audio research
HIGH DEFINITION®

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D-90 OWNER'S MANUAL

SCHEMATICS

AND PARTS LIST

Schematic 2-24-81
Schematic 2-15-81

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INTRODUCTION

Congratulations on your purchase. The D90 amplifier was conceived in response to the need for a totally "musical" amplifier at an affordable price for the 80's. This has been achieved, together with state-of-the-art electromechanical execution.

Our patented cross-coupled circuitry has been combined with our patented output state (not previously used). These, together with other innovations and a high energy, well regulated power supply, provide a significantly wider musical bandwidth together with ARC's traditional High Definition® music reproduction.

The two-sided, plated through-hole circuit board mounts all of the components (except chassis parts). This makes all components readily accessible for replacement if ever necessary without mechanical disassembly (except for top and bottom cover removal)!

Push pull parallel output tubes are used at approximately 63% of their dissipation ratings, thus insuring long service life.

With proper installation and reasonable maintenance, this may be the last amplifier you will ever have to purchase.

WARRANTY STATEMENT

A Limited 90-Day Warranty (from date of purchase by the original purchaser; must be within 2 years of date of manufacture) is provided by Audio Research Corporation. This includes vacuum tubes. This warranty is subject to the conditions and limitations stated within the documents attached to the outer shipping carton and is repeated in full on Page 7 of this manual.

WARRANTY REGISTRATION CAUTION

It is your responsibility to register your unit. While it is true that Audio Research Corporation will provide warranty service for 90 days even if you do not (proof of purchase, such as a photostatic copy of your bill of sale, will be required), you will lose the extended Limited 3-Year Warranty unless you register the unit within 30 days of the date of your purchase. Be sure to read our warranty statement for complete information about this. (Note that this extended warranty does NOT include vacuum tubes.)

It is also important to register your unit so that Audio Research Corporation can contact you, if the need arises, for any possible modification news, etc.

USE CAUTIONS

1. Please be certain to read this manual over to familiarize yourself with your new amplifier before placing it in service.

2. Your D90 amplifier's power cord is equipped with a standard three-prong grounding plug which, if used normally, will ground the chassis to the power line. While this procedure undoubtedly provides the maximum possible safety in use it will, in many cases, cause your audio system to have a residual hum.

   The only known way to prevent this hum, especially noticeable in bi- or multi-amplified systems, or in rack-mount installation with common mounting of multiple components, is to "float" this ground (as well as the ground of any and all other components). (ARC manufacturers all its products so that there is no direct chassis connection to the power line except for the line cord's grounding wire. This is to say that all of our units have a power transformer which isolates the power line from all active circuitry. The only current that can flow between the chassis and some other line potential is the leakage of the transformer. Under any normal use applications this does not present any hazardous shock potential.) However, if there is any question as to the safety of such a procedure, be certain to seek competent help with the installation.

   And, of course:

   WARNING

   A. To prevent fire or shock hazard, do not expose this equipment to rain or moisture.

   B. This unit contains voltages which can be lethal. Do not operate this unit with its covers removed. Refer servicing to qualified personnel.

   CAUTION

   For continued protection against fire hazard, replace all fuses only with same type and rating of fuse as specified at each fuse holder.

PACKAGING

Save all packaging. Your Audio Research® amplifier is a precision electronic instrument and should be properly cartoned any time shipment is made. You may never have occasion to return it to the factory for service, but if that should prove necessary, or other occasion to ship it occurs, the original packaging may save your investment from unnecessary damage or delay.

ACCESSORIES INCLUDED WITH YOUR D90 AMPLIFIER

Spare Fuses: 2 - 5A MDL Slo-Blo AC line fuses (3A MDX Slo-Blo for 220V)

PREPARATION FOR USE

Your D90 is shipped with all the vacuum tubes installed. A visual inspection (to determine that shipping has not caused any to break or become unseated) is recommended prior to placing the unit in service.

INSTALLATION

To insure normal component life and safe operation, this unit must be operated only in a horizontal position.

The special non-marring elastomer feet provide adequate spacing only from a smooth, hard surface. Never operate the unit while it is sitting on a surface such as a rug or carpet because airflow will be restricted and will be inadequate for proper cooling.

If the unit is to be operated in an enclosure such as an equipment rack, make certain that adequate airflow above and below the unit is provided. The "ambient" operating temperature should never exceed 120°F or 50°C. Audio Research manufactures a "Rack Mount Ventilator" (RMV-3). The use of these in rack mount installations will assure proper ventilation.

It is normal for a vacuum tube power amplifier to run "warm" or "hot" to the touch. All components within are, however, operated at safe, conservative levels and will not be improperly affected thereby.

D90 CONNECTION INSTRUCTIONS

The front panel has only an on-off (LED) indicator.

The rear panel has:

2 Input Connectors
2 Level Control Knobs
2 Output Connection Terminal Barrier Blocks
1 Line Power Cord
1 Line Fuse

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

1. Connect your speakers using the best available speaker wires (ie: Sound Connections' "Silver"; FMI Gold; FMI Brown; Monster, etc.). Take care to observe "polarity" (ie: 4, 8 or 16 ohms to speaker +; "0" ohms to speaker -). (Note that the D90 is a "non-inverting" amplifier when connected in this manner.)

   Note: It is important to use as close as possible an impedance match 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 (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 AB_1," 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 AB_1, 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.

TUBE	TP COMMON	TP
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 equalibrium) prior to adjustment (typically 2 hours).

3. Move each adjustment slowly, allowing time for circuit equalibrium 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.

WARRANTY TERMS

This unit is offered with a limited warranty as follows:

1. Warranty. Audio Research warrants the product designated herein to be free of manufacturing defects in material and workmanship, subject to the conditions hereinafter set forth, for a period of three (3) years from the date of purchase by the original purchaser. To obtain this Warranty, THE ORIGINAL PURCHASER MUST MAIL TO AUDIO RESEARCH WITHIN THIRTY (30) DAYS OF THE DATE OF PURCHASE THE WARRANTY REGISTRATION FORM TOGETHER WITH A COPY OF THE BILL OF SALE OR OTHER PROOF OF PURCHASE OF THE PRODUCT. Audio Research will then validate the Warranty and return the validated Warranty to the purchaser.

2. Conditions. This Warranty is subject to the following conditions and limitations. The Warranty is void and inapplicable if the product has been used or handled other than in accordance with the instructions in the owner's manual, abused or misused, damaged by accident or neglect or in being transported, or the defect is due to the product being repaired or tampered with by anyone other than Audio Research or an authorized Audio Research repair center. The product must be packed and returned to Audio Research or an authorized Audio Research repair center by the customer at his or her sole expense. A RETURNED PRODUCT MUST BE ACCOMPANIED BY A WRITTEN DESCRITPION OF THE DEFECT AND A PHOTOCOPY OF THIS VALIDATED WARRANTY. Audio Research reserves the right to modify the design of any product without obligation to purchasers of previously manufactured products and to change the prices or specifications of any product without notice or obligation to any person.

3. Remedy. In the event the above product fails to meet the above Warranty and the above conditions have been met, the purchaser's sole remedy shall be to return the product to Audio Research or an authorized Audio Research repair center where the defect will be rectified without charge for parts or labor, except vacuum tubes (see 7 below).

4. Limited to Original Purchaser. This Warranty is for the sole benefit of the original purchaser of the covered product and shall not be transferred to a subsequent purchaser of the product.

5. Duration of Warranty. This Warranty expires on the third anniversary of the date of purchase. During the first ninety (90) day period following the date of purchase by the original purchaser, the Audio Research Limited 90-Day Warranty supersedes this Warranty.

6. Vacuum Tubes. Vacuum tubes and replacement thereof are warranted for the original 90-day period only.

7. Miscellaneous. ANY IMPLIED WARRANTIES RELATING TO THE ABOVE PRODUCT SHALL BE LIMITED TO THE DURATION OF THIS WARRANTY. THE WARRANTY DOES NOT EXTEND TO ANY INCIDENTAL OR CONSEQUENTIAL COSTS OR DAMAGES TO THE PURCHASER. Some states do not allow limitations on how long an implied warranty lasts or an exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This Warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

D90 PRELIMINARY SPECIFICATIONS (AC line set @ 120V 60Hz for these specifications)

Power Output:
90 watts per channel minimum continuous (both channels operating) at 16 ohms from 25 Hz to 20 kHz with less than 1% total harmonic distortion

Typically below .01% at 1 watt

Approximate actual power available per channel at "clipping" (Both CH. OP, 1 kHZ): 105 Watts

Power Bandwidth:
(-3dB Points) 12 Hz and 60 kHz

Intermodulation Distortion:
Less than .5% at 1dB below rated output (100V p to p, 16 ohms) (SMPTE method)

Input Sensitivity:
1.2V RMS for rated output (Adjustable)

Input Impedance:
75K ohms, nominal at maximum gain

Output Regulation:
Apprxoimately .8dB, 16 ohm load to open circuit (damping factor approximately 12)

Negative Feedback:
17.5dB

Slew Rate:
20 volts/microsecond

Rise Time:
2.5 microseconds

Noise:
Wideband, unweighted, more than 90dB below rated output
Line components, more than 80dB below rated output

Power Supply Energy Storage:
240 joules total

Power Requirements:
105-125VAC 60 Hz (210-250VAC 50 Hz) 800 watts maximum
400 watts at "idle"
500 watts at rated power

Dimensions:
19" (48 cm) W (standard rack panel) x 7" (18 cm) H x 16.5" (42 cm) D (front panel back). Handles extend 1 5/8" (4.1 cm) forward of front panel

Weight:
64 lbs. (29 kg) Net, 80 lbs. (36.3 kg) Shipping