TRANSISTOR POWER AMPLIFIER CIRCUIT DIRECTORY

By LEONARD E. GEISLER*

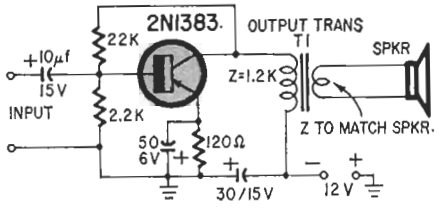
10 transistor circuits for the technician and experimenter

The experienced technician and the novice experimenter will appreciate having a variety of diagrams of common and not-so-common audio output circuits gathered together for swift comparison and evaluation. The 10 circuits here may help you build, service or design efficient, high-quality transistor output stages.

All parts values have been proved in actual lab or production-line models, so the prospective builder can be sure that all these circuits will work.

If you choose to substitute other transistors for those shown, be sure to use equivalent types. Practically no "fudging" of resistor values will be found necessary if interchangeable types are selected. The output transformers shown are representative types. No attempt to select particular types by part number has been made.

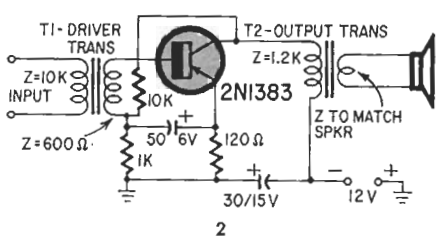
1. Probably the simplest "standard" transistor power amplifier. Gain, using the transistor listed, is a minimum of



1

30 db. Power consumption is high, whether the stage is idling or working at rated output. Distortion about 4 to 6%.

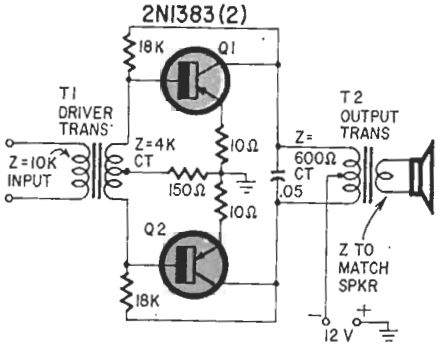
2. Increase the gain to over 33 db by adding the input impedance matching transformer to the circuit of **1.** Because of lower resistance in the bias network,



2

battery current may increase by 1 ma or more. Returning the emitter bypass capacitor to the bottom end of T1's secondary improves gain, tone quality and ac stability. Distortion of the stage at full rated output is from 3% to 5%, depending upon the quality of transformers used.

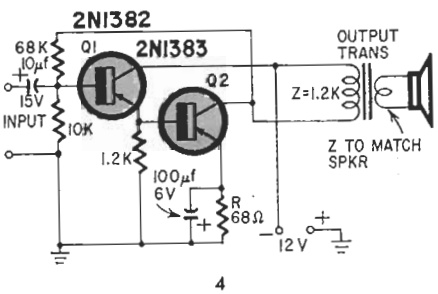
3. The transistor portable manufacturer's old standby! This familiar circuit, excavated from its well-worn rut, has been included as the prime example of bad design.



3

This circuit goes easy on the battery, but rarely can good fidelity be obtained for low cost. The amplifier takes up a lot of space and the coupling transformers add weight. Use of this circuit in a set supposedly designed for *minimum* size and weight is hard to understand.

4. Perfect impedance matching to the output transistor is provided by this circuit. Its input impedance is also high. This reduces loading on the signal source. Circuit gain is equal to or better than that of **2.** By increasing R's resistance, it is possible to operate the output transistor class AB with a slight loss in fidelity but at a greater



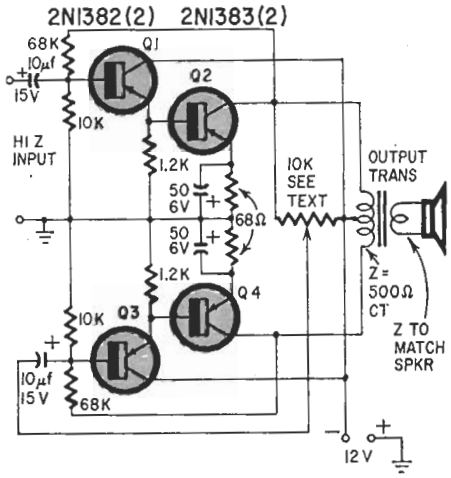
4

battery drain efficiency. The large amount of negative feedback from Q1's unbypassed emitter resistor almost completely cancels distortion in the driver, so the amplifier's output is very clean-sounding, even at the overload point.

5. Two circuits of 4 wired in push-pull, double our class-A power output, nearly triple class-AB power, and cut distortion almost in half, too.

In class A, this configuration easily delivers a clean 100 mw or more output, and in AB, up to 300 mw of clean audio. The 10,000-ohm pot across the upper half of the output transformer winding adjusts the amplitude and ac balance of the "other half" of the audio signal fed to Q3. This is a "set-and-forget" control.

By substituting suitable high-power transistors for Q2 and Q4, any power output may be obtained. Of course,



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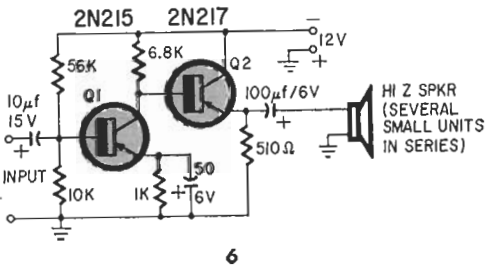
the output transformer must be selected to match the transistors used.

6. Q1's output impedance is matched to Q2's input by rearranging the wiring of **4** somewhat. This is a nearly perfect match and practically no power is lost. Phase shift is negligible, also.

As Q2's output is 600 ohms or less, it is possible to drive several low-impedance speakers wired in series, with great efficiency. The distortion of



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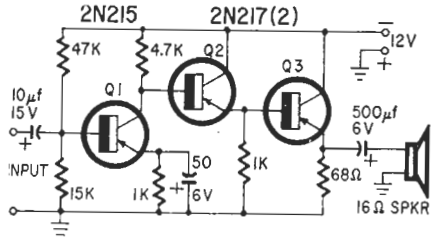
this circuit is less than 4% at full output (just barely clipping). Maximum gain is about 50 db from input to output. We have done away with the input and output matching transformers completely. If ordinary transistors are used and carefully juggled about, gains from 39 to 65 db are possible. This circuit can be made into a push-pull stage if you exercise your imagination and ingenuity. (See **5** for inspiration!)

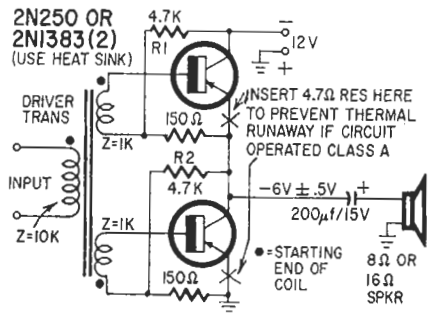
7. Another version of 6. It has lower distortion than the other circuit, and



7

very low output impedance. It can drive a low-impedance voice coil (16 ohms or less) through the large electrolytic dc blocking capacitor.

8. An efficient, low-distortion OTL (*O*utput *T*ransformer*L*ess) amplifier combines the low output impedance of the emitter follower and the power gain of the common emitter. It also



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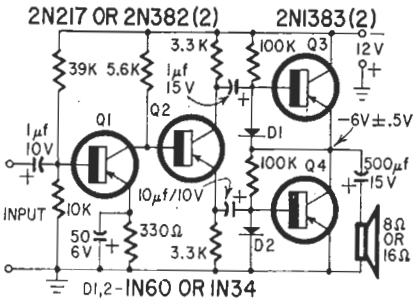
eliminates the objectionable feature of the circuit of **3**—power limitation imposed by excessive back emf of the pulsed output transformer. The circuit is biased for class AB2 with the resistor values shown and may be operated straight class-A by decreasing the values of R1 and R2 by about 1,000 ohms so about 10-ma static collector current will flow in the circuit. (I feel that no useful purpose is served by increasing bias to class A. However, it is mentioned so the experimenter may make an exact measurement of the power output, if desired.)

If class-A operation is desired, it is recommended that two small resistors —about 4.7 ohms each—be inserted in the emitter lead returns to prevent thermal runaway.

9. This is nearly the end—the split load phase inverter. Not as efficient as the coupling transformer of **8,** but its



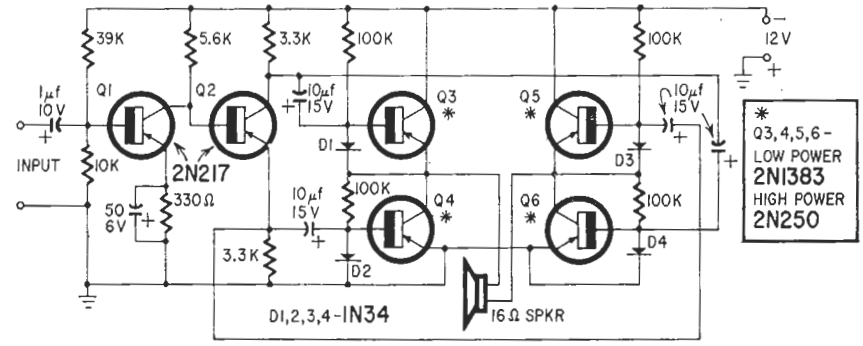
9

ac balance is excellent and automatic. Impedance matching between the phase splitter and output transistors is very close, with the two diodes acting as switches to improve overall operation further. The diodes short out excessive positive ac signal swing, which might damage the output transistors base-emitter junctions.

Transistors Q1 and Q2 are direct-coupled to eliminate parts and unwanted phase shifts. All four transistors are well matched to each other, the two output transistors operating either emitter follower or common collector. Q3 is the emitter follower, Q4 is the common collector transistor.

This type of amplifier is often shown with a matched complementary pair (n-p-n and p-n-p "mirror image" transistors) working as drivers for the output. Since well matched complementary transistors are not always available, I prefer the circuit shown here. A low-power version of this amplifier will take up about the same cubic volume as an ordinary output transformer.

10. Bridge type OTL amplifier. It has eight times the power output of the circuit of **3.** If properly constructed, it will have less than 1% total distortion. The circuit works like the one in **9** except that the extra two transistors are connected to the opposite phase output of Q2. No direct current flows through the voice coil if the four output transistors are well matched. Thus we eliminate the output coupling capacitor. Total ac voltage across the voice coil will



10

be nearly twice the battery supply on peaks. Both this circuit and the previous one are far more efficient than any other shown here.

In conclusion, I want to thank the many transistor manufacturers for their kindness in supplying application notes gratis. Mr. John Palmer was kind enough to assist us in developing the circuit of **5** as shown. END

ELECTRONIC WEATHER BUREAU. The photo shows a new telemetering system (black box on tripod brace) that relays complex meteorological information from a remote weather station (top of tripod).

Called *Teladvisor* by its maker, Berkeley Instruments, the system eliminates electrical analog-to-digital converters by digitizing standard sensing instruments directly.

Mechanical dial instruments are "read" by a digitizer that scans the dial with moving lamp and photocell, and the device records or telemeters five weather variables from the unattended station.

The transducer readings are monitored and error-checked by a single central logic card. Readout is not in arbitrary units, but in conventional ones associated with each quantity (degrees, pounds per square inch, etc.)