

## SECTION 3 OPERATION

### 3.1. FILAMENT CONTROL

When the filament circuit breaker, S-106, is closed, depressing the filament on button will energize filament contactor K-103, applying 230 volts to its coil through filament on button S-111 and normally closed contacts of filament off button S-112. Holding contacts of K-103 shunt the contacts of S-111, maintaining the circuit after the button is released. Depressing the filament off button, S-112, opens its contacts, which are in series with S-111 and K-103, and de-energizes the relay.

### 3.2. TIME DELAY

When K-103 is initially energized, the circuit to the heater element of thermal time delay relay K-101 is completed through R-171, R-173, and the holding contacts of K-103. R-171 is provided as a means of adjusting the length of the time delay by adjusting the heater current. The closing of the contacts of K-101 lights filament lamp I-101 and prepares the plate circuit for operation. Also, R-172 is shunted across the heater element of K-101 and R-171, reducing the current through the element to a value just sufficient to hold the contacts closed.

K-101 contains a resistor heating element, a bimetal strip, and contacts. The temperature within the relay affects the bimetal element, causing the contacts to close when heated, and to open when cooled. The thermal inertia of the heating element and bimetal strip, being comparable to that of the tube filaments in the transmitter, causes this relay to automatically select the proper delay period to allow the tubes to come to their proper operating temperature. During short power interruptions, there will be little or no delay in returning to the air, as the tubes, and so, too, K-101, will not have cooled sufficiently to require the full delay interval. The length of the initial delay period from a cold start is adjustable from 10 seconds to 45 seconds by means of time delay adjustment R-171. A delay of 30 seconds is recommended. Turning the control clockwise will lengthen the delay. If the delay period is to be timed, make the check only when the transmitter has been shut down for several hours, as any residual heat from a previous run will shorten the delay interval. The filament lamp indicates the end of the time delay cycle.

### 3.3. PLATE CONTROL

If the filaments have been energized and the time delay cycle has been completed, depressing the plate on button, S-113, will close the circuit to plate hold relay K-104 through S-112, S-113, S-114, overload relays K-105 and K-106, and door interlocks S-108 and S-109; the contacts of K-104, in turn, energize plate contactor K-102 through contacts 3 and 4 of K-104, arc-suppression relay K-107, contacts 5 and 6 of K-104, and K-101. A pair of contacts of K-102, when closed, shunt the contacts of K-101, relieving them of continuous load.

It can be seen from the above that is the arc-suppression relay, K-107, is energized by a fault in the antenna circuit or final tank, the opening of its contacts will de-energize K-102 only. Since K-104 remains closed, the reclosing of K-107 will re-energize K-102 and return the transmitter to the air immediately. If one of the rear cabinet doors is opened, or if an overload occurs in the modulator or final, both K-104 and K-102 will be de-energized, and the plate on button must be depressed to return the transmitter to the air. Depressing the filament off button, S-112, will shut down the transmitter completely.

#### 3.4. AUTOMATIC SEQUENCE STARTING

If desired, the transmitter may be started by pressing only the plate on button. The sequence of operation is as follows:

Depressing S-113 energizes K-104. K-104, through its contacts, energizes the filament contactor and time delay relay. At the end of the time delay interval, the closing of K-101 will automatically energize K-102, applying plate power to the transmitter.

#### 3.5. CRYSTAL SELECTOR SWITCH

Crystal selector switch S-101 is located in the center of the area behind the lower right inspection plate as indicated in figure 6-11. The switch shaft is slotted for screwdriver operation. When the switch is turned to the right, the crystal toward the right side of the chassis (as viewed from the front of the transmitter) is selected.

#### 3.6. CRYSTAL FREQUENCY TRIMMER CONTROLS

Crystal frequency trimmer controls C-101 and C-102 are located behind the lower right inspection plate as indicated in figure 6-11. These two controls provide for small adjustments in the crystal frequency. C-101, the upper control, adjusts the frequency of Y-101, the left-hand crystal as seen from the front of the transmitter.

#### 3.7. MULTIMETER SWITCH

Multimeter switch S-102 is a two-pole seven-position switch located behind the left door on the front of the transmitter cabinet as shown in figure 6-11. This switch inserts multimeter M-104 into any one of seven transmitter circuits. Table 4-1 lists the multimeter switch positions and typical readings for these circuits. The full scale reading of the multimeter is indicated for each switch position.

#### 3.8. FIRST R-F BUFFER TANK CIRCUIT TRIMMERS.

The first buffer tank circuit trimmers, C-114 and C-115, are screwdriver adjustments located behind the lower right inspection plate. The location of these two trimmers is shown in figure 6-11. They should be adjusted for maximum grid drive to the 807 r-f driver stage. The trimmers are connected in parallel as shown in figure 7-7. One of the trimmers should be adjusted to give a good

tuning range with the second trimmer, and all adjustments made with the second trimmer.

### 3.9. R-F DRIVER TANK TRIMMERS

C-125 and C-126, the r-f driver tank circuit trimmers, are screwdriver adjustments located behind the upper right inspection plate. The location of these two trimmers is shown in figure 6-11. They should be adjusted for maximum grid drive to the power amplifier. The trimmers are connected in parallel as shown in figure 7-7. One of the trimmers should be adjusted to give a good tuning range with the second trimmer, and all adjustments made with the second trimmer.

### 3.10. POWER AMPLIFIER PLATE TUNING AND LOADING CONTROLS

The power amplifier plate circuit tuning and loading controls, C-146 and C-147, are located behind the right-hand door on the front of the transmitter cabinet as shown in figure 6-11. The PA tuning control is used to resonate the power amplifier plate circuit. An increase in loading is obtained by reducing the capacity of the power amplifier loading capacitor, C-147, while simultaneously retuning the power amplifier plate circuit to resonance by means of the PA tuning control. With a pi-L output network of the type used in the 20V-2 transmitter, any adjustment of the PA loading control will detune the output network and cause the plate current to soar. Care must be exercised to keep the PA tuning at resonance whenever the PA loading control is adjusted. The loading should be increased until the r-f line current is slightly less than the desired value. The PA tuning control should then be adjusted slightly to the side of resonance that gives an increase in r-f line current. The power amplifier plate current will also increase; however, the increase in power to the r-f line constitutes a large proportion of the increase in power to the power amplifier circuit, thus yielding a higher plate efficiency. Adjust the PA tuning and PA loading controls to the point where the desired amount of r-f line current is obtained with the highest operating efficiency. The highest efficiency will always be obtained with the power amplifier plate circuit tuned slightly on the capacitive side of resonance.

### 3.11. POWER CHANGE SWITCH

Power change switch S-103 is located behind the left door on the front of the cabinet as shown in figure 6-11.

Two resistors in series with two parallel resistors are contained in the power amplifier plate circuit. POWER CHANGE switch S-103 shorts out these resistors for high power operation and removes the short for low power operation. A jumper strap is provided across the parallel resistors R-194 and R-195 for 500-watt operation on low power, and must be removed for 250-watt operation on low power. Tapped resistor R-196 is used to adjust low power output to exactly 250 or 500 watts. The POWER CHANGE switch may be operated whether the transmitter is broadcasting or not. Minor corrections in power output are made with the power amplifier tuning and loading controls.

### 3.12. PA DRIVE CONTROL

PA drive control R-182 is a screwdriver adjustment located behind the upper right-hand inspection plate as shown in figure 6-11. It is used to vary the r-f driver screen voltage in order to regulate the grid drive applied to the power

amplifier. PA drive control R-182 should be adjusted at the same time and in the same manner as audio hum control R-120, described in paragraph 3.13 below. When adjusted in this manner, optimum voltage will be applied to the r-f driver screen circuit.

### 3.13. AUDIO HUM CONTROLS

Audio hum control R-120 is a screwdriver adjustment located behind the upper right inspection plate as shown in figure 6-11. It is a variable resistor used to shift the ground point of the power amplifier filament circuit to a point which will minimize the hum caused by the a-c filament voltage. The other audio hum control, R-146, is the only control located behind the lower left inspection plate. The position of this screwdriver adjustment is indicated in figure 6-11. The operation of this control is the same as that of audio hum control R-210; it shifts the ground point of the modulator filament circuit to minimize hum.

In order to adjust audio hum controls R-120 and R-146, and PA drive control R-182, inject a 1000-cycle audio signal of sufficient amplitude to modulate the carrier 100 percent. Calibrate a noise meter, remove the modulation, and read the noise level. Adjust PA drive control R-182 for minimum noise. Adjust audio hum controls R-120 and R-146 to further reduce the noise level.

### 3.14. MODULATOR BIAS ADJUSTMENTS

Modulator bias adjustments R-162 and R-163 are located behind the upper left inspection plate as indicated in figure 6-11. These two screwdriver adjustments control the amount of negative bias applied to the grids of the individual modulator tubes. Turning R-162 counterclockwise increases the amount of bias applied to V-110, the modulator tube near the front of the cabinet. To adjust these two controls, inject a 1000-cycle signal for sufficient amplitude to modulate the carrier 95%. Vary R-162 and R-163 until minimum distortion is indicated on a distortion analyzer. R-149 can be used to adjust the total modulator plate current.

### 3.15. ARC-SUPPRESSION CIRCUIT

The arc-suppression circuit included in the 20V-2 will safeguard tubes and tank components by interrupting the plate voltages in the event of a short circuit or flashover in the transmitter r-f output circuit. The arc-suppression relay, K-107, has normally-closed contacts in series with the plate contactor coil. The coil of K-107 is connected in series with monitor coil L-110, as shown in figure 7-3. The end of the monitor coil that connects to the relay is bypassed to ground for rf. The bias supply is used to supply current for the operation of K-107. When an arc-over occurs in the power amplifier output network due to lightning or any other cause, the ionized path produced by the r-f voltage in the arc has a sufficiently low d-c resistance to complete the relay coil circuit and energize the relay. When the relay operates, its contacts open, disabling the high- and low-voltage plate supplies, removing the transmitter carrier from the air and stopping the arc-over. When the arc is extinguished, there is no path to ground for the d-c relay coil current, and its contacts close, returning the carrier to the air. Ordinarily, this complete operation will occur so quickly that only the click of the plate contactor will notify the operator that an arc-over has occurred.

## 3.16. STARTING THE EQUIPMENT IN A NEW INSTALLATION

- a. Before starting the transmitter for the first time, inspect it carefully for any mechanical damage.
- b. Be sure that all tubes are in their proper sockets, and that the crystals are in place.
- c. Inspect all door interlocks. Press on the contact block until the spring is completely compressed. Release the pressure. If the contact block does not spring out to its original position, check the interlock carefully and adjust it until it operates properly.
- d. Remove the plate caps from the two 866A and two 575A rectifiers. Make sure that the caps hang free and are not near any metal parts.
- e. Close both rear cabinet doors.
- f. Press the filament on button. The filament and time delay circuits should operate as described in paragraphs 3.1. and 3.2.
- g. Wait until the filament lamp lights, then press the plate on button; the plate lamp should light immediately.
- h. Press the filament off button; the transmitter should shut down completely.
- i. Remove the modulator tubes from the equipment.
- j. Replace the plate caps on the 866A low-voltage rectifiers only.
- k. Select the desired crystal, using crystal selector switch S-101.  
(See figure 6-11.)

## CAUTION

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OBSERVE SAFETY PRECAUTIONS. DO NOT MAKE ADJUSTMENTS INSIDE THE EQUIPMENT WITH HIGH VOLTAGE APPLIED. DO NOT DEPEND ON DOOR INTERLOCKS. ALWAYS SHUT DOWN THE EQUIPMENT WHEN MAKING ADJUSTMENTS.

- l. Apply power to the filaments and allow the transmitter to run for twenty minutes with only the filaments lighted. This operation is necessary in order to properly age the mercury vapor rectifier tubes. Aging is required for all new tubes and for used tubes that have been agitated or inverted.
- m. Press the plate on button.

n. Rotate the multimeter switch through the first four positions and check the readings with those given in table 4-1. Some deviation from these readings is to be expected.

o. Set the multimeter switch to the position designated 807 grid, 25 ma., and adjust the buffer plate tank trimmers for maximum 807 grid current. These two trimmers, C-114 and C-115, are located behind the lower right inspection plate, as shown in figure 6-11. The two trimmers are connected in parallel; one of the trimmers should be set to provide a good tuning range with the second.

p. Check the first buffer cathode current against table 4-1.

q. Set the multimeter switch to the position designated PA Grid, and tune the driver plate tank trimmers in the same manner as the buffer plate tank.

r. Shut down the power and replace the plate caps on the HV rectifiers. Replace the modulator tubes in their sockets.

s. Turn the two front-panel modulator bias adjustment controls, R-162 and R-163, to their maximum counterclockwise positions. Turn modulator bias adjustment R-149, located at the rear of the power supply chassis, to maximum clockwise position. This adjustment results in maximum bias and minimum modulator plate current.

t. Adjust the clip on the monitoring coil, L-110, located in the r-f tank compartment and illustrated in figure 6-7, to a position near the ground end of the coil.

u. Set the power change switch to the low position.

v. Set the PA loading control at 100. This adjustment produces minimum loading.

w. Close the rear cabinet doors and turn on filament and plate power.

x. As soon as the plate voltage is applied, adjust the PA tuning for minimum PA plate current.

y. Turn the multimeter switch to the PA grid position and retune the 807 r-f driver plate tank for maximum PA grid current.

z. Set modulator bias controls R-162 and R-163 to center of their rotation. Adjust modulator bias control R-149 on power supply chassis so that total modulator current is approximately 120 ma.

aa. Turn the power change switch to the high position and recheck the power amplifier plate tuning.

- bb. Recheck the driver plate tank for maximum PA grid current.
- cc. Increase the power amplifier loading to obtain the desired power output, using the method described in paragraph 3.10.
- dd. Adjust the tap on L-110 to obtain the desired output for the monitoring equipment.

### 3.17. ADJUSTMENT OF AUDIO SECTION

Apply a 1000-cycle tone of sufficient amplitude to modulate the r-f carrier 95 percent. Adjust the two modulator bias controls, R-162 and R-163, to obtain minimum distortion as measured with a distortion analyzer. R-149 may be readjusted as necessary to bring R-162 and R-163 into range. Total static current should remain near 120 ma.

Increase the level of the 1000-cycle modulating signal until 100% modulation is obtained. Calibrate a noise meter and remove the modulation. Read the noise level. Adjust PA drive control R-182 and audio hum controls R-120 and R-146 to reduce the noise to a minimum value. The location of these controls is shown in figure 6-11.

### 3.18. OVERLOAD RELAY ADJUSTMENT

To change the setting of the power amplifier overload relay, (see figure 6-10) remove the relay cover, turn the transmitter on and load it to operating values. Gradually change the setting of the thumb screw in the relay and momentarily run the power amplifier off tune and watch the PA plate current meter. Set the thumb screw at the desired drop-out point, retune to resonance and replace the relay cover. Reset the flag by pressing the plunger at the bottom of the relay.

To change the setting of the modulator overload relay, remove the relay cover, turn the transmitter on and load it to operating values. Set the thumb screw in the same manner as for power amplifier overload adjustment (above) except introduce an audio sine wave at 1000 cps into the audio input and run the gain up until proper overload drop out is established.

### 3.19. STARTING IN NORMAL OPERATION

- a. Close the rear cabinet doors.
- b. Depress the filament on button.
- c. Turn the power change switch to the correct position for the desired power output.
- d. Depress the plate on button.
- e. If the power output is to be adjusted, set the PA loading and PA tuning controls as described in paragraph 3.10.
- f. Record meter readings and monitoring observations. Typical meter readings are listed in table 4-1.