

## INSTRUCTIONS TO MAKE HELMHOLTZ COIL

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A **Helmholtz coil** is a device for producing a region of nearly uniform magnetic field. It is named in honour of German physicist Hermann von Helmholtz. A Helmholtz pair consists of two identical circular magnetic coils that are placed symmetrically one on each side of the experimental area along a common axis, and separated by a distance  $h$  equal to the radius  $R$  of the coil. Each coil carries an equal electrical current flowing in the same direction. Setting  $h = R$ , which is what defines a Helmholtz pair, minimizes the nonuniformity of the field at the center of the coils.

from: [http://en.wikipedia.org/wiki/Helmholtz\\_coil](http://en.wikipedia.org/wiki/Helmholtz_coil) (21. 10. 2013)

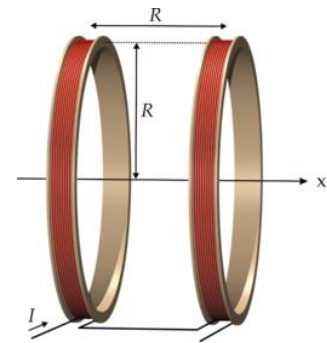


Figure1

We take 1,1 cm wide Oriented strand board (OSB) plate and cut out of it a shape from Figure2. The circular curve on the top of the OSB plate has a radius of 20 cm .

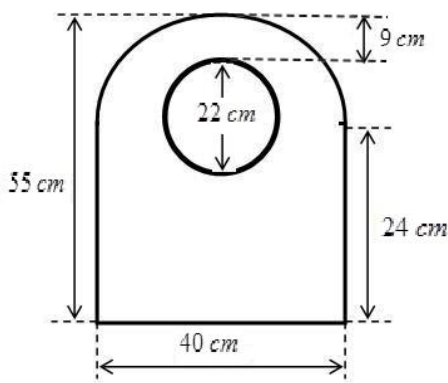


Figure2 (OSB plate)

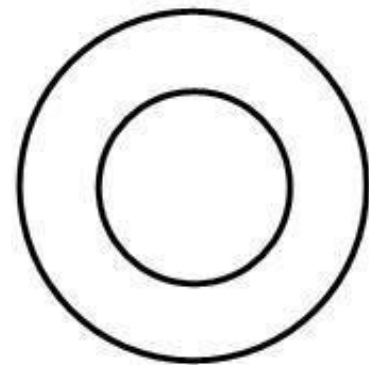


Figure3 (Plywood)

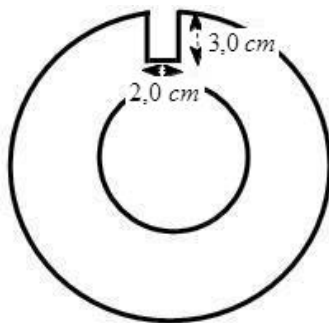


Figure4 (Styrofoam)



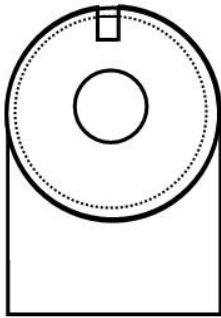
The next round part (which is attached to the board in Figure2) should be 1,0 cm thick Styrofoam. With a cutter we cut out a circular ring (Figure3) with an external radius 18,5 cm; the width of the ring is 7,5 cm .

The last item is 0,4 cm thick Plywood. The external radius of this ring (Figure 4) is, again 20 cm , the width of the ring is 9,0 cm . At the top of this ring we cut out a small rectangle of 2,0 cm  $\times$  3,0 cm , where it will be seen how the loops go around in the shape of a ring.

All the three elements have the same circular hole with the diameter of 22 cm and for all the three elements the duplicates are created.

Bonding: On the first OSB plate we bond the Styrofoam and on it plywood. We use the joiner's glue, spread it thoroughly, squeeze and let the glue dry. Making the coil, no iron parts should be used (eg. iron screws).

The Figure5 and Figure6 show the bonded product (the dotted circle represents the Styrofoam ring). Thus obtained laminated board and Styrofoam in between them, which is (due to the smaller diameter) the groove. Into the groove we roll exactly 20 turns of wire. The Diameter of the wire with insulation is  $2,3\text{ mm}$ ; we need approximately  $60\text{ m}$  of such wire.



**Figure5 (Bonded product-scheme)**



**Figure6 (Bonded product-in real)**

Figure7 shows a wooden plug to attach the wire and below it the hollowed rectangle that shows the progress of the threads of a wire.

For both discs the procedure of reeling the wire is the same: we pierce the OSB plate and pull through at least  $2\text{ m}$  of the wire, the rest of the wire we reel on the resulting disc (in the groove). After exactly 20 loops we wrap the wire on the wooden plug, which is inserted into the top of the OSB plate, as shown in Figure below. We connect both ends of the wire and wrap them together. At the end, we separate the wires again and fit each of them with a jack connector.



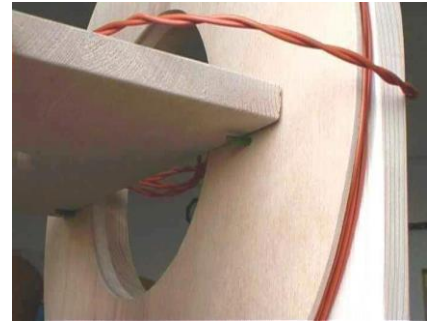
**Figure7 (Wooden plug)**

Figure8 shows how the bearing plate is jammed in the supporting timbers. The Mounting rail has a length of  $35\text{ cm}$ , width of  $4\text{ cm}$  and height of  $5\text{ cm}$ . The inner distance between the discs is precisely  $20,0\text{ cm}$  (equal to the radius of the Helmholtz coil).



**Figure8 (Supporting timbers)**

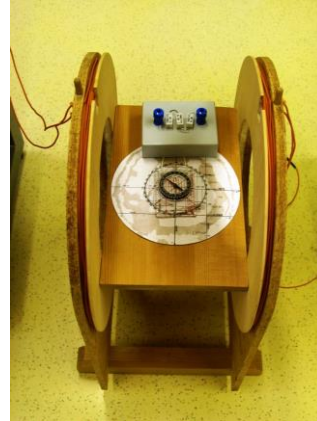
In the center of Helmholtz coil we mount (with 4 wooden plugs) a wooden board (Figure9) which you can glue a protractor and place the compass on, from which we can read the rotation of the magnetic needle in a homogeneous magnetic field inside the coil which we create by changing the current in the coil.



**Figure9 (Wooden board)**



**Figure10 (The final product)**



#### Measurement:

Each coil has two connectors. One connector from each coil is bonded to an Ammeter, the second connector from the first coil is bonded to a resistor ( $30\ \Omega$ ), and the second from the second coil is bonded to a voltage source. From the voltage source, we put another wire to a resistor and so the electric circle is closed. When the electric current is flowing through the Helmholtz coil by moving the compass upon the wooden board inside the coil you can observe that the magnetic field is relatively homogeneous, not only in the middle of the coil. When the compass is not showing a homogeneous field, this means that you have probably connected the coil in a wrong way. In that case you have to swap the connectors of one coil. It is important to have a well-designed compass tip to make a clear deviation. It is applicable to use a magnifying glass to be more precise at reading.

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