BUILD YOUR OWN BFO METAL DETECTOR

Simple BFO metal detector

BFO (beat frequency oscillator) metal detectors use two oscillators, each of which produces a radio frequency. One of these oscillators uses a coil of wire that we call the search loop. The second oscillator uses a much smaller coil of wire, and is usually inside the control box and is called the reference oscillator. By adjusting the oscillators so their frequencies are very nearly the same, the difference between them is made audible as a beat note, this beat note changes slightly when the search loop is moved over or near to a piece of metal. It has been found in practice best to make the search oscillator fixed say at 100khz and to arrange for the reference oscillator to be adjustable 100khz plus or minus 250hz. This gives a beat note of 250hz to 0 to 250hz. The beat note disappears or nulls when the two oscillators are about equal. This type of detector is most sensitive when the beat note is close to zero, about 5hz (motor boating) any slight change being noticeable.

Parts list

Power source:
Any 9v battery PP3 is ideal.

Capacitors:

2 off 220uF 16v electrolytic.
5 off .01uF polyester.
5 off .1uF polyester.

Resistors:
All resistors 1/4 watt 5%
6 off 10k
1 off 1K
1 off 2.2m
2 off 39k

Transistors:
All BC 183B. Just about any small signal npn with a gain of 250+ will do. There are hundreds to choose from.

Audio output:
A 2.5 inch 8 ohm speaker will work but headphones or earpiece are preferable the higher the impedance the better.

Many of the above parts could be salvaged from a broken transistor radio.

Once the components have been obtained the circuit can be built in a few hours using copper clad stripboard, or if you the facilities make a printed circuit board using the layout below. The original layout as below should print out at about 50mm x 100mm.

Coils
This is the only tricky part. The search loop is best wound on to a plywood former. **Method 1:** Cut three circles from some 3mm plywood, one 15cm diameter and two 16cm diameter. Using wood glue make a sandwich with the 15cm circle in the center. When the glue has set you can wind 10 turns of . 25 mm swg enameled copper wire around the groove in the edge of the former. Connect this coil when finished to the points marked coil 1 on the schematic. **Method 2:**
Cut a 16mm diameter circle from some 10mm plywood. Then with this circle clamped in a vice run a saw around the edge of the circle so as to make a slot about 5mm deep and 2mm wide around the edge to accommodate the windings. If you have access to an oscilloscope or frequency counter make a note of the frequency. Ideally This coil will be oscillating at about 104khz, with an amplitude of about .5v p to p. The second or reference oscillator needs to be made much smaller and if possible attached to the control box so it can be adjusted as the detector is used. To make a really good adjustable reference oscillator you will have to visit a DIY store, what you need are some plastic water fittings, two examples are shown below. The smaller one is the inlet pipe to a plastic ball valve assembly fitted with a brass nut. The larger one is a plastic tank connector fitted with a brass nut from an old tap. Both of these work well and are glued to the control box in a position where they can be adjusted. The reference coil itself is wound on a piece of wood or plastic about 10/12mm diameter and about 50mm long The actual number of turns of this coil depends on the diameter of the former and can only be found by experiment. Start with about 125 turns . 25 enameled copper wire (this coil when finished has to fit inside the plastic tube) and remove turns until the two frequencies are close. This coil is attached to the circuit board at points marked coil 2. If all is well the detector should be howling at this point. When the two oscillators are well matched it should be possible by adjusting the brass nut in or out to bring the beat note to a halt or null.

Note.

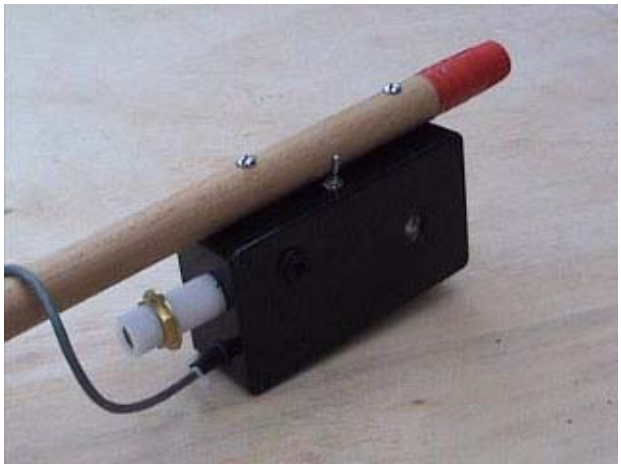
On the working detector shown in these pictures we wound 10 turns on to the searchcoil which then oscillated at 104 khz Then we wound on to a piece of 12mm dia x 50mm long wooden dowel (taken from a bird cage) 120 turns of wire. This was pushed inside a threaded plastic tube from a ball valve assembly. This oscillated at 96 khz without the brass nut and increased gradually as the brass nut was screwed on up to 106 khz. This was perfect for tuning the detector.

Searchcoil made from 10mm thick plywood

The reference coil is wound on to a piece of wooden dowel about 12mm diameter x 50mm long. This has to fit inside the Plastic pipe fitting above, and is tuned by moving the Brass nut. Drill a very small hole 1mm through each end of the wooden dowel so that you can pass the beginning and end of the wire through

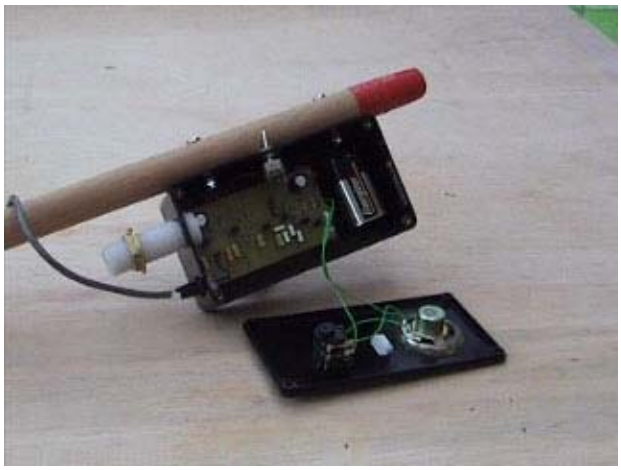
these holes to keep the windings in place.

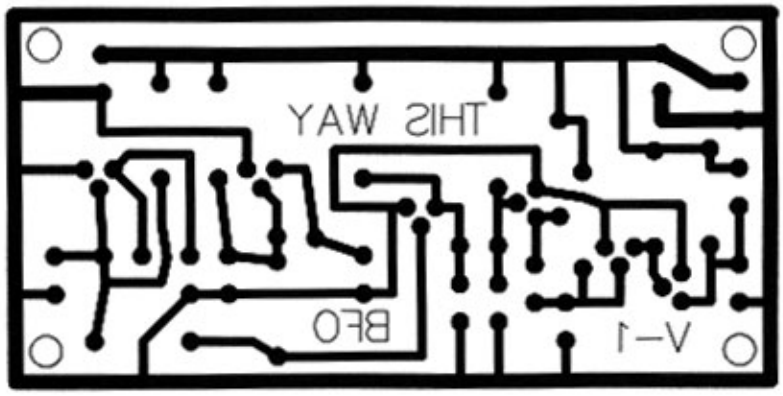
This large coil is 30cm wide by 60cm long (12 inches by 24 inches) and is made from 10mm plywood. It has 5 turns of wire in a 3mm deep groove cut around the edge with a saw. it oscillates at 104 khz . If you want to make different size coils start with the big one, as with only 5 turns you can only alter it in big jumps eg. 4 turns = 115 khz and 6 turns = 85khz . next make the reference coil to match. next make the next smallest coil and so on. The smaller coils are easier to match up as adding or removing a turn at a time only alters the frequency in small amounts

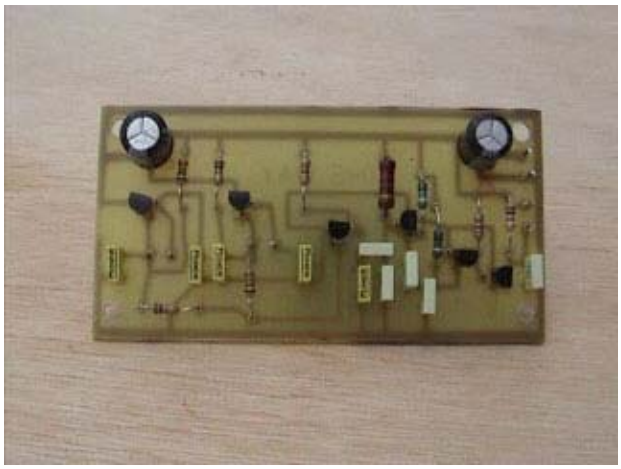


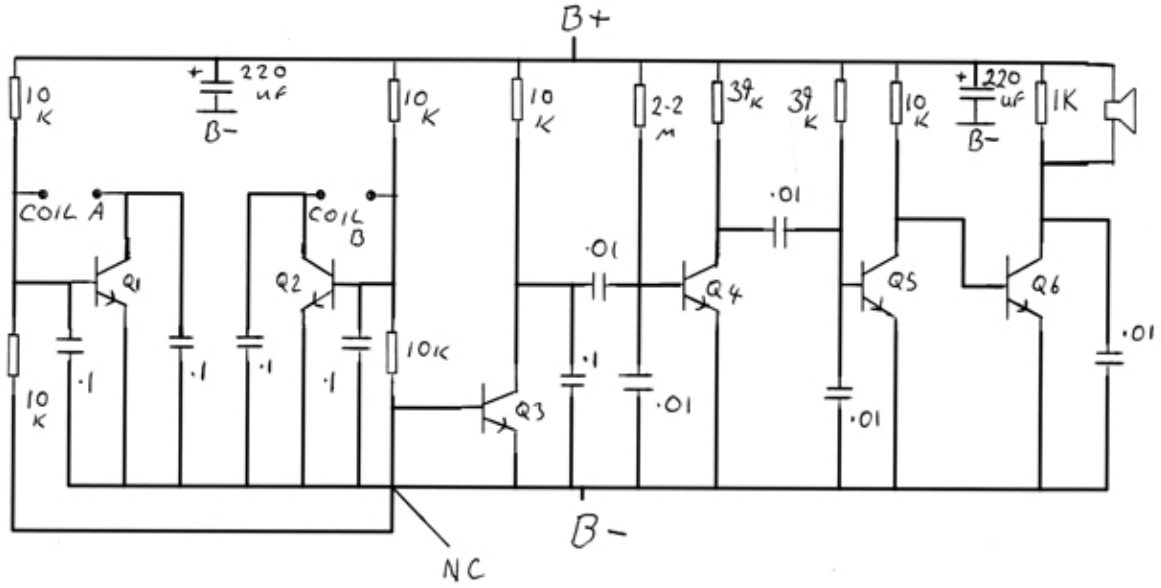
Building a practical detector.

Building a practical detector for outdoor use will depend on the skills and materials at your disposal. The golden rule is keep it lightweight, avoid using heavy materials such as hardwood or perspex. The round search loop needs to be glued to some sort of handle, with the circuit board inside a small box at the other end for balance. You will need to adjust the reference oscillator from time to time when in use.









Coil A = Search coil: Coil B = Reference coil: NC = No connection: B+ = Battery + 9V PP3 or similar : B- = battery -

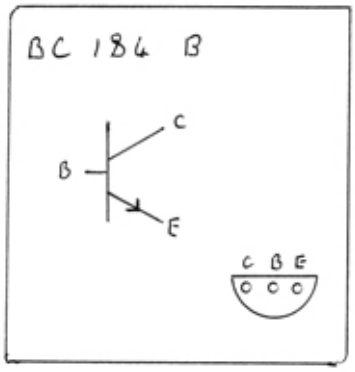
Notes for the electronics beginner.

2 off 220uf / 16v Electrolytic :
These are 220 microfarad / 16v working voltage. You can use a higher working voltage but not less. Higher working voltage capacitors work just the same but they get physically bigger. They have a negative lead that must be connected to the battery - track. These components must go in the correct way round.

5 off .1 and .01 polyester :
These also have a working voltage. 63 volt in quite common and will be ideal. If you want to use the pcb layout above you will need capacitors with 5mm lead spacing. .1 can be marked as .1 or 100n or sometimes 104 : .01 can be marked as .01 or 10n or sometimes 103. These components can go in any way round.

All resistors 1/4 watt 5%:
These are general purpose carbon film resistors with a 5% tolerance and rated at 1/4 watt. You could use resistors of a higher wattage as this does not affect the working they just get bigger. 1 watt or bigger will not fit on the board. These components can go in any way round.

Transistors:
The bc 184b transistor is described has Audio, low current, general purpose NPN . These are quite easy to get in the UK but may be difficult to get in other countries. There are hundreds of types of small plastic NPN transistors available around the world and just about all will work in this circuit. You will have to be sure of the pinouts though. You can get the pinouts for most transistors from manufacturers websites. This will be the most likely problem area when building this project. These components must be connected correctly. PNP types won't work.



Frequently asked questions.

Q. How many meters down can I detect a single Gold coin with this detector.

A. None. For a single coin its about 120 mm if you are lucky. A bit more for larger objects.

Q. I built it but I cant get it to work.

A. Well it does work and usually straight away. The most likely reasons for not working would be. Transistor of the wrong type eg. PNP, or connected wrong. Wrong pinouts. Stripboard can be used but be careful not to get solder bridges across the tracks. If the search coil and reference coil are way off frequency you won't get any sound.

Q. What is the best size for the searchoil.

A. The bigger the coil the deeper it goes. But big coils are no good for small objects like coins and rings. The 16 cm coil is just about perfect for coins and rings.

Q. Can I buy a kit of parts from you for this project.

A. No we don't sell anything to do with this project.

Q. Our son wants to build this detector for a school exam project, could you build it for him and send it to us.

A. No tell him cheats never prosper. (trouble is cheats do prosper) .

Email BFO#Saxons.uk.com Please include name and location e.g. John from Alabama

= @

If you are successful with this project send us an email, small picture would be nice but not essential.

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GOOD LUCK