Loudspeaker from Available Tools

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People's curiosity leads to new experiences, which are the basis for the formation of new knowledge. The tendency to understand how technology works has led us to the question, "*How to arouse pupils' curiosity*?" A loudspeaker is the device that mediates the conversion of electrical energy into mechanical energy. This transformation is happening in mobile phones, computers and other devices that we use on a daily basis. Although pupils have no problem using technology, they rarely think about the principle of its operation. The production of a loudspeaker is one of the possibilities that could arouse pupils' interest in exploring how devices work.

The paper includes description and photo documentation of the loudspeaker production from commonly available tools. We also propose several options for including loudspeaker design into physics instruction. One of the alternatives is the production of individual parts of the loudspeaker during the teaching of *electricity and magnetism*, when pupils gradually produce individual components, get acquainted with their properties, functions and in the end connect the components into the final device. The production of a loudspeaker offers the opportunity to improve practical and technical skills and gain new knowledge. Pupils can optimize the loudspeaker they produced and explore which parameter most affects its volume.

The Production Process

For the loudspeaker production following items are needed: a cardboard cut-out, a syringe, neodymium magnets, a varnished copper wire, a solid magnetic wire, pliers, an adhesive tape, hot glue gun, and an audio cable with soldered crocodile clips (Fig. 1)

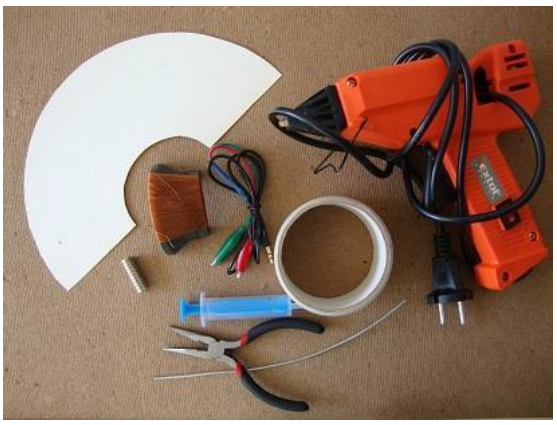

Figure 1 – The tools

The basis of speaker production is the construction of the main components: loudspeaker cabinet (cabinet), diaphragm, and coil.

The cabinet

Loudspeaker cabinet and its properties affect speaker volume. The cabinet can be made of various materials. Cardboard is a good and cheap alternative because it ensures its strength. Cut out the surface of a truncated cone from the cardboard (Fig. 1) and glue its sharp edges with a hot glue gun so that the bases have the largest possible area.

The diaphragm

Place the speaker diaphragm on the smaller of the cabinet bases (Fig. 2). Use adhesive tape for its production and stick the adhesive tape in two layers (crosswise). When producing the diaphragm, attention must be paid to ensure that the adhesive tape is tensed and firmly adhered to the speaker cabinet which ensures the strength and flexibility of the diaphragm.

Figure 2 – The diaphragm

The coil

The most time-consuming task in the production of a loudspeaker is to wind up a coil. For the production we use varnished copper wire (e.g. with a diameter of 0.2 mm) and a syringe adjusted to the required shape. It is important to keep in mind that we will need to attach the syringe to the speaker diaphragm. We cut a cylinder about 3 cm high from the syringe and then use about 1 cm to make legs (Fig. 3), with which we attach the syringe with the wound wire to the speaker diaphragm.

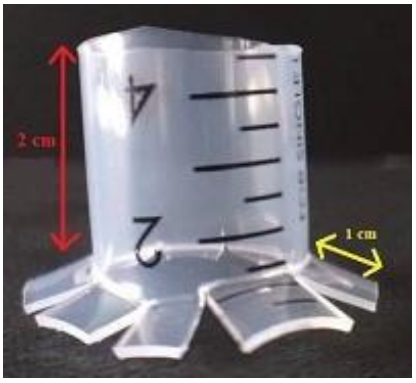

Figure 3 – The adjusted syringe

If we have the cylinder ready, we will proceed to the coil winding. As we will connect the audio cable to the coil using crocodile clips, we keep at least 10 cm of wire and after that we create the first turn of the coil. For easier winding, we can stick the first turn to the syringe with an adhesive tape. The finished coil has a syringe diameter, a height of at least 2 cm, and a number of turns of about 500. After the coil is wound, leave at least 10 cm of loose wire again and remove the isolation from the ends of the winding (with the use of scissors or a knife, scrape the wire varnish about 2 cm from the end).

Figure 4 – The coil glued to the diaphragm

If we have parts of the loudspeaker prepared, the constructed components will be joined into one unit. We place the produced coil on the cabinet diaphragm. The attention must be paid to ensure that the syringe feet touch the diaphragm as much as possible. The reason for that is to optimize the transmission of coil oscillations on the magnetic core to the loudspeaker diaphragm. We glue the coil to the diaphragm by a hot glue gun (Fig. 4). We do not use too much glue so that the diaphragm keeps its necessary properties to ensure efficient transmission of oscillations.

To place neodymium magnets into the coil cavity, a metal structure is used. This structure is made of metal wire, which we adjust to the shape as shown in Figure 5.

Figure 5 – Metal structure for insertion of neodymium magnets into the coil cavity

We bend the wire with pliers so that the magnets hold firmly on the metal structure. We also need to ensure that the arms of the structure copy the shape of the cabinet and do not deform it.

After that we attach the neodymium magnets to the finished structure, and glue this last part of the loudspeaker prepared in this way to the outside of the cabinet with a hot glue gun. When placing the metal structure, attention must be paid to ensure that the magnets are as much as possible in the coil cavity and also that the structure does not prevent the coil from oscillating. At least 2 mm of oscillation space must be left between the structure and the coil (Fig. 6).

Figure 6 – Placement of the metal structure

By joining components together, we create our own functional loudspeaker. We need an audio-video cable with a jack connector and soldered crocodile clips to connect the loudspeaker to a phone or a computer (Fig. 7).

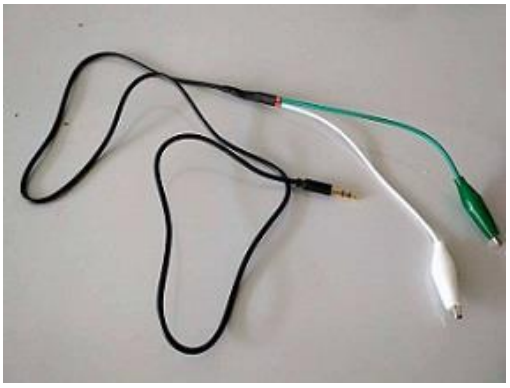

Figure 7 – An audio-video cable with a jack connector and soldered crocodile clips

We know from experience that the loudspeaker does not have a high volume, so to test it, it is appropriate to set the highest volume on the device. The functionality of the loudspeaker is surprising to pupils. They do not expect that they would create a functional loudspeaker (Fig. 8).

Possibilities of Inclusion into the Teaching Process

Production of the loudspeaker with pre-prepared cut syringes and a finished audio-video

cable, the detailed production of which can be found on the Physics Drawer [1] page, is not a time-consuming task. Pupils are able to create the loudspeaker in one class hour, as the production of individual parts of the loudspeaker does not dependent on each other.

Figure 8 – Finished loudspeaker

We can divide the production of the loudspeaker into partial steps over a longer period of time. In the teaching of *electricity and magnetism*, we can observe the magnetic field of a produced coil, and we can demonstrate that the coil through which an electric current flows behaves like a magnet. We present the proposed activities in more detail in the work *Electroacoustic transducers* [2]. Older pupils have the opportunity to explore the characteristics of the produced coil, such as its inductance.

During the mutual movement of the magnet and the coil, we can demonstrate the formation of induced voltage, the course of which we can show to pupils using an oscilloscope, and thus bring pupils closer to the phenomenon of electromagnetic induction, which is one of the principles of loudspeaker operation. In this way, we can show pupils that the knowledge gained in physics lessons can be used in practice.

The production of a loudspeaker is also a suitable topic to explore the parameters that most affect its final volume. Pupils can examine which parameter has the greatest influence on the volume change. Whether it is the number of the coil turns, or the number of neodymium magnets in the coil cavity, or the shape and size of the diaphragm or cabinet.

References

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