D-150
SM-5
S1P1-21-0

crown

SERIAL NO. ________________

ISSUED TO ________________

SERVICE MANUAL
D-150
DUAL·CHANNEL
POWER AMPLIFIER

Div. of INTERNATIONAL RADIO & ELECTRONICS CORP. BOX 1000 ELKHART, INDIANA 46514

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SECTION 1
INTRODUCTION

FIGURE 1-1.
INTEGRATED CIRCUIT STEREO
D-150 AMPLIFIER

1.1 SCOPE OF MANUAL

This manual is intended to provide the user and service technician necessary technical information required to install, operate and repair the CROWN D-150 Dual-Channel Power Amplifier properly and to maintain the unit in optimum operating condition.

The manual is comprehensive; containing a physical description of the D-150, electrical and mechanical specifications, complete installation and operating instructions, a detailed circuit description and service procedures to include troubleshooting and repair. Also included are complete parts lists, a unit schematic and exploded view drawings to assist in identification of parts and understanding the functional operation of the D-150 amplifier.

A thorough reading of this manual and strict adherence to the instructions, procedures and cautions will assure many years of professional quality service and listening enjoyment from your CROWN D-150 Dual-Channel Power Amplifier.

1.2 EQUIPMENT DESCRIPTION

The D-150 is a dual-channel medium power amplifier for ultra-low distortion amplification from 5Hz to 20KHz with operation into loads of 4 ohms and higher. The unit features extremely low harmonic and intermodulation distortion, very low noise, highest "damping factor," and quality parts and workmanship. The unit may be wired to produce a balanced 50 volt monaural output. The amplifier is fully protected against mismatched and shorted loads by a resetting V-I (volt-ampere) limiter having no obnoxious muting or program delays. A thermal switch removes power from the unit if overheating occurs due to insufficient ventilation.

The power supply features large computer-grade filter capacitors giving over 20 joules of energy storage.

A total of 24 discrete transistors, 1 linear IC (dual op amp), 20 diodes and 1 bridge rectifier are utilized in a CROWN-pioneered Class AB+B output circuit. The effective number of semiconductors is 40 transistors and 30 diodes.

The input voltage-amplifiers, (IC), are powered by two voltage-regulated supplies. This results in complete channel-to-channel isolation and independence from line voltage variations.

Two level controls are mounted adjacent to the input jacks to allow balancing and optimizing of system levels.

SECTION 2
SPECIFICATIONS

Power Output	Power output not less than 75 watts R.M.S. per channel into 8 ohms (both channels operating), 20-20,000Hz at rated distortion. Typically 100 watts R.M.S. per channel into 8 ohms, 180 watts R.M.S. per channel into 4 ohms.
Power Bandwidth	Power bandwidth ±1dB, 5-20,000Hz at 75 watts R.M.S. per channel into 8 ohms.
Frequency Response	±0.1dB 20-20,000Hz at 1 watt into 8 ohms; ±1dB 4-100,000Hz.
I.M. Distortion	I.M. less than 0.05%, 0.01 watt to 75 watts, 60Hz and 7,000Hz mixed 4:1. Harmonic — less than 0.05%, 0.01 watt to 75 watts, 20-20,000Hz.
Phase Response	±15°, 20-20,000Hz at 1 watt into 8 ohms. (See graphs)
Damping Factor	Greater than 200 from zero to 1000Hz into 8 ohms.
Hum and Noise	110dB below 75 watts R.M.S. output.
Verification	Each unit accompanied by its individual hand-entered proof-of-performance report.
Load Impedance	4 to 16 ohms (complete stability with any load); dual binding-post outputs.
Construction	100% American-made with industrial grade construction for years of continuous use.
Input	Impedance — Nominal 25K ohm, screwdriver adjust on rear. Input sensitivity 1.2V for full output. Standard ¼" phone-jack on rear.
Turn-on	Instantaneous, with no program delay, and minimum thump.
Circuit	Unique wideband, stable design utilizing one linear IC (dual op-amp). Total equivalent of 40 transistors, 24 diodes, and four rectifier-diodes.
Protection	Amplifier is short- and mismatch- and open-circuit-proof. Unique V-I limiting is instantaneous with no thumps, cutout, etc.
Power Supply	Two massive capacitors with energy-storage exceeding 20 joules. Total of two regulated supplies for complete isolation and stability. No fuses except AC power-line.
Dimensions	17" width, 5¼" high, 9" deep (from mounting surface). All-aluminum construction with massive chassis, and extruded front-panel. Amplifier will panel-mount in a 16¾" x 5" opening (with optional front panel). With adapters, standard 19" rack mount.
Weight	22 pounds (24 pounds rack mount).
Warranty	3-year on all parts, labor, and round-trip shipping.

SECTION 3
INSTALLATION AND OPERATION

3.1 GENERAL

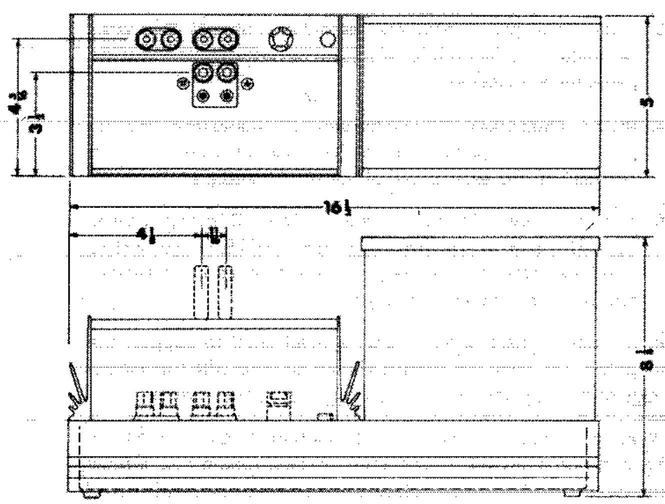
This section contains installation and operation instructions for the D-150 amplifier. Also included are descriptions of the protective mechanisms for the amplifier and the load, together with a list of operating precautions to help clarify proper operating procedures.

3.2 UNPACKING

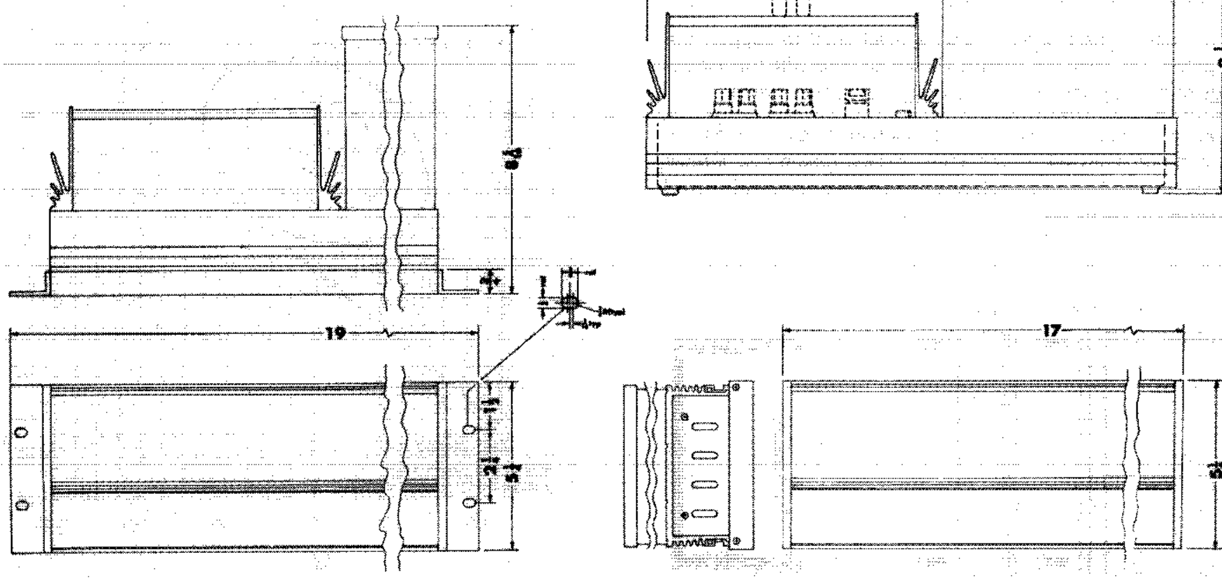
Immediately upon receipt of the amplifier shipment, inspect the unit for any damage incurred in transit. The amplifier was carefully inspected and tested and left the factory unmarred. Notify the transportation company immediately if any damage is found. Only the consignee may initiate a claim with the carrier for damage during shipment. However, CROWN will cooperate fully in such an event. Be sure to save the carton as evidence of damage for the shipper's inspection.

CROWN recommends that you save the packing materials, even if the unit arrives in perfect condition. They will prove valuable in preventing damage should there be occasion to transport or ship the unit. Both the carton and internal pack are specifically designed for protection during transit. **Do not ship the unit without this factory pack!**

Be sure to return the warranty registration form to the CROWN factory within ten days for the full warranty coverage.



NOTE: The "basic" D-150 shown at right may be converted for rack- or cabinet- (panel) mounting by installing the front panel with brackets or end-caps as shown below.



RACK MOUNTING *CABINET MOUNTING*

FIGURE 3-1.
D-150 MOUNTING DIMENSIONS

3.3 MOUNTING INSTRUCTIONS

The D-150 may be custom or rack-mounted if an accessory front-panel kit with rack-mounting brackets was purchased. The installation of this kit is detailed in Figure 3-2. Refer to Figure 3-1 for mounting dimensions. Sufficient ventilation must be provided for the unit. Air must be allowed to circulate over the chassis, otherwise the amplifier will intermittently turn off due to the internal thermal protection feature. Applications — other than standard "Hi-Fi" — requiring long, sustained signals at high power levels may require the use of a cooling fan.

3.4 ACCESSORY PANEL KIT INSTALLATION (MODEL PK)

To install the D-150 amplifier in a "custom configuration", an accessory cabinet (Model 5-D or 5-R) or a rack, the accessory front panel must be attached first. Refer to Figure 3-2.

1. Pull four rubber feet off the bottom of the amplifier.
2. Place amplifier on bench or table; stand on end with transformer down.
3. Slide front panel onto the amplifier chassis; the word "Amplifier" on the front panel should be on the lower end of the panel being installed.
4. Plastic wedges supplied with the panel kit should be forced into positions 1 and 2 on both ends of the unit as far as possible. Clip or break off the excess part of the plastic wedges.
5. Align end caps to the unit so holes "A" and "B" match the end caps. Use 6/32 x ½ socket cap screws. (NOTE: Socket screws may look as though they are cross threading but will straighten approximately half way through.)

In a "custom installation", install a solid shelf to support the amplifier. The shelf top surface should be flush with the bottom edge of the required 16 9/16" wide x 5 3/16" high panel cutout.

When using angle brackets for rack mounting (Figure 3-2) always have the brushed side of the angle bracket toward you. Simply mount the end brackets in place of the end caps and rack mount as shown in Figure 3-l.

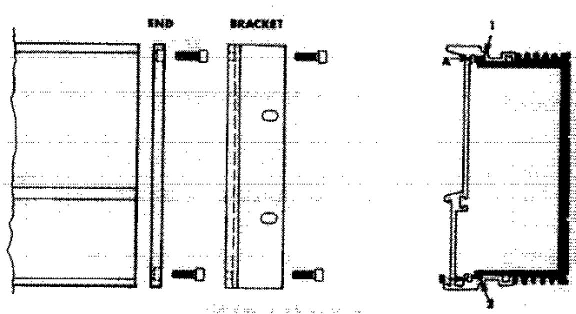


FIGURE 3-2.
PANEL KIT MOUNTING

3.5 AMPLIFIER PROTECTION MECHANISMS

The D-150 is protected against all the common hazards which plague highpower amplifiers, including shorted, open, and mismatched loads; overloaded power supplies; excessive temperature; chain destruction phenomena; input overload damage; and high frequency overload blowups.

Protection against shorted and mismatched loads is provided by an instant-acting limiter which instantaneously limits at the volt-ampere product to the maximum safe-stress value for the output transistors.

The area in which the amplifier will drive the load without being V-I limited is depicted by the cross-hatched areas of Figure 3-3.

If a load initiates protection in the amplifier, it can be detected generally by watching the transfer characteristics of the amplifier on an oscilloscope or by plotting the load's V-I behavior, if known, on to Figure 3.3. In applications where the load is a loudspeaker, amplifier protection will be evidenced by distortion in the speaker. The audible effect ranges from something resembling cross-overnotch distortion to a snapping sound, depending on the overall load characteristics. Speaker systems which are truly 8 ohms or greater will not initiate the protection system.

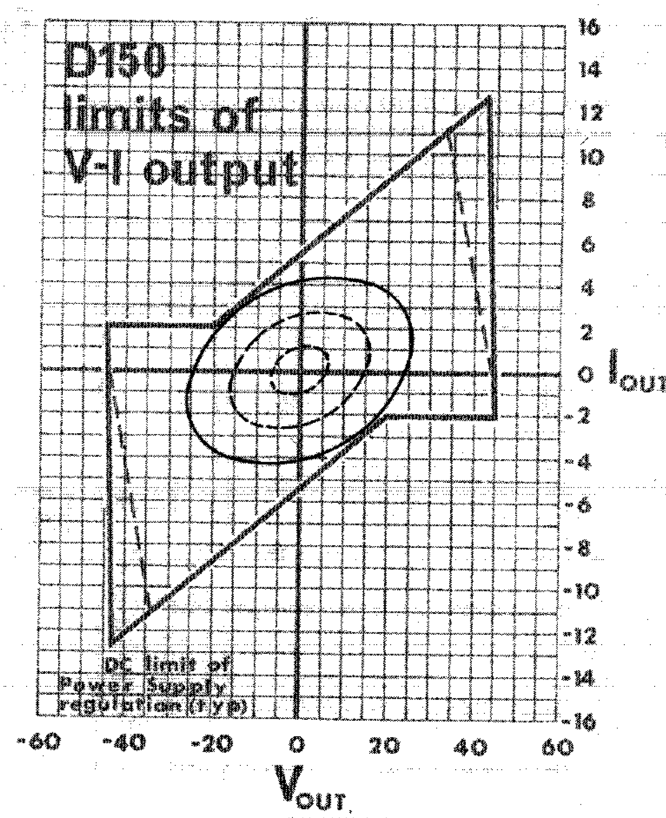


FIGURE 3-3.
GRAPH of V-I OPERATING RANGE of D-150 OUTPUT

The AC line for 120VAC is fused with a 4A, 250V type AG fuse (on 240, 250VAC, 2A type AG). The use of any other type of fuse will invalidate the warranty.

A thermal switch is mounted on the chassis to protect the amplifier against insufficient ventilation. If it becomes too hot, the AC line power will be interrupted until the temperature falls to a safe level, whereupon power will automatically be restored. When such an event occurs, the external symptoms are: no output, and a warm amplifier.

The amplifier's voltage-amplifier circuitry is designed to be inherently current-limited. If any of the devices fail, no damage occurs to the rest of the stages.

The input stage is protected against overdrive damage by a series limiting resistor should the input signal level become excessive.

The amplifier features a controlled slewing-rate which, coupled with the V-I limiter, protects the amplifier from blowups when fed large RF input signals.

3.6 LOAD PROTECTION METHODS

The most common of all protection schemes is a fuse in series with the load. The fuse may be single, fusing the overall system. Or, in the case of a multi-way speaker system, it may be multiple with one fuse on each speaker.

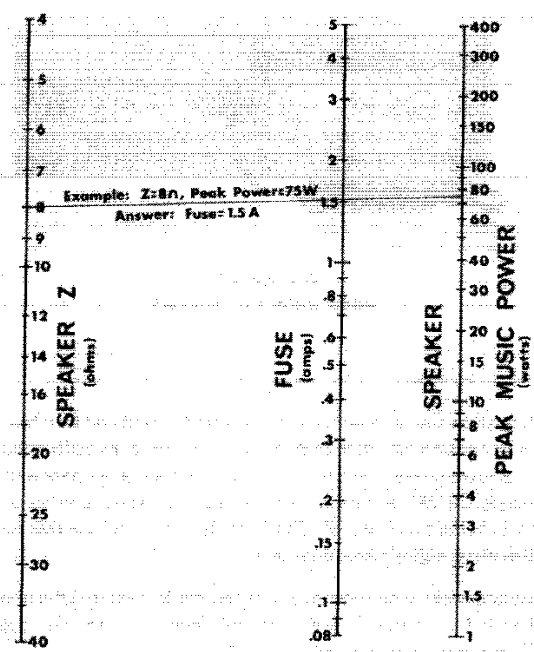


FIGURE 3-4.
FUSE SELECTOR NOMOGRAPH FOR LOUDSPEAKER PROTECTION

Fuses help to prevent damage due to prolonged overload, but provide essentially no protection against damage that may be done by large transients and such. To minimize this problem, high-speed instrument fuses such as Littlefuse 361000 series are most appropriate for such applications. For a nomograph showing fuse size vs. loudspeaker ratings refer to Figure 3-4.

Another form of load protector is shown schematically in Figure 3-5. Whenever the load is overdriven, a relay switches a lamp in series with the load, smoothly relieving the overload. The lamp then doubles as an overdrive indicator as it glows. If overdrive is unreasonably severe, the lamp will serve as a fuse. By adjusting the relay tension adjustment and the protection level control, this system is useful from 25 to 200 watts for a typical 8 ohm load.

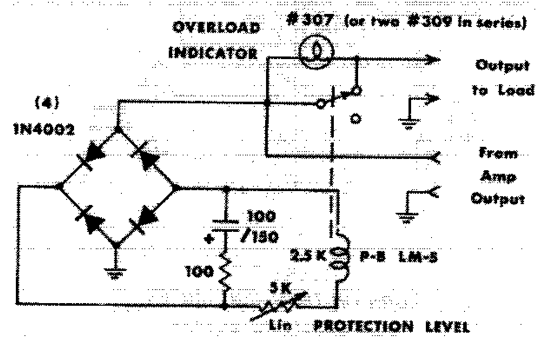


FIGURE 3-5.
RELAY-CONTROLLED PROTECTOR WITH OVERLOAD INDICATOR

Another more sophisticated form of overload protector relieves the overload by controlling the amplifier's input signal which is creating the overload. This form of protector not only saves the load but also eliminates amplifier overload. With this device, it is possible to operate the amplifier at its maximum level with a minimum of clipping. This device is shown schematically in Figure 3-6. It features an overdrive indicator, distortionless photo-optical control, and a Protection Level control giving adjustment from 1W to 200W when driving 8 ohms.

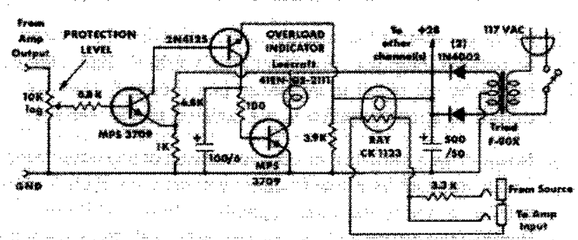


FIGURE 3-6.
PEAK POWER LIMITING COMPRESSOR WITH OVERDRIVE INDICATOR

A common problem which causes damage and irritation is the turn-on thump problem typical to many signal sources. Figure 3-7 shows the schematic of a muter which, when inserted in the input signal line, mutes for several seconds before connecting the source to the amplifier, thereby eliminating turn-on transients. It also removes turn-off transients occurring after the relay drops open (=0.1 sec.).

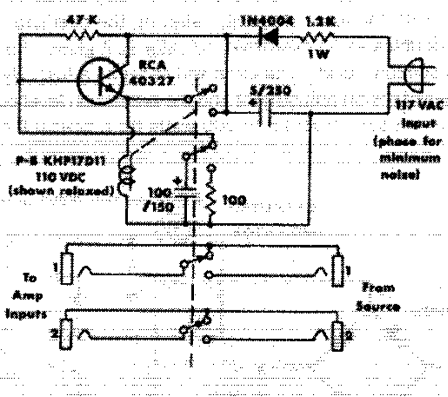


FIGURE 3-7.
TURN-ON-TRANSIENT MUTER
FOR LOAD PROTECTION

NOTE: When using the CROWN IC-150 this muter is not required. A built-in muter protects your speakers from any signal source whose AC power is switched by the IC-150.

3.7 OPERATING PRECAUTIONS

Following are a number of operating precautions given as an aid to understanding proper and improper amplifier usage:

1. Use care in making connections, selecting signal sources, and controlling the output level. The loudspeaker you save may be your own. CROWN is not liable for any damage done to loads due to careless amplifier usage or deliberate over-powering. For pointers on load protection see paragraph 3.6.

2. Never parallel the two outputs by directly tying them together or parallel them with any other amp's output. Such connection does not result in increased power output. Damage incurred by such operation is not covered by the warranty.

3. Never drive a transformer-coupled device or any other device which appears as a low frequency short (less than 3 ohm) without a series isolating capacitor. Such operations may damage the device and/or needlessly activate the V-I limiting (see Figure 3-3).

4. Do not short the ground lead of an output cable to the input signal ground as oscillations may result from forming such a ground loop.

5. Operate and fuse the amplifier only as set forth in paragraph 3.6.

6. Operate the amplifier from AC mains of not more than 10% above the selected line voltage and only on 50, 60 or 400Hz AC. Failing to comply with these limits will also invalidate the warranty.

7. Never connect the output to a power supply output, battery, or power main. Damage incurred by such a hookup is not covered by the warranty.

8. Do not expose the amplifier to corrosive chemicals such as soft drinks, lye, salt water, etc.

9. The amplifier is not recommended for high power industrial usage at frequencies above 20KHz.

10. Tampering in the circuit by unqualified personnel or the making of unauthorized circuit modifications invalidates the warranty.

11. Do not expose the output leads to areas likely to be struck by lightning. Such an installation could invalidate the amplifier.

3.8 CONNECTING OUTPUT LINES

Input and output connectors are located on the chassis as shown in Figure 3-8.

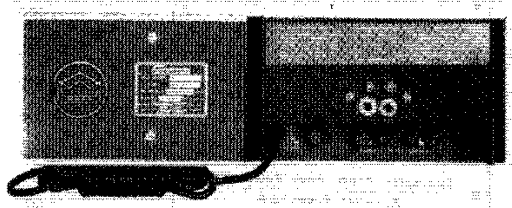


FIGURE 3-8.
REAR VIEW OF CHASSIS

It is always wise to remove power from the unit and turn the input level controls off while making connections, especially if the load is a loudspeaker system. This will eliminate any chance of loud blasts. CROWN is not liable for damage incurred at any transducer to its being overpowered! The use of the enclosed speaker fuses is therefore highly recommended.

Before making connections, it is recommended that the operator familiarize himself with the amplifier's protective system. Reference paragraph 3.6.

Because of the locations of the output connectors (color-coded binding posts) it will be easiest to make these connections first. High-quality, dual "banana" plugs are the preferred connections for permanent installations.

Because the output wire gauge and length raises the resultant source impedance or lowers the Damping Factor by adding series resistance, the nomograph (Figure 3-11) is provided for wire selection. For dynamic moving-coil loudspeakers the value R_L should preferably be that measured by an ohmmeter across the voice coil, rather than the manufacturer's rating. For electrostatic speakers and such, the manufacturer's rated impedance should be used for R_L.

If the load (matching transformer, inductance, or full-range electrostatic speaker system) appears as a short-circuit at low frequencies, a large non-polarized capacitor (paralleled with a resistor) should be placed in series with the load.

For electrostatic speakers (if the manufacturer has not provided a capacitor) an external non-polar capacitor of 590-708 mfd and 4 ohm power resistor should be placed in series with the plus (+) speaker lead. This will prevent large low-frequency currents from damaging the electrostatic transformer or from unnecessarily activating the D-150's protective system. An effective test to determine if such parts are needed is to measure the DC resistance between the output terminals with an ohmmeter. If the resistance is less than 3 ohms, the parts should be added as shown schematically in Figure 3-9.

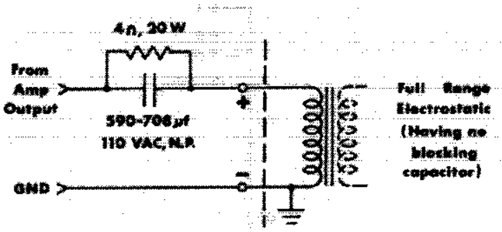


FIGURE 3-9.
SCHEMATIC FOR FULL RANGE
ELECTROSTATIC SPEAKER CONNECTION

When selecting connectors for the load (speaker) end of the output lines, the following general precautions apply (with all power connectors):

1. A male plug, carrying signal, must not be on the far end of the line where it can be exposed, giving rise to both shock and short-circuit hazards.
2. Connectors which might accidentally cause the two channels to be tied together during making and breaking of connection should not be used. A common example is the standard 3-circuit ¼-inch phone jack and plug when wired for stereo sound.
3. Connectors which can be plugged into AC power receptacles should **never** be used.
4. Connectors having low-current-carrying capacity are "verboten."
5. Connectors having any tendency to short, or having shorted leads, are unadvisable.

Most commercially-available headphones employ a 4-circuit ¼-inch phone plug which violates condition No. 2. This is no handicap if a pad is inserted between the amp and jack, which is only sensible when such a large amplifier is coupled to such a small transducer. If this precaution is ignored, not only may the transducer be burned out but permanent hearing loss could result. The recommended pad is shown in Figure 3-10.

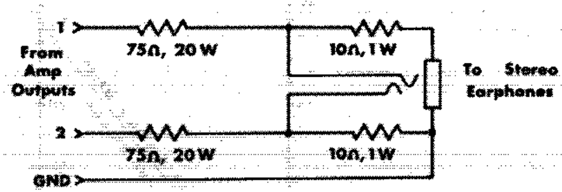


FIGURE 3-10.
SCHEMATIC OF EARPHONE PAD

3.9 CONNECTING INPUT LINES

Connecting the inputs will require observance of three basic precautions: Undesirable signals to the inputs, "ground loops," and feedback from output(s) to input(s).

In high fidelity audio applications any good vacuum-tube or solid-state control center will operate successfully into the 25K ohm inputs of the D-150. Occasionally a high-impedance output of poorly-designed preamps will be encountered, and/or a larger output coupling capacitor may be required (to prevent excessive low-frequency rolloff).

For loudspeaker-driving applications, the input should be free of large sub-audio or undesired low frequencies, as they cause overheating and overloading of the loudspeaker. To remove such low frequencies, a series capacitor may be placed in the input signal line. (The graph of Figure 3-12 indicates the effect of the size of the capacitor on the frequency response.) Only a low-leakage paper, mylar, or tantalum capacitor should be used for this purpose.

If large amounts of ultrasonic or RF frequencies are found on the input, such as bias from tape recorders, etc., a low-pass filter should be placed on the input. While practically-obtainable RF input levels will not damage the amplifier, they may cause burnout of tweeters or other sensitive loads, activate the amplifier's protective systems, or cause general overload in the controlled-slewing-rate stage of the amp (which is employed to provide RF overload protection). The following filters are recommended for such applications (Figure 3-13).

A second precaution is "ground loops" — electronic jargon for undesirable circulating currents flowing in a grounding system. A common form of loop (possibly resulting in hum in the output) is a pair of input cables whose area is subjected to a magnetic hum

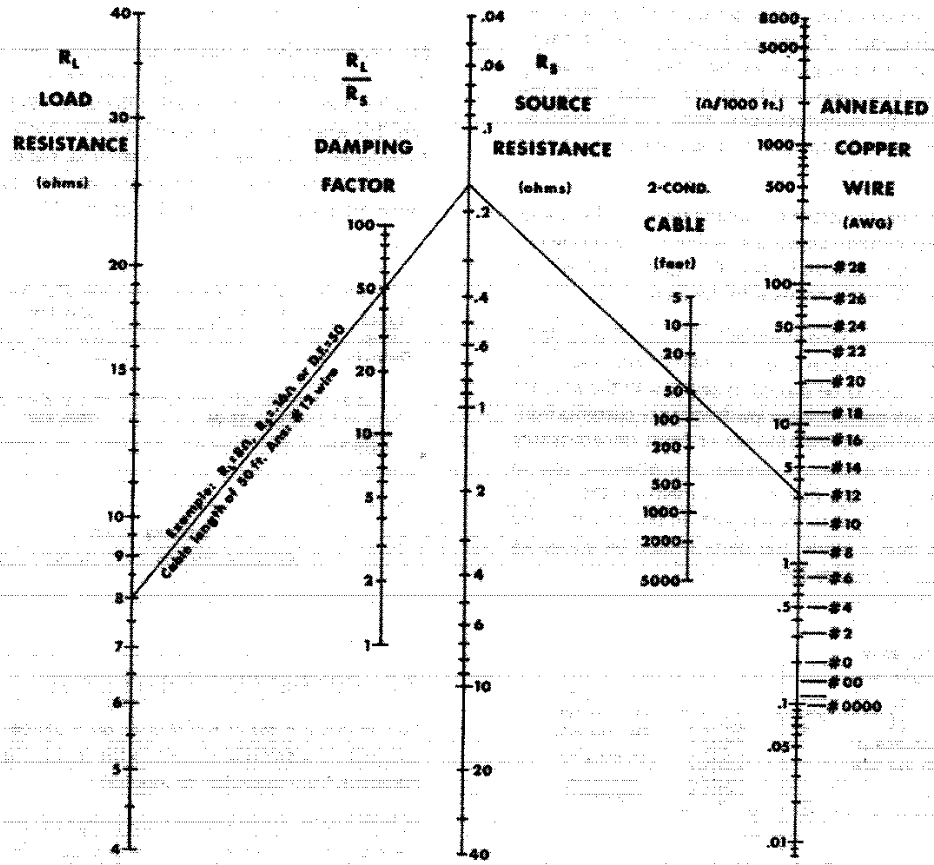


FIGURE 3-11.
SOURCE RESISTANCE and DAMPING FACTOR VS. LENGTH and SIZE of OUTPUT LEADS

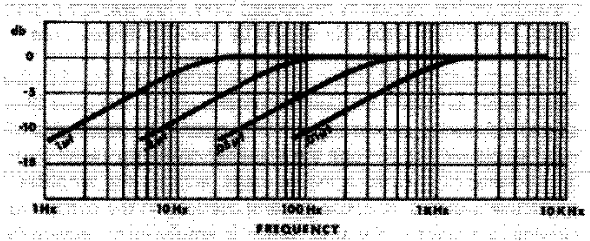


FIGURE 3-12.
GRAPH FOR SELECTION OF INPUT CAPACITOR

field. In practice, both cables should lie together along their length, and away from the power transformer. Tying the input and output grounds together may also form a ground loop.

A third precaution (with input and output grounds together, as in testing or metering) is feedback oscillation, from load current flowing in the loop. In industrial use, even the AC power line may provide this feedback path. Proper grounding, and isolation of inputs, of common-AC-line devices is good practice. Refer to paragraph 5.6 for testing precautions.

3.10 CONNECTING POWER

The amplifier is furnished with a three-wire AC plug as standard equipment. Adaptors are readily available commercially for adapting this to a two-wire system if necessary.

The amplifier offers two standard line-voltage connections: 120 and 240 VAC. The tag attached to the line cord indicates for which

Because the output wire gauge and length raises the resultant source impedance or lowers the Damping Factor by adding series resistance, the nomograph (Figure 3-11) is provided for wire selection. For dynamic moving-coil loudspeakers the value R_L should preferably be that measured by an ohmmeter across the voice coil, rather than the manufacturer's rating. For electrostatic speakers and such, the manufacturer's rated impedance should be used for R_L.

If the load (matching transformer, inductance, or full-range electrostatic speaker system) appears as a short-circuit at low frequencies, a large non-polarized capacitor (paralleled with a resistor) should be placed in series with the load.

For electrostatic speakers (if the manufacturer has not provided a capacitor) an external non-polar capacitor of 590-708 mfd and 4 ohm power resistor should be placed in series with the plus (+) speaker lead. This will prevent large low-frequency currents from damaging the electrostatic transformer or from unnecessarily activating the D-150's protective system. An effective test to determine if such parts are needed is to measure the DC resistance between the output terminals with an ohmmeter. If the resistance is less than 3 ohms, the parts should be added as shown schematically in Figure 3-9.

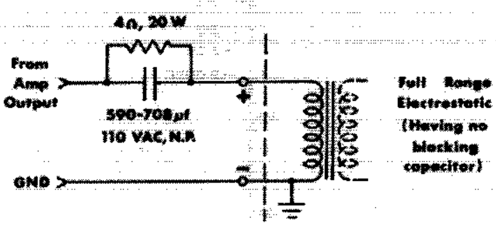


FIGURE 3-9.
SCHEMATIC FOR FULL RANGE ELECTROSTATIC SPEAKER CONNECTION

When selecting connectors for the load (speaker) end of the output lines, the following general precautions apply (with all power connectors):

1. A male plug, carrying signal, must not be on the far end of the line where it can be exposed, giving rise to both shock and short-circuit hazards.
2. Connectors which might accidentally cause the two channels to be tied together during making and breaking of connection should not be used. A common example is the standard 3-circuit ¼-inch phone jack and plug when wired for stereo sound.
3. Connectors which can be plugged into AC power receptacles should **never** be used.
4. Connectors having low-current-carrying capacity are "verboten."
5. Connectors having any tendency to short, or having shorted leads, are unadvisable.

Most commercially-available headphones employ a 4-circuit ¼-inch phone plug which violates condition No. 2. This is no handicap if a pad is inserted between the amp and jack, which is only sensible when such a large amplifier is coupled to such a small transducer. If this precaution is ignored, not only may the transducer be burned out but permanent hearing loss could result. The recommended pad is shown in Figure 3-10.

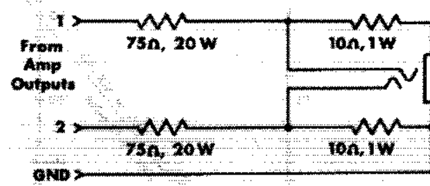


FIGURE 3-10.
SCHEMATIC OF EARPHONE PAD

3.9 CONNECTING INPUT LINES

Connecting the inputs will require observance of three basic precautions: Undesirable signals to the inputs, "ground loops," and feedback from output(s) to input(s).

In high fidelity audio applications any good vacuum-tube or solid-state control center will operate successfully into the 25K ohm inputs of the D-150. Occasionally a high-impedance output of poorly-designed preamps will be encountered, and/or a larger output coupling capacitor may be required (to prevent excessive low-frequency rolloff).

For loudspeaker-driving applications, the input should be free of large sub-audio or undesired low frequencies, as they cause overheating and overloading of the loudspeaker. To remove such low frequencies, a series capacitor may be placed in the input signal line. (The graph of Figure 3-12 indicates the effect of the size of the capacitor on the frequency response.) Only a low-leakage paper, mylar, or tantalum capacitor should be used for this purpose.

If large amounts of ultrasonic or RF frequencies are found on the input, such as bias from tape recorders, etc., a low-pass filter should be placed on the input. While practically-obtainable RF input levels will not damage the amplifier, they may cause burn-out of tweeters or other sensitive loads, activate the amplifier's protective systems, or cause general overload in the controlled-slewing-rate stage of the amp (which is employed to provide RF overload protection). The following filters are recommended for such applications (Figure 3-13).

A second precaution is "ground loops" — electronic jargon for undesirable circulating currents flowing in a grounding system. A common form of loop (possibly resulting in hum in the output) is a pair of input cables whose area is subjected to a magnetic hum

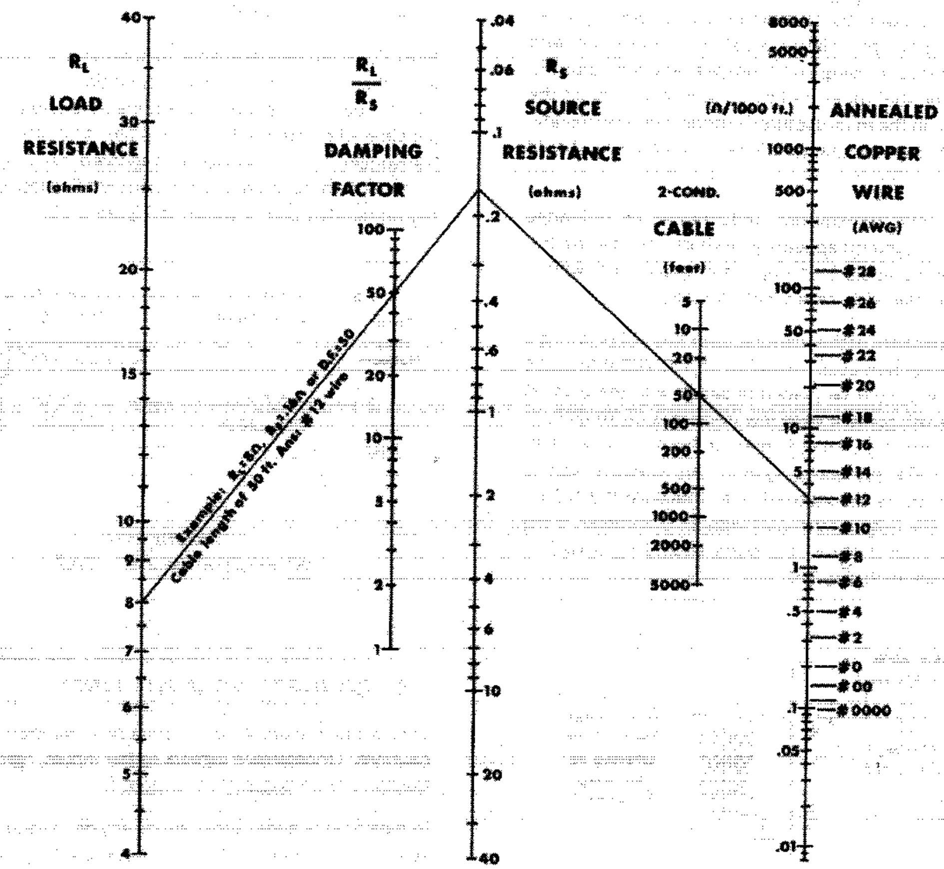


FIGURE 3-11.
SOURCE RESISTANCE and DAMPING FACTOR VS. LENGTH and SIZE of OUTPUT LEADS

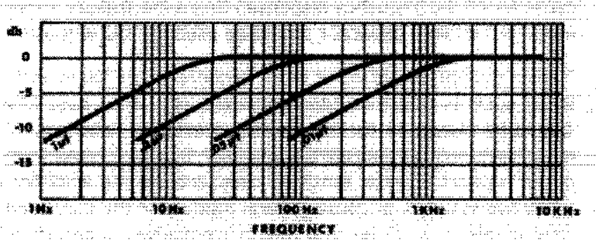


FIGURE 3-12.
GRAPH FOR SELECTION OF INPUT CAPACITOR

field. In practice, both cables should lie together along their length, and away from the power transformer. Tying the input and output grounds together may also form a ground loop.

A third precaution (with input and output grounds together, as in testing or metering) is feedback oscillation, from load current flowing in the loop. In industrial use, even the AC power line may provide this feedback path. Proper grounding, and isolation of inputs, of common-AC-line devices is good practice. Refer to paragraph 5.6 for testing precautions.

3.10 CONNECTING POWER

The amplifier is furnished with a three-wire AC plug as standard equipment. Adaptors are readily available commercially for adapting this to a two-wire system if necessary.

The amplifier offers two standard line-voltage connections: 120 and 240 VAC. The tag attached to the line cord indicates for which

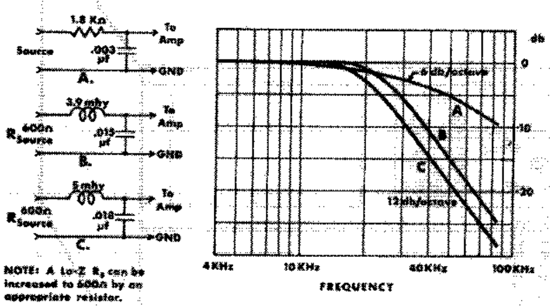


FIGURE 3-13.
LOW-PASS FILTERS FOR SEVERE RF AT INPUTS

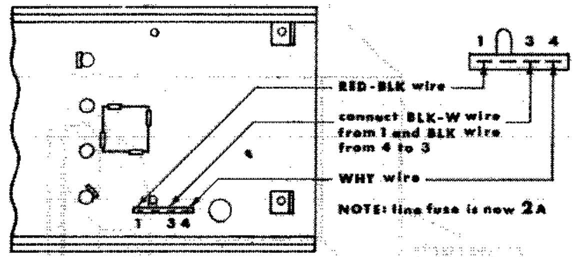


FIGURE 3-14.
LINE VOLTAGE CONNECTIONS (240 VAC)

voltage the amplifier is connected. Most units are connected for 120 VAC. Figure 3-14 shows pictorially how the 240 VAC connected unit should appear. Note the change to a 2A line fuse.

When testing the amplifier, the line voltage must be the peak equivalent to a sinusoid of the indicated line voltage when at full load. Line regulation problems can introduce serious errors in the measurements on an amplifier of this size.

Only a competent technician should attempt alteration of the line voltage connections.

3.11 OPERATING CONTROLS

The D-150 contains all the facilities essential for a high performance amplifier.

The input controls are mounted by the input jacks. Each control should be adjusted for the desired amplifier gain or output level. When the control is fully CW, the gain is 26dB as determined by precision 1% resistors in the D-150's feedback loop.

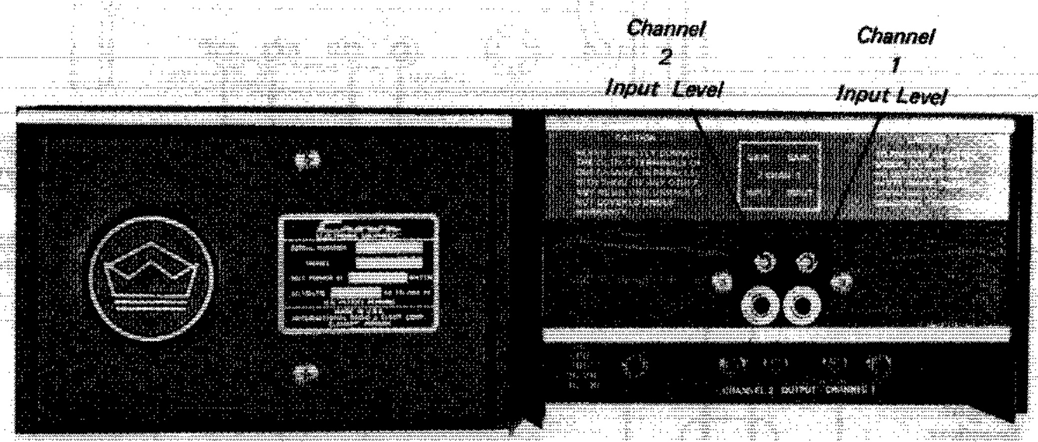


FIGURE 3-15.
OPERATING CONTROLS

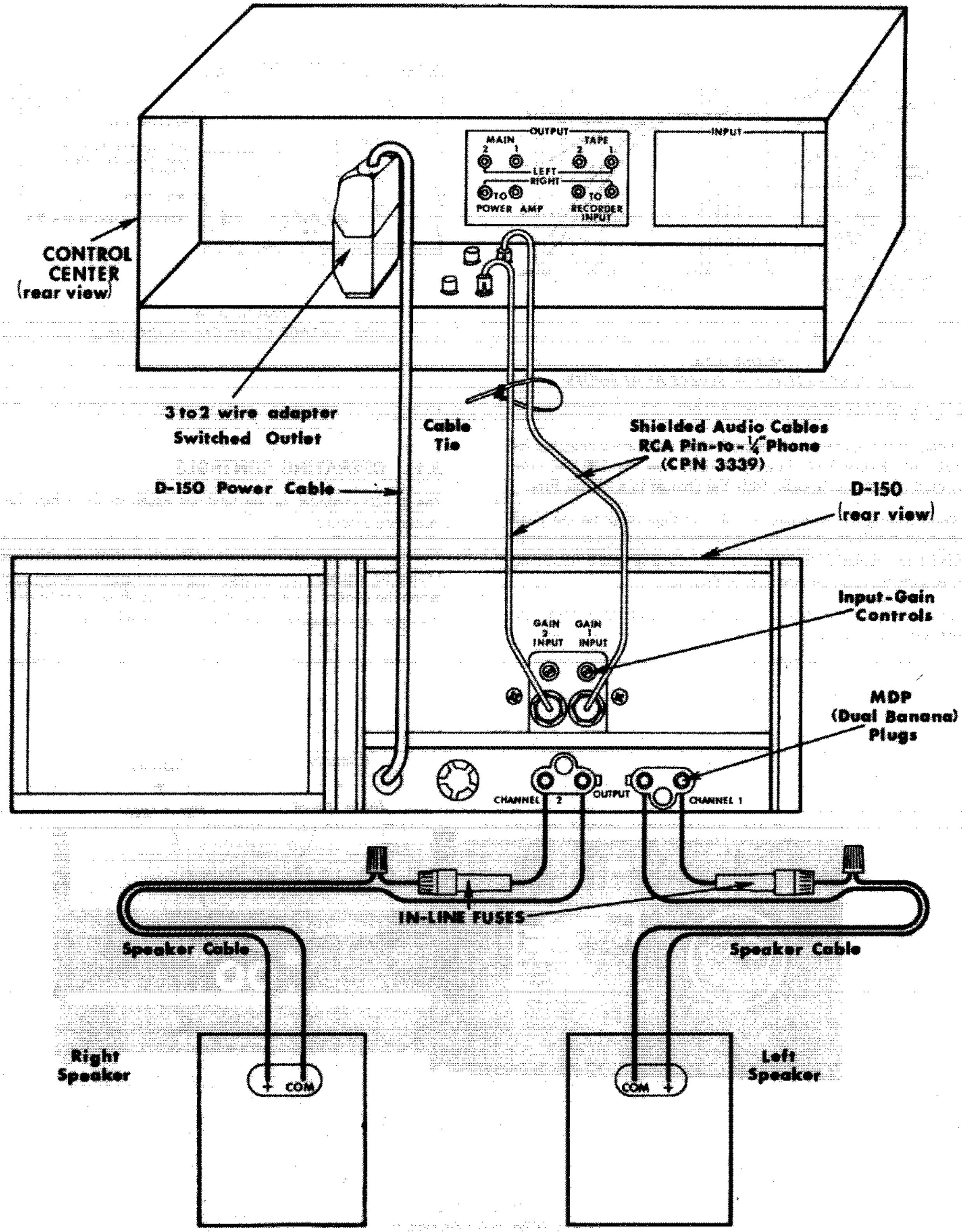


FIGURE 3-16.
TYPICAL HI-FI INSTALLATION

3.12 NORMAL HI-FI INSTALLATION

1. Two-conductor speaker cables must connect to the OUTPUT dual binding posts using terminal lugs, tinned ends, or the special "banana" plugs supplied with the D-150. Connect the in-line fuses as recommended in the Accessory Bag and Figure 3-16.

2. Since the D-150 is a "basic amplifier," the main outputs of the control-center or "preamplifier" must be connected via shielded audio-cables to the two jacks marked INPUT. Use RCA-pin at preamp and standard ¼-in. phone-plug at the D-150.

   The two cables should be tied parallel along their entire length using the accessory cable ties.

3. U/L requirements prefer a 3-wire AC power connector; however, proper connections to a switched outlet on the control center requires the use of a 3-to-2 wire adapter. NOW, plug the AC into a **switched** outlet on the control center.

4. Your Control Center may now be turned on. Then advance the D-150 Input-Gain Controls about ½-open (150° clockwise).

When using the CROWN IC-150 Control-Center, the LOUDNESS should attain almost full rotation (2 to 4 o'clock) for loudest "concert-hall" volume. If at 3 o'clock the volume is low, increase the D-150 input gain controls; if too high, decrease the D-150 gains.

3.13 CLEANING

The CROWN D-150 has a rugged anodized front panel (optional) for life-time service. The panel can be cleaned with a moist cloth and mild detergent. Never use steel wool, scouring powder, lye solution, or any strong abrasive cleaner as these will damage the panel's finish.

The chassis should require no more cleaning than periodic dusting with a clean dry cloth.

SECTION 4
CIRCUIT DESCRIPTION

4.1 PRINCIPLES OF OPERATION

The D-150 has two direct-coupled amplifier circuits which employ a dual IC op amp and silicon transistors in all amplifier stages. The CROWN-designed and developed circuit represents a level of quality and performance presently unequaled in the field of audio amplifier design.

The dual IC op amp is of a low noise type having a large gain bandwidth. The results of using it for the input voltage amplifier is that a maximum amount of feedback is applied reducing distortion to record low values. The typical full output (75w, 8 ohms) SMPTE IM is 0.002%. This implies that the full power 1KHz THD is in the vicinity of 0.0005% which is below the capability of present harmonic distortion measurement systems. Multiple feedback loops are employed to allow a maximum of overall feedback.

The lack of noise is evidenced by a typical 20Hz-20KHz effective input noise of 1.25 u volts which produces an effective 8 ohm out-out of 80 micro-micro (pica) watts.

The output stage is a quasi-complimentary format employing the CROWN class AB+B technique which uses no bias current in the output transistors. The result is maximum efficiency with minimum crossover notch distortion and idling amplifier-heat. Thus there is no bias current adjustment, as the output circuit is not temperature-tolerance critical.

In the new output circuit, the driver transistors carry the bias current, while the output transistors serve only as boosters. The output transistors sense when the driver transistors are delivering significant current to the load and take over and deliver the large load currents.

The output circuit is protected by a V-I limiter which limits the drive to the output configuration whenever the output transistors are overloaded. V-I (volt-ampere) limiting is inherently superior to all other forms of protection as it directly senses the overload condition and acts instantly to relieve the overload, acting only so long as the overload exists. The result is complete freedom from program delays with reliability and maximum safe output power.

The power supply is a continuous-duty type. The main DC supplies are full-wave capacitor input type with a heavy duty bridge rectifier assembly. Computer grade electrolytics furnish over 20 joules of energy storage.

The D-150 represents nothing short of the highest quality in both circuitry and components. It should provide a lifetime of trouble-free service for the most discriminating users.

SECTION 5
SERVICE PROCEDURES

5.1 INTRODUCTION

This section contains technical information required to properly service and repair the CROWN D-150 Dual-Channel Power Amplifier. Included are disassembly and reassembly procedures, a troubleshooting chart (for isolating and identifying defective components), adjustments, test setups and procedures, and component replacement procedures. Use this information in conjunction with Section 6, Schematics, Parts Lists and Component Location, to obtain best results.

5.2 SERVICE POLICIES

Due to the sophisticated circuitry, only a fully-trained, competent service technician should be allowed to service the D-150 amplifier. User servicing should be confined to routine replacement of the fuse on the rear panel. Please observe the following label on the rear panel.

CAUTION. TO PREVENT ELECTRIC SHOCK, DO NOT OPEN. NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO A QUALIFIED TECHNICIAN.

For other service, it is recommended that the unit be returned to the factory in the original packing or replacement packing obtained from the CROWN factory. The CROWN warranty is described in paragraph 5.3. For warranty service the unit must be returned to the factory or approved warranty stations.

Before returning a CROWN D-150 amplifier to the factory for service, authorization should be obtained from the service manager. All shipments must be sent UPS, Railway Express or Truck Freight, prepaid and insured at total value. The factory will return your serviced unit by UPS, Railway Express or Truck Freight.

5.3 WARRANTY

CROWN guarantees this equipment to perform as specified. CROWN also warrants the components and workmanship of this equipment to be free from defects for a period of 90 days from date of purchase.

This warranty does not extend to fuses, and/or component or equipment damage due to negligence, misuse, shipping damage or accident; or if the serial number has been defaced, altered or removed.

An application for a FREE 3-year WARRANTY TITLE is included with the instruction manual received with the equipment. Upon receipt of this completed form, CROWN will issue the Warranty Title — subject to the conditions contained therein. This title applies to the original end-purchaser and will be issued only upon receipt of the application.

Important!! Note the following caution which is screened on the amplifier rear panel. **CAUTION!! NEVER DIRECTLY CONNECT THE OUTPUT TERMINALS OF ONE CHANNEL IN PARALLEL WITH THOSE OF ANY OTHER. ANY RESULTING DAMAGE IS NOT COVERED BY WARRANTY.**

5.4 DISASSEMBLY FOR SERVICING

The D-150 amplifier is specifically designed for easy servicing. It may be partially disassembled and still be made operational for bench testing and servicing. This may be accomplished by removing the bottom cover, transformer cover and wrap-around, and the board and electronics cover (paragraph 5.4.1).

These steps provide easy access to nearly all major components of the amplifier. Those that are not now accessible for servicing can be removed following the procedures given for replacing individual assemblies.

CAUTION!!

DO NOT attempt component replacement or other repairs with power applied.

5.4.1 Removal of Bottom Cover, Transformer Cover and Wrap-Around, and Board and Electronics Cover

Refer to Figure 6-2.

1. Remove power from amplifier.
   NOTE: If an accessory panel has been installed on the amplifier, remove as shown in Figure 3-2.
2. Remove four hex head screws (44), two from each end of the bottom cover (42), and remove the bottom cover.
3. Remove two screws (51), from the top of the transformer cover (50), and remove the transformer cover and the transformer wrap-around (49).
4. Remove two screws (46) from the top of the board and electronics cover (45) and remove the cover.
5. Reverse the above sequence of actions to reassemble the amplifier.

5.4.2 Removal of Control Plate Assembly

Refer to Figure 6-4.

1. Remove board and electronics cover as described in paragraph 5.4.1, Step 4.
2. Remove two screws (13) from top of control plate assembly, 40951.
3. Carefully lift control plate assembly and turn nearest edge (where screws were removed) upward until bottom of control plate is accessible. Do not place unnecessary strain on wiring connected to main PC board.
4. Input level controls (2) and input jacks (5) are now accessible for replacement.

5.4.3 Replacement of Components on Main PC Board, 7891U

Refer to Figures 6-2 and 6-3.

1. Remove board and electronics cover (paragraph 5.4.1, Step 4). Both component and solder sides of board are now accessible.
2. Carefully unsolder and replace (with identical parts) any defective components.

CAUTION

Use normal soldering precautions. DO NOT use excessive heat; heatsink adjacent components to prevent damage.

3. The IC is a plug-in component.
4. Resistors (R111, R211) (selected bias resistors) are plug-in components.

5.4.4 Replacement of Input Level Potentiometers (R101, R201)

Refer to Figure 6-4.

1. Remove board and electronics cover, paragraph 5.4.1, Step 4.
2. Remove control plate assembly, paragraph 5.4.2.
3. Unsolder and tag for identification all leads to the terminals of input level potentiometer (2).
4. Remove control nut (4) using a ⅜" hex wrench and remove defective R101 or R201 from the control plate (10).
5. Solder leads removed in Step 3 to terminals of new input level potentiometer (2).
6. Place new potentiometer in position and replace control nut (4).
7. Replace control plate assembly, paragraph 5.4.2.
8. Replace board and electronics cover, paragraph 5.4.1.

5.4.5 Replacement of Thermal Switch, SW-1

Refer to Figure 6-2.

1. Remove bottom cover (paragraph 5.4.1, Step 2).
2. Remove board and electronics cover (paragraph 5.4.1, Step 4).
3. Disconnect two Faston connectors (19) (20) from terminals of thermal switch SW-1.
4. Remove two each, screws (15), hex nuts (18), star washers (16), solder lugs (17) and remove thermal switch SW-1 from the chassis.
5. Place new thermal switch SW-1 in position and replace hardware removed in Step 4.
6. Reconnect two Faston connectors (19) (20) to terminals of new thermal switch SW-1.
7. Replace board and electronics cover (paragraph 5.4.1, Step 4).
8. Replace bottom cover (paragraph 5.4.1, Step 2).

5.4.6 Replacement of Bridge, DM-1

Refer to Figure 6-2.

1. Remove transformer cover and transformer wrap-around (paragraph 5.4.1, Step 3).
2. Remove bottom cover (paragraph 5.4.1, Step 2).
3. Disconnect four Faston connectors (19) (20) from terminals of bridge DM-1 (11).
4. Remove screw (12), star washer (13) and hex nut (14) securing DM-1 to chassis.
5. Place new bridge DM-1 in position and replace hardware removed in Step 4.
6. Reconnect four Faston connectors (19) (20) to terminals of bridge DM-1.
7. Replace bottom cover (paragraph 5.4.1, Step 2).
8. Replace transformer cover and transformer wrap-around (paragraph 5.4.1, Step 3).

5.4.7 Replacement of Filter Capacitors, C23 and C24

Refer to Figure 6-2.

1. Remove bottom cover (paragraph 5.4.1, Step 2).
2. Remove transformer cover and transformer wrap-around (paragraph 5.4.1, Step 3).
3. Remove one Faston connector (19) (20) from filter capacitor (C23 or C24) terminal.

4. Remove two screws (7), one solder lug (9), two panel washers (8) and two fiber shoulder washers (10) from the filter capacitor terminals.
5. Remove defective filter capacitor (C23 or C24) from the chassis.
6. Place new filter capacitor in position and replace hardware removed in Step 4.
7. Reconnect Faston connector (19) (20) to filter capacitor terminals.
8. Replace transformer cover and transformer wrap-around (paragraph 5.4.1, Step 3).
9. Replace bottom cover (paragraph 5.4.1, Step 2).

5.4.8 Replacement of Output Inductors, L102 and L202

Refer to Figure 6-5.

1. Remove bottom cover (paragraph 5.4.1, Step 2).
2. Remove board and electronics cover (paragraph 5.4.1, Step 4).
3. Unsolder one end of brown coil wire (2) from the output binding post terminal and the other end from the adjacent driver transistor terminal.
4. Remove hex nut (7), star washer (6), nylon washer (3), output coil toroid core and brown wire (1) and (2).
5. Place new output coil toroid core and new brown wire in position and replace hardware removed in Step 4.
6. Solder one end of brown coil wire (2) to the output binding post terminal and the other end to the adjacent driver transistor terminal.
7. Replace board and electronics cover (paragraph 5.4.1, Step 4).
8. Replace bottom cover (paragraph 5.4.1, Step 2).

5.4.9 Replacement of Driver and Output Transistors

Refer to Figure 6-2.

1. Remove bottom cover (paragraph 5.4.1, Step 2).
2. Remove board and electronics cover (paragraph 5.4.1, Step 4).
3. Unsolder and tag for identification all wires and component leads connected to transistor terminals. **DO NOT** unsolder leads attached to solder lugs mounted on transistors.
4. Refer to detail drawings of output and driver transistors and remove hardware shown and the defective transistor.
5. Coat both sides of the insulator (27) (28) between the transistor case and the chassis with a heat-conducting compound (DC-340).
6. Install new transistor and tighten screws and hex nuts snugly to assure good heatsinking.
7. Resolder wires and component leads removed from transistor terminals in Step 3 above.
8. Replace board and electronics cover (paragraph 5.4.1, Step 4).
9. Replace bottom cover (paragraph 5.4.1, Step 2).

5.4.10 Replacement of Power Transformer, T-1

1. Remove bottom cover (paragraph 5.4.1, Step 2).
2. Remove transformer cover and transformer wrap-around (paragraph 5.4.1, Step 3).
3. Disconnect seven transformer wires that pass through the hole in the chassis beside the transformer base.
   a. Two red wires; remove Faston connectors from DM1 terminals and remove Faston connectors (19) (20) from the red wires.
   b. One yellow wire; unsolder from solder lug (9) at junction of capacitors C23 and C24.
   c. One black and one white wire; unsolder from terminal strip (25).
   d. One black/red wire and one black/white wire; unsolder from terminal strip (25).
4. Pull all wires back through hole in chassis.
5. Remove hardware securing transformer T1 to the chassis.
   a. Remove four hex nuts (23).
   b. Remove four star washers (22).
   c. Remove two bottom cover mounts (24).
   d. Remove terminal strip (25).
   e. Remove four transformer mounting screws (21).
6. Remove defective transformer T1.
7. Cut leads on new transformer T1 to same length as those on the transformer being replaced.
8. Place new transformer T1 in position on the chassis and replace, in reverse order, all items removed in Step 5.
9. Pull all transformer wires through chassis hole to bottom side of chassis.
10. Connect seven transformer wires to destinations shown in Step 3.
11. Replace transformer cover and transformer wrap-around (paragraph 5.4.1, Step 3).
12. Replace bottom cover (paragraph 5.4.1, Step 2).

5.5 TEST EQUIPMENT

The D-150 amplifier is a relatively complex unit, and consequently requires a comprehensive array of standard and special test equipment for complete servicing. A recommended list of test equipment is shown in Table 5-1. This list is adequate to service all CROWN amplifiers.

In the absence of a complete set of test equipment, it should be noted that most troubleshooting can be successfully done with an oscilloscope, an ohmmeter, a voltmeter and a signal generator. Any amplifier malfunctions which cannot be identified and repaired with this basic equipment should be referred to the CROWN factory or authorized service center.

5.5.1 Calibration of Test Equipment

It is important that test measurements made during servicing be accurate and dependable. Otherwise the performance of the amplifier cannot be properly evaluated. Test equipment shown in Table 5-1 should remain properly calibrated with only periodic (6 month intervals) checks. If less expensive (and thereby less dependable) test equipment is used, frequent calibration is necessary to assure the accuracy required for proper servicing.

5.6 TEST PROCEDURES

This paragraph lists precautions essential to obtain accurate test measurements when dealing with high-purity amplifiers such as the CROWN D-150.

1. Use the proper line voltage (120 VAC or 240 VAC) for which the power supply has been wired for normal operation. The line voltage should be measured with a peak reading ac voltmeter and adjusted to the rms equivalent voltage (to compensate for line voltage regulation errors during the course of the test measurements). All measurements should be taken at the power amplifier plug. When testing for IHF music-power measurements, the line voltage is to be set at 120V when the amplifier is wired for 120V (IHF Standards). If the amplifier is wired for 240V, the equivalent test may be given by applying 240 volts.
2. The loads should be resistive, having less than 10% reactive components at any frequency up to five times the highest test frequency. All output measurements should be taken at the output terminals and not at any other points along the output cables through which the load current is flowing. The load should employ only high-current connectors and be connected to the output binding-post terminals.
3. The input level controls should be set to maximum for all distortion tests to assure repeatability of all measurements.
4. When measuring hum and noise, all inputs should be disconnected from the amplifier and the level controls set to minimum or to maximum, preferably minimum.
5. Whenever possible avoid ground loops in the test equipment caused by connecting the output ground to the input ground. **Never** connect the ground of the cable going to the load back to the input ground.

   Ground loops are especially obnoxious when measuring distortion. An IM distortion analyzer, for example, has its input and output terminals tied to a common ground. Such a test should use an ungrounded output return, with the output lead(s) wrapped around the well-shielded and grounded input cable.
6. Always monitor the test oscillator when measuring frequency response. Use a wide-band ac voltmeter, or use the same meter for both input and output level measurements, if the meter's frequency response is known not to be dependent on attenuator settings.
7. Accuracy in measuring voltages for computing wattage is critical. For example, a 2% voltage error together with a 1% resistance error can result in an error of 10 watts power into an 8-ohm load.
8. Residual distortion and noise levels should be fully known for all the test equipment in order to accurately evaluate amplifier performance.
9. Never attempt to measure damping factor by placing abnormal loads on the output. DF measurements taken during clipping, or any other form of overload, are meaningless. The preferred method is to apply an externally generated current to the output terminals and measure the resultant voltage at the terminals. A convenient current is one ampere — as the resultant voltage will read directly in ohms for (Z_O). Damping factor is defined as (Z_L/Z_O), where (Z_L) is typically 8 ohms. A convenient generator for the 1A current is that amplifier channel not under test. A non-inductive resistance of 8 ohms — coupled between both channels' output terminals — will provide 1A when 8 volts are impressed across the resistor (by that channel not under test).
10. Never measure hum and noise when in the presence of strong magnetic fields. The amplifier should be at least 4 inches away from any large metallic objects or shield plates for a reading to be meaningful.
11. Noise measurements should be taken with a bandpass filter of 20-20 KHz. For audio purposes the measurement of noise above 20 KHz is unimportant.
12. When repairing an amplifier it should not normally be operated with a load until it performs properly unloaded. If serious problems with the amplifier exist, a load will only compound those problems by blowing fuses and causing additional damage by drawing high current.
13. Ohmmeter tests can usually be performed on semiconductors with the 1.5-volt probe. On the RX1 scale, the normal forward breakdown resistance for semiconductors will usually fall in the 5-15 ohm range.

To check resistor values without removing them from the circuit and without forward biasing any junctions, the low voltage probe (100 mv range) should be used.

The effect of parallel resistance paths must be considered in determining whether a test reading is normal. The simplest procedure is a comparison with the same reading under identical

EQUIPMENT	REQUIREMENTS	APPLICATION	SUGGESTED MODEL
Oscilloscope	Capable of displaying a 10 megahertz signal.	Monitoring output during service and testing.	Telequipment SS4A or equivalent.
Voltohmmeter (VOM)	Low-voltage resistance probe (100mv range). High-voltage resistance probe (1.5 v range).	Check resistance values (low voltage probe). Check semiconductor junctions for opens or shorts (high voltage probe). Check DC voltages.	Triplett 601 or equivalent
Signal Generator	Sine/square wave available; flat frequency response.	Provide test signals for service and checkout. (10KHz sq; 20KHz sine)	Wavetek 130-Series or equivalent
Wattmeter	Reasonable accuracy at 20W without cutting into voltage at high power levels.	Check power consumption.	Simpson 390 (panel meter 1379) or equivalent
Circuit Breaker	15 ampere rating.	In AC line to amplifier; protects circuitry from overload if power supply has shorted.	
AC Line Monitor	Peak reading meter.	Monitor line voltage for amplifier testing.	Information available from CROWN.
Variac		Keep line voltage at 120V during tests.	Superior Powerstat 116B or equivalent.
AC Voltmeter	100 mv low range.	Set output level for testing; check noise level.	Hewlett-Packard 400F or equivalent
Filter	20-20KHz bandpass, low noise.	Between amplifier and voltmeter in noise test.	Information available from CROWN.
Intermodulation Distortion Analyzer		Check IM distortion from 150W to 15 MW.	Available from CROWN
Dummy Load	2, 4, 8 Ohm; able to dissipate 500W without strain; less than 10% reactive component at any frequency up to 5 times the highest test frequency. (100KHz x 5 = 500KHz)	Check amplifier performance under load.	Information available from CROWN.

TABLE 5-1
LIST OF TEST EQUIPMENT

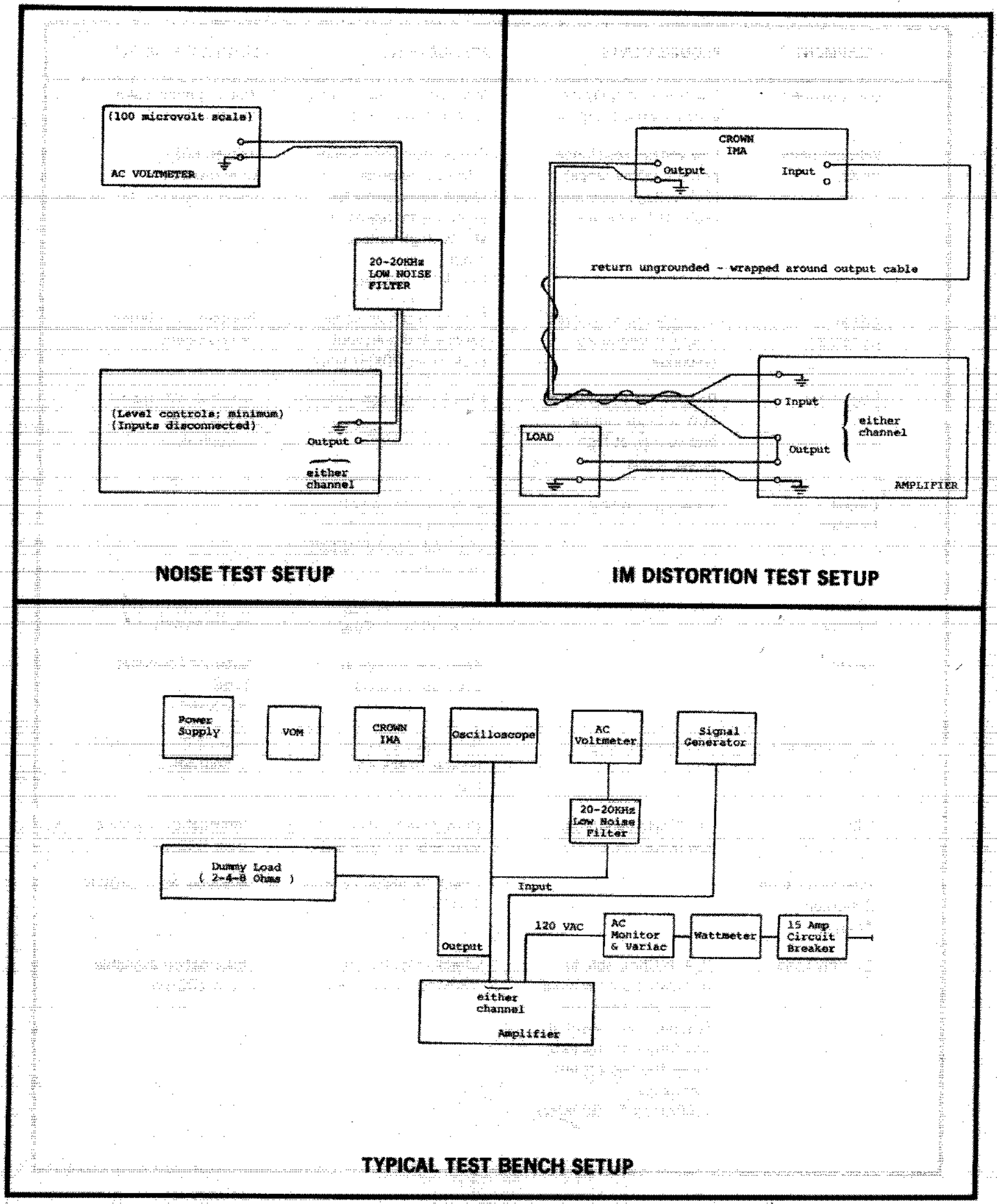


FIGURE 5-1
TEST EQUIPMENT COMPLEMENT

conditions on a properly functioning channel. If both channels are defective, compare the reading with those on a good amplifier.

Approximate resistance measurements for transistors (outside a circuit) appear below. Large resistance means little or no indication on the RX1 scale. Base-emitter and base-collector readings in a transistor should match within several ohms. The first lead in the list below takes the positive meter probe for an NPN transistor; the negative meter probe for a PNP transistor.

Base-emitter	5-15 ohms
Emitter-base	Large
Base-collector	5-15 ohms
Collector-base	Large
Collector-emitter	Large
Emitter-collector	Large

Diodes should show approximately 5-15 ohms forward resistance and large reverse resistance.

Know your ohmmeter — all types do not operate the same. Some have the positive lead common, others the negative. You must be aware of this when measuring forward or reverse junction resistances. Some meters use a nine-volt test voltage on high resistance scales which can forward bias enough junctions in a solid state circuit to cause avalanche confusion. Know the test voltage for the scale used.

5.7 TROUBLESHOOTING

The information contained in the troubleshooting chart has been compiled from data gathered from field service reports and factory experience. It contains symptoms and usual causes for the service problems described, however, do **not** assume that these are the only problems that may occur. The D-150 amplifier is a complex piece of electronic equipment and all available data concerning the reported trouble should be systematically analyzed before undertaking any drastic repairs or component replacement procedures. The following general procedure should be used in servicing the D-150.

a. Verify and Identify the Problem

Assemble and analyze all data accompanying the amplifier. Do **not** automatically assume that the amplifier is, in fact, defective. Problems arising from the system configuration in which the amplifier is being used may be blamed on the amplifier. Most written complaints are sketchy, sometimes ambiguous, and generally tend to oversimplify problems. Some problems may be painfully obvious — blown fuses, broken parts, or the smell of burned components. Should the problem not be simple to find, it may be helpful to contact the user directly and ask the following questions:

(1) What are the details of the system in which the amplifier was being used? Has the system been carefully checked for possible problems outside the amplifier?

(2) Describe the problem? Symptoms? One channel affected or both? Which channel?

(3) Did the problem occur more than once? Were circumstances identical for all occurrences?

(4) What kind of input signal and load were used?

(5) How long was the amplifier in operation when the failure occurred? Was it warmer than usual?

If the user is not available and the problem is not obvious, perform the regular factory checkout procedure. The troubleshooting chart is organized according to the sequence of the factory checkout procedure and common service problems appear in the order they are most likely to occur.

b. Visual Inspection

A detailed visual inspection is worth performing for almost all problems and may avoid unnecessary additional damage to the amplifier.

(1) Check for loose wires and wires that may be crimped or squeezed against components or the chassis in assembly. Suspicious wires may be pulled gently to assure they are securely fastened.

(2) Check for loosened screws holding wiring connections.

(3) Check for bad solder connections. Loose transistor leads may cause oscillation, noise or DC imbalance.

(4) Check for parts damaged by heat or high power; usually apparent by discoloration or burned odor.

5.7.1 Turn-on Procedure

Plug in the D-150 amplifier with no signal input and no load.

SYMPTOM	PROBABLE CAUSE AND REMEDY
AC fuse blown.	Wrong size fuse. Replace with correct value.
	Wrong line voltage. Check AC line voltage.
	Pinched or shorted wires in power supply. Make visual check of power supply wiring.
	Short in transformer primary. Also make ohmmeter check of power cord for hot-to-ground short.
	Miswiring of transformer primary. Check primary wiring according to color code shown in paragraph 5.4.10.
	Short in rectifier bridge, DM-1. Replace bridge.

5.7.2 Output Offset Voltage Check

Check output offset voltages for both channels. Measurement to be taken across output terminals with no input signal. If voltage exceeds 10 mv, check:

SYMPTOM	PROBABLE CAUSE AND REMEDY
Excessive offset voltage with no signal input	IC defective; replace.
	No positive supply to pin 14 of IC
	No negative supply to pin 7 of IC (both ± supplies to IC are 7.5 - 9.5 Volts)
	C3 leaky; replace
	D1 open; replace
	D9 or D10 shorted; replace
	Poor solder joint at junction of C23 - C24.

5.7.3 Bias Level Check

Check bias level voltage across resistor (R20 or R27). If voltage does not fall within specified limits (310-340 mv), perform procedure for selecting proper value for resistor, R11, as shown in paragraph 5.8. If still unable to obtain correct voltage:

SYMPTOM	PROBABLE CAUSE AND REMEDY
Low or no bias	Check R15, R16, R19, R20, R25, R27
	Check bias diodes D2-D5.
	Check for leaky driver transistor (Q10 or Q12).
High bias on + output transistor	Check for leaky output transistor (Q11).
High bias on - output transistor	Check for leaky output transistor (Q13).

5.7.4 Checkout Procedure — 1KHz Input, No Load

Connect a signal generator set at 1 KHz to the amplifier input. Turn up the level control(s) and monitor the output with an oscilloscope. The waveform should appear undistorted at all amplitudes until it clips. Clipping should be sharp, with no ringing or other oscillation. If these conditions are not met, check:

SYMPTOM	PROBABLE CAUSE AND REMEDY
Fuse blows or + or - 45V appears at output	Output transistors shorted. (Q11, Q13 in both channels). Replace. or Driver transistor shorted. (Q10, Q12 in both channels). Replace. or Pre-driver transistor shorted (Q8, Q9 in both channels). Replace. Diode D9 or D10 shorted. Replace.
	NOTES: 1. Usually a component in both + and - output circuitry must short to blow the fuse with no load. 2. Usually, if only one output, driver, pre-driver or diode shorts with no load, the opposite polarity protection will activate, blocking excess current and leaving the amplifier with a + or - 45V at the output. 3. Check for open emitter resistor associated with a shorted output transistor. 4. **Replacement of Output Transistors.** Refer to Figure 6-2. Replacement transistors should be of the same make as those removed. Be sure to include all insulating material from the original transistors on the replacement. Be sure new transistors are adequately heat-sinked by using a good heat-conducting compound (Dow Corning 340) on the transistor case where it fits against the heat sink. Tighten all mounting screws snugly and evenly.
Continuous DC voltage at output.	Shorted transistors or diodes in output circuitry. Check and replace as necessary. If offset is

SYMPTOM	PROBABLE CAUSE AND REMEDY
	positive check the + side. If offset is negative check the - side.
	Defective bias diodes (D2-D5). Replace.
	NOTE: As a general procedure, use a voltmeter to compare voltage readings with those shown on the unit schematic. Begin at the input, move stage by stage through the circuitry, and note any large deviations from the quiescent voltage levels shown. Determine whether specific components are defective or simply responding to a problem elsewhere.
Oscillation at output with or without signal	Check components on Main PC Board by alternately heating and cooling (use small solder iron and circuit cooler spray) while observing the oscillation on the oscilloscope. Concentrate on transistors and diodes. Significant changes in the oscillation may pin-point a defective component.
	Check diodes and resistors by paralleling with a capacitor. This may help isolate the source of an unwanted oscillation. **CAUTION!** In some cases this technique may cause oscillation so use with care.
	Check capacitors by paralleling them with a known good capacitor of the same value. If oscillation is eliminated, an open capacitor may be indicated.
Output unstable when adjusting level pot	Dirty internal contacts on level pot. Temporary correction of this problem may sometimes be had by turning the pot back and forth repeatedly to allow the contacts to clean themselves. If this is unsuccessful, replace the pot.

5.7.5 Checkout Procedure — 1 KHz Input, With Load

Most of the common service problems should have manifested themselves previously and the remaining test procedures should be fairly routine. If troubles do occur, a likely source is the output stages, since this is the first test where these stages are subjected to a load.

1. Connect an 8-ohm load to the output. (Refer to paragraph 5.6.2).
2. Monitor the output with an oscilloscope and an accurate AC voltmeter.
3. Connect a sine wave oscillator set at 1 KHz (+10dB out) to the amplifier input.
4. Turn up the level control of the channel under test. The output must clip at over 98 watts (28 volts). Typically, the clip point is 105 watts or above, with the ac line voltage at 120 volts. The waveform should be clean, and should clip evenly and symmetrically with no ringing.
5. Change load to 4 ohms. Clip point should occur at approximately 170 watts (26 volts).

5.7.6 Checkout Procedure — Protection Circuit Tests

The protection circuit test is a clipping test designed to verify the operation of the limiting circuits.

1. Set the amplifier output at approximately 28V across 8 ohms.
2. Switch the load to 2 ohms. At this load impedance the output will cause enough power supply sag to clip the output but may not cause the sharp clip indicative of limiter circuit action. Slowing the oscilloscope trace to look for power supply ripple at the clip level will indicate whether the power supply or limiter circuits are causing the clip.
3. In order to insure that the limiter circuits are operating, it may be necessary to drive a 1-ohm load. If the oscilloscope trace still shows only power supply clipping, the associated limiter(s) is not turning on and the limiter circuitry is defective.

SYMPTOM	PROBABLE CAUSE AND REMEDY
+ signal does not clip on 2-ohm load	Check components in + limiter (Q6 circuit).
- signal does not clip on 2-ohm load	Check components in - limiter (Q7) circuit.
Either + or - signal clips at wrong level on 2-ohm load.	Check limiter circuits. Refer to Figure 5-2 for clipping levels.

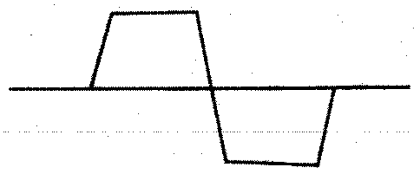


FIGURE 5-2.
TYPICAL PROTECTION CLIPPING, 2-OHM LOAD

5.7.7 Checkout Procedure — 20 KHz Sine Wave Input

1. Set the signal generator at 20 KHz at the amplifier input with an 8-ohm load connected to the amplifier output.
2. Turn the level control up until clipping occurs. Clipping must take place above 85 watts (typically in the 95-100 watt range). Refer to Figure 5-3 for output waveform characteristics.

NOTE:
The output must clip before it distorts elsewhere. The dotted line in Figure 5-3 shows typical unacceptable distortion on the leading edges of the waveform.

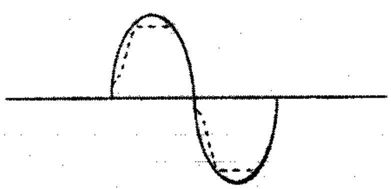


FIGURE 5-3.
TYPICAL 20KHz SINE WAVE TEST OUTPUT WAVEFORM

5.7.8 Checkout Procedure — 10 KHz Square Wave Input

This test is designed to critically examine the frequency response and rise time of the amplifier to show how fast the amplifier can follow rapid signal changes.

1. Set the signal generator for a 10 KHz square wave, 20V p-p at the amplifier input.
2. Connect an 8-ohm load to the amplifier output.
3. Turn up the level control to maximum.
4. The output waveform (Refer to Figure 5-4) should be clean and sharp throughout the entire range of the level control.

5.7.9 Checkout Procedure — IM (Intermodulation) Distortion Test

1. Use the IM distortion test setup shown in Figure 5-1.
2. Calibrate the IMA and set up the IM input signal at 60 - 7 KHz, 4:1 ratio as described in the IMA manual.
3. Connect an 8-ohm load to the amplifier output.
4. Measure the IM distortion at 5 dB intervals from 75 watts output to 7.5 milliwatts output as shown below. All distortion readings must be less than 0.01%.

BOTH RIGHT AND LEFT CHANNELS

.0	%	75W out	.0	%	237 MW
.0	%	23.7W out	.0	%	75 MW
.0	%	7.5W out	.0	%	23.7 MW
.0	%	2.3W out	.0	%	7.5 MW
.0	%	.75W out			

SYMPTOM	PROBABLE CAUSE AND REMEDY
High IM distortion	IC1 defective. Replace.
	Change transistor, Q4.
	Change routing of leads from from Main PC board to output transistors and the output binding posts.

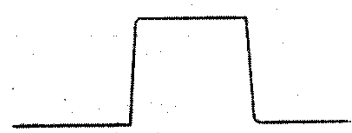


FIGURE 5-4.
TYPICAL 10 KHz SQUARE WAVE TEST OUTPUT WAVEFORM

5.7.10 Checkout Procedure — 20-20 KHz Hum and Noise Test

1. Use the noise test setup shown in Figure 5-1.
2. Remove input from the amplifier.
3. Set level controls at minimum (CCW).
4. Set AC voltmeter to 100 microvolt scale.
5. Measure the noise level relative to 75 watts into 8 ohms. The hum and noise level must be 115 dB or greater below the full 75 watt output power. A typical value is -118 to -122 dB.

SYMPTOM	PROBABLE CAUSE AND REMEDY
High noise level	Bad solder joints. Visually inspect the defective channel components and leads.
	Poor ground connections. Check all ground wires. Check output jack ground. Check insulating washers on input jacks.

5.7.11 Checkout Procedure — Quiescent AC Power Consumption

Use a wattmeter and check the power consumption at the amplifier output when the amplifier is turned on (idling) but carrying no signal. The amplifier must draw **less** than 30 watts with the ac line voltage at 120 volts. A typical reading is 20 watts.

SYMPTOM	PROBABLE CAUSE AND REMEDY
High quiescent ac power input	Bias diode (D2 through D5) open. Replace.
	Shorted positive output or driver stage along with a shorted negative output or driver stage.
	+45V shorted to chassis at C21 or Q10.
	Output may be shorted at C22 or Q12 collector.

5.8 BIAS LEVEL CHECK AND ADJUSTMENT

Refer to Figure 5-5. The correct bias level for the D-150 amplifier is set at the factory and will not usually require adjustment unless components affecting the level are replaced. Component changes likely to affect bias settings are the pre-driver, driver, output stages and bias diodes (D2-D5).

Correct bias maintains the driver and pre-driver stages at normal operating levels and keeps the output stages turned off. This condition is achieved when a voltage of 325±15 mv (.310 - .340 volts) appears across the output stage bias resistor (R11) for each channel.

a. To check bias level:

1. Remove board and electronics cover from the amplifier (paragraph 5.4.1, Step 4).
2. Remove bottom cover from the amplifier (paragraph 5.4.1, Step 2).
3. This check is to be made with the amplifier idling (no input and no load).
4. Connect power to amplifier and allow unit to warm up to normal operating temperature.

CAUTION ! !

Do not measure bias level voltage until unit is fully warmed up. Voltage begins to climb at turn-on, peaks and gradually drops to the normal level. Measurements taken during warm-up are likely to be misleading.

5. Measure the voltage across one of the output stage bias resistors for each channel (R120, R127; R220, R227). Voltage should be between 310-340 mv. If voltage is abnormal, use the following procedure to obtain correct bias level voltage.

b. To adjust bias level voltage:

Adjustment of bias level voltage is made by changing the value of the selected resistor in the bias circuit (R11). These resistors are mounted in plug-in sockets on the Main PC Board. Generally, selected bias resistors range from 33 to several hundred ohms. Carbon resistors, 10% tolerance, are normally used.

1. If the measured bias voltage was **high**, replace the factory-installed resistor with one of **higher** value. This will **lower** the bias voltage.
2. If the measured bias voltage was **low**, replace the factory-installed resistor with one of **lower** value. This will **raise** the bias voltage.

Continue replacing the selected resistor, using the above procedure, to bring the bias voltage as close to 325 mv as possible.

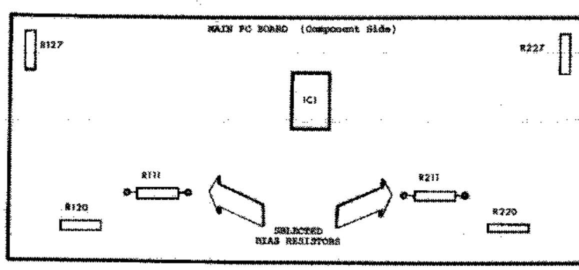


FIGURE 5-5. BIAS LEVEL CHECK COMPONENTS

SECTION 6
SCHEMATICS, PARTS LISTS AND COMPONENT LOCATION

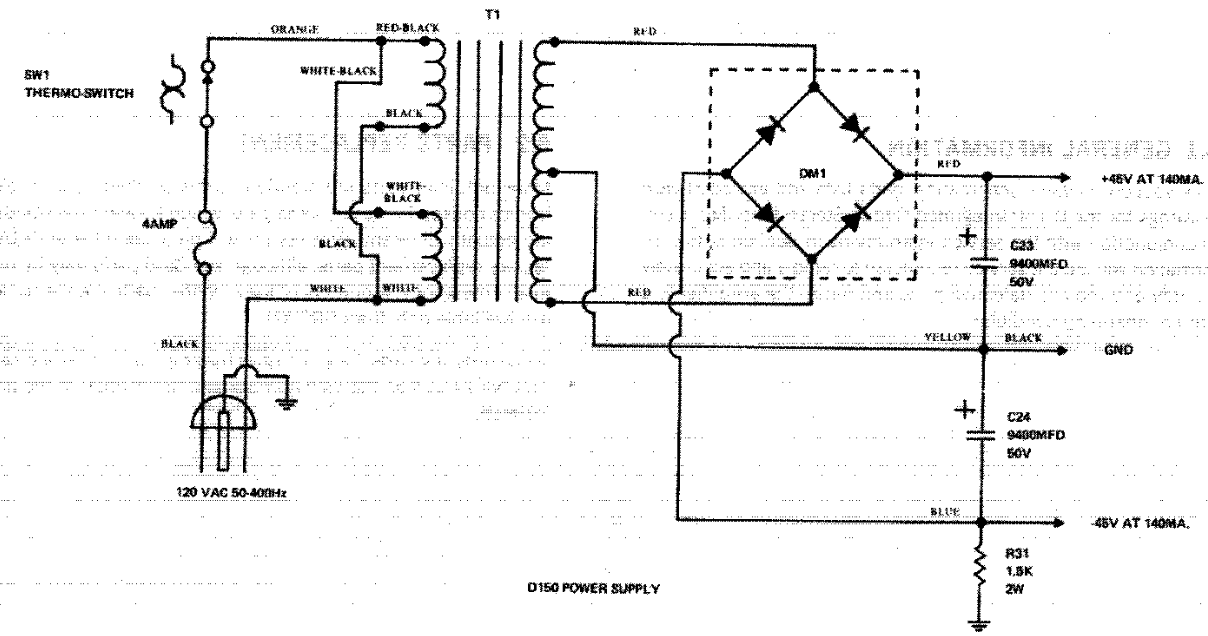
6.1 GENERAL INFORMATION

This section contains schematics, parts lists and exploded view drawings for the D-150 Integrated Circuit Stereo Amplifier. Used in conjunction with the service instructions in Section 5, this information will aid the service technician to rapidly and accurately identify and replace defective parts and return the amplifier to a normal operating condition.

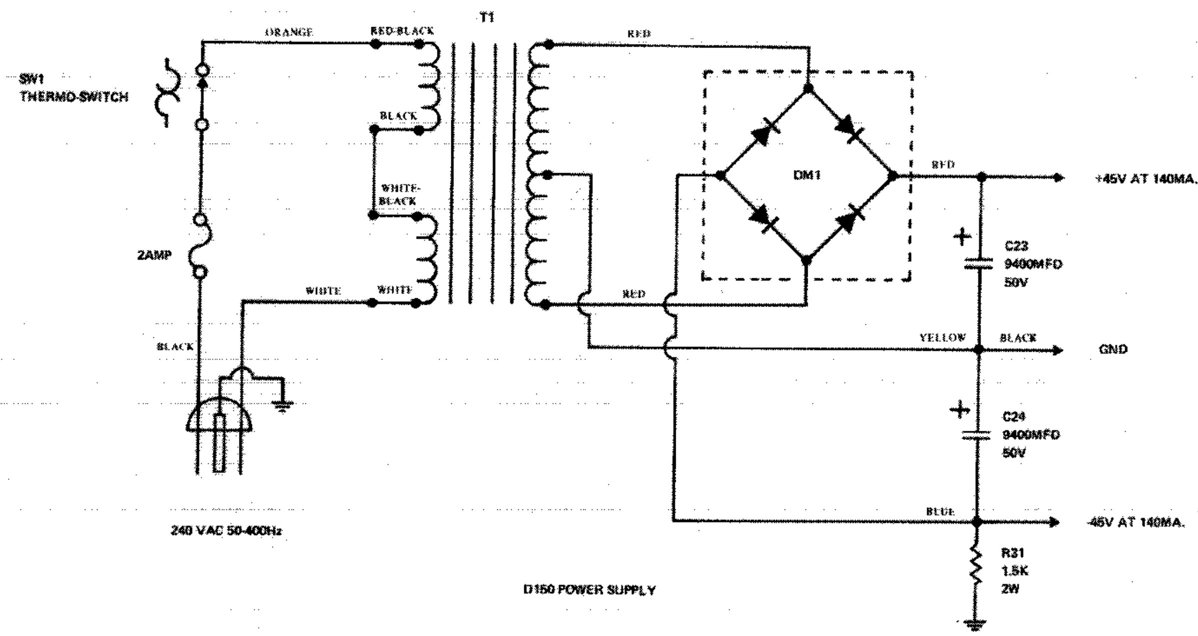
6.2 PARTS REPLACEMENT

Many amplifier parts are standard items stocked by local electronics houses. However, some parts which appear to be standard are actually different. Best results will be obtained with CROWN factory replacement parts, although standard parts may be used in an emergency. A number of the amplifier parts are special and are available only from CROWN.

When ordering parts, be sure to give the amplifier model and serial number as well as the part number and description of the parts ordered.



D150 POWER SUPPLY



D150 POWER SUPPLY

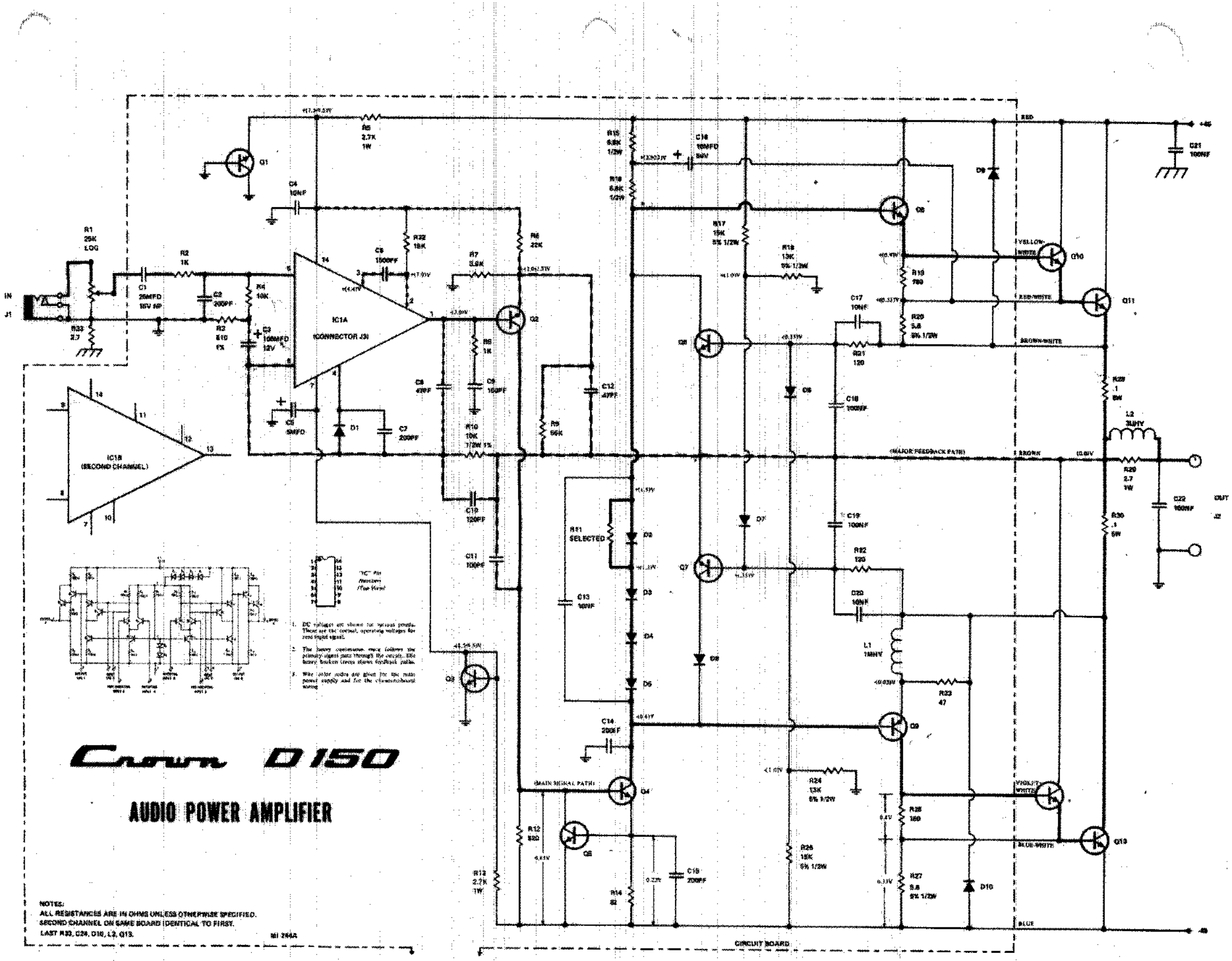


FIGURE 6-1.
SCHEMATIC DIAGRAM, D-150 AMPLIFIER

Schematic Designation	Description	Crown Part No.	Draw No.	Other Information
	CHASSIS ASSEMBLY			
	Chassis, D-150	3544	1	
	Power Cord, male, 3, #18, 8'	3474	2	
	Strain relief, Heyco	2803	3	Mounts power cord
OUTPUT	Binding posts, dual	2823	4	
	Fuseholder, HTA	3256	5	
	Fuse, MTH-4A	1261	6	Used when wired for 120VAC
	Fuse, MDX-2A	3973	6	Used when wired for 240VAC
	Standard fuse block	3776		Internal fuse for CSA approval
	3 AG/AGC 5 Amp fuse	3774		Internal fuse for CSA approval
	Capacitors:			
C21, 25, 122, 222	.1 mfd, 200V, filmatic	2938		
C23, 24	9400 mfd, 50V	3309		
	Screw, 10-32 x ½, THP, NIC	2049	7	Mounts C23, 24
	Washer, panel	2045	8	Mounts C23, 24
	Lug, solder	2934	9	Terminal on C23, 24
	Washer, shoulder, fiber, 5/16	3320	10	Mounts C23, 24
DM1	**Bridge:** 15A, SDA9802	3552	11	
	Screw, 6-32 x ¾, CAD	2135	12	Mounts DM1
	Washer, star, #6 internal	1823	13	Mounts DM1
	Nut, hex, 6-32, CAD	1889	14	Mounts DM1
	Resistors:			
R31	1.5K ohm, 2W, 10%	3303		
R128, 130, 228, 230	.1 ohm, 5W, 10%	3291		On output solder lugs
R129, 229	2.7 ohm, 1W, 10%	1001		
SW1	**Switch:** thermal, SPST NO 160F	2799		
	Screw, 6-32 x ½ BHP, CAD	2176	15	Mounts SW1
	Washer, star, #6 internal	1823	16	Mounts SW1
	Lug, solder, #6 hole	3163	17	Mounts SW1
	Nut, hex, 6-32, CAD	1889	18	Mounts SW1
	Faston Flag Terminal	3298	19	On DM1, SW1, C23, C24
	Faston Flag Housing	3297	20	On DM1, SW1, C23, C24
T1	**Transformer:** D-150, 46P15C	3286		
	Screw, 10-32 x ½, THP, NIC	2049	21	Mounts T1
	Washer, star, #10 internal	2279	22	Mounts T1
	Nut, hex, 10-32	2170	23	Mounts T1
	Bottom cover mounts blk	3743	24	On T1 mounting screws
	Terminal strip, 1-G-2	3599	25	Under T1 mounting screw
Q110, 112, 210, 212	**Transistors:** 2N3585, selected	3295		Drivers
	Insulator, TO-66	3346	26	Mounts drivers
	Insulator, TO-66, mica	2553	27	Mounts drivers
	2N3773, selected	3773		Outputs: each channel should be same mfgr
	Insulator, TO-3, anodized	3570	28	Mounts outputs
	Insulator, TO-3	3179	29	Mounts outputs
	Screw, 6-32 x ½ BHP, CAD	2176	30	Mounts outputs and drivers. Except one mounting hole; see below.
	Washer, star, #6 internal	1823	31	Mounts drivers/inputs
	Solder lug, #6 hole	3163	32	Mounts drivers/inputs
	Nut, hex, 6-32, CAD	1889	33	Mounts drivers/inputs
	Washer, shoulder, plastic	3335	34	Mounts output (last hole)
	Screw, 4-40 x ⅝ RHS, CAD	3334	35	Mounts output (last hole)
	Washer, star, #4 internal	1824	36	Mounts output (last hole)
	Solder lug	1220	37	Mounts output (last hole)
	Nut, hex, 4-40, CAD	1938	38	Mounts output (last hole)
	Fins, D-150	3453	39	Heatsinks
	Screw, 10-32 x ⅜ SCP	3313	40	Fastens center fin
	Screw, 10-32 x ½ SCP	1994	41	Fastens outside fin; two bottom cover mounts go under screws.
	Bottom cover, D-150	40968	42	Black coating/w feet
	Feet, rubber, self-stick	3342	43	On bottom cover
	Screw, #8 x ⅜, hex, SMTS	2708	44	Fastens bottom cover
	Board & electronics cover	40967	45	
	Screw, 8-32 x ¼, THP, CHR	2271	46	Fastens 40967
	Label, back, D-150	3332	47	Input label
	Label, Amplifier, D-150	3770	48	Serial number
	Transformer Wraparound, D-150	3516	49	
	Transformer Cover, D-150	3355	50	
	Screw, 10-32 x ½, THP, NIC	2049	51	Fastens cover (3355)

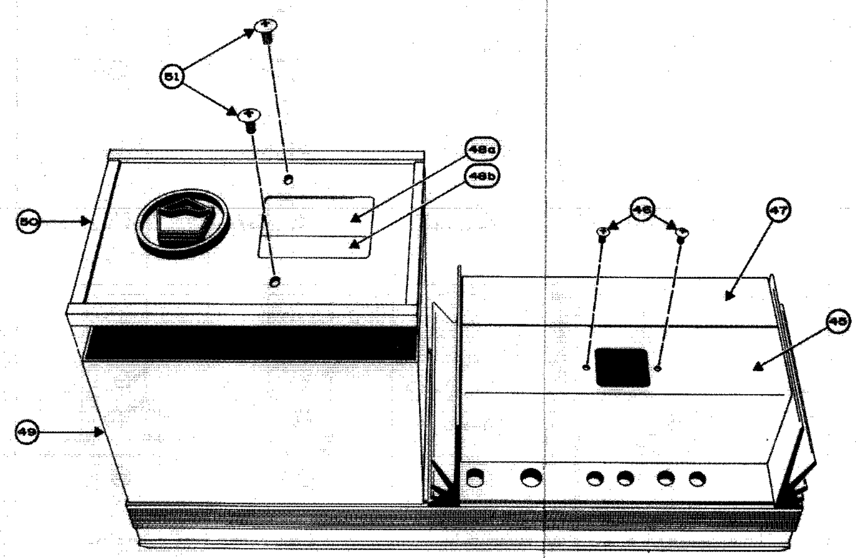


FIGURE 6-2.
CHASSIS ASSEMBLY, EXPLODED VIEW

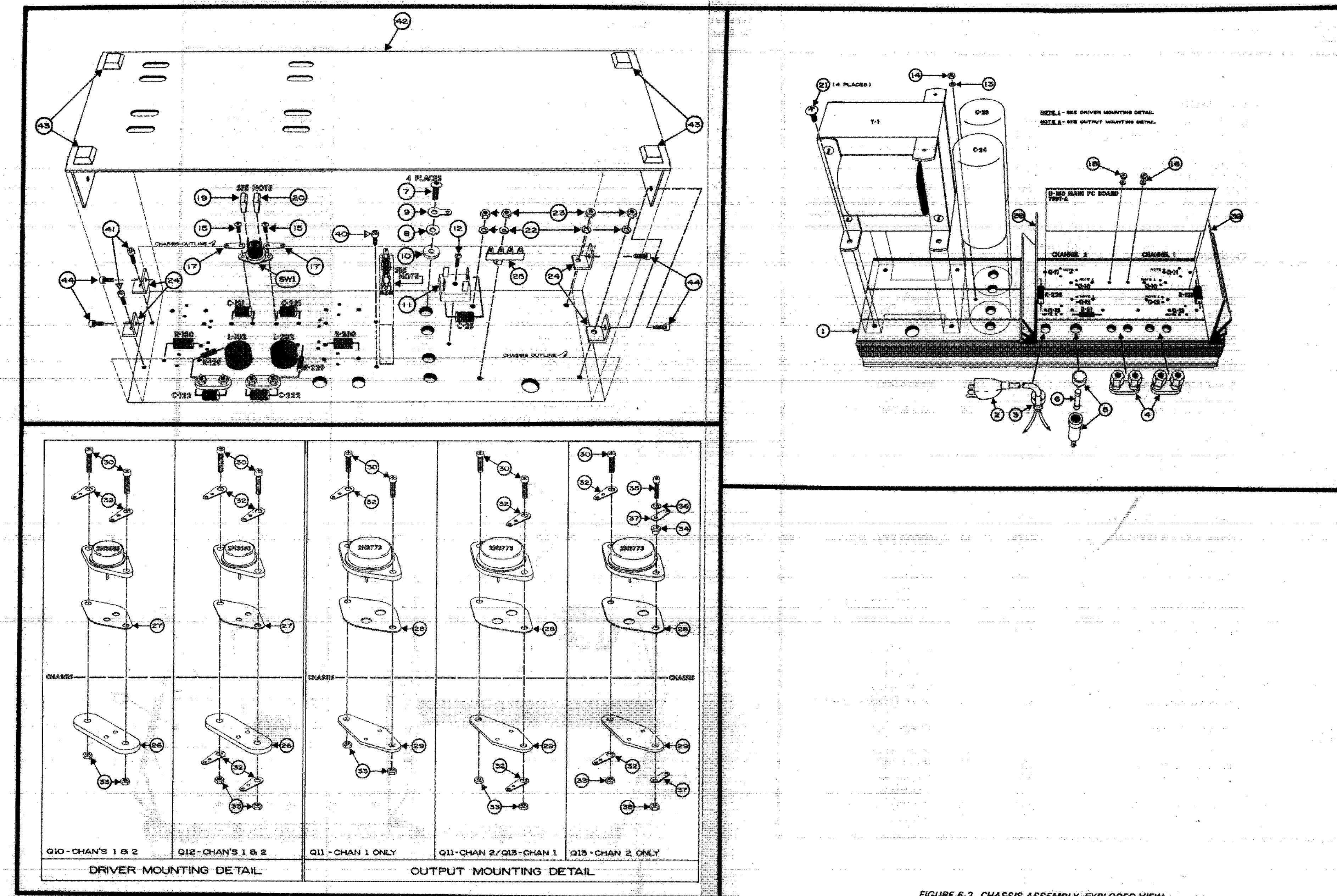
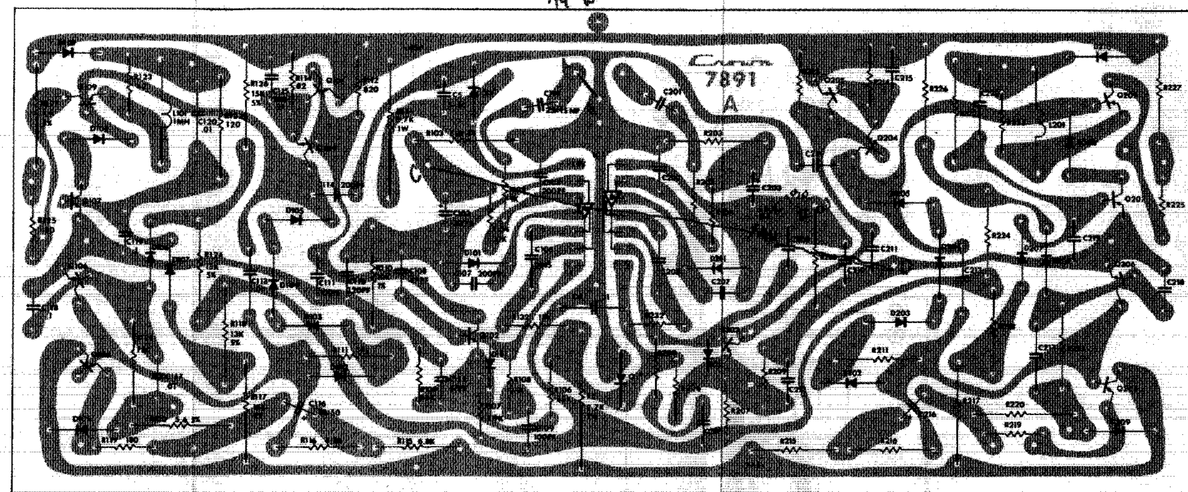


FIGURE 6-2. CHASSIS ASSEMBLY, EXPLODED VIEW



Schematic Designation	Description	Crown Part No.	Other Information
	D-150 MODULE	40971ML	
	D-150 Main PC Board	7891U	
	Capacitors:		
C4, 113, 117, 120, 213, 217, 220	.01 mfd, ceramic, disc	1751	
C5	5 mfd, 30V, vertical	2868	
C101, 201	25 mfd, 15W, NP, vertical	3186	
C102, 107, 114, 115, 202, 207, 214, 215	200 pf, mica	3411	
C103, 203	100 mfd, 16V, vertical	3729	
C106, 206	.0015 mfd, filmatic	3089	
C108, 112, 208, 212	47 pf, mica	3409	
C109, 111, 209, 211	100 pf, mica	3410	
C110, 210	120 pf, mica	3290	
C116, 216	10 mfd, 50V, vertical	3728	
C118, 119, 218, 219	.1 mfd, ceramic, disc	2600	
L101, 201	**Coil:** 1 mhy, axial lead	2441	
	Diodes:		
D101, 103-107, 111, 201, 203-207, 211	1N4148	3181	
D102, 108, 202, 208	1N270	3447	
D109, 110, 209, 210	1N4003	2851	
IC1 (A&B)	**Integrated Circuit:** uA739C	3231	uA749 (3643) may be substituted with proper load resistor (2629)
	Resistors:		
R5, 13	2.7K ohms, 1W, 10%	1079	
R102, 108, 202, 208	1K ohm, .25W, 10%	2627	
R103, 203	510 ohm, .5W, 1%, film	3304	
R104, 204	10K ohm, .25W, 10%	2631	
R106, 206	22K ohm, .25W, 10%	3302	
R107, 207	3.9K ohm, .25, 10%	2630	
R109, 209	56K ohm, .25W, 10%	2882	
R110, 210	10K ohm, .5W, 1%, film	2343	
R111, 211	75 ohm, .5W, 5%	2423	Selected value, approx.
R112, 212	820 ohm, .25W, 10%	3301	
R114, 214	82 ohm, .25W, 10%	3300	
R115, 116, 215, 216	6.8K ohm, .5W, 10%	1639	
R117, 126, 217, 226	15K ohm, .5W, 5%	3133	
R118, 124, 218, 224	13K ohm, .5W, 5%	3305	
R119, 125, 219, 225	180 ohm, .25W, 10%	2873	
R120, 127, 220, 227	5.6 ohm, .5W, 5%	3299	
R121, 122, 221, 222	120 ohm, .5W, 5%	3837	
R123, 223	47 ohm, .25W, 10%	1011	
R132, 232	18K ohm, .25W, 10%	2633	
	3.3K ohm, .25W, 10%	2629	* Load resistor for uA749
	10K ohm, .25W, 10%	2631	* Load resistor for uA739

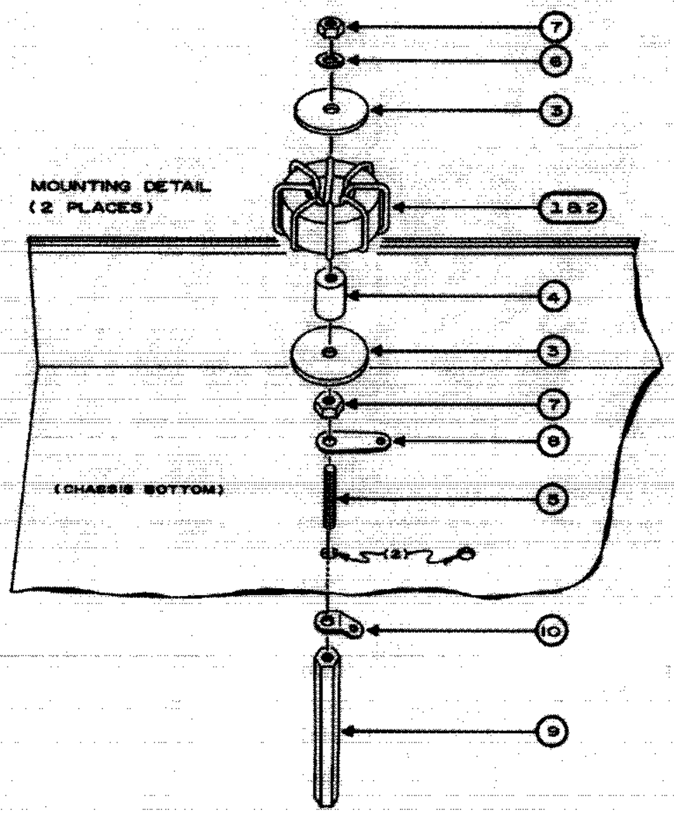
Schematic Designation	Description	Crown Part No.	Other Information
	Transistors:		
Q1, 3	1N961B, zener	3549	Early units (transistor, 2961)
Q101, 202	2N5383, selected	2982	
Q104, 204	NPSL01	3232	
Q105, 205	2N3859A, selected	2961	
Q106, 206	2N1304	2721	
Q107, 207	2N1305	2817	
Q108, 208	40327 61061, selected	3348	
Q109, 209	2N4929 SS7304, selected	2923	
	Miscellaneous:		
	TO-5 mounting pad	1250	Used on Q106-109, 206-209
	TO-5 cooler	3175	Used on Q108-109, 208-209
	Transistor lead, PC receptacle	3519	Mounts R111, 211
	IC socket, DIL, 14-pin	3450	

*IC load resistors both mounted on foil side of PC board; one from pin 1 to 7, one from pin 7 to 13 of IC.

NOTES:

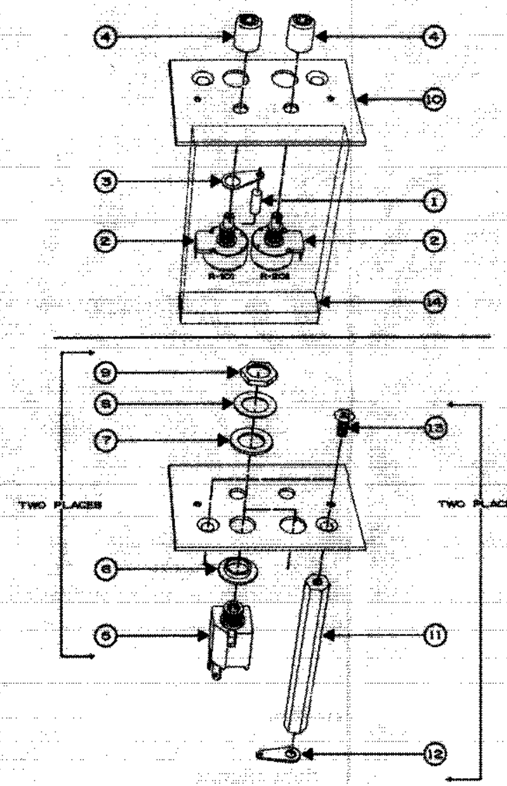
- Schematic designations preceded by 1 are left channel; by 2, right channel.
- Values shown for left channel only.
- *Early units used a zener-connected transistor (CPN 2961) for Q1 and Q3.

FIGURE 6-3.
COMPONENT LOCATION, D-150 MAIN PC BOARD, 7891U



Schematic Designation	Description	Crown Part No.	Draw No.	Other Information
L102, 202	**OUTPUT INDUCTOR ASSEMBLY**	40959		
	Output coil toroid core	3555	1	
	Wire, brown, #18, 16"	3585	2	
	Washer, nylon	3609	3	One each side of coil
	Spacer, inductor	3310	4	Mounts inside coil
	Screw, 8-32 x 1¾, stud	3324	5	To mount coil
	Washer, star, #8 internal	1951	6	To mount coil
	Nut, hex, 8-32, CAD	1986	7	One each side of coil
	Lug, solder, 806, #10 hole	3312	8	Mounts under coil in place of star washer
	Cover, spacer	3311	9	Used on other side of chassis to mount coil
	Lug, solder, #8 hole	2935	10	Mounts under cover spacer

FIGURE 6-5.
OUTPUT INDUCTOR ASSEMBLY, EXPLODED VIEW



Schematic Designation	Description	Crown Part No.	Draw. No.	Other Information
	CONTROL PLATE ASSEMBLY	40951		
	Resistor:			
R33	2.7 ohm, .5W, 5%	2857	1	
R101, 201	25K ohm, potentiometer	3307	2	Input level controls
	Lug, solder, ¼" hole	3380	3	Mounts under one pot
	Nut, control, ¼", CHR	3040	4	Used to mount pots
INPUT	Jack, Hi-D Jax, 112A, 2-cond	3423	5	
	Washer, shoulder, fiber, ⅜"	1306	6	Mounts jacks
	Washer, fiber	1646	7	Mounts jacks
	Washer, control, bright, NIC	2189	8	Mounts jacks
	Nut, control, bright, ⅜", NIC	1288	9	Mounts jacks
	Control Plate, D-150	3674	10	
	Cover spacer	3311	11	Used to mount plate
	Solder lug, # 8 hole	2935	12	Mount between spacer and chassis. Spacers mount to stud screw from output inductors on chassis bottom.
	Screw, 8-32 x ¼ FHP, CHR	2136	13	Fastens control plate
	Tape, foam, ½"	2859	14	On control plate

FIGURE 6-4.
CONTROL PLATE ASSEMBLY, EXPLODED VIEW

SECTION 7
APPLICATION NOTES

GENERAL

Application notes will be published periodically and distributed to owners of CROWN equipment for insertion in the service manual.

Information will be distributed concerning component changes, new accessories, special applications, modifications to equipment and any other technical data CROWN considers significant to help you use and maintain your equipment in optimum operating condition.

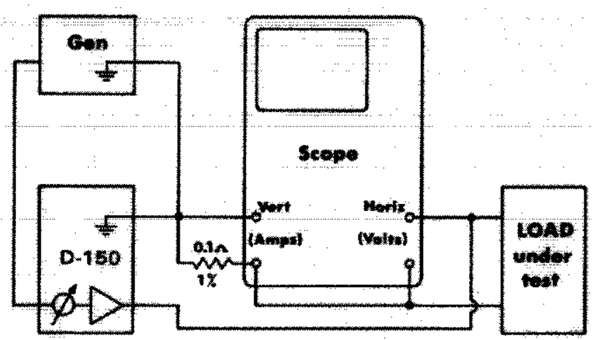
V-I NEEDS OF A LOAD

Evaluating the V-I (volt-ampere) needs of a load: Many loads exhibit large reactances (or energy storage), which limits a power amplifier's ability to deliver a maximum power. If a load stores energy, which in turn flows back into the amplifier, it is clear that the maximum power efficiency of the system is not being achieved. Power that flows back into a linear amplifier must necessarily be dissipated in the form of heat. A pure reactance is not capable of dissipating any power; therefore to drive such a load would only cause power amplifier heating.

In practice all loads exhibit some energy dissipation — however large their energy storage characteristics may be. The ideal coupling to any load is one that optimizes the desired dissipation component while minimizing the reactive or stored-energy component that is seen by the amplifier's output terminals.

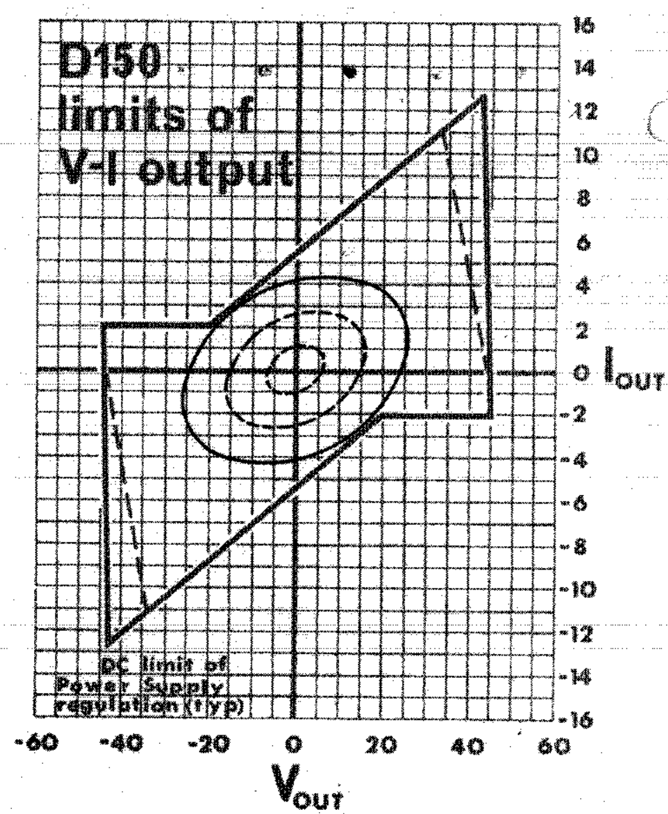
In applications where the input is sinusoidal and of small proportional frequency deviation, a relatively stable load may be resonantly tuned to present a real value of impedance to the amplifier.

Any load, no matter how complex its behavior, has a V-I operating range which may be mapped by the following test.



The maximum voltage and amperage excursions in all directions about zero (center of scope screen) define the volt-ampere operating range of the load. If a load is known to be linear over its operating range it is not necessary to supply the maximum desired power to the load. The test may be conducted at low signal levels and the current-sensing resistor (indicated as 0.1Ω) may be enlarged to a convenient value for the oscilloscope's deflection sensitivity. The resulting plot may be then linearly scaled to the desired operating level.

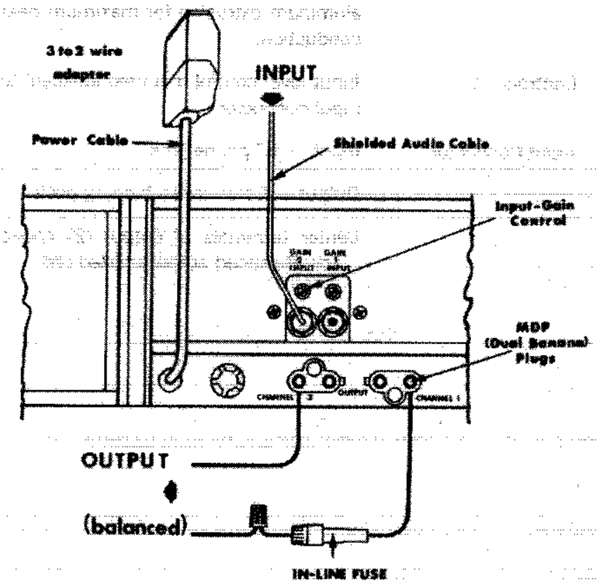
In the following example a reactive load is being fed a sinusoid of varying intensity. The V-I limits of the amplifier are super-imposed in dotted lines. It can be seen that the amplifier needs to be in the hysteresis position to drive this load with this sinusoidal input.



D-150 MONO CONVERSION

A. Wire Changes

1. Remove the two screws (adjacent to the inputs and gains) from the board-cover. Lift cover straight up.
2. Ground No. 1 input (chan. 1) by soldering a ¾" bare wire (as shown in Figure 1) between points A and B.
3. Connect a 10K, 1%, ½w resistor — with sleeving on both leads — between points C and D, using pre-drilled holes.



B. Operation

1. Make output cable as shown in Figure 2.
2. Connect one lead to "HOT" (red) amplifier output-post of channel 1, the other lead to "HOT" of channel 2.

   CAUTION: DO NOT CONNECT EITHER "HOT" OUTPUT TO GROUND (EITHER BLACK POST).
3. Connect an 8 ohm (or higher) load to the output cable. A fuse is recommended!
4. Connect input signal, using std. ¼ phone plug, to channel 2 input-jack. The "channel 2" gain (input level control) may be adjusted for desired output-level.
5. The 3-wire AC powercord meets U/L requirements, but many installations will require a 3-to-2 wire adapter to avoid "ground-loops" — circulating currents caused by more than one ground-path.

C. Specifications

F-Resp.	±.15db 20 Hz-20 KHz 1W 8 Ohm ±1db 4 Hz-60 KHz 1W 8 Ohm
Power Resp.	±1db 5 Hz-15 KHz 250W 8 Ohm
Power at Clip Pt.	Typically 320W into 8 ohm 1 KHz
Total Output (IHF)	Music Power 400W 8 Ohm 210W 16 Ohm
IM Distortion	Less than .1% from 10mW to full output. Typically .01% at 250W
Damping Factor	Greater than 140 Zero - 1KHz 8 Ohm
Hum and Noise (20Hz-20KHz)	110 db below 250W (typically 117db)
Slewing Rate	12 Volts/Microsecond
Load Impedance	8 Ohm or higher (complete stability with any load)
Output Signal	Balanced
Input Sensitivity	1.1V for 250W into 8 Ohm
Input Impedance	25K Nominal
Voltage Gain	32.3db ±.2db
Protection	Short, mismatch, and open circuit proof. V-I limiting is instantaneous with no annoying thumps, cutout, etc. Thermal switch in AC line protects against overheating caused by insufficient ventilation. Controlled slewing rate voltage amplifiers protect overall amplifier against RF burnouts.
Power Supply	Two massive capacitors with energy storage exceeding 20 joules. Total of two regulated supplies for complete isolation and stability. No fuses except for AC power line.

Power Requirements	Requires 50-400 Hz AC connectable for 120V or 240 VAC ±10%. Draws 30 watts or less on idle. Draws 500 watts or less at 250W out into 8 Ohm.
Heat Sinking	Entire chassis is used as heat sink. Chassis is a rugged heavy gauge aluminum extrusion for maximum heat conduction.
Controls	Input level control mounted adjacent to input connector.
Input Connector	Input — ¼" phone jack
	Output — Color coded binding posts
	Center terminals of output (2) coded black. Balanced outputs coded red.
	AC Line — Three-wire (grounded) male connector on 5 ft. minimum cable.
Dimensions	16½" long, 5" wide, and 8" high (without panel), 17" long, 5¼" high, 8¾" deep with front panel (optional). 19" standard rack mounting hardware included with front panel.
Weight	22 lb. net wt., 24 lb. with front panel
Finish	Black anodized chassis. Front panel (optional) is bright anodized brushed aluminum with black leatherette lower panel.

PA ADAPTER PANEL INSTALLATION

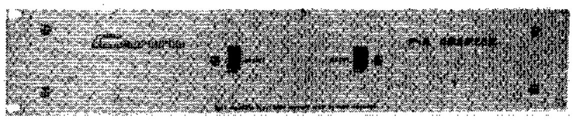


FIGURE 1.
FRONT VIEW OF P-A ADAPTER PANEL

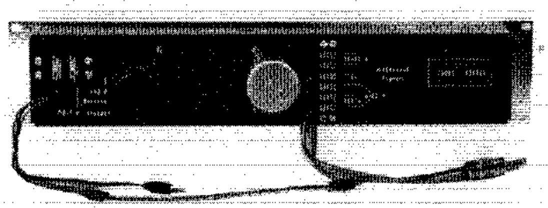


FIGURE 2.
REAR VIEW OF P-A ADAPTER PANEL

The PA adapter panel is used to connect the amplifier to obtain a monaural 50-volt balanced output line (see schematic, Figure 4). This is achieved by a precision push-pull transformer (inverted signal to Channel 1). This results in over 150 watts of 50-volt balanced output from the two output terminals in 16 ohms, over 250 watts when terminated in 8 ohms.

The adapter panel provides balanced inputs of 150 ohms, 600 ohms CT, and 5000 ohms bridging. Sensitivity is -5dbm, 600 ohms.

Two switches are provided on the front panel for insertion of hi-cut and lo-cut filters. The characteristics of these filters may be altered by changing internal capacitors in accordance with Figure 3.

The P-A adapter comes wired for an amplifier input impedance of 10K. Therefore it will be necessary to parallel the 18K resistors (furnished with the adapters) across the amplifier inputs as described on a note with the resistors.

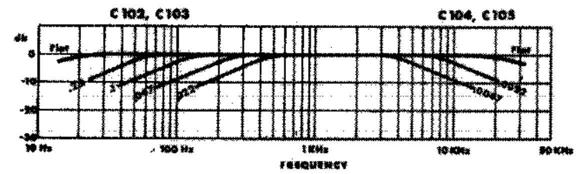


FIGURE 3.
P-A ADAPTER FILTER RESPONSE

The output circuit contains a roll-off capacitor (C 101) which should be used if matching transformers are used on the output line. This will prevent large low-frequency currents from flowing into their primaries.

If matching transformers are not used, and the low-frequency impedance (DC resistance) of the load is 6 ohms or greater, the system may be directly coupled to the amp output terminals, bypassing C 101. Otherwise, use the output terminals on back of the adapter panel.

To ensure maximum output (without premature clipping) both amplifier level controls must be full CW.

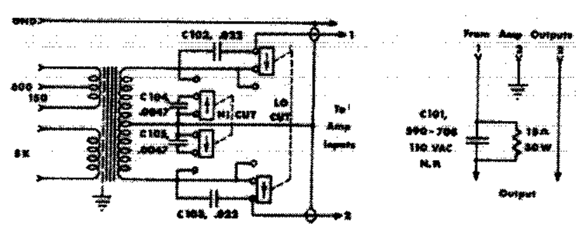


FIGURE 4.
P-A ADAPTER SCHEMATIC