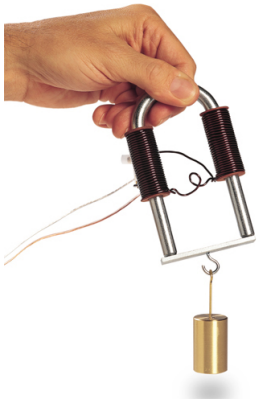


Electromagnet

P8-8100

BACKGROUND:

The discovery that currents produce magnetic fields was made by Hans Christian Oersted in 1820. Oersted made his discovery during a classroom demonstration on electricity, galvanism, and magnetism. Because Oersted made his important discovery while teaching, the American Association of Physics Teachers awards a medal named after him each year to a teacher who has made a significant impact on the teaching of physics.

Oersted's discovery led to some further surprising features of electromagnetism. First, the magnetic field created by a current is perpendicular to that current. And second, the field is not at right angles to the current, but rather goes in a particular direction around the current. Fig. 1 shows a wire carrying a current from right to left and the magnetic field it creates is represented by the arrows going around the wire. The Right-hand Rule shows the direction of the arrows or the magnetic field lines.

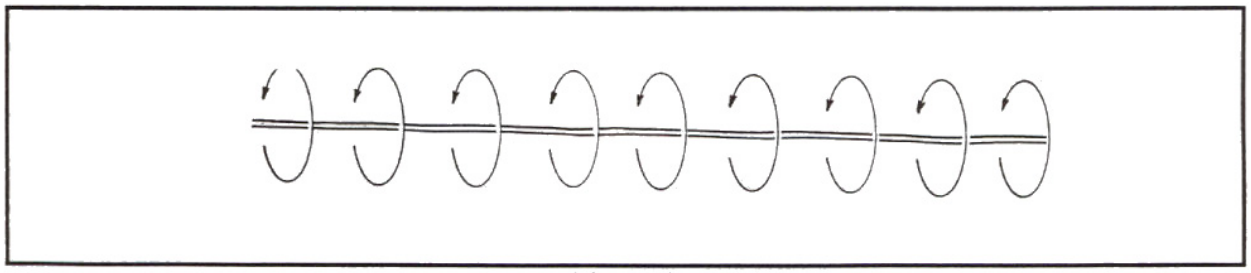


Figure 1

If you take this same wire and put a loop in it you will get the magnetic field configuration in fig. 2.

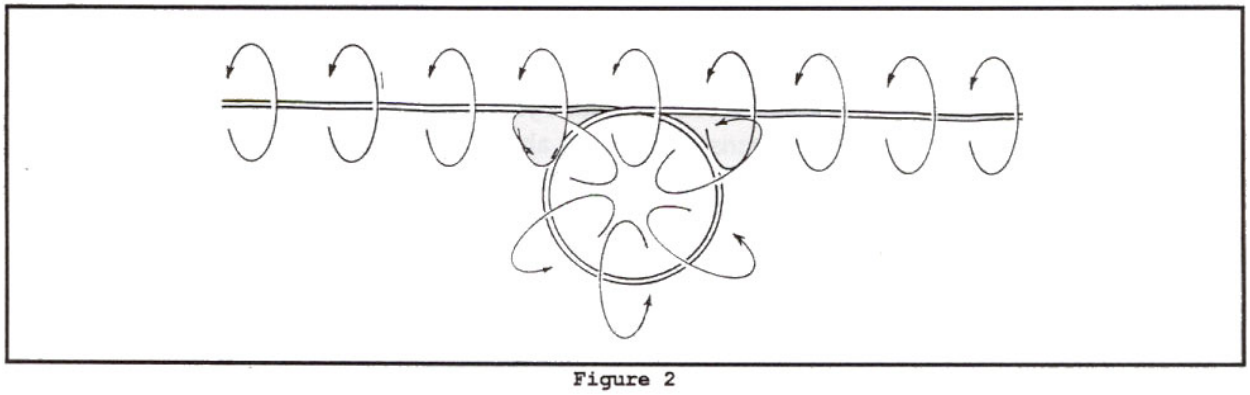


Figure 2

Notice the high concentration of arrows in the center of the loop that all point in the same direction. This represents a strong magnetic field in the center of the loop. Someone got the bright idea of adding a bunch of these loops in a row to make a "tunnel" of high magnetic field pointing in the same direction. Fig. 3 shows a series of these loops and the effect their magnetic field has on iron filings.

These solenoids can be used to induce magnetism in soft iron. For instance, if a bar of iron were inserted into the solenoid, the strong magnetic field forces the iron molecules in the bar to align themselves, thus creating their own north and south poles.

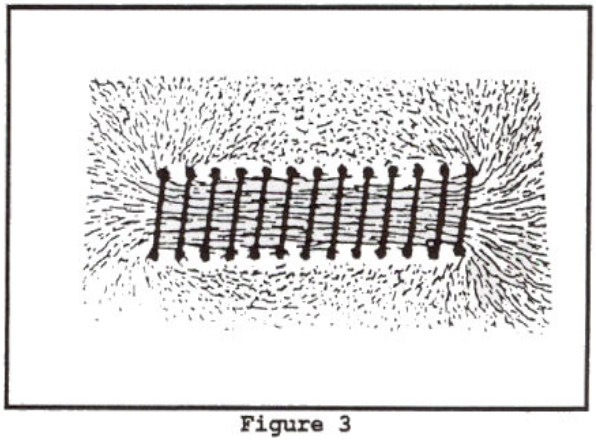


Figure 3

THE ELECTROMAGNET:

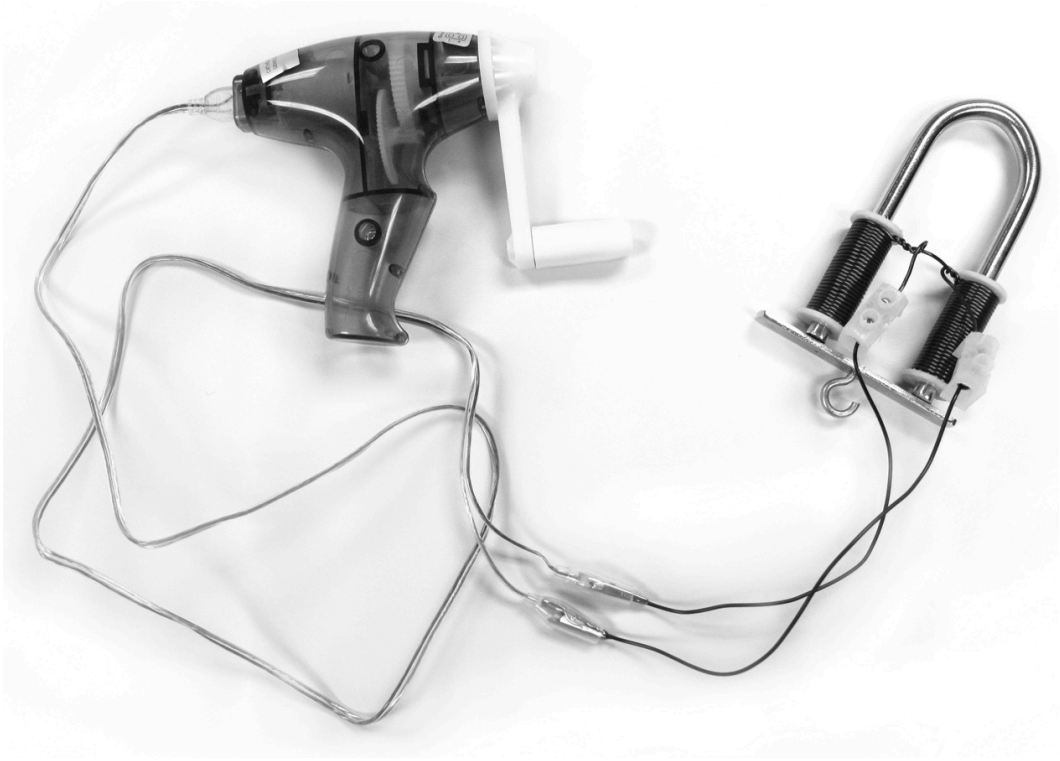
If you take a look at your electromagnet, you will notice that there are two solenoids of wire. These coils have soft iron inserted into the middle of them. By following the wire closely with your eye, you can also see that the coils are wrapped around in *opposite* directions. The coils, when carrying a current, induce two magnetic fields and force the iron to become magnetized. Each coil, because the current flows in opposite directions, creates a different magnetic pole on the ends of the horseshoe shaped iron bar.

EXPERIMENTAL TIPS:

Recommended Items:

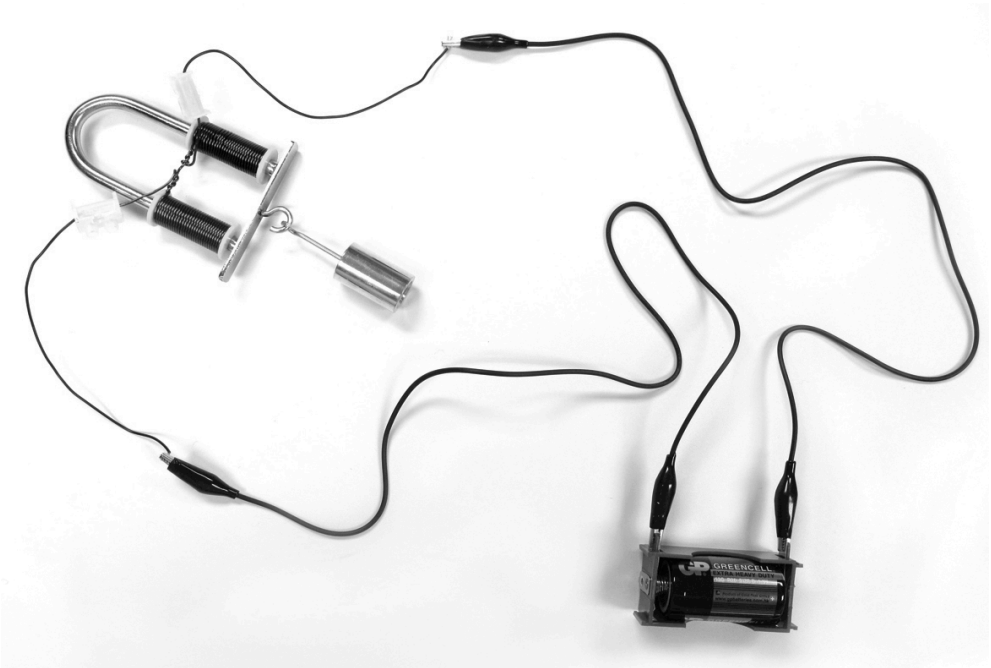
Genecon (P6-2631)
Hooked Mass Set, 9 Masses (P1-1000)
Alligator Lead/10 Pack (P4-3000)
D-Cell Battery Holder (P4-1600)
D Battery/2 pack (04-2106)

1. The **Genecon** (P6-2631) a hand-held electric generator, is an ideal companion to our electromagnet. By hooking up the Genecon's clips to the electromagnet (unscrew the small screws and clip the Genecon leads into the plastic covers), students can turn the crank and create enough current to induce magnetism. Have students hang weights from the hook and determine how much force they are creating. What happens when they stop cranking?



2. Students can use a **compass** (P8-1170) or the 3D magnetic compass (P8-8005) to study the magnetic field of the iron horseshoe and the coils. What does the 3D magnetic compass show is happening at the top of the coils? Does the north pole coincide with predictions based on the right-hand rule? What happens when students change direction with the Genecon

3. Batteries work even better in creating a magnetic field. The more current, the more weight the electromagnet can carry. (Shown using Alligator Lead and D-Cell Battery Holder.)



RELATED TOPICS:

Currents generate magnetic fields *and magnetic fields exert forces on currents*. That is how electric motors and television screens work. Ask about Arbor Scientific's **Electric Current and Fields Kit** (P8-8008) and **Electric Swing Apparatus** (P8-8009).

REFERENCES:

This data sheet borrows heavily from *Physics* by D. Halliday and R. Resnick, published by John Wiley & Sons, and *Conceptual Physics* by Paul G. Hewitt. Pearson Education, Inc..

TROUBLE SHOOTING:

If your electromagnet doesn't seem to be working, try tightening the two lowest screws on the clips. The screws must actually pierce the wire's outer coating for the clips to make good contact. The electromagnet can hold up to 2kg of weight maximum.