Example 8.2 **The Hermes Active Loop**

The Hermes Active Loop was 1 yard in diameter and made of two parallel loops of 1" aluminum tubing. The inductance was about 1.4 μH and the loop-amplifier combination was designed to have an effective height of 1 m into a 50Ω load. Figure 8.7 shows a loop post-mounted with two air-speed coaxial lines connecting it into an array. Figure 8.8 shows a schematic of the first stage of a general amplifier, similar in intent and topology to the Hermes amplifier of the 1970s. All the voltage gain and the feedback are in the first stage. The second stage was an emitter follower, and the third stage was an open-collector (choke-loaded) common-emitter stage with an unbypassed emitter resistor to give unity voltage gain and very linear current gain into the RF load. The transformer T1 is 1:1, C1–C3 are bypass and blocking capacitors, and R1–R3 are determined by the bias requirements.

Figure 8.7: The Hermes Active Loop, post-mounted, with air-speed transmission lines to make it part of an array. Photo courtesy of US Antenna Products LLC, Frederick, MD, U.S., which is the current manufacturer.

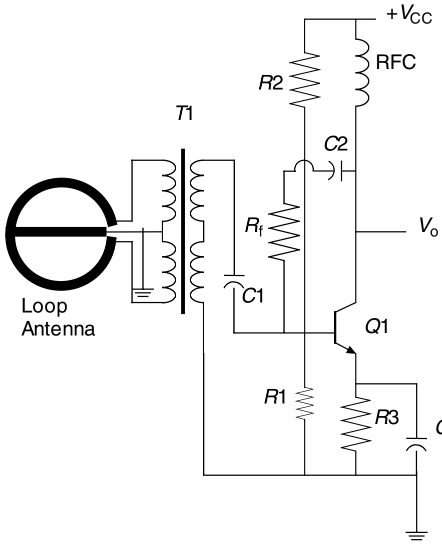

Figure 8.8: Schematic of a general version of the first stage of the amplifier for the Hermes Active Loop, circa 1977.

Figure 8.9 shows a small-signal equivalent circuit including two noise sources that depend on the base and collector bias currents.

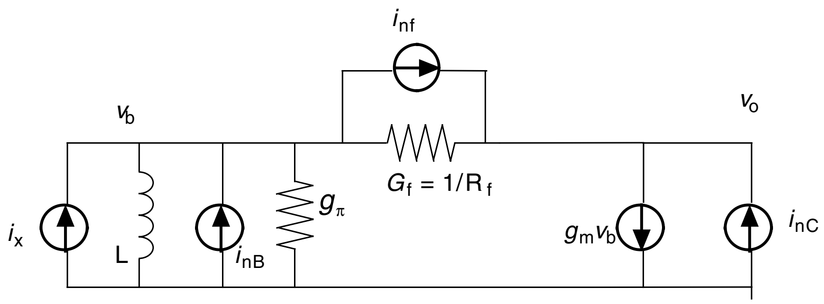

Figure 8.9: Small-signal equivalent circuit for Figure 8.8.

In Figure 8.9, I have neglected the transistor's internal feedback elements and the base bias resistors of Figure 8.8. i_x represents the current from external waves. The noise sources are given by $i_{nB}^2 = 2qI_Bbw$, $i_{nC}^2 = 2qI_Cbw$ [10, p. 305], and $i_{nf}^2 = 4kT_obw/R_f$. I_B and I_C are the base and collector bias currents. $q = 1.6\text{E} - 19\text{C}$ is the electron charge magnitude. Let $Y_b = g_\pi + 1/(j\omega L)$. Then:

$$v_o = \frac{1+R_f g_m}{g_m+Y_b}\left(i_x + i_{nB}\right) + \frac{1+R_f Y_b}{g_m+Y_b} i_{nC} - R_f i_{nf} \tag{8.27}$$