac to the motor through the opposite limit switch and through phase-shift capacitor 1C8 in the opposite direction, causing the motor to rotate in the reverse direction.

Tap electrical limit switch 1S13 operates in a similar manner, except that it is driven through a gear train by tap motor 1B3 and is set to open the energizing path to the motor as the tap reaches its lower limit. Tap electrical limit switch 1S14 is a microswitch that is opened by the tap assembly as it reaches its upper limit.

(4) TAP COARSE TUNE-FINE TUNE. - The operation of the circuit with switch 2S4 on TAP COARSE TUNE-FINE TUNE is the same as for COIL COARSE TUNE-FINE TUNE, except that tap motor 1B3 is operated in conjunction with phase-shift capacitor 1C8 and limit switches 1S13 and 1S14.

(5) TWELVE-POSITION CAPACITOR SWITCH 2S2 AND CAPACITOR SERIES-SHUNT SWITCH 1S9. - For the operation of the 12-position CAPACITOR switch and the CAPACITOR SERIES-SHUNT switch, refer to paragraph 4-2b(1).

(6) DIRECTIONAL COUPLER. - Refer to figure 4-4 for the simplified schematic diagram. Transmission line current I flows through the line center conductor and through the center of a toroid core. The conductor forms the primary and the coil the secondary of a toroidal transformer 2A1T1. Induced toroid current produces a voltage that divides equally across resistors 2A1R1 and 2A1R2. This results in two equal voltages, E_1 and E_2 , across the resistors. Since the junction of resistors 2A1R1 and 2A1R2 is grounded, E_1 and E_2 are opposite in phase and proportional to line current I . Line voltage E_1 is applied across two capacity dividers, 2A1C1-C3 and 2A1C2-C4, resulting in two equal voltages of the same phase, E_3 and E_4 .

When the transmission is mismatched (terminated in an impedance other than to 50 ohms), E_1 and E_2 represent the vector sum of two components, one proportional to the current of the forward wave, and the other proportional to the current of the reflected wave. Similarly, E_3 and E_4 represent the vector sum of forward and reflected wave voltage components. Capacitors 2A1C1 and 2A1C2 are factory adjusted so that the magnitude of the forward voltage and current components are identical; also, the reflected components are equal. The settings of 2A1C1 and 2A1C2 are correct for a 50-ohm transmission line only.

The phase relationship among the various components is such that the r-f voltages across rectifier 2A1CR1 (E_f) are equal to the arithmetic sum of the two equal forward components, while the r-f voltages across rectifier 2A1CR2 (E_r) are equal to the arithmetic sum of the two equal reflected components.

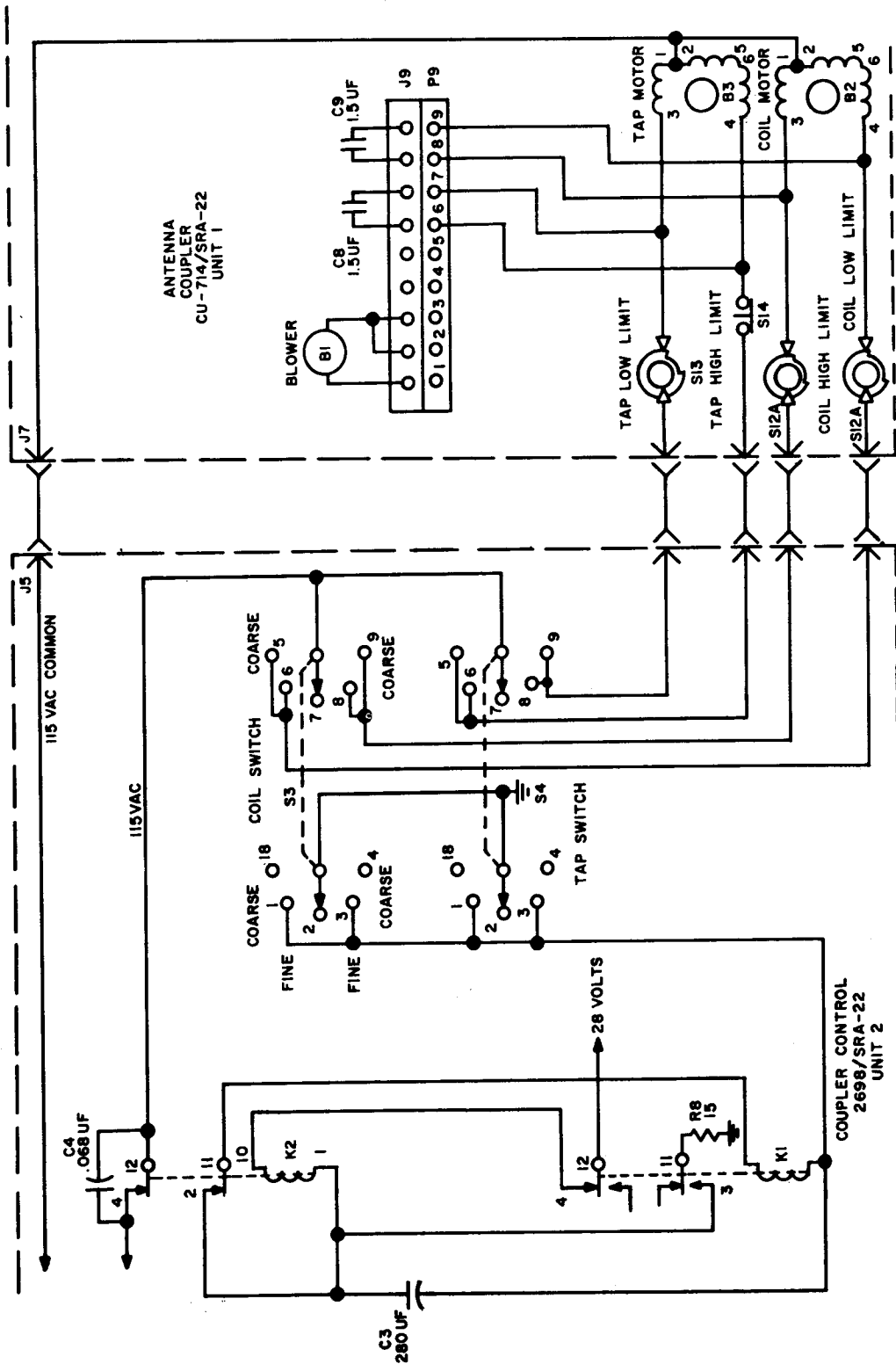


Figure 4-3. Coil-Tap Tuning Circuit, Simplified Schematic Diagram

(8) TUNE-OPERATE SWITCH. - When the TUNE-OPERATE switch is held in the TUNE position, the antenna coupler positioning circuits are enabled by the application of 115 volts ac. In addition, when the TUNE-OPERATE switch is in the TUNE position, the AN/XXX output is limited to a reduced "tune power." When the TUNE-OPERATE switch is released to the OPERATE position, the antenna coupler positioning circuits are disabled to prevent accidental de-tuning.

(9) VSWR PROTECTOR. - If, during full operation, the reflected power exceeds approximately 30 watts, the VSWR protector circuit will automatically disable the transmitter and cause the CAPACITOR run light to blink. Refer to figure 4-5 for the simplified schematic diagram.

Positive 28 volts is applied through relay 2A2K1 to the anode of Silicon Controlled Rectifier (SCR) 2A2CR4. Even though the SCR is forward biased, it remains non-conducting (acting as a thyatron) until triggered. Diode 2A2CR1, Zener diode 2A2CR2, resistors 2A2R1 through 2A2R4, and thermistor 2A2RT1 constitute a regulated negative power supply that applies -0.5 volt with respect to ground to the SCR cathode. When the reflected power seen by the directional coupler exceeds approximately 30 watts, sufficient voltage is developed in the directional coupler 2A1 and applied to the SCR gate, through transient filter consisting of resistor 2A2R5 and capacitor 2A2C1, to trigger the SCR into conduction. This energizes relay 2AK1, which will remain energized until the +28 volt supply is interrupted by placing the TUNE-OPERATE switch in TUNE. Energized relay 2A2K1 opens contacts 2 and 8, breaking transmitter interlock number 2 line. The keying path for driver stage blocking bias is thereby opened, causing the driver stage to remain cut off so that transmitter power output falls to zero.

Diode 2A2CR3, capacitor 2A2C2, resistor 2A2R6, and CAPACITOR run lamp 2DS3 (a neon lamp) constitute a relaxation oscillator circuit. Energized contacts 4 and 7 of relay 2A2K1 switch CAPACITOR run lamp across capacitor 2A2C2, causing the CAPACITOR run lamp to blink. This indicates that the reflected power reached approximately 30 watts and the VSWR protector circuit has been actuated. The transmitter will remain disabled and the CAPACITOR run lamp will continue to blink until the VSWR protective circuit has been reset.

To reset the VSWR protective circuit, the TUNE-OPERATE switch is held in the TUNE position. This interrupts the energizing current to relay 2A2K1 and SRC diode 2A2CR4 and permits the transmitter to function in a TUNE condition. At the same time, the antenna coupler can be retuned to eliminate the excessive VSWR which caused the protector device to be tripped initially. After the antenna coupler is retuned, release the TUNE-OPERATE switch to the OPERATE position to place the VSWR protective device back in operation.

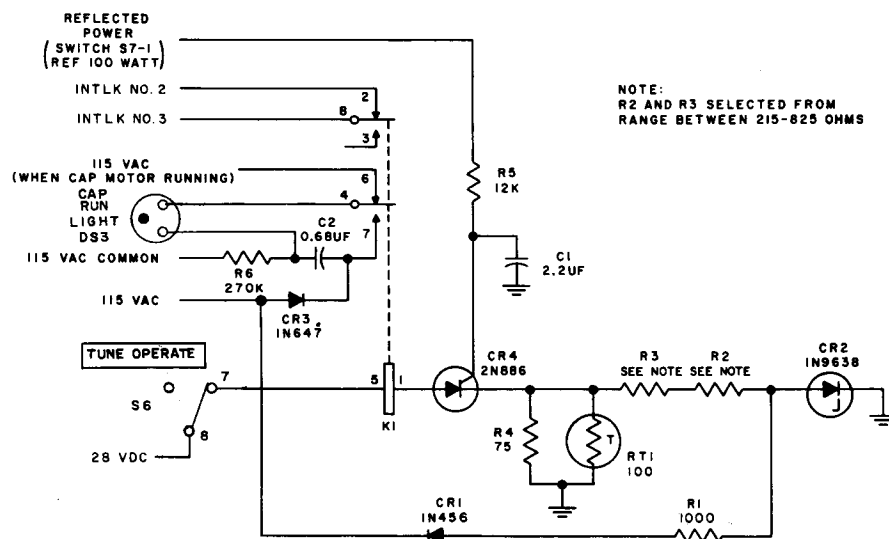


Figure 4-5. VSWR Protector 2A2, Simplified Schematic Diagram

b. ANTENNA COUPLER CU-714/SRA-22.

(1) CAPACITOR DRIVE CIRCUIT. - The CAPACITOR switch, located in the coupler control unit, is a 12-position wafer switch which causes the variable vacuum capacitor to be driven to a predesignated position. Refer to figure 4-6 for the simplified schematic diagram.

When one of the 12-positions on the switch is selected, 115 volts ac is applied through the common contact of switch 2S2, through binary combinations of contacts 7, 8, 9, and 10, depending upon which position is selected, to switch 1S10 contacts 7, 8, 9, or 10 in the antenna coupler unit. From the common contacts of switch 1S10, the 115 volts ac is applied to the two common contacts of limit switch 1S11 through contacts 2 or 3 to capacitor motor 1B4. The position of limit switch 1S11, in conjunction with phase shift capacitor 1C5, will determine the direction in which capacitor motor 1B4 will rotate.

The capacitor is driven from minimum to maximum capacitance, or the reverse, by capacitor drive motor 1B4. Switch 1S9, which is mounted on the same shaft as limit switch 1S11, determines whether the capacitor is in series or shunt with the antenna. The switch shaft is spring operated by a cam on the 192° sector gear. When shunt capacitance is selected, the capacitor is driven by the motor from minimum to maximum in shunt with the antenna. On reaching position 12, if series capacitance is selected by switch 2S5, the motor will run beyond position 12 in the maximum capacitance direction until the sector gear cam operates limit switch 1S11. This causes SERIES-SHUNT switch 1S9 to operate and place the capacitor in series with the antenna, and, at the same time, reverse the direction of capacitor drive motor 1B4. The motor will run toward the minimum capacitance until the selected capacitor position is reached. As CAPACITOR switch 2S2 is operated toward position 1, capacitor motor 1B4 drives capacitor 1C7 toward minimum capacitance. Selection of the SHUNT position of switch 2S5 causes the capacitor motor to run below position 1 until switches 1S9 and 1S11 operate, placing the capacitor in shunt with the antenna and reversing the direction of capacitor motor 1B4.

If the capacitor is in shunt with the antenna and a lesser value of capacitance is selected, or the capacitor is in series with the antenna and a greater value of capacitance is selected, the capacitor motor must drive in the direction opposite to that selected to its extreme limit, operate switches 1S9 and 1S11, reverse direction, and drive to the opposite limit. This will cause limit switch 1S11 to operate again, returning series-shunt switch 1S9 to its original position and again reversing direction of motor 1B4. Drive motor 1B4 will now run to the new position selected by CAPACITOR switch 2S2.

CAPACITOR RUN light 2DS3 is connected from the 115-volt ac common through a 270K resistor to the common contact of switch 1S10 on the antenna coupler. Capacitor drive switch 1S10 is driven through the 192° sector gear by capacitor drive motor 1B4. When switch 1S10 is driven to the position to break the circuit, the capacitor drive motor 1B4 will stop and the CAPACITOR RUN light will go out.

(2) TUNING AND LOADING. - In general, the following conditions apply to Antenna Coupler CU-714/SRA-22 operation. When the antenna appears capacitive and less than 50 ohms, no additional capacity is necessary to resonate the antenna. When the antenna appears inductive and less than 50 ohms, series capacity is necessary to resonate the antenna. When the antenna appears inductive and more than 50 ohms, shunt capacity is necessary to resonate the antenna. Wire and whip antenna reactance periodically changes sign many times through the frequency range of 2.0 to 30.0 megacycles. Refer to figure 2-1. Observe that, at 6.0 megacycles (in this particular example), the antenna presents nearly 50 ohms resistive impedance with no reactance. If means were provided to bypass the tuner, it could be eliminated at this frequency. At all other frequencies, various combinations of inductance and capacitance are required.

Tuning and loading are performed by manually operating the controls on the front panel of Coupler Control C-2698/SRA-22 for a minimum of reflected power and a high forward power as indicated on the r-f power meter in the coupler control. Refer to figure 3-1 for relationship of SWR to incident and reflected power.

CAUTION

Keying the transmitter during any operation that causes series-shunt switch 1S9 to be operated can result in damage to the transmitter or tuner. The series-shunt switch is operated in the following circumstances.

1. Operating Coupler Control SERIES-SHUNT switch 2S5 from SERIES to SHUNT or vice versa.
2. While in SERIES, selecting a larger value of capacity.
3. While in SHUNT, selecting a smaller value of capacity.

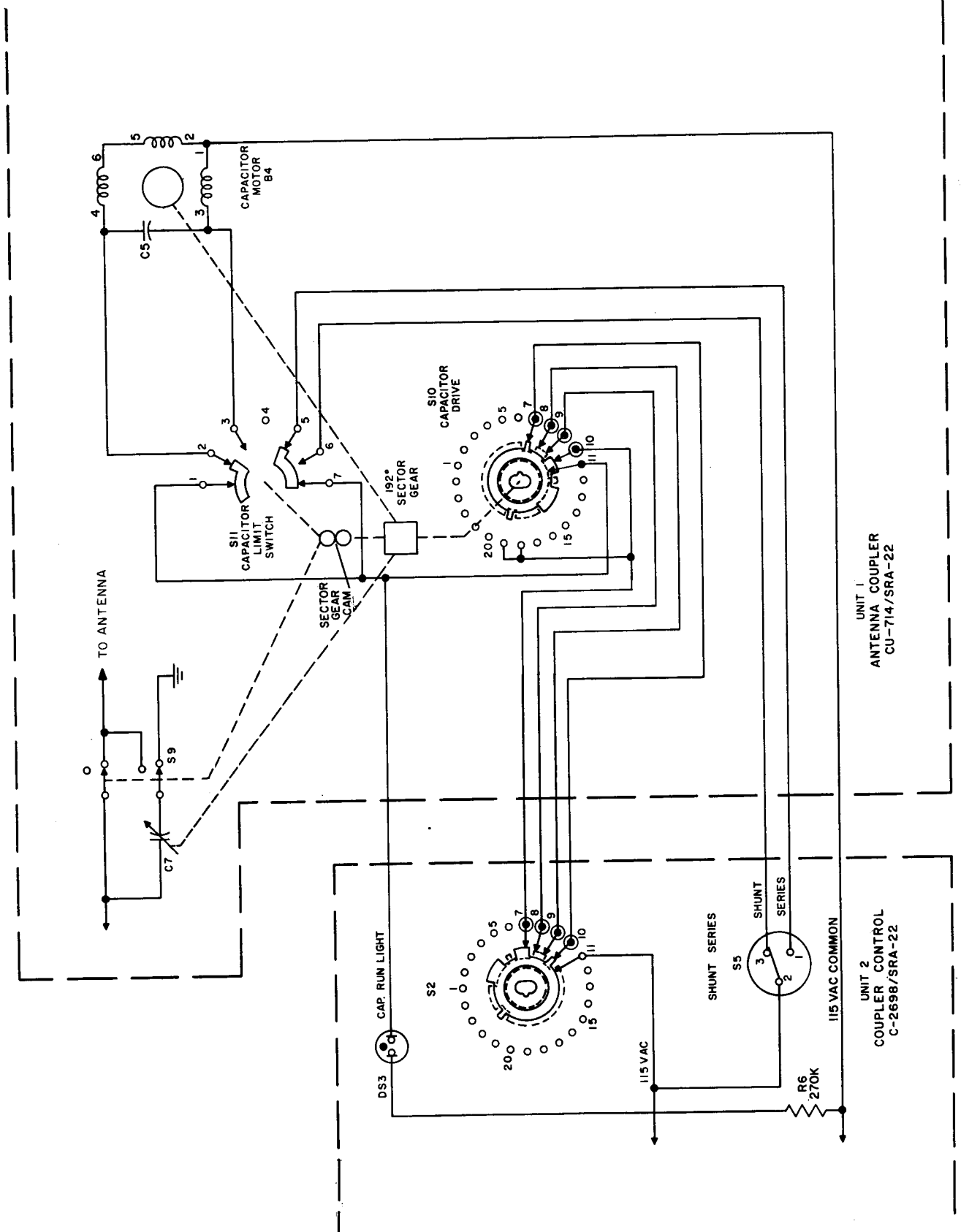


Figure 4-6. Capacitor Drive, Simplified Schematic Diagram

(3) BLOWER. - Keyed 115 volts ac is applied to pin 3 of jack 1J9 on the blower assembly when Radio Set AN/XXX is transmitting. Pin 2 of jack 1J9 is supplied with 115 volts ac through a temperature switch, 1S8. This switch does not operate until the temperature in the antenna coupler unit reaches 65° C (149° F), completing the circuit to the blower motor. The enclosed air of the antenna coupler is circulated by the blower when the transmitter is keyed (P. A. plate voltage applied) or when the temperature inside the antenna coupler exceeds 65° C (149° F). The enclosed air is forced through the double wall of the case and cooled by natural radiation and convection.