

Fig. 3. Improved power amplifier principle. Output stage eliminates quasi-p-n-p, employs local feedback around output emitter follower, and implements a new class AB biasing technique.

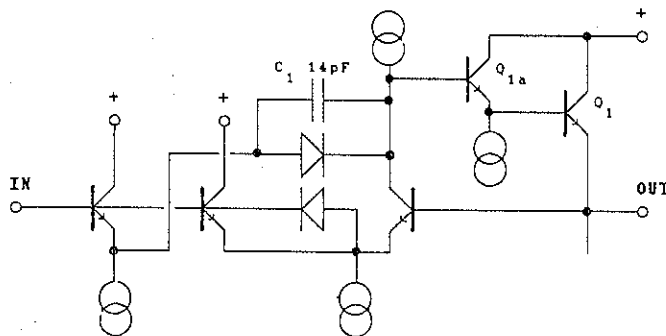


Fig. 4. Local-feedback amplifier A of Fig. 3, driving output transistor Q_1 . High-frequency feedforward is provided by C_1 .

The amplifier A provides local feedback around the output emitter follower Q_1 to eliminate the nonlinear error signal caused by Q_1 's V_{BE} variations. In this way the signal at node N is passed to the output without introducing distortion. Note, however, that this local feedback technique requires Q_1 to be conducting at all times. This key requirement is taken care of by the new control law which guarantees continuous conduction of both output transistors, as mentioned before.

IV. LOCAL FEEDBACK AMPLIFIER WITH HIGH-FREQUENCY FEEDFORWARD

Fig. 4 shows details of the amplifier A of Fig. 3. The differential-amplifier configuration is well-known. The feedforward capacitor C_1 eliminates phase shift at high frequencies by reducing the signal path to a simple emitter follower. Current gain from input to output is equally high (β^3) for low and high frequencies (via C_1). The two diodes avoid overdrive of the amplifier under transient conditions.

V. IMPROVED CLASS AB BIASING TECHNIQUE IMPLEMENTING A NEW BIAS CONTROL LAW

The bias control loop is shown in detail in Fig. 5. Transistors Q_5 and Q_6 sense the output transistor currents. Their emitter areas are much smaller than those of Q_1 and Q_2 . Resistors R are small and simply serve to limit sense currents to safe values when the output transistors are driven very hard. The control loop operates as follows. Suppose the input stage drives the base of Q_3 slightly negative. Then Q_1 will be driven harder and Q_2 less hard, causing the output to swing positive. The sense current I_{s1} will increase, causing Q_{10} to conduct more, thereby driving Q_9 . Similarly, I_{s2} will decrease causing Q_7 to conduct less, thus increasing node A 's voltage via Q_8 . This increases the p-n-p differential pair Q_{11}, Q_{12} to compensate for the decreased drive to Q_2 and, in addition, also enhances Q_1 's drive. The final result is that I_{s2} (and therefore also I_2) will be forced equal to a well-defined residual value no matter how hard Q_1 is driven. For negative output swing, I_{s1} (and I_1) will be forced equal to a residual value while I_2 increases. It follows that the loop operates in a smooth, continuous fashion and accurately controls the smallest of I_1 and I_2 , thereby ensuring both output transistors remain in well-defined conducting states at all times. Since the loop is sensitive to the sum of I_1 and I_2 , the influence of the small current-limiting resistors R can be neglected.

Straightforward analysis of the translinear [8] biasing work comprising Q_7 - Q_{14} provides additional understanding [9]. We assume that the emitter areas of Q_5 and Q_6 are N times smaller than those of Q_1 and Q_2 and that the remaining transistors have equal sizes. Furthermore, we assume Q_{11} and Q_{12} to carry equal currents (this requires output transistor combinations having high current