

2. Turn both input level controls fully counter-clockwise.
3. Connect the amplifier to the preamplifier or electronic crossover, using only the highest grade audio interconnect cables (Sound Connections Silver Cable is recommended).
4. Connect the power line cord to the AC power, observing Paragraph 2 under USE CAUTIONS on Page 2 of this manual.
5. Proper adjustment of the input level controls can be accomplished very simply. Turn your preamplifier level control to 12 to 1 o'clock while playing a record. Then, advance (from the previously counter-clockwise settings) the amplifier level controls to your normal listening level. This provides optimum "bandspread" of adjustment at the preamplifier, as well as providing optimum signal-to-noise ratio. (The D90 will normally perform best with its level controls near maximum.)

CAUTION

Make certain the amplifier is installed according to the instructions under INSTALLATION on Page 3 of this manual.

D90 ADJUSTMENT PROCEDURE AND DISCUSSION

The D90 utilizes very high quality commercial grade components and this, together with conservative operation of all components and tubes, should provide long adjustment-free service life.

After long service, or after vacuum tube failure and replacement, or in a location with consistently low line voltage, it may be desirable to readjust the amplifier for optimum performance.

CAUTION: The following procedures should not be attempted by the owner unless he is technically qualified. There are high voltages and currents within this unit which can be lethal under certain conditions. Refer all such adjustment to a qualified individual.

There are four parameters which may be adjusted (in the following sequence) in the D90 after removing the top cover:

1. OUTPUT TUBE IDLE CURRENT ("BIAS")
 2. CROSS COUPLER DC BALANCE
 3. PHASE INVERTER AC BALANCE
 4. OUTPUT AC BALANCE (NOT IN SOME EARLY UNITS)
1. OUTPUT TUBE IDLE CURRENT ("BIAS")
- The output stages of the D90 are partially cathode coupled "push-pull parallel class AB₁," utilizing our patented circuit which operates the tubes in true "pentode" configuration and efficiency with the low distortion of "triodes" and at the same time providing better coupling than either conventional circuit.

As shipped from the factory, the output tubes are adjusted for a nominal 75 mA. per tube with a stable AC line voltage of 120 Volts. Under these conditions the tubes are each dissipating approximately 30 watts of their 50 watt rating (44 watt plate, 6 watt screen). This point of operation provides "enriched" class AB₁, and will satisfy most critical listeners. It is possible to operate the tubes as high as 100 mA. each at idle for full class A operation without exceeding their dissipation ratings. While this may provide an additional measure of quality with the finest of speaker systems, it will also cause the D90 to run significantly hotter, and the need for some forced air cooling becomes desirable. Under these conditions output tube life will also be shorted from an expected 2000+ hours of satisfactory use downward depending upon the ventilation provided.

1A. "BIAS" ADJUSTMENT PROCEDURE

A digital voltmeter capable of accurate measurement of .05 to .1 Volt DC is required to accomplish this adjustment.

There is a 1 ohm 5% wirewound resistor in the cathode circuit of each output tube, and test connections (test points referred to schematically and on the PWB as TPs) are provided on either end of these resistors so that a voltage measurement can be conveniently made across each resistor. These test points are identified and accessible from the top side of the PWB.

Because the resistor is 1 ohm, you can conveniently "direct" read the total cathode current in each tube. A .05 Volt reading equals 50 mA. A .1 Volt reading equals 100 mA. A .075 Volt reading equals 75 mA., etc.

<u>TUBE</u>	<u>TP COMMON</u>	<u>TP</u>
V11	13	5
V13		9
V15	15	7
V17		11
V12	14	6
V14		10
V16	16	8
V18		12

V11 and V13 are adjusted together by RV9
 V15 and V17 are adjusted together by RV11
 V12 and V14 are adjusted together by RV10
 V16 and V18 are adjusted together by RV12

It is important that all 8 output tubes be reasonably matched (within 5%) for highest performance operation.

Observe the following:

1. These adjustments should be accomplished under no signal conditions and with line voltage at its "normal" for your location.

2. The D90 should be thoroughly "warmed up" (thermal equilibrium) prior to adjustment (typically 2 hours).
3. Move each adjustment slowly, allowing time for circuit equilibrium as you make your readings.

2. CROSS COUPLER DC BALANCE

Because of the nature of the "cross coupled" circuit, the bias of the driver stage following is determined by the DC balance of the cross coupler. Best sonic operation occurs when these DC voltages (found at TPs 1, 2, 3 and 4) are the same within 0.1 Volt DC. The actual voltage is not critical between the range of 105 and 110 Volts. It is the balance that is important.

2A. CROSS COUPLER DC BALANCE ADJUSTMENT

A digital voltmeter having a 10 megohm input impedance and 3 1/2 digit resolution or better is required for this adjustment.

RV5 and RV7 adjust the left channel (TP2 & TP4)
RV6 and RV8 adjust the right channel (TP1 & TP3)

Adjust RV5 and RV7 to achieve identical voltages at TP2 and TP4. There is some interaction because of the nature of the circuit, so repeat the adjustments as necessary to achieve identical voltages.

Repeat the above using RV6 and RV8 to achieve identical voltages at TP1 and TP3.

It is not required that the left channel voltages be equal to the right channel voltages. It is important that each channel's two TP voltages match and that they be within the range of 105 to 110 Volts DC.

This adjustment procedure is essential after changing V3 or V4 tubes. The DC balance normally does not change with varying line voltage conditions. However, it may be desirable to check the DC balance after hundreds of hours of operation to insure optimum performance.

3. PHASE INVERTER AC BALANCE

Normally the phase inverter AC balance control does not require readjustment.

This procedure requires the use of an oscillator and an oscilloscope. For best results the scope should have a 10 megohm input probe for this adjustment.

With the unit on and fully "warmed up," remove vacuum tubes V7 and V8. (Note which is which for later reinstallation in the original locations.) Connect the scope ground to the opposite end of resistor R19 from TP3. Connect the scope hot lead to TP1 and adjust the test oscillator for a 6 Volt peak-to-peak signal. Disconnect the scope hot lead from TP1, reconnect to TP3 and adjust RV4 for a 6 Volt peak-to-peak signal. Once again, there is some interaction because of the nature of the circuitry,

so repeat this procedure until you are satisfied that the two signals are identical in amplitude (within 0.1V peak). (A nominal 1 kHz signal is all that is required for this adjustment.)

Repeat the foregoing procedure for the left channel using TPs 2 and 4.

Reinsert V7 and V8 tubes in their correct sockets.

Once again, if the appropriate personnel and test equipment are not available, we strongly urge you not to attempt to adjust the AC balance by "listening it in." The cross coupled driver circuit automatically works to correct unbalance, and it is almost certain that you will not get correct results aurally. Remember that this adjustment tends to be very stable long-term and should not normally require adjustment.

4. OUTPUT AC BALANCE (NOT IN SOME EARLY UNITS)

Normally the AC balance does not require readjustment unless the output or driver tubes are changed. This adjustment should not be attempted unless the previous adjustments are checked first.

Adjust RV13 and RV14 for minimum 2nd harmonic distortion at about 1 watt 1 kHz output into a 16 ohm load, typically less than .01%.

If your D90 does not have RV13 or RV14 trim pots, contact Audio Research Factory Service for prebalanced tubes for V7 or V8.

To place the unit in operation the following procedure is recommended:

1. Connect your speakers using the best available heavy gage speaker wires. Take care to observe "polarity" (ie: 4, 8 or 16 ohms to speaker "+"; "0" ohms to speaker "-"). (Note that the D90B is a "non-inverting" amplifier when connected in this manner.)

Note: It is important to match impedances as closely as possible between amplifier and speaker so as to allow optimum transfer of power to the speaker while preserving minimum distortion operation of the amplifier.

2. Turn both input level controls fully counter-clockwise.
3. Connect the amplifier to the preamplifier or electronic crossover, using only the highest grade audio interconnect cables.
4. Connect the power line cord to the AC power, observing Paragraph 2 under USE CAUTIONS on Page 2 of this manual.
5. Proper adjustment of the input level controls can be accomplished very simply. Turn your preamplifier level control to 12 to 1 o'clock while playing a record. Then, advance (from the previously counter-clockwise settings) the amplifier level controls to your normal listening level. This provides optimum "bandsread" of adjustment at the preamplifier, as well as providing optimum signal-to-noise ratio. (The D90B will, however, normally perform best with its level controls at or near maximum.)

CAUTION

Make certain the amplifier is installed according to the instructions under INSTALLATION on Page 3 of this manual.

D90B ADJUSTMENT PROCEDURE AND DISCUSSION

The D90B utilizes very high quality commercial grade components and this, together with conservative operation of all components and tubes, should provide long adjustment-free service life.

After long service, or after vacuum tube failure and replacement, or in a location with consistently low line voltage, it may be desirable to readjust the amplifier for optimum performance.

CAUTION: The following procedures should not be attempted by the owner unless he is technically qualified. There are high voltages and currents within this unit which can be lethal under certain conditions. Refer all such adjustment to a qualified individual.

There are four parameters which may be adjusted (in the following sequence) in the D90B after removing the top cover:

1. B+ REGULATOR VOLTAGE
2. OUTPUT TUBE IDLE CURRENT ("BIAS")
3. DC BALANCE
4. AC BALANCE

1. B+ REGULATOR VOLTAGE

This adjustment sets the plate supply voltage for the input and phase inverter stages. Control RV17 is located next to the large capacitor shield on "channel one" side. Adjust for +300VDC on .47uF capacitor C47 lead located just behind the large filter capacitors.

2. OUTPUT TUBE IDLE CURRENT ("BIAS")

The output stages of the D90B are partially cathode coupled "push-pull parallel class AB₁," utilizing our tightly-coupled output transformers, which provide low distortion and sonic accuracy.

As shipped from the factory, the output bias adjustments are set for a nominal 60 mA. per tube with a stable power line of 120 Volts. Under these conditions the tubes are each dissipating approximately 25 watts of their 35 watt rating (30 watt plate, 5 watt screen). This point of operation provides "enriched" class AB₁, and will satisfy most critical listeners.

Make sure adequate ventilation is provided to prolong tube life.

2A. "BIAS" ADJUSTMENT PROCEDURE

A digital voltmeter capable of accurate measurement of .05 to .1 Volt DC is required to accomplish this adjustment.

There is a 1 ohm 5% wirewound resistor in the cathode circuit of each output tube, and test connections (test points referred to schematically and on the PWB as TPs) are provided on either end of these resistors so that a voltage measurement can be conveniently made across each resistor. These test points are identified and accessible from both the top and bottom sides of the PWB.

Because the resistor is 1 ohm, you can conveniently "direct" read the total cathode current in each tube. A .06 Volt reading indicates 60 mA.

<u>TUBE</u>	<u>TP COMMON</u>	<u>TP</u>
V7		5
V9	13	9
V11		7
V13	15	11
V8		6
V10	14	10
V12		8
V14	16	12

An individual adjustment is provided for each of the eight output tubes. The "front" controls affect the "front" tubes, etc. RV7 sets V7, RV9 sets R9, etc.

It is important that all 8 output tubes be reasonably matched (within 5%) for highest performance operation. (Matched sets are available from Audio Research.)

Observe the following:

1. These adjustments should be accomplished under no signal conditions and with line voltage at its "normal" for your location.
2. The D90B should be thoroughly "warmed up" (thermal equilibrium) prior to adjustment (typically 2 hours).
3. Move each adjustment slowly, allowing time for circuit equilibrium as you make your readings.

3. DC BALANCE

Because of the nature of the push-pull direct coupled input circuit, the bias of the driver stage following is determined by the DC balance of the input stage. Best sonic operation occurs when these DC voltages (found at TPs 1, 2, 3 and 4) are the same within 0.05 Volt DC or better. The actual voltage is not critical at about 100 to 102 VDC. It is the balance that is important.

3A. DC BALANCE ADJUSTMENT

A battery-operated digital voltmeter having a 10 megohm or higher input impedance and 3½ digit resolution or better is best for this adjustment.

RV3 and RV5 adjust the left channel (TP1 & TP3)
RV4 and RV6 adjust the right channel (TP2 & TP4)

Adjust RV3 and RV5 to achieve identical voltages at TP1 and TP3. Allow time for the servo to settle to its final voltage. There is some interaction between adjustments because of the nature of the circuit. Make final trim adjustment for as close to 0 DVC difference between TP1 and TP3 with the DVM connected between TP1 and TP3.

Repeat the above using RV4 and RV6 to achieve identical voltages at TP2 and TP4.

It is not required that the left channel voltages be exactly equal to the right channel voltages. It is important that each channel's two TP voltages match and that they be within the range of 100 to 102 Volts DC.

It should not be necessary to readjust DC balance once it is set. The servo balance circuits compensate for tube aging, tube changing and line voltage variations.

4. AC BALANCE

Normally the AC balance does not require readjustment unless the output or driver tubes are changed. This adjustment should not be attempted unless the previous adjustments are checked first.

Adjust RV15 and RV16 for minimum 2nd harmonic distortion at about 1 watt 1 kHz output into a 16 ohm load, typically less than .001%. As an approximation, the adjustments can be made for minimum 1 kHz total harmonic distortion and noise, typically less than .01%.