

ALL ABOUT MAGNETS

Permanent magnets in starters & DC motors



BY BOB THOMAS

Often taken for granted unless they are broken, permanent magnets have played an important part in the development of the compact and powerful starter motors seen today. Aside from being damaged by the shock of a hammer blow, field magnets have proven to be quite durable and long lasting. However, that has not always been the case, because the permanence of some magnets can be compromised under certain circumstances.

While it's simple to identify polarity, it's not so easy to measure the actual magnetic strength without removing the magnets from their field case or having access to some expensive scientific instruments. To make it even more difficult for rebuilders, there are a variety of different types of magnets that have been used in DC motors, and it is not always easy to identify them.

Permanent magnets have been around for thousands years in the form of iron ore that has been naturally affected by the earth's magnetic field. Magnetite, once called lodestone, was used by Chinese fortune tellers who discovered that it would swing to point in a predictable direction when suspended by a string. Sometime later, lodestone was used to make the first compass. Today, man-made permanent magnets, much stronger than natural magnetite, are being used in place of motor field coils in nearly all applications. Their use allows for a more compact design that produces more power from less current.

Permanent magnet DC motors were first introduced in the late 19th century, but they failed to gain widespread use because of the weak strength of the magnets available at that time. The first big step in permanent magnet technology came in the 1930s with the development of Alnico magnets. By adding small amounts of **aluminum**, **nickel**, **cobalt** and **copper** to the iron, the magnetic properties were greatly enhanced. Alnico can retain up to 17 times the magnetic force of magnetite. The downside of Alnico is its low resistance to demagnetization. If not stored or handled properly, Alnico magnets can lose most of their magnetic strength very quickly. The once-popular Alnico horseshoe magnet (that was sold at hardware stores up until the 1970s) came with a steel "keeper" bar to bridge the poles when it was stored. Without the keeper, its magnetic strength deteriorated.

If you find yourself working on an older permanent magnet motor, it would be wise to assume that it could have Alnico magnets. When you remove the armature, you must bridge those magnets with something. A similar-sized armature is an easy substitute that will act as a keeper. Failing to do this will cause the opposing unbridged magnets to demagnetize one

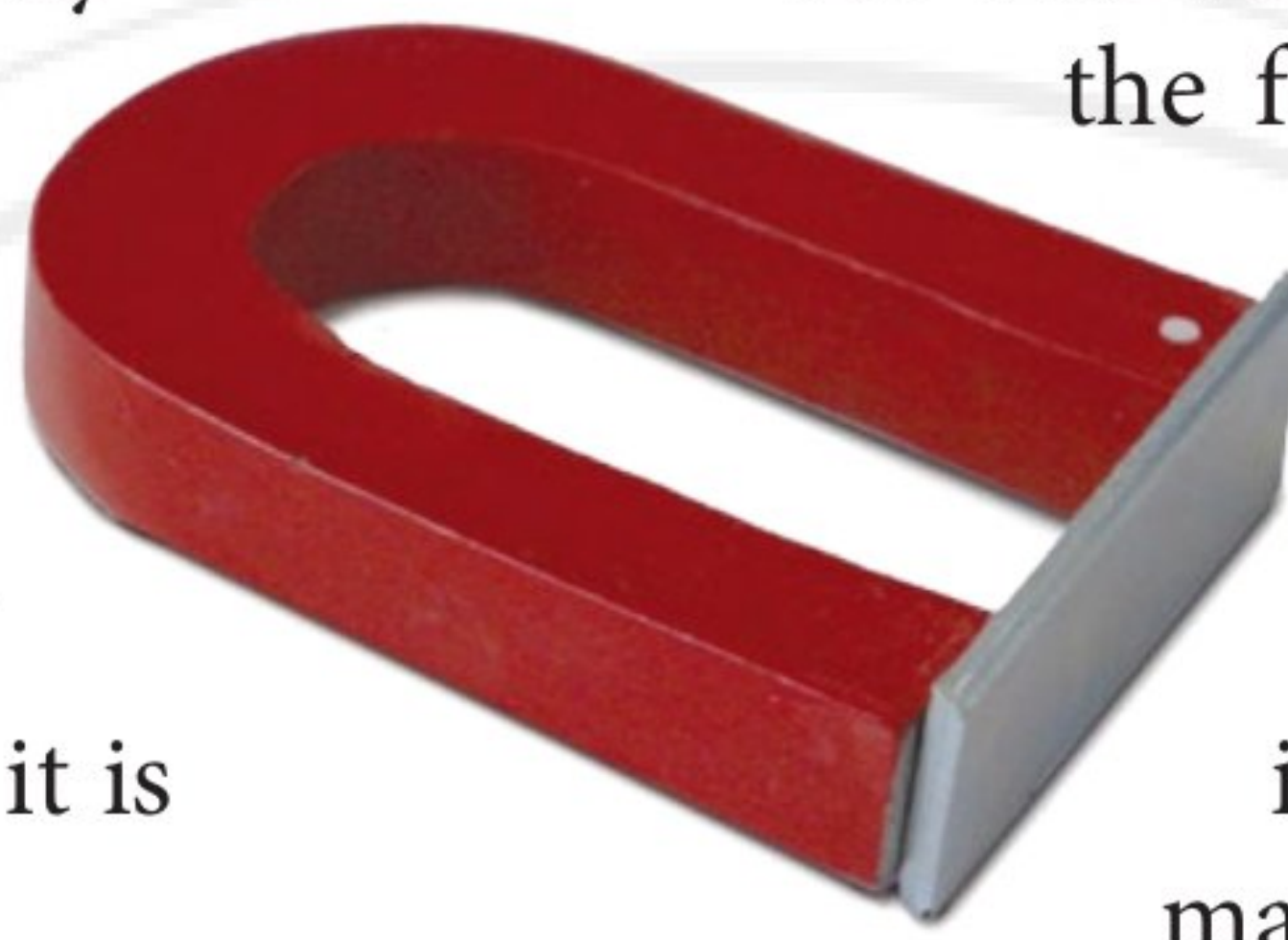
another over a period of time that could be days or hours. Any time spent unbridged will cause some loss if you are working with Alnico magnets.

The first commercial ceramic magnets based on barium or strontium mixed with lead-iron oxides were developed in 1952 by the Phillips Company. They are made from finely powdered barium ferrite or strontium ferrite that is formed under heat and pressure. Their magnetic strength is enhanced by aligning the individual particles with a strong magnetic field during the forming and curing process. Once cured, ceramic magnets resist demagnetization. Their strength is comparable to Alnico in terms of magnetic force, but they are much more permanent. They also have the advantage of being able to be formed into many different shapes. They are low in cost to manufacture, and because of the composition, they resist corrosion. The only real drawback of ceramic magnets is that they are very brittle and can be easily cracked or broken. Today, rubber-based binders are used in place of ceramics to make magnets that are not only unbreakable but flexible. If you have ever used magnetic business cards, they were probably barium or strontium lead oxide magnets.

In the 1970s, the first of what became known as rare-earth magnets were developed. The name comes from the use of rare elements in the alloy, the first of which was samarium. Researchers developed permanent magnets made from powdered samarium and cobalt fused under heat. These magnets took advantage of the way the atoms bonded (called magnetic domains) into hexagonal crystals that align magnetically on their own. This discovery changed everything. Once made, samarium-cobalt magnets are 50 times stronger than magnetite and are highly resistant to demagnetization.

Then in the 1980s, a company named Magnequench, then a subsidiary of General Motors, developed a magnet using neodymium and boron, which produced magnetic forces nearly 75 times stronger than magnetite. These magnets were used in Delco's first permanent magnet planetary gear starters. Because they are also far less expensive to manufacture than samarium-cobalt magnets, neodymium-boron magnets are now being used in a wide variety of motor applications from small power tools to large traction motors. The majority of starters being manufactured today are using neodymium-boron magnets. Their only real drawback is a low resistance to corrosion. That is usually overcome by coating or covering them to prevent contact with air and moisture.

Using magnets to replace conventional field coils saves a significant amount of energy. This is because amperage is no longer required to power the field, where most of the power

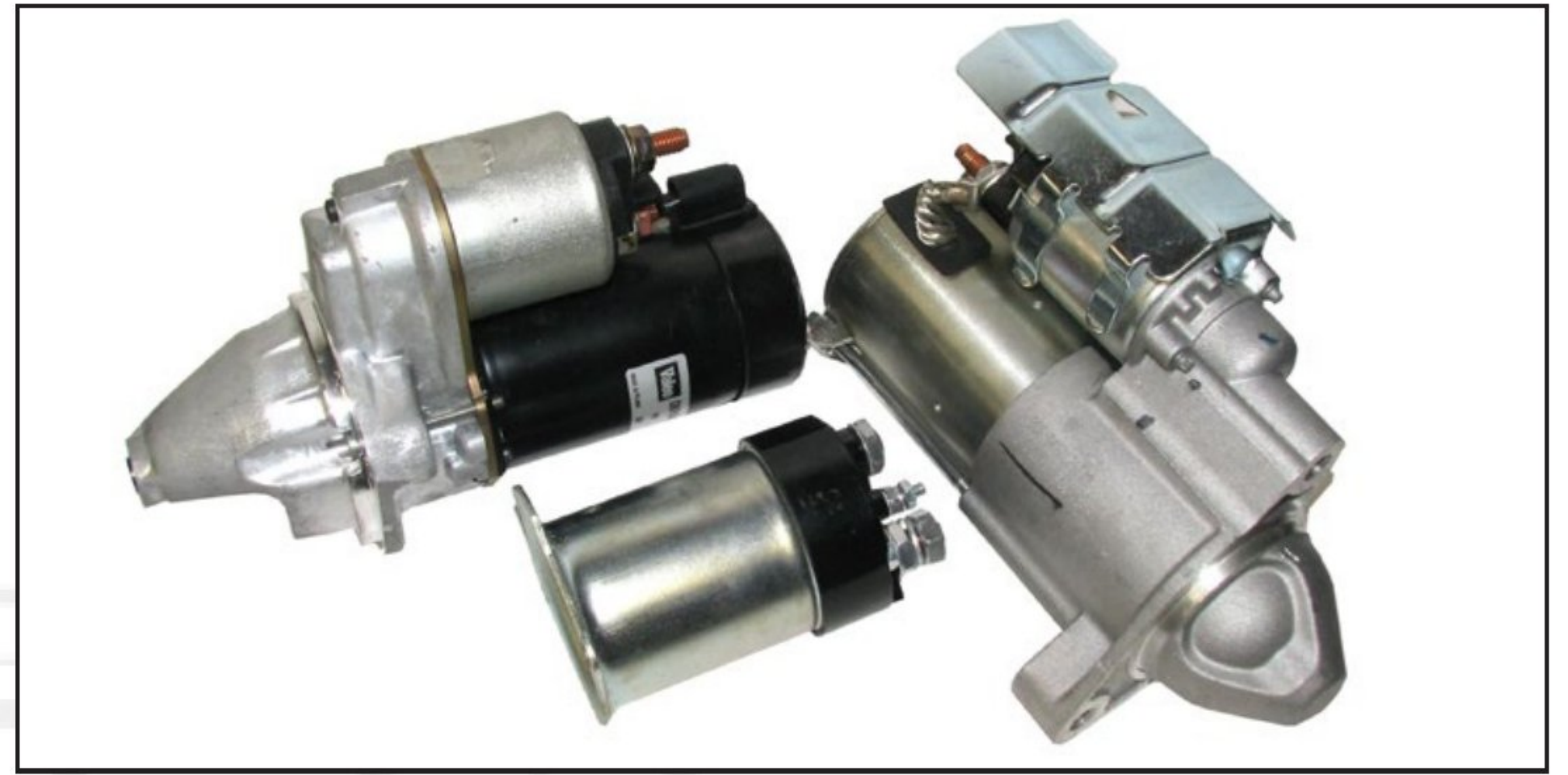


is consumed once operating speed is reached. This allows today's starters to produce more torque with less amperage. That equates to fewer cranking amps from the vehicle's battery and allows for the use of smaller battery cables as well. It also means that starters take up less space in the crowded engine compartment of today's cars, trucks and equipment.

Small permanent magnet motors are being used in place of wound field coil motors in virtually all applications because of their power to size ratio. They have replaced actuators on vehicles that once used cables or solenoids to do everything from controlling air flow to opening and closing the throttle. Outside the automotive world, permanent magnet DC motors are being used in many applications from conveyor systems to hospital beds. Many of these specialized motors are very expensive new, costing into the thousands of dollars. You may have to look a little harder to find the parts, but they are available. You already have the tools you need to rebuild them. This is an opportunity that many rebuilding shops fail to take advantage of.

As you are aware, the major drawback of permanent magnets is that they are brittle and can be broken quite easily. When this happens, it is usually because the starter or motor has been dropped, or a customer has beat on it with a hard object—like a hammer. The ERA offers its members reasonably priced durable warning labels that can help you to prevent that problem. Look on the ERA website for information on how you can order them.

ERA



Modern permanent magnets combined with gear reduction technology result in some amazingly small, yet powerful starter motors. An old-style 10MT Delco solenoid is shown as a size reference.



