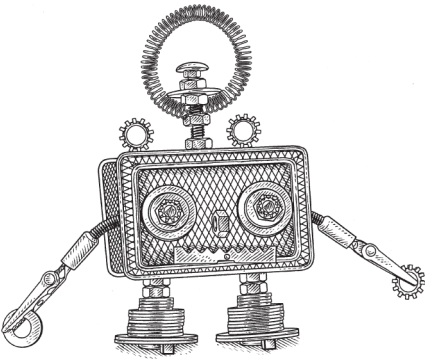


HOMEMADE: THE HEART AND SCIENCE OF HANDCRAFTS  
CAROL ENDLER STERBENZ

## Robert: The Nuts-and-Bolts Robot



Lock washers in two sizes:

2 small,  $\frac{3}{8}$ " (1.0 cm) in diameter (l)

3 medium,  $\frac{5}{8}$ " (1.6 cm) in diameter (m)

Thin wire

Instant glue (cyanoacrylate)

Awl

Pliers

Adjustable wrench

Wire cutters

Marker

Ruler

### SETUP

None

Remember Erector sets? Here's a robot project to engage today's budding mechanical genius. The body is an open-mesh drawer organizer with a magnetic strip on top, and the metallic parts include nuts, bolts, washers, and springs. Follow the exploded diagram to put them all together.

Recommended age: 8+ years

Skill level: Moderate, with some steps to be done by an adult

Supervision: High

Mess factor: Low

### MATERIALS AND TOOLS

Open mesh box,  $3\frac{1}{2}$ "  $\times$   $2\frac{1}{4}$ "  $\times$   $2\frac{1}{2}$ " (8.9  $\times$  5.7  $\times$  6.4 cm) (a)

Wire spring,  $\frac{3}{8}$ " diameter  $\times$   $5\frac{3}{4}$ " long (1.0  $\times$  14.6 cm) (b)

Alligator clip with spring lead (c)

Sawtooth picture hanger,  $1\frac{1}{2}$ " (3.8 cm) long (d)

2 hex tap bolts,  $\frac{1}{4}$ "  $\times$  1" (0.6  $\times$  2.5 cm) (e)

2 connecting bolts,  $\frac{1}{4}$ "  $\times$  2" (0.6  $\times$  5.1 cm) (f)

1 carriage bolt,  $\frac{1}{4}$ "  $\times$  2" (0.6  $\times$  5.1 cm) (g)

14 machine nuts,  $\frac{1}{4}$ " (0.6 cm) diameter (h)

Flat washers in three sizes:

21 small,  $\frac{5}{8}$ " (1.6 cm) in diameter (i)

19 medium, 1" (2.5 cm) in diameter (j)

4 large,  $1\frac{1}{2}$ " (3.8 cm) in diameter (k)

### Step 1

Prepare the mesh box.

Place the mesh box face down on a protected work surface. Use the ruler and marker to mark two dots on the bottom of the box, about  $1\frac{1}{4}$ " (3.2 cm) from each short edge, for the eyes. Mark one dot in the center of one long edge for the neck. Mark two dots on the opposite long edge for the legs. Use an awl to pierce through the mesh at each dot to open up a  $\frac{1}{4}$ " (0.6 cm) hole.

### Step 2

Add the eyes.

Referring to the exploded diagram, thread a small flat washer and a medium flat washer onto a hex tap bolt. Insert the end of the bolt into an eye hole in the mesh box. On the inside of the box, thread a small flat washer and a machine nut onto the bolt. Use pliers or an adjustable wrench to screw the nut tight against the washer. Make and attach a second eye in the same way.

### Step 3

Add the antenna.

Screw a machine nut onto the carriage bolt. Add a medium washer and another machine nut to hold the washer snug. Slip both ends of the coil spring onto the bolt to form a ring. Screw on a nut to hold the spring in place.

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Screw on another nut but leave a  $\frac{1}{2}$ " (1.3 cm) space between it and the nut above. Add a washer and then insert the end of the bolt into the neck hole of the mesh box. On the inside of the box, thread a small flat washer and a machine nut onto the bolt and tighten with pliers or an adjustable wrench.

**Step 4**

Add the legs.

Thread two large flat washers, eight medium flat washers, and four small flat washers onto a connecting bolt. Screw on two machine nuts to hold the washers snug. Thread on a small flat washer. Insert the end of the bolt into a leg hole of the mesh box. On the inside of the box, thread on another small flat washer and a machine nut and tighten with pliers or an adjustable wrench. Make and attach a second leg in the same way.

**Step 5**

Add the arms.

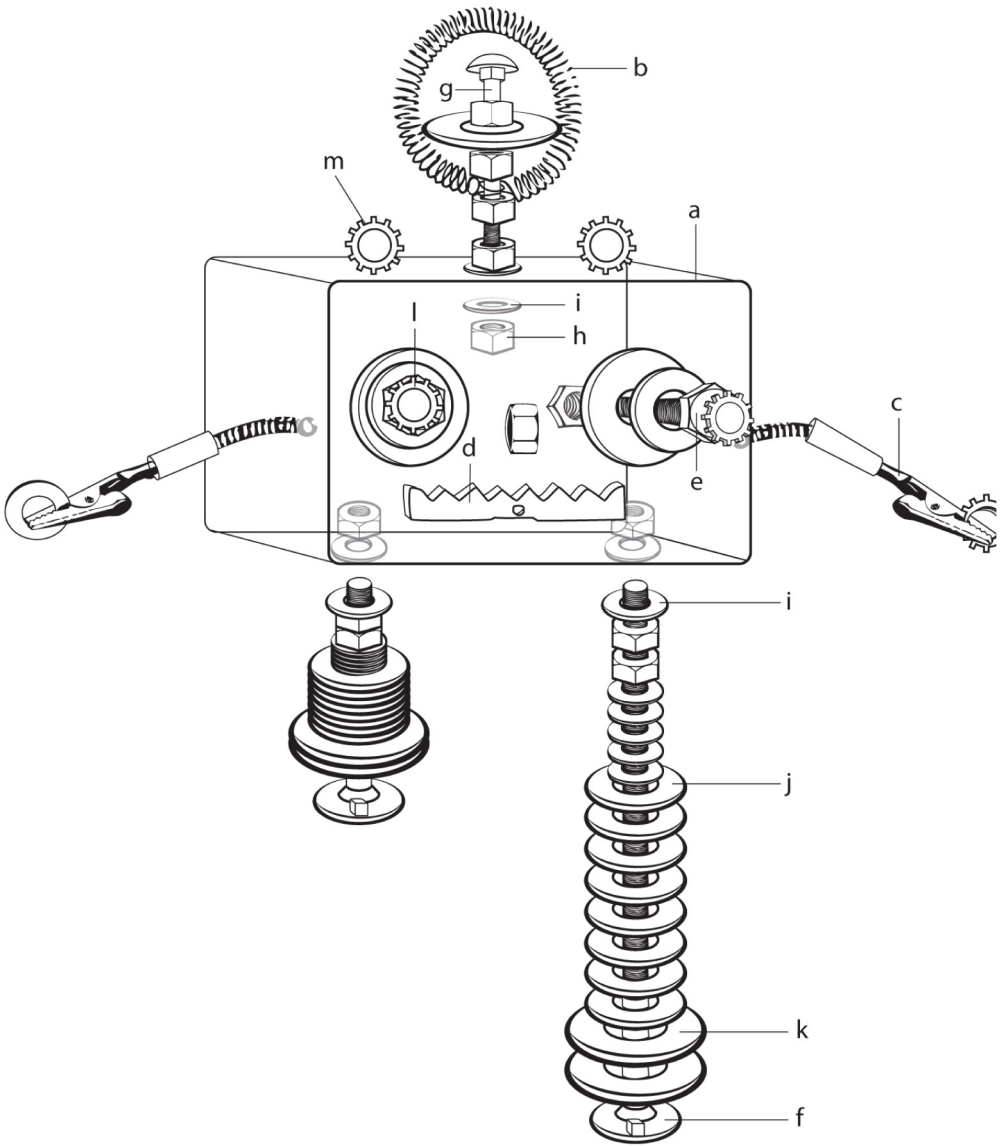
Use a ruler and wire cutters to measure and cut two 4" (10.2 cm) lengths of wire. Slip one wire through the spring end of the alligator clip with spring lead. Pass both wire ends from outside to the inside of one side of the mesh box. On the inside of the box, twist the wire ends together to hold the arm in place. Attach the second arm in the same way.

**Step 6**

Add the details.

Cut four 4" (10.2 cm) lengths of wire. Following the wiring method in step 5, turn a machine nut on its side and wire it to the mesh box between the eyes for a nose. Wire the sawtooth picture hanger below the nose for a mouth. Wire two medium lock washers to the top of the box so that they stand up. Glue a small lock washer to each eye and let dry. Give the robot a flat washer and a lock washer to hold.

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Assembly Diagram

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