

example. These markings are provided so that proper phasing of a pair of speakers can be maintained. It is not necessary when connecting the leads from the amplifier to the speaker to be sure that the red amplifier terminal is connected to the (+) speaker terminal, or that the (C) terminal is connected to the black amplifier post. However, once the "sense" of the wiring has been established by connecting one speaker to the amplifier, the second speaker must be connected in the same way so that the speakers will be in phase. With ordinary lamp cord, this is easy, because one lead is coded — usually either with a "tracer" thread wound around one of the wires, or with a slight molded ridge on the outer plastic insulation of one conductor, or with different color conductors.

The nominal power rating of the Stereo 120 is based on a load impedance of 8 ohms. Loudspeakers with impedances of 4 and 16 ohms can also be utilized with slight reduction of the maximum power capability at some frequencies. Since all loudspeakers have varying impedance characteristics with frequency, an optimum match to any amplifier is a compromise over much of its range. The maximum power output into a given speaker varies with frequency with both tube and transistor amplifiers, because the speaker's rated impedance is typically its minimum impedance. The Stereo 120 can deliver not less than 50 watts into the 4 ohm AR-3, for example, throughout the speaker's useable range. With a 16 ohm speaker, maximum power can be expected to be about 40 watts at most frequencies. This question has been largely overlooked in the past because the output transformers in tube amplifiers could match to different nominal speaker impedances, but the problem was not significantly different. A more detailed explanation of amplifier power output characteristics is available on request from Dynaco.

Monophonic operation

The outputs of the Stereo 120 (and other transistor power amplifiers) should *not* be connected together (paralleled) in an attempt to obtain higher power output. If they are paralleled, there is little benefit of power increase under practical conditions, and there is a possibility of damage to the amplifier. Using isolating resistors between the two channels wastes power and destroys the amplifier's damping factor.

For higher power monophonic applications, the preferred procedure is to drive each channel of the Stereo 120 with identical signals (using the "A+B" or "Mono" position on the preamplifier, or a "Y" connection) and connect each output channel to a *separate* loudspeaker system. This has the advantage that the speaker will be operated with less likelihood of overload, for speakers are rarely designed to handle more than 60 watts of sustained power.

Of course, either channel may be used independently as a 60 watt mono amplifier by simply leaving the input and output of the second channel unconnected. No "load" is required on the unused channel when there is no input signal.

Cautions to be observed

The Stereo 120 contains circuits which will provide nearly complete protection against abuse (including the cautions noted below), but you should not challenge fate. We all know that parachutes are quite safe — but why jump to test one? The need for protective circuitry in solid state equipment is a direct result of its inherent susceptibil-

ity to failure compared with the ruggedness of vacuum tube equipment. You will avoid possible damage to costly transistors and other components if you follow these few simple rules:

1. Do not connect or disconnect inputs or outputs when the amplifier power is on.
2. If you hear any abnormal noises, turn off the equipment and locate and eliminate the source of the noises before using the Stereo 120. These noises may result from partially connected audio cables or similar faults not connected with the Stereo 120, but they can be signals or symptoms of signals of excessive amplitude.
3. The volume control of the preamp or other source should be at a low setting when the amplifier is turned on. At any time that the sound is weak or garbled, locate the trouble *before advancing the volume control*.
4. Do not operate a tape recorder in the fast wind or rewind mode when the volume control is advanced, as this could produce large signals at inaudible frequencies.
5. Avoid any output connection system which risks connecting the "hot" side of one channel to the "hot" side (red terminal) of the other channel. This is not likely in any properly wired system or accessory, but an accidental change of polarity in the connections to a system requiring common ground connections could be costly. Of particular note: headphone junction boxes.
6. If it is necessary to switch from one speaker to another when the amplifier is turned on (as in a distribution system to several rooms) *always make the changes at a low setting of the preamp volume control*. The setting of individual speaker level controls is unimportant.
7. Avoid shorting together the two wires to a loudspeaker, and do not use any switches in the output which are of the shorting type. Be sure that no strands of connecting wires are free to touch anything except the intended terminal.

Amplifier operation

Now you are ready to plug the line cord into the proper AC outlet and listen to the system. A switched outlet on the preamplifier will be the most convenient arrangement, for then the power switch on the Stereo 120 can be left on and switching will be automatic when the preamplifier is turned on. If the Stereo 120 is inadvertently left on for a lengthy period of time, no problems will be encountered. The components do not get hot with extended use under normal or under no-signal conditions. The slight warmth felt when the unit is on is from some power resistors on the amplifier boards. The transistors and other components will remain cool except under high signal conditions. With sustained high power output it is normal for the bottom to become much warmer than the cover, because the heat sinks dissipate heat through the chassis.

Since there is little heat in normal use, the Stereo 120 does not require the degree of ventilation needed for a tube amplifier, though what heat is generated must be effectively dissipated. The amplifier may be placed almost anywhere, in any position, as long as it is not blanketed with magazines, records or similar obstructions. If the amplifier is used where sustained high power output is required (and transistors heat up the fastest at about half the maximum power output) adequate ventilation is necessary. At full power continuous output on both channels, the Stereo 120 draws almost 400 watts and it, like any other transistor amplifier, will generate as much heat as a comparable tube amplifier.

Those who desire to use headphones with this amplifier will find that most headphone manufacturers make adapters available which provide the necessary level controls or resistors to reduce the power to the headphones, and to maintain low noise. General information on this subject is available on request from Dynaco.

Checking speaker phasing

The simplest procedure for determining correct speaker phasing is to play a monophonic program (turn the pre-amplifier to "A+B" or "Mono") through both speakers.

Then if the phasing is correct, there will be a smooth transition of sound as you move from one speaker to the other. If the speakers are not in phase, there will be an abrupt shift from one to the other at some point between the two. If convenient, an alternative method is to face the two speakers toward each other about 6 inches apart, and when the "Common" and "Hot" leads to one speaker are interchanged, there will be a noticeable loss of bass energy when the speakers are out of phase. Only the pair of leads from the amplifier to *one* of the speakers should be interchanged to correct the phasing, and there is no need to alter the phasing once the speakers are properly connected.

TECHNICAL INFORMATION

CIRCUIT DESCRIPTION

The Stereo 120 has a number of unique circuit features on which there are several patent applications. They contribute to the amplifier's exceptionally low distortion, long term reliability, resistance to abuse, and to its remarkable degree of reproducibility which marks a truly successful design. Those not interested in the technology may omit this section. A more detailed technical description for servicing will be found in a later section of this manual.

The power supply utilizes a full wave silicon diode bridge rectifier. It is regulated against changes in line voltage, and its output is stabilized so that changes in the load caused by varying signals will not result in voltage shifts. This regulation affords five advantages over conventional amplifiers: 1) It assures that the Stereo 120 will meet its performance specifications over a wide range of line voltages. 2) It protects the amplifier from damaging AC-line transients. 3) It maintains the prescribed operating margins to assure long transistor life. 4) It provides a "clean" overload characteristic. 5) It avoids transient distortion caused by changing operating parameters when the supply voltages change under heavy current demands — a normal characteristic of Class B amplifier circuits.

Transistors Q7, Q8 and Q9, and a Zener diode provide voltage regulation to within 1%. Conventional regulators are capable of self-destruction with sustained, excessive loading of the supply. In the Stereo 120 a novel circuit configuration switches the supply from a fully regulated, low impedance source to a de-regulated, high impedance one when a predetermined maximum current is reached. Thus the supply effectively regulates up to a certain point, and then protects both itself and the load from damage that could result from excessive current.

The power supply protection prevents it from delivering normal voltages if the input signal is excessive at the instant of turn-on. Once the input level is reduced, the supply will come on, and operation is no longer affected. An electronic delay at turn-on avoids the sharp "thump" in the signal commonly associated with some solid state amplifiers.

The audio portion of the Stereo 120 also includes unique circuitry to provide an unusual amount of protection while delivering exceptional performance. Transistors Q1 and Q2 are a direct-coupled feedback pair providing a high degree of stability and great linearity. This pair drives the power section, transistors Q3 through Q6, which are direct-coupled and include DC feedback stabilization. These four transis-

tors act as a push-pull power transformer in that they do not have voltage gain, but they transform the signal from high impedance to low impedance. All six transistors in the driver and power sections are included in one overall feedback loop.

Like the power supply protection, the amplifiers are also designed to *reduce* — not just limit — the current through the output stage when there is any tendency to exceed a reference limit as a result of excessive drive signals or heavy loads. This protects both the load (the loudspeaker) and the source (the output transistors).

In the Stereo 120 the output transistors are operated *without quiescent current* and without the consequent heat rise caused by the bias current, eliminating the need for temperature compensating devices. However, the Stereo 120 does not exhibit any signs of the "Class B notch" commonly attributed to a lack of bias current.

The output signal is taken from the junction of Q5 and Q6 through coupling capacitor C7, which prevents DC from reaching the speaker. An output capacitor large enough to assure unrestricted low frequency response was chosen instead of the conventional and less costly plus-minus output circuit. It eliminates any need for balance adjustments or matching of components, and assures speaker protection in the event of output transistor failure.

All of the large capacitors used in the Stereo 120 are special high-purity "computer grade" electrolytics chosen for maximum reliability. The output capacitors also serve as convenient forms for small value air-core chokes in the output which, in conjunction with an R-C circuit, roll off the response in the RF region (above 500,000 Hz), reducing interference and affording absolute stability under all circuit conditions.

PERFORMANCE TESTS

Special care must be taken when subjecting transistorized amplifiers to laboratory tests. Solid state circuits draw much more current at the frequency extremes than in the mid-band, and tests with other than the 8 ohm load for which the amplifier is designed may also draw higher current. High current raises transistor temperatures, causing increased current demand, so tests must be performed quickly under these conditions to avoid the action of the protective cut-back circuits which limit the current in the Stereo 120 for safety reasons. The action of the protective circuitry may yield erroneous results, such as a notably lower apparent power output for rated distortion.

High power measurements should first be "set up" with a low input signal, and then raised to a previously determined level for a quick reading. The extended power and frequency response of the Stereo 120 requires that even low power tests above and below the audible range be made quickly to avoid protective cut-back. This limits the practical duration of high frequency square wave tests, for example.

Prolonged tests at high power levels, at the frequency extremes, or with abnormal load impedances require adequate thermal recovery time. Without it, the transistors are rendered more susceptible to subsequent overload, and the safety margin afforded by the protective circuits is sharply reduced. Callous disregard of these effects may result in eventual failure, for there is no such thing as absolute protection against deliberate abuse.

The heat which is generated is dissipated through the heat sinks to the chassis, so the bottom of the amplifier will get quite hot during tests. Remember that the maximum dissipation in transistorized circuits occurs at about half power. At maximum current drain, the Stereo 120 will dissipate as much heat as two 60 watt tube amplifiers, so adequate ventilation must be provided.

The Stereo 120 includes a protection circuit which keeps the power supply shut down if a high prolonged signal is applied to the input before the amplifier is switched on. Prolonged operation in this mode will cause R24 in the power supply to overheat. Reducing the input gain will allow the amplifier to turn on normally, with no subsequent effect on the program material.

The line fuse in the Stereo 120 has been chosen to provide maximum protection while allowing short duration currents in excess of its rating. The current demand for both channels operating at full power steady-state at 20 KHz (the severest test), for example, will slightly exceed the fuse rating, but the slo-blo fuse will handle this for several seconds.

When making full power tests at the frequency extremes, it is important that the line voltage be corrected for power line drop because of the high current demand. The reserve regulation capacity of the supply will be limited by excessive line losses, and the indicated distortion may rise at maximum power when both sides are driven simultaneously.

USE WITH DYNACO PREAMPLIFIERS

The Dynaco PAS-2X, PAS-3X and PAT-4 preamplifiers and the Dynatuner may be used directly with the Stereo 120 without modification. Older model Dynaco PAS-2 and PAS-3 preamplifiers may be updated to the latest "X" series by adding the TC-3X tone control modification kit. Buy the TC-3X from your dealer or order it directly from Dynaco for \$10.00 (no C.O.D.'s, please). You may also modify the Dynaco PAM-1, PAS-2 and PAS-3 preamps to accommodate the 100,000 ohm input impedance of the Stereo 120 without making the tone control changes of the TC-3X. This is accomplished as follows in the PAS-2 and PAS-3 stereo preamplifiers:

1. Purchase two 100,000 ohm, 1/2 watt, 10% tolerance resistors.
2. Unsolder and discard the two 510,000 ohm (green-brown-yellow) resistors connected to the audio output sockets on the back panel of the preamplifier and re-

place them with the 100,000 ohm resistors. Solder all connections.

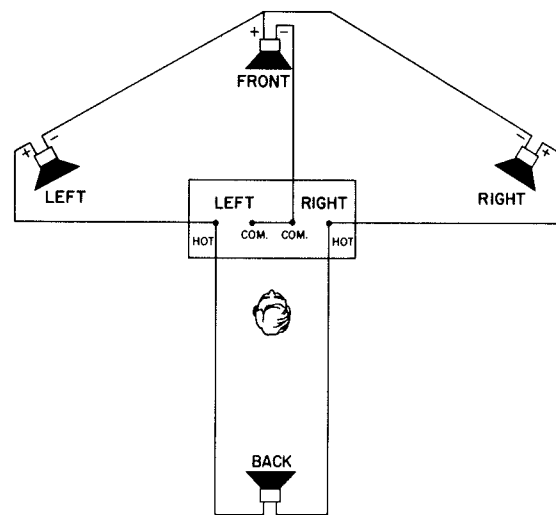
3. Snip out and discard the two 62,000 ohm (blue-red-orange) resistors on the PC-5 circuit board adjacent to eyelets #8 and #18. This completes the modification.

The modification for the PAM-1 mono preamp is as follows:

1. Purchase one 100,000 ohm, 1/2 watt, 10% tolerance resistor for each preamplifier.
2. Unsolder and discard the 510,000 ohm (green-brown-yellow) and the 62,000 ohm (blue-red-orange) resistors between lugs #2 and #3 of the 7-lug terminal strip in the preamp. Solder the 100,000 ohm resistor between these two lugs. This completes the change.

DYNACO 4-DIMENSIONAL SOUND SYSTEM

A remarkably simple technique for providing front-to-back, as well as left-to-right source localization utilizes any Dynaco stereo preamp, and 4 speakers connected to the Stereo 120 as shown below. The back speaker reproduces the difference information in the two channels, which may include an additional source, but more importantly it enables recovery of ambience, or "hall sound" hitherto masked in conventional playback of many *present* recordings. These random phase ambience effects will be most evident in recordings made "live," and where an additional distant microphone was used. The front speaker provides more precise stereo imaging with proper energy distribution.



Best results occur when all speakers have identical efficiency, impedance and sonic characteristics, as separate level controls are not feasible. The front speakers should be matched in any case. Dynaco speakers, with very uniform impedance characteristics, are ideal, and permit the A-50 to be used with the A-25 with outstanding results.

Small rooms frequently benefit most from this system. Listener position is more critical in 4-D playback. The back speaker is best when placed *above* the listener, with moderate level. A series 10 watt, 20 ohm variable resistor is a convenient means of accommodating different back speaker efficiencies and locations. A switch to disconnect the back speaker is advisable for listening to noisy programs.

Since the speaker impedance isolates the amplifier terminals, no amplifier damage results from this connection from "hot" to "hot." No back speaker connection is made to a ground terminal. If the amplifier design cautions against connecting its ground terminals together, which is

rare, then the front speaker should be eliminated, and the left and right speakers connected normally.

To balance the system for 4-D playback, disconnect the ground return from the front, switch the preamp to MONO ("A" only on the PAT-4; "A+B" on the PAS-3X) and play a record with the volume control at its most-used setting. Adjust the *balance* control for *minimum* output from the speakers. Then adjust the tone controls—preferably to the flat settings—for *minimum* output. The tone controls need not be flat, but will null when the two channels are identical. You can reposition the knobs on their shafts to indicate the center null position. Reconnect the center ground, and switch the preamp to the 6 db blend position (tops of "A" and "B" depressed on the PAT-4; the narrowest rectangle on the PAS-3X). This is now the normal stereo playback mode when using 4 speakers. The blending is equal in amplitude and opposite in polarity to the crosstalk introduced by the center (front) speaker connection, which cancels the crosstalk and insures full separation at the speakers.

ASSEMBLY INSTRUCTIONS

GENERAL ASSEMBLY INFORMATION

Assembly of the Stereo 120 is exceptionally 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, uncluttered layout that makes wiring quick and easy. The construction time will be only a few hours, but it is best to work slowly and carefully rather than worry about the time.

When you unpack your kit, check off the components against the parts list at the back of the manual. You can identify unfamiliar parts by matching them to the pictorial diagram or photograph.

Have the proper tools at hand before starting assembly. You will need a pencil-type soldering iron of 30- 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 $\frac{1}{16}$ " 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.

If you have a soldering gun, it should be used with care, especially when working on the circuit boards. Not only can a gun provide more heat than is necessary, with some risk that an unskilled user might damage the board, but 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 delicate components such as transistors are less likely to be damaged in the soldering process if you use a hot iron 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.

A good solder connection does not require a large amount of solder around the joint. A well-made connection looks

The same connection for the front speaker, which reproduces a combined mono signal, enables it to be used as a remote speaker as an alternative, or as a center-fill when the side speakers are unusually far apart.

CONNECTIONS FOR 240 VOLT AC LINE

The FA-704 power transformer supplied in the Stereo 120 may be connected for a 240 volt AC line as well as for the standard 120 volt AC line, which is how the transformer is connected unless this manual is stamped "240 volt". The transformer has dual primary windings, and they are connected in parallel for 120 volts, and in series for 240 volts. Steps 26 and 29 on page 12 and the diagrams on pages 19 and 20 of this manual detail both arrangements.

The 3 ampere slo-blo fuse supplied with 120 volt wiring should be replaced with a 1.5 ampere slo-blo fuse when the amplifier is wired for 240 volt use.

The Stereo 120 is designed for use with either 50 Hz or 60 Hz current.

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.

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.

Whenever one wire is to be soldered to a connection such as a lug or a transistor lead, 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 so state. If no symbol is shown, do not solder; further connections will be made to that point before soldering is called for.

Components such as resistors and capacitors are marked individually with their values, or with a color code. The color code will be given in the instructions when needed. The first color band on a resistor is the one nearest the end.

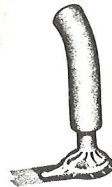
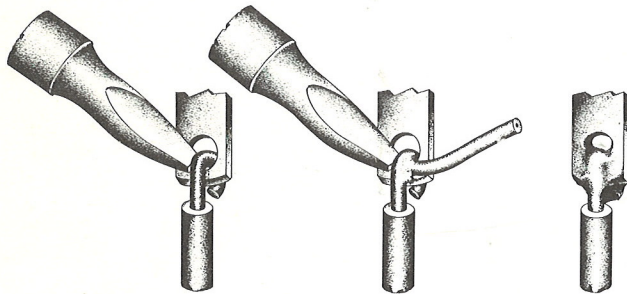
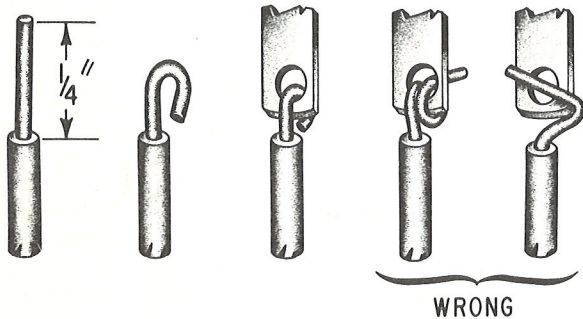
A number of steps begin, "Connect one end of a wire . . .", with the length of wire specified. In each case, first cut a piece of the correct color wire to the specified length, and then remove about $\frac{1}{4}$ " of insulation from *each* end before making the connection. This is easiest with wire strippers, but diagonal cutters can be used if you are careful not to nick the wire and weaken it. With stranded wire such as transformer leads and line cords, be particularly careful not to cut the strands when stripping the ends.

MECHANICAL ASSEMBLY

The position of all wire leads should follow the diagram and photograph 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.

Check your work after each step. 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.

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 $\frac{1}{4}$ -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 the circuit board, the Stereo 120 makes it easy 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.

Although the Stereo 120 has an unprecedented number of safety devices which will prevent breakdown in use, only you can prevent breakdown resulting from improper construction. 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.

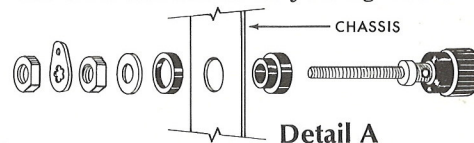
The three etched circuit boards and all of the 5 power transistors have been in-circuit tested before leaving the factory. This assures that all of the semi-conductors, as well as most of the other component parts, are performing to specifications. Only the interconnection of these parts is left to you.

There are 3 sizes of hardware — #4, #6 and #8. The #4 is the smallest, and the #8 the largest. The size used at each step is specified, and you should familiarize yourself with each. When #6 screws are called for, the $\frac{1}{2}$ inch length should be used. The $1\frac{1}{2}$ " #6 screws will be specified when they are used in the subassemblies. For your convenience, no #4 lockwashers are supplied. Use #6 lockwashers when #4 screws and nuts are called for.

1(✓) Select four #6 screws, nuts and lockwashers and the four rubber feet. Insert the screws into the feet until the screw heads are entirely recessed within the feet. The fit is very tight, so you can invert the chassis and place the foot over a hole in the bottom, and then force the screw down. After the screws are inserted into the feet, mount the feet loosely on the bottom of the chassis in the *round* holes nearest the chassis corners. A lockwasher goes under each nut. Later, 3 of these feet must be temporarily removed when mounting the circuit assemblies, but installing them now will avoid damaging your work surface.

2(✓) Install the 2 input sockets with #4 screws, nuts and lockwashers under the nuts. There is an inner "hot" connector and a shorter outer "ground" tab on each socket. Install each socket with the ground tab toward the outside as shown in the pictorial diagram.

3(✓) Install the 2 black output binding posts in the lower holes next to each input socket. See Detail A. A shoulder piece goes outside the chassis with the smaller diameter portion protruding through the hole. The insulating plastic ring fits over it inside the chassis, followed by the washer. Before tightening the first nut, unscrew the outside knurled end and observe the hole in the metal shaft. For greatest convenience in connecting loudspeaker leads to these posts later, rotate the assembly so that this hole is in a horizontal position. Slip a piece of wire through the hole for easy observation as you tighten the first nut. Slide on the connecting lug, and fasten with the second nut. Position each connecting lug as shown in the pictorial diagram, and keep the wire horizontal as you tighten the second nut.



4(✓) Install the two red binding posts in like manner in the upper holes. Keep the hole in the metal shaft horizontal, and note the correct lug placement in the pictorial diagram.