Phoenix Crystal Receiver

Back in the 1920's the first radios that the general public had access to were simple unpowered receivers. With only one or two receivable stations selectivity was not really a problem. Over the years many designs have been used some simple and easy to reproduce and others complicated but offering higher performance levels.

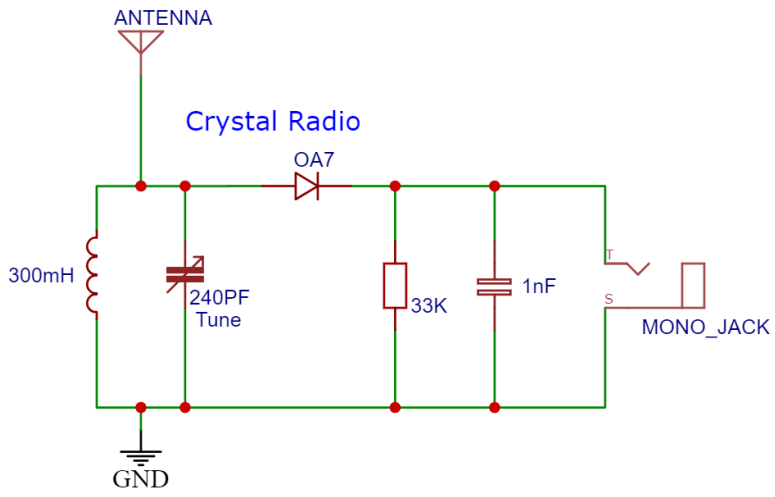
For many these radios have lost favour as we use modern sensitive receivers that offer room filling volume with a wide choice of different stations that would be impossible to hear with the simplest crystal radio and its headphones.

Many people despite the short comings of these early radios still enjoy building and using crystal radios, it's a magical feeling listening to a radio that never needs batteries and just pulls its power directly from the signal in the sky.

The Crystal radio kit here winds back time to give you the experience that early radio pioneers felt but uses modern quality parts that give good levels of performance more suited to todays crowded medium wave band.

The kit here is complete with a 'Vintage' looking enclosure and front panel in the style of radios by companies such as heathkit, this style was typical for radios of the 1950's but the technology used was still 1920's!.

Typical Crystal Radio Circuit from the 20's



This was a popular circuit that still is used today in many Crystal radio Kits, it does have some problems. With the antenna connected directly to the top of the coil the selectivity is low and the set may only pick up one or two stations, often the same stations can be heard at all points of the tuning control at the same time. This circuit was fine in the early days of radio when there was only one local station to hear anyway.

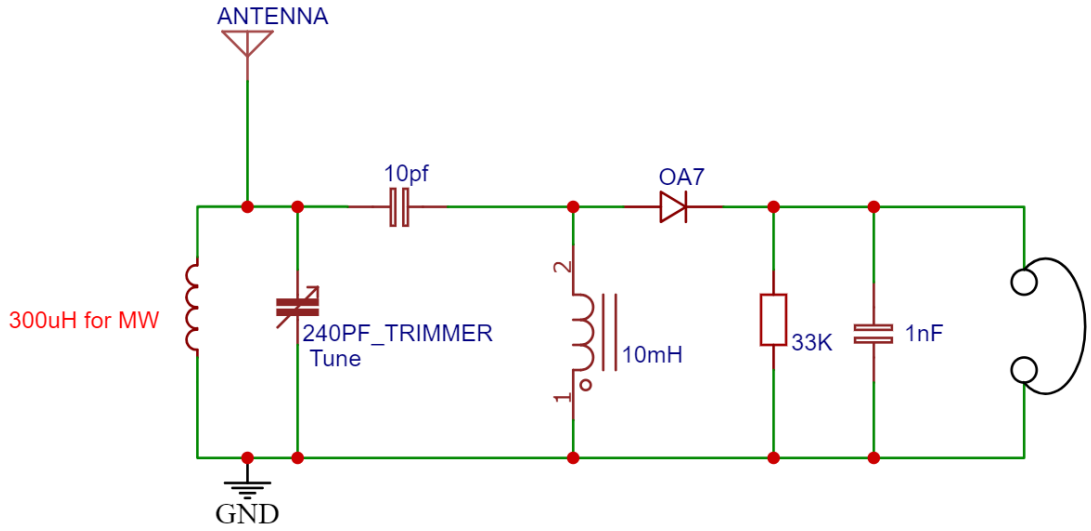
With good quality parts the circuit here is still usable today despite its short comings.

This design was improved upon by 'tapping' the coil so that the diode could be connected at some point further down the coil than the top, the purpose of doing this was to reduce

the loading that the detector put on to the coil, this improved the selectivity and made the radio much more suitable for use on the now busy MW band . The problem with adding taps is that it makes the coil more difficult to build and often a number of taps are needed to find the best match.

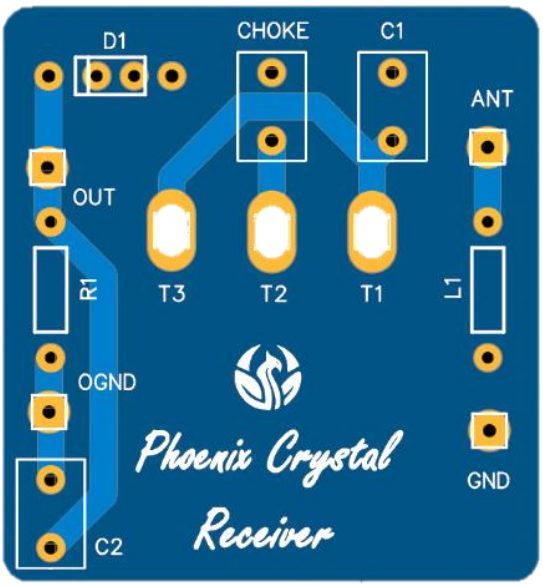
The circuit we have used allows the use of a simple coil. Rather than tap the coil to reduce the load from the detector we are using a small low value capacitor to connect the detector, this allows good signal transfer from the coil but still gives higher selectivity, a winner on both accounts.

The next important part of the circuit is the diode, not any diode can be used for this, most modern day diodes are silicon and have a relatively high forward volt drop (typically 0.7 volt) that means the signal would need to be really strong just to get the diode to conduct and so the radio would be very insensitive, to the point I doubt if you would hear anything at all. A better choice is the germanium diode, these diodes have a forward volt drop of less than half of a silicon diode and so much weaker signals will be heard. Nowadays it's harder to get a good diode but we have managed to get a supply of one of the finest germanium detector diodes made, a rare gold contact point OA7 diode. The selectivity and sensitivity of this circuit is very good but is still low cost and easy to build.



We have now altered the circuit more to allow the antenna to be inductility coupled to the tuning coil to improve the performance from the circuit above.

To make the circuit easier to build we have supplied a small printed circuit board that the parts fit onto.



This Crystal radio can be built in a number of different ways so read ALL the instructions BEFORE you build it!.

Lets look at the parts that come with the kit.

1 x PCB (this is the main part of the radio kit)
L1 Antenna Coil (See Instructions) OA7 Gold Point Contact Diode
Choke 10mH
C1 10pF Disk
C2 1nF (Green)
R1 33K or 36K $\frac{1}{4}$ watt Resistor
4 x Sockets
1 x Front Panel
1 x Case
1 x Tuning Knob
Mounting screw set

Important note.

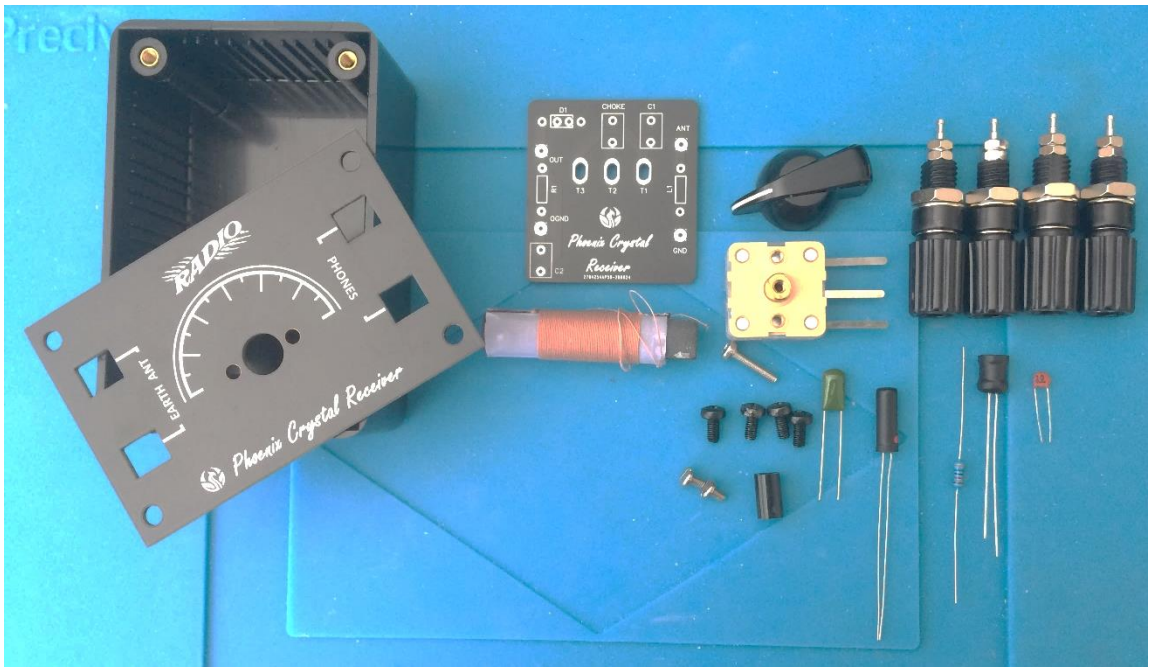
Remember this radio gets all its power from the radio signal and so it's important to give it a good antenna and earth so it can catch as much signal as it can.

The output is designed for use with high impedance headphones for best results, the next in choice would be the Crystal earphone, these are troublesome at best and often stop working, but they are easy to get going again, just needing a flick or a tap on the desk to get them going. At a push I have used standard earbuds or headphones if the signals are strong, but if you have to do this try and use sensitive headphones for the best volume and do remember that these are not the right type of phones for a crystal set and so result may vary depending on how strong the signals are and the quality of the headphones, I have some rather expensive communications headphones that seem to work ok on strong signals but high impedance phones are much better.

If you do try standard modern headphones wire the two elements of the headphones in series with each other. Please give it ago and let me know if it works for you, I have a reasonable antenna, a 60ft endfed long wire up at about 25-30ft and I get reasonable volume and selectivity from a number of stations using normal headphones with such an antenna and earth.

Lets Build the radio

Heres a photo of the parts you should have



In addition to these parts you will have some lengths of foam tape, more on these later.

First job is to fit the 4 terminal posts to the front panel.

Looking at the front panel you can see that there are four square holes for the terminal posts. Fit the posts and use a spanner/pliers to tighten the posts to the front panel, the square hole stops the post from rotating while you do this, don't go mad. It's not a test of strength!

Next let's move to the PCB

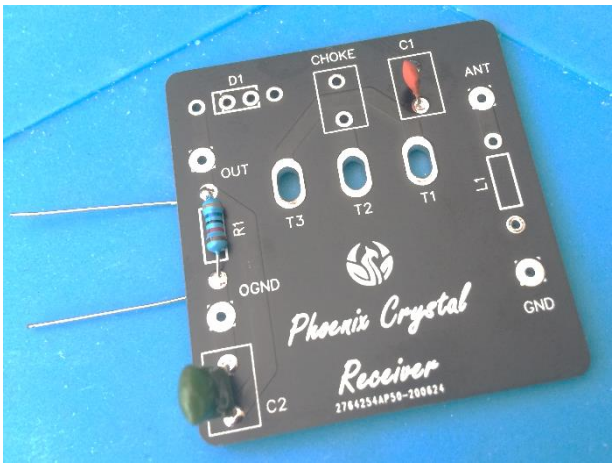
The PCB is designed to make building the crystal radio very easy and trouble free. Larger wide spaced pad have been used so it's suitable for beginners to build.

Let's start by fitting the resistor in position R1

The resistor value is not very critical and any value around 30-40K will be fine. I tend to use either 33 or 36K ohms in my radios. You will be supplied with a resistor in that range for R1,

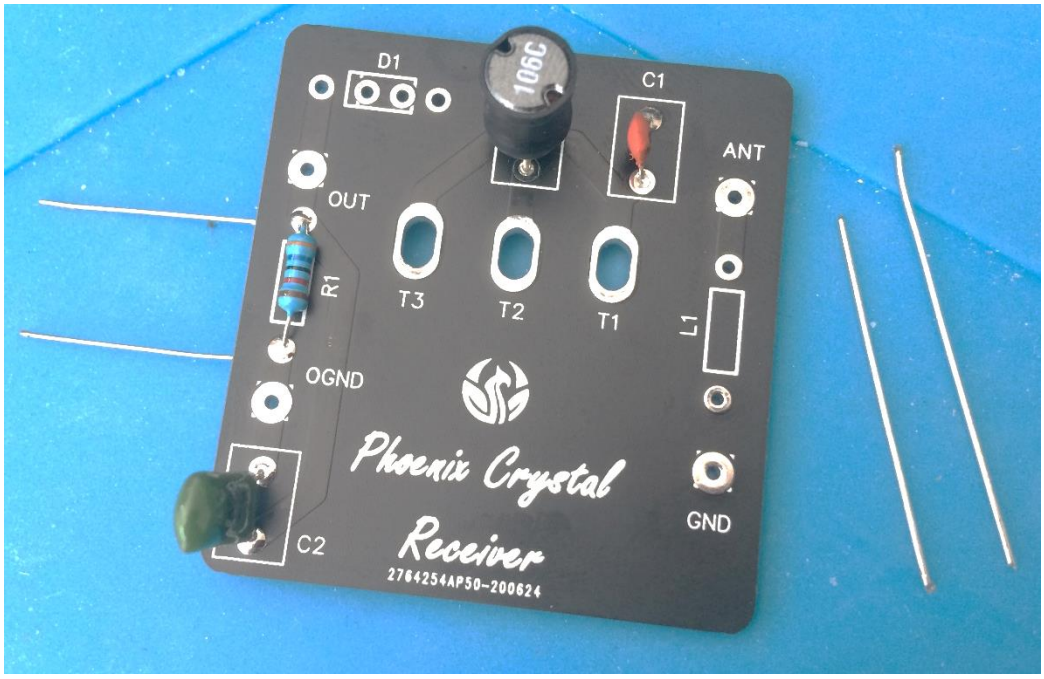
Fit R1 as indicated on the PCB but **DO NOT** cut the leads. If you do don't panic it just makes an extra job for you later! Now read the instructions and stop jumping ahead…

Now fit C1 and C2, C1 is a small orange disk and C2 is a green pillow shape component



This is what your board should look like, the picture does not show the thin leads from R1 very well.

Next fit the Choke, this is a small black cylinder with two fairly thick wires coming out of the bottom.

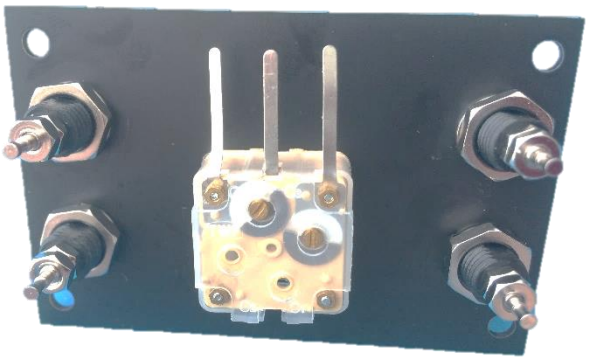


One of the most important parts of a crystal radio is the diode, most modern diodes are made from silicon, that's great for many applications but for our radio that gives us a problem, most silicon diodes have a forward volt drop of around 0.6-0.7 volts, in our radio the signals we are working with will be much less than that and it's doubtful that you would receive anything at all if we used one. Thankfully we can still obtain the old germanium type diodes used in radios early days. Of the suitable diodes one of the best is an OA7 gold point contact diode. (Typical between 0.1 – 0.2V forward drop) We have been lucky in obtaining a supply of these which is very good news and that's what we have in this kit.

Now let's fit this device too, the diode doesn't look like most diodes you have seen, it's a tall glass cylinder painted black with a red dot near one of the two wires coming from its base, The diode fits into the place labelled D1 on the PCB, the layout allows for the use of other germanium diodes if the supply of the OA7 dries up. The OA7 uses the two inner most holes for D1, the red dot should be on the side near to the choke (if you fit this the wrong way it will still work as well)

BEFORE you solder fold the diode over as shown in the picture, otherwise it may hit the bottom of the box when you fit it later.

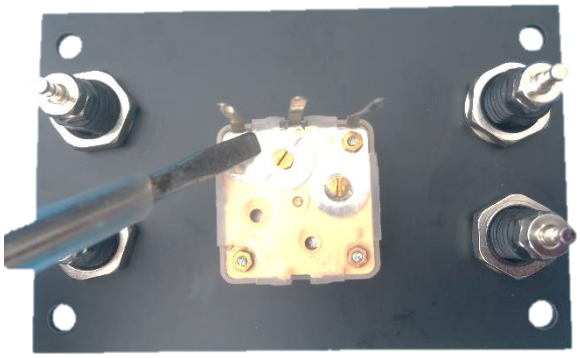
Now we have finished with the board for a short time.



Now we are fitting the capcitor to the front plate. Two small steel screws are provided with the kit, they are 2.5mm thread, be careful if you lose one, if you try any 2.5mm screw it can damage the vanes of the capacitor if they are too long.

Once fitted fold the legs over so the stick out at 90 degrees from the board.

NOW IMPORTANT... on the rear of this capacitor there are two screw trimmers, they **MUST** be set to min capacitance as shown in the picture here.



Now we can fit the PCB to the front panel.

Place the board over the 3 legs sticking up .

Solder and trim these three wires, you may want to stand the diode up while you do this.

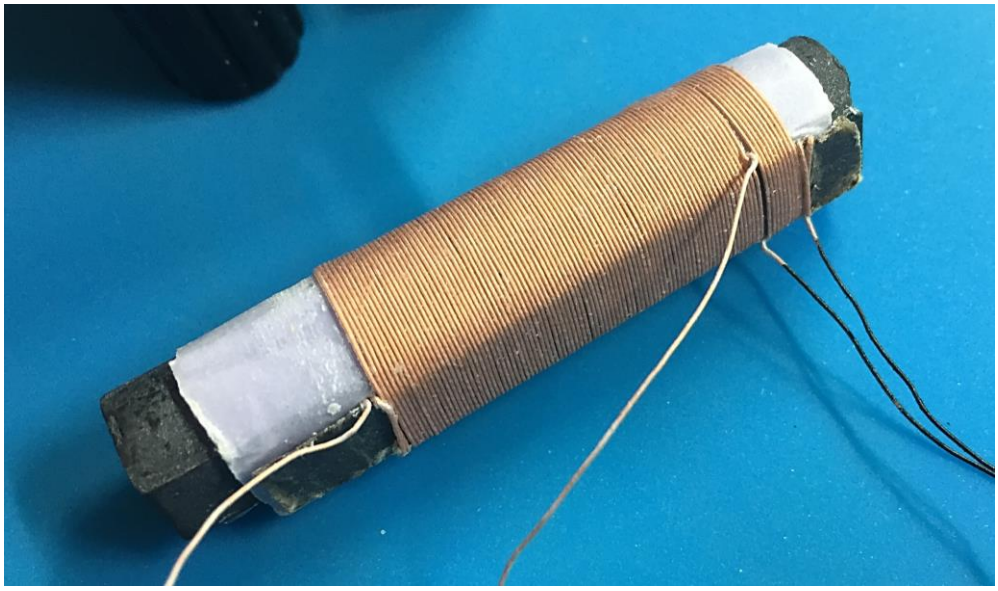
You can see that the wires from R1 are still sticking out to the left of the board right next to the two terminal posts. Now we will connect them to the posts, these are the audio output wires.

Undo the two nuts and you can just wrap the ends of the R1 wires to the posts, secure with the nuts, if you didn't keep the two wires then solder wires to the pads next to R1 and connect them to the terminal posts, you could solder the wires if you wish to the pins at the end of the terminal posts.

That's the output side connected now to work on the input side.

The radio comes with a pre made coil, the wire on this coil is a special type called Litz wire. It offers much better performance than coils wound with standard enamelled copper wire. You will need to take care with this wire as it's very thin and can be broken if you don't take care.

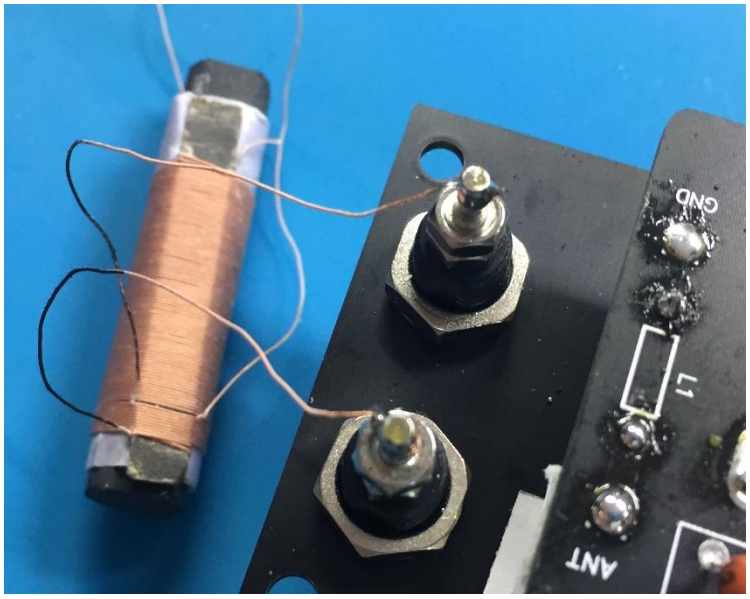
The coil is in fact two different coils on the same rod, the main coil is the tuning coil, the second coil is used as an antenna coupling coil. It is VERY important you do not mix the wires up or the radio will not work.



This is the coil, you will see that there is a small coil at one end and a longer coil coving most of the rod. The small coil is the coupling coil and the longer one the tuning coil.

We need to connect the coil to our radio. This is the hardest part of the kit. Take your time as it's also the most important section. **READ ALL** this section before starting on this task.

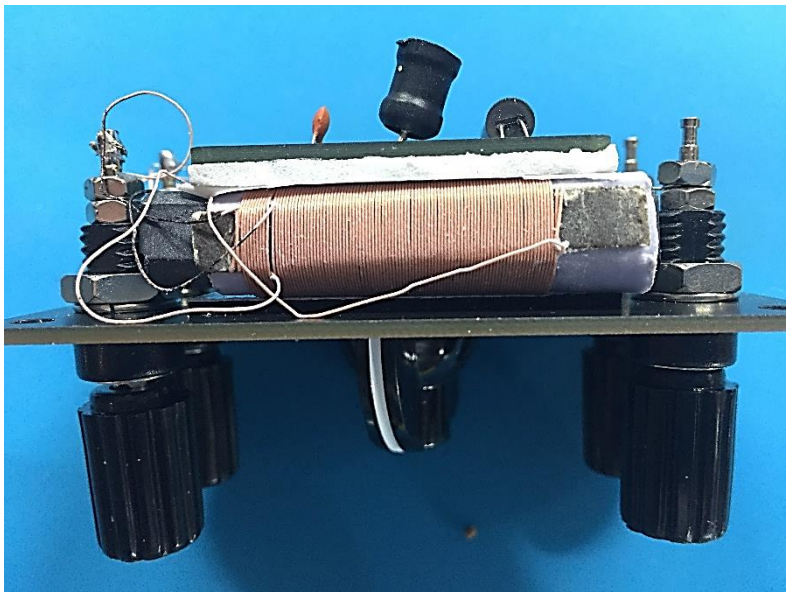
The two wires from the longest coil are a creamy white colour. These two wires connect to the main PCB. The two coloured (Black) wires connect to the antenna and earth terminal posts. Here are the two black wires connected to the posts,



It will be better to solder these rather than to try and trap them using the nuts on the posts, the wires are thin and the nuts can cut through them.

The picture here is my prototype board and has been soldered to and number of times in development so sorry if it's showing battle scars in the pictures.

Now solder the other two remaining wires to the main PCB, solder them to the points marked ANT and GND.



Now we need to fit the coil in the radio, take care with this not to break any of the coils thin wires. Slide the coil so that the end of the longest coil is as close to the ends of the rod as it can be.

If you look at the assembled PCB and front plate you will see the gap between the back of the board and the front panel. Just behind the Choke is the place we are going to fit the coil, take the foam tape and put a length on the back of the PCB. Leave the backing paper on the side nearest to the coil so it doesn't stick to it.

I also put a small length on the back of the front panel too. Now you should be able to slide the coil on its rod between the front panel and the PCB, the foam tape will hold it in place.

Now drop the front assembly onto the box and secure with the four black screws supplied.

Fit the screw and plastic spacer to the centre of the tuning capacitor. Be careful doing this, it would be easy to damage the internals of the capacitor by stressing it trying to tighten the extender. Look at the small brass shaft of the tuning capacitor, you will see two small flats, hold these flats in a pair of cutters to stop the shaft from turning while you tighten the extenders screw. That way you can tighten the screw without risk to the capacitor. Then fit the tuning knob. I just tighten the knob a little at first, just so it grips very slightly, then turn the tuning control and set it so it points correctly. Once you have it set correctly set the control to point upwards and then you can get easy access to the fixing screw, tight then screw to secure the knob.

The finished radio should look like this.

Turn over the radio and fit the four small stick on feet.

We done you have completed the radio. This is not the end, now the fun begins……

Connect you headphones /earphone to the two terminal posts labels 'PHONES' and connect your antenna and earth wires.

Right the BIG topic, many books have been written on this subject, it's a bit of a black art.

Antennas,

Most books I have read tell you that for a crystal radio to work you need to provide it with a very good antenna and earth. I can understand why. The 'Power' to the radio is just from the amount of signal that the antenna (and earth) can feed to the radio, the more signal the louder the volume. Books tell you to get a 50 to 100ft wire up in the sky as high as you can. Drive copper rods into the ground to act as an earth connection. Books say it's not going to be worthwhile without these. Well that would be great if you can do that but I do understand that this can be difficult to do. Back in the 30's when crystal sets offered the only form of 'radio' entertainment people accepted this as normal but now with our modern portable radios, digital TV etc you may be tempted to expect some performance without such this but despite us living in 2020's, we are using technology from a 100 years ago here and the rules haven't changed. The better the antenna and earth the better your signals will be with the set, you can try connecting a wire to a metal water pipe (Central heating pipes can be a good way to go) for the earth and a 30ft plus (Longer is better) wire as high as you can for the antenna will provide reasonable signals for this set.

It's as I said antennas can be bit of a black art, and something that you can play with for hours/days to try and find the best arrangement for you and your location.

I hope you enjoyed building the crystal radio and that you enjoy using a bit of 1920's technology.

The crystal radio will never compare to the modern receiver but it will work as long as there are radio signals still in the air and never need a battery.

Possible modifications

i) The one problem I always find with crystal sets today is the earphone itself. All Crystal earphones have a common problem. Due to such low demand worldwide for them only one factory builds them, unfortunately they are not well built. They suffer from a problem of either sticking or just randomly stop working, it's an easy fix, just a tap on the desk will get them going again. Against all the rules of crystal sets, try standard headphones, the type that come with mobile phones. Due to the unusual circuit of this crystal set I find with a strong signal level they work!

V) Try anything (that's not connected to power cables !!! (be safe!)) metallic as an antenna, I know people have used the old fashion metal beds in the past,

Good Reception and have fun

73 Paul M0BMN