POWER AMPLIFIERS

single transistor with transformer coupling to the speaker to a of various types. The choice of circuit design and components is and cost. Here's how to design output circuits for high fidelity.

sistors and allow large current swings.

The signal is capacitive coupled to output load R_L. The size of the capacitor limits the low-frequency output and should be chosen to be consistent with the acceptable performance requirements of the overall circuit.

R_F and C_F, in conjunction with R_{E1}, are the primary components of the feedback circuit. C_F is usually adjusted in the laboratory for the most faithful reproduction of square waves.

The output circuit in Fig. 1 can be simplified by omitting all diodes and replacing those in the base circuit with proper value resistors. But this can only be done at the expense of performance and temperature stability.

Circits using driver transformers are necessary when germanium output devices are used. Due to the relatively large leakage currents, complete isolation of the output transistors by the driver transformer is desirable. Although quasi-complementary circuits omitting the transformers have been used with germanium transistors, this circuit emerged as the primary arrangement when silicon transistors became readily and economically available.

Quasi-complementary power amplifiers

The basic circuit of the quasi-complementary arrangements is shown in Fig. 2. It is direct coupled throughout. The signal is amplified by Q1 and fed to the complementary pair, Q2 and Q3. During the positive portion of the cycle, the bases of the complementary pair are positive with respect to the emitters; the npn Q2 conducts while pnp transistor Q3 is turned off. The reverse is true during the alternate half cycle.

The half cycles are supplied to output transistors Q4 and Q5 after having been amplified by the complementary pair. Both portions of the cycle are fed to R_L through C_L and reconstituted across the load resistor. Feedback is fed through the parallel combination consisting of C_F and R_F.

The dc conditions are such that half the supply voltage must be present at the point labeled in the drawing as $E_{CC}/2$. Determined by resistors R_{B1} and R_{X1}, the bias current through Q1 is instrumental in establishing this quiescent condition. The collector load on the transistor consists essentially of R_{B2} + R_{Y2} + D1 + D2. The diodes are used to set and maintain the idling current in the output circuit despite temperature fluctuations, and may be replaced by other temperature sensitive devices. Resistors are often used when compensations for temperature variation is not essential.

There are several inherent problems with this circuit. All are solved by adding capacitor C2 in a positive feedback bootstrapping arrangement. Note also that the resistors in the base circuit used to bias Q2, have been split into to components, R_{B2} and R_{Y2}, providing a junction to accept C2.

On large signals, the bias on the driver transistors tend to shift the operation to class B, producing crossover distortion. To compensate for this, large amounts of feedback must be placed around the circuit. Gain must be large to accommodate all the feedback that is required. Positive feedback supplied by capacitor C2 increases the load impedance the complementary pair presents to Q1 with the consequent increase in gain of the circuit.

Large positive peaks in the signal tend to cut off Q2 by placing the base and emitter of the transistor at $+V_{CC}$. However, there is a voltage across C2 due to its being charged while the circuit is idling. This voltage keeps the base at a positive potential with respect

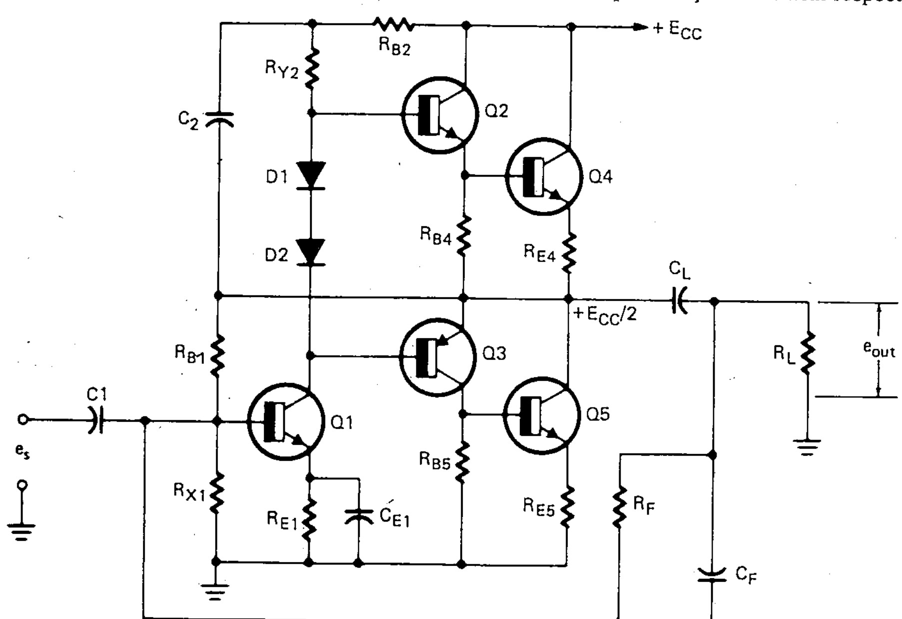

FIG. 2—BASIC QUASI-COMPLEMENTARY OUTPUT STAGE. The complementary pair, Q2 and Q3, acts as a phase splitter delivering equal signals 180° out of phase to Q4 and Q5.

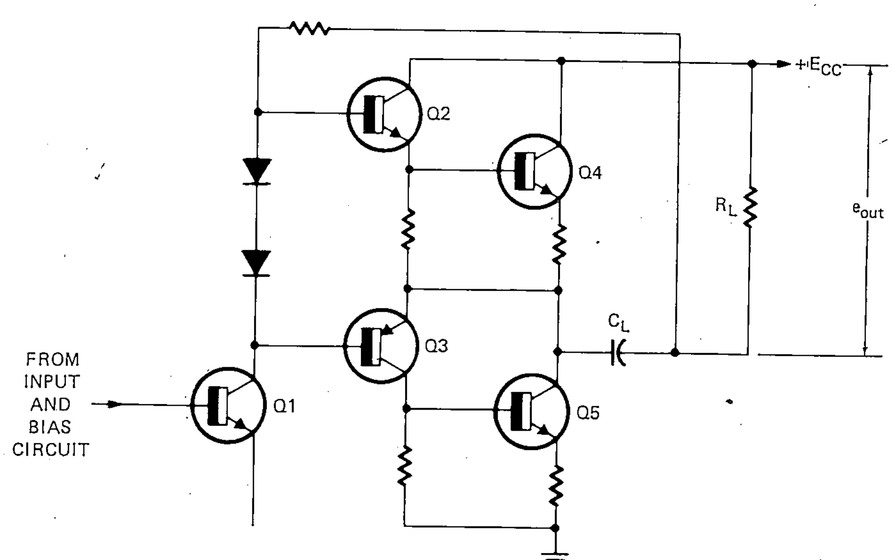

FIG. 3—BOOTSTRAP CAPACITOR, C1 in the previous figure, has been eliminated by combining its function with that of the output blocking capacitor. Load returns to ground through E_{cc}.