TomcoTechtips

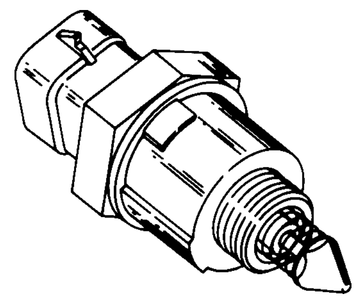
TM

ISSUE 22

IDLE AIR CONTROLS

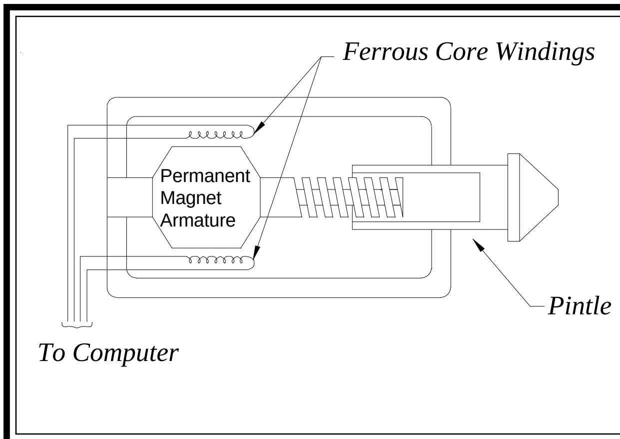
The Idle Air Control (IAC) valve is a stepper motor. Located in the throttle body, this is a small reversible motor that is controlled by voltage pulses. A stepper motor provides a greater degree of control than the permanent magnet motors that we discussed in Tomco Tech Tips #21. This is because they can be turned in increments or steps.

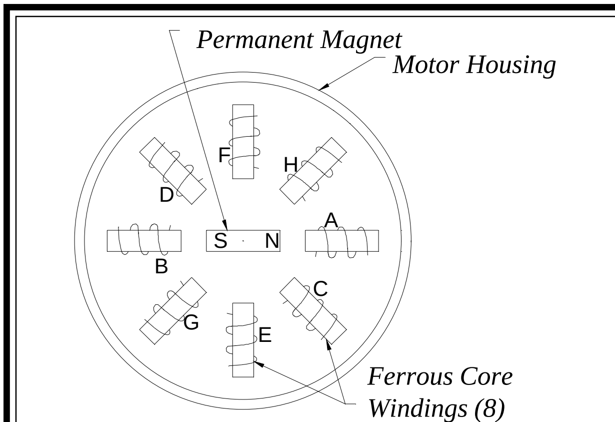
Let's look at a simple model of an IAC to help us understand the principles behind these stepper motors. A look inside reveals a permanent magnet which has a north and south pole. This permanent magnet is located on an armature shaft in the center of the motor. The armature contains a pintle that can be extended or retracted as the armature moves (FIG. 1). The permanent magnet is surrounded by ferrous core windings. These ferrous core windings are set up opposite one another. In our model we will use a permanent magnet surrounded by eight ferrous core windings (FIG 2).

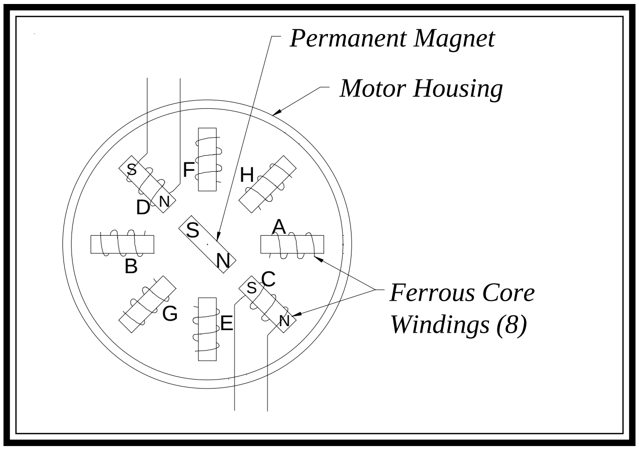


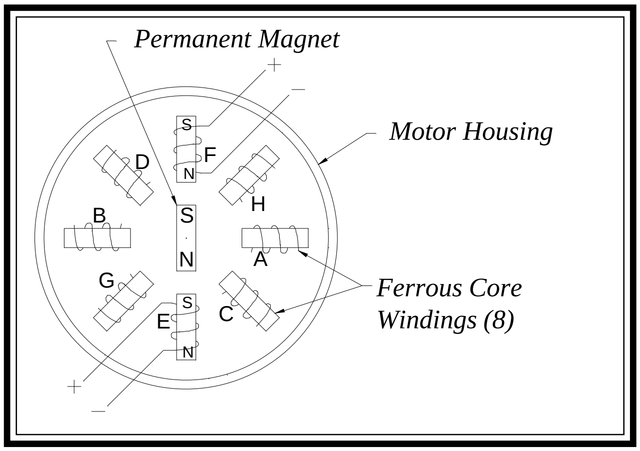
These ferous core windings, when energized, become electromagnets (having a north and south pole.) The direction of the current passed through the ferrous core windings determines which end becomes the north pole and which end becomes the south pole. The ferrous core windings are energized in pairs that are 180° apart. In our model AB, CD, EF, and GH will be our pairs.

Let's say that our permanent magnet is at rest at AB which has left the south pole of the permanent magnet towards B and the north pole









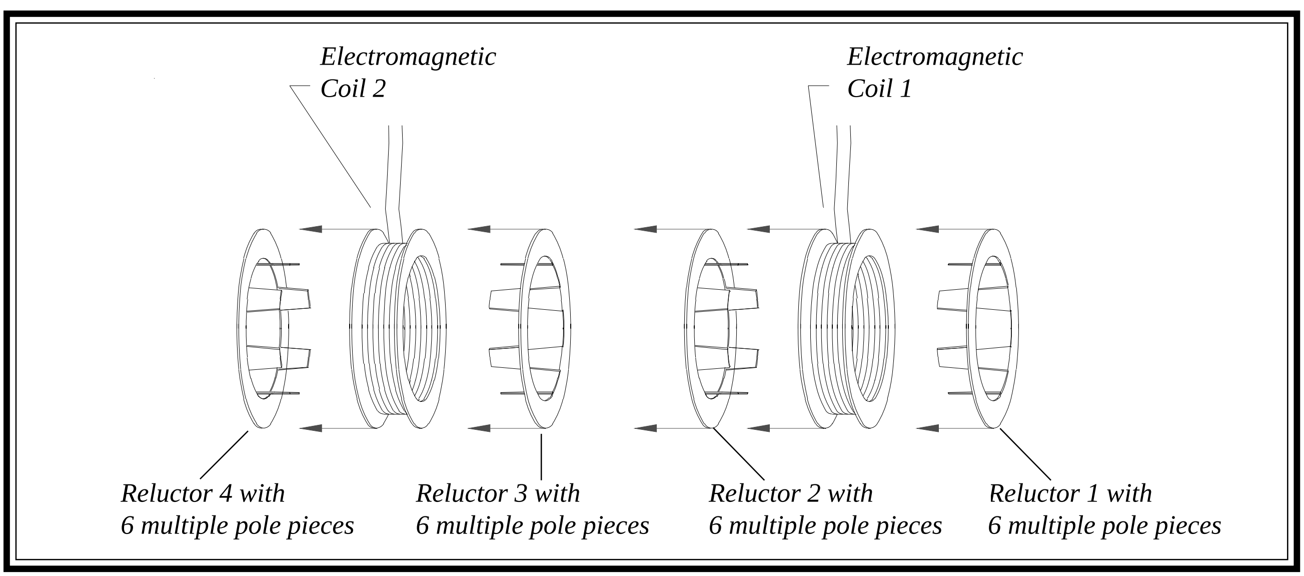
towards A. If a change in idle speed is required, the computer will energize pair CD or GH. The pair the computer energizes depends on the direction the pintle is to move.

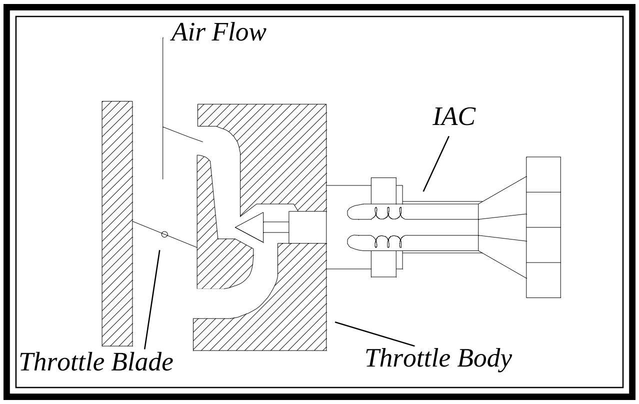
In our example the computer energizes CD so that D has a north pole close to the center and C has a south pole close to the center (FIG 3). This causes the south pole of the permanent magnet to be attracted to the north pole of D. It also causes the north pole of the permanent magnet to be attracted to the south pole of C. This results in the permanent magnet moving to position CD. If the pintle needs to move further, the computer will de-energize pair CD and pair EF will be energized causing the permanent magnet to move another step to EF (FIG 4).

If the pintle needed to be moved in the opposite direction from it's original rest at AB, the computer would have energized GH instead of CD. This would have caused the same series of steps as noted above only in the opposite direction.

After the permanent magnet turns a complete 180° the polarity of the ferrous core windings will have to be reversed. This is because the poles of the permanent magnet have also turned 180°. If we were to supply current in the same direction as before we would have like poles at the permanent magnet and at the ferrous core windings. The like poles would repel and prohibit the movement of the permanent magnet.

The computer can supply a number of





pulses to move the pintle to its desired position. The computer also keeps track of the pulses so it knows exactly where the pintle is located.

The model we described is a simple model. In reality these stepper motors can be of many different configurations. Some stepper motors have two coils (FIG 5). Each of these coils has a reluctor containing up to 12 points (six on top and six on the bottom of the coil). When these coils are put together there is a total of 24 points. These points become the focal point of the magnetic fields, allowing a greater number of steps in one revolution. This results in a greater degree of control of the pintle position. The principles of the simple model still apply, there are just more points to contend with.

The computer uses the IAC to control idle speed. The IAC controls the idle speed by controlling the amount of air that bypasses the throttle blade (FIG 6). When the vehicle is idling the throttle blade is in a closed or nearly-closed position. Air is passed around the throttle blade through a passage located in the throttle body. The IAC pintle is located in this passage. The amount the pintle is extended or retracted determines the amount of air that is bypassed around the throttle blade.

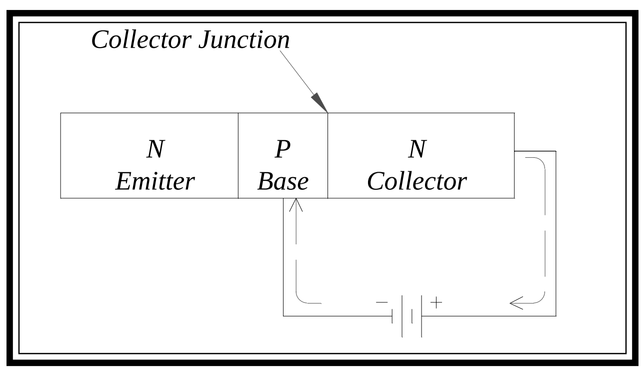
When the pintle is retracted, the passage is opened wider, allowing more air to bypass the throttle blade. This results in an increase in idle speed. When the pintle is extended, the passage is less open, allowing less air to bypass the throttle blade. This results in a decrease in idle speed.

The computer-controlled IAC helps to maintain a fixed idle speed under various operating conditions and changes in engine load (eg. A/C on or off, or transmission in or out of gear). This prevents engine stalling and keeps the engine at a steady idle.

TRANSISTORS

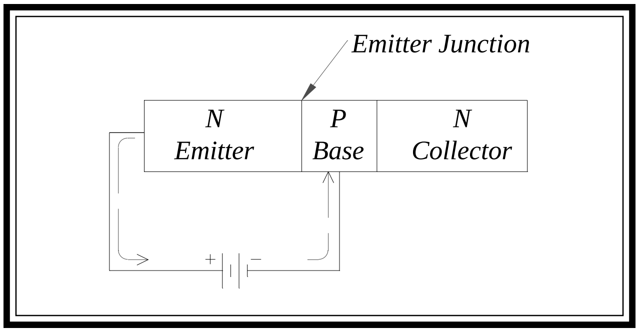
Transistors have three semiconductor regions, containing two junctions (see Tomco Tech Tip #21 for details). As in a diode, these junctions have to be properly biased in order for the transistor to perform a useful function. For our study of transistors we will use a NPN transistor as a model. We will look at both of the PN junctions separately to see how they function. Then we will combine their functions to see the total workings of the transistor.

In Figure 7 we have an example of a NPN transistor. The junction at the base and collector region is commonly referred to as either the collector-base junction or the collector junction. The collector junction is a PN junction that



functions the same as a PN junction in a diode.

An external voltage has been applied to the collector junction. This external voltage is reverse biasing the PN junction. We know from our study of diodes that reverse biasing a PN junction allows only an insignificantly small amount of leakage current to be flow passed



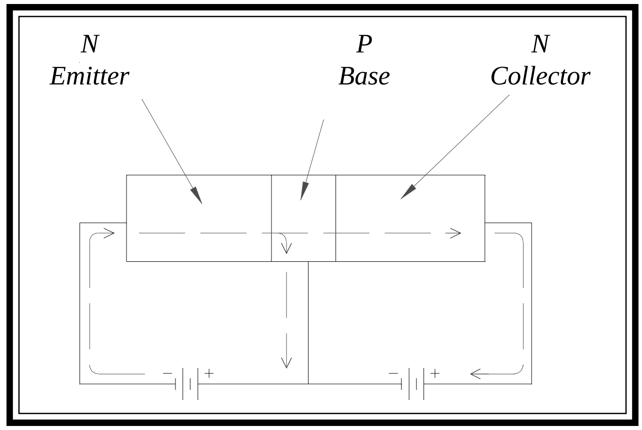
through the junction. Under normal operating conditions the collector junction in a NPN transistor is reversed biased.

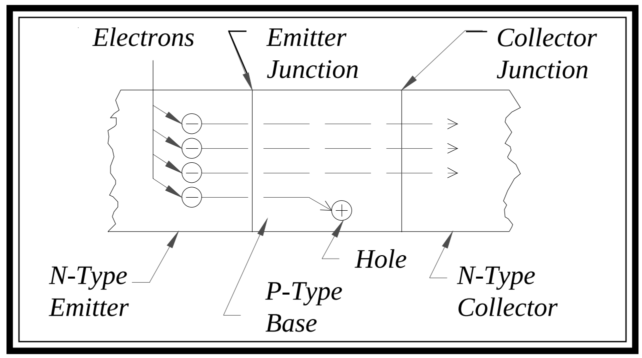
In Figure 8 we will look at the junction between the base and the emitter. This junction is known as either the emitter-base junction or emitter junction. The emitter is also a PN junction that functions the same as in a diode.

An external voltage has been applied to the emitter junction. This external voltage is forward biasing the PN junction. We know from our study of diodes that forward biasing a PN junction allows current to flow through the junction. Under normal operating conditions the emitter junction in a NPN transistor is forward biased.

Now lets combine the two segments to see how they work together (Fig. 9). The emitter junction has been forward biased. This forward biasing forces electrons in the N type material and holes from the P type material towards the junction. If this were an independent diode current would flow and conduct a forward current which would flow only through the emitter junction and its external voltage source.

In a transistor there is a very thin base region. This means that the electrons in the emitter greatly exceed the number of holes in the





base region. Most of the electrons that cross the emitter junction will have no holes to combine with. This results in electrons accumulating in the base region.

These electrons are heavily influenced by the external positive potential applied to the collector region. The influence is so great that most of the electrons (90-95%) from the emitter flow travel across the collector junction into the collector region (Fig. 10). From here the electrons flow into the positive side of the external voltage source which is used to reverse bias the collector junction. This flow is referred to as collector current.

Our discussion of Transistors will continue in Tech Tip #23.

TTT22
Printed in the U.S.A. • 3.00