

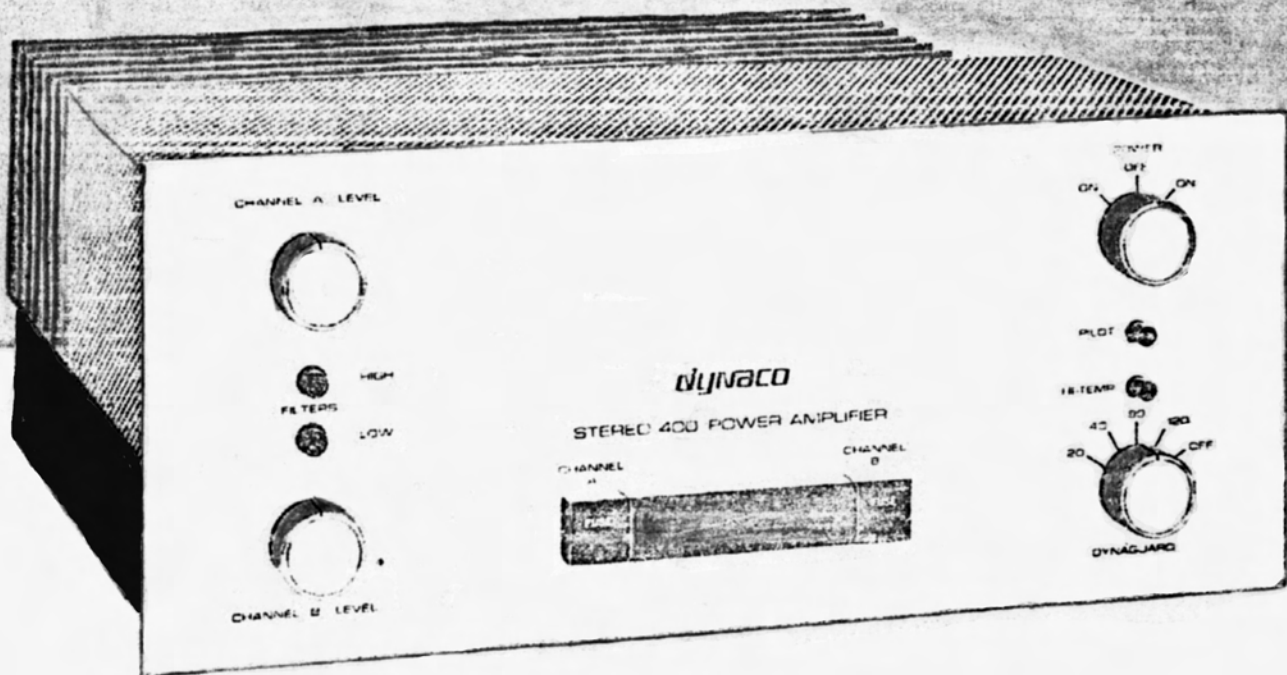
SERIAL NUMBER

# *dynaco*

## STEREO 400

This number must be mentioned in all communications concerning this equipment.

### INSTRUCTIONS FOR ASSEMBLY OPERATION



patents pending

929028-4

***dynaco inc.***

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## SPECIFICATIONS

**Power Output Ratings:** Less than 0.25% total harmonic distortion at any power level up to 200 watts continuous average power per channel into 8 ohms (100 watts per channel into 16 ohms) at any frequency between 20 Hz and 20 kHz with both channels driven. Distortion reduces at lower power levels.

**Available Power Output:** (see above for F.T.C. Power Ratings)

20 Hz to 20 kHz, both channels driven:

200 watts continuous average per channel @ 8 ohms.

300 watts continuous average per channel @ 4 ohms.\*

100 watts continuous average per channel @ 16 ohms.

Monophonically:

600 watts continuous average @ 8 ohms.\*

\* 5 minute sustained full power limit without a fan

**Intermodulation Distortion:** Less than 0.1% at any power level up to 200 watts rms per channel into 8 ohms with any combination of test frequencies. Distortion reduces at lower power levels.

**Power at Clipping, Single Channel, 2500 Hz, less than 1% distortion:**

235 watts @ 8 ohms.

350 watts @ 4 ohms.

135 watts @ 16 ohms.

**Half-Power Bandwidth:** 100 watts per channel at less than 0.25% total harmonic distortion from 5 Hz to 35 kHz into 8 ohms.

**Frequency Response:** +0, -1 dB, 8 Hz—50 kHz @ 1 watt into 8 ohms.  
±0.5 dB, 20 Hz—20 kHz @ 200 watts.

**Hum and Noise:** Greater than 95 dB below rated output, full spectrum.  
Greater than 100 dB below rated output, 20 Hz—20 kHz.

**Input:** 50,000 ohm load; 1.6 volts for 200 watts @ 8 ohms.

**Slewing Rate:** 8 volts per microsecond.

**Damping Factor:** Greater than 80 to 1 kHz into 8 ohms.  
Greater than 30 to 10 kHz into 8 ohms.

**Channel Separation:** Greater than 60 dB by IHF standards.

**Connectors:** Inputs: phono jacks. Outputs: color coded 3-way binding posts with standard 3/4" spacing.

**Dimensions:** 17" wide; 14" deep; 7" high.

**Weight:** Shipping weight 58 lbs. Net weight 52 lbs.

**Power Consumption:** 120 v.a. quiescent; 11 amps maximum; 50/60 Hz, 120 vAC.

IT IS ESSENTIAL THAT YOU READ AND UNDERSTAND THE OPERATING INSTRUCTIONS BEFORE YOU CONNECT YOUR STEREO 400. ANY AMPLIFIER WITH THE POWER OUTPUT CAPABILITY OF THE STEREO 400 IS ABLE TO DAMAGE ALMOST ANY LOUDSPEAKER IF IT IS IMPROPERLY USED.

Dynaco is not responsible for damage to the load (loudspeaker) as a result of excessive or improper input signals and resulting high power output.

## INTRODUCTION

The Dynaco Stereo 400 is a basic power amplifier employing all silicon solid state devices. They include 44 transistors, 51 diodes, 2 silicon controlled rectifiers, and 4 integrated circuits. The series-connected output circuitry is of full complementary symmetry design. The entire main amplifier is direct coupled. Its measured distortion levels approach the threshold of the most exacting laboratory test equipment, not only at the commonly specified full power ratings, but more importantly at very low power outputs as well. This is the result of circuit techniques which eliminate any discernible crossover notch at low levels, and it contributes in large measure to the Stereo 400's freedom from listening fatigue. Its lucid, utterly uncolored neutrality reveals delicate nuances and musical shadings in the best program material—one result of achieving unconditional stability with varying loudspeaker loads.

Implicit in the design of a superb high power amplifier is the responsibility to include superior techniques of protection for both the amplifier and the speaker load, if long-term trouble free operation is to be achieved. To this end, Dynaco has included more separate protective systems and features than have ever been employed in such a product.

These include an AC line circuit breaker (rather than a fuse); four separate power supply fuses; electronic volt-

amp limiting to ensure safe operation of the output transistors; independent high temperature cutouts on each channel, which are mounted directly on the output transistors to assure maximum sensitivity; over 1000 square inches of radiating area for the mammoth heat sink; provision for accessory fan cooling with optimum efficiency; delayed turn-on to eliminate loudspeaker thumping; relay protection against DC signals at the output; load (speaker) protection fuses accessible on the front panel; input level controls to reduce sensitivity; input filters to control the bandwidth; and the exclusive DYNAGUARD™ adjustable dynamic power limiting circuit to protect the speaker load.

The Stereo 400 was engineered to accommodate a wide range of specialized needs in studio, laboratory and industrial applications, as well as in the home. It has been designed as two independent 200 watt (at 8 ohms) amplifying channels with a common power supply having a high degree of inherent regulation. For special requirements, a technician can easily convert it to a monophonic 600 watt (at 8 ohms) output.

Accessory provisions for mounting on a standard 19 inch rack, an alternative front panel which includes two output meters, a cooling fan, and an alternative power transformer for international AC line voltages are available at additional cost.

## OPERATING INSTRUCTIONS

### INSTALLATION

The Stereo 400 should be located where the front panel power switch is convenient, since control preamplifiers do not normally include the requisite heavy-duty switching. If the amplifier is to be mounted near a phono cartridge, you should check to be sure the cartridge does not pick up hum from the power transformer. Convenient as it may appear the amplifier heat sink is *NOT A RECORD RACK*. Nothing should be placed on top of the unit. In addition to the finned heat sink, it is normal for the perforated cover to get rather warm behind the level controls.

**VENTILATION** is an important consideration with any amplifier of this size. Although solid state units do not generate the high heat expected from tube designs at normal output levels, they can be limited by excessive heat buildup. Further, solid state designs generate their maximum heat output at less than half power. Thus **ADEQUATE AIR CIRCULATION IS ESSENTIAL**. The Stereo 400 puts out the heat of a 100 watt lamp under quiescent (idle) conditions, and several hundred watts of heat at high power levels. The massive heat sink

has more than enough cooling capacity for any music and speech signals—even at very high powers—if fresh air flow under and around the unit is unrestricted. Otherwise, space is provided for a fan to be mounted at the end of the heat sink.

The Stereo 400 was intended to be installed horizontally, with the feet providing clearance for air flow under the unit. Do not allow the ventilation slots in the bottom to be restricted. If the amplifier is to be mounted vertically (face up) **DO NOT TRY TO SUPPORT THE UNIT BY THE FRONT PANEL**. Vertical mounting is permissible so long as a fan is provided for air circulation.

If you wish to mount the amplifier through a cabinet panel, a cutout 6½" by 16⅝" is suggested. Remove the feet for front mounting access. A supporting shelf flush with the bottom of the cutout should include an opening for the chassis vents.

The panel height of 7" fits a 19" rack mounting standard, and accessory brackets providing for such installations are available from Dynaco at additional cost.

## CONNECTIONS

### AC Power

The power cord should be plugged into a 3-wire grounded *wall outlet* providing 120 volts, 50/60 Hz on a 15 amp (minimum) circuit. If a matching outlet is not available, an adapter with separate ground wire may be obtained locally. Be sure to secure its green ground wire to the center screw of the *wall outlet* plate. In most instances this ground wire should *not* be attached to the preamplifier chassis. If a longer power cord is needed, use a 3-wire cable of the type specified for air conditioners.

Do *not* attempt to switch the amplifier remotely by plugging it into a switched outlet on a control preamplifier unless the outlet is designated as a 12 amp (1400 watts) or higher capacity. *Most preamps are not normally designed to handle the high current switching.* Dynaco's PAT-5 is an exception.

### Input

Signal input connections are via shielded cables to conventional phono jacks on the rear panel, under the heat sink. Channel A is designated the left channel; B the right. The amplifier's nominal input load impedance is 50,000 ohms. The input sensitivity is 1.6 volts for full output. The Stereo 400 may thus be easily driven by control preamplifiers such as the Dynaco PAS-3X, PAT-4 or PAT-5. Dynaco tube type preamplifiers made before 1966 require an internal modification, details of which will be supplied by Dynaco on request. Some other tube type preamplifiers may require modification for optimum performance into a 50 K ohms load.

It is desirable to keep the left and right input cables close together throughout their run to avoid extraneous hum.

### Output

Select output leads of sufficient size to preserve the outstanding performance capabilities of your amplifier. Standard 18 gauge lamp cord ("zipcord") is suitable for distances up to 30 feet with an 8 ohm load. A larger wire size is advised for longer distances—#16 for 50 feet; #14 for 80 feet. #18 and #16 lamp cord is available from hardware and electrical supply stores, and is the easiest to use and conceal. For a 4 ohm load, these maximum distances should be cut in half.

Connect the left speaker to Channel A output terminals. Be sure to maintain similar wiring "sense" for each speaker, so that they will be connected *in phase*. Normally the (-), common, or ground terminal of each speaker is connected to the black amplifier terminal. Proper phase sense is easily maintained with lamp cord because one conductor is coded with a molded ridge on the outer insulation, or different color conductors are used.

Two speakers are connected in phase when maximum low frequency output is heard when they are driven from a monophonic source. Lowered output is observed when the connection to one of the speakers is reversed (out of phase, or reversed polarity). When using multiple speakers on each channel, or when 4 channel systems are used, it is important that all of the speakers in the same area be wired in phase.

The amplifier terminals are 3-way binding posts which

will accept single or double "banana plugs", spade lugs, or simply stranded wire. If stranded lamp cord is used, the wire ends should be "tinned" with solder first to avoid fraying. To connect the wire, unscrew the terminal cap until the vertical hole through the metal shaft is uncovered from below, push the wire end through the hole, and tighten the cap.

Make certain that no wire strands can touch other than the intended terminal. Double banana plugs (from radio supply houses) are the most convenient connectors, and are simply inserted into the ends of the terminals. They are particularly useful if a second set of speakers is to be connected in parallel, as they plug into one another.

The 200 watts per channel rating of the Stereo 400 is based on a load impedance of 8 ohms. Loudspeakers with impedances of 4 to 16 ohms may be utilized. Power output increases with decreasing impedance, producing 300 watts per channel at 4 ohms. If the load impedance falls below 4 ohms, the protective circuitry of the amplifier may limit the output.

The black "common" output terminals are electrically connected internally. They are also connected to the chassis, so the Stereo 400 may be used with special output connections which require common grounds. You must be *certain* that the polarity of such output connections is never reversed, however, so that the red "hot" terminals can never be connected together in other equipment.

## CONTROLS

The power switch lights the pilot lamp when turned to either "on" position. The choice enables you to reverse the polarity of the line cord in case a hum loop is evident.

In most instances the input level controls will both be turned fully clockwise for maximum sensitivity. You may wish to reduce the setting of these controls to prevent excessive signals from overdriving the speakers if the preamplifier volume should be turned fully up. However, such operation may result in somewhat higher noise level from the preamplifier.

Input filters are provided for 50 Hz and 15 kHz (-3 dB points) low and high frequency rolloff. These are engaged when the button is "in".

Dynaguard is a switchable dynamic power limiter circuit for speaker protection. The numbers indicate the average power output per channel into 8 ohms at which the circuit will function to limit the output. When that threshold is reached, an overload lamp is lighted behind the dark plastic window, adjacent to that channel's output fuse. The circuit then begins to limit the output to protect the speaker. For most speakers, the lowest switch position (20) is recommended.

The lighting of the Hi-Temp lamp indicates that a thermal sensor has shut off the amplifier. Normal operation will resume automatically when the output transistors cool below the limit threshold. Continued operation at the same signal levels may again actuate the protective cutout.

The Stereo 400 provides speaker protection fuses on the front panel. The amplifier is supplied with 5 ampere 3AG types. This size is necessary for final testing, and provides NO PROTECTION for any speaker. A pair of 1 ampere, regular fast acting types are separately provided for speaker protection. You should install them now.

Use a higher value only if it is recommended by the manufacturer of your speakers. Some speakers even specify a smaller amperage for safety. Be sure to obtain spares of the proper value, and keep them handy.

Press down and inwards on the lower section of the fuse plate to release it. Reinstall it by pressing inwards and slightly *up* on the *top* half of the plate. Be sure it is fully seated.

## OPERATION

When you turn on the amplifier there is a delay before the relay connects the speakers. This eliminates annoying (and potentially harmful) high power onset thumps through the speakers. The relay also provides clean shut-off, without decaying transients.

*You should turn the power amplifier on last, and off first.* No damage will ensue if you do not, but otherwise DC level changes in other related equipment may cause the relay to click annoyingly.

For maximum speaker protection, the 20 watt (at 8 ohms) position of the Dynaguard selector is recommended. This will not have any effect on normal listening, and short duration peaks of much higher levels may pass without any restriction. Only if the composite signal sustains an average level greater than the switch setting for a finite time period will the overload lamp glow, and the limiting action take effect. Read the following explanation of Dynaguard, and know your speaker's power capabilities before switching to any higher threshold level. In the "off" position, no Dynaguard protection is afforded.

The input filters will find greater use in public address and musical instrument applications than in home music systems. Since they are intended to function only at the frequency extremes, the effect of these filters will not be obvious. The high filter may help to eliminate certain interference effects with the smallest limitation on absolute quality. Under exceedingly high drive conditions, the use of these filters may afford greater amplifier power reserve and added speaker protection by reducing potential overloading signals above and below the audio range.

The Stereo 400 includes circuits to protect against the hazards of shorted and open circuited outputs, and abnormal load demands, even at full power. Good operating practice will avoid the need to test their effectiveness, however, for there is no such thing as absolute protection from abuse.

The combination of enormous power potential and the relative fragility of most high quality sound reproducers makes it imperative that you take care to avoid such common faults as dropping a stylus (tone arm) onto the record; allowing the arm to skid across the record; or flicking the stylus clean with your finger while the volume is up. These are typical errors which generate heavy low frequency pulses capable of severely overdriving the speaker at subsonic frequencies before any protective system can engage.

### Dynaguard

This new approach to speaker protection is not nearly so restrictive as a limiter, and does not suffer the reduction in dynamic range or the "breathing" characteristics of compressor circuits. And, it signals its protective operation. The assumption is made that any speakers used

with such an amplifier can accommodate frequent peaks well above their nominal power ratings for short intervals. The threshold power (per channel) for an 8 ohm load is marked on the panel. A 16 ohm load cuts each marked power level in *half*. A 4 ohm load *doubles* each figure.

Dynaguard has absolutely no effect on distortion, frequency response or output level until its triggering threshold is reached. Then it functions as a dynamic power limiter. It senses the integrated power output separately on each channel. When that reaches the selected level, lighting the overload lamp, the limiting action commences. At lower levels a graduated power/time relationship regulates the duration of the permissible overdrive as a function of the wave form and degree of overdrive. Thus it passes very short peaks up to amplifier clipping, and longer duration peaks of intermediate powers, so long as the average power level is substantially below the set threshold. The overdrive headroom is curtailed as the integrated power output rises.

For typical music signals and high accuracy loudspeakers only the 20 and 40 positions offer significant protection. The 80 and 120 settings are of value chiefly in industrial or laboratory applications. The dynamic range of any quality musical program material is such that peaks 10 dB above average levels are common. A peak 8 dB above 40 watts will exceed the amplifier's maximum power. Such peaks will thus be limited before the overload lamp glows in the 40 position. Any overload lamp indication at 80 or 120 on musical signals demonstrates the need for a *much* larger amplifier, such as a Stereo 400 wired for monophonic 600 watt output, and additional speakers.

The overload lamp may flicker just below the threshold at which protective signal limiting commences. A second or so after the lamp glows steadily with severe overdrive, you will hear increased distortion and a drop in level as full limiting takes effect. This loss of level is simply a function of the truncated waveform, not of any circuit gain change. There is no difference in nominal gain in the different Dynaguard settings.

The circuit does not latch, but it may give that appearance because limiting is continued until the integrated signal level drops below the threshold and the lamp extinguishes. There is zero breathing effect, and the maximum envelope delay is less than 5 seconds for the entire cycle.

It is normal for the Dynaguard lamps to light briefly when the amplifier is turned on.

### Relay Operation

The primary purpose of the relay is to disconnect the load if potentially destructive signals or equipment malfunction imposes direct current on the output. The relay control circuits are triggered independently from each channel, but both are shut down concurrently. They are designed to trip even with equivalent out-of-phase offset signals in each channel, and sense both positive and negative deviations.

The relay control circuit parameters are factory set to provide substantial protection, based on the premise of good quality signal inputs. The DC threshold is nominally 1.5 volts. Since subsonic signals appear similar to DC at high power levels, the relay may trip as a result of signals you previously did not know existed. Likewise, severe overload at the output will appear similar to DC, and thus may actuate the relay.



You may wish to increase the sensitivity of the relay circuit, particularly if you use speakers which may be easily damaged by excessive signals. Earlier production Stereo 400s were set for ½ volt DC threshold, but customer preference caused us to change. See the section "Momentary Sound Interruption" on page 27 for details.

Attention paid to input signal quality will avoid a major cause of speaker failure with high power amplifiers. Some of these signals are not audible. Warped records, acoustic feedback, excessive rumble, FM muting effects, switching transients, and even the operation of some controls can all present signals for which the relay is designed to trip, to protect the speaker. Thus relay operation under such conditions is not a malfunction, but instead indicates that other measures may be able to reduce the problem at the source. Even the best of FM muting circuits may trip the relay at certain dial traversing speeds. Often moving a control or selector switch more deliberately will avoid the effect.

### Loudspeaker Rating Considerations

Nominal speaker power ratings are a matter of concern. There is currently no U.S. standard. Manufacturers usually provide a "music power" rating, or indicate amplifier power limits. These should not be confused with continuous, or "rms" power acceptance for a sustained period, which will be substantially lower. It is rare for a speaker to be able to handle as much power near the frequency extremes as in the midrange. Single woofer high fidelity speaker systems rarely have "music" ratings as high as 100 watts, or continuous duty wide band sine wave ratings as high as 40 watts.

In view of the power limitations of most high accuracy speaker systems, the connection of two or four similar speakers in the same location to a single channel is often advisable with high power amplifiers. Lacking more definitive advice, a rough test is to place your hand in front of the woofer when playing a loud passage at your anticipated listening level. If you can feel any heat generated by the voice coil, you should consider the need for additional speakers to reproduce that level safely. When high output, high accuracy reproduction is desired, a series-parallel connection of four 8 ohm speakers (such as the Dynaco A-35) on each channel provides a resultant 8 ohm load with exceptional power handling capacity.

Speaker impedance varies with frequency—often by a factor of 4 or 5 to 1. Even the least variable speakers, like Dynaco's, have a 2:1 change. While most nominal ratings are close to the actual minimum impedance, when combinations approach the 4 ohm minimum recommended amplifier load, the safest procedure is to measure the resistance across the terminals with an ohmmeter. Speaker impedance usually varies upwards from this value. Use this figure to determine whether multiple speakers (on each channel) should be connected in parallel:

$$2 \times 8 \text{ ohms} = 4 \text{ ohms}$$

$$2 \times 16 \text{ ohms} = 8 \text{ ohms}$$

$$4 \times 16 \text{ ohms} = 4 \text{ ohms}$$

or in series:  $2 \times 4 \text{ ohms} = 8 \text{ ohms}$

$$2 \times 8 \text{ ohms} = 16 \text{ ohms}$$

$$4 \times 4 \text{ ohms} = 16 \text{ ohms}$$

These simple examples assume identical models. It is not wise to connect dissimilar speakers in series because of adverse audio effects.

### Output Fuse Protection

Why are both Dynaguard and speaker fuses provided? We realize that some users will switch off Dynaguard despite our advice. And most users tend to use too large a fuse so as to avoid the annoyance of a blown fuse when you lack a spare. A fuse provides a slow-acting, but nonetheless final measure of protection with different characteristics than Dynaguard. You can choose its value to have either or both protective systems, or virtually none at all if Dynaguard is switched off.

Since the power passed by a fuse varies with load impedance, and test signals have little correlation to music signals, and fuses vary in their tolerance of music overloads, the protective rating determination for a speaker is largely empirical. Logic would suggest the smallest value fuse which does not blow frequently at what are high, but nonetheless safe levels for your speaker. There are few speakers capable of safely handling more power than will blow a 2 ampere fuse.

The speaker manufacturer who specifies a fuse rating solves your problem. Lacking this, remember that a fuse will not blow until a *sustained* signal *well above* its rating is imposed for a time. A slo-blow fuse will allow appreciably more overdrive than the same value standard fast-blow type, and is thus not generally recommended for speaker protection. There are also very fast-acting types usually used for instrument protection, but these are not as readily available.

The lowest Dynaguard setting is the practical limit for assured operation of the protection circuit, yet some speakers need protection sooner—as little as ½ ampere, or 4 watts for a 16 ohm speaker, if the fuse blows at its rating. Tests have shown that musical signals which frequently cause the overload lamp to glow brightly in the minimum Dynaguard 20 position with an 8 ohm speaker will occasionally blow a 1 ampere regular fuse (nominally 8 watts). A 1 ampere slo-blow type did not blow. Peaks up to the full power of the amplifier were sometimes passed during these tests.

The chart below shows the highest *sustained* power level which will *not* blow the fuses shown. Remember that speaker impedance typically rises well above its nominal value. Experience suggests that on this basis power levels of 10 watts are safe starting points for most high fidelity speakers using a single woofer.

		SPEAKER IMPEDANCE		
		4 ohms	8 ohms	16 ohms
FUSE SIZE	½ ampere	1 watt	2 watts	4 watts
	¾ ampere	2.2 watts	4.5 watts	9 watts
	1 ampere	4 watts	8 watts	16 watts
	1½ ampere	9 watts	18 watts	36 watts
	2 ampere	16 watts	32 watts	64 watts

### Monophonic Operation

A single channel of the Stereo 400 may be operated at any time, provided there is no input signal to the unused channel. There is no need for any load resistor on the unused channel, as the design is completely stable.

*Never* connect the red output terminals together (in parallel) in an attempt to obtain higher power output.

Owing to speaker impedance variations, there is little benefit of useful power increase when paralleled, and there is a probability of damage to the amplifier. A simple solution for high power monophonic requirements with multiple speakers is just to split the speakers between the two channels, and drive both with the same input signal.

For very high power requirements, the Stereo 400 can be internally reconnected by a technician for 600 watts mono output at 8 ohms. This combines the two channels differentially, providing a floating (ungrounded) output between the two red output terminals. This monophonic output has sufficient voltage to drive a 70.7 volt line distribution system. Information on the internal changes will be supplied by Dynaco on request.

The Channel B level control and input are used for mono signals. The A input is disconnected internally. In such use, the Dynaguard power settings operate at 4 times the 8 ohm markings. Because of component tolerances, both Dynaguard overload lamps may not light simultaneously, but the circuit will function in accordance with the *right* (B output) lamp. The output fuses are connected in series. If one is of lower rating, its value

governs the acceptable power into the load. If both are rated the same, it is wise to replace both if one blows.

Because of the nature of the volt-amp limiting protection which is a part of this amplifier, monophonic power output at impedances below 8 ohms drops off rapidly. Loads should be chosen which vary upwards from 8 ohms.

### Fan Cooling

If ventilation is limited, as when the amplifier is mounted in a partially closed cabinet, the thermal sensors may turn off the amplifier. The space at the end of the heat sink is designed to hold a standard low noise circulating fan for optimum air flow. The quietest (low speed) fans are sufficient.

A mounting bracket for a Rotron Whisper™ fan with the standard square Venturi™ mounting, is available for \$3 postpaid from Dynaco. Please include the serial number of your amplifier. Similar fan designs are sometimes supplied with double-faced adhesive foam mounting blocks which may simply be placed on the chassis. A complete fan kit is also available from your Dynaco dealer.

## ASSEMBLY INSTRUCTIONS

Assembly of the Stereo 400 is relatively simple when compared to other kits. The preassembled etched circuit boards have saved you much of the work, and the assembly that remains is arranged in an open layout that makes wiring quick and easy. It is best to work slowly and carefully rather than worry about the time.

Construction will be greatly simplified if you have someone help you by reading the steps aloud, selecting the required parts, and preparing the necessary wire lengths as you proceed.

When you unpack your kit, check off the components against the parts list on page 40. Separate the hardware items in an egg carton or similar container. You can identify unfamiliar parts by checking them against the pictorial diagram, even though that drawing is necessarily somewhat distorted for visual separation.

Have the proper tools at hand before starting assembly. You will need a pencil-type soldering iron of 40- to 60-watt rating with a small tip, long nosed pliers, diagonal cutting pliers, a medium-sized screwdriver, and 60/40 rosin core solder not larger than 1/16" diameter. You will also find a damp sponge or cloth helpful to wipe the tip of the iron clean periodically. An inexpensive wire stripping tool is helpful, but some people prefer a single-edged razor blade for removing the insulation.

A good solder connection does not require a large amount of solder around the joint. A well-made connection looks smooth and shiny because the solder *flows into the joint* when both parts are hot enough.

There are four steps to making a good solder connection:

1. Make a good mechanical connection.
2. Heat *both* parts with the tip of the iron *at the junction*.
3. Apply solder to the *junction* until it melts and flows.
4. Allow the connection to cool undisturbed.

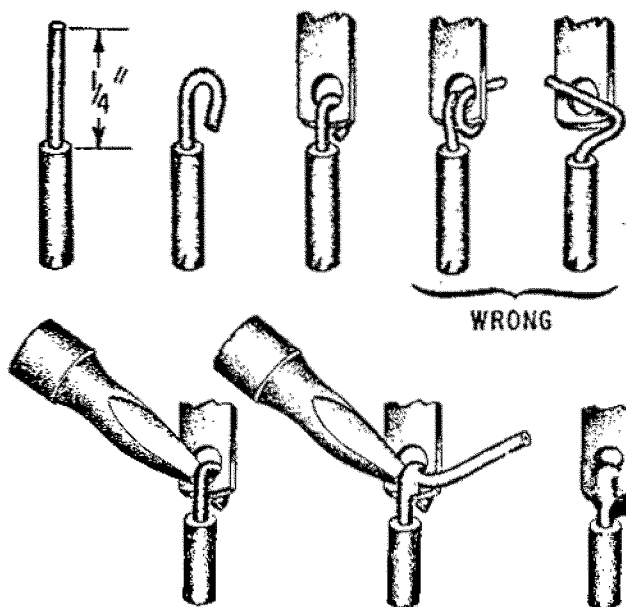
### ALL SOLDERING MUST BE DONE WITH A GOOD GRADE OF ROSIN CORE SOLDER.

Under no circumstances should acid core solder be used. Unmarked solder, cheap solder or any of doubtful origin should be discarded, and *separate solder fluxes should never be used*. The warranty is voided on any equipment in which acid core solder or acid type fluxes have been used. Silver solder is not suitable. The recommended solder is 60/40 (60% tin, 40% lead) *ROSIN CORE*. Do not confuse this with 40/60, which is harder to use.

If you have a soldering gun, it should be used with care, especially when working on the circuit boards. A soldering gun can provide more heat than is necessary, with some risk that an unskilled user might damage the board, and because it requires some time to heat each time the trigger is squeezed, many users tend to make poor solder connections simply because they do not wait long enough for it to reach its operating temperature each time.

You should realize that many of the more delicate components are less likely to be damaged in the soldering process if you use a hot iron for a short time, rather than a cooler iron for a longer period. You will also make a better connection with the hot iron. If you keep the iron clean by wiping the tip frequently, and occasionally add a small amount of solder to the tip, it will aid the transfer of heat to the connection. Do not allow too much solder to build up on the tip though, or it may fall onto adjacent circuitry.

One of the best ways to make a good mechanical connection is to bend a small hook in the end of the wire, and then to crimp the hook onto the terminal lug. The amount of bare wire exposed need not be exactly 1/4-inch, but if it is too long, the excess might touch another terminal lug or the chassis. Do not wrap the wire around the lug more than one time, as this makes the connection difficult to remove if an error is made.



When soldering a lead to an eyelet on one of the circuit boards, you may wish to apply the iron to one side of the board while the tinned wire end is pressed into the solder-filled eyelet from the opposite side. When the eyelet is heated, the wire enters easily, but be careful that you *do not push the wire all the way into the eyelet up to the insulation*. If you do, you will not be able to see if you have made a secure connection, or if more solder is needed to provide a smooth flow from the wire, to the eyelet, and onto the circuitry on the board.



### WIRING THE KIT

The position of all wire leads should follow the diagram closely, bearing in mind that the pictorial diagram has necessarily been distorted somewhat to show all connections clearly. See that uninsulated wires do not touch each other unless, of course, they are connected to the same point. It is especially important that uninsulated wires or component leads or terminals do not touch the chassis accidentally.

Whenever one wire is to be soldered to a connection such as a lug terminal or eyelet, the instructions will indicate this by the symbol (S). If more than one wire is to be soldered to the same point, the instructions will cite the number of wires that should be connected to that point when it is to be soldered. If no soldering instruction is specifically given, do not solder; other connections will be made to that point before soldering is called for.

When the instructions refer to "tinning" a wire, apply the iron to the bared wire end, and after a moment, touch the solder to the wire so that the solder lightly coats the wire. This makes it easier to get a good connection when the wire is inserted into an eyelet, for example.

Check your work after each step, and make sure the entire step has been completed. When you are satisfied that it has been correctly done, check the space provided and go on to the next step. Be sure you read carefully the explanatory paragraphs in the assembly instructions.

Many of the wiring steps will call for "preparing" a wire of a certain length and color. This involves cutting

the necessary length of wire and stripping  $\frac{1}{4}$  inch of insulation from each end. This is most easily done with wirestrippers, but diagonal cutters can be used if you are careful not to nick the wire and weaken it.

Transistor equipment, unlike much tube equipment, will not tolerate wiring errors, sloppy or incomplete soldering. **TAKE THE TIME TO BE NEAT AND ACCURATE**, and your amplifier will operate properly at first, and for many years to come.

All mounting screws are installed from the *outside* of the chassis, and a lockwasher is used under each nut, except when otherwise specified.

The three etched circuit boards, which include most of the electronic components for the Stereo 400, have each been in-circuit tested before being packed into the kit. These tests include every significant performance criterion—gain, power, distortion, frequency response, functioning of protective circuitry—as well as provide precise adjustment of necessary circuit parameters to assure that your amplifier will meet or exceed the specifications when these instructions are adhered to, and all connections have been properly completed.

As complex a kit as this necessarily includes many varieties of hardware. Before starting assembly you should separate those which are somewhat similar in appearance, using an egg carton, muffin pan, or similar compartmented tray. The #4 hardware is the smallest diameter. For your convenience, #6 lockwashers are used on both #4 and #6 screws. The quantity supplied (from the parts list at the back of this manual) will aid you in distinguishing unfamiliar types. When the instructions call for #6 *long* screws, use the  $\frac{1}{2}$ " length. The *short* ones are  $\frac{5}{16}$ " in length. There are only four  $\frac{3}{8}$ " #6 screws, which are used to mount the fuse blocks. Separate these now to avoid confusion. Sheet metal screws have a much more coarse (widely spaced) thread. A hardware set is one each screw, nut and lockwasher.

The pictorial diagram serves to clearly trace all connecting wires for verification of proper construction. It cannot at the same time show all wires in their exact location on the chassis. While placement of wiring is not critical in the Stereo 400, you should follow the written instructions for wire placement, rather than the diagram. Some wires may seem unduly long for final assembly, but this extra length provides for future service accessibility.

Where stranded wire is used, as on the transformer leads, be very careful not to cut through the strands when stripping the end. Where stranded wire is supplied for hookup wire in the kit, the strands will be bonded together to minimize this likelihood and make handling easier.

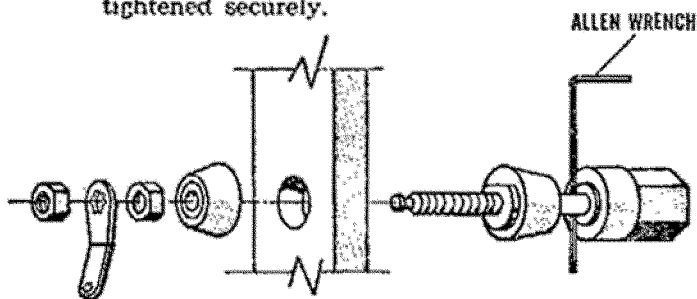
The connecting lugs on some components may not have holes to provide an easy mechanical connection. Crimping the wire in a tight "U" around the lug will hold it securely for soldering. In such cases, it may be helpful to strip the wire  $\frac{3}{8}$ ", rather than the standard  $\frac{1}{4}$ ". Soldering to these lugs will be easier, too, if you first "tin" the lug and the wire before making the mechanical connection. The integrity of every soldered connection is important. The mechanical crimping of the wire serves only to hold the wire stationary while solder is applied, to be sure of a good bond. You can drill holes in the lugs of the power switch and thermal sensors for easier connection if you wish.



## MECHANICAL ASSEMBLY

Place the large black heat sink assembly before you, turned upside down so that the three terminal strips are visible. The back of the heat sink has six large holes punched in the vertical rib; the front rib has only three large holes. Below this, you will also see six small threaded holes in the front fin.

- 1( ) Select the 3 rubber grommets and insert them in the large holes in the front rib from the outside.
- 2( ) Select the dual input socket strip, the matching insulator strip, 2 small flat washers, and two sets of #6 long hardware ( $\frac{1}{2}$ " screws, nuts and lockwashers). This input socket strip mounts *inside* the center of the back rib, with the sockets projecting into the holes. Insert the screws from the outside, install the insulator first, then a flat washer on each screw, followed by the socket strip, lockwashers and nuts. The  $\frac{1}{2}$ " screws will engage the nuts securely, but will not project through.
- 3( ) Select the 2 black binding posts (each is in two parts), 4 chrome plated #10 nuts and 2 large ground lugs. Install the black binding posts from the *outside* of the back rib in the inner holes nearest the input socket strip. Note the molded shoulder on each section which centers the post in the hole. Loosely secure the post with one nut. Unscrew the cap, and observe the connecting hole through the post. Keep this hole vertical while you tighten the nut securely. The Allen wrench, dropped through the hole, is a convenient alignment device. Install the ground lug, pointing outwards and down, and secure it with a second nut tightened securely.

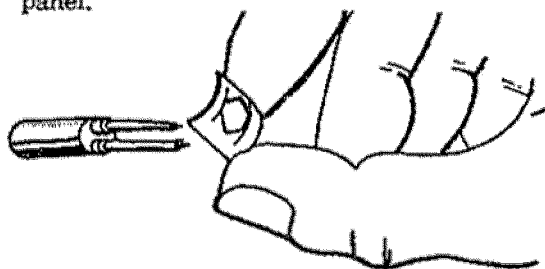


- 4( ) Select the 2 red binding posts, the 4 remaining chrome nuts, and 2 large ground lugs. Install them adjacent to the black posts in the outer holes in like manner, being sure to keep the connecting hole vertical as before, and tighten the nuts securely.

Set the heat sink aside and select the inner front panel. The edges are bent toward the inside. The two large square holes (for the optional meters) are at the top of the panel.

- 5( ) Select the large rectangular power switch and one of the two largest  $\frac{1}{2}$ " nuts. Install the switch from the inside through the upper right panel hole PS. Note the key which engages the slot on the switch bushing. Secure it with the nut on the outside.

- 6( ) Select the 2 control potentiometers and two  $\frac{3}{8}$ " nuts. Install the controls in the left panel holes LV and RV so that the locating lugs engage the small holes in the panel.
- 7( ) Select the 12 lug rotary switch, three  $\frac{3}{8}$ " lockwashers, and a  $\frac{3}{8}$ " nut. Place all 3 lockwashers on the shaft, and then install the switch in hole DS so that the locating lug is adjacent to the small panel hole. Tighten the nut securely.
- 8( ) Select the 2 lamp sockets and 2 sets of #6 short hardware. Insert the screws from the outside through holes DL and DR near the center, install the socket pointing downward, and secure each with a lockwasher and nut.
- 9( ) Select the 2 red neon indicator lamps and the 2 spring steel Tinnerman™ nuts. Install the lamps from the outside of the panel below the power switch and secure them by pushing the spring nuts over the leads and the body, and against the panel.



- 10( ) Select the longer 6-lug terminal strip (with the "O" or loop style lugs) and two sets of #6 short hardware. Install the strip so that it is centered between the two neon lamps.

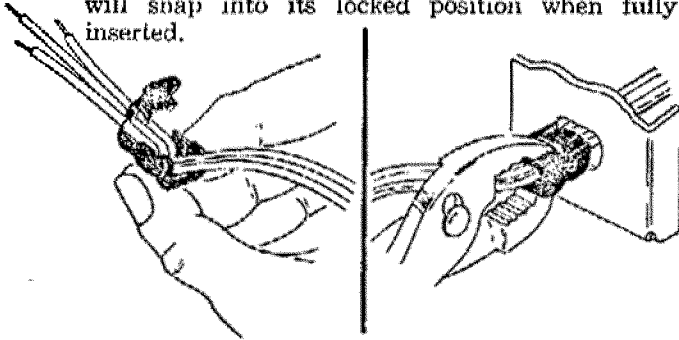
Be particularly careful in handling the circuit boards, as they represent a substantial portion of the cost of the Stereo 400. Because space is restricted, many of the components stand upright on the board, and careless handling can unduly flex and possibly break their leads. There are also a number of adjustable components on the circuit board whose values (positions) have been precisely set under operational test conditions for optimum performance. Be *very careful* that none of these are disturbed in handling the boards.

- 11( ) Select the PC-29 circuit board, 2 of the L-shaped metal mounting brackets and 4 sets of #4 hardware. Install the brackets on the *components side* of the board at the corners above and below the push button switches. The brackets point toward the components so that the mounting holes line up with the switches. Insert the screws first through the board from the back (circuit) side of the board, then through the bracket, with each nut securing a lockwasher against the bracket. Do *not* tighten these nuts.
- 12( ) Select the two  $\frac{3}{4}$ " self-tapping #4 screws and the 2 short tubular spacers. While supporting the switch assembly on the PC-29 board, temporarily start the screws into the switch bracket, so they cut a thread. Remove them, insert them through the small holes at the left of the front panel, slide a spacer over each, and install the PC-29 assembly with the components toward the center of the panel. Be sure the screws do not damage components on the board.

- 13( ) Select 2 sets of #4 hardware and fasten the PC-29 L-brackets to the front panel. Tighten these bolts *first* and then go back and tighten the 4 bolts securing the brackets to the circuit board.

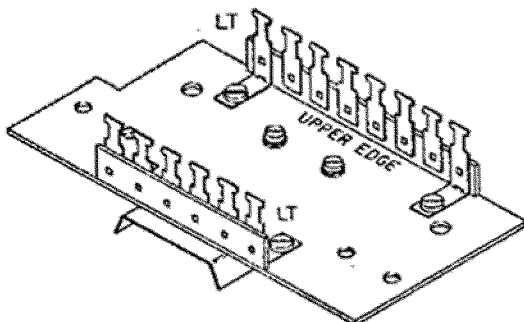
Set the front panel assembly aside and select the large Z-shaped line cord bracket.

- 14( ) Select the line cord and the molded plastic strain relief. Mark the line cord 17" from the stripped wire ends. Bend the cord sharply back on itself at the marking so that a "V" is formed. Install the strain relief at the V as shown with the small end of the strain relief nearest the bared wire end. Insert the line cord through the hole in the end of the Z bracket from the outside. With heavy pliers, crimp the two halves of the strain relief together around the wire to partially form the wire before insertion. Now grasp only the larger diameter portion of the strain relief with the tips of the pliers, squeeze it fully closed, and insert the combination into the hole. The strain relief will snap into its locked position when fully inserted.



- 15( ) Select the rectangular 10 amp circuit breaker with the red button. (Units supplied for 220 volt AC operation will use a 5 amp breaker.) Remove the outer knurled nut and leave the hex nut snugly in place. Select the remaining  $\frac{3}{8}$ " lockwasher and install it on the breaker. Mount the breaker from the inside of the Z-bracket above the line cord, with the side lug positioned *away* from the threaded mounting stud in the bracket. Secure it with the round knurled nut tightened with pliers.
- 16( ) Select the round black plastic access plug and snap it through the hole in the Z-bracket from the outside (red button side). *Do not push your finger through it!* Its removal from your finger necessitates its destruction, and playing with it can be painful. This plug simplifies optional fan installation.

Set the bracket assembly aside, and select the flat metal relay mounting plate. Hold it horizontally. When you are looking at the top surface, the upper left corner is notched out.



- 17( ) Select the 8-lug terminal strip and 2 sets of #6 short hardware. Install the terminal strip along the top surface *upper edge* of the relay mounting plate.

- 18( ) Select the remaining 6-lug terminal strip and 2 sets of #6 short hardware. Install the strip along the top surface *lower edge* of the mounting plate.

- 19( ) Select the 2 dual fuse clip blocks and 4 sets of  $\frac{3}{8}$ " long #6 hardware. These 4 are the only #6 screws of this length. Fasten the fuse blocks on top of the plate in each lower corner. The lockwashers and nuts go underneath the plate.

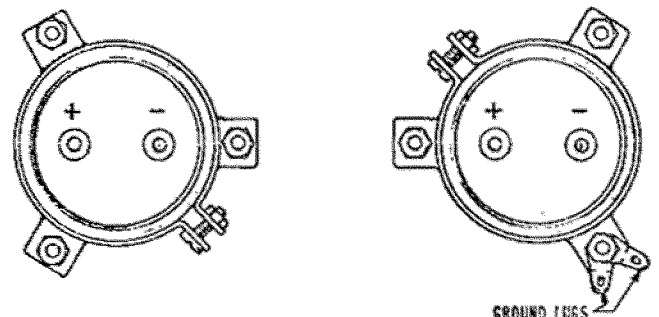
- 20( ) Select the relay, two #6 short screws and lockwashers. Slide a washer on each screw and insert them through the center holes in the plate from the top. Mount the relay underneath the plate via its two threaded holes, so that the insulating piece projects slightly beyond the lower edge of the plate. Note the relay terminals are shown in the pictorial diagram outside the relay mounting plate.

Set the relay assembly aside and select the main chassis. The single slot is nearest the front edge. You are looking at the inside when the ends are upturned. All hardware should be installed with the screw heads on the *outside* of the chassis.

- 21( ) Select the 4 large rubber feet and the four  $\frac{1}{4}$ " diameter bolts. Push the bolts through the feet until the heads are fully recessed and then mount the feet at the four corners of the chassis on the *outside*.

- 22( ) Select one of the large 10,000 mfd capacitors, one of the large circular capacitor mounting brackets, and 4 sets of #6 hardware (with one long and three short screws). *Do not remove the clear plastic outer insulation from either of these capacitors.* This bracket will be installed near the left front corner of the chassis. Note on the diagram below the correct orientation of the clamp, and also the direction of insertion of the clamping screw. One set of #6 long hardware is first to be installed in the clamp before mounting. Insert the capacitor in the bracket and temporarily tighten the clamp. Now mount the bracketed capacitor with the remaining hardware.

- 23( ) Select the remaining large capacitor and its bracket, 2 of the large ground lugs, one long and three short #6 screws, 4 nuts, but only 3 lockwashers. Slide the capacitor into the bracket as before with the long clamping screw oriented as in the diagram. Tighten the clamp temporarily and install the assembly near the front of the chassis.



FRONT EDGE OF CHASSIS

GROUND LUGS

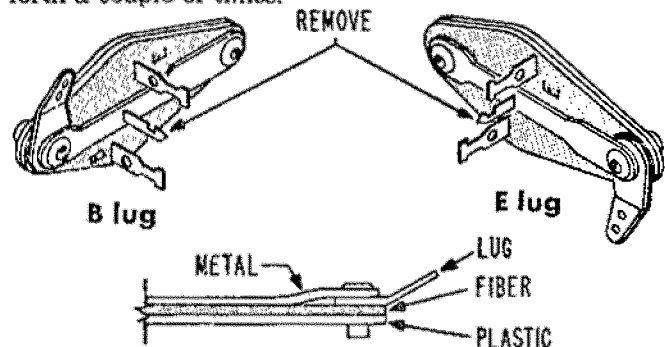
The two ground lugs are mounted on the front screw without a lockwasher before the nut is installed. The ground lugs should be separated by about  $\frac{1}{4}$ " to make connection of wires easier. They should be bent up to a vertical position. Make certain that this connection is mechanically tight because this is the main ground connection for the amplifier. Loosen the clamping screws and orient both capacitors so that the terminals are in line across the chassis, identified left to right in this order: (+), (-), (+), (-). The negative terminals may not carry a specific marking. Now securely tighten the clamping screws on both capacitor brackets.

The next eight steps describe the installation of several components which require the application of the white silicon thermal compound supplied in a capsule. This material is necessary to assure a good heat transfer while maintaining electrical insulation. The quantity supplied should be more than adequate if you apply it properly. A uniform film is all that is needed on *one* of each pair of mating surfaces.

This thermal compound can be most annoying if carelessly handled. It is difficult to remove from clothing, and stray smudges of it can make your finished amplifier look sloppy. The best removal agent for clothing, if needed, is a freon degreasing agent available in a pressure spray can at electronic supply houses. With care, and an adequate supply of paper tissues, it won't be necessary. To make the job easier, we have grouped together all the steps which require this application. Stop at this point if you are tired, and save the entire operation for the next session, as this is the most tedious part of the kit. You may wish to use a pair of plastic gloves if available. The important point is to clean up any excess as you go along. There are many ways of applying this material. One is to squeeze a bit at a time out of a hole punched in the capsule, spreading it with your finger tip. Another (recommended) way is to cut the capsule open and apply it with the tip of a screwdriver. You can also apply it with a toothpick, especially if the same screwdriver would be used to install the mounting hardware. You will probably find it easiest to read the following steps now and place the necessary materials in groups, in order, to reduce unnecessary handling and confusion. When the two mating surfaces are brought together, a slight twisting motion will facilitate uniform contact and squeeze out the excess around the edges where it can be wiped off.

24( ) Select the one inch square diode block, the small flat washer, the  $\frac{3}{4}$ " #6 screw, nut and lockwasher. Note that the terminals of the block are identified (+); (-); and (two) AC. The block will be mounted to the right of the single slot on the chassis with the (+) terminal (which may be identified by a red dot) over the tiny hole in the chassis nearest the right front corner. *Be certain this diode block is correctly oriented.* Apply a thin film of thermal compound to the bottom of the rectifier and install it over the screw through the chassis, securing it with the flat washer, then the lockwasher and nut. Recheck the location of the (+) terminal and tighten the bolt securely. Wipe off any thermal compound which has contacted the lug terminals on the rectifier.

Set the chassis aside and return now to the large heat sink assembly. You will now install the eight power output transistors. They will plug into sockets on the heat sink ribs, and it is first necessary to prepare the sockets. To allow more room for connections, the center (collector) socket terminal will be removed and replaced by a small ground lug mounted under one of the attaching screws on each socket. The lug must be forced between the metal and fiber portions of the socket with the lug projecting at right angles to the socket frame with the bent portion pointing in the same direction as the socket terminals. Note that the holes for the transistor pins are off center. The longer end is identified with an "E" stamped in the fiber. A ground lug installed at the mounting hole at that end will be called an E lug and will point to the *left* when reading the "E". The shorter end of the socket is identified with a B and that lug will point to the *right*. Since the center socket terminal is no longer required, you may easily break it off by bending it back and forth a couple of times.

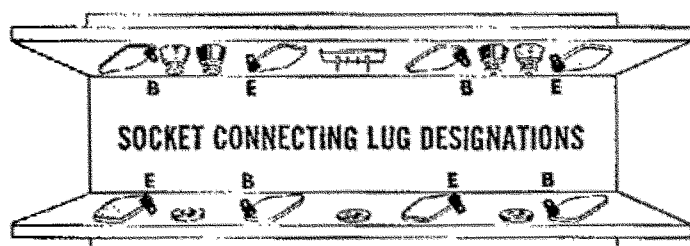


25( ) Select the 8 transistor sockets and the 8 small ground lugs. Break off the center terminal of each socket. Install an "E" lug on 4 of the sockets, and a "B" lug on the remaining 4. Be sure the connecting lug goes between the metal and fiber sections, *not* between the plastic and fiber sections.

The metal insulators (shaped like a power transistor) are hard-anodized for excellent thermal conductivity with electrical isolation. Do not scratch them. Apply the thermal compound in a *very thin film* to both surfaces while holding it by the tab at the "B" end. Excess compound will be messy, and is a disadvantage, since the compound is intended only to fill in minute voids between flat metal surfaces. Orient the insulator correctly, and install it on the transistor. Then the combination is installed on the outside of the heat sink rib and plugged into the socket on the inside. Choose the correct socket lug position (see diagram on next page) so that the lugs point toward each other for each pair of adjacent sockets. Try a "dry run" without the compound first so that each socket and the E or B lug is oriented correctly for easiest handling.

The simplest procedure seems to be the following: after placing the compound-coated insulator on the transistor, wipe the end  $\frac{1}{4}$ " of each transistor pin clean of all compound. Then orient the combination properly to match the mounting holes and press it against the outside of the rib with a *slight* twisting motion to assure uniform contact. While holding it in place, snap the socket over the pins. When firmly engaged, this will hold each assembly temporarily so that the screws can be installed in one final operation to minimize smearing. As you tighten the mounting screws, check the position of each connecting lug.

You may wish to apply compound to one transistor insulator at a time, or you may find it easier to perform the operation on all four transistors as a group.



- 26( ) Select the 4 transistors, Part #561356 (2N6029 or 2N6030), 4 metal insulating wafers, and 8 of the  $\frac{3}{4}$ " sheet metal screws. First check to be sure the transistor pins are straight. These 4 transistors will be mounted on the *outside* of the *back* heat sink rib (the one with the red and black binding posts). Apply a *thin* film of compound to both sides of the insulator, orient it correctly, and install it over the transistor pins. *Wipe the pins clean* and plug each assembly through the rib into the appropriate socket with the correct lug orientation. Secure each with 2 sheet metal screws.
- 27( ) Select the 4 transistors, Part #571104 (2N5629 or 2N5630), the 4 remaining insulating wafers, and 4 more  $\frac{3}{4}$ " sheet metal screws. Check for straight transistor pins. Apply thermal compound to the insulating wafers as before, wipe the pins clean, and install these on the *outside* of the *front* heat sink rib, snapping them into the appropriate sockets. The 4 sheet metal screws are installed only in the two outside (Q2) transistors at this time. Now the connecting lugs on the group of four transistors at each end of the heat sink should all tend to point toward each other.
- 28( ) Select the two  $\frac{1}{2}$ " diameter thermal sensors, the two spring metal clips shaped somewhat like the power transistors, and the 4 remaining  $\frac{3}{4}$ " sheet metal screws. Apply a *thick* film of thermal compound to the central portion of the round case section of the two inside (Q1) transistors on the front rib (those which have not yet been attached with screws). Slide the spring metal brackets over the lugs of the sensors so that the mounting flange projects in front of the flat surface of the sensor and fasten one assembly on top of each of the inner transistors with the sheet metal screws. Rotate the sensors slightly before the screws are tightened to get a good contact, and align the sensors so that their four connecting lugs are in one line.
- 29( ) Select the 2 hollow black plastic transistor covers, and 2 #6 short screws. Install them on the back rib of the heat sink.
- 30( ) Select one of the PC-28 circuit boards with the attached heat sink transfer assembly, 2 of the long tubular spacers, two  $1\frac{1}{2}$ " #6 screws and 2 lockwashers. Handle this board assembly carefully so as not to disturb the variable resistors on the board or to bend the component leads excessively.

Slide the lockwashers onto the screws first and insert the screws through the board, then through the spacers, and finally through the heat sink transfer assembly. Note how the unit will be mounted to the front fin of the large heat sink near the center. The *eyelets* on the circuit board are placed *adjacent to the output transistors* on the heat sink. Apply a relatively thick uniform film of thermal compound to the flat surface of the transfer assembly which will mate with the large heat sink. Use about half the remaining compound if necessary. A small amount of compound applied to the four projecting threads on each screw is suggested for lubrication to avoid stripping the threaded holes in the heat sink. Then mount the circuit board assembly to the heat sink with the two #6 screws. Neatness will be served by aligning the projecting screws with the holes in the heat sink before allowing the two surfaces to touch. The slight twisting motion is not needed here.

- 31( ) Select the other PC-28 circuit board assembly, the remaining 2 long spacers, two  $1\frac{1}{2}$ " #6 screws and 2 lockwashers. Assemble this unit as before, handling the board carefully, and applying the compound fairly liberally, especially near the bend in the transfer assembly. Lubricate the projecting screw threads, *make sure the circuit board eyelets are adjacent to the output transistors*, and install this assembly at the end of the heat sink.
- 32( ) With a piece of wire lubricate 6 holes in the large heat sink assembly with the thermal compound as follows: the two holes in the front fin adjacent to the circuit board; the blind hole at one end of each rib where it joins the fin assembly; the single hole between the power transistors adjacent to each red binding post.

This completes the need for the compound. It is advisable to wipe off all the excess, including the threads of the transistor mounting screws, to avoid needless smears as you complete construction. This completes the basic mechanical sub-assembly portions of the kit.

## WIRING THE HEAT SINK

To simplify wiring, wherever possible these steps will make the first connections to the least accessible connecting terminals, and connect to the easiest ones last. On each transistor socket, the terminal nearest the inside of the heat sink is the emitter or "E" terminal. Connections to the collector or "C" terminal are made to the connecting lug under the screw. The base or "B" terminal is the one nearest you on each socket.

While transistors and diodes can be damaged by *excessive* heat, it is important that you solder connections properly, applying enough heat to the junction so that when solder is applied it flows smoothly over the joint.

A good mechanical connection is important at each step. In a number of steps where final soldering of a terminal will not occur until several steps later, some builders may prefer to lightly "tack solder" each lead as they go along, but if you do this where the instructions do not call for soldering, be sure to leave open space on the terminal for future wiring.

The following steps refer to the four output transistors for the *right channel*, and to the *right channel* PC-28 which is mounted in the *center* of the heat sink. Note that right and left *channel* designations are reversed relative to the left and right *sides* of the pictorial diagram of the heat sink, because the heat sink is upside down.

- 1( ) Prepare a 2 $\frac{3}{4}$ " green wire. Connect one end to the 2-lug terminal strip TS lug #1. Connect the other end to Q3E. (S). Ignore any outer lugs which are bent over.
- 2( ) Prepare a 2 $\frac{3}{4}$ " red wire. Connect one end to TS lug #2. Connect the other end to Q2E. (S).
- 3( ) Prepare a 3 $\frac{1}{4}$ " red wire. Connect one end to Q4E. (S). Connect the other end to Q3C.
- 4( ) Prepare a 3 $\frac{1}{4}$ " black wire. Connect one end to Q1E. (S). Connect the other end to Q2C.
- 5( ) Select 2 of the .18 ohm, 10 watt resistors. Trim the leads as required and connect one end of each resistor to the center terminal strip TS lug #3. Connect the other end of one resistor to TS lug #1. Connect the remaining end of the second resistor to TS lug #2.
- 6( ) Select 1 of the 4 plastic diodes, part #544012. The cathode end of a diode is marked with a stripe, "+" sign, arrow head or the end is of a different diameter. It is essential that each diode be installed with the proper orientation or polarity. Trim the leads as required and connect the cathode end of the diode to Q1C. Connect the other end to TS lug #2.
- 7( ) Select another plastic diode. Connect the cathode end to TS lug #1. Connect the other end to Q4C.
- 8( ) Prepare a 4" white wire. Connect one end of this wire to lug #2 of the thermal sensor on the *right channel* Q1. (S). Connect the other end to lug #3 of the thermal sensor on the *left channel* Q1. (S).

In succeeding steps connections will be made to eyelets on the circuit boards. A good connection is more certain if the tip of the wire is first "tinned" by heating it and applying a small amount of solder before it is connected to the eyelet. Melt the solder in the eyelet and insert the wire so that bare wire is visible on *both* sides of the board. Let the soldering iron contact the junction so that the solder flows smoothly from the circuitry, *across the eyelet* and surrounds the wire. Hold the wire steady while the connection cools, and then wiggle it to be sure the connection is secure. If in doubt, reheat the connection and add more solder.

You may wish to add a small amount of solder to each of the 15 eyelets on both boards now, so that connections will be easier. The following connections will all be made to the back (circuit side) of each board.

- 9( ) Prepare a 6" red wire. Thread the wire through grommet G1 and connect one end to TS lug #2. (S-4). Connect the other end to PC-28 eyelet #13. (S).

- 10( ) Prepare a 7 $\frac{1}{4}$ " green wire. Pass one end through G1 and connect it to TS lug #1. (S-4). Connect the other end to eyelet #12. (S).
- 11( ) Prepare a 7" black wire. Pass one end through G1 and connect it to Q2C. (S-2). Connect the other end to eyelet #11. (S).
- 12( ) Prepare a 7 $\frac{3}{4}$ " green wire. Pass one end through G1 and connect it to Q2B. (S). Connect the other end to eyelet #10. (S).
- 13( ) Prepare an 8 $\frac{3}{4}$ " red wire. Pass one end through G1 and connect it to Q3C. (S-2). Connect the other end to eyelet #9. (S).
- 14( ) Prepare a 9 $\frac{1}{2}$ " black wire. Pass one end through G1 and connect it to Q3B. (S). Connect the other end to eyelet #8. (S).

The next steps refer to the *left channel* power transistors and the *left channel* PC-28 board.

- 15( ) Prepare a 2 $\frac{3}{4}$ " green wire. Connect one end to Q3E. (S). Connect the other end to TS lug #5.
- 16( ) Prepare a 2 $\frac{1}{2}$ " red wire. Connect one end to Q2E. (S). Connect the other end to TS lug #6.
- 17( ) Prepare a 3 $\frac{1}{4}$ " red wire. Connect one end to Q4E. (S). Connect the other end to Q3C.
- 18( ) Prepare a 3 $\frac{1}{4}$ " black wire. Connect one end to Q1E. (S). Connect the other end to Q2C.
- 19( ) Select the 2 remaining .18 ohm resistors. Connect one end of each to TS lug #4. Connect the other end of one resistor to TS lug #5. Connect the remaining end of the second resistor to TS lug #6.
- 20( ) Select one of the plastic diodes, Part #544012. Trim the leads as required and connect the marked cathode end to TS lug #5. Connect the other end to Q4C.
- 21( ) Select the remaining plastic diode, Part #544012. Trim the leads and connect the cathode end to Q1C. Connect the other end to TS lug #6.
- 22( ) Prepare a 4 $\frac{3}{4}$ " red wire. Pass one end through G3 and connect it to TS lug #6. (S-4). Connect the other end to eyelet #13. (S).
- 23( ) Prepare a 5 $\frac{1}{2}$ " green wire. Pass one end through G3 and connect it to TS lug #5. (S-4) Connect the other end to eyelet #12. (S).
- 24( ) Prepare a 4 $\frac{3}{4}$ " black wire. Pass one end through G3 and connect it to Q2C. (S-2). Connect the other end to eyelet #11. (S).
- 25( ) Prepare a 5 $\frac{1}{2}$ " green wire. Pass one end through G3 and connect it to Q2B. (S). Connect the other end to eyelet #10. (S).
- 26( ) Prepare a 6 $\frac{1}{2}$ " red wire. Pass one end through G3 and connect it to Q3C. (S-2). Connect the other end to eyelet #9. (S).
- 27( ) Prepare a 7" black wire. Pass one end through G3 and connect it to Q3B. (S). Connect the other end to eyelet #8. (S).



In the following steps the directions will indicate connections to be made to either the right *channel* or left *channel* components. Be careful you do not confuse them. Heat sink wiring designations *do not* refer to the left side or right side of the diagram. As a number of long heavy gauge wires will be projecting from this assembly, they should be bent down out of the way so there is no risk to your eyes.

- 28( ) Prepare a 15" blue wire. Pass one end through the center grommet G2 and connect it to the *left channel* lug Q1C.
- 29( ) Prepare a 5½" red wire. Pass one end through G3 and connect it to *left* Q1C. (S-3). Connect the other end to *left* eyelet #15. (S).
- 30( ) Prepare a 15" white wire. Pass one end through G2 and connect it to *right* Q1C. Starting at least 2 inches beyond the grommet, lightly twist together the blue and white wires (about 3 or 4 complete twists).

This light twisting will only provide future identification. When twisting of the *heavy* (white, blue or yellow) wires is called for anywhere in this kit, it will be solely for purposes of identification or convenience, so only a few twists need be made.

- 31( ) Prepare a 5" red wire. Pass one end through G1 and connect it to *right* Q1C. (S-3). Connect the other end to *right* eyelet #15. (S).
- 32( ) Prepare a 16½" blue wire. Pass it through G2 and connect it to *right* Q4C.
- 33( ) Prepare a 10" black wire. Pass one end through G1 and connect it to *right* Q4C. (S-3). Connect the other end to *right* eyelet #4. (S).
- 34( ) Prepare a 16½" yellow wire. Pass one end through G2 and connect it to *left* Q4C. Now twist the blue and yellow wires together for identification, starting at least 2 inches from the grommet.
- 35( ) Prepare a 7¼" black wire. Pass one end through G3 and connect it to *left* Q4C. (S-3). This lug is rather difficult to reach. Make sure that all three leads are securely soldered, but do not apply excessive heat or you may damage the diode. If you choose to remove one of the output terminals for easier access to this lug, remember to properly locate the connecting hole through the shaft upon reinstallation. Connect the other end of the black wire to *left* eyelet #4. (S).
- 36( ) Prepare a 16" yellow wire. Pass one end through G1 and connect it to the *right* red binding post lug. (S). It will be easier to connect to these binding post lugs if they are bent out at right angles, toward the grommets.
- 37( ) Prepare a 16" white wire. Pass one end through G3 and connect it to the *left* red binding post lug. (S). Twist this wire together with the yellow wire through G1, starting about 2 inches in the front of the center grommet.
- 38( ) Prepare a 19" blue wire, but remove ½" of insulation from one end. Pass the *shorter* bared end through G1 and connect it to the *right* black binding post lug.

- 39( ) Prepare another 19" blue wire, insulation from one end. Pass the *shorter* end through G3 and connect it to binding post lug. Twist these two together starting at least 2 inches from the center grommet.
- 40( ) Prepare a 7½" green wire. Pass one end through G3 and connect it to *left* Q1B. Pass the other end to *left* eyelet #5. (S).
- 41( ) Select one of the 1000 ohm 10 watt resistors. Connect one end to TS lug #4. Connect the other end to the *left* black binding post lug.
- 42( ) Prepare a 5½" green wire. Pass one end through G3 and connect it to *left* Q1B. (S-3). Connect the other end to *left* eyelet #14. (S).
- 43( ) Prepare a 7¾" red wire. Pass one end through G1 and connect it to TS lug #4. Connect the other end to *left* eyelet #7. (S).
- 44( ) Prepare a 10½" green wire. Pass one end through G1 and connect it to *right* Q1B. (S-3). Connect the other end under the heavy wires and to *right* eyelet #5. (S).
- 45( ) Prepare a 6½" green wire. Pass one end through G1 and connect it to *right* Q1B. (S-3). Connect the other end under the heavy wires and to *right* eyelet #14. (S).
- 46( ) Prepare an 11" red wire. Pass one end through G1 and connect it to TS lug #3. Pass the other end under the heavy wires and connect it to *right* eyelet #7. (S).
- 47( ) Select the remaining 1000 ohm, 10 watt resistor. Connect one end to TS lug #3. Connect the other end to the *right* black binding post lug.
- 48( ) Prepare an 18" white wire. Pass one end through G2 and connect it to TS lug #4. (S-3). It is essential that you carefully check the connection of each lead to a terminal when several wires are connected to that terminal.
- 49( ) Prepare a 19" yellow wire. Pass one end through G2 and connect it to TS lug #3. (S-3).
- 50( ) Prepare both a 26" red wire and a 26" black wire. Pass one end of each of these wires through G2 so that the black wire projects 3" and the red wire 2½" through the grommet between the diode and heat sink. Twist them together two or three turns, and connect the black wire to input socket lug #2. (S). Connect the red wire to input socket lug #1. (S). On the other side of the grommet, twist these two wires together uniformly throughout their length so that there are about three twists every 2 inches.
- 51( ) Prepare a 24" black wire and a 24" green wire. Pass these through G2, twist them as before, and connect the black wire to input socket lug #2. (S). Make certain that this connection is separate from that of the black wire connected to input socket lug #2. Connect the green wire to input socket lug #4. (S). Twist the wires together uniformly throughout their length so that there are about three twists every 2 inches.

- 52( ) Select the 5 "U" shape mounting brackets for the heat sink, and 10 sets of #6 long hardware. The brackets are to be installed between the ribs of the heat sink with the long flat side out, and nearly flush with the edge of the rib. Four of the brackets are to be mounted adjacent to each pair of output transistors. The last is facing out, at the left channel end of the heat sink. Install the screws from the outside of each rib.
- ( ) Prepare a 14½" red wire and a 14½" black wire. Twist these together uniformly throughout their length and connect one end of the black wire to *right* PC-28 eyelet #2. (S). Make this connection from the *front* (components side) of the circuit board. Connect the corresponding end of the red wire to eyelet #1 on the *front* side of the same board. (S).
- 54( ) Prepare a 15" green wire and a 15" black wire. Twist these wires together throughout their length and connect one end of the black wire to the *front* of the *left* PC-28 eyelet #2. (S). Connect the corresponding end of the green wire to eyelet #1. (S).
- 55( ) Prepare a 13½" black wire. Connect one end to the *front* of the *right* PC 28 eyelet #3. (S). Note that eyelet #3 is very close to eyelet #2, and they represent a common circuit connection.
- 56( ) Prepare a 17½" black wire. Connect one end to the *front* of the *left* PC-28 eyelet #3. (S). Bring this wire across the PC-28 board in front of the row of eyelets and twist it lightly together with the single black wire from the right channel PC-28, so that the unconnected ends are even. These two wires will be connected to the same point in a later step.
- 57( ) Prepare a 22" white wire. Connect one end to lug #1 of the thermal sensor on *right* Q1. (S).
- 58( ) Prepare a 27" white wire. Pass one end under the group of wires leading to the *right* PC-28 (from the right channel side near G1) and connect it to lug #4 of the thermal sensor on *left* Q1. (S). The pictorial diagram has distorted the placement of this wire for clarity. Twist this wire together with the white wire from the preceding step throughout their length so that the unconnected ends are even.

Check your wiring and soldering accuracy (eyelet #6 or no connection), and shake out any loose wire clipings. Be certain no bits of wire adhere to the thermal compound. Set the heat sink aside, and return to the main chassis with the capacitors near you. You're about half way through!

### WIRING THE MAIN CHASSIS

- 1( ) Select the relay mounting plate and 2 of the ⅜" #10 SEMS screws with attached lockwashers. Install the plate on capacitor terminals C1 #2 (-) and C2 #3 (+), with the notched out corner of the plate adjacent to terminal #1.
- 2( ) Select the remaining two ⅜" #10 SEMS screws and the 2 remaining large ground lugs. Install the ground lugs facing to the front left on capacitor C1 lug #1, and to the front on C2 lug #4.

- 3( ) Prepare a 2¾" yellow wire but strip 1" of insulation from one end. Pass the longer bared end through fuse block lug #8 and connect it to fuse block #7. Solder only lug #8. Connect the other end to capacitor C2 lug #4. (S).
- 4( ) Prepare a 2¾" white wire, but strip 1" of insulation from one end. Pass the longer bared end through fuse block lug #3 and connect it to lug #4. Solder only lug #3. Connect the other end to capacitor C1 lug #1. (S).
- 5( ) Select the six .1 mfd disc capacitors. Do not confuse the single .01 mfd disc capacitor, which is used elsewhere. Trim the leads of all 6 capacitors to ¼" of bare wire.

These capacitors will be installed on the relay mounting plate terminal strips. For convenience, they will be connected to the small holes at the *base* of each lug terminal rather than wrapped around the terminal. When soldering is called for here, solder the leads to the lower portion of the terminal only. Future connections will be made to the larger portion of the terminal. Do not allow bare leads to touch the relay mounting plate.

- 6( ) Select one of the .1 mfd disc capacitors and connect one lead to fuse block lug #4. (S-2). Connect the other lead to LT lug #9. This capacitor and the one in the following step should point downward against the front edge of the relay plate.
- 7( ) Select another .1 mfd disc capacitor and connect one lead to fuse block lug #7. (S-2). Connect the other lead to LT lug #14.

The remaining 4 capacitors will be placed between the two terminal strips, and should lie flat against the relay plate. Note that the pictorial diagram has necessarily distorted the spacing of the components on the relay plate to clearly show wires which pass beneath it in the final assembly.

- 8( ) Select one of the .1 mfd disc capacitors and connect one lead to LT lug #9. (S-2). Connect the other lead to LT lug #10. (S).
- 9( ) Select another .1 mfd capacitor and connect one lead to LT lug #14. (S-2). Connect the other lead to LT lug #13. (S).
- 10( ) Select another .1 mfd capacitor and connect one lead to LT lug #3. (S). Connect the other lead to LT lug #4. (S).
- 11( ) Select the remaining .1 mfd capacitor and connect one lead to LT lug #5. (S). Connect the other lead to LT lug #6. (S).
- 12( ) Prepare a 3¾" black wire. Connect one end to relay lug #6. (S). This lug is located *under* the 6-lug terminal strip. The relay lugs are shown in front of and behind the relay mounting plate assembly in the pictorial diagram for ease in tracing wires. Connect the other end of this black wire to fuse block lug #5.

You will next install a few parts on circuit board PC-30. These items are to be installed on the side which does *not* have the etched circuitry. The holes for each component are indicated in white on the component side of the board.

Bend the leads at right angles to each component, and insert the leads so that the part is flat against the board (except for the resistors). Turn the board over, and solder each lead to the copper circuitry. Then cut off the excess lead. The location R318 will be left vacant, as it provides for an optional resistor for meter lighting.

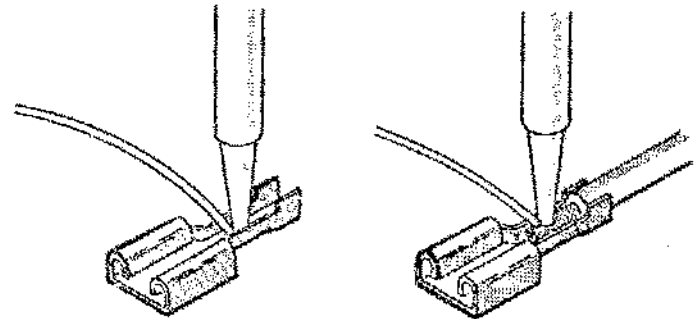
- 13( ) Select the PC-30 board and the 2 small glass zener diodes, part #540113. These are designated as D304 and D305. Each diode has the cathode end marked with a stripe, an arrow head, or a colored tip. Install each diode so that the arrow head on the board points toward the marked (cathode) end of the diode. Both diodes point in the same direction. Solder all 4 leads.
- 14( ) Select the two 500 mfd (or 470 mfd) capacitors. Note that the (+) lead is marked on the capacitor, and the (+) symbol on the board indicates the correct orientation for each in locations C302 and C303. These capacitors point in opposite directions. Solder all 4 leads.
- 15( ) Select the 600 ohm 10 watt resistor, and install it in location R307. Do not place it against the board, but allow the leads to support it  $\frac{1}{8}$ " above the board. Solder both leads. These holes have eyelets for mechanical security. Be certain that you have soldered the lead to the eyelet, and across the eyelet to the copper circuitry on the board. A good solder connection is essential. An incomplete connection here, or to the resistor in the next step, is the most common error in assembling this kit. Care will save a costly repair.
- 16( ) Select the 850 ohm 10 watt resistor and install it in location R308. It too should be supported  $\frac{1}{8}$ " above the board. Solder both leads, and double-check the soldering across the eyelet to the circuitry.
- 17( ) Select 4 sets of #4 hardware and the 2 remaining L-shaped brackets. Install the brackets on the components side of PC-30, with the short leg of the bracket pointing away from the board, and adjacent to R308. Insert the screw through the board first, then through the bracket. Secure these loosely with a lockwasher and nut on each.
- 18( ) Select the vertical chassis brace and 2 sets of #4 hardware. Fasten the PC-30 brackets to the brace so that the etched circuit side of the board is toward the shorter edge of the brace, and the components will be adjacent to the bend. Tighten these bolts first, and then those holding the board, securely.

Connections to the eyelets on the board will be easier if you fill each eyelet with solder first. It is convenient now to heat each eyelet in turn from one side while feeding solder from the other side. Be certain that solder flows across the eyelet and onto the circuitry for a secure connection.

- 19( ) Select 2 short #6 screws and lockwashers. Place a lockwasher over each screw before insertion, and install the brace on the chassis adjacent to capacitor C2. The front flange will be flush with the front edge of the chassis.

- 20( ) Prepare an 8" black wire, but strip  $\frac{1}{2}$ " from one end. Connect the shorter bared end to the circuit (front) side of PC-30 eyelet #6. (S). Connect the longer end to one of the ground lugs at the base of capacitor C2. Because 4 or 5 wires will be connected to each of these 2 ground lugs, attach each wire by wrapping it around the lug, starting at the base of the lug with succeeding wires working upward. Since this is the main ground connection of the amplifier and good solder connections are essential, it is advisable to solder each wire in turn as you connect it at this point.
- 21( ) Prepare a  $13\frac{1}{2}$ " white wire. Connect one end to the bare wire between fuse block lugs #3 and #4. (S). Connect the other end to the front of PC-30 eyelet #1. (S).
- 22( ) Prepare a 9" yellow wire. Connect one end to the bare wire between fuse block lugs #7 and #8. (S). Connect the other end to the front of PC-30 eyelet #4. (S).

Terminal clips called for in future steps should be connected to the wire as follows: First "tin" that narrow portion of the clip shank which accepts the bared wire end. Then lay the wire in the clip so that the wider portion of the shank grasps the insulation. Solder the wire only in the narrow shank portion, and when it has cooled, squeeze the wider end around the insulation.



- 23( ) Prepare a 3" yellow wire. Install a terminal clip on one end. (S). Connect the other end to the front of PC-30 eyelet #5. (S). Flow solder across the board to eyelet #4. Push the clip over the (-) terminal of the diode block, lug #1.
- 24( ) Prepare a  $22\frac{1}{4}$ " white wire. Install a terminal clip on one end. (S). Connect the other end to the front of PC-30 eyelet #2. (S). Flow solder across the board to eyelet #1. Push the clip over the (+) terminal of the diode block, lug #3.
- 25( ) Prepare a 20" green wire. Connect one end to the front of PC-30 eyelet #3. (S).
- 26( ) Prepare a 21" red wire. Connect one end to the front of PC-30 eyelet #7. (S).
- 27( ) Prepare a  $22\frac{1}{2}$ " black wire. Connect one end to the front of PC-30 eyelet #17. (S). Position this wire down past eyelet #3 and twist it lightly together with that green wire, and the red wire from eyelet #7. Place this group out of the way under the chassis.

- 28( ) Prepare a 2½" red wire. Connect one end to relay lug #2. (S). Connect the other end to LT lug #4.
- 29( ) Prepare a 2½" green wire. Connect one end to relay lug #3. (S). Connect the other end to LT lug #5.
- 30( ) Prepare a 2½" black wire. Connect one end to relay lug #1. (S). Connect the other end to LT lug #3.
- 31( ) Prepare another 2½" black wire. Connect one end to relay lug #4. (S). Connect the other end to LT lug #6.
- 32( ) Select one of the 10 ohm 10 watt resistors. Connect one end to LT lug #10. (S). Pass the other lead around LT lug #2, and connect it to LT lug #3. Solder only lug #2 at this time.
- 33( ) Select one of the choke coil assemblies and trim each lead to ½". Connect one lead to LT lug #3. (S-3). Connect the other lead to LT lug #11.
- 34( ) Prepare a 6½" white wire. Connect a terminal clip to one end. (S). Connect the other end to LT lug #11. (S-2).
- 35( ) Select the remaining 10 ohm 10 watt resistor. Connect one end to LT lug #13. (S). Pass the other lead around LT lug #7 and connect it to LT lug #6. Solder only lug #7 at this time.
- 36( ) Select the remaining choke assembly and trim its leads to ½". Connect one lead to LT lug #6. (S-3). Connect the other lead to LT lug #12. Now check to see that the choke coils do not touch each other, and that they are not able to touch the mounting plate.
- 37( ) Prepare an 8½" yellow wire. Install a terminal clip on one end. (S). Connect the other end to LT lug #12. (S-2).
- 38( ) Prepare a 20" red wire and a 20" green wire. Lightly twist these two wires together throughout their length. Pass the pair under the relay between the two capacitors and connect the red wire to LT lug #4. Connect the green wire to LT lug #5. While a later connection will be made to each of these terminals it is suggested that you solder the two wires on each terminal for security.
- 39( ) Prepare a 17" red wire and an 18" black wire. Starting with two even ends, lightly twist these wires together throughout their length except for 2" at the uneven end. At this uneven end connect the red wire to relay lug #5. (S). Connect the corresponding end of the black wire to LT lug #14. Place this pair of wires out of the way under the chassis.
- 40( ) Prepare a 7" blue wire, but strip ½" of insulation from one end. Connect the longer bared end to one of the ground lugs at the base of C2. (S). Connect the other end to LT lug #14. (S-2).
- 41( ) Select the Z-bracket and line cord assembly, and a terminal clip. The line cord has 3 conductors (wires). The center (green) conductor is the ground connection. Separate one of the outer conductors from the other two for a distance of 14". Cut off and discard 11" of this separate wire. Strip ¼" of insulation from the end, being careful not to cut through the strands of this wire. Twist the strands together tightly and tin them with solder. Install the terminal clip on this lead. (S). Push this terminal clip over the *outer* lug of the circuit breaker. This is *not* the lug marked with the red dot. You may separate the green ground lead from the remaining line cord lead for at least 8 inches.
- 42( ) Prepare a 14" white wire. Connect a terminal clip to one end. (S). Push this terminal clip over the circuit breaker lug marked in red. Set this assembly aside for the present.
- 43( ) Select the power transformer, the four ½" #10 screws, the 4 large flat washers, and the 4 #10 KEP nuts with lockwashers attached. When installing the transformer, be careful of the components on the PC-30 board. Lift the 3 blue leads over the top of the board, and bring the 3 red leads out below the board before you attach the transformer to the chassis. Mount the transformer with the leads toward the front of the chassis, using a large flat washer on top of each foot before the nut is installed. Tighten these screws when the end of the transformer is 1/16" from the inner edge of the chassis.
- The standard transformer for the Stereo 400, for use with 120 volts AC lines as in the United States and Canada, is part #464026. An alternative power transformer, part #164030, providing for other line voltage options, is available at extra cost. If there is *any possibility that you may require the optional transformer, do not install the standard version, for it cannot be exchanged once it has been installed.* Contact Dynaco about the cost differential and exchange provisions, and remember that the circuit breaker should be a 5 amp size for 200, 220, or 240 volt lines.
- Instructions for connecting the primary windings of the international transformer for various line voltages will be found on page 36 of this manual. The following connections of the secondary windings are the same for both versions. The transformer leads may be shortened for neatness, but if they are cut too short for re-use, and a defect should develop in the transformer, the guarantee on the transformer may be voided. Twist and tin the strands if you shorten a lead, and *be sure all strands are soldered to each terminal.*
- Insofar as possible the transformer leads will conform to the colors indicated. If there is a variation, these leads will carry numbered tags which refer to the [number] following the color reference.
- 44( ) Connect the blue/yellow [7] lead to the *back* of PC-30 eyelet #16. (S).
- 45( ) Connect one of the 2 blue [6] leads to the *back* of PC-30 eyelet #14. (S). Connect the remaining blue [8] lead to the back of eyelet #19. (S).
- 46( ) Connect the red/yellow [4] lead to one of the ground lugs at the base of C2. (S).

- 47( ) Connect the green [9] lead to one of the ground lugs at the base of C2. (S).
- 48( ) Select 2 terminal clips. Install a clip on each of the 2 red [3] and [5] leads. Because this wire is quite heavy, you may wish to bend open the channel on the shank of the clip so that a good solder connection will be assured. Twist these red wires lightly together and push one clip on diode block lug #2, and the other clip on lug #4.
- 49( ) Select the .01 mfd disc capacitor and the piece of insulating sleeving. Trim each capacitor lead to 1¼". Cut two ¾" lengths of sleeving, and install one on each capacitor lead. One capacitor lead is to be connected to the terminal clip on each red transformer lead. Wrap the lead around the terminal shank, crimp it tightly, and solder each. Standing the capacitor upright on these long leads makes it easier to disconnect these clips from the diode block if servicing should require it.
- 50( ) Select the Z-bracket line cord assembly, 4 #6 short screws and 4 lockwashers. Thread the wires from this assembly under the outer edge of the transformer from the back, and install the bracket at the right rear corner of the chassis. Place a lockwasher over each screw before insertion. You may find it easiest to install the bottom screw first.
- 51( ) Connect the green ground wire from the line cord to one of the ground lugs at the base of C2. (S). This makes a total of 5 wires thus far connected to these 2 ground lugs. A total of 9 will be attached here.

This completes the second major portion of the amplifier. Set this chassis assembly aside and select the front panel assembly.

#### WIRING THE FRONT PANEL

- 1( ) Prepare a 2" red wire. Connect one end to DL lug #1. (S). Connect the other end to DR lug #3.

There are 6 small ¼ watt resistors in the kit. 2 each of 3 values. These will all be mounted on switch DS. Trim each lead on all of these to no more than ½".

The DS switch lugs are numbered clockwise from the inside switch assembly bolt when looking at the back of the switch.

- 2( ) Select one of the 270 ohm (red-violet-brown) resistors. Connect one lead to DS #10. Connect the other lead to DS #11.
- 3( ) Select one of the 360 ohm (orange-blue-brown) resistors. Connect one lead to DS #11. (S-2). Connect the other lead to DS #12.
- 4( ) Prepare a 24" green wire. Connect one end to DS #12. (S-2).
- 5( ) Select one of the 110 ohm (brown-brown-brown) resistors. Connect one end to DS #10. (S-2). Connect the other end to DS #9.

- 6( ) Prepare a 25" black wire. Connect one end to DS #9. (S-2).
- 7( ) Select the remaining 270 ohm (red-violet-brown) resistor. Connect one lead to DS #4. Connect the other lead to DS #5.
- 8( ) Select the remaining 110 ohm (brown-brown-brown) resistor. Connect one lead to DS #4. (S-2). Connect the other lead to DS #3.
- 9( ) Prepare a 25" red wire. Connect one end to DS #3. (S-2). Twist lightly together these red, green and black wires from the switch, and pass the group under the circuit board between control RV and the adjacent switch spacer.

All of the wires on the front panel which will subsequently connect to eyelets on the PC-29 circuit board will pass through this opening next to RV. However, for clarity in tracing individual wires, the pictorial diagram differs from actual placement by showing these wires going direct to the eyelet on the components side of the circuit board. In fact, *all* of these wires should come up *behind* (to the left of) the board, and be connected from the back (circuit side) of the eyelet.

- 10( ) Select the remaining 360 ohm (orange-blue-brown) resistor. Connect one lead to DS #5. (S-2). Connect the other lead to DS #6.
- 11( ) Prepare a 26½" red wire. Connect one end to DS #6. (S-2).
- 12( ) Prepare a 2" black wire. Connect one end to DS #8. (S). Connect the other end to DS #2.
- 13( ) Prepare a 24½" black wire. Connect one end to DS #2. (S-2). Twist this wire lightly together with the red wire from step 11, and place them under the circuit board with the previous group at RV. The pictorial diagram differs for clarity.
- 14( ) Prepare a 22" green wire. Connect one end to DS #7. (S).
- 15( ) Prepare a 20" red wire. Connect one end to DS #1. (S). Twist this wire lightly together with the green wire from step 14, and place them under the circuit board at RV. The pictorial diagram differs for clarity.

On the PC-29 circuit board the "eyelets" are actually plated-through holes in the board, rather than hollow rivets. If a hole is not already filled with solder, you will likely find it easier to make future connections by doing this now. "Tin" each wire with solder before connecting it to the board.

- 16( ) Select the red and green twisted pair from under the board at RV, and connect the red wire to eyelet #17. (S). Connect the green wire to eyelet #14. (S).
- 17( ) Select the red and black pair at RV and connect the black wire to eyelet #7. (S). Connect the red wire to eyelet #4. (S).
- 18( ) Select the red, green and black group at RV and connect the green wire to eyelet #3. (S). Connect the red wire to eyelet #2. (S). Connect the black wire to eyelet #1. (S).



- 19( ) Prepare a 5½" red wire and a 5½" black wire. Twist these wires *tightly* together uniformly throughout their length (about 3 full turns every 2"). Connect one end of the red wire to eyelet #21. (S). Form a small hook in the corresponding end of the black wire and squeeze it around the projecting terminal on eyelet #22. Keep it close to the board at the base of the terminal and *solder* this connection.

This was the first of 4 black wires which will be connected in like manner to this projecting terminal at eyelet #22. As each wire is added, keep it close to the previous wire to allow room for other connections. It is best to solder each wire individually to be sure of a good ground connection, although the final step will indicate that all 4 wires are to be soldered. Do not use too much heat, or the terminal could be dislodged from the eyelet hole.

- 20( ) Connect the red wire of the short red and black twisted pair to RV lug #2. (S). Connect the black wire to RV lug #3.
- 21( ) Prepare a 9" black wire and a 9" green wire. Twist these wires *tightly* together as before, and connect the green wire to eyelet #23. (S). Connect the black wire to eyelet #22. (S). At the other end connect the green wire to LV #5. (S). Connect the black wire to LV #6. This pair should be placed against the front panel toward RV.
- 22( ) Prepare a 12" green wire. Pass one end under the board at RV and connect it to eyelet #16. (S). Connect the other end to DL lug #2. (S).
- 23( ) Prepare a 14" black wire. Pass one end under the board at RV and connect it to eyelet #13. (S). Connect the other end to DR lug #4. (S).
- 24( ) Prepare a 16" green wire and an 18" black wire. Start with two even ends, and twist these wires lightly together to within 3" of the other end of the green wire. With the uneven ends near the center of the panel, pass the even ends under the board at RV, and connect the green wire to eyelet #11. (S). Connect the corresponding end of the black wire to eyelet #10. (S).
- 25( ) Prepare a 4" white wire, but strip ½" of insulation from one end. Connect the shorter bared end to lug #2 of the power switch PS. (S). Pass the longer end through TL lug #5 and connect it to TL lug #6.

*NOTE:* Skip this step if the international transformer #464030 is used, and to be wired for 200, 220 or 240 volts AC.

- 26( ) Prepare a 4½" white wire, except strip ½" of insulation from one end. Connect the shorter bared end to PS lug #1. (S). Pass the other end through TL lug #3, and connect it to TL lug #4.
- 27( ) Strip a ½" piece of black wire bare, and connect it between TL lug #1 and TL lug #2.

*NOTE:* If this amplifier uses the international power transformer, part #464030, and is to be wired for either 200, 220 or 240 volts AC, connect a 100,000 ohms resistor (brown-black-yellow) in place of this short piece of wire.

You may trim the leads of the 2 indicator lamps to a convenient length. Be sure to twist the strands together and tin them before you make the connection so that there is no possibility of a loose strand touching an adjacent terminal. The two leads of each lamp are interchangeable.

- 28( ) Connect one lead from *each* lamp to TL lug #4. (S-3).
- 29( ) Connect the remaining lead from lamp PL to TL lug #5. (S-3). [One through wire = 2].
- 30( ) Connect the remaining lead from lamp HL to TL lug #2. (S-2).
- 31( ) Prepare a 2" white wire. Connect one end to PS lug #6. (S). Connect the other end to PS lug #3. You may wish to solder lug #3 for security until a further connection is made to this lug.

## FINAL ASSEMBLY

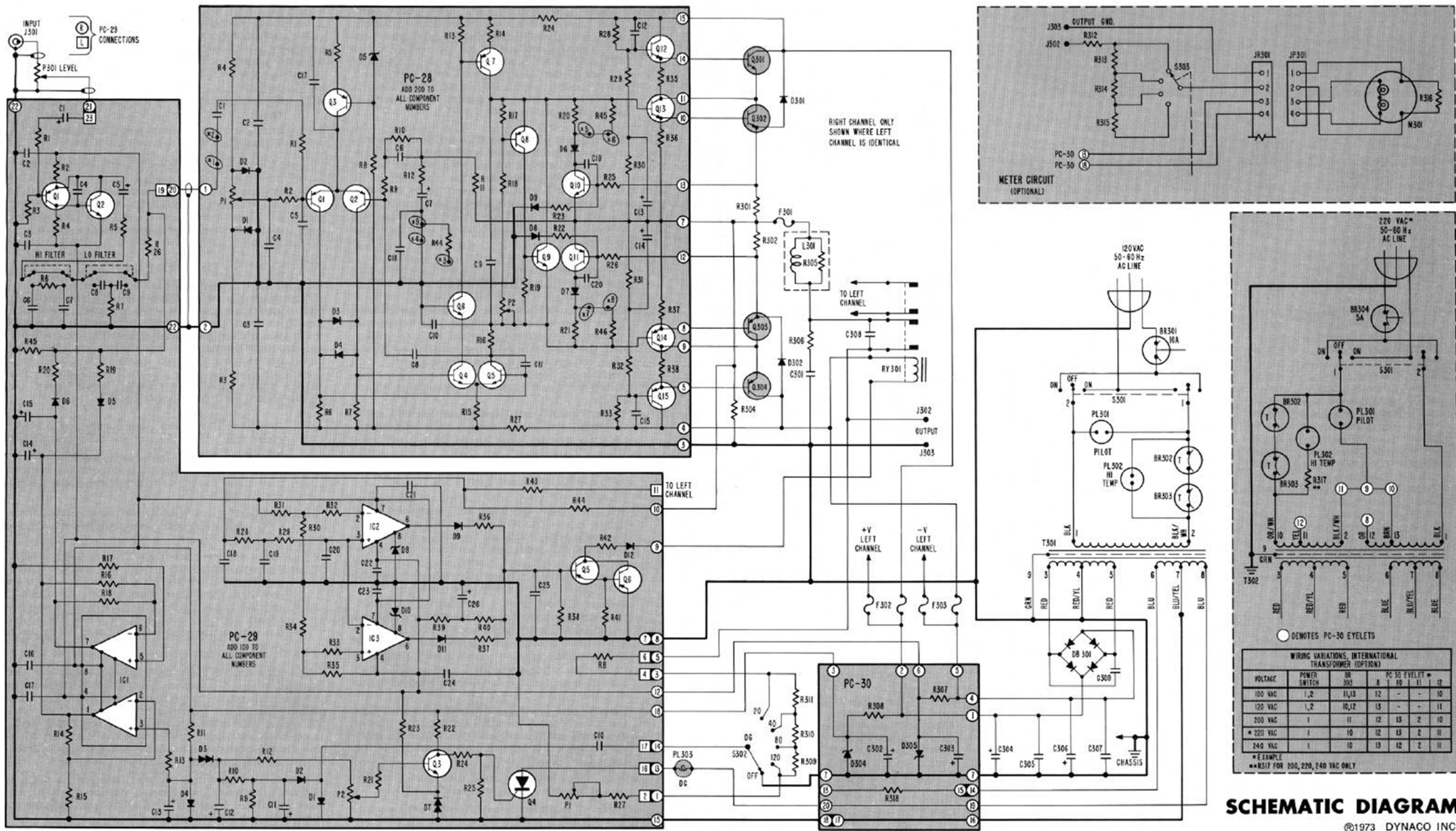
Now place the main chassis and the front panel in their approximate positions, with the front panel laid flat. The twisted groups of wires previously tucked under the chassis should be brought above the panel. Select two ⅝" #6 sheet metal screws, and loosely fasten the edges of the chassis to the front panel. Since these screws cut their own threads, the panel hole is smaller, and some force is required. This will help keep things stable while making connections.

- 1( ) Prepare a 9" red wire. Connect one end to PC-30 eyelet #20. (S). Connect the other end to DR lug #3. (S-2).
- 2( ) Select the white wire from the circuit breaker from under the power transformer. Connect it to PS #3. (S-2).
- 3( ) Strip a 1" piece of white wire bare. Form it into a "U" ½" wide, and connect it between PS #4 and PS #5. Solder both lugs.
- 4( ) Select the free end of the line cord from under the power transformer, twist the strands together and tin them, form a hook in this end, and connect it to the link of wire between PS lugs #4 and #5. (S). Make sure that there is *no possibility* for any bare leads to touch the wrong terminal on the switch, or any part of the front panel.

The following 2 steps describe the wiring for the standard power transformer, part #464026. When the international power transformer, part #464030, is installed, even if it is presently to be wired for 120 volts, the wiring will differ because of the additional leads. Instructions for wiring it will be found on page 36 of this manual, and these should be followed now in place of the following 2 steps.

Transformer leads may be shortened for neatness if you wish. However, be sure you do not cut them too short for re-use, especially if an alternative line voltage connection may be needed in the future.

Now turn to page 24.



## SCHEMATIC DIAGRAM

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## SCHEMATIC DIAGRAM COMPONENT VALUES

All resistors are 1/4 watt, 5% unless otherwise indicated.

	PART #		PART #		
R101	470 ohms	119471	R209	100 ohms	119101
R102	1,000 ohms	119102	R210	22,000 ohms	119223
R103	120,000 ohms	119124	R211	6,200 ohms	
R104	10,000 ohms	119103		5% 1/2 watt film	133622
R105	470 ohms	119471	R212	220 ohms	119221
R106	470 ohms	119471	R213	130 ohms	119131
R107	18,000 ohms	119183	R214	150 ohms	119151
R108	3,900 ohms	119392	R215	100 ohms	119101
R109	15,000 ohms	119153	R216	22 ohms	119220
R110	10,000 ohms	119103	R217	1,000 ohms	119102
R111	100,000 ohms	119104	R218	2,200 ohms	119222
R112	680 ohms	119681	R219	1,000 ohms	119102
R113	100,000 ohms	119104	R220	39 ohms	119390
R114	100,000 ohms	119104	R221	39 ohms	119390
R115	10,000 ohms	119103	R222	2,400 ohms	119242
R116	10,000 ohms	119103	R223	2,400 ohms	119242
R117	5,100 ohms	119512	R224	10 ohms AB	119100
R118	10,000 ohms	119103	R225	100 ohms	119101
R119	100 ohms	119101	R226	100 ohms	119101
R120	100 ohms	119101	R227	10 ohms AB	119100
R121	2,700 ohms	119222	R228	1,000 ohms	
R122	8,200 ohms	119822		5% 2 watt	110102
R126	680 ohms	119621	R229	750 ohms	
R127	100 ohms	119101		5% 2 watt	110751
R128	150,000 ohms	119154	R230	300 ohms	
R129	150,000 ohms	119154		5% 1 watt	116301
R130	1,000 ohms	119102	R231	300 ohms	
R131	7,500 ohms	119752		5% 1 watt	116301
R132	390,000 ohms	119394	R232	750 ohms	
R133	390,000 ohms	119394		5% 2 watt	110751
R134	1,000 ohms	119102	R233	1,000 ohms	
R135	7,500 ohms	119752		5% 2 watt	110102
R136	3,300 ohms	119332	R235	47 ohms	
R137	3,300 ohms	119332		5% 1/2 watt AB	103470
R138	47,000 ohms	119473	R236	47 ohms	
R139	5,600 ohms	119562		5% 1/2 watt AB	103470
R140	5,600 ohms	119562	R237	47 ohms	
R141	10,000 ohms	119103		5% 1/2 watt AB	103470
R142	200 ohms		R238	47 ohms	
	5% 2 watt	110201		5% 1/2 watt AB	103470
R143	200,000 ohms	119204	R244	6,800 ohms	
R144	100,000 ohms	119104		5% 1/2 watt	113682
R145	390,000 ohms	119394	R245	39 ohms	119390
R146	2,200 ohms	119222	R246	39 ohms	119390
R147	2,700 ohms	119272			
			R301	0.18 ohms	
R201	1,000 ohms	119102		3% 10 watt	120180
R202	22,000 ohms	119223	R302	0.18 ohms	
R203	33,000 ohms	119333		3% 10 watt	120180
R204	33,000 ohms	119333	R304	1,000 ohms	
R205	4,700 ohms	119472		10% 5 watt	120107
R206	2,200 ohms	119222	R305	10 ohms	
R207	2,200 ohms	119222		10% 10 watt (part	
R208	100,000 ohms	119104		of L301 assembly)	453001
			R306	10 ohms	
				10% 5 watt	121105
			R307	600 ohms	
				10% 10 watt	120601
			R308	850 ohms	
				10% 10 watt	120851
			R309	110 ohms	119111
			R310	270 ohms	119271
			R311	360 ohms	119361
			R312	7,500 ohms	119752
			R313	7,500 ohms	119752
			R314	15,000 ohms	119153
			R315	12,000 ohms	119123
			R316	1,000 ohms 1/2 watt	113102
			R317	100,000 ohms 1/2 watt	102104
			R318	3.3 ohms	103030
			BR301	AC line breaker	
				10A	342700
			BR302	thermal sensor	
				85°C 15A	342001
			BR303	thermal sensor	
				85°C 15A	342001
			BR304	AC line breaker 5A	342701
			C101	4.7 mfd 15v 20%	
				tantalum	282505
			C102	.01 mfd 100v 20%	
				disc	234103
			C103	.01 mfd 100v 20%	
				disc	234103
			C104	12 mmfd disc	244120
			C105	10 mfd 15v	281106
			C106	.0082 mfd 100v 5%	
				mylar	264822
			C107	.0082 mfd 100v 5%	
				mylar	264822
			C108	.47 mfd 100v 10%	
				mylar	260474
			C109	.47 mfd 100v 10%	
				mylar	260474
			C110	35 mfd 30v	
				non-polarized	283366
			C111	5 mfd 15v	283505
			C112	5 mfd 15v	283505
			C113	500 mfd 3v	281507
			C114	50 mfd 10v	281506
			C115	50 mfd 10v	281506
			C116	.01 mfd 100v 20%	
				disc	234103
			C117	.01 mfd 100v 20%	
				disc	234103
			C118	.47 mfd 100v 5%	260474
			C119	.47 mfd 100v 5%	260474
			C120	.47 mfd 100v 5%	260474
			C121	.01 mfd 100v 20%	
				disc	234103
			C122	.01 mfd 100v 20%	
				disc	234103
			C123	.01 mfd 100v 20%	
				disc	234103
			C124	.01 mfd 100v 20%	
				disc	234103

		PART #		PART #		PART #		
C125	200 mfd 3v	281207	D108	silicon diode		P201	1,000 ohms trimpot	190103
C126	470 mfd 12v	283507		1N4148	543148	P202	1,000 ohms trimpot	190103
			D109	silicon diode				
				1N4148	543148			
C201	5 mfd 15v tantalum	282503	D110	silicon diode		P301	100,000 ohms	
C202	.1 mfd 100v 20%			1N4148	543148		½ watt linear	142104
	disc	224104	D111	silicon diode				
C203	.1 mfd 100v 20%			1N4148	543148			
	disc	224104	D112	silicon diode		PL301	neon lamp	521021
C204	50 mfd 10v			1A 200prv		PL302	neon lamp	521021
	non-polarized	282506		1N4003	544012	PL303	#53 lamp	526053
C205	180 mmfd 100v 10%	224181	D201	silicon diode				
C206	.47 mfd 100v 5%	260474		1N4148	543148			
C207	320 mfd 6v	281327	D202	silicon diode				
C208	47 mmfd 100v 10%			1N4148	543148			
	disc	224470	D203	silicon diode		Q101	transistor 2N3962	562962
C209	.1 mfd 100v 20%			1N4148	543148	Q102	transistor SE4010	572010
	disc	224104	D204	silicon diode		Q104	thyristor 2N5061	574061
C210	.001 mfd 100v 10%			1N4148	543148	Q105	transistor FT4356	562356
	disc	240102	D205	zener diode		Q106	transistor 2N4889	562889
C211	82 mmfd 100v 10%			14v .4w 5%	540014			
	disc	224820	D206	silicon diode		Q201	transistor 2N4889	562889
C212	.001 mfd 100v 10%			1N4148	543148	Q202	transistor 2N4889	562889
	disc	240102	D207	silicon diode		Q203	transistor 2N4889	562889
C213	200 mfd 15v	283207		1N4148	543148	Q204	transistor 2N3440	572440
C214	200 mfd 15v	283207	D208	silicon diode		Q205	transistor 2N3440	572440
C215	.001 mfd 100v 10%			1N4148	543148	Q206	transistor 2N3440	572440
	disc	240102	D209	silicon diode		Q207	transistor 2N5415	562415
C217	.001 mfd 100v 10%			1N4148	543148	Q208	transistor BC308B	567070
	disc	240102				Q209	transistor SE6020A	577021
C218	180 mmfd 100v 10%	224181	D301	silicon diode		Q210	transistor SE6020A	577021
C219	.022 mfd 100v 10%	264223		1A 200prv	544012	Q211	transistor BC308B	567070
C220	.022 mfd 100v 10%	264223	D302	silicon diode		Q212	transistor TIP41C	577041
				1A 200prv	544012	Q213	transistor TIP41C	577041
			D304	zener diode		Q214	transistor TIP42C	567042
				13v 1w 5%	540113	Q215	transistor TIP42C	567042
			D305	zener diode				
				13v 1w 5%	540113			
C301	.1 mfd 100v 20%					Q301	transistor 2N5630	571104
	disc	224104				Q302	transistor 2N5630	571104
C302	500 mfd 15v	281508				Q303	transistor 2N6030	561356
C303	500 mfd 15v	281508				Q304	transistor 2N6030	561356
C304	10,000 mfd 80v	284109	DR301	silicon diode bridge				
C305	.1 mfd 100v 20%			25A	544504			
	disc	224104						
C306	10,000 mfd 80v	284109	F301	fuse 5A 3AG	342006			
C307	.1 mfd 100v 20%		F302	fuse 6A SAG	342025	RY301	relay DPST	
	disc	224104	F303	fuse 6A SAG	342025		15A 48v coil	539248
C308	.1 mfd 100v 20%							
	disc	224104	IC101	IC NE5558	587458			
C309	.01 mfd 1000v disc	228103	IC102	IC LM301AH	587709	S101	switch 8PDT dual	338000
			IC103	IC LM301AH	587709			
D101	silicon diode					S301	switch DPDT	
	1N4148	543148					rotary 15A	333241
D102	silicon diode		L301	choke assembly		S302	switch DP5T rotary	333025
	1N4148	543148		(wound on R305)	453001	S303	switch DP4T rotary	333020
D103	dual silicon diode							
	BZ102	545361	M301	meter, dB, 3½"	508028			
D104	silicon diode					T301	power transformer	464026
	1N4148	543148				T302	power transformer,	
D105	silicon diode						international model	464030
	1N4148	543148	P101	470 ohms trimpot	140471			
D106	silicon diode							
	1N4148	543148						
D107	silicon diode							
	1N4148	543148						

- 5( ) Twist tightly together the strands on the black [1] transformer lead and tin them with solder. Connect this lead to TL #6. (S-2).
- 6( ) Twist together and tin the strands of the black/white [2] transformer lead, and connect it to TL #1. Another connection will be made to this terminal later, but you may wish to solder this lead for security.
- 7( ) Pass the red, black and green group of wires from the PC-30 power supply board under PC-29 at RV, and connect the green wire to eyelet #18. (S). Make sure this wire is soldered to the circuitry on *both* sides of the board. Connect the black wire to eyelet #15 of PC-29. (S). Connect the red wire to eyelet #12. (S). Make sure this wire also is soldered to the circuitry on *both* sides of the board.
- 8( ) Pass the red and green pair of wires from the rear terminal strip on the relay mounting plate, under the plate and under PC-29 at RV, and connect the red wire to eyelet #6. (S). Connect the green wire to eyelet #5. (S). The pictorial diagram differs for clarity.
- 9( ) Pass the red and black pair of wires from the relay and front terminal strip under PC-29 at RV, and connect the red wire to eyelet #9. (S). Connect the black wire to eyelet #8. (S). The diagram differs for clarity.

Select the heat sink assembly and make one final check of its wiring, and all solder connections for a smooth, shiny flow of solder. Check particularly the orientation of the 4 diodes.

Set the heat sink in its approximate position (with the circuit boards facing you, and to your left) at the rear of the chassis. Place the protruding wires approximately as follows:

The long white pair down along the chassis between C2 and the large brace, and then under the wires to PC-30, and up to the right. The diagram differs.

The pair of blue wires, and the pair of black wires under the relay plate, and around C2 to the ground lugs. These are long for future service access.

The single yellow wire, and the single white wire under the relay plate and across the front panel.

The 3 pairs of heavy wires (blue and white, blue and yellow, yellow and white) over the top of the relay plate.

The four pairs of lighter wires (2 each red and black, green and black) around the outside of C1 and across the front panel to the left of PC-29.

The pairs of wires in the following two steps should be connected to the *same* ground lug as shown in the diagram. Be sure each wire is *very* well soldered for a secure ground connection to avoid hum.

- 10( ) Select the pair of blue wires under the relay plate. Connect both to the same ground lug at the base of C2, and solder each carefully.
- 11( ) Select the pair of black wires under the relay plate and connect both to the same ground lug at the base of C2. (S). Check that all 9 wires to these two ground lugs are securely soldered.

- 12( ) Select the long pair of white wires. Connect one wire to TL #3. (S-3). [One through wire = 2]. Connect the other wire to TL #1. (S-3). Place these wires down near switch DS and in front of the diode block. Excess length should be stored at the rear.

NOTE: With the international transformer, the number of wires soldered at each lug may differ.

- 13( ) There is a single white wire and a single yellow wire *under* the relay plate. Do not confuse these with the single white and yellow wires *attached* to the relay plate which already have terminal clips installed. Select the 2 wires which come from the heat sink, and a terminal clip, and install a clip on the white wire. (S). Then select the black and green pair on the front panel, and connect the green wire to the terminal clip you have just mounted on the white wire. (S).
- 14( ) Select the single yellow wire from under the relay plate and pass it behind and to the right of the blue and yellow wires connected to the relay plate front terminal strip. Select a terminal clip, and install it on this yellow wire. (S). Select the black wire from the black and green pair, and connect it to this terminal clip as well. (S).
- 15( ) Select the blue and yellow pair and connect the yellow wire to fuse block lug #5. (S-2). Connect the blue wire to fuse block lug #6. (S).
- 16( ) Select the white and yellow pair and connect the yellow wire to LT lug #5. (S-3). Connect the white wire to LT lug #4. (S-3).
- 17( ) Select the blue and white pair and connect the white wire to fuse block lug #2. (S). Connect the blue wire to fuse block lug #1. (S).
- 18( ) There are 2 red and black twisted pairs. Select the pair from grommet G2 and connect the black wire to RV lug #3. (S-2). Connect the red wire to RV lug #1. (S). Be careful when working near these controls that you do not burn the insulation on adjacent wires.
- 19( ) Of the 2 green and black pairs, select the pair from grommet G2 and connect the black wire to LV lug #6. (S-2). Connect the green wire to LV lug #4. (S).
- 20( ) Select the red and black pair from the right channel PC-28 board eyelets 1 and 2, and connect the red wire to PC-29 eyelet #20. (S). Connect the black wire to the terminal at eyelet #22. (S).
- 21( ) Select the green and black pair from the left channel PC-28 board, and connect the green wire to eyelet #19. (S). Connect the black wire to the terminal at eyelet #22. (S-4). Be sure that this terminal is still securely fastened to the circuit board.
- 22( ) Select the 2 small #53 light bulbs and install them in the bayonet sockets on the front panel.

Check to make sure the 5 brackets under the heat sink are positioned properly for mounting. The bracket on the left end faces outward, and the others downward.



Make certain that no wires are likely to be pinched between the chassis and the heat sink rib, and that there are no loose pieces of wire or solder under the heat sink. Be very careful of components on the circuit boards. Place the extra length of the white wire pair behind the power transformer, and position the other wires down against the chassis. Slide the heat sink forward into position so that the back rib is flush with the edge of the chassis, and see if the holes in the brace align with holes in the heat sink. If not, either support the chassis underneath in the center to counteract bowing due to transformer weight, or shift the transformer slightly if it is interfering with the brace. In the next step, a screwdriver with at least a 5/16" shaft should be used.

- 23( ) Select 2 #6 short screws and lockwashers, and place the lockwashers on the screws. Slide the heat sink 1/4" to the rear to enable you to install the screw in the lower hole of the brace. Hold it in position with the screwdriver while you slide the heat sink forward to engage the screw, making certain that you do not pinch any wires under the heat sink. Once the lower screw is started, use the same technique to hold the upper screw until it is started. Do not fully tighten these screws yet.
- 24( ) Select 2 more #6 short screws and lockwashers, and place the lockwashers on the screws. Use these to attach the line cord Z-bracket to the heat sink. You may first need to loosen the 4 screws holding the bracket to the chassis. Tighten all these securely.
- 25( ) Select 2 #8 screws and lockwashers. Install these at the other end of the heat sink through the edge of the chassis, and tighten.

If you intend to install the MC-4 accessory meter kit on this amplifier, refer to those instructions now to save you some disassembly time later. See page 35 of this manual.

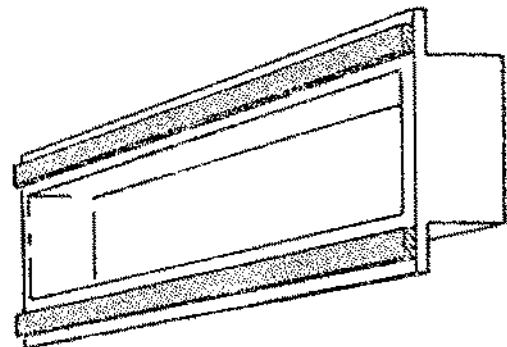
Now is the time to carefully examine the chassis and front panel to remove any loose pieces of wire or solder. If you feel ambitious, you can first complete the next 2 steps, and then pick the amplifier up, turn it over, and shake out any loose particles!

You (or preferably someone else) should check out every visible connection against the pictorial diagram. Make one last critical check of all solder connections for a smooth, shiny, unbroken flow of metal. Also make sure that none of the finned heat sinks on transistors located on the boards can contact one another, or that components have been moved so that there is any possibility of contact between adjacent bare leads.

- 26( ) Check to make sure that the terminal clips are all securely installed on the diode block, and that there are no wires close to the relay where they may impede its operation. Make sure all of the twisted groups of wires along the front panel are positioned along the lower edge where they will be clear of the long opening near the bottom of the panel. Select the 2 yellow wires with terminal

clips installed (one with a black wire attached) and push them through the long opening to the right of lamp DR. Push the two white wires (one with green) with terminal clips through the opening to the left of lamp DL. Swing the panel upright, making sure that no wires are pinched between the panel and the chassis. Watch that the twisted pairs of wires to the PC-29 board do not interfere with any components on the PC-28 boards. Select 2 #6 short screws and lockwashers, install the lockwashers, and secure the front panel to the vertical chassis brace. Tighten these, and both screws at the back of the brace into the heat sink as well.

- 27( ) Tighten the two #6 sheet metal screws at the ends of the front panel. Check to be sure that no wires near the power switch on the control RV can be pinched by these screws with their sharp threads.
- 28( ) Select the gold front plate, the dark rectangular plastic insert, and the two lengths of rubber stripping. Cut the stripping to fit the length of the plastic insert, and remove the protective backing to expose the self-adhesive side. Apply one piece to each back flange of the insert as shown, and install the insert from the back side of the front plate.



- 29( ) Select the 2 square black plastic fuse holders. Note that one face is designated "top". With this surface facing the top edge of the front plate, install each fuse holder from the front of the plate so that it snaps into position. The caps will be installed later.
- 30( ) Bring the front plate close to the front panel and install the 4 terminal clips on the fuse holder lugs while pressing against the front surface of the holder to prevent it from being dislodged.
- The white + green to lower lug of channel A.  
The white to upper lug of channel A.  
The yellow + black to lower lug of channel B.  
The yellow to upper lug of channel B.
- 31( ) Select the remaining three 3/8" nuts and the remaining 1/2" nut. Fasten the front plate assembly to the front panel with these nuts on the control shafts. Check to make sure that the white wires to the channel A fuse holder in particular do not get pushed back to where they can interfere with the operation of the relay.

- 32( ) Select the 2 black push buttons and press them onto the switch shafts.
- 33( ) Select the 4 knobs, the 4 Allen set screws, and the L-shaped Allen wrench. Install the set screws in each knob by first placing the set screw on the end of the wrench for easier handling. The set screw engages the flat portion of the shaft of each control. Push the knob "home" on the longer shafts, and adjust the knob position to match if any are slightly shorter. Be careful you do not scratch the panel as you tighten each screw securely.

If you have access to a vacuum tube voltmeter, transistorized voltmeter, or a volt/ohm/milliammeter with a sensitivity of at least 20,000 ohms per volt, there are some measurements which can be made to verify basic operational integrity. These are described under "Preliminary Tests" at the conclusion of these instructions. Now is the easiest time to perform them.

- 34( ) Select the 4 shorter (6 ampere) fuses and install them in the fuse blocks on the relay plate.
- 35( ) For the front panel fuse holders (speaker fuses) the kit includes a pair of 5 ampere rating, and a pair of 1 ampere rating. The fuse size you use will determine what, if any, protection they provide for your speakers. The 5 ampere value enables the amplifier to be driven to full output for 8 ohm and 16 ohm tests. It provides *no speaker protection*. We recommend you install the 1 ampere size, and read the section of this manual covering this matter in depth. Select the two fuse holder caps, snap the appropriate fuse into the cap, and insert it with the lettering upright, pressing against the *upper half* of the cap. (To remove the fuse, press the lower portion of the cap). The cap snaps securely into position when fully seated.
- 36( ) Select 4 #6 short screws and lockwashers, and the black cover. The back lip of the cover stays forward of the heat sink and the upright portion of the line cord Z-bracket. The side flanges go inside the upturned chassis ends. Place lockwashers on the screws, and install the screws through the ends of the chassis.
- 37( ) Select the 8 black #6 short self-tapping screws and install them around the front edge of the cover.
- 38( ) Select 2 #6 sheet metal screws and fasten the vertical portion of the Z-bracket to the back of the cover.
- 39( ) Be careful not to rest the weight of the amplifier on the front or knobs, or on the output binding posts at the rear. Turn the amplifier over and install the remaining hardware to secure the heat sink (8 #8 screws and lockwashers) and the front panel (4 #6 sheet metal screws).
- 40( ) Make sure the back heat sink fin surface is clean. Remove the paper backing from the self-adhesive long metallic label, and affix it to the portion of the fin just above the curve at the base. Remove the backing from the serial number label and center it above the other label.

This completes the assembly. You may wish to secure the Allen wrench with tape underneath the chassis for future needs. Be sure that you read the entire section on operating instructions before you connect this amplifier to loudspeakers. A unit of such power is quite capable of damaging any loudspeaker if it is improperly used.

### PRELIMINARY TESTS

The availability of a VTVM, TVM, or VOM with at least 20,000 ohms per volt sensitivity will enable you to make some checks to minimize the likelihood of trouble. Since each PC-28 and PC-29 circuit board has been checked in actual operation prior to packing into the kit, a component fault there is most unlikely. However, a splash of solder, poor or wrong connections, or broken or shorting component leads can result in failure. These tests can help prevent a minor construction error from causing a costly major breakdown.

All of the following checks should be made *before the amplifier is turned on*, and with all of the 6 fuses (4 power supply; 2 speaker) out of the circuit.

1. From fuse block lugs #1, 2, 5 and 6 (amplifier heat sink side) to ground: 2900 ohms  $\pm$  150 ohms.
2. From each PC-28 eyelet #7 to ground: 900 ohms  $\pm$  150 ohms.

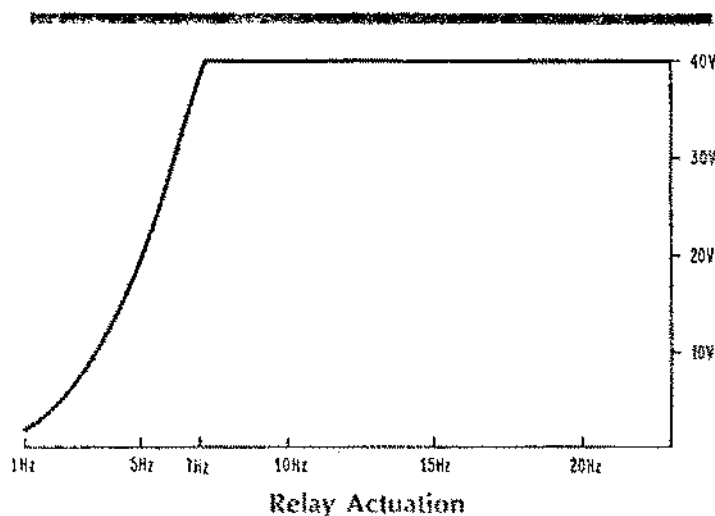
Some meters may indicate lower readings. Or, reversing the meter leads may give a proper reading. As a rule, so long as neither a short circuit nor an open circuit is indicated for these tests, you may proceed.

If these checks are satisfactory, plug in the amplifier. Turn the power switch to either "on" position for the following DC voltage checks. If an incorrect measurement is obtained, be sure to turn off and *unplug the amplifier* before proceeding further.

3. From fuse block lugs #3 and 4 (white wire) to ground: +74 volts  $\pm$  2 volts.
4. From fuse block lugs #7 and 8 (yellow wire) to ground: -74 volts  $\pm$  2 volts.
5. From PC-29 eyelet #18 to ground: +13 volts  $\pm$  1 volt.
6. From PC-29 eyelet #12 to ground: -13 volts  $\pm$  1 volt.

If all of these are satisfactory, unplug the amplifier and complete final assembly steps.

If an incorrect measurement is obtained, refer to "In Case of Difficulty" before proceeding further.



## TECHNICAL INFORMATION

### IN CASE OF DIFFICULTY

If your Stereo 400 passes all the preliminary tests, and appears to function satisfactorily, you can usually assume it is meeting all of its specifications. If difficulties are encountered in a unit as complex as this, the average kit builder should confine his servicing to the basic suggestions given here, and if a suitable meter is not available you should attempt *only* the most rudimentary check-out yourself. The Stereo 400 is considered to have **NO USER-SERVICEABLE PARTS INSIDE.**

Because 90% of the difficulties which are encountered in kit-built units can be attributed to incorrect wiring or a poor solder connection, it is strongly recommended that you ask someone else to check your wiring against the pictorial diagram, as frequently one person will make the same error repeatedly.

There are certain general precautions to be observed in servicing any transistorized equipment:

1. Never make circuit changes of any kind when the amplifier is turned on.
2. Be particularly careful not to short any transistor leads to each other or to the chassis when the power is on.
3. When using test equipment, you must avoid transient voltage peaks and excessive test voltages.
4. Exercise caution when soldering and unsoldering transistor and diode leads to avoid excessive heat.

### Failure in Preliminary Tests

**Test #1** If a short circuit is indicated, remove the wires to PC-28 eyelets #4 and 15 of the suspect channel. If the same low reading is obtained, the heat sink assembly is faulty, and you should check the power output transistor sockets for shorts, a missing insulator, or other improper mounting. If the new measurement is infinite (open) check the PC-28 board.

If the test indicates too high a resistance, miswiring or a poor solder connection is likely.

**Test #2** If the measurement is very low, remove the wire from the eyelet, and check for the proper 900 ohm resistance from the wire to ground. If it is now correct, check PC-28 for faults. If the measurement is still low, check the heat sink wiring.

If a high reading is obtained, check the heat sink wiring and also the main ground connection at the base of C2 for poor contact.

**Tests #3, 4, 5 and 6** Incorrect values require checking the power supply wiring (the power transformer, diode block, and PC-30) and in particular the orientation of the diodes and capacitors on PC-30. Check for good connections across all of the PC-30 eyelets, including those supporting the resistors.

If **Test #5 or 6** measures low, unsolder the wire from the eyelet. If the voltage on the wire is now normal, check PC-29 for solder splashes, etc. Continued low readings is cause to recheck PC-30.

### No Sound Output

A blown speaker fuse is the most likely cause of interrupted sound on one channel. If the fuse is replaced, and input and output connections are secure, and the level control is clockwise, check the internal audio wiring for short circuits. These are the twisted pairs from the input sockets (through the center heat sink grommet) to the level controls, then to eyelets #21, 22 and 23 on PC-29, and from eyelets #19 and 20 to PC-28 eyelets #1 and 2.

To ascertain if the amplifier is at fault, first interchange the speaker connections at the amplifier output to eliminate a defective speaker or faulty wiring. If the problem does not "follow" the speaker, then interchange the input cables at the back of the amplifier. If the effect then switched channels, it is in the associated equipment or cables ahead of the amplifier.

If there is no sound on either channel, and the pilot lamp is out, reset the red circuit breaker button on the back. If the breaker pops again, do not attempt to reset it before servicing.

If a thermal sensor has shut down the amplifier, the Hi-Temp lamp will light unless it is defective, but a thermal sensor will reset itself after a couple of minutes.

If the "click" of the relay is not heard soon after the power is switched on, unplug the amplifier and check the 4 power supply fuses. If they are intact, check out the relay wiring, and make sure that none of the wiring can physically interfere with the operation of the relay. Then turn the unit on and measure the DC voltage on PC-29 eyelets #10 and 11. If eyelet 11 exceeds  $\pm 0.5$  volt, check the wiring of the left channel. If eyelet 10 exceeds  $\pm 0.5$  volt, check the wiring of the right channel.

If a power supply fuse is open, make the preliminary tests *before replacing the fuse*. When one of these fuses fails, it is most likely that further service is required, and simply replacing the fuse may compound the problem.

### Momentary Sound Interruption

Short duration interruption of the signal on both channels is very likely to be caused by the relay speaker protection circuit. As supplied, it is designed to trip on an output DC threshold of  $1\frac{1}{2}$  volts, for it thus affords some speaker protection against the more violent sonic abuses of dropped tone arms, warped records, tuner muting circuits, etc., in addition to protection against DC offset damage.

We feel such protection is mandatory in a high power amplifier. Customer preference has dictated a change from the  $\frac{1}{2}$  volt sensitivity of earlier Stereo 400s, which afforded even more protection. Should you wish this increased sensitivity, change the value of two resistors on PC-29. R31 and R35 are each now 7,500 ohms (violet-green-red). Changing both to 12,000 ohms will increase sensitivity to 1 volt. Changing both to 27,000 ohms will provide  $\frac{1}{2}$  volt DC sensitivity.

Frequent relay actuation is cause to suspect malfunction or severe input signal problems. If eyelet #7 of PC-28 is not at zero DC, P1 can make small corrections. More than 200 millivolts with no input signal indicates likely amplifier malfunction.

## CIRCUIT DESCRIPTION

The accompanying block diagrams will aid an understanding of the specific circuit concepts expressed in the Stereo 400. Those not interested in the technology may ignore this section.

In brief, the amplifier stages are fully DC coupled, with a complementary driver, and a series connected output stage. The input is a differential pair fed from a constant current source. The full wave bridge power supply includes 10,000 mfd on both plus and minus outputs, providing filtering and dynamic load stability. Fuses on both the plus and minus supplies, volt/amp dissipation limiting, and thermal sensing cutouts provide protection for the amplifier.

The input is actively isolated from the source by a PNP-NPN follower for each channel. The input follower stages feed the switch-selected low and high filters, and then to the amplification stages.

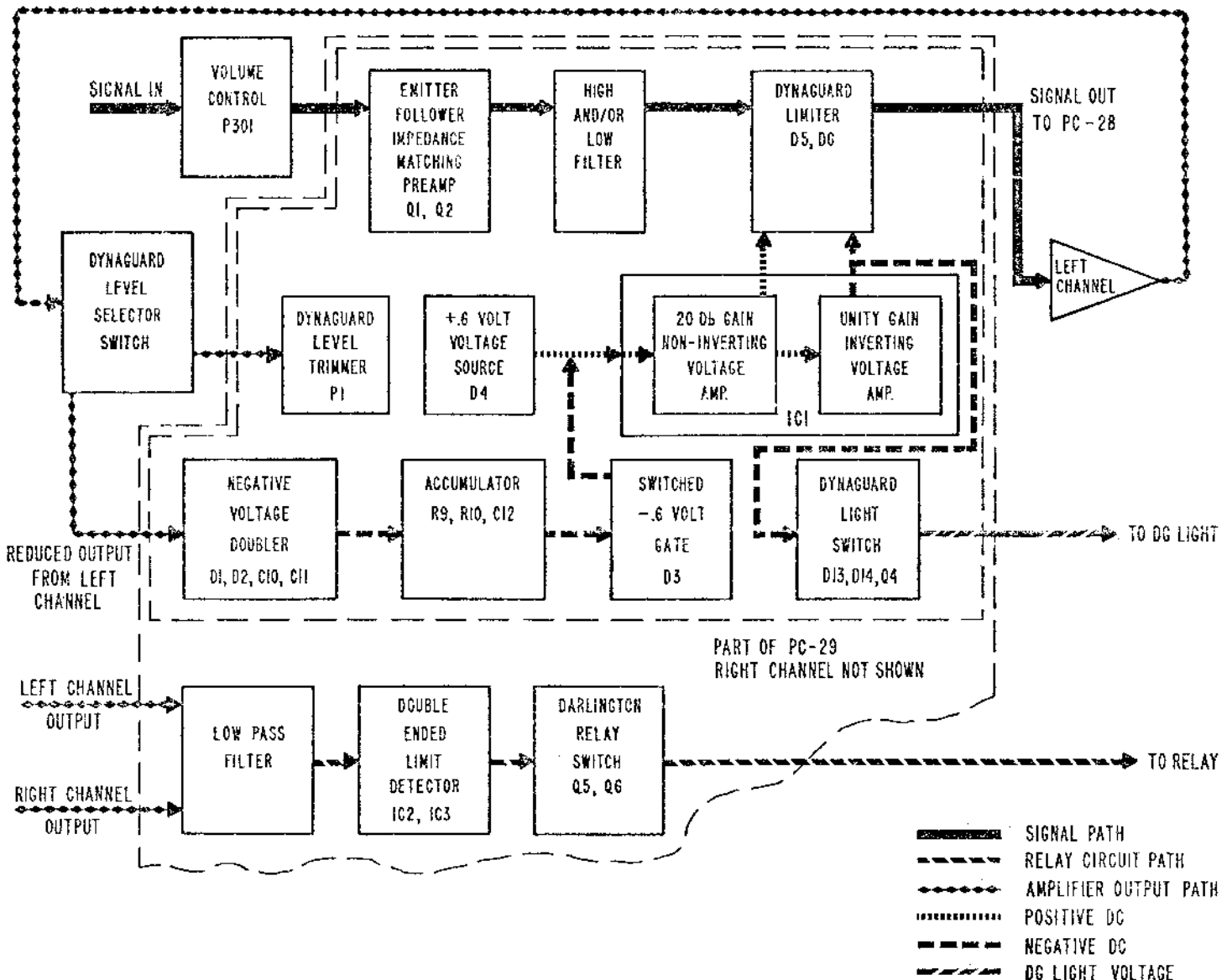
The Dynaguard circuit continuously monitors the rectified and integrated output voltage from the amplifier.

This signal is an indication of the power available to a load at the amplifier output, whether or not a load is connected. When the integrated signal exceeds the reference (permissible) level, the limiting action commences. Dynaguard limits the maximum area under the output voltage curve to the selected level within 1 dB, from its threshold to drive levels above 200 watts. Below its activation threshold it is effectively disconnected.

The DC speaker protection circuit monitors the output of both channels through a low pass filter. This signal is fed to a double ended limit detector with end limits of  $\pm 0.5$  volt DC. Excessive voltage opens the relay and disconnects the load.

To explore the circuit theory in more detail, consider the PC-29 board as three basic sections:

- 1) a) Follower (left and right)—Q1, Q2.
- b) Filters (left and right)—C6, R6, C7; C8, R7, C9.



- 2) Dynaguard circuit (left and right)
  - a) Voltage doubler and accumulator—C10, D1, D2, C11; C12, R9, R10, P1.
  - b) Logic—D3, D4.
  - c) Function—IC1, D5, D6.
  - d) Light control—D7, D13, D14, Q4, R21, R22.
- 3) Relay Circuit
  - a) Low pass filter—C18, R28, C19, R29, C20.
  - b) Double-ended limit detector IC2, IC3, D8, D9, D10, D11.
  - c) Switch Q5, Q6.

### Follower / Filters

This may be described as a voltage follower with approximately unity gain, since the voltage at Q1E is always slightly more positive than the voltage at its base. The driven transistor in the Darlington pair, Q2, provides high current amplification with very low output impedance.

Basic 6 dB/octave single section filters are enhanced to an actual 8 dB/octave characteristic by C6 and the preceding impedance forming an additional low-pass section of the high filter, and C9 and its following impedance forming an additional high-pass section of the low filter.

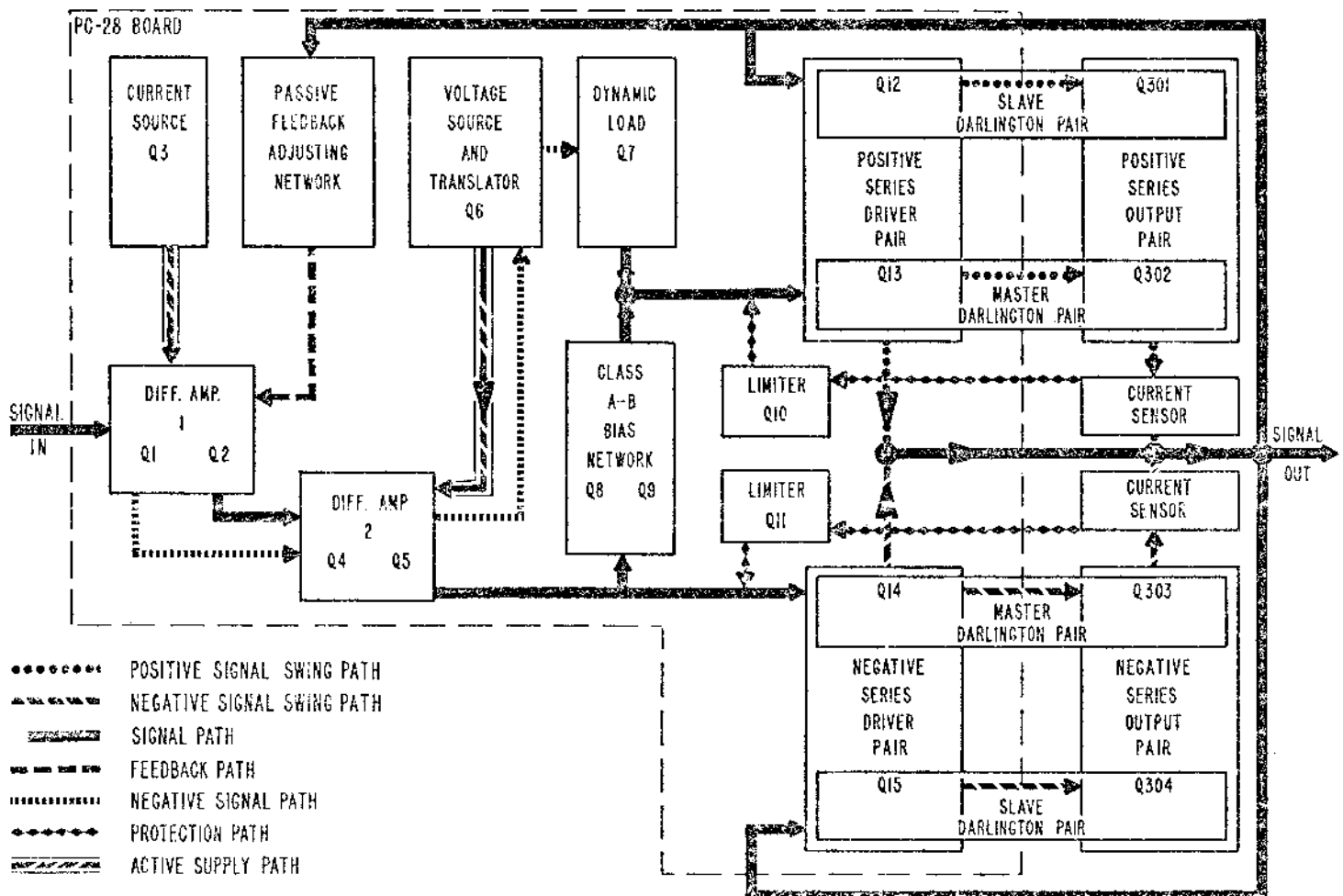
### Dynaguard Circuit

The amplifier's output voltage is proportioned by the setting of the front panel switch and level trimpot P1. It is clamped by C10 and D1, and rectified at peak negative value by D2 and C11. The rectified voltage is then stored in the accumulator C12, R9, R10 which is designed to bleed off the charge at the prescribed rate.

D4 is a +0.7 volt reference voltage source. D3 will start conducting when the voltage at its cathode becomes more negative than -0.7 volts, and any increase there will also appear at the anode of D4, shutting it off as a positive voltage source.

Two operational amplifiers in IC1 serve as a 20 dB voltage amplifier and inverter. When D4 conducts, the amplifier feeds about 5.5 volts to the cathode of D5, which is then inverted with unity gain for the anode of D6. Thus, when D4 is conducting, D5 and D6 are heavily reverse biased and do not affect the signal.

However, when high amplifier output voltage causes D3 to conduct, the voltage input to IC1 will start dropping to zero, and the voltages on D5 and D6 will decrease. The amplifier output will exhibit Dynaguard action when the D5 and D6 voltage becomes low enough to cause the input signal voltage to start limiting. The lowered output will in turn decrease the signal to IC1, thus keeping the limited voltage constant.





The positive-going signal from the anode of D6 provides an on gate voltage for Q4, turning on the Dynaguard signal lamp.

To adjust the Dynaguard threshold level, first switch off Dynaguard, and drive the amplifier to 40 volts out (across 8 ohms, though a load is not required) at a mid-frequency (nominally 1 KHz). Switch to the Dynaguard 120 position and adjust P1 for 31 volts out.

### Relay Circuit

A three-section low pass filter prevents signals above 10 Hz from shutting off the relay. The circuit provides DC continuity to IC2 and IC3, making the relay most responsive to any DC voltages appearing at the amplifier output.

The reference input voltages for the positive and negative limit detectors IC2 and IC3 are set by the ratios of R30 and R31; and R34 and R35. The reference output voltages are set by the voltage divider R46 and R47 in conjunction with diodes D8 and D10. D9 and D11 prevent feedthrough between IC2 and IC3 when either is operating.

Q5 and Q6 are a PNP-PNP Darlington pair used as a switch in series with the relay coil, activated by the output of the double-ended limit detector.

### Driver and Output Stages

Consider the PC-28 circuit board and output stage as five basic sections:

- 1) Differential amplifier #1—Q1, Q2, Q3.
- 2) Differential amplifier #2—Q4, Q5, Q6, Q7.
- 3) Bias Adjuster—Q8, Q9.
- 4) a) Master power amplifier—Q13, Q302 (+ signals).  
—Q14, Q303 (— signals).  
b) Slave power amplifier —Q12, Q301 (+ signals).  
—Q15, Q304 (— signals).
- 5) Protection circuitry—Q10, Q11, D8, D9, R301, R302, D301, D302.

### Differential Amplifier #1

Q1 and Q2 are driven from a constant-current source, Q3. D5 and R5 set the current level through Q3. Q1 and Q2 drive similar loads, ensuring approximately equal signals of opposing phase at the collectors of Q1 and Q2. D1 and D2 limit excessive out of phase signals.

The feedback network consists of R9, R10, R11, R12, C6 and C7. Since the negative feedback to the base of Q2 approximates the signal feeding the base of Q1 when the signal is DC, unity DC gain is ensured. As a result the DC level at the output varies with the DC input to Q1, determined by P1. D1 and D2 maintain a constant voltage across P1, while C2 and C3 are diode noise filters, and C4 is a ripple filter.

### Differential Amplifier #2

The differential pair Q4 and Q5 is driven by the signals on R6 and R7. Their quiescent DC voltages and R15 determine this amplifier's quiescent current. Q6 supplies a constant voltage to the collector of Q4, and transmits the signal current from Q4 to Q7B. Thus Q7B sees a signal of the same phase and amplitude as Q5B. Q5

and Q7 may each be considered as common-emitter amplifiers whose load resistance is the dynamic resistance of the other. C8, C10 and C11 provide high frequency feedback/compensation.

### Bias Adjuster

An adjustable electronic zener with negligible dynamic resistance is formed by Q8, Q9, R17, R18, R19 and P2. Thus the signal sees the bases of Q14 and Q13 tied together. P2 adjusts the zener voltage to bias the amplifier into class AB operation. This circuit determines the quiescent current in the driver and output stages. Q8 is mounted to thermally track the driver transistors, providing temperature compensation for the amplifier.

### Master / Slave Power Amplifier

Only positive signal operation will be covered since the negative portion is similar. The master Darlington amplifier, Q13 and Q302, drives the output line. At the required quiescent current for Q13, R36 maintains Q302 nearly cut off. The centerline signal (eyelet #7) is bootstrapped to the base of Q12 by C13 and R29. The bias network for Q12 is R28, R29 and R30, providing a zero quiescent reference for the output line along with R31, R32 and R33.

As a result of the bootstrapping, the slave Darlington pair, Q12 and Q301, has a signal input identical to that of the master. Thus we have a high current, high voltage output stage, operating effectively as one Darlington amplifier with twice the voltage capability. R304 provides a reference emitter impedance during no-load conditions.

### Protection Circuitry

A volt-amp limiter circuit provides identical protection for both positive and negative sides of the amplifier. Again referring only to positive signal operation, when the current through R301 exceeds a preset limit, the resulting voltage turns on Q10, limiting the drive to Q13 until the current is reduced. Voltage protection is obtained from R23, R25 and D9. Any reverse voltage caused by an inductive load will be limited to 0.7 volts across both output devices by D301.

## SERVICE INFORMATION FOR THE TECHNICIAN

(FOR QUALIFIED PERSONNEL ONLY)

Proper disassembly will contribute measurably to efficient servicing. The lengths of wire connecting separate portions are long enough to permit servicing access without disconnection. While the factory assembled units may not follow the color code employed in the kit, the pictorial diagram which is a part of this manual may also aid the technician.

Most of the information of help to the technician will be found in the detailed circuit description and its accompanying block diagrams in this manual. You should also familiarize yourself with the sections "Preliminary Tests" and "In Case of Difficulty." Voltage test points for the circuit boards will be found at the back of this manual. The parts list for the schematic diagram follows it in the center of the manual.

## Disassembly

1. Remove the perforated cover: 8 black screws; 2 screws at each end; 2 sheet metal screws at the right rear above the line cord.

2. Remove the gold front plate: a nut behind each knob, which requires a #5 Allen wrench; then slide it forward until the clips can be removed from the front panel fuse holders. Squeeze the sides of the holders to remove them from the front plate for reconnection to the output leads. Unplug the meters, if they are installed.

3. Lower the inner front panel: loosen the sheet metal screw at each end; remove four more underneath and the two screws securing it to the vertical brace.

4. Remove the heat sink assembly: two rows of four screws under the rear of the chassis; two screws on each end; two screws through the center brace (a screwdriver with a 5/16" shaft is needed here).

## Servicing and Adjustments

It is recommended that while service work is being performed on one channel, the other channel be disconnected by removing the appropriate power supply fuses to minimize the risk of damage. If any supply fuses are found to be open, all four output transistors for that channel should be checked. A fault on the PC-28 board is cause to check all its suspect transistors with in-circuit resistance measurements. If those tests are inconclusive, each should be pulled out and checked with a transistor tester.

The recommended procedure for reconnection of a channel is: 1) Connect an 8 ohm test load to the output jacks, with *no input* signal. 2) Raise the AC to 120 volts gradually with a variac. Insert the B- fuses on the right side of the relay mounting plate. Monitor the B+ current with a meter in place of the left side fuse(s) on the mounting plate, and adjust the bias on each channel with P202, which should be able to vary the current from 100 to more than 150 ma. Operate for 10 minutes, then adjust P202 for minimal crossover distortion at 2 watts output. Alternatively, set for 150 ma. Be careful that meter connections are secure, and cannot short. Install B+ fuses. 3) Adjust the DC center-line voltage for each channel with P201 for 0 volts ( $\pm 20$  millivolts) at the output. 4) Now apply a signal and monitor it with an oscilloscope. At 200 watts output (into 8 ohms), a 1000 Hz sine wave should draw about 2 amperes. If all measurements check, the 200 watt output should be shorted for 5 seconds to ensure proper protective circuit functioning. The current reading should hold at about 2 amperes during the shorted output test.

## Checking Semiconductors

An ohmmeter can sometimes serve as a gross check for transistor or diode failure. The device must be removed from the circuit. Diodes should have a high resistance in one direction (probe polarity) and a low resistance in the other.

Transistor types vary widely in resistance, but a (near) short circuit indicates probable failure. Readings from base to collector should be similar to those from base to emitter. Both will have a higher reading with one probe polarity

than with the reverse orientation. NOTE: Some types of solid state meters do not provide enough probe voltage to forward bias a silicon junction. Hence, a high resistance reading may be obtained in both directions.

Such gross checks can only ascertain clearly faulty semiconductors. More sophisticated test equipment, or direct substitution is necessary to qualitatively evaluate their performance.

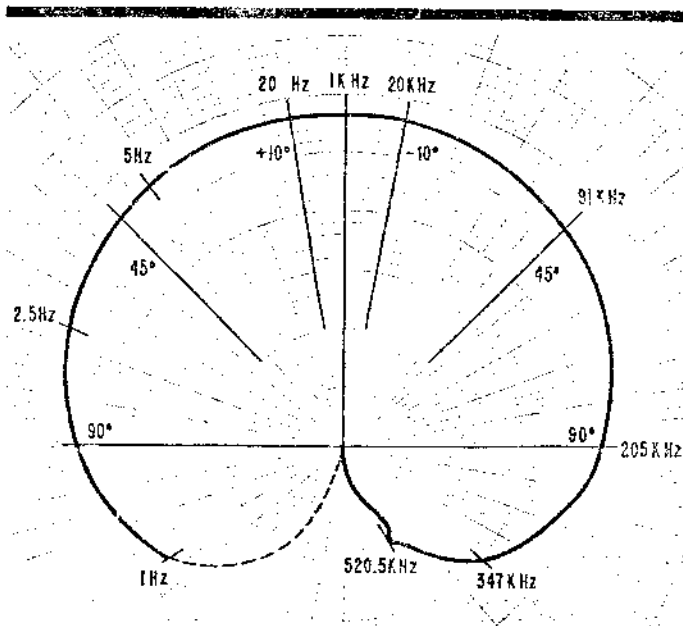
## PERFORMANCE TESTING

The intention to test an amplifier of this power potential assumes a requisite level of technical competence and familiarity with the proper equipment. High power tests, and any distortion tests, require larger output fuses than those normally used. A minimum 5 ampere rating is needed for 8 ohm loads; 9 amps for 4 ohms; and 3 amps for 16 ohms. For mono full power tests at 8 ohms, a 9 ampere fuse is needed in each channel.

Prolonged high power test signals at low impedance at some frequencies may eventually trigger the thermal cut-out even though the heat sink may be fan cooled and does not appear unduly hot. The thermal sensors are mounted on the transistor cases for quick response, and under some conditions the case cannot transfer the heat to the sink fast enough, especially if the amplifier is already hot when the test begins. The thermal sensors shut the amplifier off when they reach 85°C.

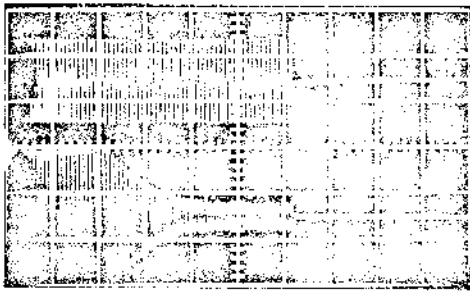
The power supply with its low loss transformer has a high degree of inherent regulation, but since up to 11 amps is drawn, the voltage drop off the line may be appreciable, especially if a variac is used. Thus the AC line must be corrected to 120 volts (measured on an rms reading meter) during high power testing.

The relay circuit will be triggered at relatively low powers below 10 Hz because the longer duty cycle appears as DC to the protective circuit. The amplifier has considerably greater power capability at sub-sonic frequencies than the protective circuits nominally pass.

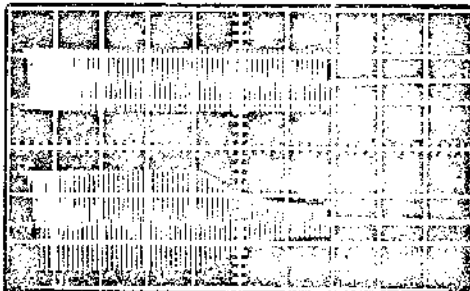


Gain-Phase Relationship

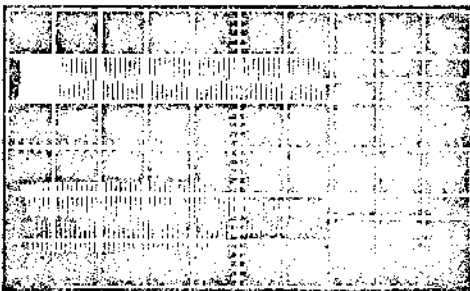
## DYNAGUARD ATTACK AND DELAY CHARACTERISTICS



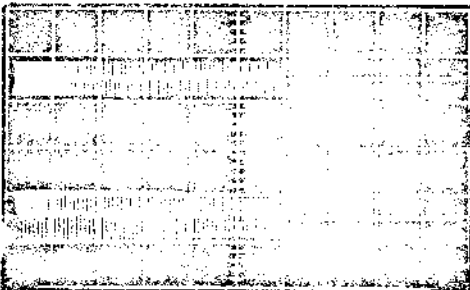
1 second  
200 watt drive / Dynaguard-20  
100 Hz      100 ms/cm



1 second  
100 watt drive / Dynaguard-20  
90 Hz      100 ms/cm



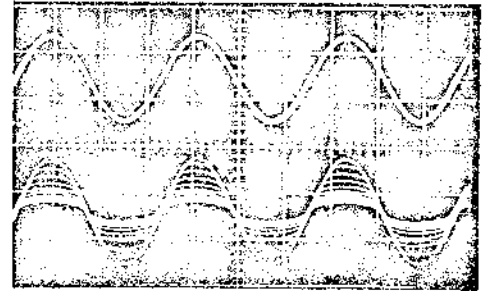
1 second  
50 watt drive / Dynaguard-20  
40 Hz      200 ms/cm



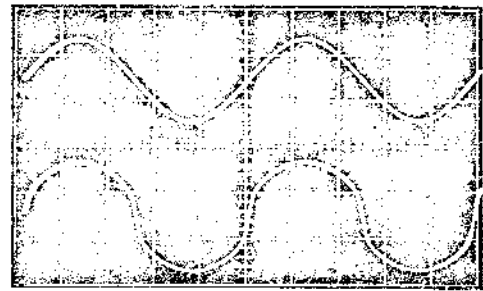
1 second  
30 watt drive / Dynaguard-20  
20 Hz      500 ms/cm

These oscilloscope photographs graphically show the ability of Dynaguard to permit lesser level overdrive signals to pass for substantial periods, while restricting very powerful passages to brief intervals. The input signal is the upper trace. The frequency and traversing rate have been varied to show the signal more clearly, but corresponding time intervals are marked on each display.

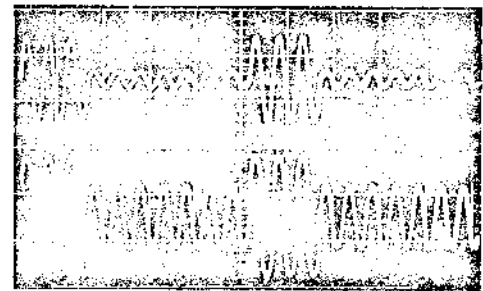
The multiple photograph (input above) shows the family of smoothly limited traces as Dynaguard-20 action is initiated on a 200 watt signal.



Onset of Dynaguard-20 on 200 watt signal 150 Hz

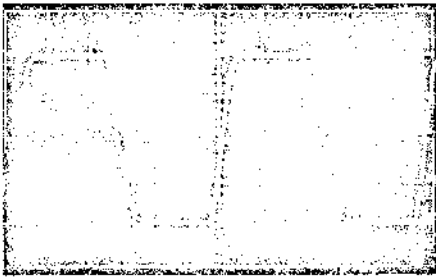


The rounded, rather than a squared or jagged, characteristic of this severely limited 200 watt signal in the Dynaguard-20 position maintains the best possible audio quality by minimizing extraneous harmonics. Input signal is upper trace.

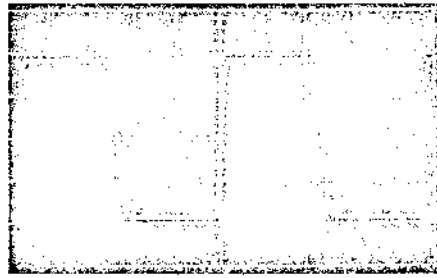


With Dynaguard-20 locked in, a 200 watt signal is limited, while an alternate 7 watt signal is totally unaffected. This preserves the essential signal characteristics, and does not reduce the dynamic range as a compressor does. Input signal above. In this example, the (upper) input signal would normally drive to an average rms output of 68.5 watts. Dynaguard limits it to an average rms output of 13.8 watts. An equivalent input for 200 watts average would yield a 20 watt Dynaguard average level.

## SQUARE WAVE PERFORMANCE AT 200 WATTS



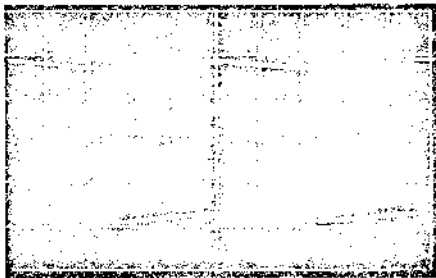
20 KHz, 200 watts



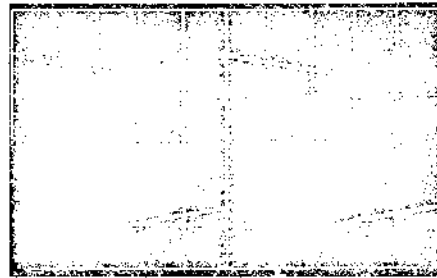
10 KHz, 200 watts



1000 Hz, 200 watts



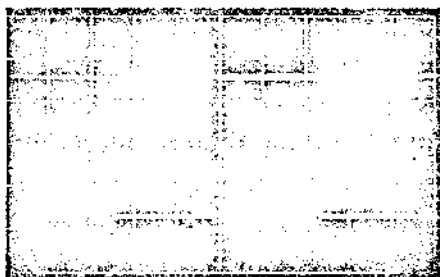
100 Hz, 200 watts



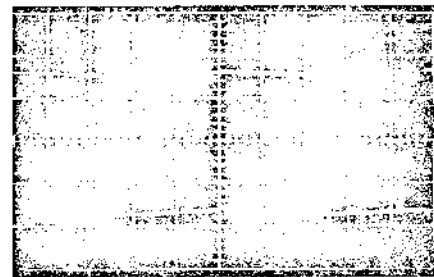
50 Hz, 200 watts



20 Hz, 200 watts



100 Hz, 200 watts  
protective rolloff removed



20 Hz, 200 watts  
protective rolloff removed

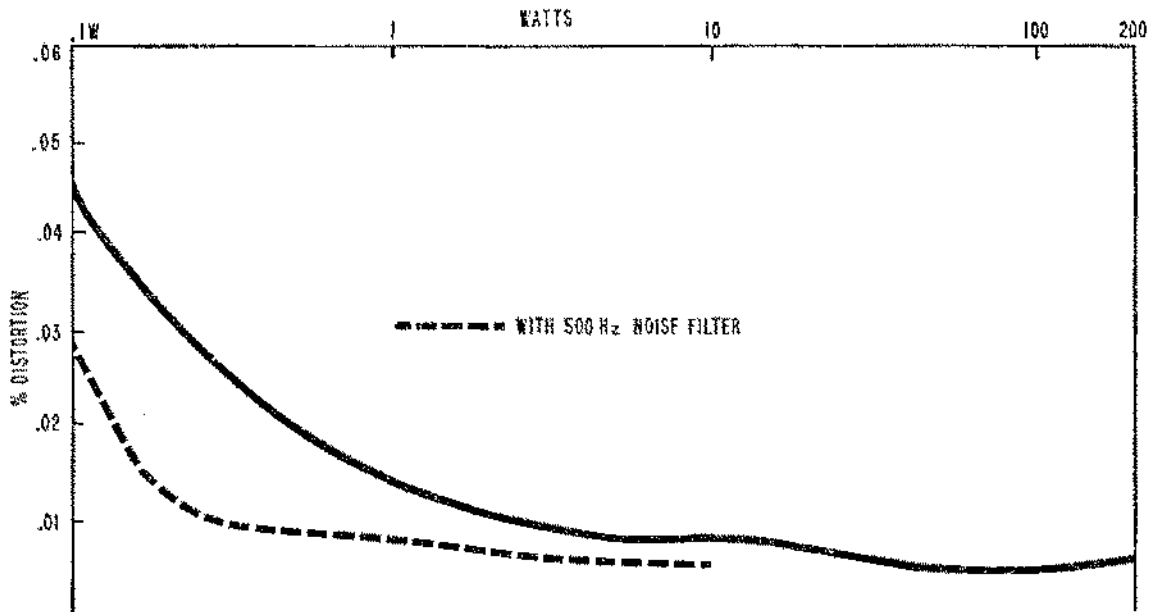
### 200 WATT SQUARE WAVE CAPABILITY

These photographs are remarkable, for they demonstrate performance beyond the capability of most amplifiers. Usually, square wave performance is reported only at *one watt*, for high power tests will show ringing, if not outright oscillation on a high frequency square wave, and often outright failure of the amplifier on 20 Hz full power square wave attempts. Low power square waves can only look even better than these, which are truly state-of-the-art. Adequate square wave representation requires bandwidth in excess of 1/10th to 10 times the displayed fre-

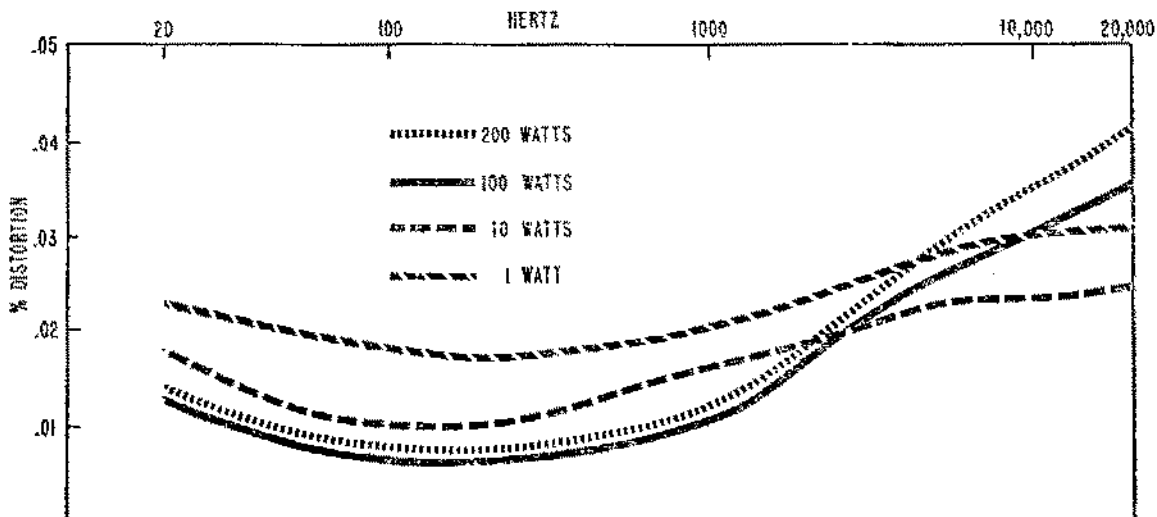
quency, so these demonstrate linearity *at full power* from a few Hertz to almost 100,000 Hz.

To show *for informational purposes only* the inherent low frequency capability of the power amplifier, we have removed the protective rolloff circuitry in the last two photographs to show nearly perfect full power reproduction even at 20 Hz. For the protection of loudspeakers, we do not recommend such operation (without the designed protective rolloff) under *any* circumstances, and such operation will void the warranty. All measurements utilized an oscilloscope with a 10 MHz bandwidth, and a true RMS meter.

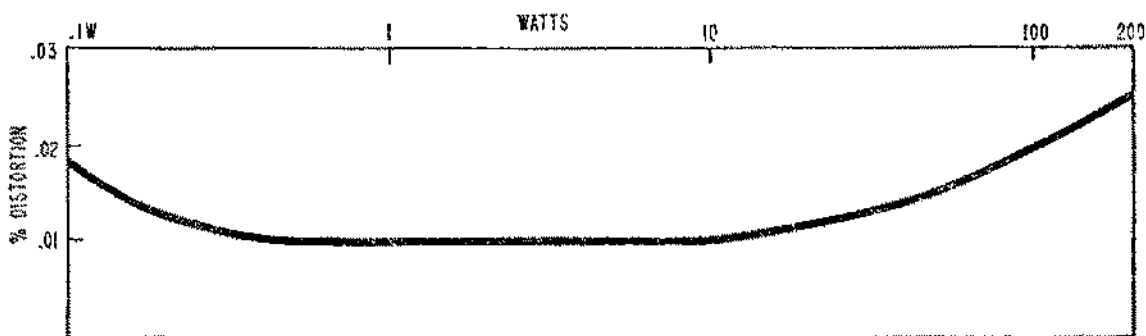
## TYPICAL PERFORMANCE CURVES



Total Harmonic Distortion @ 1 KHz vs. Power Output, both channels driven, 8 ohm load



Total Harmonic Distortion vs. Frequency, both channels driven, 8 ohm load



Intermodulation Distortion vs. Power Output, both channels driven, 8 ohm load

To arrive at "typical" curves, four amplifiers were evaluated on all bases. In each case, the curve shown is the next-to-the-worst of the four. Therefore, do not expect exact correlation between curves.



## THE MC-4 ACCESSORY METER OPTION FOR THE STEREO 400

The optional meter conversion kit is most easily installed at the completion of the wiring of the basic Stereo 400, as this saves disassembly of the front panel. Follow the assembly and wiring instructions supplied with the MC-4 kit when you conclude step #25 of the Final Assembly instructions, and then continue with step #26 in this manual. All that then remains is to connect the meter plugs when the front plate is installed.

Meters serve to monitor the output signal voltage level of each channel. These lighted Dynaco meters employ average-reading movements with VU ballistics. Their action is thus "fast" enough to respond to substantial musical peaks, but no meter can accurately indicate the magnitude of transient waveforms which permeate music. They are effective in determining electrical balance of stereo programming when correctly interpreted, but the very nature of stereo implies discrete information on each channel, so precise level matching rarely occurs. With sine wave test signals, the meter indication is an accurate measure of output power. A square wave test signal puts out approximately 11% more voltage than the equivalent sine wave meter indication.

The relay protective circuit of the Stereo 400 protects the meters against damaging onset and decay transients.

To protect your meters from "pegging" (overdrive) it is recommended that the #1 position of the meter range switch be used in all cases where the anticipated power levels are not known, and when commencing any test. Because the power capabilities of the Stereo 400 are so much greater than the average levels employed in music listening the meters will be almost inactive in the #1 position for such use. Switching to successively higher sensitivity ranges until the loudest passages indicate near "0" will yield the most information.

Even at normal listening levels with high quality program sources, the accurate reproduction of brief musical peaks requires short duration power output far in excess of meter indication, and it is this capability which makes high power amplifiers sound better. Peaks 10 dB above the meter level are common, and occasionally peaks may exceed 20 dB. The #3 meter range will likely be the most useful, where peaks 10 dB above 0 will be near the upper limits of low distortion amplifier output.

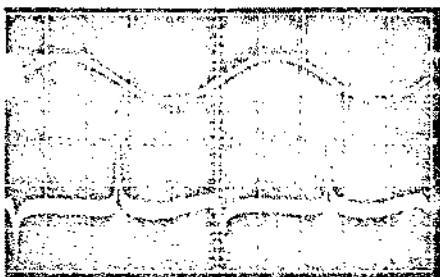
The #4 (most sensitive) range, which will likely be used for listening at moderate levels, has been found to give some general musical correlation with the Dynaguard "20" position, and the recommended 1 ampere speaker fuse on an 8 ohm load. In other words, where musical levels indicate near 0 dB (5 watts), the Dynaguard lamp (and protective circuit) will sometimes be activated, and sustained operation at those levels will blow that fuse. A similar relationship will occur with a 2 ampere fuse on a 4 ohm load, and with a 1/2 ampere fuse into 16 ohms.

The chart below lists 8 ohm load power outputs in watts on each meter range. For a 4 ohm load, the wattage should be doubled. For a 16 ohm load, they must be halved. When the amplifier is wired in bridge mode for mono use, both meters will read similarly, and the power indicated by either meter would be multiplied by 4 for an 8 ohm load.

Scale	Meter Range			
	1	2	3	4
+ 3	312	156	40	10
+ 2	248	124	32	8
+ 1	197	98	25	6
0	156	78	20	5
- 1	124	62	16	4
- 2	98	49	13	3
- 3	78	39	10	2.5
- 5	50	25	6	1.5
- 7	31	15	4	1
-10	15.5	8	2	0.5
-20	1.5	0.8	0.2	0.05

The 0 dB meter reference is also identified as 70.7 and 25 for commercial sound distribution applications. The #1 meter range has been selected so that it will read 70.7 volts across 8 ohms (625 watts) when the amplifier is operated in the mono "bridge" mode. The #2 range will zero at 25 volts per channel into 8 ohms (78 watts) in normal stereo operation.

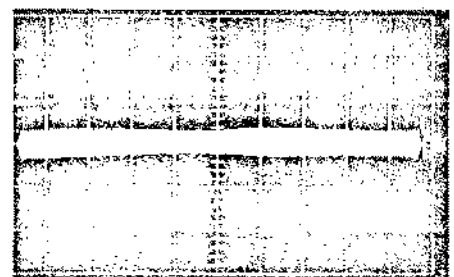
The black screw head on the front of the meter should not be moved, for it will change the zero reference of the meter. The meter circuit accuracy is  $\pm 1$  dB.



Notch Distortion  
Brand "X", 1 watt, 4 ohms, 1 KHz  
0.04% distortion



Notch Distortion  
Brand "X", 1 watt, 4 ohms, 1 KHz  
0.04% distortion



Stereo 400  
No notch, 1 watt, 4 ohms, 1 KHz  
0.03% distortion

### LOW POWER FREEDOM FROM DISTORTION

"Transistor sound" is often believed to originate in "crossover notch" distortion, which is most noticeable at low levels. The first photo shows input above, and harmonic distortion analyzer output below, from another 400

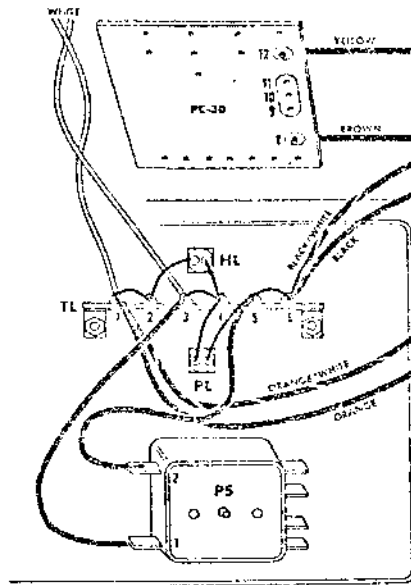
watt amplifier. The second and third photos show the signal as abscissa, and the analyzer output as ordinate. Note that total harmonic distortion differs only by 1/100th of 1% with much notch distortion! The Stereo 400 is literally free of this fault.

## INTERNATIONAL AC LINE VOLTAGE OPTIONS

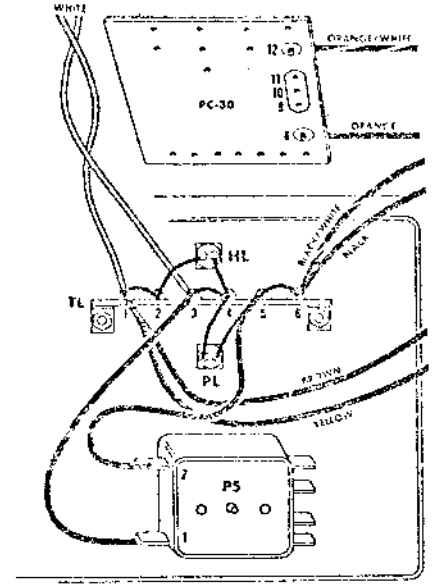
The alternate international power transformer for the Stereo 400, part #464030, has dual tapped primary windings which are connected in parallel for 100 or 120 volts, and in series for 200, 220 or 240 volts.

The standard 10 ampere circuit breaker is supplied for 100 or 120 volt operation. An alternate 5 ampere breaker is available for 200, 220, and 240 volt operation. To provide the High-Temp lamp with proper voltage, an additional 100,000 ohms resistor is also required for the higher line voltages. It is installed between lugs #1 and #2 of terminal strip TL, in place of the wire jumper. The Stereo 400 is designed for use with either 50 or 60 Hz AC current.

These diagrams show changes in the connections of the transformer primary windings only. The secondary connections are identical to the regular instructions. Be *certain* that each connection is carefully soldered. Leads connected to PC-30 eyelets #8 and #12 are simply secured. They are not used. When leads connect to PC-30 eyelets #10 and #11 it is important that you *flow a substantial quantity of solder across the board between these eyelets* to assure an adequate path for the heavy current.

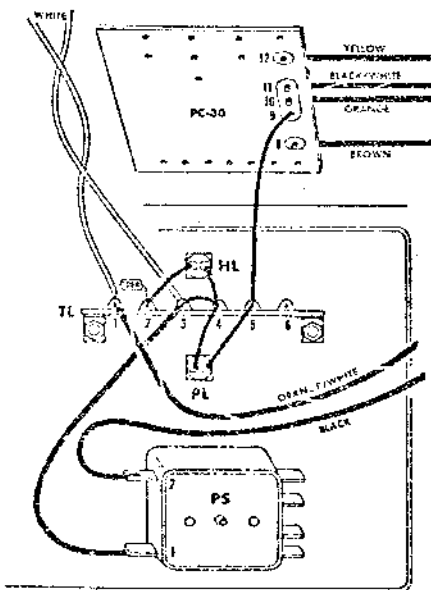


120 VAC

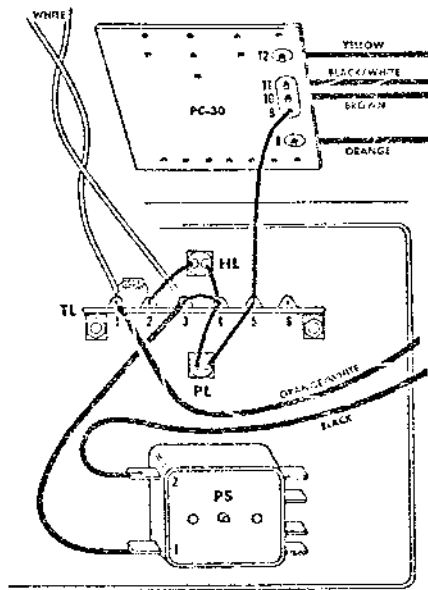


100 VAC

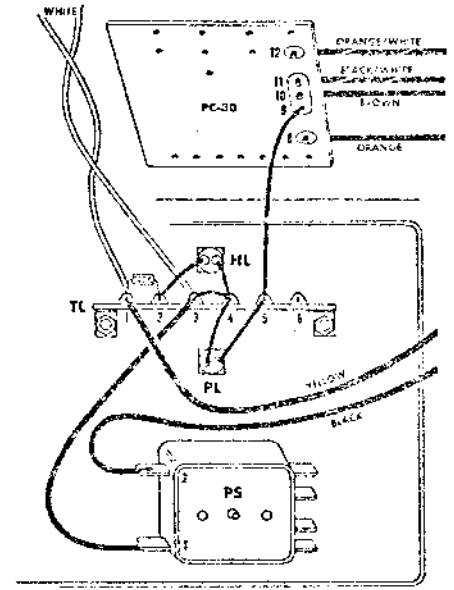
Note: Kits supplied for 200-240VAC include the 100,000 ohm resistor, part #102104, and the 5 ampere circuit breaker.



240 VAC



220 VAC



200 VAC

## SERVICE POLICY AND LIMITED WARRANTY

The Stereo 400 has been carefully engineered to provide many years of musical enjoyment without difficulty. Each factory-assembled Stereo 400 has been subjected to a full complement of performance tests prior to shipment. Each PC-28 and PC-29 circuit board in the kit has been tested and adjusted in operation as a fully functioning unit to verify its performance capability. Nevertheless, through damage in transit, faulty kit assembly, or human error, service may sometimes be required.

To provide rapid and reliable service, Dynaco has authorized competent, well-equipped service facilities in several localities in the United States and Canada, in addition to its service facility at the factory. These stations are authorized to make repairs in and out of warranty under the terms listed below. Service is always available at the factory, but you will often find a more convenient facility locally. A current list of these facilities is enclosed. Write to Dynaco for the name of the service station nearest you.

It is the owner's responsibility to *take or send the unit freight prepaid to the service facility*. In the event that you incorrectly diagnose which unit is faulty, please understand that you will be responsible for a check-out charge on any properly performing kit or factory-assembled unit submitted for testing.

Shipment should be made via motor freight, REA Express (CN or CP Express in Canada), or Bus Package Express. **DO NOT USE PARCEL POST FOR IT IS NOT A SAFE METHOD OF SHIPPING ELECTRONIC EQUIPMENT.** Should damage occur due to unauthorized parcel post shipment of the complete amplifier, repairs will be made at the owner's expense, as neither the factory nor the service stations have the facilities to process parcel post claims. Be sure the shipment is fully insured (note Bus Express limitations).

It is *essential* that the amplifier be packed properly if it is to survive the considerable hazards of shipment. The original kit foam packaging, if intact, is suitable for shipping the completed amplifier. If you require packaging, send \$4.75 to Dynaco. Double boxing is strongly recommended if you formulate your own packaging.

Include with the returned unit the following information: 1) Your name and complete shipping address (Post Office box numbers are not suitable); 2) the serial number (from the cover of this manual), *together with a copy of your dated bill of sale*; 3) the symptoms, complete, but preferably brief. If the problem is intermittent, this *must* be noted.

Warranties apply to the original purchaser only; they are not transferable. They do not apply to units which have been physically or electrically abused, or to units which have been modified without prior written factory authorization. The use of non-Dynaco replacement parts may in some instances void the warranty. If you suspect a defect in the power transformer, the leads must be unsoldered, not cut for its return. The warranty on the transformer is void if the leads have been cut too short for re-use.

Dynaco maintains a Technical Services Department to help you locate the source of, and possibly correct a problem yourself. When writing, please mention the serial number of the Stereo 400 and describe any tests you have performed, and their results.

### WARRANTY FOR FACTORY ASSEMBLED UNITS

The Stereo 400 is warranted for a full year from the purchase date, including parts and labor and shipment costs *from* the service facility to the owner (within the U.S. or Canada). The owner is responsible for shipment *to* the service facility, and must submit a copy of the dated bill of sale. An additional 90 day warranty is provided on the service work performed, including shipment both ways, labor and parts.

### WARRANTY FOR KIT-BUILT UNITS

The components in a Stereo 400 kit are warranted for a full year from the purchase date. If a defective component is found in a completed circuit board module, or kit, simply return that individual part to the *factory* prepaid, and it will be replaced at no charge. Local service stations are not obligated to supply separate parts.

If you cannot locate the source of the difficulty, ship the entire Stereo 400 to the nearest authorized service station or to the factory for service. In-warranty parts will be replaced at no charge, although a service fee will be charged for the labor to diagnose, correct, and test the unit to ensure that it meets factory specifications. Shipping charges to and from the service facility are the owner's responsibility. Units will normally be returned on a COD basis. An additional 90 day warranty is provided on the service work performed, including shipment both ways, labor and parts.

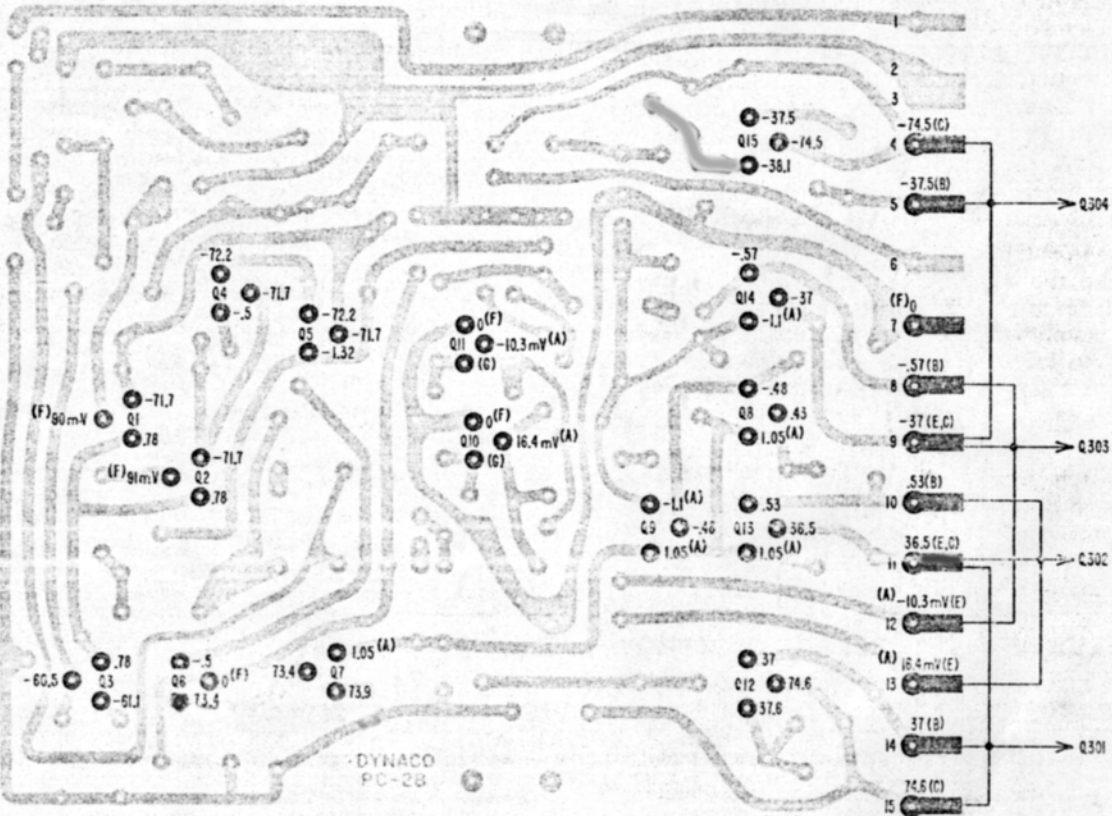
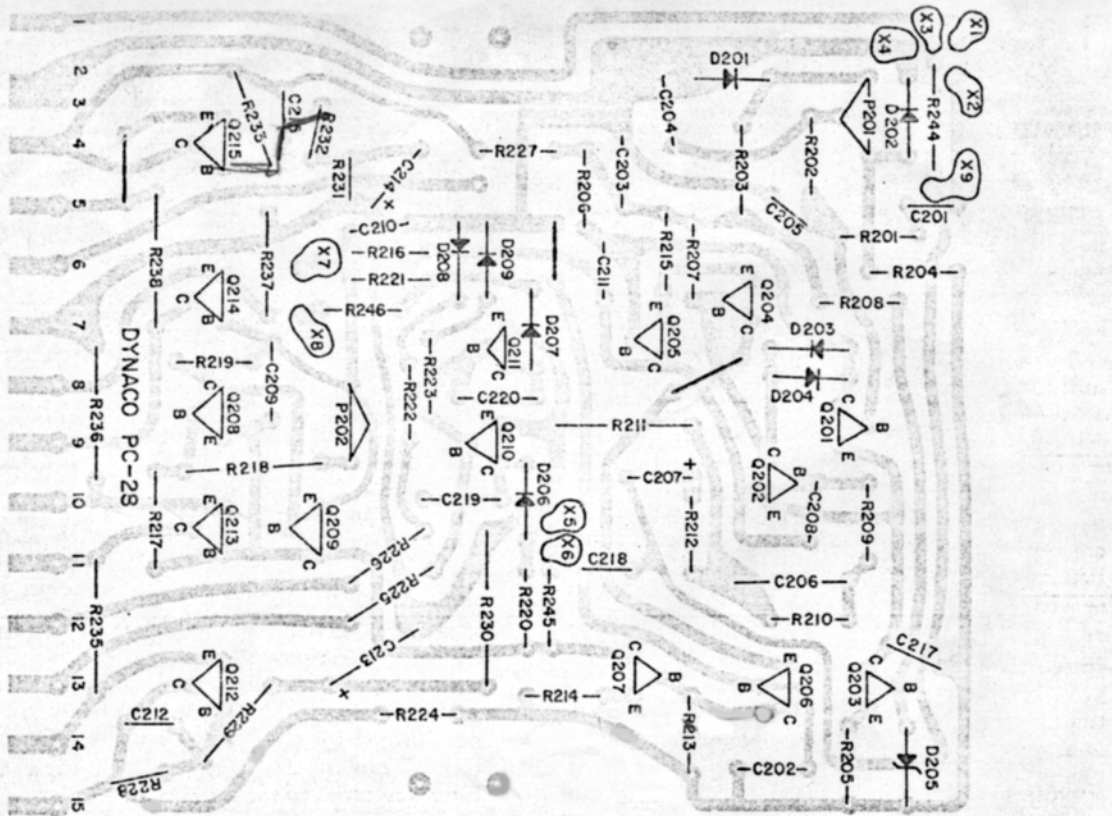
If you are competent to ascertain that a problem in the amplifier is confined only to a particular circuit board assembly, or only to the output heat sink assembly (which includes the two PC-28 circuit boards), you may at your option unsolder (do not cut wires), remove and return such an assembly *only to the factory* for service. Likewise, the transformer may be disconnected and removed to enable shipping the otherwise completed amplifier *to the factory*. It is then within UPS weight limits. Since responsibility for proper diagnosis, packaging and reinstallation is yours alone, we recommend you contact Dynaco prior to such action, to be certain it is the best alternative.

This warranty is void if the kit has not been completely assembled, or if other than rosin core solder has been used. Units assembled with acid core solder or paste flux will be returned unserviced.

### SERVICE BEYOND THE WARRANTY PERIOD

Dynaco establishes maximum labor fees which may be charged by its service facilities (plus the cost of parts, and shipping charges) without prior approval by the owner. A current list of authorized service stations, and the current established fee for any unit will be supplied by Dynaco on request. Dynaco cannot assume responsibility for service at other than *Dynaco authorized service stations*.

Dynaco reserves the right to limit the service facility or the established fees to two years from the date of purchase. Dynaco assumes no liability or responsibility for injury or damages sustained in the assembly or operation of this equipment, or for damage to other equipment connected to it. Dynaco reserves the right to make design changes without the obligation to revise prior versions. Prices and specifications subject to change without notice.



**VOLTAGE TEST POINTS**

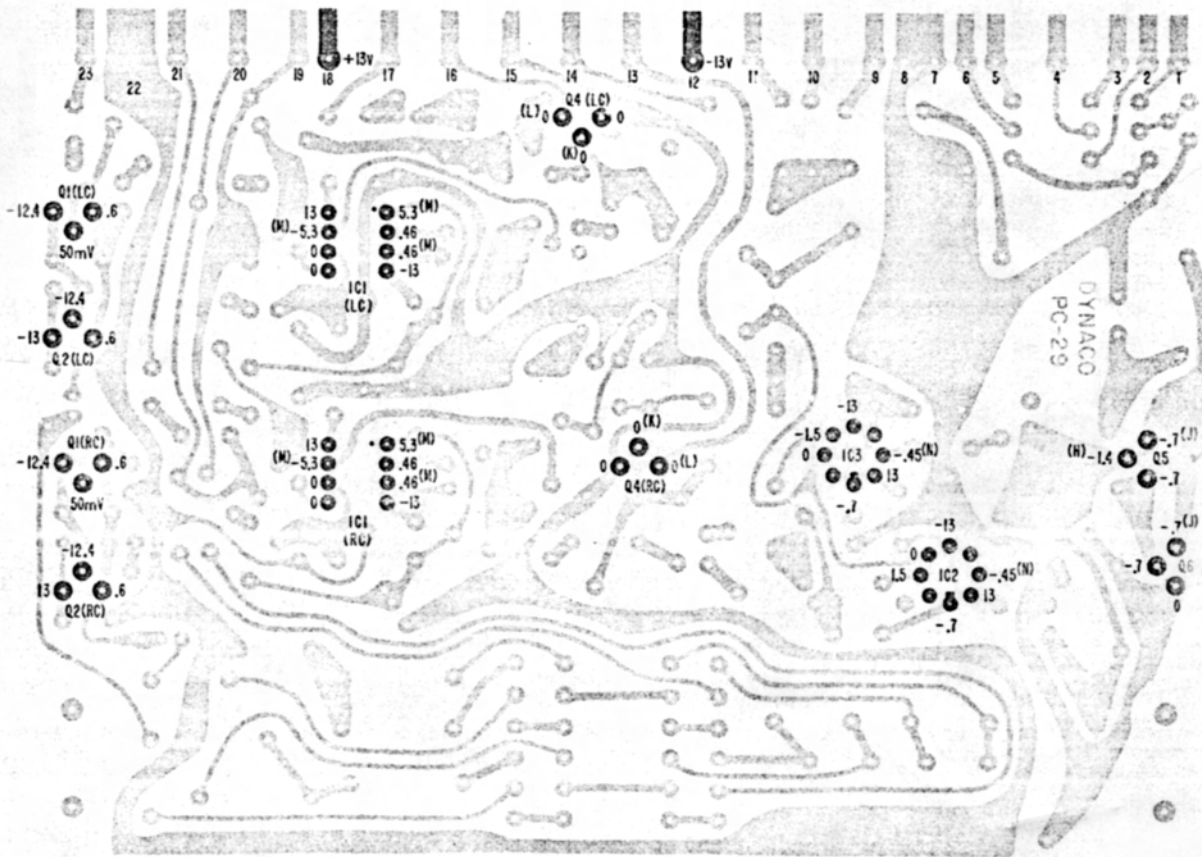
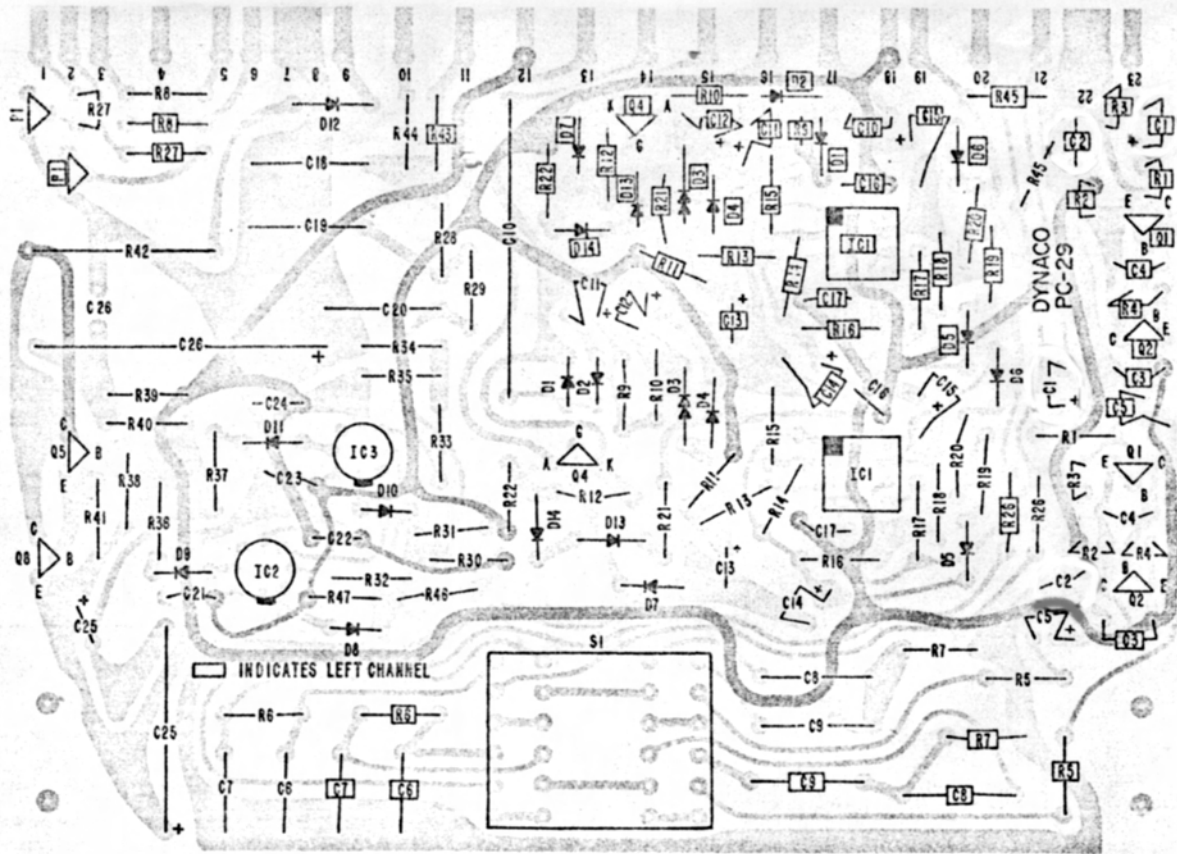
All voltages measured with a VTVM or TVM, 120 VAC line, chassis ground reference, volume controls fully counter-clockwise, and Dynaguard switch "off" unless otherwise noted. 10% tolerance permissible.

**Notes:**

- A Will vary with P2.
- F Will vary with P1.

G Do not measure. Reading valid only when amplifier is limiting.





- H Becomes positive when relay shuts off.
- J Becomes -74 volts when relay shuts off.
- K Will rise to 0.7 volts when Dynaguard is on.

- L Will rise to -6 volts when Dynaguard light is on.
- M Will drop close to 0 when Dynaguard is on.
- N Will rise to 5.1 volts when relay shuts off.