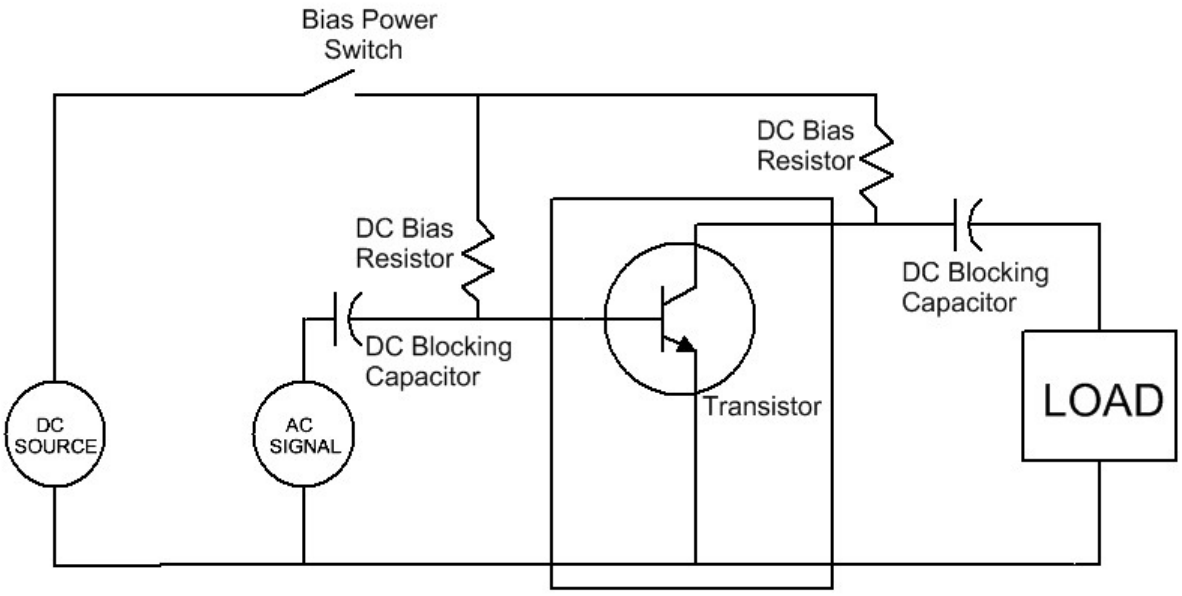
EXAMPLES OF TRANSISTOR AND TRANSFORMER IN SIMPLIFIED CIRCUITS

(Prepared by Dr. Steven Dobbs as Clarifying Alternatives to the "Transformer" and "Transistor" Figures on Pages 11-12 of the Degeneff Report (NYS000005)).

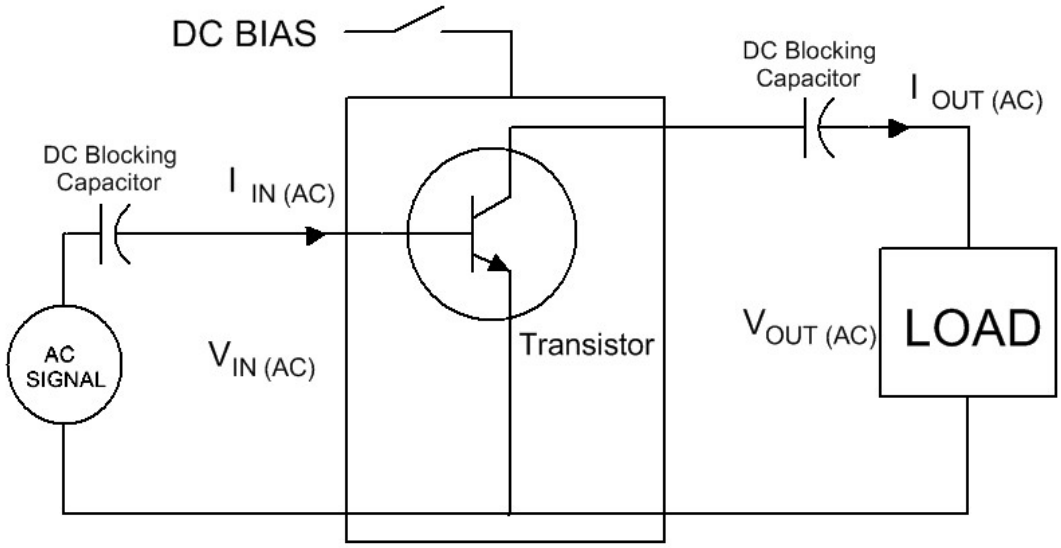
A transistor is a three-terminal device usually made of a single piece of silicon. Operation of a transistor consists of applying external voltages to "bias" the transistor into the desired state. Biasing the transistor causes charge promotion and migration in the silicon crystal so as to allow for control of the flow of current through the device. In many cases, a small amount of current in the input circuit can control a much larger current in the output circuit. Examples 1 and 2 below are simple transistor circuits.

Example 1: Simple Transistor Circuit Showing DC Bias Circuit



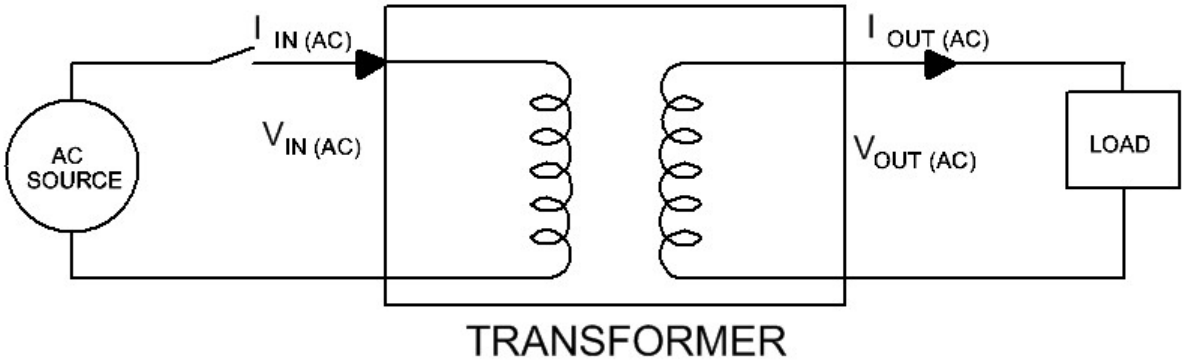
Some kind of biasing circuit, such as that shown in Example 1 above, is required for a transistor to operate. To simplify this circuit and to make it appear more similar to Dr. Degeneff's "Transistor" figure on page 12 of his report, it is shown again in Example 2 below with the bias circuit replaced with a one-line representation. The "DC Bias" is similar to Dr. Degeneff's one line "Control Signal." The capacitors shown in Example 2 below are required to isolate the DC bias to the transistor.

Example 2. Simple Transistor Circuit with One Line DC Bias Circuit



A transformer is an electrical device that converts alternating current ("AC") power at a certain voltage level to AC power at a different voltage level, without changing the frequency, or which provides isolation to electrical circuits. A transformer basically is a series of wire windings around some type of core. The core usually is constructed of a material that has a high magnetic permeability (*i.e.*, the ability of a material to act as a path for magnetic lines of force), such as iron or steel. The winding used to input power to the transformer is called the primary winding. The winding used to output power from the transformer is called the secondary winding. The passing of current through the primary winding creates an electromagnetic induction between that winding and the secondary winding. The terminal voltage and current at the input is "transformed" to different values of voltage and current at the output. Example 3 is a simple transformer circuit.

Example 3. Simple Transformer Circuit



Comparison of a transistor and a transformer inside the circuits shown in the examples above indicates that they are similar in the following ways:

1. With the switches open, both components are off.

2. When the switches are closed, both components are on.

3. The electromagnetic fields required by the components for operation are powered from external sources.

4. During operation the electromagnetic fields in both devices vary in time.

5. Varying the load in either circuit will result in changes to the output voltage and current and the internal electromagnetic field(s) in that circuit.

6. Varying the AC input in either circuit will change the output voltage and current and the internal electromagnetic field(s) in that circuit.

7. The relationships of (1) the output voltage to the input voltage and (2) the output current to the input current can be similarly expressed for both devices:

   - V_{OUT} = (Turns Ratio) x V_{IN} for a transformer circuit
   - V_{OUT} = (Voltage Gain) x V_{IN} for the transistor circuit

   - I_{OUT} = [1 / (Turns Ratio)] x I_{IN} for the transformer circuit
   - I_{OUT} = (Current Gain) x I_{IN} for the transistor circuit.

   The Turns Ratio is the ratio of the number of turns in the secondary winding and the number of turns in the primary winding.

8. Proper operation of either device can be readily monitored at its external terminals as it operates.