Past time project: How to build a telegraph set

(Telegraph construction as a technical school project)

Wolfgang Palme, DL8ABH (wolfpalme@gmx.de)

1. Introduction

As a technology teacher at a German school and a licensed radio amateur with a special affinity for Morse telegraphy, I have always tried to include aspects of amateur radio, especially telegraphy, in my lessons. Hardly any of the young people today have more precise ideas about the term "Morse" or "telegraphy". Where better to teach it them than at school?

So I decided to confront my students, pampered by mobile phones and unlimited data flow, with some aspects of communication technology of bygone times

(Photo 1: „Old“ and „New“ Telegraph Set (by DL8ABH)

and thus to expand their horizon of experience by building such an "outdated" Morse apparatus . Each pupil should plan and build a Morse key and a sounder (knocker) and would be able to do so after a phase of joint preliminary considerations, in which they could comprehend the electromagnetic principle of the transmission of messages from past times. Woodworking with simple tools was in the foreground. And, of course, they would be confronted with the Morse code during trying out their telegraph, too.

The project was carried out with 2 hours per week in the school year 2017/18 with pupils from a 9th secondary school class as part of the technical lessons.

2. Building projects in the literature

Some recent suggestions for the construction of a telegraph can still be found today in experimental books for children and young people. They do not meet our requirements because they are much too simplified and do not function properly. On the other hand, there are numerous suggestions for the reproduction of lifelike replicas on the websites and in the editions of the Morse Associations (such as Fists, AGCW), which - mostly written by radio amateurs - are far too demanding for the school.

3. Construction of the telegraph system

Jointly defined "guidelines" for the basic structure and function of the devices at the beginning should show the pupils the way. Creativity applied to design and resulted in creative differences of the products . The basic material for both devices should be wood. The dimensions mentioned here for the wooden parts, the screws and nuts, wire thickness of the coils etc. are not mandatory for a replica. But they are tried and tested and guarantee a satisfactory function.

3.1 Design description of the Morse key

(Photo 2: The photo shows a neatly made copy of a wood morse key (by DL8ABH)

The construction or reproduction of a key is unproblematic as documented in detail by the photos. Attention when drilling the holes through the lever arm and the base plate! Make sure that they ar

exactly opposite each other after they have been mounted. It is best to temporarily fix them in the correct position and drill the holes for the telegraph contact, the spring holder and the stroke adjustment in a single operation on a pillar drilling machine. All holes are centered to the longitudinal direction of the base plate and key lever. The holes for the spiral spring holder are smaller because of the thinner Spax countersunk head screws. Two short pieces of wire lead from the two key connections to the telegraph contact screw on the lever and to the mating contact under the base plate.

Photo 3: **key dimensions** (by DL8ABH)

Required material/ remarks for the key

- 1 pine base plate 180 x 90 x 18 mm
- 1 piece pine rail (rectangular or square rail 13 x 13 mm or similar)

o 170 mm long, for making the key lever

- 1 spiral spring (made of ballpoint pen)
- 2 wooden strip pieces 1o x 20 mm, each approx. 40 mm for the lateral bearing jaws
- 10 flat head screws / cylinder screws with slot M4 x 40 mm
- 10 matching hexagon nuts and washers for telegraph contact, adjustment of stroke height, for 2 electrical connection points (steel or brass)
- 1 Spax countersunk head M2 x 25 Phillips screws as lower position of the spiral spring
- 1 Spax countersunk head M2 x 20 Phillips screws piral spring holder top
- 4 felt or rubber feet
- 1 key button (wooden button for drawers or similar)
- Bell wire for wiring (approx. 50 cm)

3.2 The construction of the sounder (knocker)

Structure and Function

Photo 4: Historic Sounder (by DL8ABH)

He photo shows the typical structure of a historical sounder. It essentially consists of a horseshoe shaped electromagnet mounted on a base plate. The coils are wound with enamelled copper wire

(insulation) and enclosed in rubber cylinders. The lever arm is held almost horizontally (top position) by a U-shaped brass bow with axle and by a steel spring which tension is adjustable. An armature made of soft iron is attached to it at right angles to its length, directly above the poles of the electro-magnet. When current flows through the coils, it is pulled down and produces a sharp click when the adjusting screw hits the metal surface below it. When the power is interrupted, the spring returns the lever to its original position and another „clack“ occurs when the lever hits a screw in the frame. For a clear loud click a current of at least 250 mA is required. With some practice it is possible to hear the difference between the "click" and the "clack", where the time span between both defines whether a "dit" or a "dah" is sent. This explains the operator's ability to recognize the Morse melody.

List of material / remarks for the sounder

- 1 base plate (pine) 180 x 90 x 18 mm

- 1 threaded rod brass M4, required length approx. 2 x 30 mm (stroke adjustment), 1 x 45 mm (lever arm axis),

- 4 brass cap nuts M4

- (or 3 slotted pan head screws M4 x 24 with matching washers

- and 6 nuts made of

- 1 tension spring/ spiral spring made of ballpoint pen

- 5 wood screws M 2 or M3 x 20, (raised countersunk head, brass)

- 1 to 2 brass wood screws M2 x 8

- 1 piece square or rectangular strip (pine) with width 13 mm or 13 x 13 mm for:

o 1 lever arm, approx. 150 mm length

o 2 x 40 mm long pieces as spacers for the lateral bearing jaws

- 1 piece rectangular strip 10 x 15 mm or similar for the production of the two lateral bearing jaws (height approx. 55 mm)

- 4 felt or rubber feet

- joiner's glue

For the construction of an electromagnet that is as powerful as possible it is necessary:

- 2 hexagon head screws M8 x 60-65 with 2 hexagon head screws M8 and 4 washers with large outside diameter (ferromagnetic material: iron, steel!)

- 2 strong sheet metal strips / bars made of iron, approx. at least 2 mm thick, 20 x 65 mm

- Copper enamelled wire, details of the wire diameter are in the literature something

contradictory: 22 to 30 gauge (approx. 0.64 to o.26 mm) or approx. 1/64 inch (approx. 0.4 mm)

Elsewhere simple bell wire is recommended. We had a large roll of enamelled copper wire.

with diameter 1 mm! It also worked.

- 2 screws with nuts and washers as connection contacts /

- Banana sockets if available

- several meters of capillary (bell wire)

The construction of the sounder

Here is the wooden model of a more valuable specimen by using brass screws

Our replica requires the consideration of some technical necessities during the construction. This applies especially to the manufacture of a strong electromagnet. Generally speaking, the higher the current and the greater the number of turns, the stronger the electromagnet will be. To make a horseshoe-shaped magnet we put 2 iron or steel screws countersunk from below through the two precisely positioned holes in the base plate and then insert the pre-drilled iron bolt and the two large iron washers from above. A layer of insulating tape wrapped round the screws protects the enamelled copper wire from damage by the thread. The two remaining washers are then inserted from above and the two nuts loosely screwed on, so that two "winding roughs" of approximately the same height result for the coils. Each coils is accurately wound with at least one hundred, better two hundred turns of insulated copper wire, both should have the same number of turns. The inner coil ends are then soldered together.

Position of the magnetic poles of an electromagnet as a function of the current direction

Figure 2 A/ B (Source: DL8ABH)

Figure A shows the two coils with the same winding direction, the winding start at the bottom coming out of the inside of the coil, and the coil end at the top and outside. After applying a voltage with identical polarity, we achive polarity oft he Magnetic field like shown.

We need a powerful electromagnet with a magnetic north and south pole at the (upper) horseshoe ends! What does the optimal wiring look like? We achieve this by reversing the polarity of the second coil: We connect the two bottom ends of both coils with each other. (see figure B)

Both coils are finally welded in with suitable adhesive shrink tubing. The screws are tightened more strongly and adjusted to the exact height without crushing or damaging the two coils. The lever arm should be adjusted in such a way that the cross bar does not touch the magnetic poles (machine screws) when attracted, otherwise it will become magnetized and get stuck. If necessary the screws may be filed down a bit. The sounder should function properly if the adjusting screws and the spring tension (possibly shortening or lengthening the coil spring) are carefully adjusted.

4. post-consideration

In this project the pupils were to plan and build a simple but basically functioning telegraph system, and to create a "beautiful" product, which would show some "valuable" features in construction. In order to solve this problem, the students had to deal with telegraph literature, historical pictures, descriptions etc. And by trying out their devices, they got a good and lasting idea of telegraphy and morse code.

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