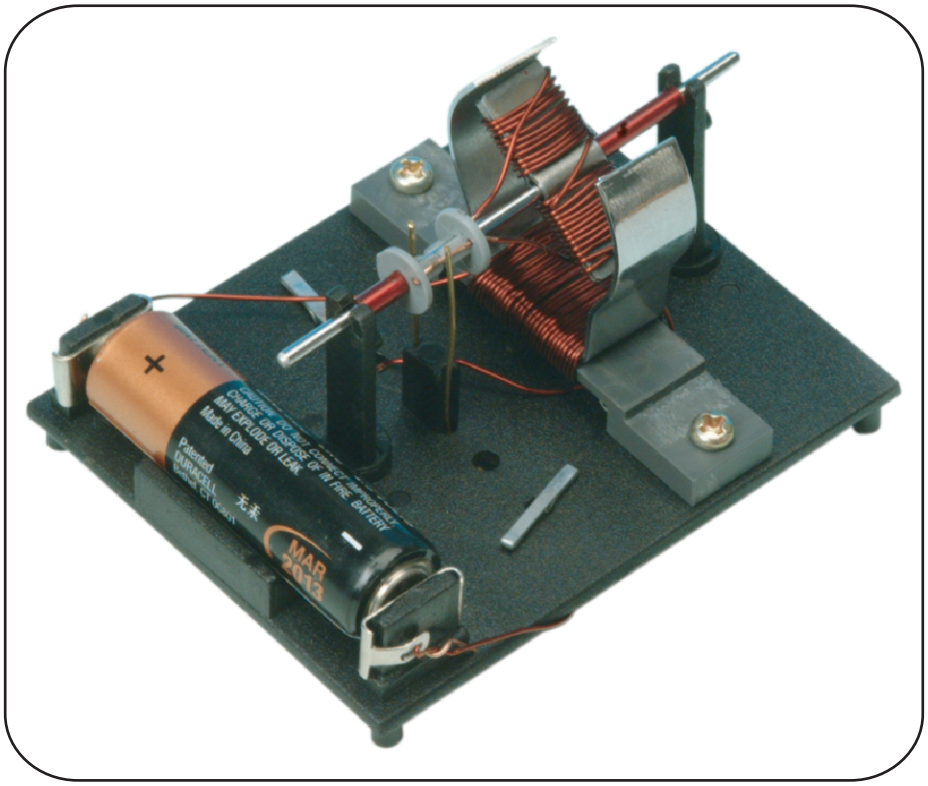
Trust | Deliver | Learn

DC MOTOR KIT

CAT NO. PH1229



Instruction Manual

PART LIST

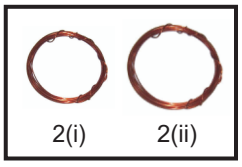
S. No.	Description	Qty.
1.	Shaft Supports	2
2.	(i) Wire 200cm long coil with Small Loop	1
	(ii) Wire 300cm long coil with Bigger Loop	1
3.	Battery Clips	2
4.	Screw & Nut	4
5.	Armature Half	2
6.	Tubing, about 2½"	1
7.	Motor Shaft	1
8.	Mounting Bracket	1
9.	Bronze Wire Brushes	2
10.	Commutator Insulators	2
11.	Plastic Base	1
12.	Field Pole	1
13.	Instruction	1

TOOLS NEEDED

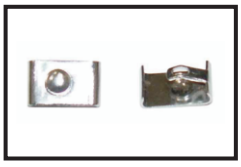
- Sandpaper
- Sharp knife, scissors, razor blade, or wire cutters for cutting and scraping.
- Small (slotted) screwdriver
- Pair of needlenose pliers

You need one (1) new AA battery, not included. A freshly charged, rechargeable Ni-MH battery will work best as it has a higher current.

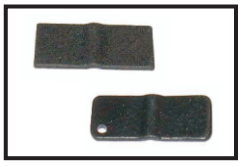

1. Two (2) Shaft Supports

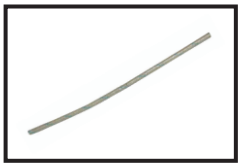


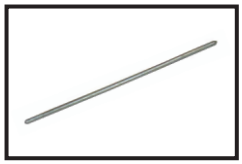
2. Two (2) copper wire coils, 200cm & 300cm long

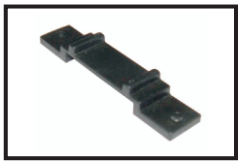

3. Two (2) Battery Clips

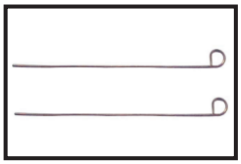

4. Four (4) Fasteners


5. Two (2) Armature halves

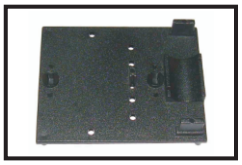

6. Insulating Tubing


7. Motor Shaft


8. Mounting Bracket


9. Two (2) Wire brushes


10. Two (2) Commutators
Slide halves together as shown.


11. Plastic Base

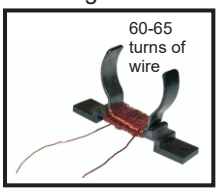

12. Field pole

MOTOR ASSEMBLY

Important! The copper wire supplied with this kit has an insulating coating on it. Using sandpaper, clean the coating of insulation to a length of 1" off all wire ends.

A. Field Coil

Diagram - 1



Scrape 1" insulation off each wire end

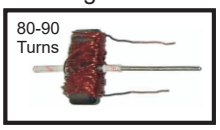
1. Unroll one of the wire coils 2 (i). Place the coil on one of your fingers and pull one end to unwind.

2. Cut a 4" piece from one end. Using sandpaper, scrape off 1" of the coating from each end. Place this piece to the side. (It will be used in Section E.)

3. Hold field pole (12) and mounting bracket (8) together. Leaving 2" of wire free, begin winding the coil tightly around the two parts, as shown in Diagram 1. Continue wrapping the coil until there are 6" left. Using sandpaper, scrape off 1" of the coating from each end.

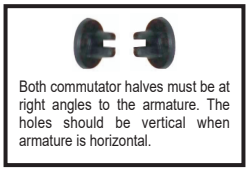
B. Armature

Diagram - 2



1. Unroll the second wire coil 2 (ii). Using sandpaper, scrape off 2" of the coating from each end.

Diagram - 3

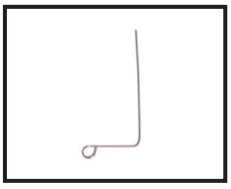


2. Put the two halves of the armature (5) together with the motor shaft (7) between them.

3. Leaving 2" of wire free, wrap the wire coil 8 times around one side and then cross over the other side and wrap the coil 8 times around that side. Repeat until there are 2" of wire left. When finished, it should look like Diagram 2. Be sure to have the windings always go in the same direction and to have about the same amount of windings on each side. Total Turns will be around 80-90 Turns. Then twist the wire on the shaft.

C. Commutator

Diagram - 4



1. Cut a 3/8" piece of tubing (6) slide one end of the motor shaft into the tubing. Tubing must be pushed directly against the armature halves. (Diagram 6)

2. Place the halves of the commutator (10) together.

3. On the same side as the tubing, slide the motor shaft through the commutator's large middle hole.

4. Run the wire from one side through one of the small holes of the commutator. Repeat with the wire from the other side.

5. Cut a 1/4" piece of tubing. Slide onto the motor shaft so that the commutator is between pieces of tubing. Trim wire.

6. Cut a second piece of tubing 1/4" long and slide onto the opposite end. Trim off the wire.

D. Assembling Motor

1. Fasten the field coil assembly to the plastic base (11) by fixing the mounting bracket with the help of a screw and nut onto holes numbed 1 in Diagram 5, keeping wire ends pointing towards the middle of the base.

2. Place one shaft support (1) into the rectangular hole closest to the field coil. The support should be perpendicular to the base.

3. Loop the end of the 2" wire from the field pole (Step 3, Section A -Field Coil) through the screw & twist it through Hole 3. See Diagram 5.

4. Loop the 4" long single wire cut from the coil (Step 2, Section A - Field Coil) through the screw & twist it through Hole 4. See Diagram 5.

5. Using sandpaper, scrape the coating off both brushes (9). Bend looped end of brush 90°. (See Diagram 4.) Flip the base over. Slide one brush through hole 5. Then slide the loop at the end of the brush over the screw in Hole 3. Tighten the screw with the nut. Slide the second brush through Hole 6. Then slide the loop over the screw in Hole 4. Tighten the screw with the nut. See Diagrams 4 & 5.

6. Place the second shaft support (1) into the rectangular hole farthest from the filed coil. The shaft support should be perpendicular to the base.

7. Using a light oil, Lubricate the armature shaft. Then lay the armature on the two shaft supports and pop into place. (The commutator should be touching the brushes.)

E. Connect Motor To Battery

1. Lace the end of the remaining 4” wire from the field coil into the small hole in one of the battery clips (3). Snap the battery clip into hole 8.

2. Lace the 6" single wire into the small hole in the second battery clip (3). Snap battery clip into hole (9). (Terminals on clips point away from each other.)

3. Place the new battery in clips. A fresh, rechargeable Ni-MH battery will work best as it has a higher current.

4. Spin the shaft by hand to get the motor started.

EXPERIMENTS

1. Put the battery in the other way. What does the motor do? Will it spin the same or the opposite way? Answer this before you do the experiment.

2. What happens to the direction of shaft rotation if you turn the commutator 180°? Answer before the experiment.

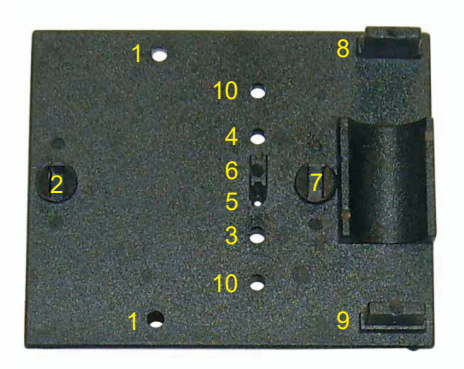
3. Put the commutator in the same plane as the armature and try to run the motor. How important is the plane of the commutator relative to the plane of the armature?

4. Handle the shaft with your fingers as it rotates at low speeds. Note how the twisting force (torque) is not constant as the shaft rotates through one revolution. Plot out the graph of torque vs. angular position. Define 0° starting point for the armature, then feel the torque as the shaft rotates through 360°. Explain your graph.

5. Short out the commutator with fine wire. Attach two wires from each brush to an armature wire. What is the resting, Stable position of the armature when power is connected? (Use short, quick connections.)

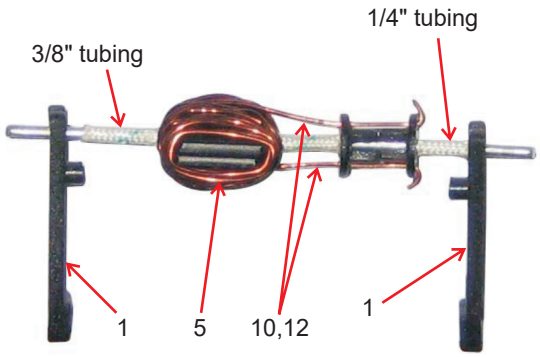
6. The field pole extends up and around the armature but has no wire around it. Do you need this? Could you wind wire around the middle of the mounting bracket instead? Unwind the field coil and remove it. Now wind the coil of wire back again and connect up the motor. Does removal of the field pole reduce the efficiency of the motor? Explain.

Diagram - 5



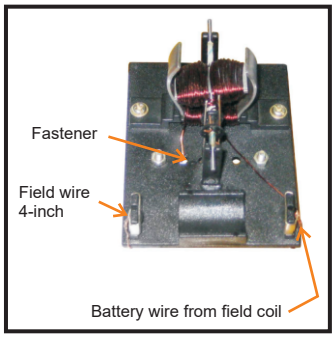
1. For field coil
2., 7. For shaft support
3. For lead to battery
4. For wire lead to field coil
5., 6. For brush
8., 9. For battery clip
10. Unused

Diagram - 6



7. Connect 6-9 volt batteries to the motor. What happens?

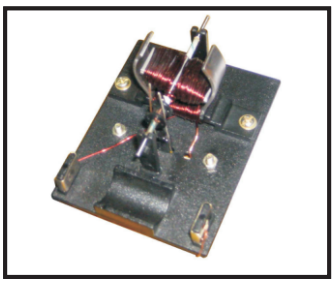
Diagram - 7



- How would you redesign the motor to run on 15 volts? Note the blackening around the brushes and commutator. Why does this happen?

- Leave the motor going with 9 volts attached and run it to destruction. What part fails first? What part do you think would have failed next? Fix it if you can and run it again until it fails. This is called destructive testing. What does it teach you?

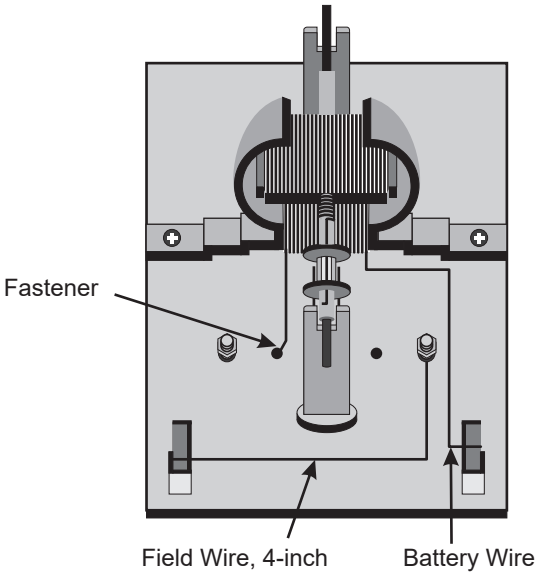
8 Try connecting an AC voltage source such as a 6-12 volt AC wall transformer in place of the battery. (Do not use the 110 volt line outlet directly as this is dangerous and will instantly destroy your motor!) Does the motor run? Why?



THEORY

Every magnet has 2 poles -north (positive) and south (negative). "Like" poles repel each other; "unlike" poles attract. One north pole repels another north and attracts a South.

Diagram - 8



The attracting and repelling of the magnets causes the motor to run. The field poles become an electromagnet when an electric current flows through the wire coil around them. The armature becomes an electromagnet when an electric current passes through its wire coil. The armature, however, produces a reversing magnetic field produced by the field poles remains stationary.

The North pole of the field pole attracts the South pole of the armature, which turns in response to this magnetic attraction. But in order to keep the armature turning, you must break the current and change the polarity of the armature magnet. Otherwise, the armature would remain permanently fixed in one position for as long as electric current was flowing, and nothing would move.

Breaking the electric current through the armature and reversing its direction is done by a switch consisting of brushes and commutators. The com-mutators attach directly to the motor due to their location on the shaft. They are connected to the armature by the wires threaded through them. The brushes rest lightly against the wires connecting the commutators to the armature. The brushes complete the electric circuit and enable the electric current to flow into the armature wires.

If the electricity always flowed in the same direction, the field magnet would pull the armature in the same position. It would freeze in this position, and there would be no motion. However, just at the height of the attraction of the field magnet for the armature magnet, when the armature magnet has turned halfway around, the brush strikes the armature wires on the motor shaft to reverse the current's direction. Instead of flowing from the left wing of the armature through to the right, it now flows in the other direction, reversing the North and South poles.

The arrangement of wires from the armature through commutators is what causes this reversal. Remember that you twisted the wires 90° to position them at right angles to the armature. Due to this orientation, the armature magnet reverses itself as the armature turns halfway, and the armature completes its revolution as what is now a North pole is repelled by the North pole of the field magnet. The South pole of the armature will be continually turning in a series of half turns to seek the stationary North field pole.

The reason the armature revolves in a complete circle of 360° rather than flipping back and forth in half circles is because the momentum of the motor will carry the attraction of North and South a little past the point of peak attraction; as polarity changes, the armature completes its revolution in an attempt to "catch up" with the change in location of the poles.

WHAT TO DO IF YOUR MOTOR DOESN'T WORK

1. Check all electrical connections. Are they scraped free of insulation? (Places to check: both wires from the armature threaded through the com-mutators-one to the battery, one to the brushes; both ends of wire leading from the battery to the brushes.)

2. Can the shaft spin freely by hand? If not, you may have to trim your tubing. (If the field pole interferes with armature rotation, gently bend it out of the way.)

3. Make sure holes in both commutators are at right angles to the armature.

4. Is your battery fresh?

5. Do both brushes contact the commutator lightly? Adjust by trial and error.

6. Use an occasional drop of oil at both ends of the motor shaft where it meets the shaft supports.

7. The "bright" surfaces of the bronze wires may oxidize eventually. This may lead to poor contact between brushes and commutators. To prevent this, coat the "bright" surface with solder by "tinning" the surfaces using an electric solder iron.

8. To keep the armature and commutators at right angles to each other, you can apply some 'super glue" to make a permanent bond at the contact points.

9. You may have to bend the field poles to get them close to the armature assembly. They should be as close as possible.

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