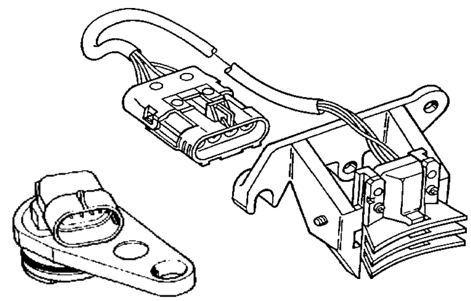
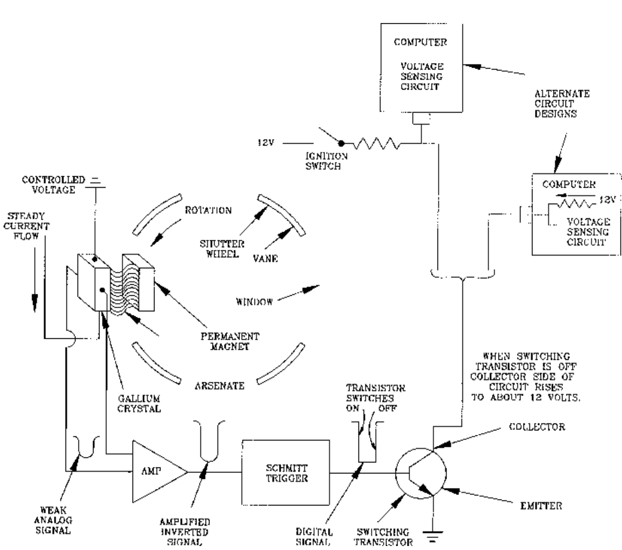
TomcoTechtips

TM ISSUE 17

CAM AND CRANK POSITION SENSORS



There are two different styles of cam and crank position sensors: the hall effect and permanent magnet sensor. In this issue, we will study the hall effect switch.



The hall effect switch consists of a permanent magnet, a gallium arsenate crystal, its related circuitry and an interrupter blade. (refer to illustration)

The gallium arsenate crystal has a steady current being passed through it from one end to the other. When the interrupter blade is not in between the magnet and the crystal, the magnetic lines of force invade the crystal. These magnetic lines of force distort the current flowing through the crystal. This results in a voltage potential at the top and bottom surfaces of the crystal. When the interrupter blade is in between the magnet and the crystal, the magnetic lines of force cannot invade the crystal. This results in a very low voltage signal. So the voltage fluctuates between a low point when the interrupter is in between the magnet and crystal and high point when the interrupter blade is not in between the magnet and the crystal.

This voltage is then amplified and inverted. A device called a Schmitt trigger changes the analog signal to a digital signal. The digital signal is then sent to a switching transistor and turns the transistor on and off. The transistor is on when the interrupter blade is not in between the crystal and the magnet and off when it is in between them.

Electronics 101

In this issue we will be looking at an electronic component used in automotive circuitry called a diode.

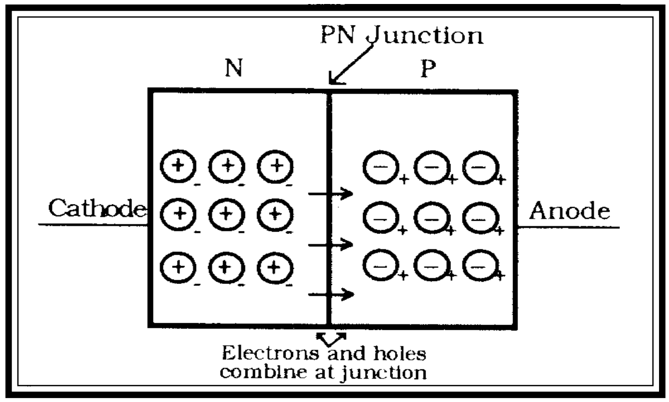
First let's define some terms. An *insulator* is a material through which electrical current flows poorly or not at all. A *conductor* is a material through which electrical current can flow easily.

A *semiconductor* is a crystalline material that falls somewhere between the characteristics of insulators and conductors. The semiconductor will not inhibit electrical current as effectively as an insulator. But it will not allow electrical current to flow as easily as a conductor.

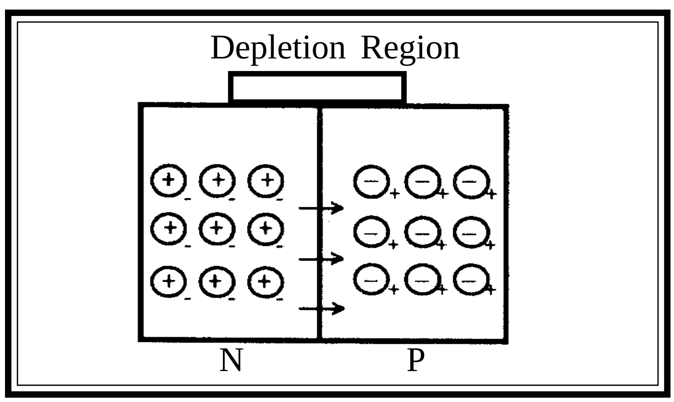
Semiconductors are usually made from silicon. The silicon is mixed with impurities to give it special characteristics. This adding of impurities is called doping. When phosphorus or arsenic is mixed with silicon it will have an excess of free electrons in its crystalline structure. This type of semiconductor is called an N-material.

When boron or gallium are mixed with silicon it will have a shortage of free electrons. This shortage of free electrons leaves spaces in the crystalline structure known as holes. This type of semiconductor is called a P-material.

The joining of an N and a P type material together in close proximity makes a diode. The P side of the diode is called the anode and the N side is called the cathode.

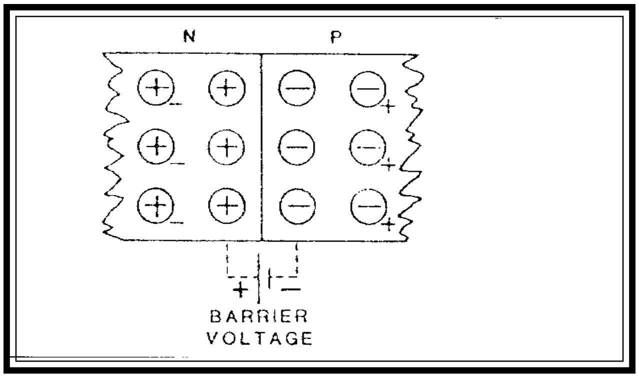


The place where the P and N materials join is called a PN junction. At the PN junction some of the free electrons from the N material side will cross the PN junction to fill the shortage of electrons or holes on the P material side. (Figure A) This process forms what is known as the depletion region, because it is depleted of holes and free electrons. (Figure B)



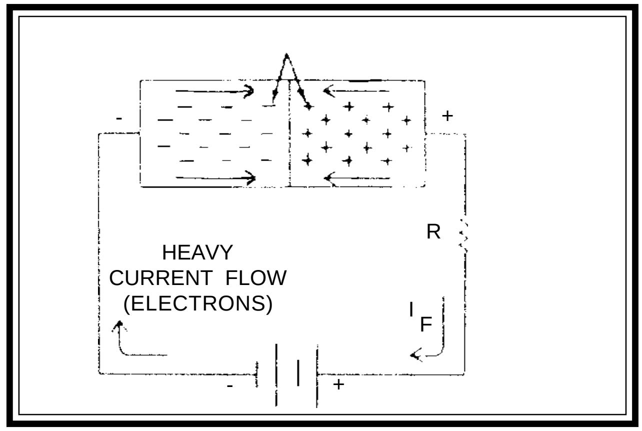
As a result of the loss of electrons, a net positive charge exists near the junction on the N side and the extra electrons on the P side create a net negative charge. These opposite charges result in a potential difference.

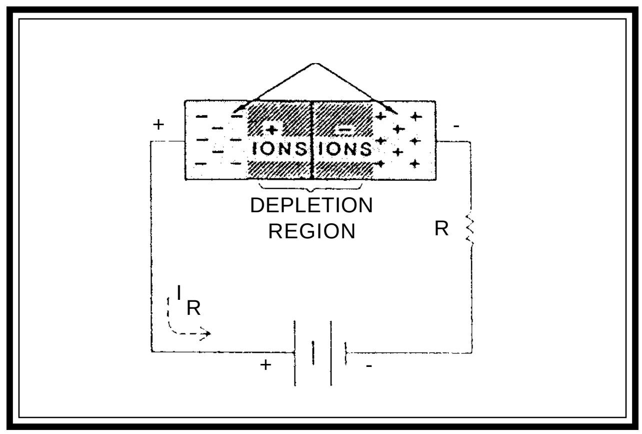
Electronics 101 (continued from page 2)



At a certain point, however, the electrical charge buildup in the P material will form a repulsive force barrier, which will inhibit the further flow of electrons. This potential difference is called the barrier voltage (typically .7 volts for silicon). (Figure C) This barrier voltage is not directly measurable, but becomes apparent when an external voltage is applied to the diode.

If we apply a voltage of .7 volts or greater, by connecting the positive terminal to the P material side and the negative terminal to the N material side, we will have current flow. This happens because the negative battery terminal repels the free electrons on the N side towards the junction where they will neutralize the positive charges in the barrier. At the same time, the positive battery terminal attracts the free electrons from the P material side of the barrier. This neutralizes the positive and negative charges which formed the barrier voltage. Therefore there is no barrier voltage to stop the flow of charges and the diode will support current flow. This flow of current is known as forward bias. (Figure D) This action will only occur if the battery voltage is greater than the barrier voltage.





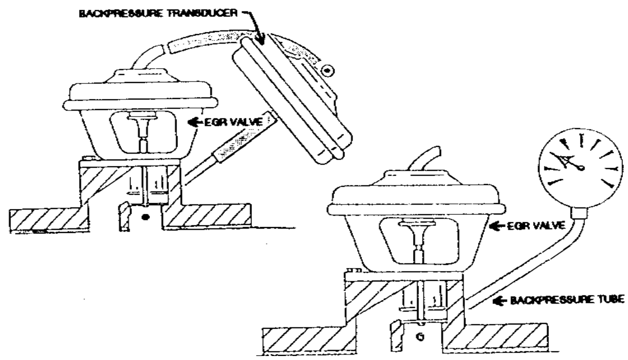
If we connect the positive battery terminal to the N material side and the negative battery terminal to the P material side no current will flow. This happens because the positive terminal attracts the free electrons away from the junction. At the same time the negative terminal is attracting the positively charged particles or holes away from the junction, effectively increasing the depletion region. This inhibits current flow and is known as reverse bias. (Figure E)

Therefore current will flow only one way through a diode.

Cam & Crank (from page 1)

Service Tips

Tricks of the Trade



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