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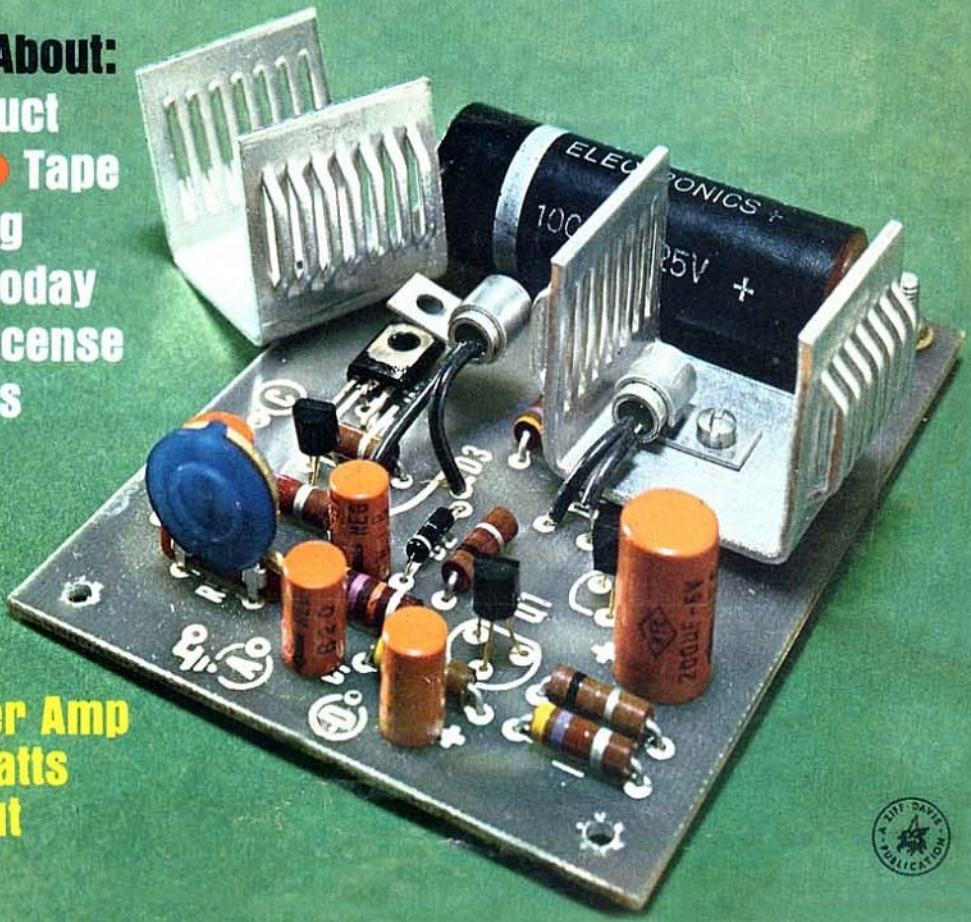


Build Hi-Fi Power Amp 22 Watts Output

IF YOU would like to update your present audio system with a low-cost, superior-quality, cool-running, low-distortion transistor power amplifier—try the "L'il Tiger." This small but versatile amplifier will put out a very clean 18 watts per channel r.m.s. with 8-ohm speakers, or a total of 36 watts for a stereo system.

Supply voltage can be anything from 12 to 45 volts, depending on the amount of output power you want, while the speaker can be rated anywhere from 3.2 to 16 ohms. The full electrical specifications given on page 33 clearly demonstrate the "L'il Tiger's" capabilities.

The amplifier owes most of its outstanding characteristics to a new breed of transistors—uniquely designed plastic complementary silicon power transistors.

Circuit Development. Circuit designers realize that a complementary transistor output stage would be the most desirable arrangement in an audio power amplifier, but until recently, *pnp* power transistors complementary to existing *npn* types either were not available, or were so expensive that they could not be considered practical. Attempts to design around this problem led to the quasi-complementary circuit (much as was used in the "Brute-70," POPULAR ELECTRONICS, February, 1967). This type of circuit uses power transistors of the same polarity, with the result that one output transistor operates as a common emitter and the other as a common collector. The output impedances are not the same for positive and negative half cycles of the audio signal, but negative feedback produces a reasonably good amplifier.

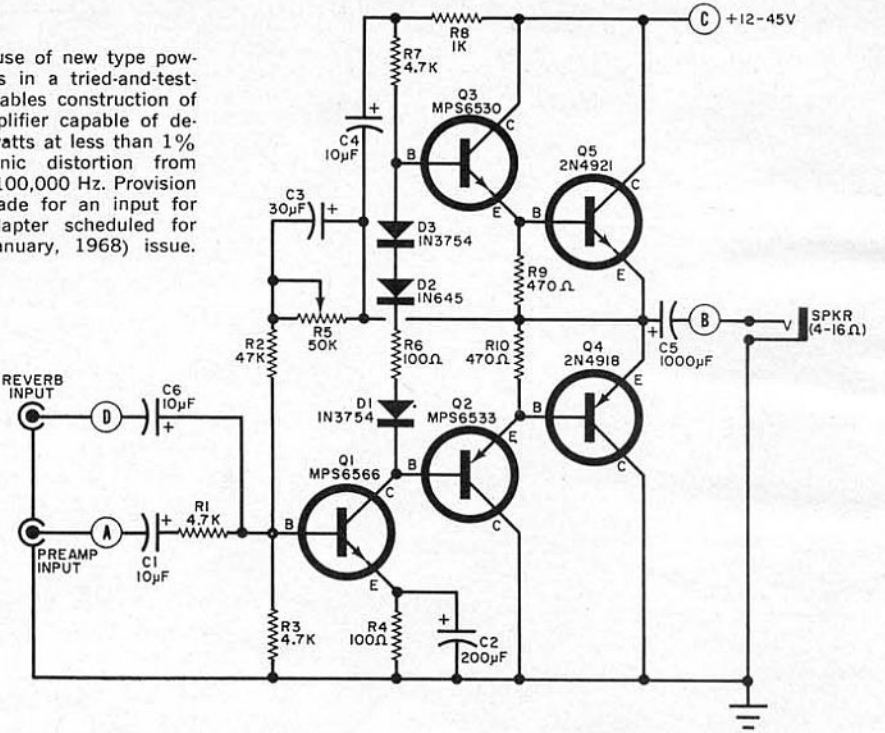


Fig. 1. The use of new type power transistors in a tried-and-tested circuit enables construction of a power amplifier capable of delivering 22 watts at less than 1% total harmonic distortion from about 20 to 100,000 Hz. Provision has been made for an input for a reverb adapter scheduled for the next (January, 1968) issue.

Another solution to the problem has been to use one silicon and one germanium power transistor in the output stage. This combination can lead to thermal (heat) compensation problems, and the transistors are usually far from complementary in their characteristics. Again, lots of negative feedback can produce a pretty good amplifier, but feedback is used to correct for circuit nonlinearities, rather than the circuit being inherently linear with feedback used only to make it better.

The unusual construction of the Motorola transistors used in the "L'il Tiger" makes it possible to manufacture them at a reasonable cost while also making heat-sinking both simple and inexpensive. With the duty cycles found in speech and music, a simple heat sink is sufficient for operation at ambient temperatures of up to 120°F.

These transistors have excellent high frequency response. Unlike many previous power transistors, the new types will produce nearly full output up to at least 100 kHz. Since feedback is used only in one voltage amplifier of the "L'il Tiger" amplifier stage (see Fig. 1), the overall circuit is extremely stable and needs no tricky amounts of high-frequency compensation.

A suitable 45-volt power supply for the "L'il Tiger" is presented in Fig. 2. Power output for various values of supply voltage and load impedance is given in Fig. 3, while Fig. 4 delineates the performance possible with a 45-volt power supply and an 8-ohm speaker. All of this performance can be had at a cost of around 50-cents-per-watt (less the cost of the power supply).

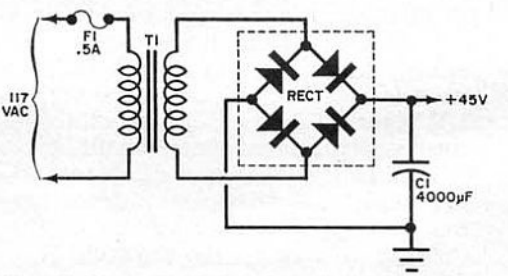


Fig. 2. Power supply for the "L'il Tiger" uses a conventional bridge rectifier and capacitor filter.

Construction. Figure 5 is an actual-size PC board foil layout, while Fig. 6 shows

HOW IT WORKS

The "L'il Tiger" circuit consists of a pair of compound emitter followers *(Q2-Q4,* and *Q3-Q5),* and a voltage amplifier *(Q1).* To prevent crossover distortion in the Class B output and driver stages, the emitter followers are biased *on* slightly by a network consisting of *D1, D2, D3,* and resistor *R6.* This method of operation results in excellent thermal stability under almost any load and temperature conditions.

The audio signal on the output line (to terminal B on the PC board) is also coupled to the junction of *R7* and *R8* via capacitor *C4.* This coupling causes the instantaneous voltage at the junction of the two resistors to follow any variation in output voltage. The immediate result is that the voltage across *R7,* which is the collector load resistor of *Q1,* remains constant and does not drop to zero when a large, positive half-cycle signal is applied to the amplifier. The end result is the reduction of distortion by the emitter followers with decreasing supply voltage.

Voltage amplifier *Q1* is a common-emitter stage having a small amount of emitter resistance *(R4)* to compensate for variations in the transistors used. The bias point for *Q1* is stabilized by d.c. feedback from the output through *R5* and *R2.* Capacitor *C3* passes the audio signal around *R5,* thus producing a.c. feedback which is not affected by any setting of *R5.* Potentiometer *R5* sets the bias for the output stages. To prevent the driving source (preamplifier, etc.) from affecting the feedback loop, resistor *R1* is introduced between the signal input and the base of *Q1.*

Output from the amplifier is taken via capacitor *C5,* whose value determines the low-frequency 3-dB point, which is about 20 Hz. The high-frequency cutoff (3-dB point) is determined by the transistors and feedback circuit. High-end cutoff is about 100 kHz.

the parts location and connection points to the printed board. The leads of the power transistors must be bent as shown in Fig. 7 so that each transistor mounting hole is aligned with the mounting hole on the printed board.

Figure 7 also shows the method of installing the heat sink and diode mounting clip to each power transistor. When the transistors are installed, the leads of *Q4* face *C5,* while the leads of *Q5* face toward *Q3.* Figure 8 shows *Q4* positioned and ready for heat sink and diode clip mounting. (Also see front cover.)

The cup-type #4-40 lock washer shown in Fig. 7 *must* be used to prevent cracking the power transistor case when it gets warm and expands. Silicone grease *must* be used between each transistor and its heat sink. Diode *D1* is connected to the clip mounted on the *Q4* heat sink, while diode *D3* is clipped to the *Q5* heat sink.

If you are planning to use the amplifier with 12- to 18-volt power supplies,

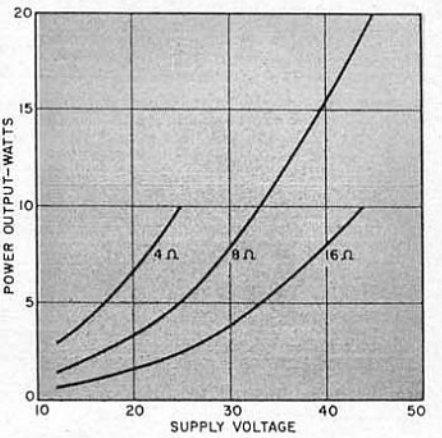


Fig. 3. If you know supply voltage and speaker impedance, amplifier power output can be determined.

AMPLIFIER PARTS LIST

C1, C6—10-μF, 15-volt electrolytic capacitor
C2—200-μF, 6-volt electrolytic capacitor
C3—30-μF, 6-volt electrolytic capacitor
C4—10-μF, 25-volt electrolytic capacitor
C5—1000-μF, 25-volt electrolytic capacitor
D1, D3—1N3754 diode
D2—1N645 silicon bias diode, or similar
Q1—Motorola MPS 6566 transistor
Q2—Motorola MPS 6533 transistor
Q3—Motorola MPS 6530 transistor
Q4—2N4918 transistor
Q5—2N4921 transistor
R1, R3, R7—4700-ohm, ½-watt resistor
R2—47,000-ohm, ½-watt resistor—see text
R4, R6—100-ohm, ½-watt resistor—see text for R6
R5—50,000-ohm, ¼-watt trimmer potentiometer (CTS X-201, or similar)
R8—1000-ohm, ½-watt resistor
R9, R10—470-ohm, ½-watt resistor
2—Staver V1-1 heat sinks
2—Diode mounting clips (RCA SA2100, or similar)
*1—Printed circuit board**

*An etched and drilled circuit board is available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216, for $2.25 postpaid; specify #140 when ordering. A complete set of parts, including the circuit board, is available for $10 postpaid; specify #CA-140 when ordering.

POWER SUPPLY PARTS LIST

C1—4000-μF, 50-volt electrolytic capacitor
F1—0.5-ampere fuse
RECT—100-PIV bridge rectifier (Varo VS-248, or similar)
T1—Power transformer: primary, 117 volts; secondary, 34 volts, 1.5 ampere (Southwest Technical Products T34P15, or similar)

A kit consisting of the above parts plus chassis and hardware (for stereo version) is available from Southwest Technical Products Corp. for $15; specify #P-140 when ordering.

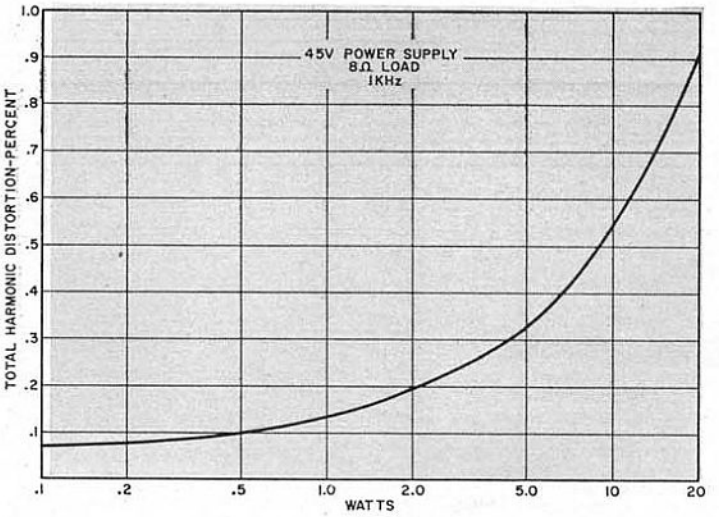


Fig. 4. Performance that can be expected from the "L'il Tiger" amplifier when using an 8-ohm speaker and a 45-volt power supply. Total harmonic distortion hits 1% at about 22 watts output.

Fig. 5. Actual-size photo of amplifier printed circuit board can be copied or the board can be purchased etched and drilled (see note in Parts List).

the value of *R2* should be changed to 22,000 ohms. You will note that the schematic and PC board show an extra input terminal marked "Reverb Input." This input has been provided to make possible the use of a reverb adapter scheduled for the next issue (January, 1968). The extra input can also be used as a mixer input by adding a 4700-ohm resistor in series with capacitor *C6*—for public address work, for example, where a microphone and phonograph are both fed into the same amplifier.

Testing and Use. The only adjustment that should be necessary is setting *R5*

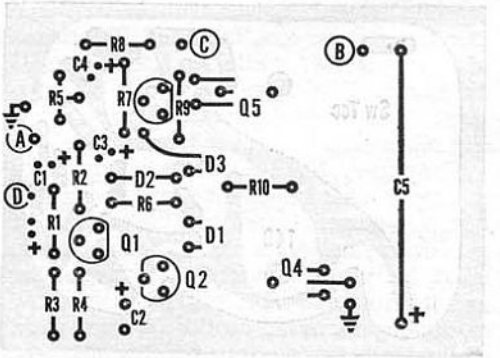


Fig. 6. Component layout on the reverse side of the circuit board. The unidentified transistor is Q3.

SPECIFICATIONS

Power Output	18 watts r.m.s., 22 watts IHFM per channel into an 8.0-ohm load with 45-volt power supply
Distortion	Less than 1% total harmonic up to full rated output
Frequency Response	3 dB down at 20 and 100,000 Hz
Input Impedance	Approximately 5000 ohms
Output Impedance	Approximately 0.1 ohm (damping factor of 80 with 8-ohm load)
Hum and Noise	More than 80 dB below 1 watt
Sensitivity	1.5-volt input for 20-watt output
Supply Voltage	12 to 45 volts d.c.

to a point that puts half of the power supply voltage across each of the output transistors. When balancing the supply voltage, measure the voltage from ground to the emitter of *Q5*.

The idle current of the amplifier should be between 5 and 10 milliamperes. If other than a 40- to 45-volt supply voltage is used, the value of *R6* should be increased slightly to bring the idle current into this range. The amount of resistance needed can be found by inserting a milliammeter in series with the power supply voltage source and using a 500-ohm potentiometer in the circuit in place of *R6*.

(*Continued on page* 98)

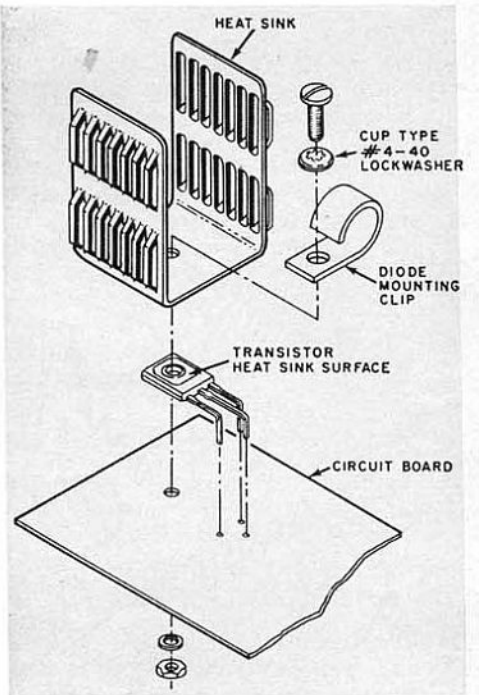


Fig. 7. Method of installing each power transistor, heat sink, and diode mounting clamp. The cup-shaped lock washer is necessary to prevent cracking the power transistor when it gets hot after long use.

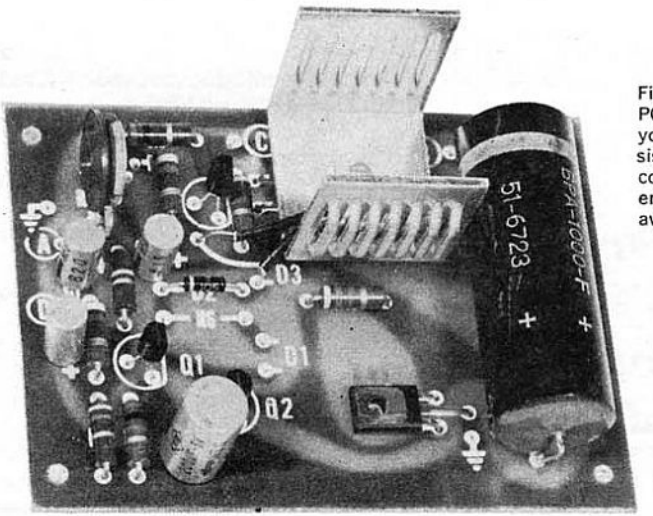
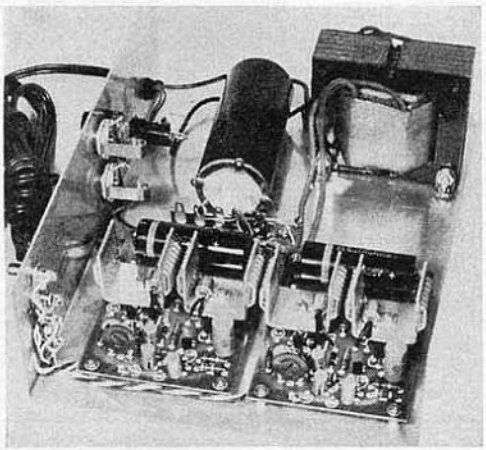


Fig. 8. This is the way the PC board should look after you install one power transistor/heat-sink/ diode-clamp combination. The other power transistor is mounted and awaiting its remaining parts.

L'IL TIGER

(*Continued from page* 33)

Just set the 500-ohm potentiometer for minimum resistance, apply voltage to the circuit, then reset the potentiometer for a current reading of about 5 mA. Measure the resistance of the potentiometer and install a fixed resistor of the next largest standard value in place of it. Make sure that this new resistor does not cause the idle current to increase above 10 mA; reduce the value of the resistor used for *R6* to the next smaller standard value if it does.



A pair of "L'il Tiger" amplifiers and common power supply can be mounted in a chassis for stereo use.

The "L'il Tiger" can be used with almost any transistor preamplifier, but the 5000-ohm input impedance is too low for many tube preamps.

Caution: Be careful not to short the heat sinks to each other while you are working on the amplifier with the protective cover removed. Remember that the heat sinks are connected directly to supply voltage and ground, respectively. Shorting them together will not harm the circuit, but will blow the fuse. Conventional microphone jacks have been used as output connectors to minimize chances of shorting the output of the amplifier. With no signal applied, a shorted output will cause no harm, but it could damage the output transistors if a large signal were applied. —30—

NGW TRANSISTOR TESTER

(*Continued from page* 59)

Depress the *SI-GE* (*SI* for silicon and *GE* for germanium) switch (*S2*). If the meter pointer goes to full-scale deflection, the transistor is a *pnp* unit; if no deflection is observed, it is an *npn* unit. If the meter deflects, move switch *S4* to *PNP* and the pointer should return to zero. If no deflection is observed in either position of *S4*, the transistor is open.

With the *NPN-PNP* switch (*S4*) in the proper position, as determined above, read the transistor's leakage current. Leakage for a germanium transistor should generally be less than 1 mA, zero for silicon transistors. (Consult a transistor manual if you observe excessive leakage for germanium power transistors. Leakage in excess of 1 mA for some germanium transistors can be normal.)

Depress *GAIN* switch *S1*, and if the meter shows less than 1 mA, set *S3* to *X100*. Multiply the meter reading by the value indicated by the position of *S3*. This is the d.c. current gain of the transistor. No meter indication means that the transistor has an interelement open.

With *S1* closed, depress *S2*. If the meter pointer deflection remains the same or drops slightly, the transistor is a germanium unit. If the indication should drop to zero, the transistor is silicon. A simplified step-by-step testing procedure that can be pasted on the tester appears on page 58.

Testing Diodes. Connect the anode of the diode to be tested to the *C*ollector jack (*J3*); the cathode goes to the *E*mitter jack (*J1*). When *S4* is then set to *NPN*, the meter should deflect fully upscale. Now set *S4* to the *PNP* position; there should be no deflection. (Full-scale deflection is obtained in both positions of *S4* when the diode under test is shorted; there is no deflection when the diode is open.)

Zener diodes with less than 6 volts breakover potential (E_{bo}) will normally produce a slight meter indication when *S4* is set to *PNP*. The tester will *NOT* check tunnel diodes, trigger diodes, constant-current diodes, or four-layer diodes. —30—