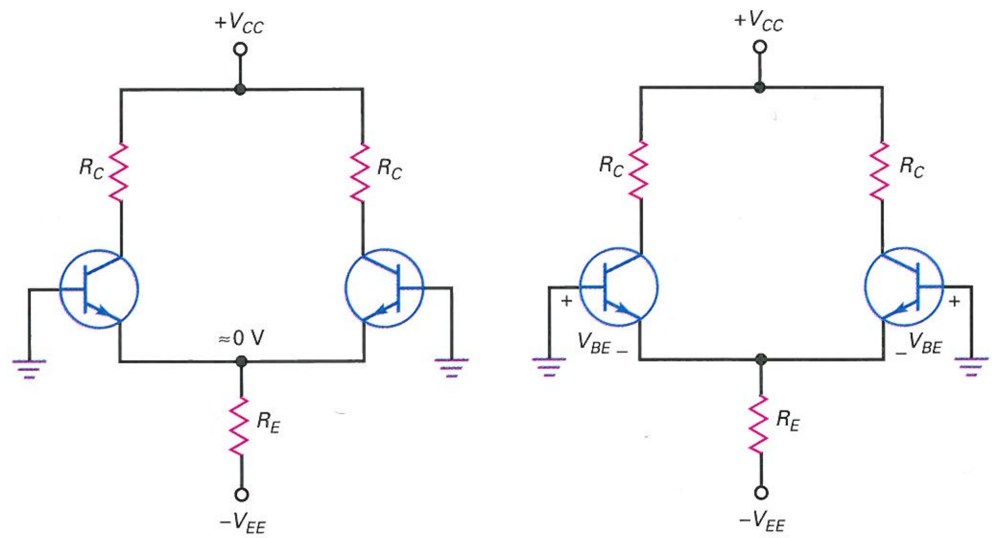
Figure 17-5 (*a*) Ideal dc analysis; (*b*) second approximation.




This equation is fine for troubleshooting and preliminary analysis because it quickly gets to the point, which is that almost all the emitter supply voltage appears across the emitter resistor.

When the two halves of Fig. 17-5*a* are perfectly matched, the tail current will split equally. Therefore, each transistor has an emitter current of:

$$I_E = \frac{I_T}{2} \tag{17-6}$$

The dc voltage on either collector is given by this familiar equation:

$$V_C = V_{CC} - I_C R_C \tag{17-7}$$

## Second Approximation

We can improve the dc analysis by including the $V_{BE}$ drop across each emitter diode. In Fig. 17-5*b*, the voltage at the top of the emitter resistor is one $V_{BE}$ drop below ground. Therefore, the tail current is:

$$I_T = \frac{V_{EE} - V_{BE}}{R_E} \tag{17-8}$$

where $V_{BE} = 0.7$ V for silicon transistors.

## Effect of Base Resistors on Tail Current

In Fig. 17-5*b*, both bases are grounded for simplicity. When base resistors are used, they have a negligible effect on the tail current in a well-designed diff amp. Here is the reason: When base resistors are included in the analysis, the equation for tail current becomes:

$$I_T = \frac{V_{EE} - V_{BE}}{R_E + R_B/2\beta_{dc}}$$

In any practical design, $R_B/2\beta_{dc}$ is less than 1 percent of $R_E$. This is why we prefer using either Eq. (17-5) or Eq. (17-8) to calculate tail current.

Although base resistors have a negligible effect on the tail current, they can produce input error voltages when the two halves of the diff amp are not perfectly symmetrical. We will discuss these input error voltages in a later section.



## Example 17-1

What are the ideal currents and voltages in Fig. 17-6*a*?

SOLUTION With Eq. (17-5), the tail current is:

$$I_T = \frac{15\text{ V}}{7.5\text{ k}\Omega} = 2\text{ mA}$$

Each emitter current is half of the tail current:

$$I_E = \frac{2\text{ mA}}{2} = 1\text{ mA}$$

Figure 17-6 Example.