

If, however, protection for small speakers against sustained high power levels is desired, an "in-line" fuse should be included in the speaker wiring. A suitable fuse value can be calculated using the following equation:

$$I = \sqrt{\frac{P}{Z}} \quad \text{where:} \quad \begin{array}{l} I = \text{fuse value in amps} \\ P = \text{RMS power rating of speaker} \\ Z = \text{nominal speaker impedance} \end{array}$$

example: What value fuse is required to protect an 8 ohm speaker rated at 35 Watts, RMS?

$$I = \sqrt{\frac{35}{8}} = \sqrt{4.375} = 2.09 \text{ Amps}$$

Use a 2 Amp instrument type fuse ("Littelfuse" 361000 series) or equivalent.

6. Output Meters - The front panel (Power Monitor) meters located to the left and right of the center meter are the left and right channel meters respectively. These meters indicate the power output or the cathode current bias of their respective channel as selected by the switch below each meter. When the switch is in the "power output (operate)" position, the meters indicate output power in watts. For 150 watts (sine wave) the meter indicator will be at the "adjust" mark or the line between the green and red operating zones. Meter calibration is based on a 4, 8, or 16 ohm resistive load connected to the proper output tap. At other power output levels, the meters will indicate as follows:

for 90 watts, 50% deflection
for 25 watts, 25% deflection
for 4 watts, 10% deflection
for 1 watt, 5% deflection

The meters operate "underdamped" to allow visual indication of transient (musical) program material. Continuous or prolonged operation in the red "caution" zone should be avoided. It is, however, considered normal for the meter to occasionally read in the red "caution" area for certain types of program material.

The meters also monitor the cathode bias current for each output tube. This feature permits optimum adjustment of the output stage idling current (for all line voltage and tube conditions) directly from the front panel. Each tube is adjusted for a 55 ma idling current which corresponds to the "adjust" mark on the meters when the meter switches are in any of the "cathode current (bias adj.)" positions. Proper procedure for making this adjustment will be given later. The meter switches must always remain in the "output power (operate)" position except when making a bias adjustment.

7. Output Meter Switches - The five position rotary switch below each Power Monitor meter controls the operating mode of the meter (as described above). THESE SWITCHES MUST ALWAYS BE RETURNED TO THE "OUTPUT POWER (OPERATE)" POSITION (FULL CLOCKWISE) - EXCEPT WHEN MAKING ANY CATHODE CURRENT BIAS ADJUSTMENTS. Make sure that the switches are returned to the "operate" position immediately after making any bias adjustments - as described below.
8. Cathode Current Bias Adjust Controls - The eight slotted rotor bias controls located in a single row near the bottom edge of the front panel can be adjusted by inserting the plastic accessory screwdriver through the appropriate access hole. Although these controls are factory set, periodic checking and adjustment of the bias current is desirable. It should be noted that the left channel output stage (V13, V15, V17, V19) is monitored with the "left" Power Monitor meter and switch while the "right" channel (V14, V16, V18, V20) is monitored with the "right" meter and switch. Optimum idling current for the push-pull parallel output stages is 55 ma (meter "adjust" mark) per tube. The range of the bias controls is approximately 25 to 85 ma. Make the bias adjustments as follows:
 - a) Allow the amplifier to warm up for five minutes.
 - b) Rotate the left meter switch from the "(operate)" position to the "V13" (bias adj.) position.
 - c) Note the left meter indication.
 - d) If necessary, turn the "V13" bias control SLOWLY until the meter indicator is at the "adjust" mark, which corresponds to 55 ma. The meter reading will "increase" with a "clockwise" rotation of the bias control as viewed from the front panel.

NEVER TURN A BIAS CONTROL RAPIDLY OR FROM STOP TO STOP.
 - e) Continue to monitor and adjust V15, V17, V19, V14, V16, V18, and V20 using the above procedure.
 - f) If an output tube fails to "adjust" properly within the range of the bias control, it must be replaced as instructed below.
9. Power Output Tube Replacement - In the event an output tube should fail, it must be replaced with its counterpart as a factory matched pair. The following schedule must be followed when replacing power output tubes:

V13 & V17, Matched Pair, Left Channel

V15 & V19, Matched Pair, Left Channel

V14 & V18, Matched Pair, Right Channel

V16 & V20, Matched Pair, Right Channel

V21 & V22, Matched Pair, Power Supply
(not monitored with front panel meter)

To replace a matched pair of tubes, remove the screws holding the top perforated cover in place. Observing the numbers by the tube socket, unfasten the tube clamp clasp around the tubes to be replaced. Remove any other tubes that are in the way of those to be replaced, keeping track of their correct "position" for when they are re-installed. WHEN REMOVING POWER TUBES, DO NOT ALLOW THE TOP OF THE TUBE TO STRIKE THE METAL PANEL OPPOSITE THE SOCKET AS TUBE BREAKAGE MAY OCCUR. Tube removal is best accomplished by grasping the metal tube base with the thumb and forefinger while allowing the end of the tube to rest in the palm of the hand. Using a slight rotary motion, remove the tube with a steady pulling force. The edge of your hand should strike the metal panel and thus prevent breakage when the tube "suddenly" releases from the socket. Install the new matched pair according to the above schedule. Insert the tube into the socket and rotate until the "key" on the stem of the tube base is aligned with the keyway in the tube socket and the tube drops into place. Push the tube firmly into the socket until the base of the tube is flush with the panel. Fasten the tube clamp around the base of the tube using the second or inner notch of the clasp. Replace the top cover and adjust the bias (if an output tube was replaced) as instructed above.

10. Front Panel Fuses and Indicators - All fuses, both line and circuit are located on the front panel. Power line fuses (5 amp type FNM) are on the left side of the panel, while the plate fuse (2 amp type KLM) and screen fuse (1 amp type KLM) are on the right. These fuses may never need replacing, however, if a malfunction should occur, a red "fuse out" indicator(s) will illuminate to identify the open fuse. Occasionally a line transient or momentary arcing within a tube will cause a fuse to blow. It is therefore recommended that a new fuse be installed (spare fuses are supplied in the accessory bag) and the unit tried before considering any service work. ALWAYS TURN THE POWER SWITCH TO "OFF" IF A FUSE BLOWS OR BEFORE REPLACING ANY FUSES.