

**BUILD TOP-QUALITY STEREO PREAMP**

# POPULAR ELECTRONICS

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**STEREO PREAMP**  
(see page 27)

FET  
PREAMP

NEW DESIGN FOR LOW NOISE AND MINIMUM DISTORTION

BY DAN MEYER

**C**ONSTRUCTION projects and kits for making high-fidelity audio preamplifiers come in many shapes and sizes. Most of them give very good results but none has the quality of the "FET Preamp" described here. Much of the excellent performance obtainable from this preamp is due to the use of silicon field-effect transistors in the amplifier stages. These transistors operate at impedance levels similar to those in vacuum-tube circuits but they have much lower noise and far less distortion than either tubes or conventional junction transistors.

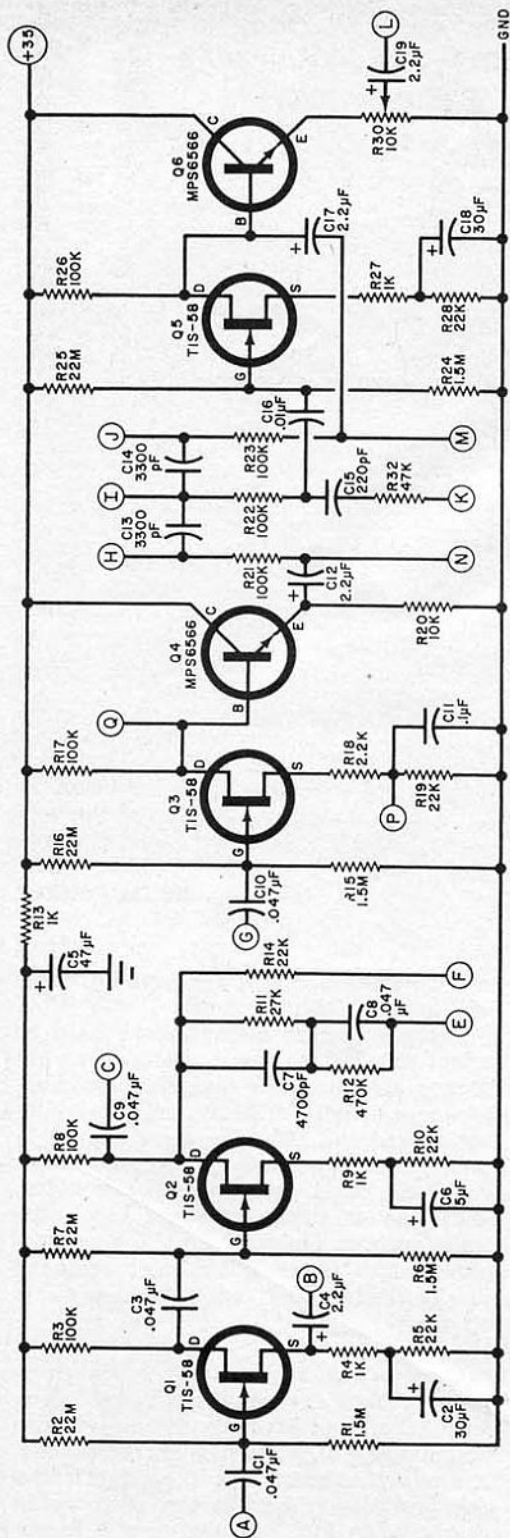
The sensitivity and output impedance of the FET Preamp are suitable for use with almost any power amplifier and full power output can be obtained from any low-level magnetic-cartridge signal source.

A high-power audio amplifier, specifically designed for use with this preamp,

will be described in a forthcoming issue of POPULAR ELECTRONICS.

Six pushbutton switches are used to select the desired input, while there are rocker switches for control of volume, loudness, high- and low-frequency filtering and the 117-volt power supply. A front-panel tape output jack and a microphone input jack are also provided. With the exception of some exotic details, such as phase reversal, every possible useful function has been included in the preamplifier, whose schematic is shown in Fig. 1.

**Construction.** For a stereo system, two preamplifiers are required. Each is assembled on a printed circuit board whose actual-size foil pattern is shown in Fig. 2. Once the board has been fabricated (or purchased), mount the components as shown in Fig. 3, being careful to ob-



serve the polarities of the electrolytic capacitors and the identifying flats on the semiconductors. When the boards are assembled, put them aside and prepare the chassis.

Although the author used a metal U-shaped chassis 9" x 7" x 2 3/4" (with a suitable wooden cover), any other arrangement can be used. In any case, mount the 12-circuit phono jack assembly (or 12 single phono jacks) on the rear apron of the chassis. Label one set of six jacks "Channel 1" and the other set of six "Channel 2." Also mount a pair of phono jacks for the outputs on the rear apron, along with two conventional 117-volt power sockets and two through-the-chassis strain reliefs (one for the a.c. line and the other for the d.c. supply to the preamp).

The front of the chassis can be prepared as shown in the photos. On the left side, cut a slot large enough to fit the four rocker switches. Mount the switches on a support such as that shown in Fig. 4 so that the four switches can be operated easily from the front.

#### PARTS LIST

- C1, C3, C8, C9, C10—0.047- $\mu$ F capacitor  
 C2, C18—30- $\mu$ F, 6-volt electrolytic capacitor  
 C4, C12, C17, C19—2.2- $\mu$ F, 50-V electrolytic capacitor  
 C5—47- $\mu$ F, 50-V electrolytic capacitor  
 C6—5- $\mu$ F, 15-V electrolytic capacitor  
 C7—4700-pF capacitor  
 C11—0.1- $\mu$ F, 12-V capacitor  
 C13, C14—3300-pF capacitor  
 C15—220-pF capacitor  
 C16—0.01- $\mu$ F, low voltage capacitor  
 Q1, Q2, Q3, Q4—Field-effect transistor (Texas Instruments TIS58)  
 Q4, Q6—Transistor (Motorola MPS6566)  
 R1, R6, R15, R24—1.5-megohm  
 R2, R7, R16, R25—22-megohm  
 R3, R8, R17, R21, R22, R23, R26—100,000-ohm  
 R4, R9, R13, R27—1000-ohm  
 R5, R10, R14, R19, R28, 22,000-ohm  
 R11—27,000-ohm  
 R12—470,000-ohm  
 R18—2200-ohm  
 R20—10,000-ohm  
 R30—10,000-ohm PC trimmer potentiometer  
 R32—47,000-ohm

all resistors  
1/2-watt

Note—A printed circuit board (#156) is available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216 for \$2.40, postpaid. A complete kit of parts including punched cabinet for stereo version (#156-C) is available from the same source for \$42.50 plus postage for four pounds.

Fig. 1. Four of six semiconductors are low-noise FET amplifiers, and two conventional junction transistors are used as interstage emitter followers.

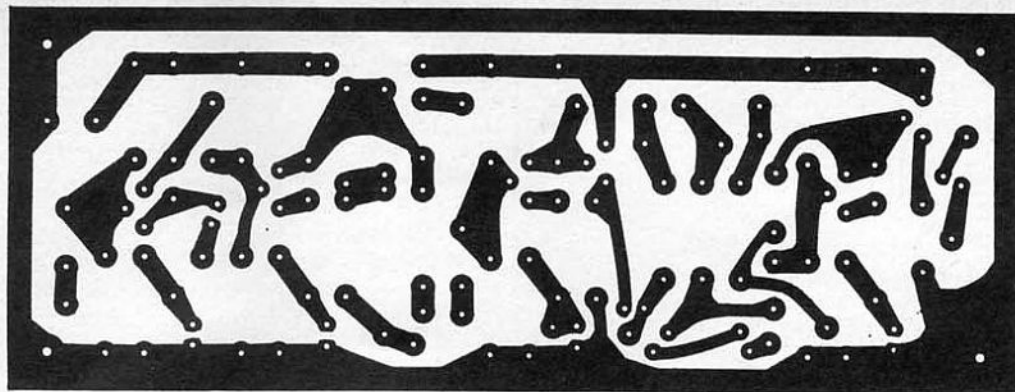


Fig. 2. Actual-size foil pattern for the preamplifier. A pair of boards would be required for stereo.

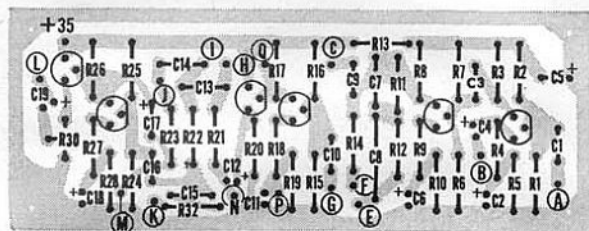


Fig. 3. After making (or buying) the PC board, install the components as shown here, taking care to observe the polarity of semiconductors and electrolytics.

Cut a long slot at the bottom of the front panel for the six pushbutton switches. The switch assembly is held on by a pair of mounting screws from the bottom of the chassis. Next to the pushbuttons, install a pair of phone jacks (one for the microphone input and one for the tape output). The three variable controls, BASS ( $R34$ ), TREBLE ( $R35$ ), and VOLUME ( $R33$ ) are mounted above the pushbutton switches.

In the photographs, the top rocker switch is labeled STEREO-MONO. In the author's final design, however, this switch was used for LOUDNESS-VOL-

UME and a s.p.s.t. switch was added to the tandem volume controls for the stereo-mono selection. The selection is made by pulling out the shaft of the volume control. In this discussion, the top rocker switch is the LOUDNESS-VOLUME control,  $S1$ . The second rocker switch from the top is the HI cut switch ( $S2$ ); the third is the LO cut switch ( $S3$ ); and the bottom one is the main a.c. on-off switch ( $S5$ ). The chassis com-

View of rear apron showing mounting details of the 12 input jacks and the location of the two resistors used to load each of the phonograph inputs.

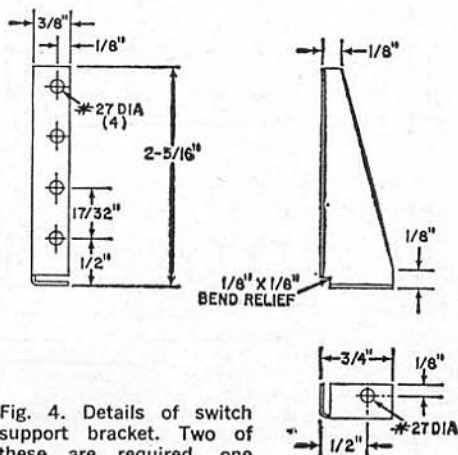
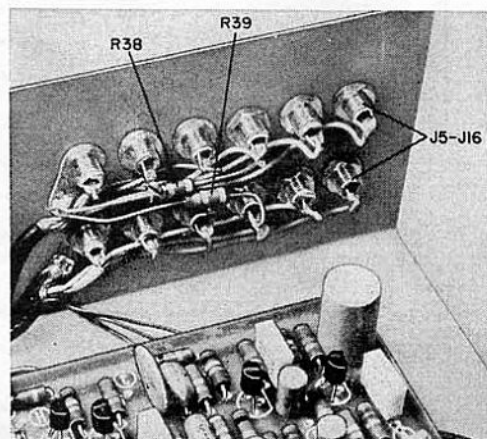


Fig. 4. Details of switch support bracket. Two of these are required, one for each side mounting.

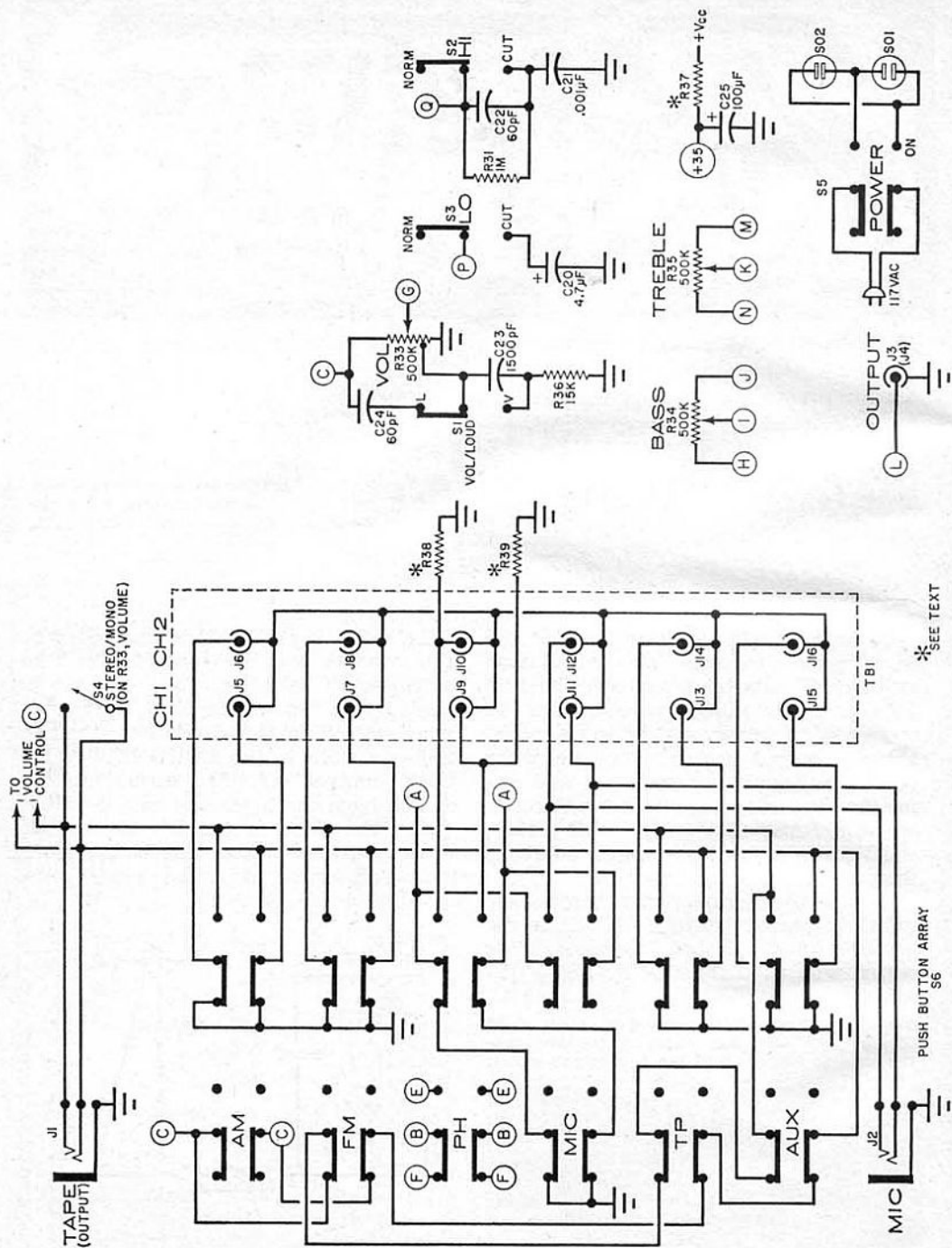
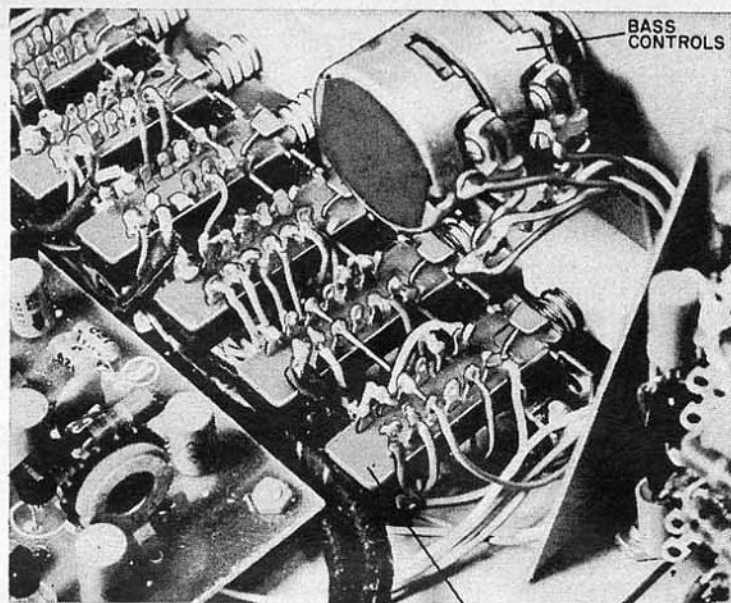


Fig. 5. Wiring of the front and rear panel components. The lettered circles are wired to similar lettered terminals on the boards. The small, individual circuits at the top are the isolated component connections.



Details of one corner of the preamp. Shown here are the tandem bass controls, a portion of pushbutton array S6, and one rocker switch support bracket.

PUSHBUTTON  
ARRAY S6

ponents are wired to the boards as shown in Fig. 5.

Mount capacitors *C23* and *C24* and resistor *R36* between the proper terminals on *S1*; and mount *C21*, *C22*, and *R31* on the proper terminals of *S2*. Connect *C20* between *S3* and ground. (The components and connections given in this paragraph must be repeated for each channel of a stereo system.)

Resistors *R38* and *R39* must be connected between the magnetic cartridge

input jacks and ground. The values of these resistors should be as recommended by the cartridge manufacturer. Although many values are specified by the various manufacturers, 47,000 ohms is the most common.

Once all chassis components are mounted, connect the various lettered terminals on the PC boards (see Fig. 5) to their respective controls in neat wire bundles. Mount each PC board on four standoffs, one at each corner.

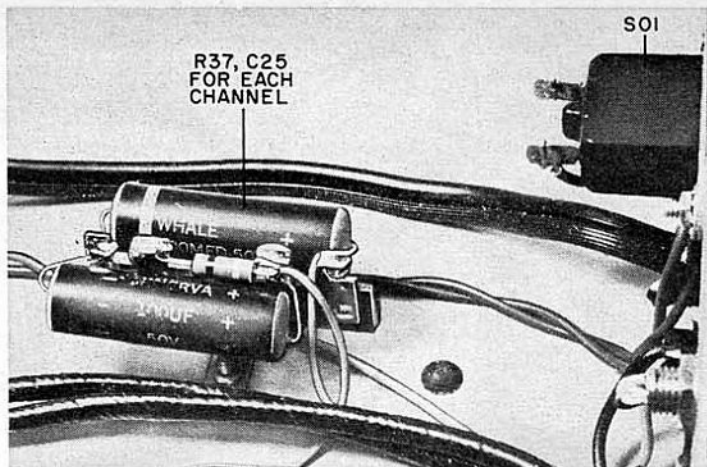
#### PARTS LIST

- C20*—4.7- $\mu$ F, low-voltage electrolytic capacitor\*  
*C21*—0.001- $\mu$ F capacitor\*  
*C22, C24*—60-pF capacitor\*  
*C23*—1500-pF capacitor\*  
*C25*—100- $\mu$ F, 50-volt electrolytic capacitor  
*J1, J2*—3-circuit phono jack  
*J3, J4*—Phono jack  
*J5*—12-circuit phono jack assembly  
*R31*—1-megohm,  $\frac{1}{2}$ -watt resistor  
*R33*—500,000-ohm tapped potentiometer\* (tandem)  
*R34, R35*—500,000-ohm potentiometer\* (tandem)  
*R36*—15,000-ohm,  $\frac{1}{2}$ -watt resistor\*  
*R37, R38, R39*—See text  
*S1, S2, S3, S5*—D.p.d.t. rocker switches  
*S4*—S.p.s.t. switch (on *R33*)  
*S6*—Six button pushbutton switch assembly, each 4 p.d.t.  
*SO1, SO2*—Chassis-mounting 117-volt a.c. outlets  
 Misc.—Line cord, strain reliefs (2), spacers, mounting hardware, knobs (3), rubber feet (4), wire, solder, etc.  
 \*Two required for stereo version.

#### PREAMPLIFIER SPECIFICATIONS

- Frequency response: 10 Hz to 100 kHz (–1 dB point)  
 Distortion: THD @ 1-V output, less than 0.15% from 15 Hz to 50 kHz.  
 Hum and noise: Phono and mic., –65 dB below full output; other inputs, –70 dB below full output.  
 Sensitivity: Phono and mic., 2 mV for 1-V output; other inputs, 0.1V for 1-V output.  
 Input impedance: Phono, 47,000 ohms (see text); other, 500,000 ohms.  
 Input before clipping: Phono and mic., 0.1V; other inputs, 10 V.  
 Maximum output: 5V r.m.s.  
 Output impedance: less than 1000 ohms.  
 Channel separation: Greater than 40 dB at 1000 Hz.  
 High filter: 3 dB down at 10 kHz.  
 Low filter: 3 dB down at 70 Hz.  
 Treble control range:  $\pm 15$  dB at 10 kHz.  
 Bass control range:  $\pm 15$  dB at 50 Hz.

To reduce the interchannel coupling, a separate voltage-dropping network, *R37* and *C25*, is used for each of the stereo channels.



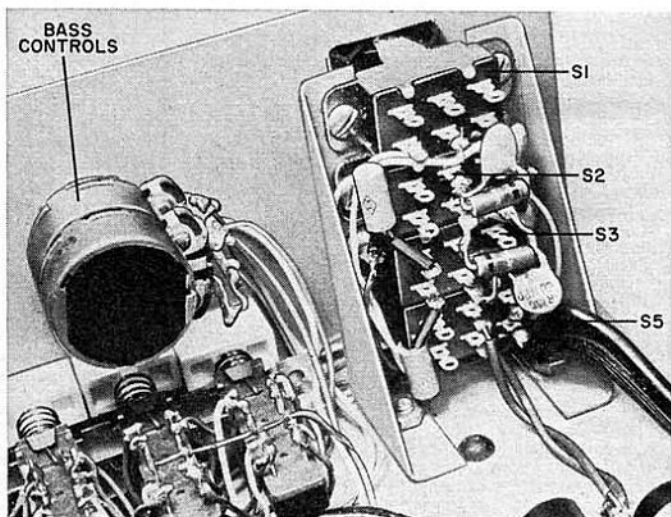
Pass the 117-volt line cord through its strain relief and connect it to switch *S5* and to the power outlets. Line voltage for the power amplifier is taken from one of these outlets; the other can be used for a record player or tape recorder.

D.c. power for the preamplifier should be obtained from a well-filtered 35-volt source. Provisions for this supply are made in the companion power amplifier to be described in a forthcoming issue. If the external power source is higher than 35 volts, resistor *R37* must be used to drop the voltage. To determine the value to use for *R37*, divide the difference between the voltage you have and 35 by 0.006. For example, if the source is 50

volts, the resistance is  $50 - 35$ , or 15, divided by 0.006, or 2500 ohms. You can use the nearest standard resistance value (2200 or 2700 in the example) at  $\frac{1}{2}$  watt. Mount *R37* with its companion filter capacitor *C25* on a multi-lug terminal strip in an open section of the chassis.

Recheck all wiring.

**Testing.** Connect the two rear-apron output jacks (*J3* and *J4*) to the inputs of the power amplifier, and connect the desired inputs to the two channels of the preamp. Turn on the power to the preamp. (The 117-volt line cord on the power amplifier can be plugged into *S01* or *S02* and switched on and off with *S5* on the preamp.) Check that approxi-



The overall rocker switch support bracket assembly. Components are mounted on switches.

## HOW IT WORKS

Input selection is made by a series of pushbuttons, each operating a four-pole, double-throw switch. When a button is "out," the input that the particular button controls is grounded to prevent cross talk from the unused inputs. Pushing "in" any of the four high-level pushbuttons breaks the connection between the first two stages of the preamp and the volume control, and feeds the selected high-level input directly to the volume control. This approach keeps the distortion as low as possible. (In some preamps, the high-level inputs are reduced resistively and all signals are amplified by the complete preamp.) In this preamp, only the microphone and phono input are amplified by the first two stages. In the phono position, the preamp feedback network is switched in and changes the amplifier curve from essentially flat to the required RIAA curve.

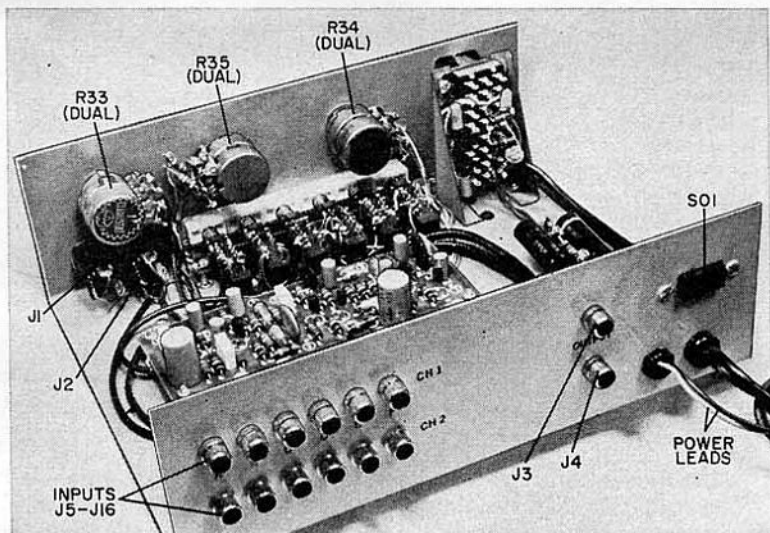
The four FET amplifier stages are similar. A common-source circuit having a large-valued source resistor and positive gate bias results in a consistent and stable amplifier. The first two stages ( $Q1$  and  $Q2$ ) use the RIAA equalization network needed for magnetic phono input. Amplifier  $Q2$  feeds the volume control ( $R33$ ), which is followed by a FET amplifier ( $Q3$ ) to provide a low-impedance driving source for the tone controls.

The tone-control circuit (between  $Q4$  and  $Q5$ )

is a low-distortion Baxendall-type circuit. This feedback type of tone control utilizes the most desirable variable turnover point characteristic. The controls give bass or treble boost or cut when offset from the normally flat center position. The tone control network, including  $Q5$ , has unity gain and is followed by emitter follower  $Q6$ . The low output impedance permits the use of a reasonably long cable between the preamp and its associated power amplifier with reduced attenuation and noise pickup. The low output impedance also insures that the preamp will be able to drive transistor amplifiers with the lowest input impedance. The most desirable situation in an audio system is to have a low impedance driving a higher impedance. This is not efficient as far as power transfer is concerned, but it does result in the lowest possible distortion.

The output level is adjusted by a trimmer potentiometer ( $R30$ ) on each channel to allow balancing without the use of concentric, or clutch-coupled, controls. It also allows exact match for the power amplifier being used.

The high-frequency filter bypasses the highs to ground at the drain of  $Q3$ , while the low-frequency filter changes the  $Q3$  source network. The stereo-mono switch is coupled to the volume control which makes it possible to switch to either stereo or mono merely by pulling out the volume control. The loudness compensation switch changes the circuit of the volume control to boost the bass and treble at low volume levels.



Though two are called for, the author mounted only one power outlet (SO1) on rear apron. The preamp controls primary power fed to main amplifier through this outlet, and takes d.c. from the amplifier.

mately 35 volts is present at the +35 terminal on each PC board. Using a high-impedance voltmeter, check that the drain voltage at each FET is between 12 and 18 volts. If any wide variation is found, check the circuit for possible errors in component values.

Depress the appropriate input push-button and operate the VOLUME, BASS, and TREBLE controls as desired. If you want loudness compensation instead of

linear volume action, operate the LOUDNESS-VOLUME rocker switch.

Place the system in MONO (by operating the volume control shaft) and adjust  $R30$  in each channel to get the same output from each. This is the only balance adjustment that needs to be made.

If there is excessive hum in the system, the preamplifier may be too near a power transformer or a.c. motor. Proper orientation reduces interference. ~~50~~



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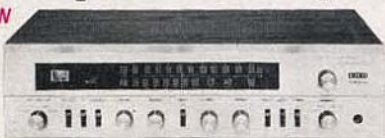
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