



BUILD 40- TO 100-WATT POWER AMPLIFIERS THAT MATCH FET STEREO PREAMP

BY DAN MEYER

THE HI-FI buff's search for the "perfect" amplifier is never ending. New components (particularly semiconductors) and new circuit wrinkles are announced almost daily to spur him on—in the hope that, sooner or later, something close to perfection will be achieved.

Presented here are two new audio power amplifiers ("Tiger" and "Super Tiger") which use the latest advancement in power transistors and up-to-the-minute circuit design. Try one of them and see if you don't think perfection is obtainable.

The two amplifiers are quite similar except that the Tiger delivers 35 watts r.m.s. (40 watts IHF) and the Super Tiger 80 watts r.m.s. (100 watts IHF). Specifications are shown in the table.

Construction (Tiger). The 40-watt IHF Tiger amplifier (schematic shown in Fig. 1) is assembled on a printed circuit board (foil pattern shown in Fig. 2). Mount the components on the board using the layout shown in Fig. 3. Be sure to use heat-sink grease between the two output transistors ($Q1$ and $Q4$) and their heat

sinks. Special clamps are called for in the Parts List to attach diode $D1$ to the $Q1$ heat sink and $D2$ to the $Q4$ heat sink. Be very careful in connecting the diodes into the circuit—proper polarities must be obtained or the transistors can be ruined. The red dot on the diode case indicates the cathode. Transistor heat sink is Staver V3-5 or similar and diode clamp is RCA SA-2100 or similar.

Two amplifiers must be made if you want a stereo version of the Tiger. Installation of the circuit boards in a cabinet is left to your discretion. The photographs show the author's approach to the packaging. The two boards are mounted on spacers. The bulky power transformer and associated rectifier components are mounted near the rear apron and the filter capacitors are on the front apron. The amplifier shown in the photos is the Tiger, but the same construction can be used for Super Tiger.

Only four external connections are required for the amplifier; two phono connectors for the inputs and a pair of jacks for the loudspeaker connections; or, if desired, a barrier strip or any other

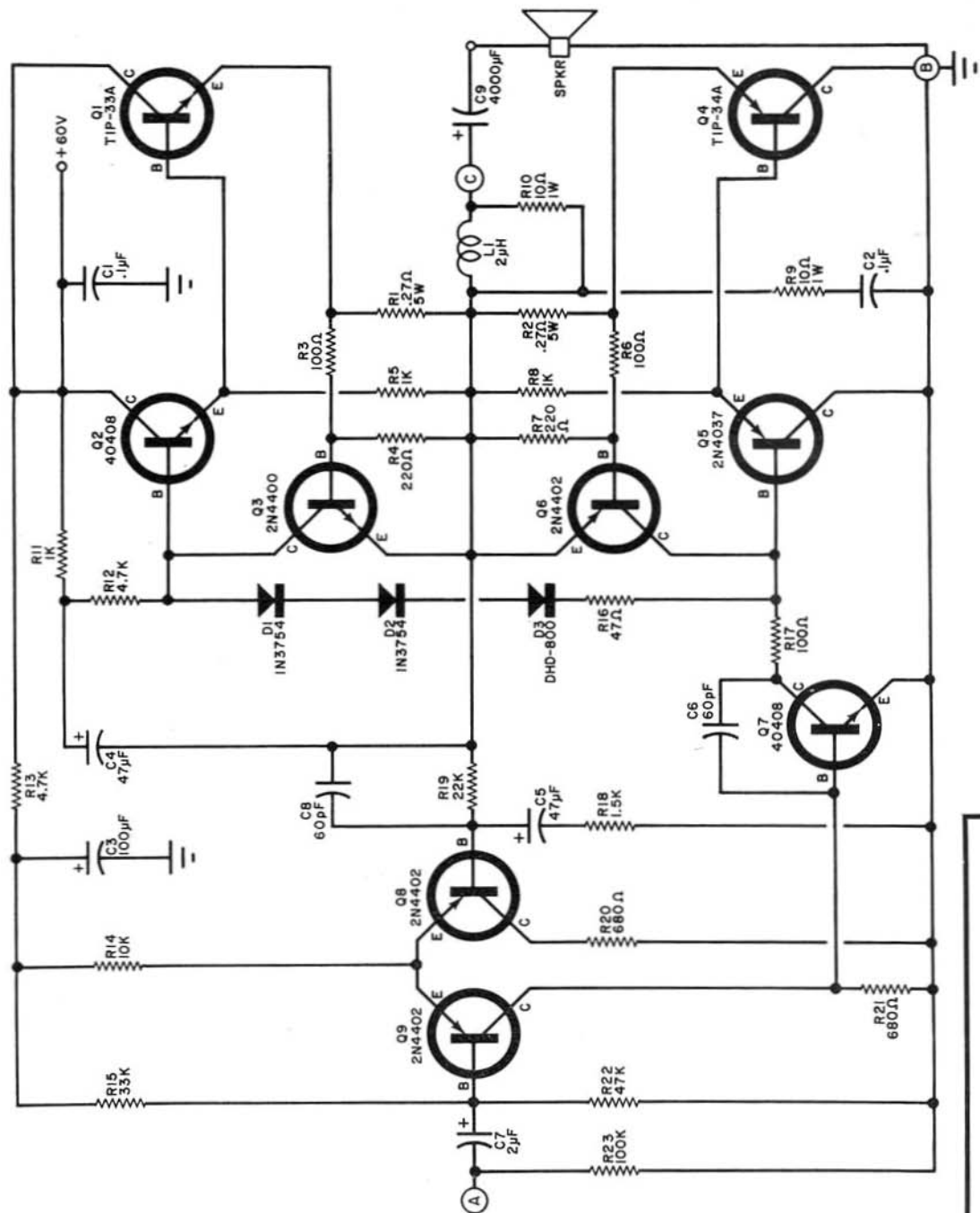


Fig. 1. The Tiger amplifier takes advantage of the latest semiconductors to produce a clean power amplifier that will compete with many commercially available power amplifiers costing many times as much.

PARTS LIST

- C1,C2—0.1- μ F capacitor
C3—100- μ F, 50-volt capacitor
C4,C5—47- μ F, 50-volt capacitor
C6, C8—60-pF capacitor
C7—2.2- μ F, 50-volt capacitor
C9—4000- μ F, 50-volt capacitor
D1,D2—1N3754 diode
D3—Silicon diode (General Electric DHD-800)
L1—Three turns of #20 or #24 magnet wire on 1/2-inch diameter—approximately 2 μ H
Q1—Transistor (Texas Instruments TIP-33A)
Q2,Q7—Transistor (Motorola SS-1123, MM3005 or 40408)
Q3—Transistor 2N4400
Q4—Transistor (Texas Instruments TIP-33A)
Q5—Transistor (Motorola SS-1122, MM4005, or 2N4037)
Q6,Q8,Q9—Transistor (Motorola 2N4402)
R1,R2—0.27-ohm, 5-watt resistor
R3,R6,R17—100-ohm
R4,R7—220-ohm
R5,R8,R11—1000-ohm
R12,R13—4700-ohm
R14—10,000-ohm
R15—33,000-ohm
R16—47-ohm
R18—1500-ohm
R19—22,000-ohm
R20,R21—680-ohm
R22—47,000-ohm
R23—100,000-ohm
R9,R10—10-ohm, 1-watt resistor
Misc.—Input jacks, output jacks, spacers, hardware, lug strips, heat sinks, clips, wire, solder, etc.

All resistors
1/2-watt

Note—The following are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216: Etched and drilled printed circuit board (#160) \$3.10 postpaid; kit for amplifier (board and components for one channel) (#160C) \$16.80 postpaid; complete stereo kit with punched chassis, \$50.00, plus shipping, 9 lb.

AMPLIFIER SPECIFICATIONS

"The Tiger"

- Power output: 35 watts r.m.s., 40 watts IHF per channel
Distortion: Less than 0.5% total harmonic at 30 watts output and 1.0 kHz
Sensitivity: 1.0 volts for full output
Input impedance: 20,000 ohms
Output impedance: Less than 0.1 ohm; damping factor of approximately 20 with 8-ohm speaker
Hum and noise: More than 80 dB below 1-watt output
Frequency response: 10 Hz to 100 kHz (-3 dB points at full output)
Power supply: 60 volts at 2 amperes

"The Super Tiger"

- Characteristics same as above except:
Power output: 75 watts r.m.s., 100 watts IHF per channel
Sensitivity: 1.25 volts for full output
Power supply: 80 volts at 3 amperes

HOW IT WORKS

The input stage of the amplifier is a differential amplifier consisting of Q8 and Q9. A circuit like this has an almost constant total current flow through the two transistors due to the large resistance of the common-emitter resistor R14. The current divides between the two transistors, and, if the base voltages are equal, the collector currents are equal. If the base voltages are unequal, the voltages across the collector resistors are unequal but the total current does not change. A voltage divider consisting of R14 and R22 sets the base voltage of Q9 and a d.c. voltage from the output stage is applied to the base of Q8. Any variation between the two base voltages results in a collector current change in both transistors. The differential input is connected so that shifts in output tend to correct the output shift (negative feedback) making the amplifier circuit automatically self-balancing. The emitters of Q1 and Q2 remain at half of the supply voltage no matter what shifts occur in transistor gain due to temperature, etc.

The ratio of R19 to R18 controls the amount of a.c. negative feedback and the overall gain of the circuit. Capacitor C5 controls the low-frequency roll-off point.

Transistor Q7 provides a voltage amplifier stage in a conventional common emitter arrangement. The collector load, R11 and R12 is a bootstrap circuit which provides the amplifier with a constant current even at full positive half-cycle output. Capacitor C6 produces the required high-frequency roll-off above 100 kHz.

Transistors Q3 and Q6 and resistors R3, R4, R6, and R7 limit the current in the output stage. This prevents the output transistors from conducting more than their rated current and being damaged if the output connection is accidentally shorted to ground.

Output current flows through R1 or R2 (depending on the half cycle) and if this current becomes too high, the voltage across R1 or R2 causes the associated transistor to start to conduct. This clamps the driving voltage so that it cannot get any higher. The peak output-transistor current is thus limited.

The output stage consists of two transistor pairs, Q1-Q2 and Q4-Q5 operated as class B amplifiers. They provide the required current gain and match the low-impedance speaker load. Diodes D1, D2, and D3 and resistor R16 provide a small "on" bias to prevent crossover distortion. Two of the diodes (D1 and D2) are mounted directly on the transistor heat sinks so that the bias voltage shifts with changes in the base-emitter voltages of the transistors as they heat up under use.

The network consisting of L1, R10, R9 and C2 is required to insure high-frequency stability under all possible loading conditions.

type of dual connector can be used for the speaker connections. Mount the fuseholder and pass the a.c. line out through a rubber grommet. D.c. voltage for powering an external preamplifier may also be supplied to a barrier strip located on rear apron of chassis.

The power supply for the Tiger is shown in Fig. 4. It is a conventional high-current bridge rectifier with filter to supply 60 volts d.c. for the amplifier. When wiring the power supply to the

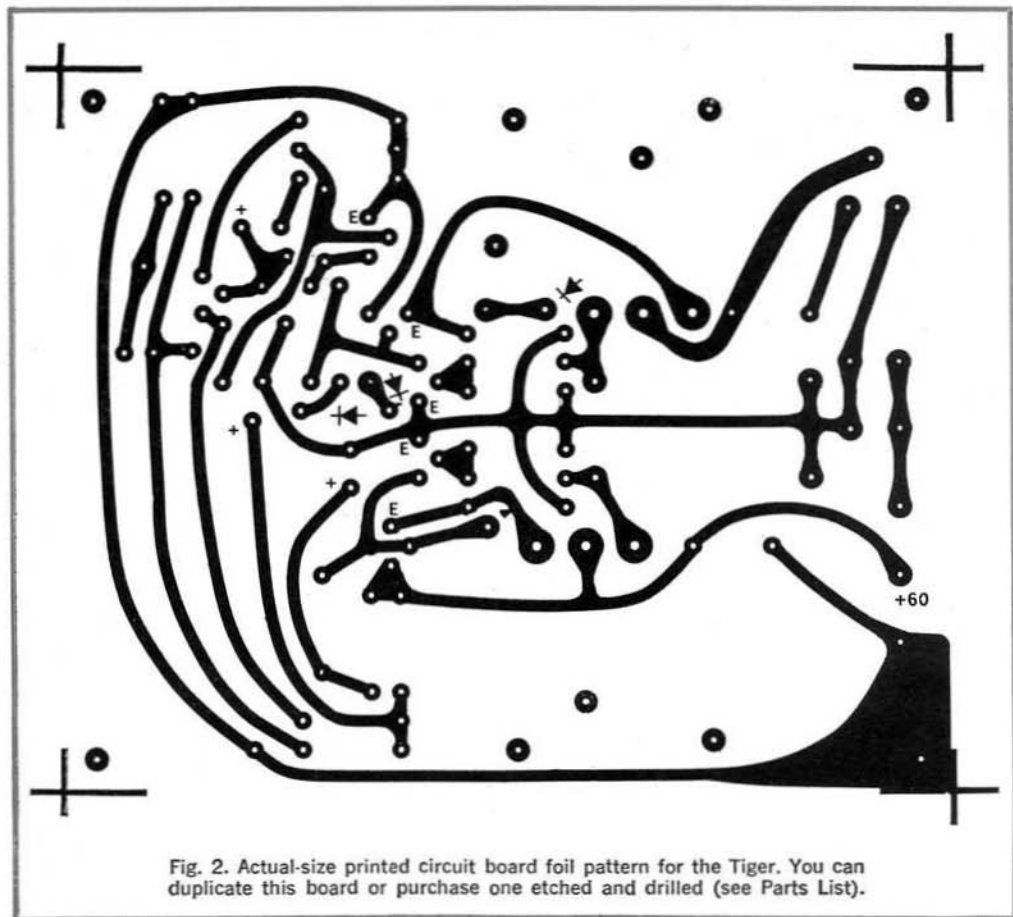


Fig. 2. Actual-size printed circuit board foil pattern for the Tiger. You can duplicate this board or purchase one etched and drilled (see Parts List).

Fig. 3. Component installation. The two holes near the power transistors (Q1, Q4) are mounting holes for the heat sinks. The associated diodes are then clamped to their respective transistor heat sinks.

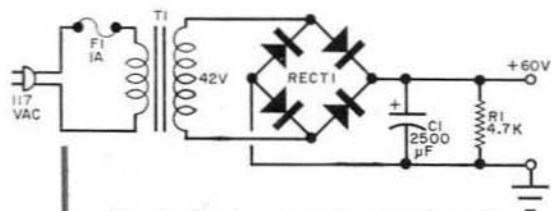
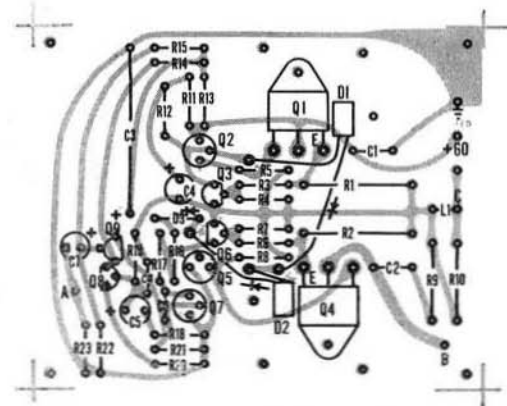
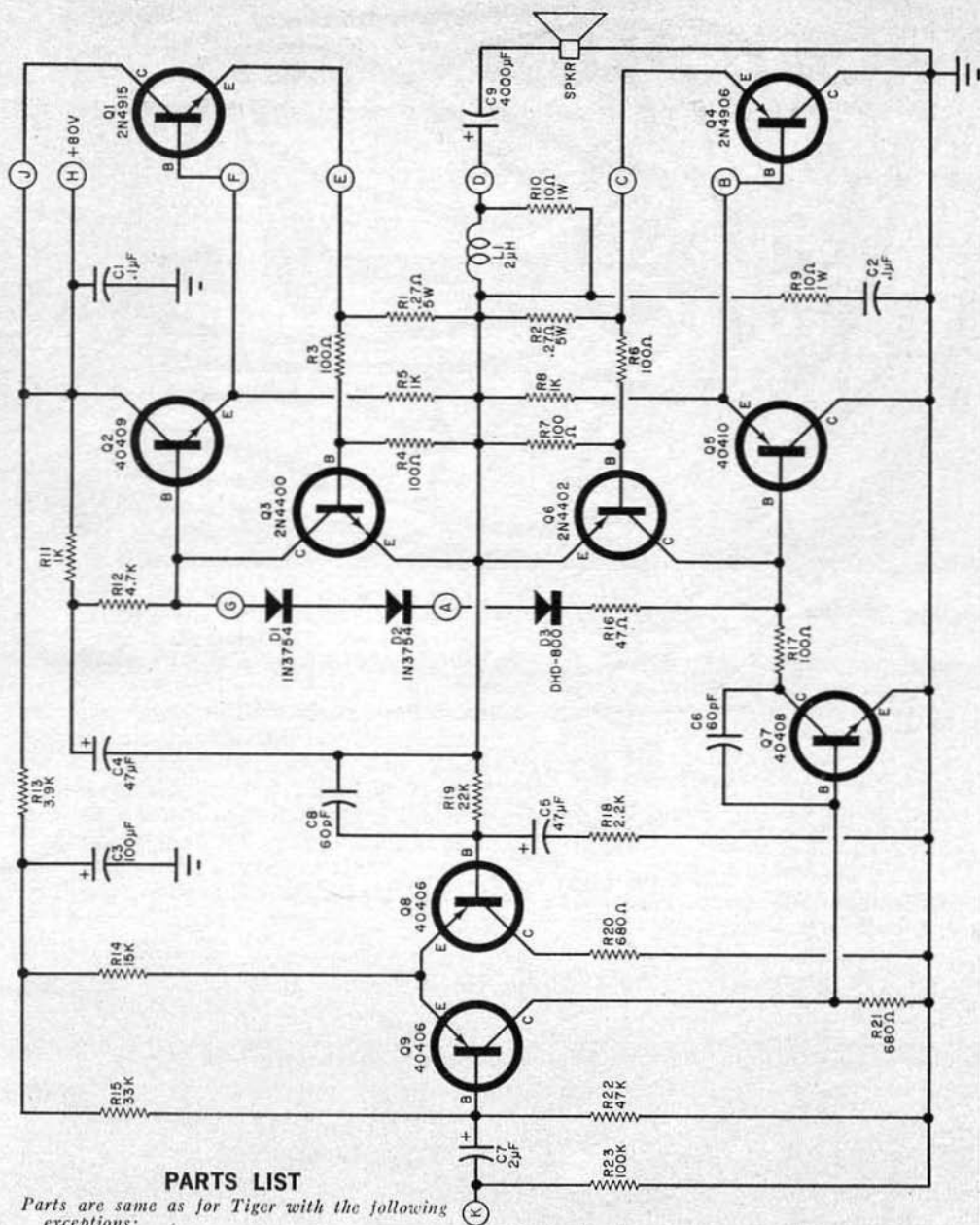


Fig. 4. Power supply for the tiger. It can be wired point-to-point with the components installed within the chassis.

PARTS LIST

- C1—2500- μ F, 75-volt electrolytic capacitor
- F1—1-ampere fuse and fuseholder
- R1—4700-ohm, 1-watt resistor
- RECT1—2-ampere bridge rectifier
- T1—Power transformer, secondary 42 V at 2 A (SW Tech P-5600 or similar)
- Misc.—S.p.s.t. power on-off switch (optional), power on neon indicator assembly (optional).



PARTS LIST

Parts are same as for Tiger with the following exceptions:

- C3—100- μ F, 100-volt capacitor
 - Q1—Transistor (Motorola or Texas Instruments 2N4915)
 - Q2—Transistor (RCA 40409)
 - Q4—Transistor (Motorola or Texas Instruments 2N4906)
 - Q5—Transistor (RCA 40410)
 - Q7—Transistor (RCA 40408)
 - Q8, Q9—Transistor (RCA 40406)
 - R4, R7—100-ohm
 - R13—3900-ohm
 - R14—15,000-ohm
 - R18—2200-ohm
- } All resistors
1/2-watt

Note—The following are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216: Etched and drilled printed circuit board (#160SB) \$2.80 postpaid; kit for amplifier (board and components for one channel) (#160SC) \$22.00 postpaid; complete stereo kit with punched chassis, \$70.00, plus shipping, 14 lb.

Fig. 5. The Super Tiger has same basic circuit as the Tiger, with high-power transistors in the output and a different circuit board.

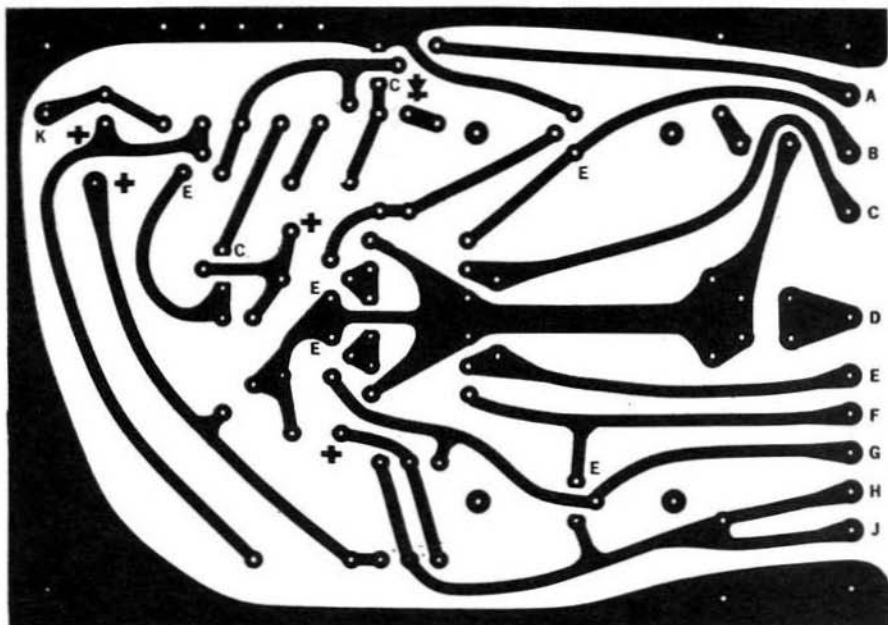


Fig. 6. Foil pattern for the Super Tiger. Like the Tiger PC board, this one is also available etched and drilled (see Parts List for Fig. 5).

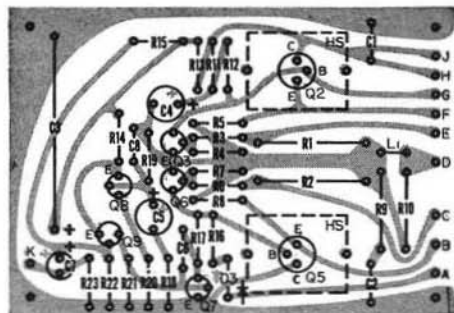
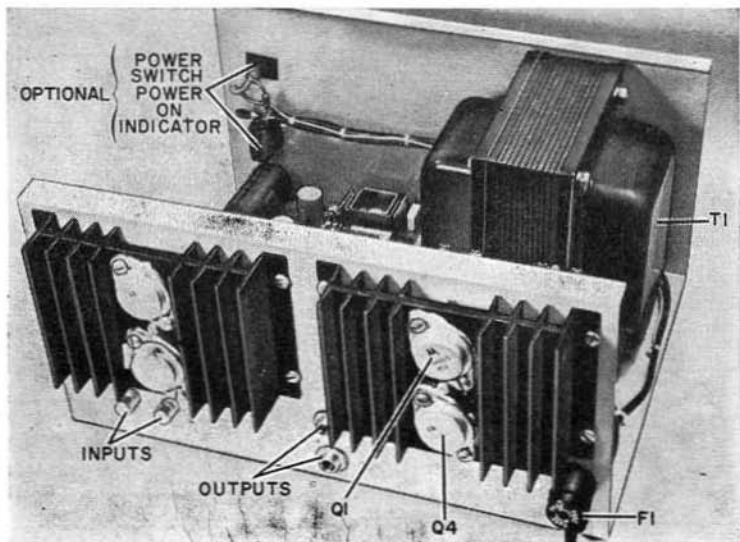


Fig. 7. Component installation for the Super Tiger. Note the location of the two transistor heat sinks (dashed line boxes) that mount on the PC boards.

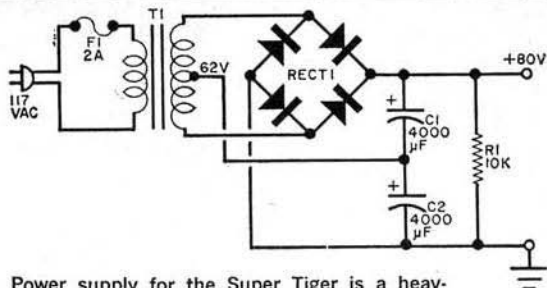
amplifier, note that there are two ground contacts on the PC board: one marked "B" and the other marked with the ground symbol. The former is the output grounding contact and should be connected directly to the loudspeaker jack along with the signal lead. Use at least a #18 wire for this connection. The other

The Super Tiger arranged for stereo. The optional power switch and indicator can be mounted on the front panel. The speaker outputs are terminated in phone jacks, although a barrier strip can be used.



PARTS LIST

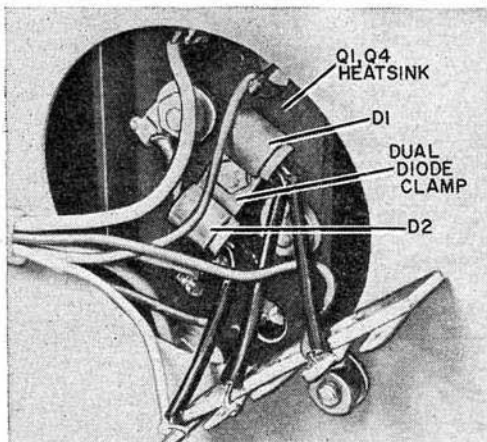
C1, C2—4000- μ F, 50-volt electrolytic capacitor
F1—2-ampere fuse and fuseholder
R1—10,000-ohm, 1-watt resistor
RECT1—4-ampere bridge rectifier
T1—Power transformer, secondary 62 V at 3 A
 (SW Tech P-3154 or similar)
Misc.—S.p.s.t. power on-off switch (optional),
 power on neon indicator assembly (optional).



Power supply for the Super Tiger is a heavier version of the one for the Tiger. The Super Tiger takes higher voltage and more current.

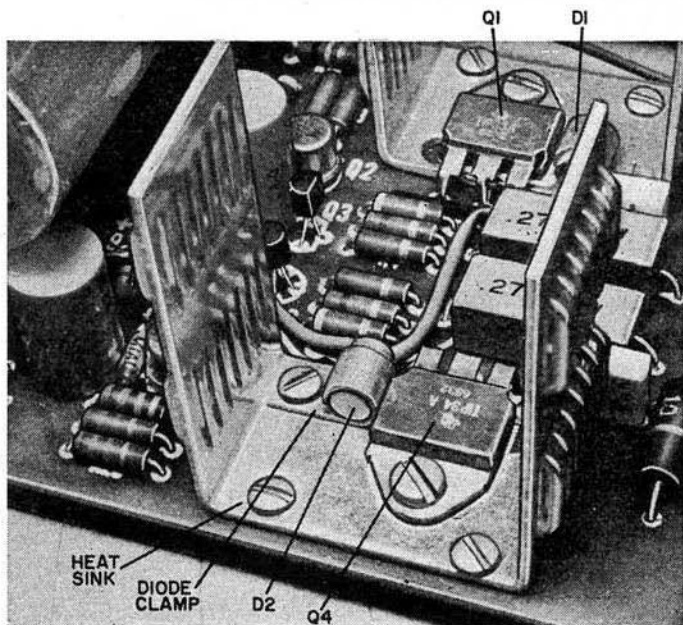
ground should be connected to the chassis in the conventional manner. Do not depend on the mounting spacers for a ground connection.

Construction (Super Tiger). The 100-watt IHF Super Tiger amplifier is electrically similar to the Tiger except that the heavy-duty output transistors are mounted off the PC board on independent heat sinks. The circuit is shown in Fig. 5 and the foil pattern for the printed circuit board is shown in Fig. 6. Once the board is made, or purchased, mount the components as illustrated in Fig. 7. Note that diodes *D1* and *D2* are on the transistor heat sinks separate from the board and their connections to the board are made through lettered terminals on the

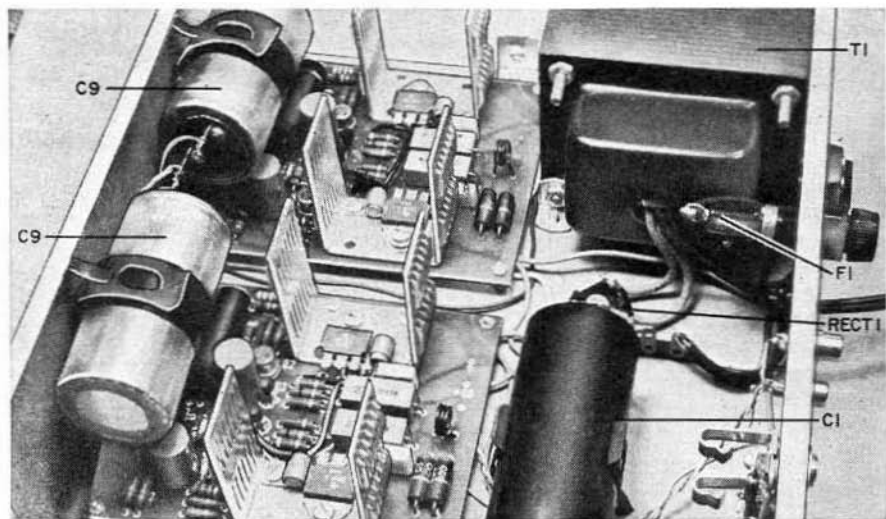


Method of mounting the diodes on power transistor heat sink. When mounting the heat sink, make sure that there is a large hole in the chassis wall so that you can readily mount the diode clamp in place.

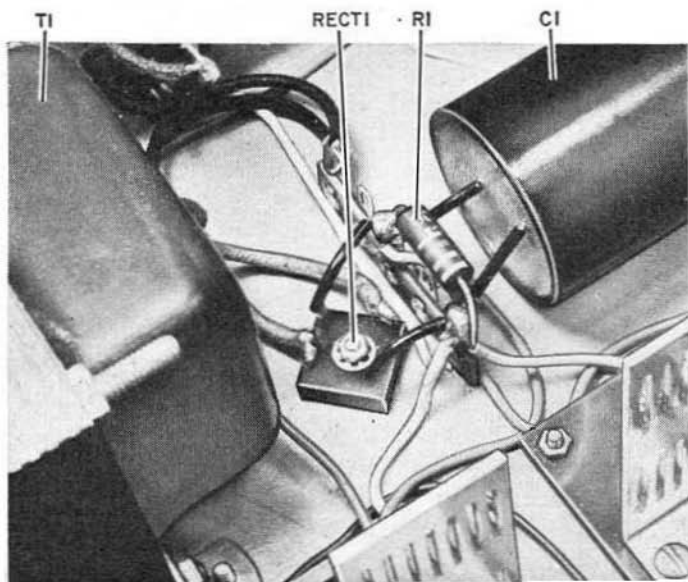
General view of one channel of the Tiger amplifier. Note how diodes are clamped to sinks.



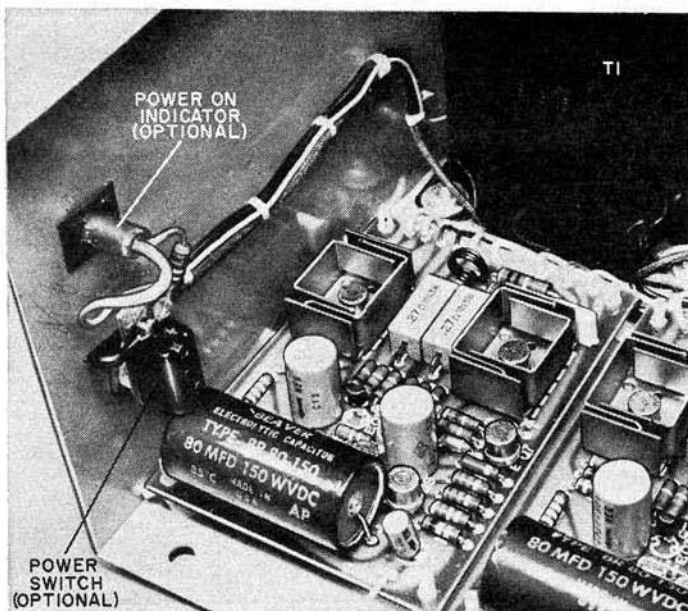
Either Tiger or Super Tiger makes excellent companion for the stereo preamp featured in the May 1969 issue. The power amplifier also supplies d.c. power for stereo preamplifier.



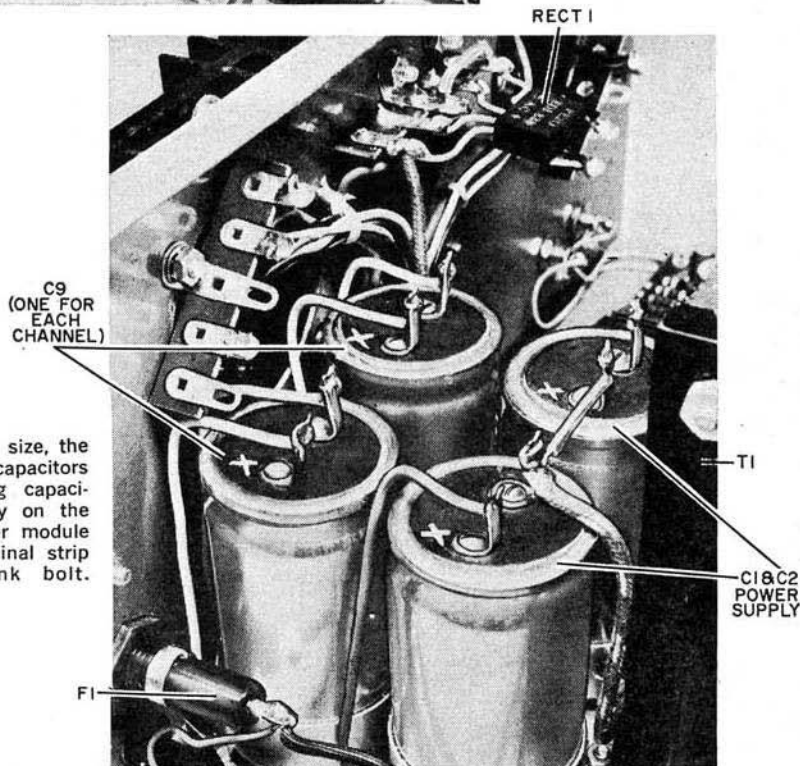
Tiger power amplifier wired for stereo (2 channels). One power supply handles both channels. Two output capacitors are mounted on the rear apron.



Close up of the power supply. Rectifier module is bolted to chassis and connections are made to a terminal strip.



Internal view of Super Tiger amplifier showing placement of optional power-on switch and indicator lamp. The heavy power transistors are mounted on opposite wall of chassis.



Due to their physical size, the power supply filter capacitors and output coupling capacitors are put directly on the chassis. The rectifier module is mounted on terminal strip held by heat sink bolt.

board. Be sure to observe the correct polarities for all diodes.

The actual physical arrangement of the boards (two for a stereo system) in an enclosure is at the builder's discretion. The bulky power transformer and filter capacitors are mounted separately

from the boards.

The circuit for the power supply for the Super Tiger is shown in Fig. 8. It is a heavy-duty bridge rectifier with associated filter and bleeder circuit. The output to the amplifier is 80 volts.

(Continued on page 99)

TIGERS THAT ROAR

(Continued from page 63)

Follow construction instructions for the Tiger with regard to inputs, outputs, etc.

Testing. Before turning on the power, examine each board, the power supply, and the interconnections for proper component installation (including polarities on capacitors and diodes), solder bridges between foil sections, and wiring errors.

Disconnect the d.c. supply to the amplifier—60 volts for the Tiger, 80 volts for the Super Tiger. Connect a d.c. voltmeter to the power supply output and turn on the power. The measured voltages should be about 5 volts above nominal—65 and 85, respectively. Turn off the power and allow the power supply to discharge through the bleeder resistor.

Temporarily connect a 1000-ohm, 1-watt resistor between the positive output of the power supply and the voltage input terminal on the amplifier board (either one in a stereo system). Connect a d.c. voltmeter across the resistor, observing the proper polarities. When the power is turned on, the voltmeter should indicate about 20 volts. If it is more than 25 volts, you have a problem in that channel. Once one channel is found to be OK, perform the same test on the other channel. If you find trouble, one quick check you can make is to measure the voltage at the output transistor emitters. It should be about half the supply voltage.

Once you are satisfied that all is correct, shut down the power, wait a moment for the power supply to discharge, and then connect a 4- or 8-ohm speaker to each output terminal.

Since the input impedance to either amplifier is about 20,000 ohms, the power amplifier can be driven from either a transistor or vacuum-tube preamp. It will work particularly well with the FET Preamp described in the May POPULAR ELECTRONICS.

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