15. TRANSMITTER COUPLER CU–402/SRT (LOAD ADJUSTING UNIT, LAU).

a. GENERAL.—The function of the load adjusting unit (LAU) is to improve the impedance match between the characteristic 50-ohm r-f output impedance of the radio frequency amplifier and the impedance presented by the antenna tuning equipment. The improved matching permits the final PA stage of the radio frequency amplifier to operate at optimum plate efficiency and improves the transfer of power to the antenna system. The LAU consists of the standing-wave ratio monitor circuit and the impedance transformer circuit.

b. STANDING-WAVE RATIO MONITOR CIRCUIT. — The function of the standing-wave ratio (SWR) monitor circuit is to detect and monitor the standing-wave ratio present in the r-f transmission line at the output of the radio frequency amplifier. The components of the SWR monitor circuit together form a unit designated Directional Coupler Z–3201 (figure 2–116).

The SWR monitor circuit is composed essentially of two bridge circuits combined with a voltage divider that is tapped to provide the required outputs. One bridge circuit provides a d-c voltage proportional to the reflected and the other bridge circuit provides a d-c voltage proportional to the incident wave in the r-f transmission line. Each bridge circuit utilizes a voltage proportional to the current in the r-f line and a voltage proportional to the voltage in the r-f line.

The r-f transmission line from the RFA is connected through J–3201 to the SWR monitor circuit and thence to the impedance transformer circuit. A voltage, e_{v2}, proportional to the r-f line voltage, is obtained directly from the line through the voltage divider, R–3201, and the d-c blocking capacitor, C–3201, to the crystal rectifier, CR–3202. A second voltage, e_{i2}, proportional to the current in the r-f line, is obtained from one-half of the secondary winding of current transformer T–3202. The center tap of the secondary winding of T–3202 is grounded, providing two voltages, one at each end, that are 180° apart with respect to each other. Resistors R–3201, R–3202, R–3203, and R–3204 are damping resistors. Voltage e_{i2}, since it is shifted 180° in phase by T–3201, is in phase with the voltage e_{v2} and both voltages add at the junction of CR–3202 and C–3201. Rectifier CR–3202 will conduct only when the voltage e_{v2} is of less value than e_{i2}.When rectifier CR–3202 conducts, a positive d-c potential will exist at the junction of CR–3202 and C–3201 because of the polarity of CR–3202. This resultant positive d-c voltage is proportional to the incident voltage on the transmission line.

A voltage, e_{v1}, proportional to the voltage on the r-f line is obtained directly from the line through voltage divider R–3201 and the d-c blocking capacitor, C–3204, and is applied to the crystal rectifier, CR–3201. Voltage e_{v1} is equal to and in phase with e_{v2}. A second voltage, e_{i1}, proportional to the r-f line current, is obtained from one-half of the secondary winding of T–3202. Voltage e_{i1} is 180° out of phase with voltage e_{i2}, obtained from the other half of T–3202 secondary. Voltage e_{i1} in this case is 180° out of phase with voltage e_{v1}. Rectifier CR–3201 will conduct only when the anode is positive with respect to the cathode. Since voltage e_{i1} is 180° out of phase with e_{v1}, these two voltages will subtract and produce a negative voltage at the junction of CR–3201 and C–3204 proportional to the reflected voltage in the r-f transmission line.

Between the junction of CR–3202 and C–3201, where a d-c potential proportional to the incident voltage is found, and the junction of CR–3201 and C–3204, where a d-c potential of opposite polarity, proportional to the reflected wave, is found, a voltage divider is connected. This voltage divider consists of resistors R–3206, R–3208, then through J–3203 pin B and interconnecting wiring to the control-indicator to pick up resistors R–410, R–415, R–414, R–412, then back to the LAU through J–3203 pin C to resistors R–3209 and R–3207. At some point on this divider there is a voltage equal to the ratio of the reflected voltage to the incident voltage, which bears a simple relationship to the standing-wave

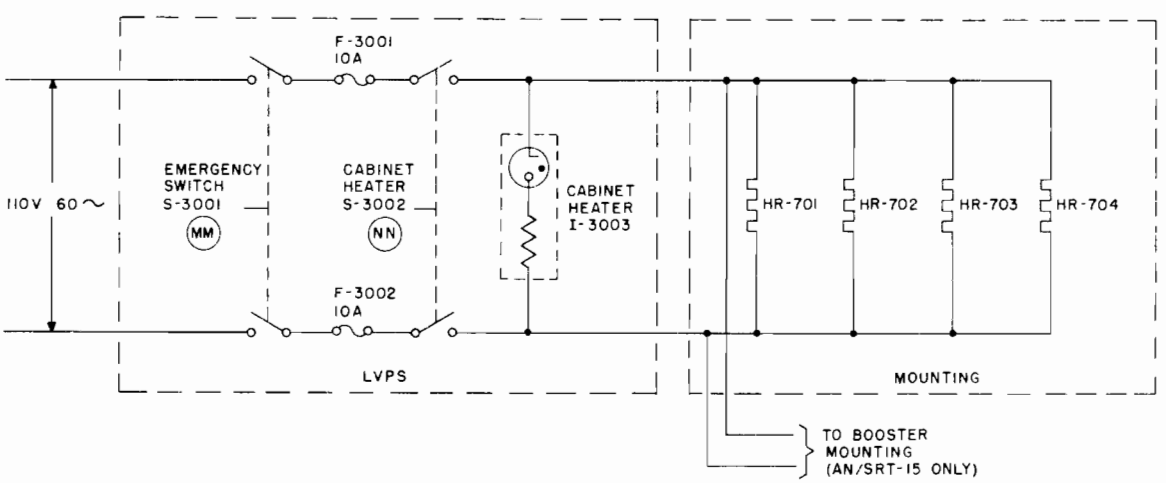

Figure 2–112. Heaters HR–701 Through HR–704, Simplified Schematic

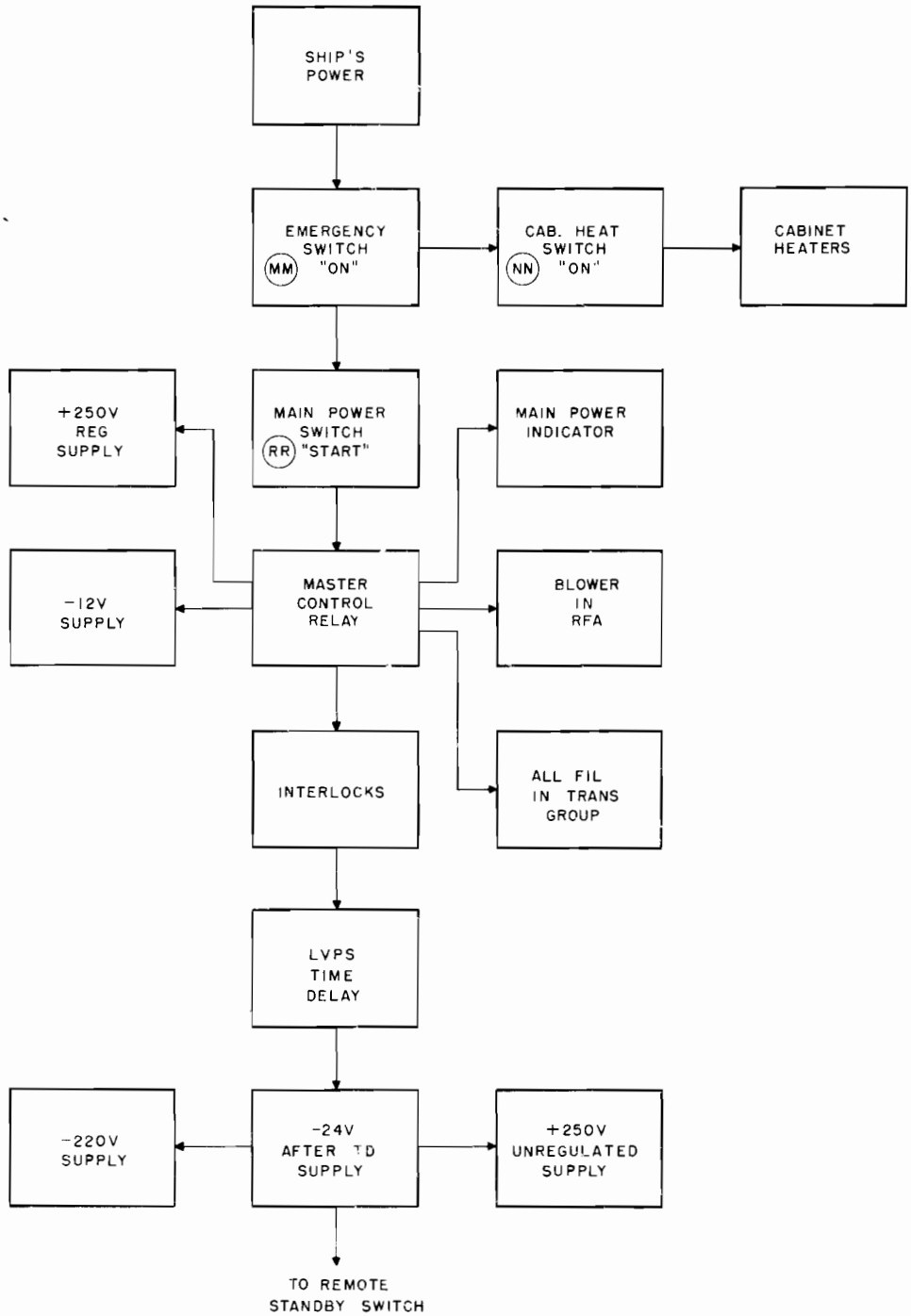

Figure 2–113. Control Circuits Operation Through –24 Volts After Time Delay, Simplified Functional Block Diagram

ratio (SWR). For any value of SWR, there will be a balanced (zero) condition at some point on the divider. The value of R–3201 is such that if there were no reflected current (SWR of 1:1), the d-c voltage at the junction of CR–3201 and C–3204 would be zero, and some positive d-c voltage would exist at the junction of CR–3202 and C–3201. With reflection on the line, d-c voltage at the junction of CR–3201 and C–3204 is negative and the d-c voltage at the junction of CR–3202 and C–3201 is positive. The zero point lies somewhere on the voltage-divider network. The voltage divider is tapped in the control-indicator unit at points that represent the location of the zero d-c voltage at standing-wave ratios of 8:1, 4:1, and 2:1. Paragraph 2*q*(6) covers the location of these taps and how the information is transformed to a meter indication of SWR.

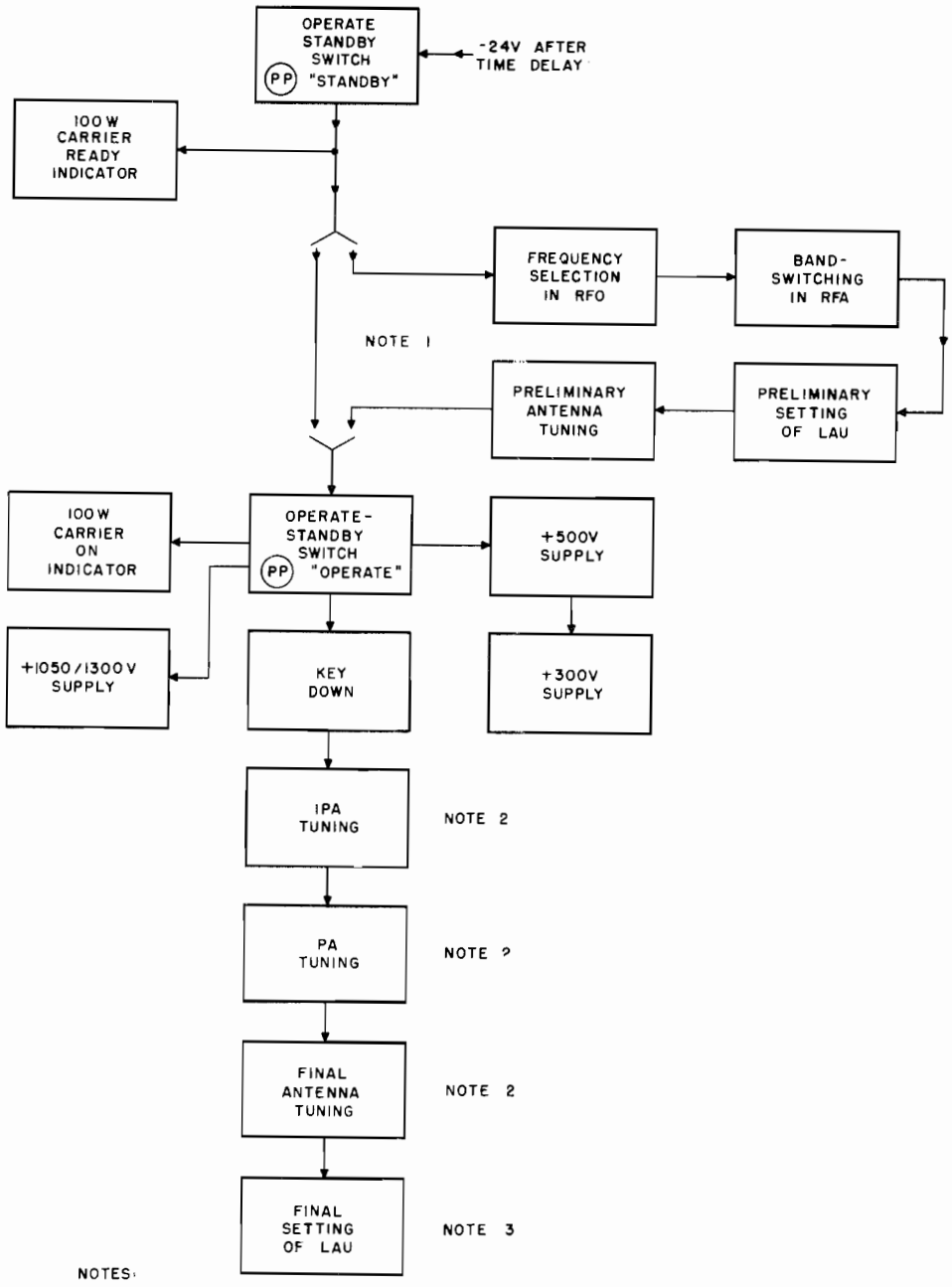

Figure 2–114. Control Circuits Operation from –24 Volts After Time Delay for 100-Watt Operation, Simplified Functional Block Diagram

c. IMPEDANCE TRANSFORMER CIRCUIT.—To improve the impedance match between the characteristic 50-ohm output impedance of the r-f output from the radio frequency amplifier (RFA) and the impedance presented to RFA by the antenna and the antenna tuning equipment, an autotransformer, T–3201 (figure 2–117), is introduced into the r-f transmission line. The r-f energy from the output of the RFA, after passing through the SWR monitor circuit, is connected to one of the taps of T–3201 through the contacts of INPUT TAP (W) switch S–3201. The output of the transformer, selected from one of the taps by the position of the OUTPUT TAP switch (WW), S–3202, is connected through r-f ammeter M–3201 to J–3202, which is the output to the antenna coupler. With controls (W) and (WW) both set at position 4, the full winding of the impedance

transformer is shunted across the line. This is the normal setting of these controls. If, after all tuning procedures have been completed, the measured SWR is higher than 2:1, controls (VV) and (WW) are set for the optimum impedance match as indicated by the tuning indications of the PA stage of the radio frequency amplifier (see Section 4, paragraph 6*a*) .

16. TRANSMITTER BAY CONTROL CIRCUITS.

a. GENERAL.—The control circuits located in the transmitter bay have been discussed separately under the descriptions of the various major units to which the individual control functions apply. The following will be a condensed discussion to unite all of the control functions. Included as control functions are the control of power circuits, manual setting up of a frequency in the RFO, manual tuning of the RFA, selection of the output power level, and placing the carrier on the air. Overload and other protection devices are employed to prevent damage to the equipment when operating at the 500-watt level. Various indicator lights show the operating condition of the transmitter bay.

b. SEQUENCE OF OPERATION.—Figures 2–113, 2–114, and 2–115 are simplified functional diagrams showing, in sequence, the operation of the control circuits. Figure 2–113 shows the operation through "—24 V after time delay", which is the same for either 100-watt or 500-watt operation. Figure 2–114 continues the sequence operation for 100-watt operation; figure 2–115 shows the sequence for 500-watt operation.

Note

As the AN/SRT–14 does not operate at the 500-watt level, the sequence of operation for 500-watt output level applies to the AN/SRT–15 and 16 only.

(1) The main power input (top block of figure 2–113) is 110-volt, 60-cycle, single-phase power received from the ship's supply. EMERGENCY SWITCH (MM) controls the power input to the transmitter bay. When switch (MM) is closed, power is delivered to the CABINET HEATER switch (NN) and to the MAIN POWER switch (RR).

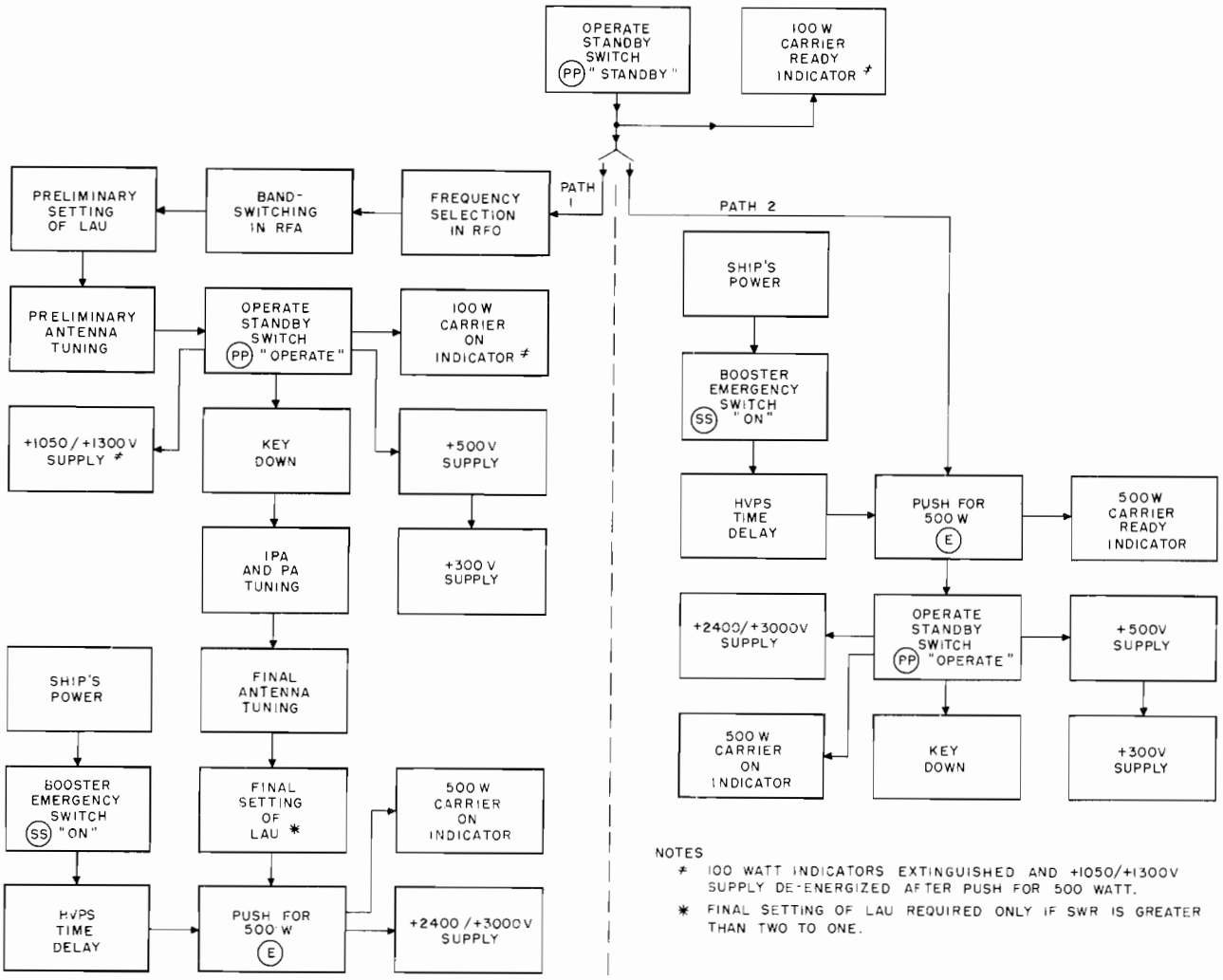

Figure 2–115. Control Circuits Operation, from —24 Volts After Time Delay for 500-Watt Operation, Simplified Functional Block Diagram

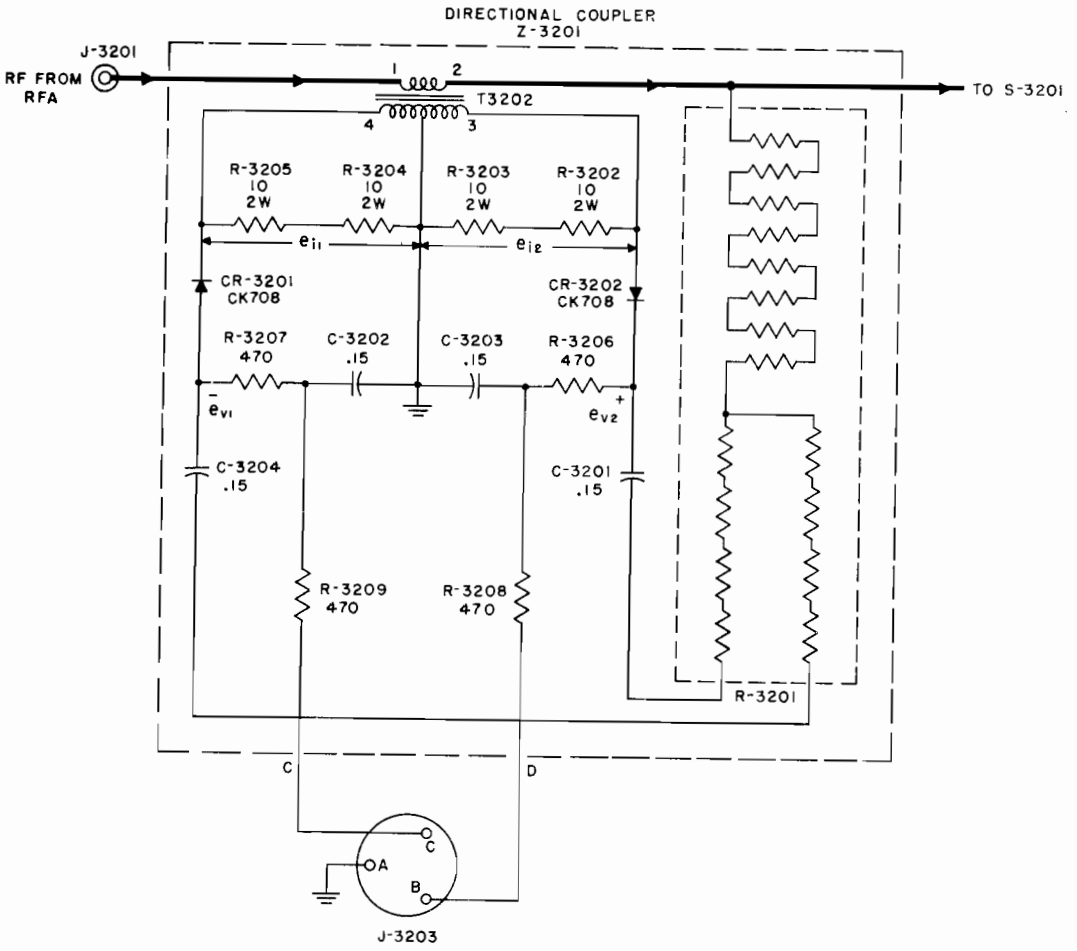

Figure 2–116. Standing-Wave Ratio Monitor Circuit, Simplified Schematic

to the RFA from J–603 pin 14 over wire 106 to J–601 and J–1301 pin 14. The output of the +250-volt unregulated supply illuminates the +250 V indicator, I–3004, and is fed to the RFO from J–3002 and J–610 pin 7 over wire 129 to J–607 and J–2917 pin 7. The output of the +300-volt supply is delivered first to the MVPS from J–3002 and J–601 pin 16, over wire 137 to J–613 and J–502 pin 16. In the MVPS the +300 volts is fed to the contacts of relay K–504. K–504 is energized when the +500-volt supply in the MVPS is energized. With K–504 operated, +300 volts is returned through the contacts 5R and 6R of K–504 to the LVPS by way of J–502 and J–613 pin 8, over wire 136 to J–610 and J–3002 pin 8. In the LVPS, the +300-volt supply is now filtered and the output illuminates the +300 V indicator, I–3005, and is delivered to the LLRM from J–3001 and J–609 pin 6, over wire 196 to J–603 and J–1101 pin 6; then it is fed to the RFA from J–603 pin 6 over wire 103 to J–601 and J–1301 pin 6.

(*c*) The MVPS contains two power supplies: the +500-volt supply and the +1,050/+1,300-volt supply. The +500-volt supply is turned on when relay K–501 is energized. K–501 operates after the LVPS time delay has run out and with the STANDBY-OPERATE switch (PP) in the OPERATE position in either 100-watt or 500-watt operation. As soon as power is applied, through the contacts 2L, 3L and 2R, 3R of K–501, to the plate transformer of the +500-volt supply, the 500 V PRI indicator, I–501, is illuminated. The output of the +500-volt supply illuminates the 500 V OUTPUT indicator, I–503, and is fed first to the LLRM from J–502 and J–613 pin 15, over wire 195 to J–604 and J–1102 pin 15; then it is delivered to the RFA from J–604 pin 15 over wire 113 to J–602 and J–1302 pin 15. The output of the +500-volt supply also energizes relay K–504, which switches on the +300-volt supply as described in the previous paragraph.

(*d*) The +1,050/+1,300-volt supply is energized when relay K–503 operates. K–503 operates in 100-watt operation only after the LVPS time delay has run out and with the STANDBY-OPERATE switch (PP) in the OPERATE position. As soon as power is applied, through the contacts 3L, 4L and 2R, 3R of K–503, to the plate transformer of the +1,050/+1,300-volt supply, the 1300 V PRI indicator, I–502, is illuminated, and when there is an output, the 1300 V OUTPUT indicator, I–504, is illuminated. In all modes of operation except phone, relay K–502 is not energized, and the output of the supply is +1,300 volts. In phone

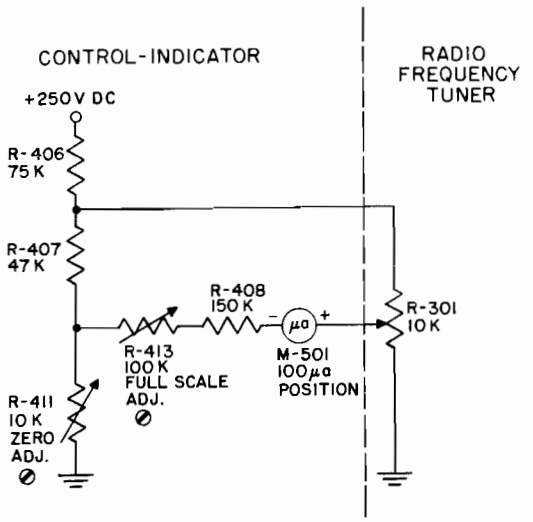

Figure 2–46. Position Indicator Circuit, Simplified Schematic

pedance transformer is not in the circuit. Placing S–403 in the 1 position will again energize B–301 through S–302, and B–303 will rotate until the actuator for S–302 falls in the notch of the positioning cam. This corresponds to the position of S–308 where the impedance transformer is in the circuit.

(5) POSITION INDICATOR CIRCUIT. — The POSITION indicator, M–402 (figure 2–46), gives an indication of the position of the shorting ring on the main tuning coil of the radio frequency tuner. To accomplish this a potentiometer, R–301 in the tuner, is geared to the same drive mechanism in the tuner that positions the shorting ring. The gear ratio is such that full excursion of the shorting ring will produce about 70 percent of full rotation of R–301. R–301 is part of a voltage divider network from +250 volts dc to ground, comprised mainly of R–406, R–407, R–411, and R–301. The values are such that the potential at the high end of R–301 is about +25 volts, with the low end grounded. As R–301 only travels 70 percent of its full rotation, when the shorting ring is driven to the top limit of its travel, the arm of R–301, which is connected to one side of POSITION meter M–402, will be at about +21 volts. When the ring is at the bottom limit, the arm of R–301 will be about +4 volts. With the arm of R–301 at the low limit, the value of R–411 is adjusted so the potential at the junction of R–407, R–411, and R–413 is the same as at the arm of R–301 (approximately +4 volts), at which point no current will flow through M–301, and the indication will be zero. With the arm of R–301 at the high end of the travel, there will be a potential of approximately 17 volts across the combination of limiting resistors R–413, R–408, and M–301. R–413 is adjusted for full-scale reading on M–301. By making both the low-scale and high-scale adjustments, accurate positioning of the shaft of R–301 with respect to the traverse of the shorting ring is eliminated, it being necessary only to ensure the total traverse lies between the limit stops of the potentiometer. Both R–411 and R–413 are screw-driver adjustments on the front panel of the control indicator and are designated ZERO ADJ and FULL SCALE ADJ respectively.

(6) SWR INDICATOR CIRCUIT.—The SWR indicator circuit (figure 2–47) is used in conjunction with voltages supplied to it from the SWR monitor circuit, which is a component of the load adjusting unit (see paragraph 15*b*). The input to the SWR indicator circuit from the SWR monitor consists of two voltages of opposite polarity, one proportional to the voltage of the "reflected" wave and the other proportional to the "incident" wave as measured on the r-f output line of the transmitter. Across the input there is a tapped divider consisting of R–410, R–415, R–414, and R–412. The values of these components are such that if the standing wave on the r-f line is 8:1, the potential at the junction of the R–410 and R–415 is zero; accordingly, the 8:1 position of the SWR CALIBRATE switch, S–408, is connected to this point and the SWR BALANCE meter, M–410, would be at the center null position. If the standing-wave ratio is less than 8.1, with S–408 set at the 8:1 position, the SWR BALANCE meter M–401 will read to the left of the null position (green area) and, conversely, if the ratio is higher than 8:1, M–401 will read to the right of the null position (red area). Similarly, the voltage at the junction of R–415 and R–414 will be zero when the standing-wave ratio is 4:1. With the SWR CALIBRATE switch, S–408, set at the 4:1 position, which is connected to the junction of R–415 and R–414, M–401 will again read at the center null position for a value of 4:1 SWR. A 2:1 value of standing-wave ratio will give a zero potential at the junction of R–414 and R–412; consequently, the 2:1 position of S–408 is connected to this point. R–416 is a limiting resistor of sufficient size to limit the current flowing through M–401 to a value below its safe limit value of 5 ma when the transmitter is in 500-watt operation. R–409 is the damping resistor for M–401. S–408 has an OFF position that disconnects the SWR BALANCE meter, M–401, from the circuit.

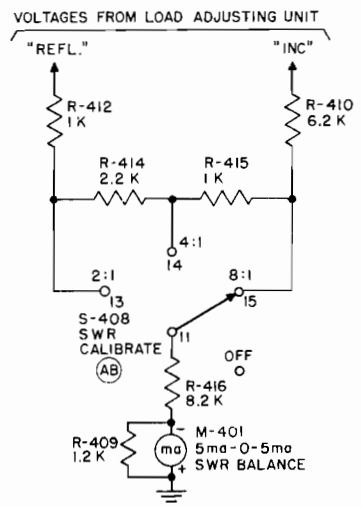

Figure 2–47. SWR Indicator Circuit, Simplified Schematic