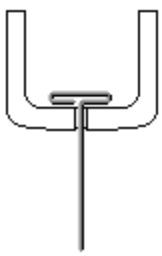
Assembly Instructions: Kit #10

Kit #10 allows with a simple turn of the knob switching between four different motors:

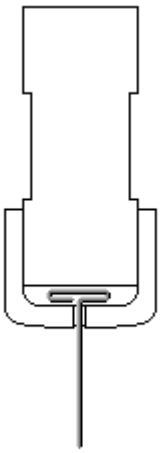
- R – Regular reed switch motor
- T – Reed switch motor with the transistor
- H – Hall Effect motor
- O – Motor with optical control

Assembly instructions for Kit #10 are almost the same as for Kit #9, but add solar panel for green energy projects. For the motors utilizing a reed switch there is also a speed control unit.

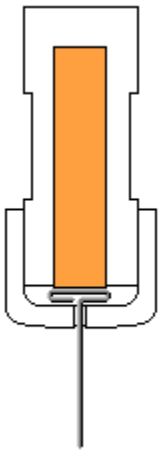
1. Insert the T-pin into one of the caps.



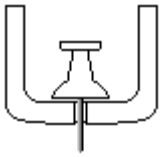
2. Insert the rotor core into the same cap as shown below. Apply some pressure to push the rotor core approximately 1/2" (10-12 mm) into the cap.



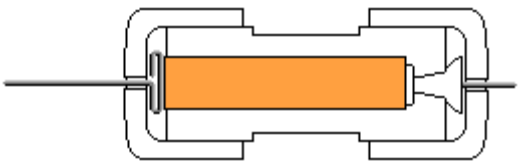
3. Put in the wooden insert.



4. Insert the pushpin into the other cap until it is fully seated and the end of the pushpin sticks out approximately 1/4" (6-7 mm). You may need to push it hard.

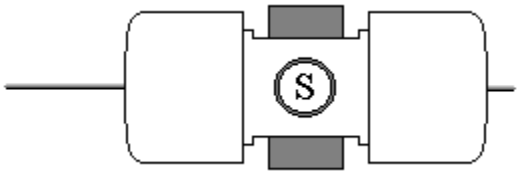


5. Put everything together as shown below. Push the caps towards each other until they cannot move any more. The T-pin must be secured firmly. This process may require some strength. Be careful not to bend the T-pin or poke yourself.

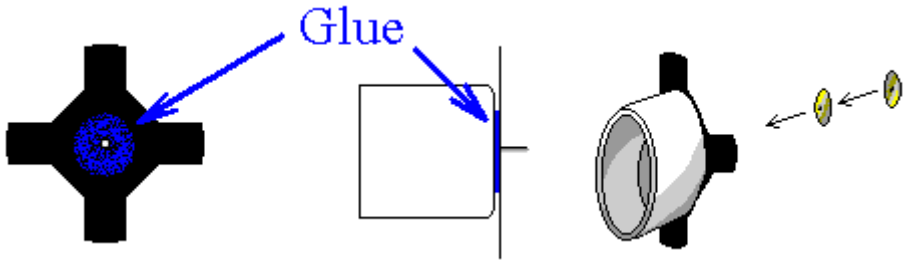


6. Glue the magnets to the flat surfaces of the rotor core with the letter ‘S’ facing outside (or a dimple facing inside). Your kit includes 4 magnets. If you want to try 2 magnets first, glue them to the opposite sides. Straighten the T-pin if necessary. You can check it by spinning the rotor between your thumb and index finger. Again, be very careful.

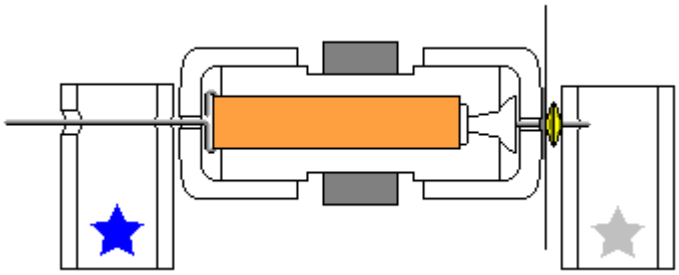
   All kits have magnets with one of the poles marked with either a letter ‘S’ on the South pole or a dimple on the North pole. If you want South side to look better, you may cut out the white glossy round labels that are provided and paste them. You may do it before attaching the magnets to the rotor. It is recommended to use regular white glue or a glue stick on the labels for better results.



7. Cut out the disk (supplied with the kit). Poke a hole in the center, which is marked by a cross. Apply some glue to the middle of the disk and glue it to the cap with a shorter axle (with the pushpin). Slide two sequins as shown below. The sequins act as a spacer between the disk and the stand and work better if their convex surfaces face outwards. You may use only one sequin with convex surface facing the stand.

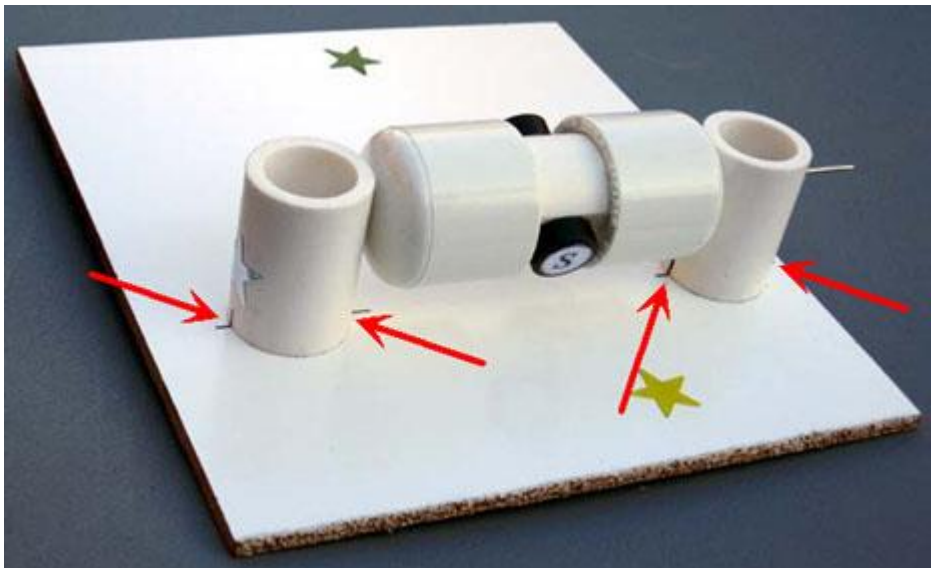


8. Insert the rotor into the stands marked with blue and silver stars as shown below. Hold the stands and test to see if rotor spins freely. Make final adjustments to the T-pin if necessary.

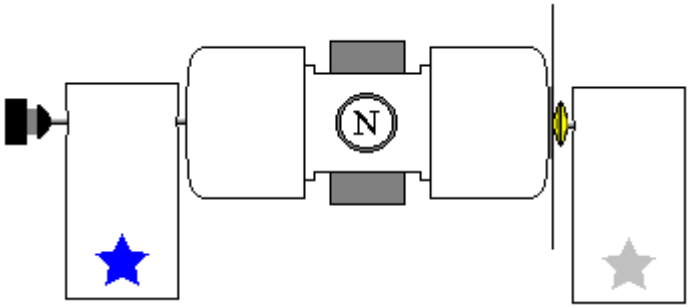


9. IMPORTANT: *If you plan to attach propeller to your motor try to glue the stand with the blue star as close to the edge as possible. You may need to shift the whole rotor assembly.*

   Glue the stand with the silver star to the board. Try to cover the corresponding star completely. Align the marks on the stand with the line on the board as shown below. Note that the star's position and the marks are approximate, sometimes you need to move the stands slightly to achieve the lowest friction. Keep in mind that super glue bonds instantly, so try to be as accurate as possible in these procedures.

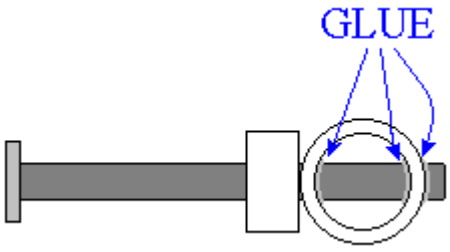


10. Insert the rotor into the stand marked with the blue star. Glue it to the board the same way as the first stand. Leave a gap of about 1/16" (1/32", or 0.8 mm on each side) between the rotor and the stands. Test again to see if the rotor spins freely. At this time, or later, you may take the rubber plug and fix it as shown below. You can glue different things to the outer flat surface of the plug. Try to be accurate, redo this step if necessary.

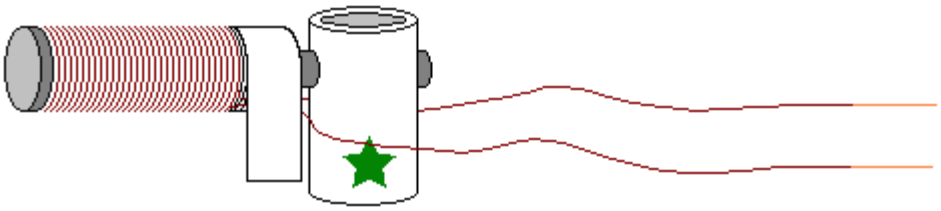


11. If you purchased the wire comparison kit, instead of steps 11-13 for this kit, follow instructions for wire comparison kit. After that, please, continue the assembly instructions from step 14.

    Otherwise, insert the nail into the stand with the green star. If it is loose you may apply glue as shown below.

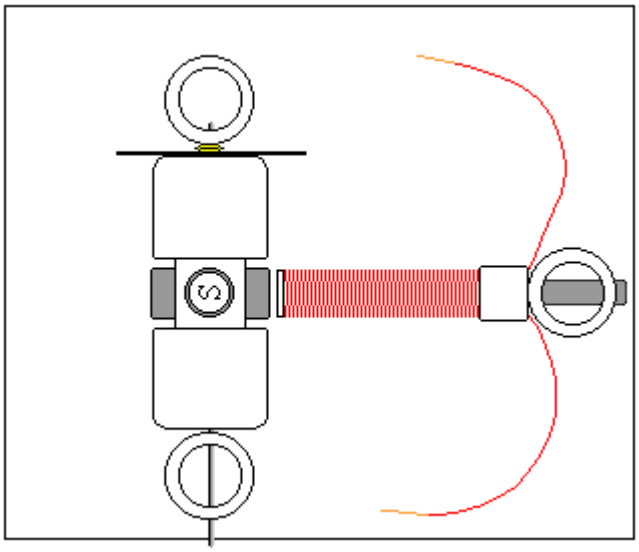


12. Cut two pieces of wire 9" (22-23 cm) long. Leave them for now - they will be used for connecting the reed switch. All remaining wire on the spool should be used to wrap around the area between the tape and the head of the nail.
    - Tape one end of wire leaving about 6" (15 cm) open. You may use the tape that is already on the nail.
    - Wind all the wire in one rotational direction (either clockwise or counterclockwise) moving back and forth along the nail. Try to be as accurate as possible. Do not let the wire slide off the end of the electromagnet.
    - Tape the second end of the wire using the same tape. Both open ends of wire should be about 6" (15 cm) long.
    - Clean about 3/8" (10 mm) of the wire tips with fine sandpaper (included) or a sharp knife to remove the insulation.

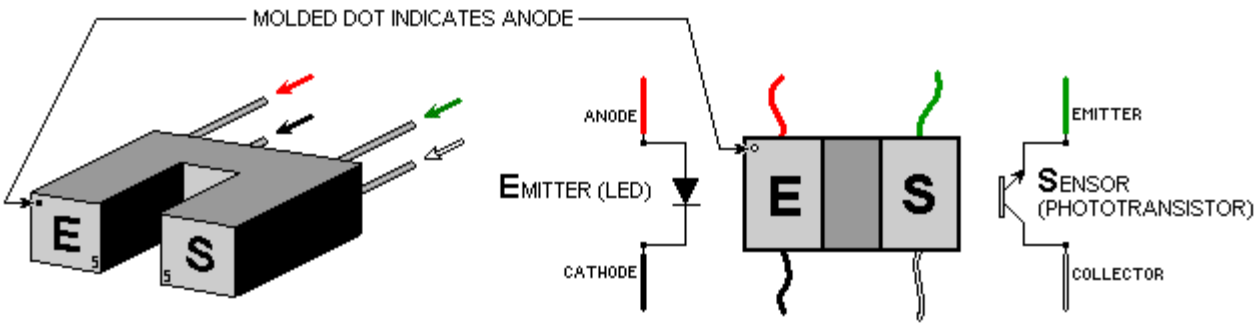


Test the electromagnet! Connect one wire to "+" and another wire to "-" of the battery. If electromagnet is assembled correctly the head of the nail should attract metal objects such as paper clips, small nails, knife blade, etc.

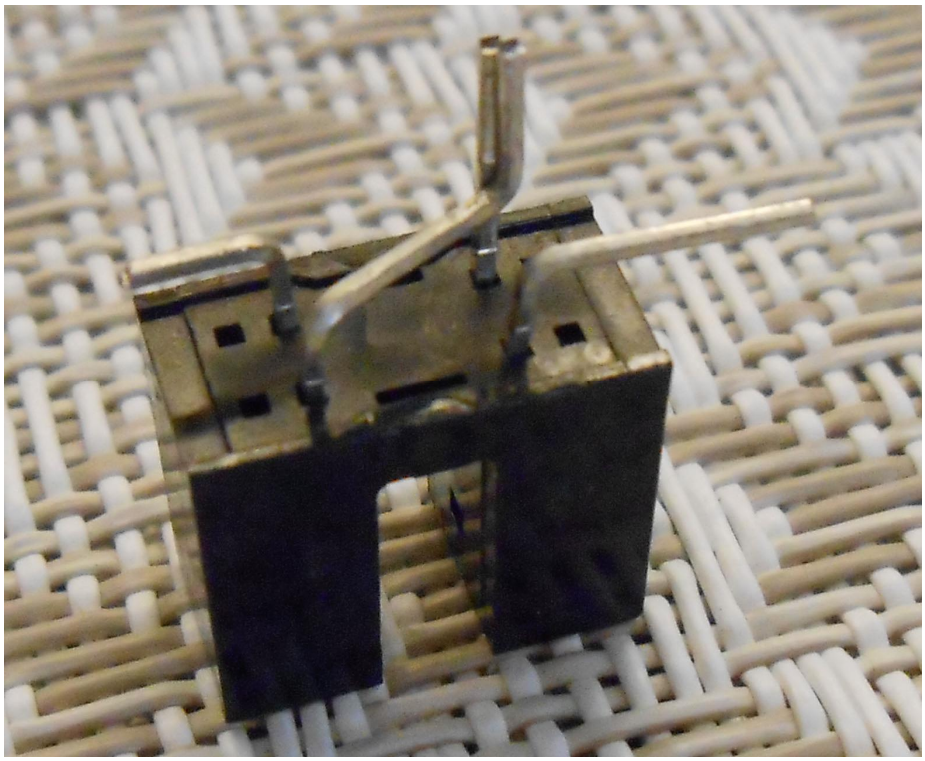
13. Glue the electromagnet to the board as shown below. Turn the rotor slowly to see if the magnets hit the electromagnet. If one or more do, move the electromagnet back until there is a 1/16" (1.5 mm) gap between the electromagnet and the closest magnet on the rotor.



14. Locate the optointerrupter pins as shown on the following picture. It is very important to identify all four pins properly. Wrong connection in the motor will destroy the optointerrupter.



Bend and trim optointerrupter pins as shown below (view from non-branded side). Tweezers or needle-nose pliers may be very helpful. You may use scissors for trimming.



Locate the 270 Ohm and 4.7 K (4700 Ohm) resistors. The 270 Ohm resistor has red, violet, brown and gold color bands. The 4.7 K resistor has yellow, violet, red and gold color bands. Bend the leads of the resistors as shown below.

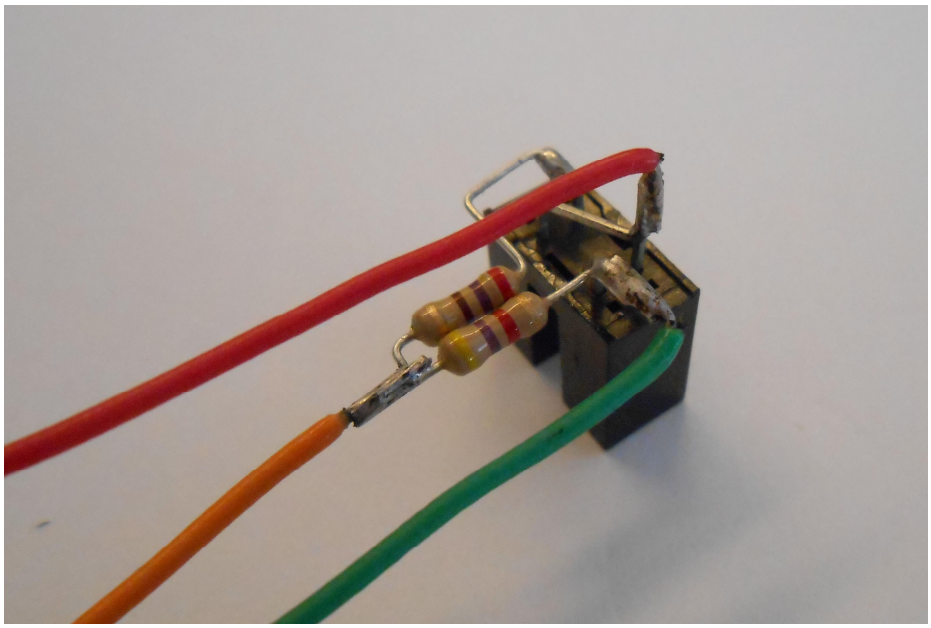
Solder these resistors together and to the optointerrupter as shown in the next picture. See the Links page at our web site for tips on soldering if you do not have enough experience in this procedure.

IMPORTANT: Do not overheat the optointerrupter when you solder it. The soldering iron heat may destroy this sensitive device. If you were unable to attach the wire in 3 seconds, let the optointerrupter cool off, and then try it again.

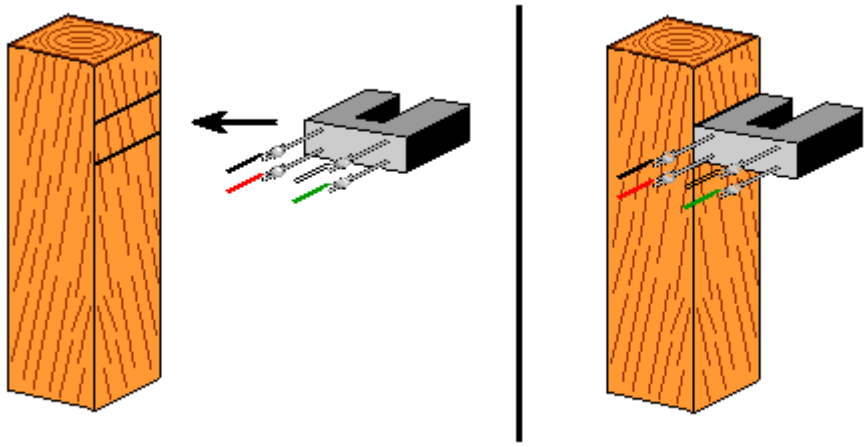
Make sure that 270 Ohm resistor is connected to LED cathode, 4.7 K resistor is connected to the emitter of the phototransistor, and LED anode and the collector of the phototransistor are connected together:

15. Solder 3 pieces of the hook-up wire to the optointerrupter assembly. If your kit includes one large piece of hook-up wire, cut it into 8 pieces of about 9" (22-23 cm) each; if it includes four 18" long pieces cut them in half. Strip about 3/8" (10 mm) of insulation on each end of these wire pieces using a sharp knife.

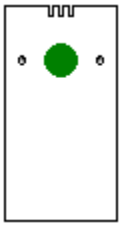
    Wire colors shown on the picture are used for reference only. You may use different colors or even one color.



16. Locate two marked lines and glue the optointerrupter to the square wooden stand as shown below with branded side facing up (shown without the resistors):



17. Attach the self-sticking felt pad to the reed switch stand as shown. This soft pad decreases the reed switch vibration thus decreasing the sound it generates.



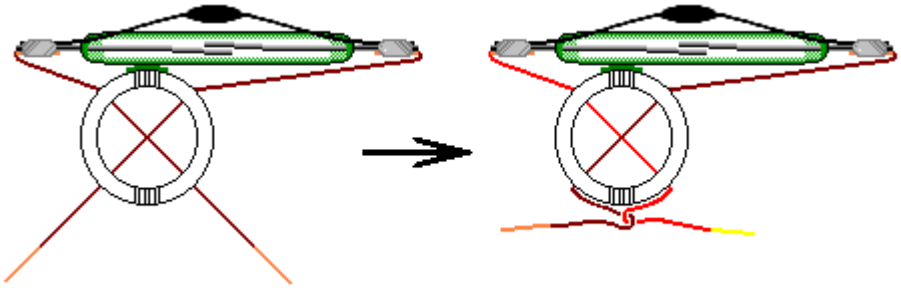
18. Assemble the reed switch on universal stand. You may add a ZNR if you want to experiment with higher voltages or make more reliable reed switch motor. The ZNR is a small electronic part that absorbs the spark inside the reed switch. It provides an additional reed switch protection even in the motor with the transistor.

    The ZNR is not required for the motor to work. You may also add it later.

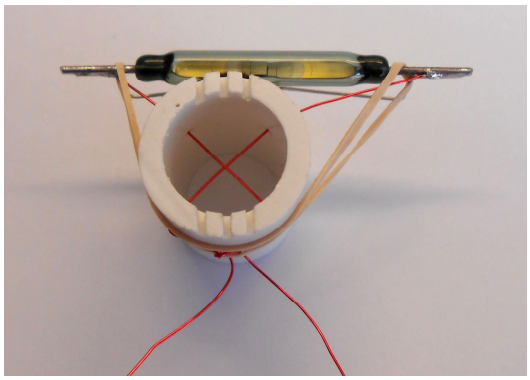
    Take the two pieces of magnet wire you cut earlier and clean the wire tips using sandpaper to remove the insulation. Clean about 3/8" (10 mm) on both ends of each wire piece.

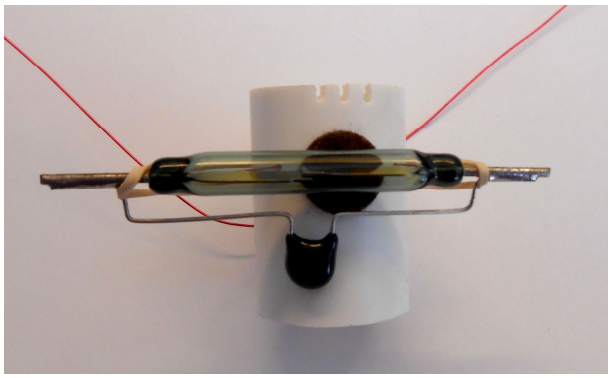
    Form ZNR leads as shown below. Solder wires to the reed switch and the ZNR.

    Solder the second wire and insert the reed switch wires into the universal reed switch/Hall Effect switch stand. Be careful not to break the reed switch, it is very fragile. Twist the wires. Make sure that the reed switch is not centered on the stand and shifted to the side as shown in the pictures.

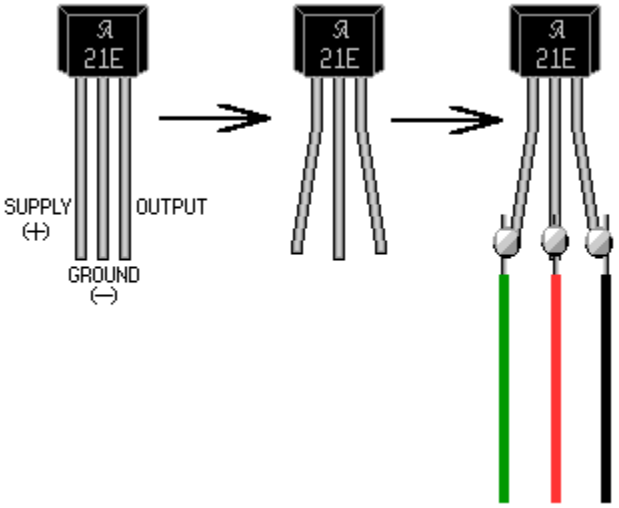


Use rubber band to prevent the reed switch from moving. The ZNR should be located below the reed switch.

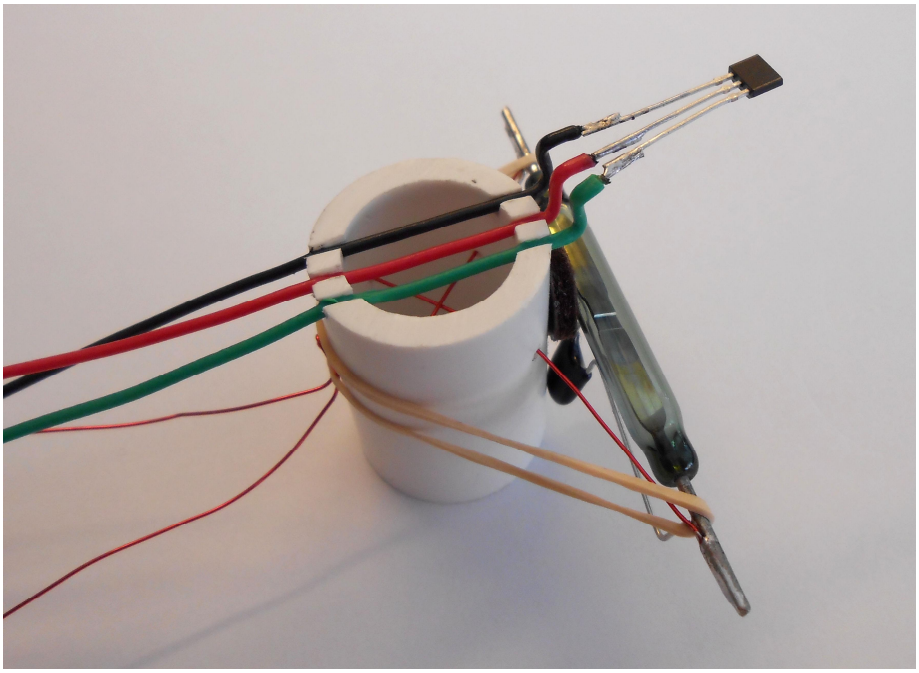




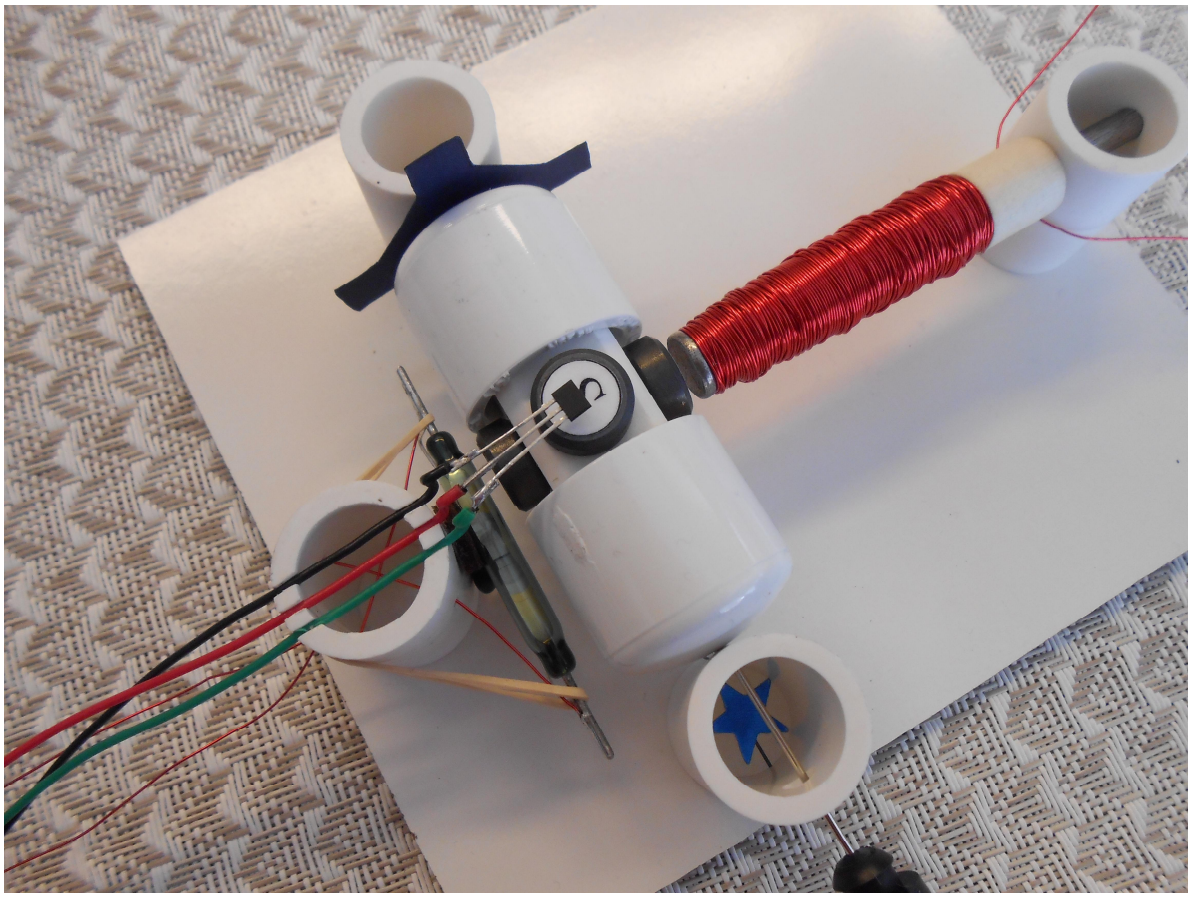
19. Bend the leads of the Hall Effect switch apart and solder three wire pieces to them. Do not overheat the Hall Effect switch.



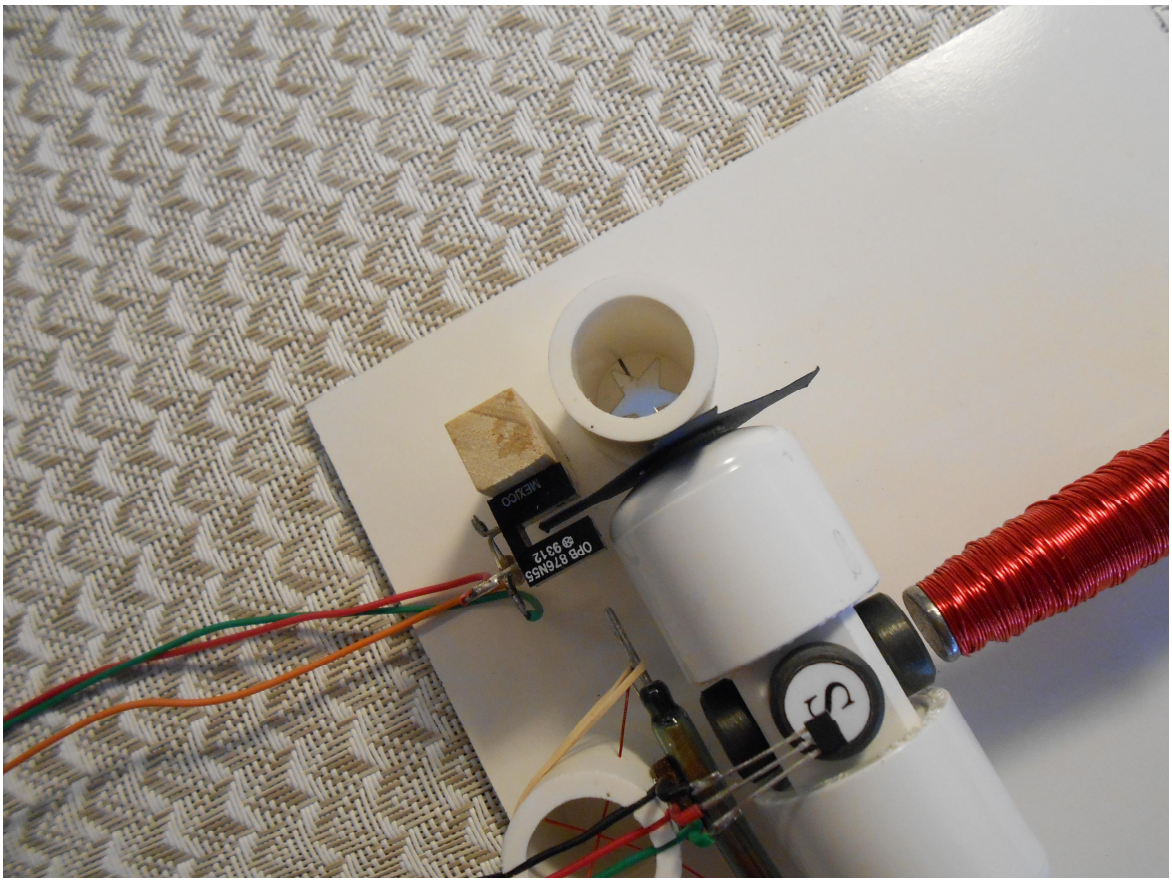
20. Insert the Hall Effect switch into the universal stand as shown below. Note that reed switch and Hall Effect switch will be controlled by different magnets to reduce the interference. Make sure that the leads of the Hall Effect IC do not touch each other and branded side is facing down.



21. Glue the universal stand to the board as shown in the picture below. The Hall Effect switch and reed switch should be located at the closest distance from the magnets. Check the rotation of the rotor to make sure that the magnets do not hit any of the switches.

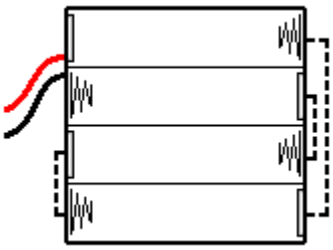


22. Glue the optointerrupter stand to the board as shown in the picture. If you rotate the rotor, the disk blades should be in the middle of the slot as deep as possible without hitting the optointerrupter. You may apply the glue to the board to prevent it from soaking into the stand. Hold the middle part of the rotor and rotate the cap that has the disk attached until one of the blades is inside the slot. You will need to experiment with it later to find the best position of the disk to provide a good start and the best speed.

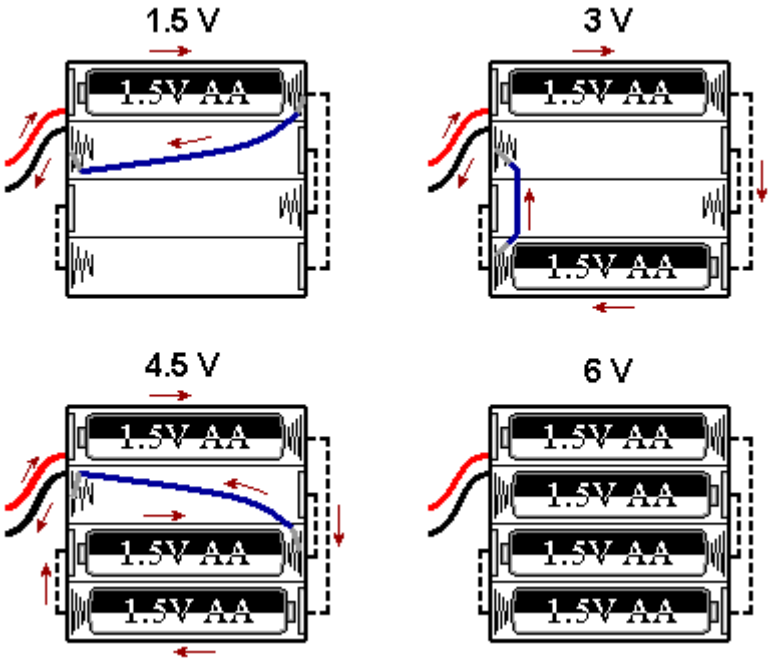


23. Attach the battery holder to the board. The battery holder allows you to experiment with 4 different voltage settings (1.5, 3, 4.5, and 6 V DC). You will need 4 AA size batteries.

    To understand how the jumper wire works let's take a look at the connections inside a typical battery holder:



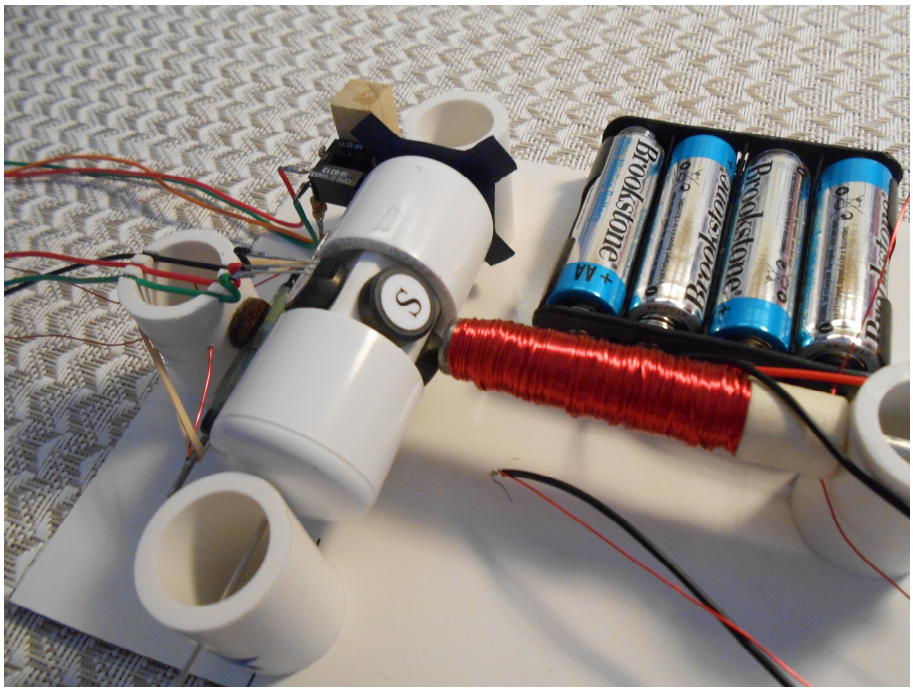
The following diagram shows how to get 1.5, 3, 4.5, and 6 Volts using 1, 2, 3, or 4 batteries and a jumper wire shown in blue color. Arrows show the current flow for 1.5, 3, and 4.5 Volts settings. Could you trace the current when all 4 batteries are inserted (there is no jumper wire in this case)?



Inspect your battery holder – it may have different connections inside. In this case you can still use the jumper wire in the same manner to get all 4 voltages, but you will need to find appropriate connection points for each voltage setting.

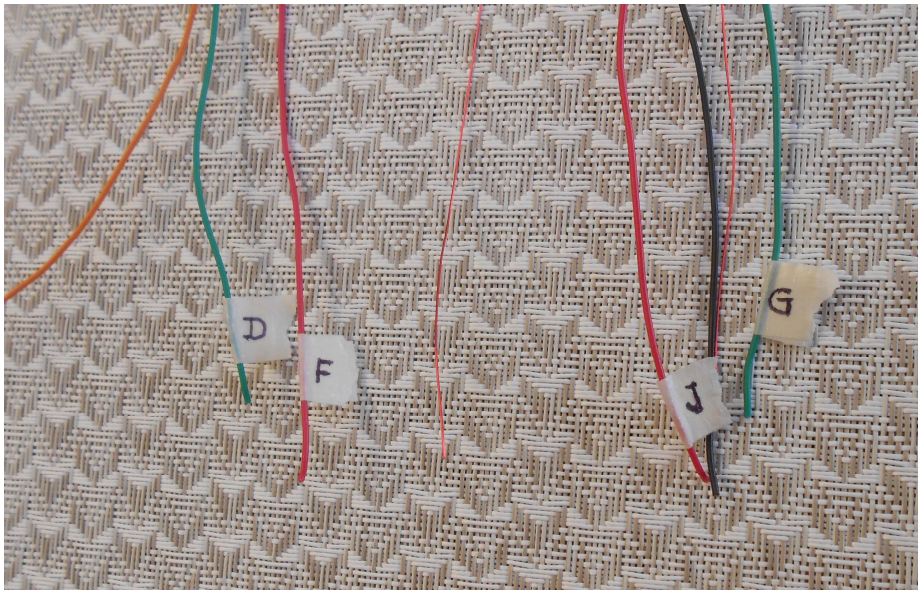
Insert bare ends of the jumper wire between the spring and plastic case to make a good contact and hold them in place. This is how the jumper wire is actually used for 3 Volts experiments:

24. Insert the batteries and briefly connect battery holder wires to the electromagnet. If electromagnet is connected properly it should repel the magnets on the rotor turning it 45° as shown below. If it does not work – switch the wires.

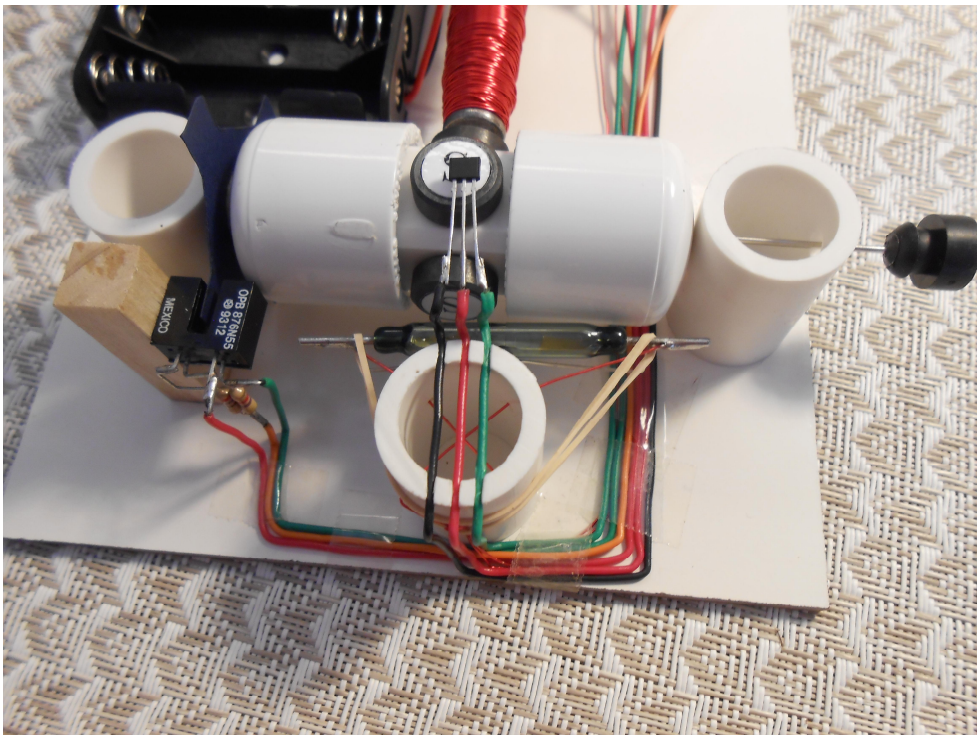


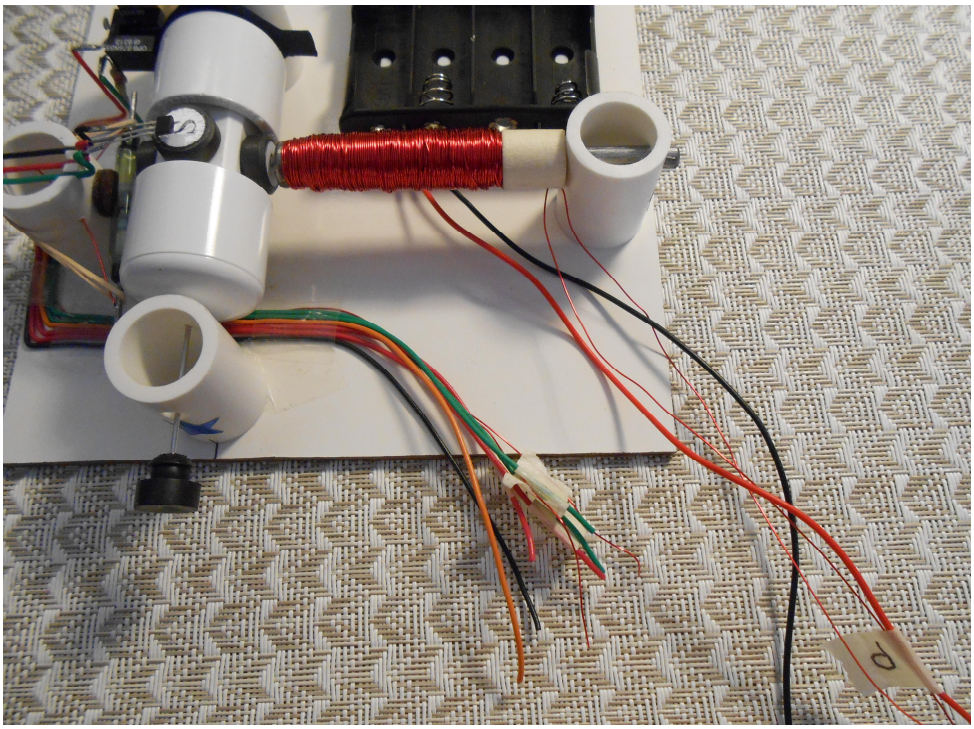
After finding the correct connection, note how the electromagnet wires are connected to the battery holder. The wire that is connected to the positive battery wire holder is marked “U” on the electrical diagram (see Appendix A) and will be connected to terminal “2” of the switch. The electromagnet wire that was connected to negative battery wire is marked “V” and will be connected to terminal “1” of the switch. Do not mix the electromagnet wires or your motor will not work!

25. Mark the wires from the optointerrupter and a Hall Effect switch. It is recommended to mark at least the wires that have the same color. You may use the electrical diagram from the Appendix A to have the same letters – it will simplify their identification later.



26. Arrange and route the wires as shown. You may use a scotch tape to hold them in place.

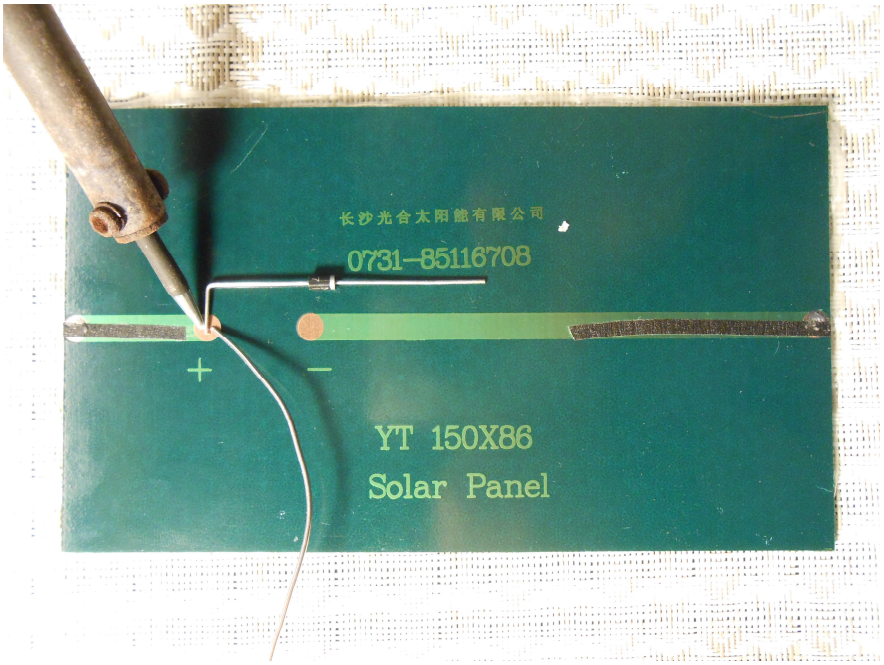


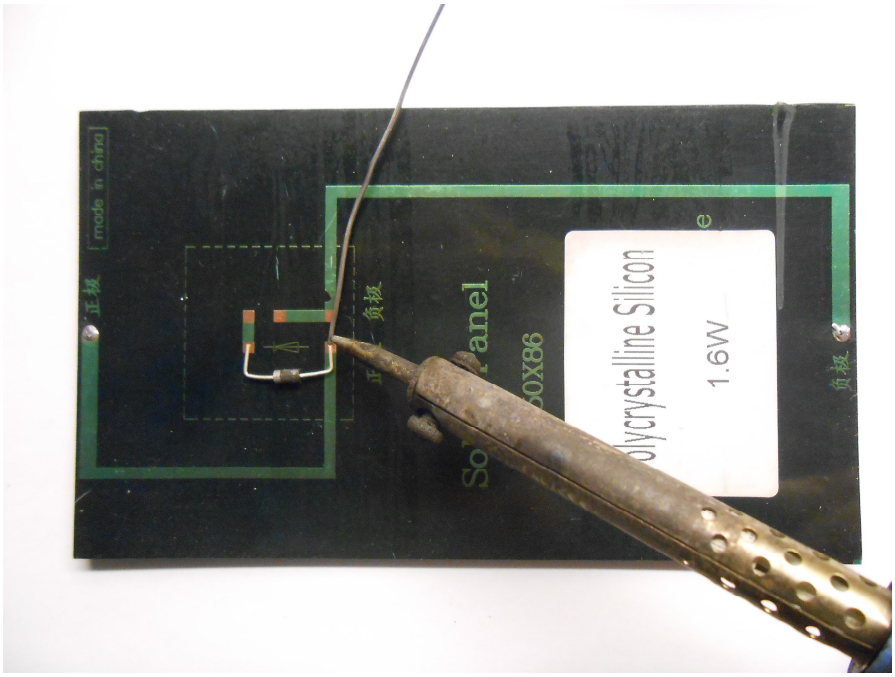


27. Assemble solar power module. Under direct sun all the motors should work without batteries; however the main purpose of the solar panel is recharging the batteries. NiMH (Nickel-Metal Hydride) batteries work great and they are being recharged even when the power switch is off.

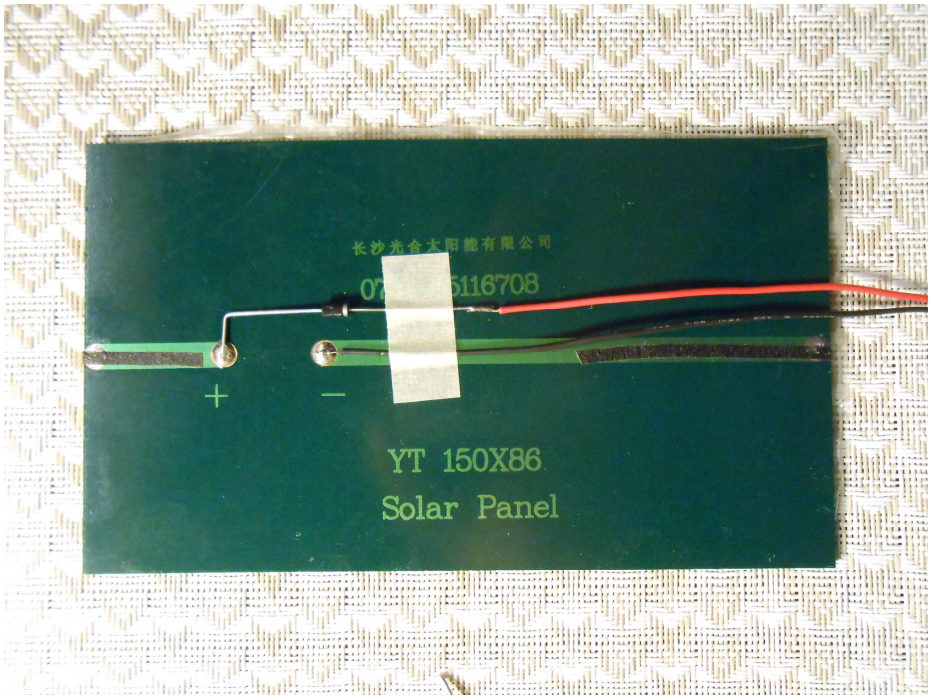
    You may receive one of two slightly different solar panels with identical electrical parameters.

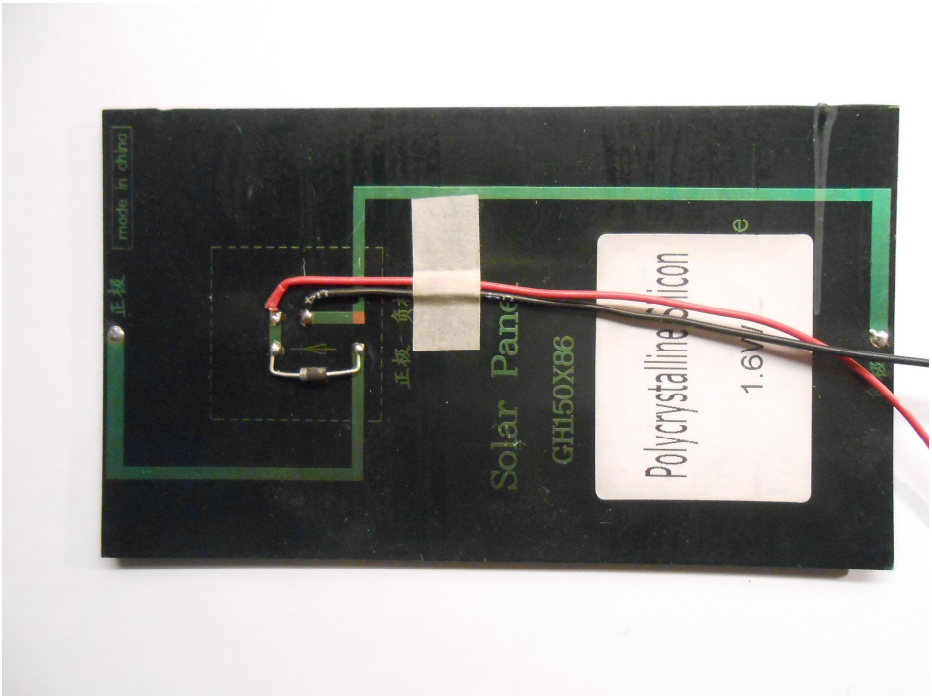
    Solder the Schottky diode to the solar panel. Note the polarity of the diode! Thin silver band depicts the cathode; the other end is anode.



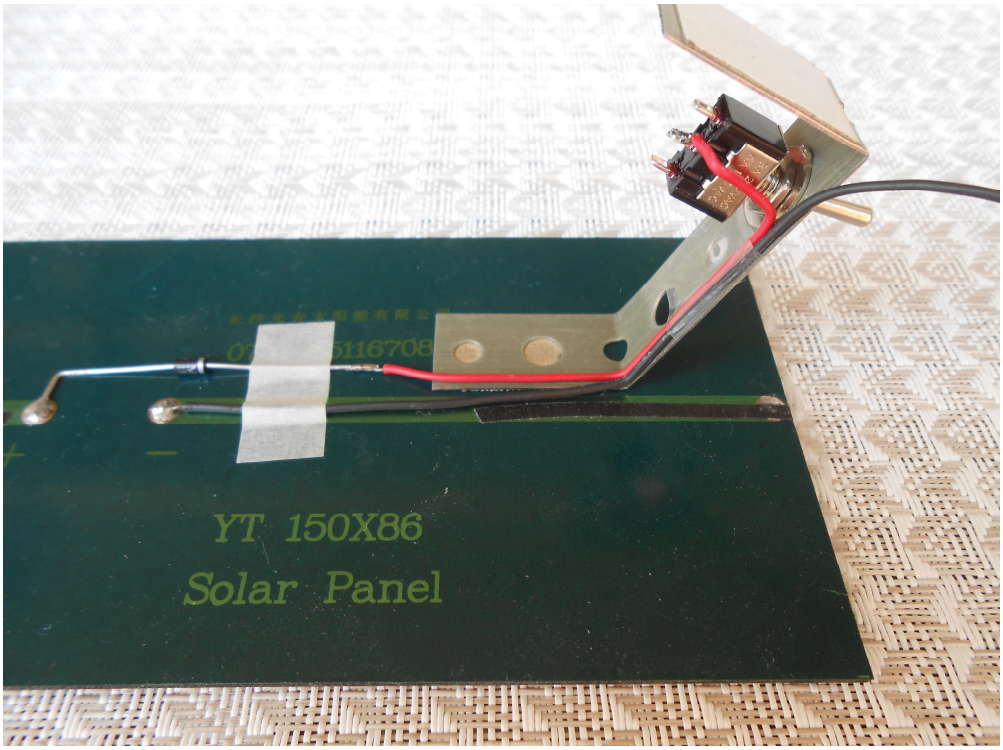


28. Solder the long piece of wire included in your kit (it should be about 13” long and is shown as black on this picture; however color does not matter) to the negative connection point on the solar panel. Solder another piece of wire to the cathode of the Schottky diode. Tape them to the board.

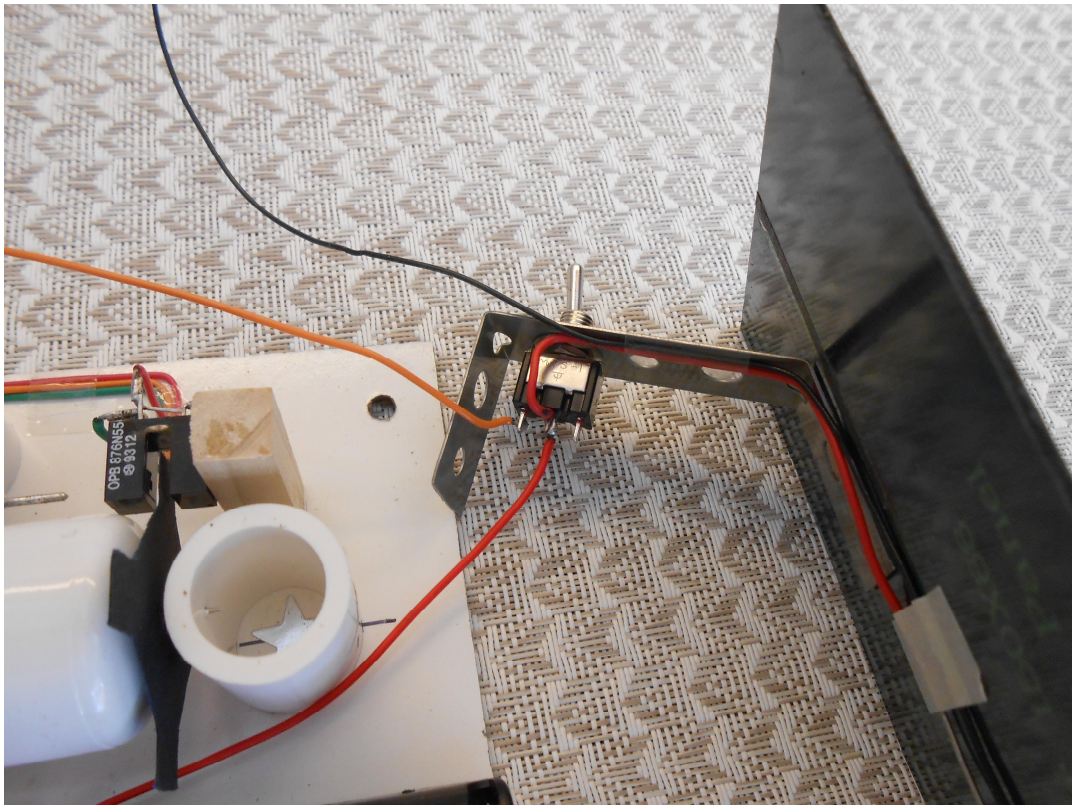




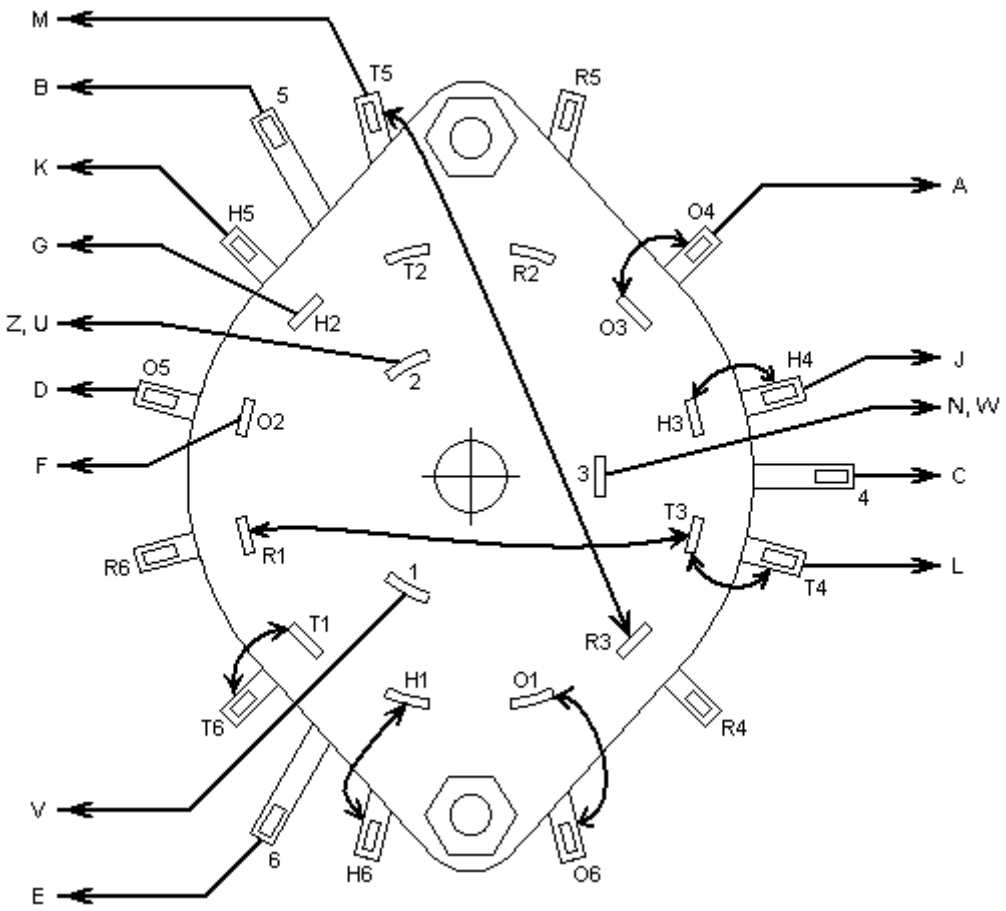
29. Attach the bracket to a solar panel. Assemble the switch on the bracket. Solder the wire from the Schottky diode to the middle point of the switch and tape wires to the bracket.



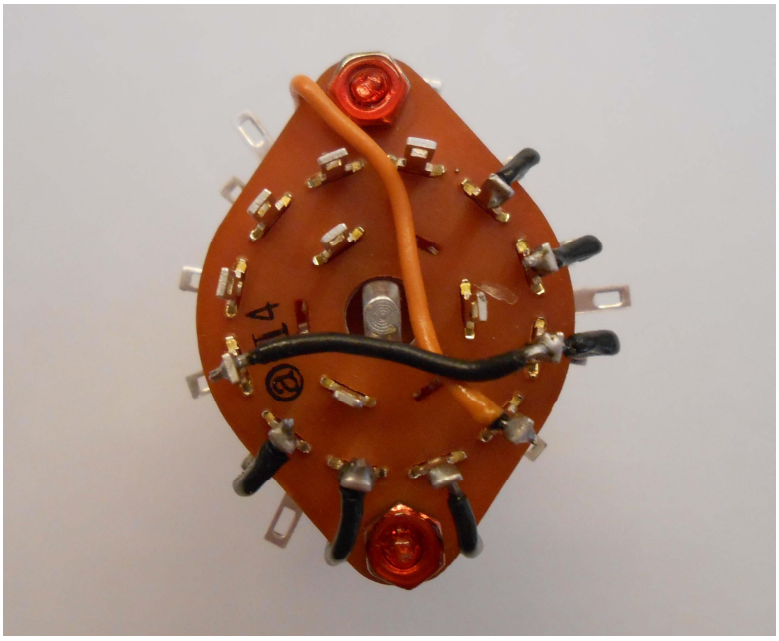
30. Solder positive wire from the battery holder to the middle point of the main switch. Solder another 9” piece of wire to the switch as shown.



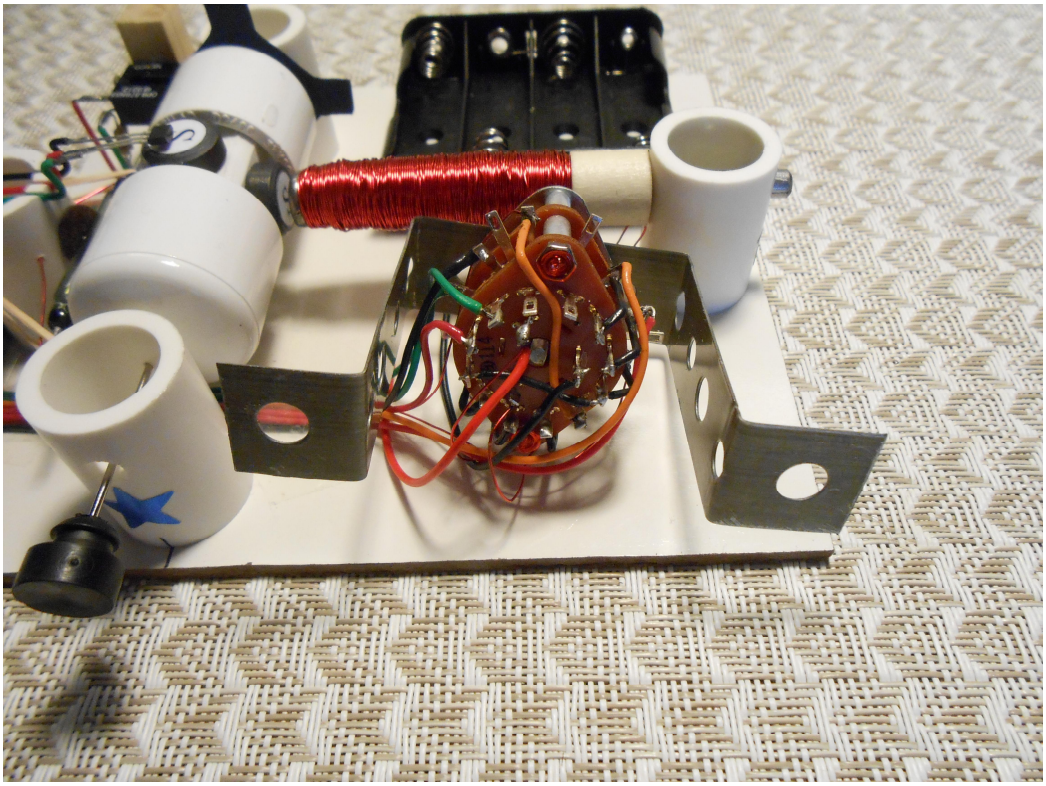
31. The following diagram shows the connection of all the wires to the switch. Note that all the letters are corresponding to the electrical diagram at the end of these instructions (see Appendix A).



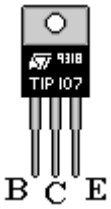
Connect connection points O3-O4, H3-H4, T3-T4, O1-O6, H1-H6, T1-T6, T5-R3 and T3-R1 using pieces of unused wires.



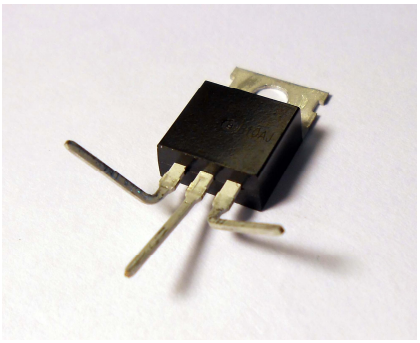
32. Temporarily attach the switch to the bracket and solder all the wires as shown below. Use the diagram from previous step with the electrical diagram from Appendix A.
IT IS EXTREMELY IMPORTANT TO CHECK AND DOUBLE CHECK ALL YOUR CONNECTIIONS! If you connect wrong wires the motors will not work and you may even destroy some electronic parts.



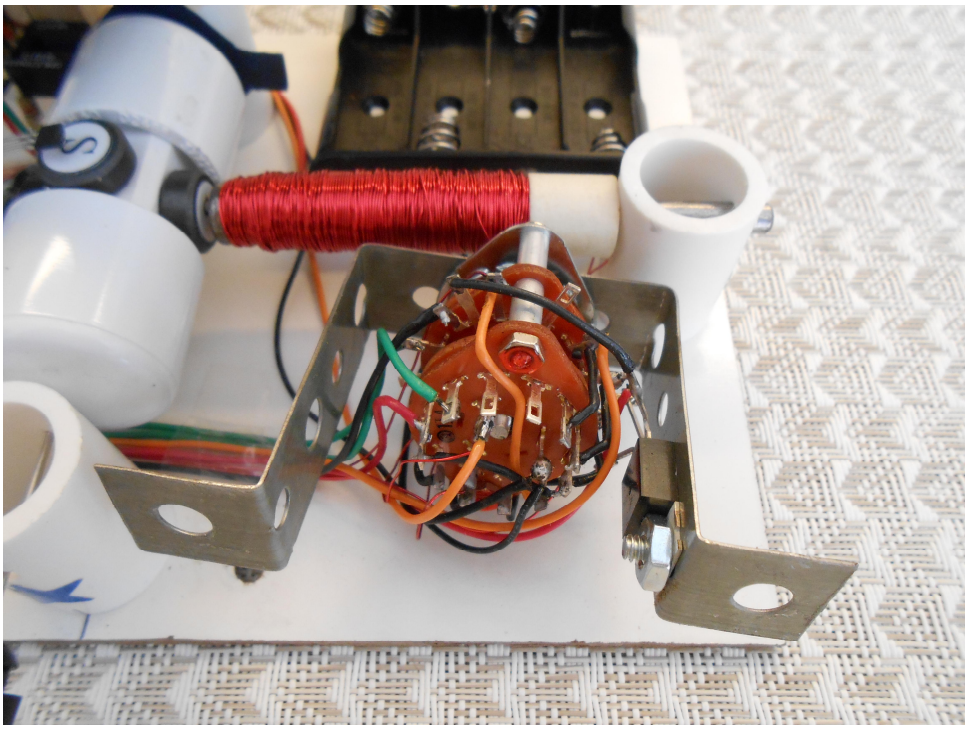
33. Locate the base (B), collector (C) and emitter (E) leads on the transistor:



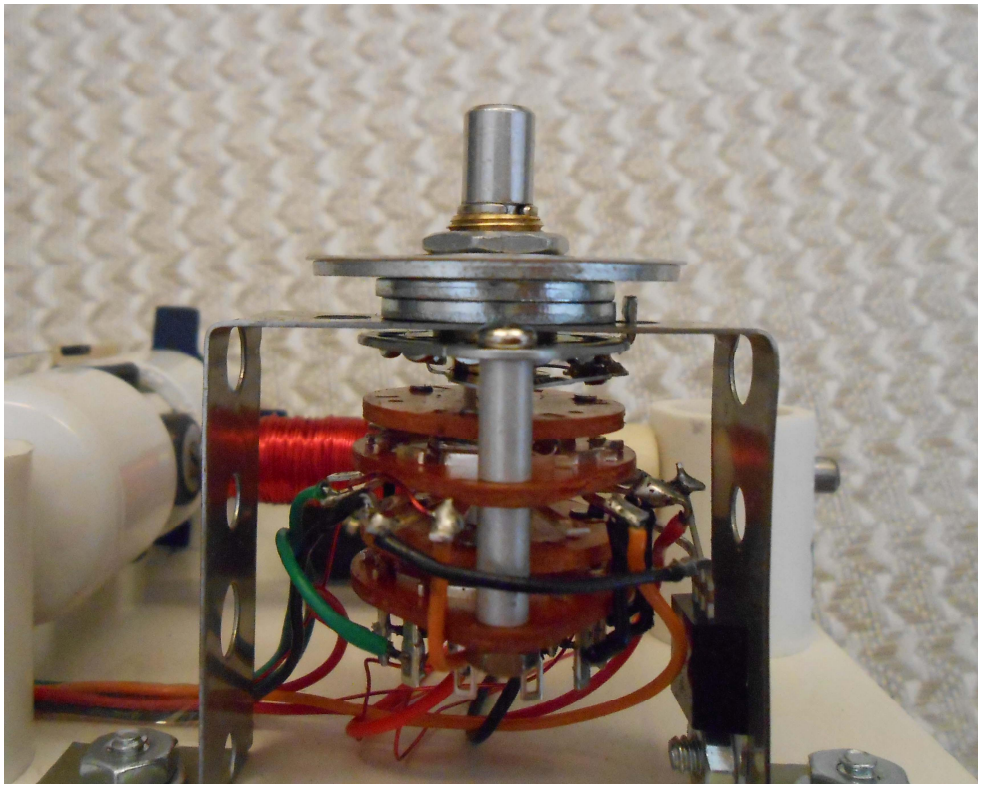
Bend the leads of the transistor as shown:



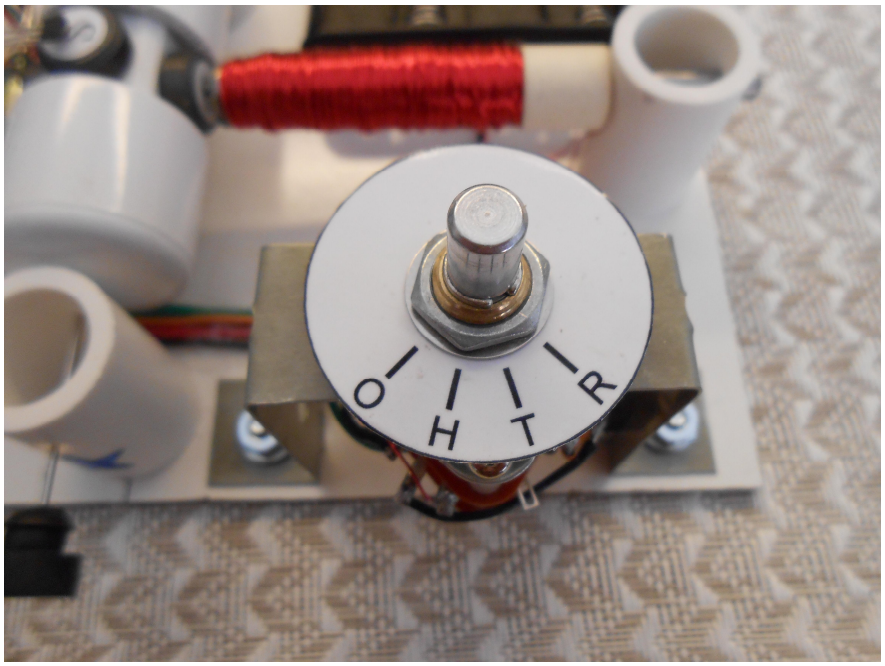
34. Attach the transistor to the bracket and solder it to the switch (collector is soldered directly to the switch; base and emitter are using two wire pieces). Usually the bracket provides enough heat dissipation for voltages up to 12 Volts. Solder the wires from the solar panel.



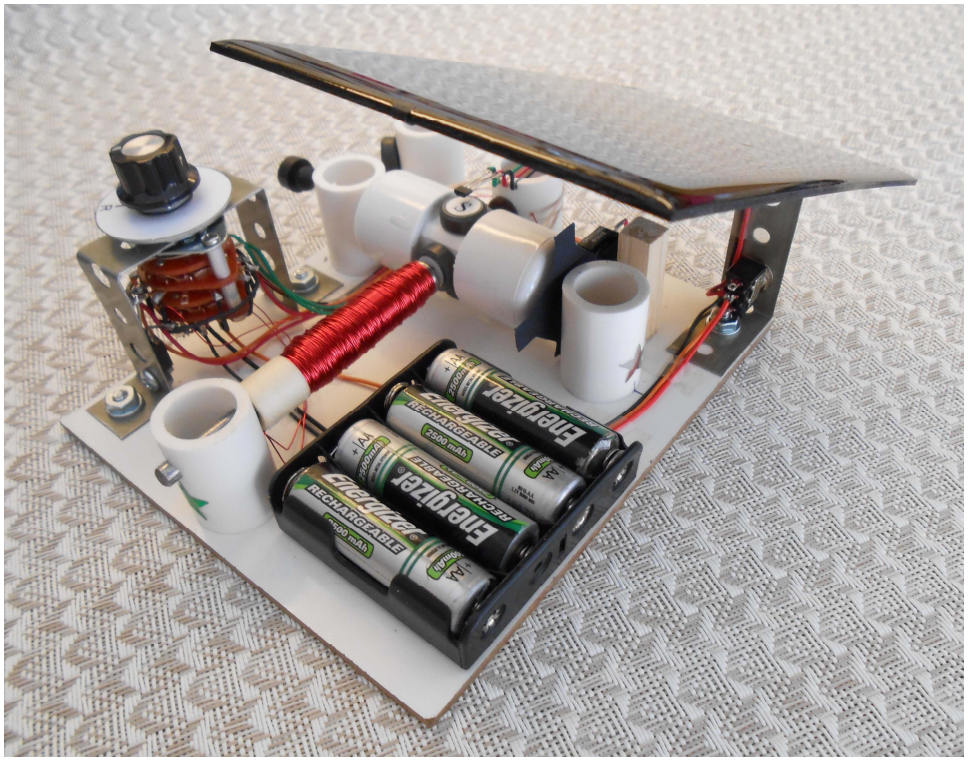
35. Tighten the knob on the switch using a set screw on the side and turn it counterclockwise until the last click, then remove the knob. Now add all the washers and a dial as shown:



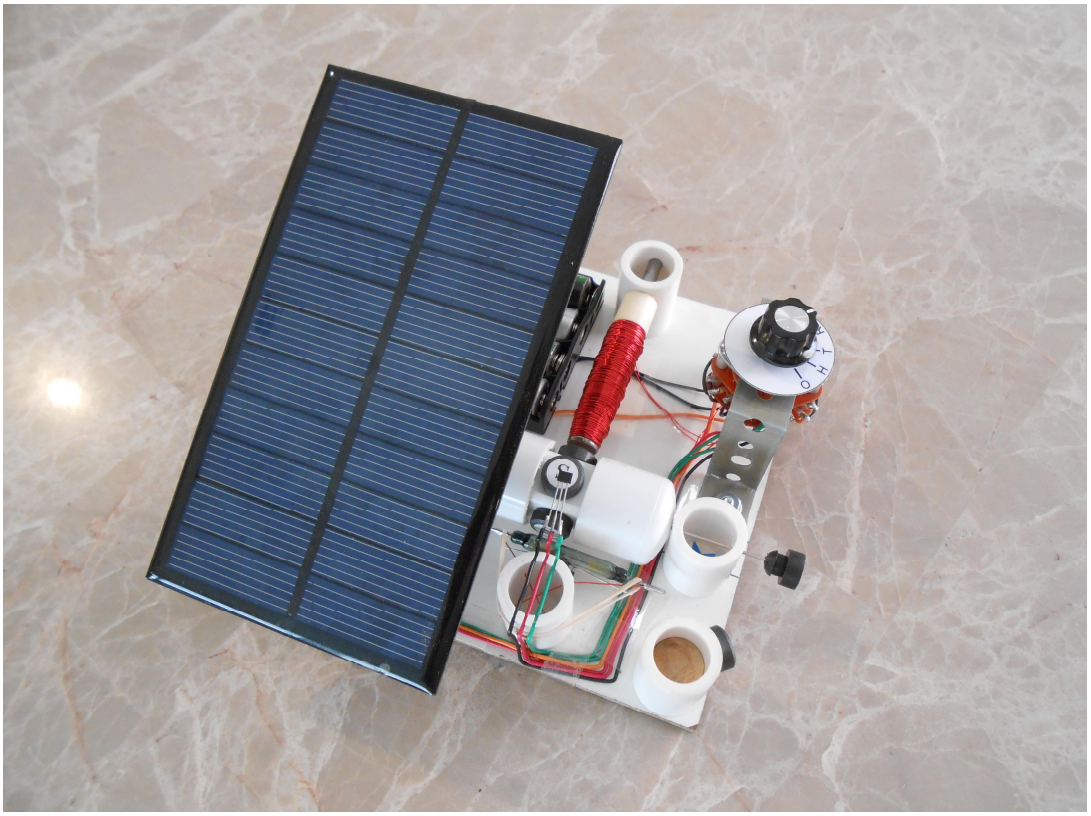
36. Attach the bracket to the board as shown on the previous picture. Before tightening the switch nut align the dial as shown below. After that align the knob with R (standard reed switch motor) and tighten the set screw.



37. Attach solar panel bracket to the board as shown using included hardware:



38. Attach variable speed control unit as shown. See separate instructions for the Experimentation Kit #1 for proper magnet orientation and assembly procedures. Note that speed control works only with reed switch motors.



Your motors are ready to use! Keep in mind that only regular reed switch motor should work on 1.5 Volts (1 battery); all the others require at least 3 Volts.

If your switch does not work check all the wiring. If one of the motors does not work – check corresponding Troubleshooting section of our web site.

Kit #10 includes lots of stuff to experiment with. You need to follow separate instructions for:

Generator – Generator Kit Instructions
Speed control – Assembly Instructions for the Speed Control Kit
Motor speed measurement – Instructions for RPM Measurement Attachment
Color Kit – Instructions on included disk

Please check our web site for other information on all motors built from this kit. “How It Works” and “Your Project” sections contain a lot of useful information.

Good luck with your experiments!

Appendix A. Electrical diagram of the Kit #10 (Kit #9 with solar panel)