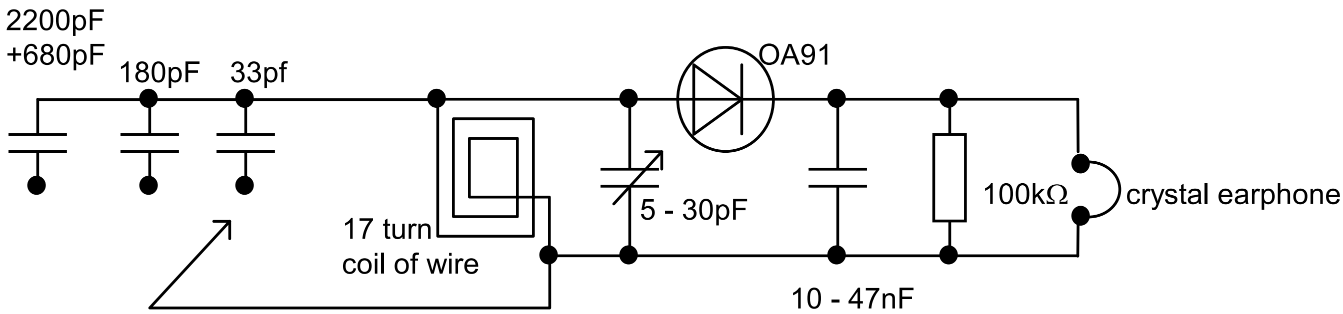
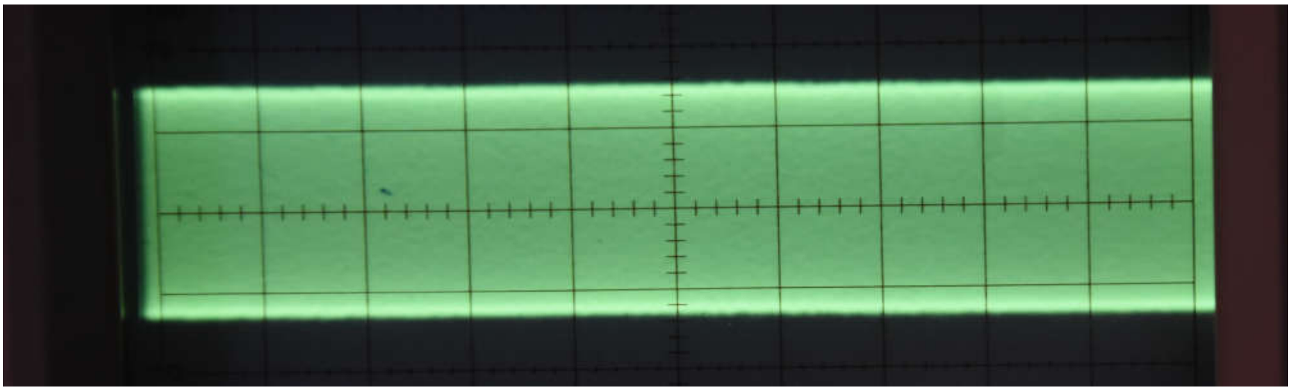
Cornflake Packet Radio Project.
Medium Wave Crystal Set

Specification
Does not need a power supply.
Provides reception on the Medium and Long wave band.
Receives sufficient energy to power a sensitive crystal earpiece.
Can be used with an external amplifier - i.e. computer speakers.
Uses a loop coil to receive the magnetic field component of the radio waves.

Circuit Diagram

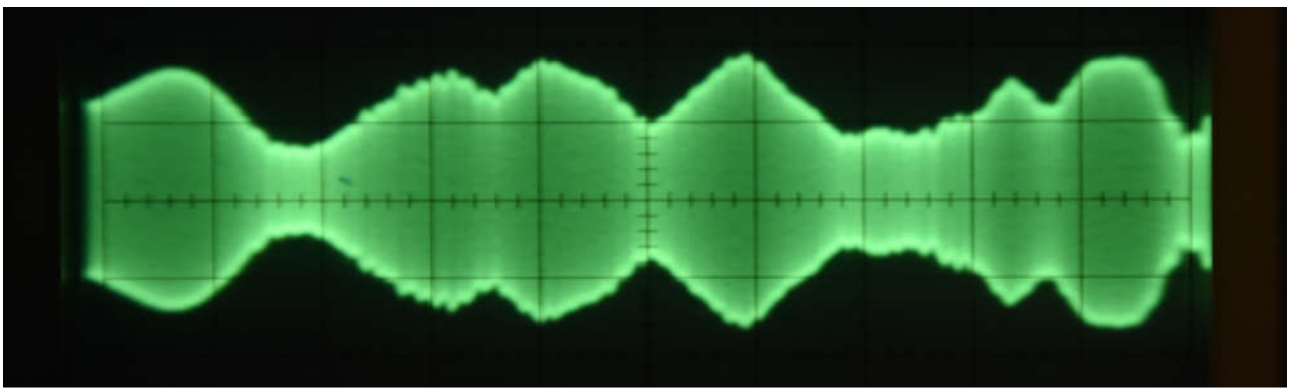


How it works
On the medium and long wave bands, the radio station sends out a 'carrier wave' signal at a certain frequency, e.g. Radio 4 has a carrier frequency of 198kHz.



Oscilloscope picture of the R4 carrier wave from the Cornflake crystal set.
The time base is 2ms/div and the Y sensitivity is 0.5V/div.

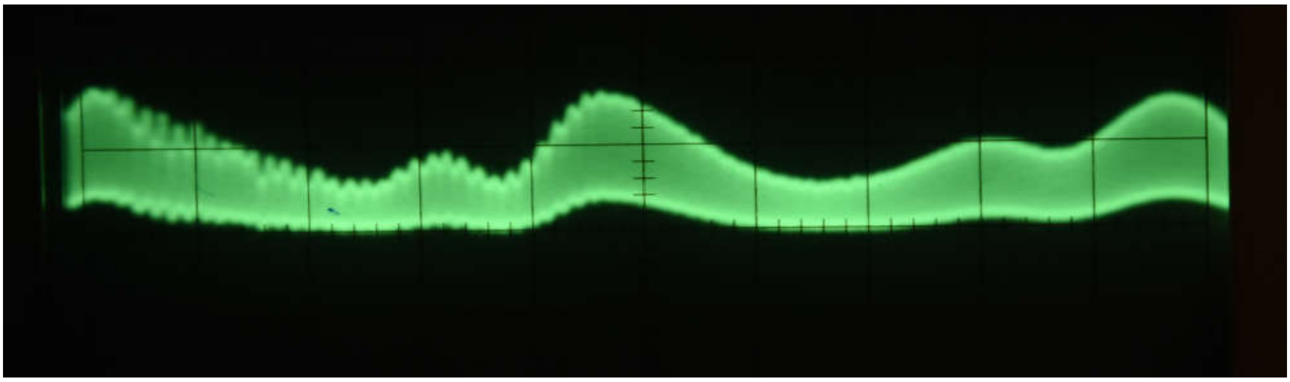
To transmit information (speech, music) the amplitude of the carrier wave is varied (modulated)



The time base is 2ms/div and the Y sensitivity is 0.5V/div.

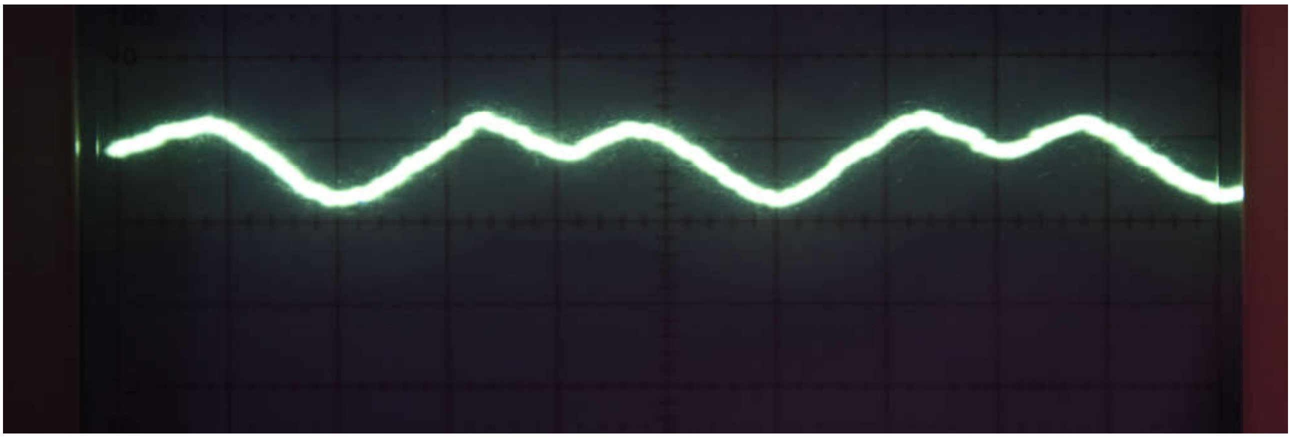
The purpose of the radio receiver is to receive the carrier wave and extract the information from the variations in the amplitude of the carrier.
A 'crystal set' is the simplest of all radio receivers and produces a usable output when tuned to a strong radio station signal. When radio waves pass through the coil of wire, the magnetic field of the radio wave causes small voltages to be produced in the coil. The capacitor in parallel with the coil form a tuned circuit, which absorb all of these small voltages except for those at the same frequency as the tuned circuit. The voltage across the coil will look like the picture above.

In order for speech and music to be extracted from the radio signal, the voltage is passed to the diode, which only allows the positive part of the signal to go through.



The time base is 2ms/div and the Y sensitivity is 0.5V/div.

The 10 - 47nF capacitor and 100kΩ resistor then removes the radio frequency so that the speech/music can be heard in the crystal earphone.



The time base is 2ms/div and the Y sensitivity is 0.5V/div.

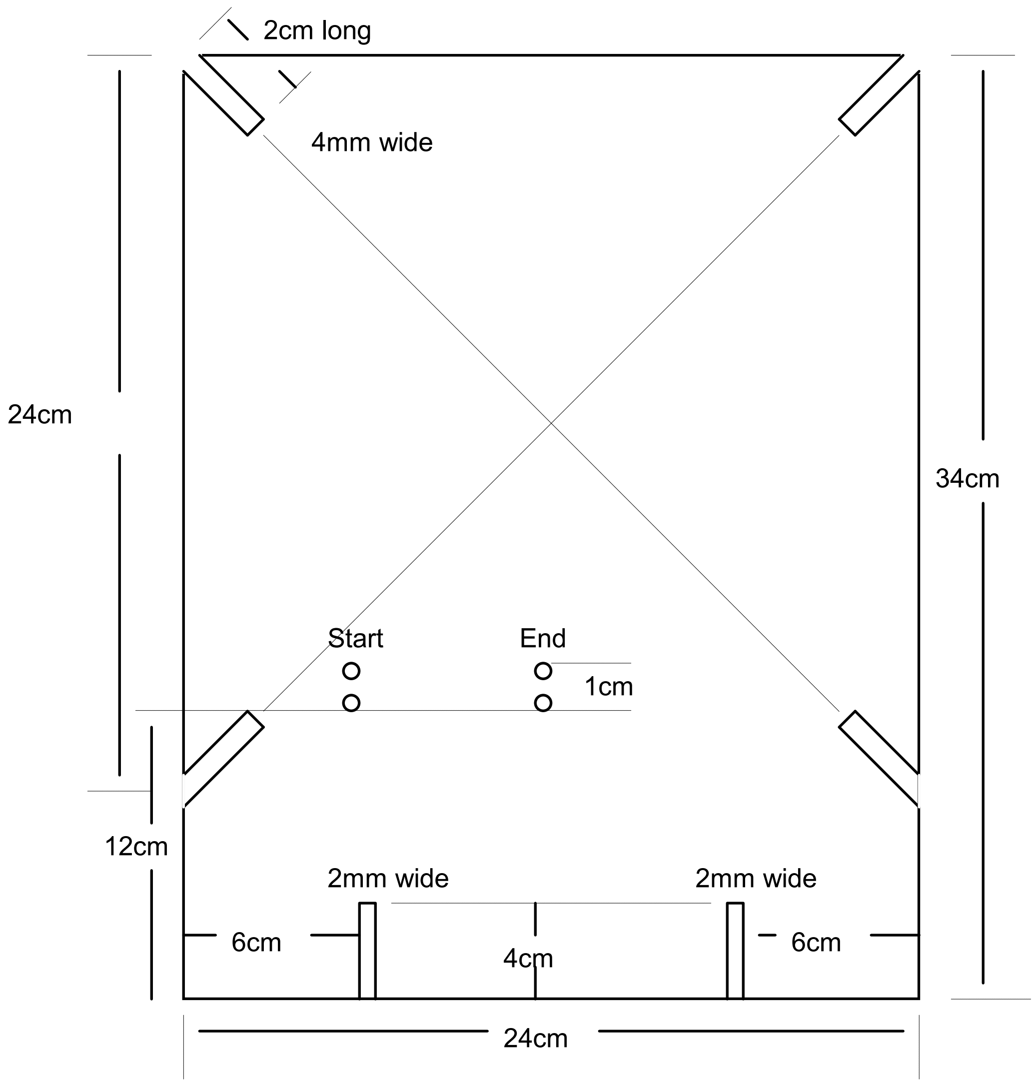
A voltage is also produced across the 10 - 47nF capacitor which is proportional to the strength of the received radio signal.
The voltage produced in a crystal radio is small (≈0.5V) and so a diode made from Germanium is the best type to use. (e.g. OA81, OA91). Unfortunately, these diodes are becoming scarce and may be difficult to obtain.
However, the BAT43 Schottkey diode has a turn on voltage of approximately 0.25V at 1mA and so can be used successfully as a substitute for a Germanium diode.

Construction

The first thing to make is the coil. This is wound on a piece of thick cardboard/thin wood that is 34cm x 24cm. The original was made from the front and back of a 790g packet of Cornflakes, stuck together with PVA glue to make a more rigid piece of card.
Slots are then cut into the card as shown below, to enable the coils to be wound and to provide a base to stand the card up. The diagram below is NOT to scale.

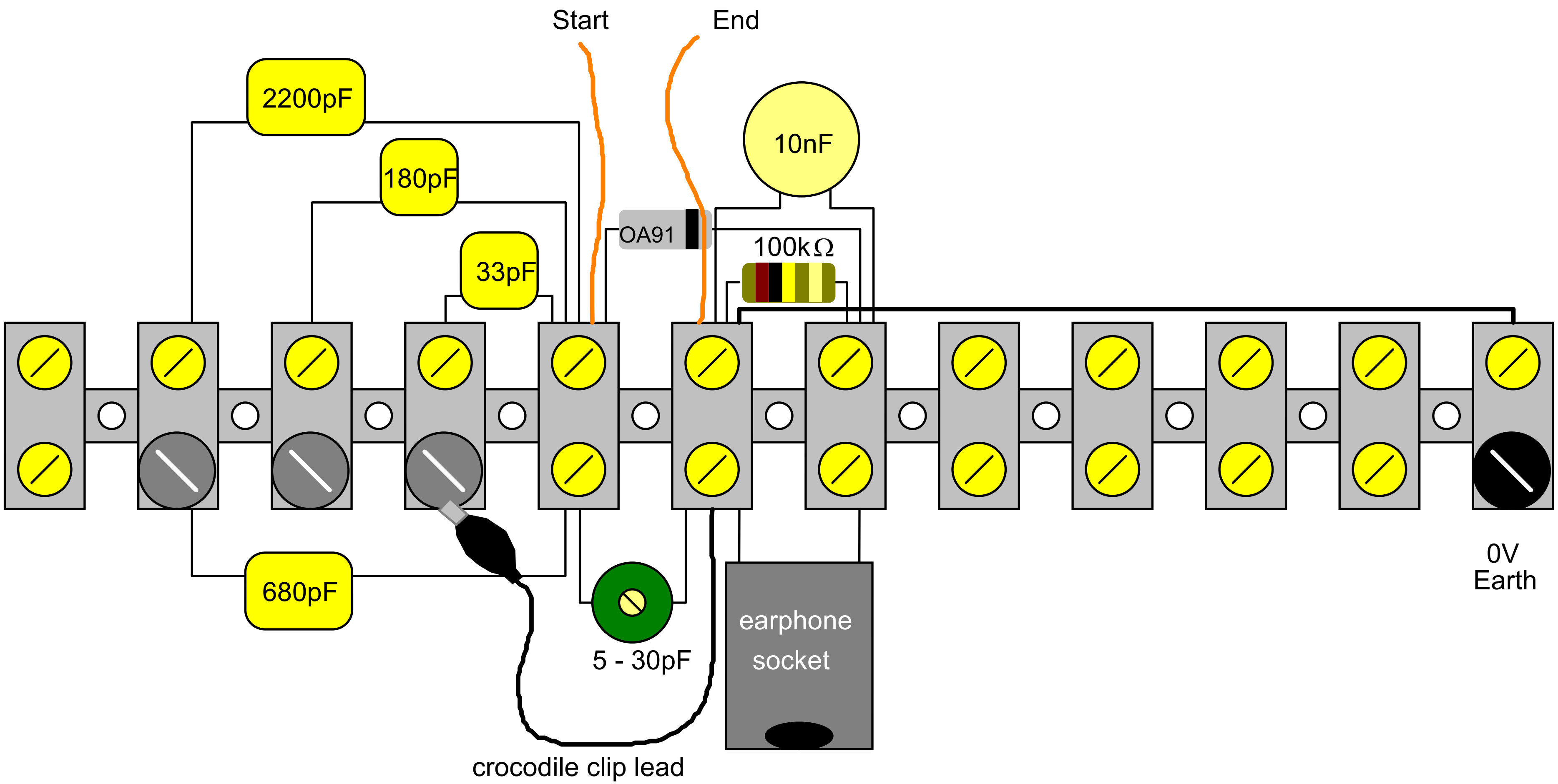
The diameter of the wire is not critical and 30swg (0.31mm) enamel coated copper wire was used for the prototypes.
The wire is secured by looping it through the 'start holes'. Remember to leave sufficient wire at the end to connect to the terminal strip circuit. The wire is then wrapped around the corner slots in the cardboard, finishing on the 17th turn and securing the end by looping through the 'end holes'. Again remember to leave sufficient wire at the end to connect to the terminal strip circuit.

The enamel will need to be removed from the wire at the ends of the coil. The easiest way is to use the flame from a match to burn away a cm or so of the enamel at the end of the wire. The ends can then be gently cleaned with a nail file or emery board.



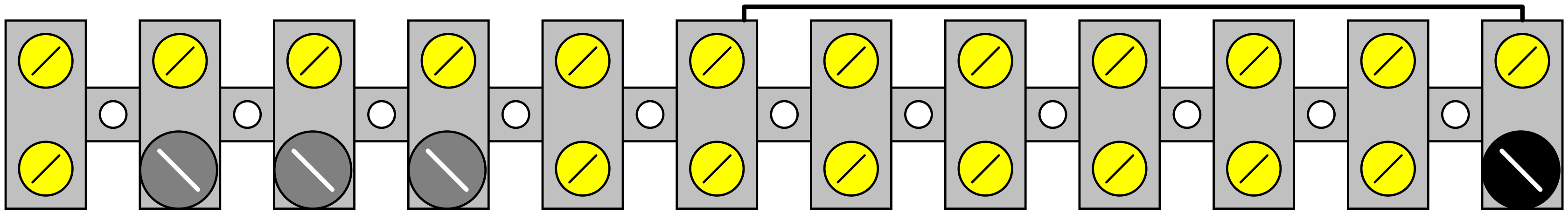
Terminal Strip Layout

In the diagram below, the bolts in some of the terminal strip connectors have been replaced with longer ones to enable a crocodile clip to be easiily attached. The replacement bolts will need to be either M2.5 or M3 (depending on the make of 3 amp terminal strip) and 12 - 20mm long.

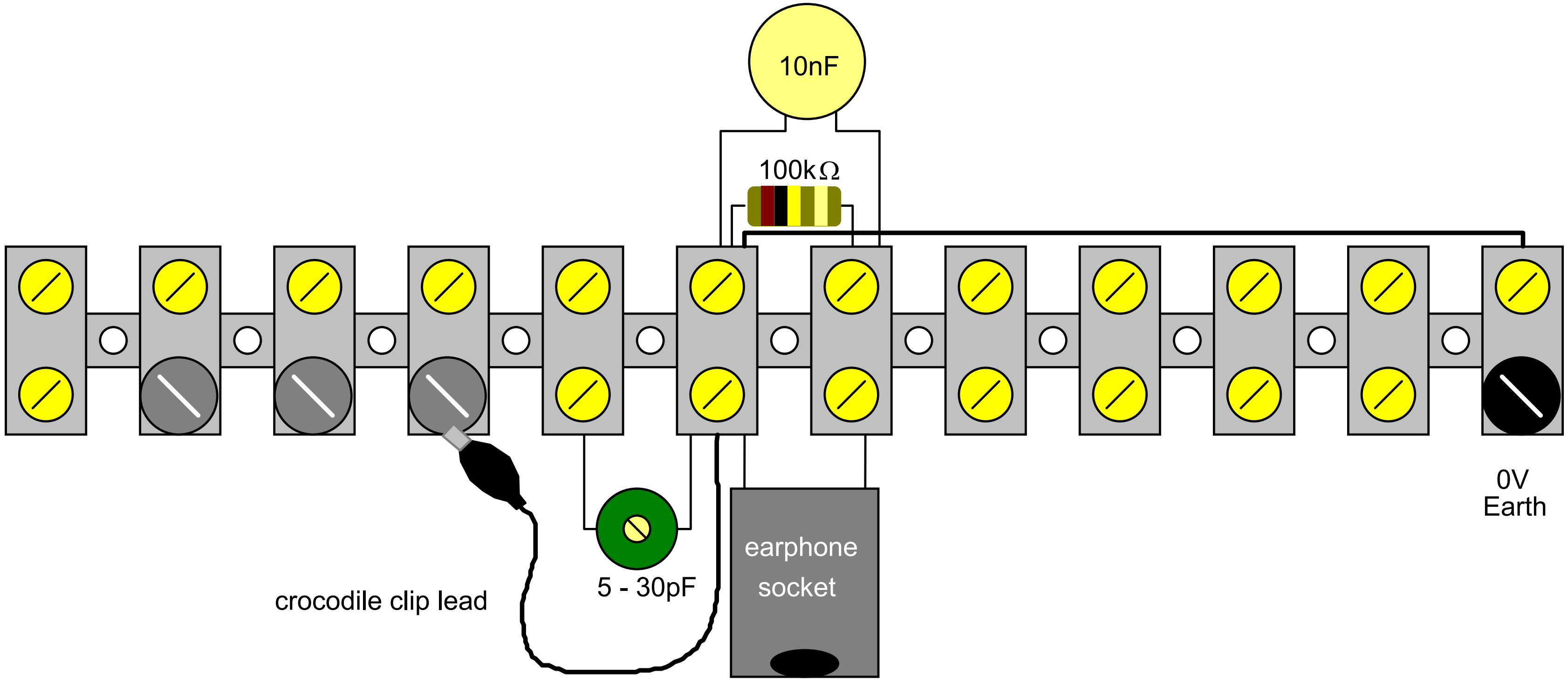


Step by step construction.

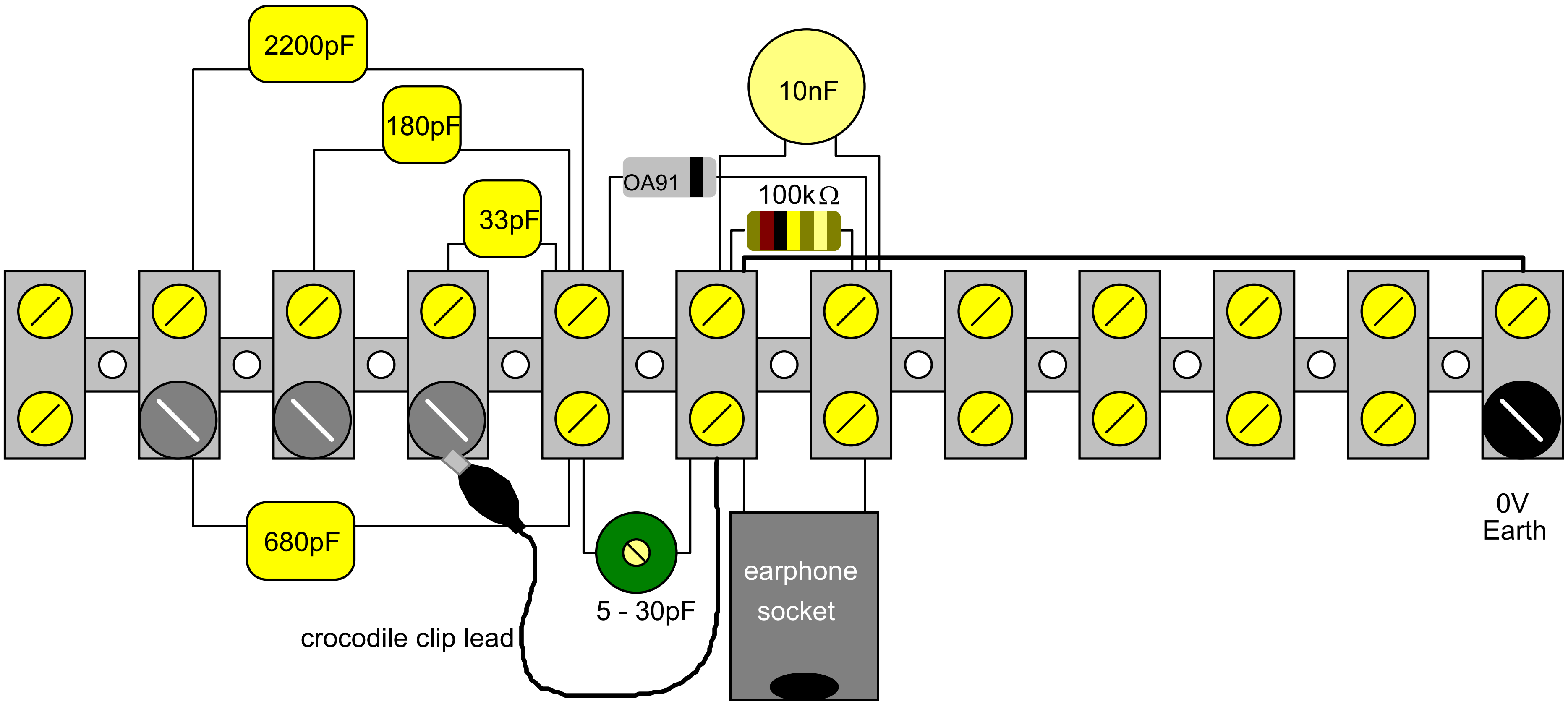
1). Cut a piece of black insulated wire approximately 11cm long and strip both ends. Bend the ends of the wire so that it will fit as in the diagram below.



2). Take the 100kΩ resistors (brown, black, yellow and gold), the 10nF capacitor, trimmer capacitor, earphone socket and crocodile clip lead.
Carefully bend the leads so that they will fit as in the diagram below. Trim the leads if necessary.
It does not matter which way round they are connected.



3). Take the remaining capacitors and carefully bend the leads so that they will fit as in the diagram below. Trim the leads if necessary.
It does not matter which way round they are connected.
Take the OA91 diode and carefully bend the leads so that they will fit as in the diagram below. Trim the leads if necessary.
Ensure that the diode is connected the correct way round.



4). Finally connect the wires from the coil to the terminal strip connector and plug in the crystal earpiece to the earphone socket.
Leave the crocodile clip unconnected and with the coil standing vertically set the trimmer capacitor until the plates almost fully overlap.
You should hear faint sounds in the crystal earpiece - Absolute radio. Keeping the coil vertical, rotate the coil horizontally until the sounds are the loudest. Now adjust the trimmer capacitor for the clearest sounds.
Connecting the OV terminal to the mains electricity earth may make the sounds louder.

If no sounds are heard, check the wiring for errors. Check that the enamel has been completely removed from the ends of the coil wires.
Some crystal earpieces are not very sensitive. If the crystal earpiece is suspected, plug computer speakers into the earphone socket, switch on and then try again to tune in Absolute radio.

Using the Medium Wave Crystal Set.

Selecting different radio stations is achieved by moving the crocodile clip between the various screw connectors and by adjusting the 5 - 30pF trimmer capacitor.

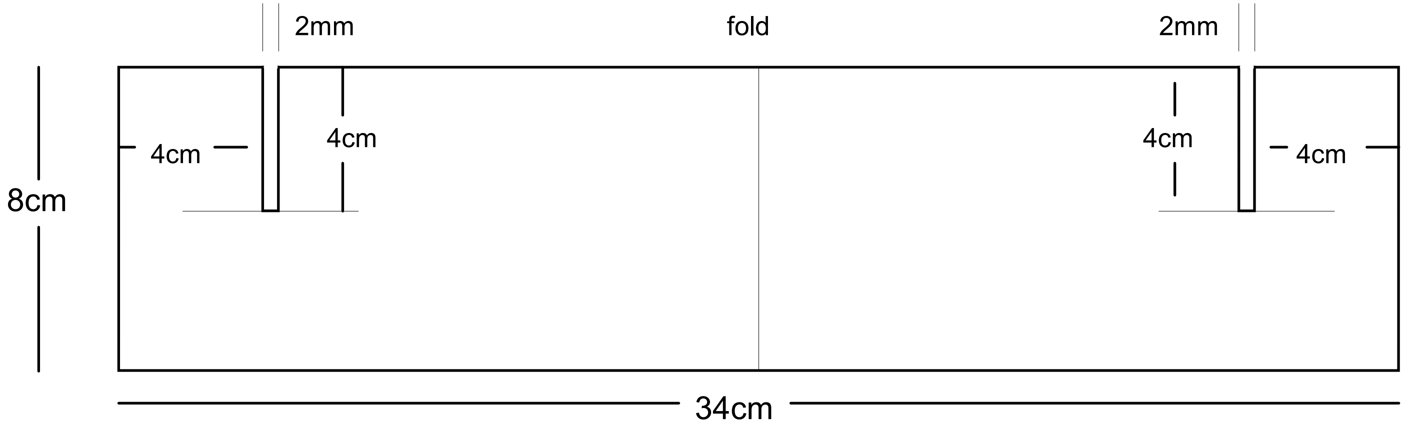
- Absolute Radio on 1215kHz needs 21pF and so the crocodile clip should be left unconnected and the trimmer capacitor adjusted for clear reception.
- Talk Sport on 1053kHz needs 47pf and so the crocodile clip is connected to the free end of the 33pF capacitor and the trimmer capacitor adjusted.
- Radio 5 Live on 693kHz needs 183pF and so the crocodile clip is connected to the 180pF capacitor capacitor and the trimmer capacitor adjusted.
- Radio 4 on 198kHz needs 2880pF and so the crocodile clip is connected to the 2200pf and 680pF parallel capacitors. The trimmer capacitor may have little effect on this station because of the large capacitance used. Reception of Radio 4 will be poor with the coil used for this radio.

For much better reception of Radio 4 see the Long Wave Crystal Set document.

The 17turn coil has an inductance of ≈220μH and the crystal set circuit an inherent capacitance of ≈57pF.

Cornflake Radio Stand

The Cornflake radios work best when the coils are vertical. The narrow sides of the Cornflake packet are used to make the radios stand upright.
Cut the two narrow sides so that they are 34cm × 8cm. Fold these in half (17cm × 8cm), so that the grey side is in the inside of the one and the outside of the other. Apply glue to the grey sides of the card and stick together.
When the glue has dried, cut two slits in the top of the card 2mm wide and 4cm long, 4cm from the ends of the card, as in the diagram below.



This card can now be partially folded and slotted into the slots at the base of the card holding the coil.
If the fold is to the rear of the card holding the coil, it should now stand vertically when placed on a flat surface e.g. a table top.