Chris Tucker's

antenna workshop

Get going 'mobile' on 'Eighty' with Chris G4DCH's project!

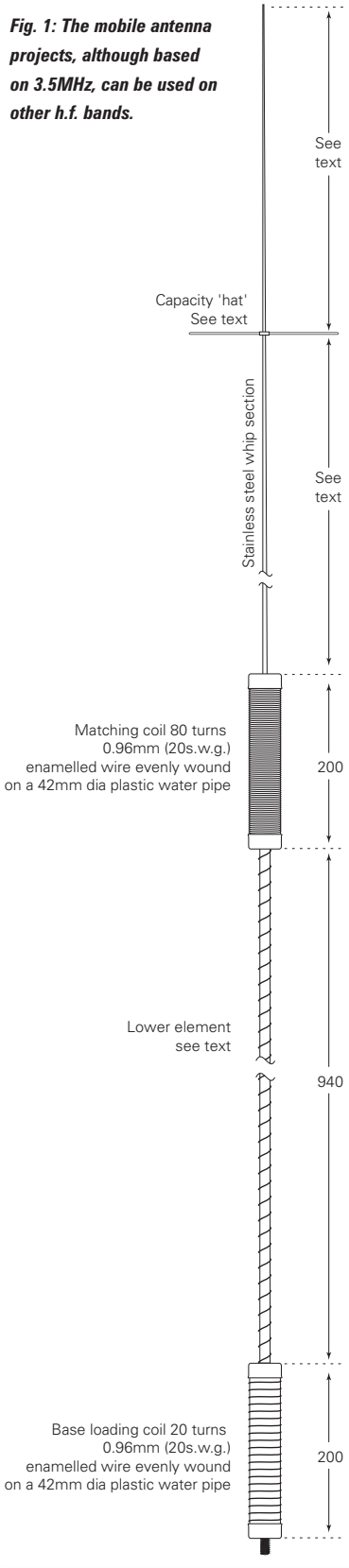

Fig. 1: The mobile antenna projects, although based on 3.5MHz, can be used on other h.f. bands.

To begin with a bit of history, I've been a professional antenna design engineer, working in the defence industry for the past 30 years. The antennas I have designed have operated generally in the microwave region, ranging from 1 to 50GHz. However, being more familiar with phased arrays, wave-guide structures, etc., high frequency (h.f.) antennas design, especially mobile whips, were as much a black art as most other people consider microwave antenna design!

However, at the start of this article I would like to mention two things. Firstly, the antennas I have designed and constructed can be made for a few pounds. They have been made from components that can be readily purchased from shops such as Maplins, your local DIY store and supermarket. Secondly, I should mention that I don't have a workshop full of sophisticated tools – instead I just use just everyday ones such as; a drill, various saws and files and my piece-de-resistance, a cheese grater! (More on this secret ingredient later!).

Base Loaded

The first antenna I made was a base-loaded whip for 3.5MHz (80m), but this turned out to be a bit of a disaster! Except for one contact with another Amateur about 10km (approx. six miles) away and one report from a short wave listener (s.w.l.), QSOs were non- existent.

Undeterred, I was still determined to continue and after trawling the net for ideas, I came across a article for a 14MHz mobile whip. Using this 14MHz design as the basic idea, I started work on calculating the coil dimensions needed for an 3.5MHz version. The antenna consists of four main parts: a base matching coil, a short helical section, a centre loading coil and the top whip section (see the overall lay-out in **Fig. 1**).

Base Matching Coil

The base loading coil, **Fig. 2**, is made using 20 turns of 0.9mm (20s.w.g.) enamelled copper wire spaced 2mm apart between windings, wound on a 42mm outside diameter (OD) *pvc* water pipe. The coil is tapped at 10 turns, which acts as the 50Ω feed point. The bottom of the coil is attached either to a mounting stud such as a M10 bolt or (as I use in my version) an old SO239 (Male) connector, potted with resin compound into the tube.

At this point, individual constructors may need to use their own ingenuity, depending on how you intend to mount the antenna onto a vehicle. One method that has worked for me used a pipe reducer 38 OD to 20mm, which you can buy from any d.i.y. store.

The SO239 can be then be cemented into the reducer using any of the hard-setting epoxy resin adhesives. If you need to use some additional packing to make a tighter fit, you can take a note from my book as I have used strips of plastic cut from milk cartons after they've been thoughly cleaned and de-greased. Note: Plastic tube fittings can be glued using *UHU* or Bostik all purpose adhesives.

A link wire is then attached from the 50Ω connector to the tapped point on the coil. This link wire should stand proud of the coil by at least 20mm. An alternative method (that I've used) on a similar antenna designed for 1.8MHz, brings the link up through the centre of the coil and emerges through a hole drilled near the tap point and then soldered.

The bottom end of the coil is soldered to the earth side of the same connector. The top of the coil is cemented (again using *UHU* or Bostik all purpose adhesive), to a 38 to 20mm pipe reducer to take the next section of the antenna.

Helically Wound Section

The helical section is a 20mm OD plastic overflow tube 940mm long with a helical winding of 2mm (14s.w.g.) enamelled copper wire wound up the tube with 33mm

The G4DCH 3.5MHz Mobile Antenna

Chris Tucker G4DCH is a keen Amateur with much experience! Here the ever-effervescent Chris describes his mobile 3.5MHz antenna.

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spacing between each winding. This spacing is not critical but should be between 30 and 35mm apart.

The 38 to 20mm pipe adaptor glued into the top of the matching coil allows the middle section to be fitted into the bottom section. The bottom end of the coil will be soldered to the base matching section – once all the sections have been constructed and aligned.

Centre Loading Coil

The centre loading coil, **Fig. 3**, attaches to the helical section using the same 20mm to 38mm pipe adaptor as was used on the bottom section. The coil is wound in the same way as the base matching coil on 42mm OD *pvc* water pipe, about 200mm long. The coil consists of 80 turns of 0.92mm (20s.w.g.) close-wound on the tube.

Note: Here's another handy little tip! The top cap for the coil is cut from a cheap plastic chopping board which can be obtained from various supermarkets. These boards are made from polypropylene and are ideal for many different construction ideas. They cost about £2 for the thicker ones and about £1 for the thinner ones.

I've used these cutting boards in various ways in my antenna construction projects for making caps and insulators, etc. I cut the discs out using a rotary saw used for cutting holes in kitchen cabinets to take waste water pipes. The discs are cut slightly oversize for fitting into the pipe section, then shaved down using the cheese grater! I have also used it as part of the mounting bracket for the antenna on my car.

I then drill a hole in the centre of the cap to take the ferrule for the top whip section. The top of the coil is then attached to the whip using a ferrule and screw arrangement. I cut the ferrule from an old 144MHz mobile whip antenna, which already had a screw thread on one end.

The ferrule is bolted through the cap of the loading coil with a solder tag and wire attached to it. The wire from the solder tag is soldered to the top of the loading coil, before the cap is cemented and screwed in place.

Fig. 2: The base matching coil.

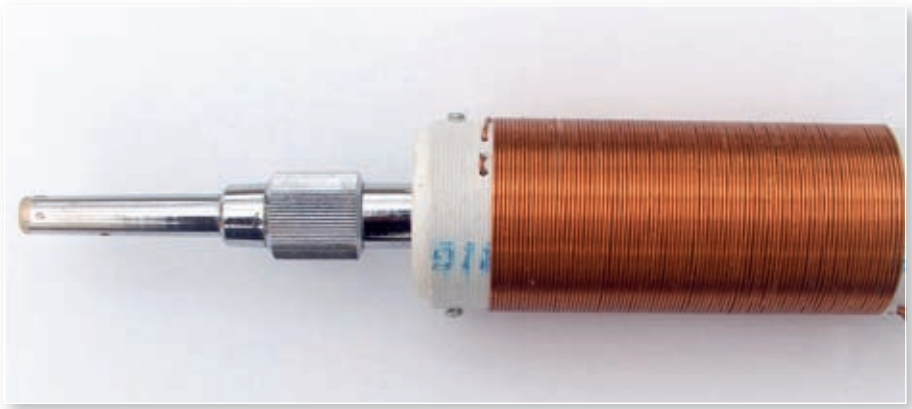

Fig. 3: The centre loading coil.

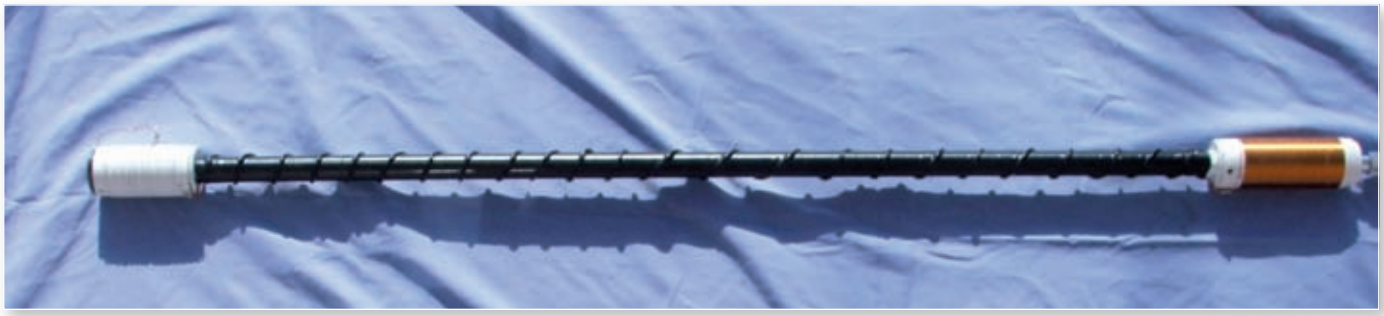

Fig. 4: The final assembly is firmly fixed using epoxy resin or similar adhesive.

Top Whip Section

The top part of the antenna uses a standard 1.3m long stainless steel whip. I used an old 144MHz whip section, but stainless steel sections can be picked up from rallies quite cheaply. **Note:** These will need adjusting by cutting to length, to bring the antenna to the desired frequency.

Final Assembly

Once you're happy with the construction of the coil sections, they can be assembled together and glued using epoxy resin or similar adhesive, **Fig. 4**. To make sure the sections will survive the stresses placed on them while mobile I also use small (8mm) 2M size self-tapping screws, using three or four around each joint circumference should be adequate. **Note:** Two screws aren't sufficient as the cap can rotate around them, should the cap's adhesive fixing fail.

To check on the resonant point of the antenna, one piece of essential equipment is the MFJ-259 or similar antenna analyser. If you don't have one yourself, then try to borrow one to do the tuning measurements!* This last part must be carried out on the vehicle you wish to mount the antenna, **Fig. 5**. The mounting should have all the necessary brackets and earth bonding wires in place as these will all affect the tuning point of the antenna.

What I found best is first to check to see on what frequency the antenna is resonant, as this will be dependent on the length of whip section – this needs to be about 3.8 to 4MHz. If the antenna indicates it's low, e.g. 3.2MHz, then either take a few turns off the centre loading coil or reduce the length of the whip by small steps, until a tuning point of about 4MHz is reached.

Then construct a simple X shaped capacity hat from two pieces of 1.6mm (16s.w.g.) tinned copper wire about 150mm across. Fix this about two thirds of the way up the whip. This should bring the tuning point down from 4MHz to around 3.5MHz. Next, you should then carefully trim the length of each arm of the capacity hat until the desired operating frequency is reached e.g. 3.66MHz.

Fig. 5: The final tuning must be done while the antenna is mounted on the vehicle to be used. Chris G4DCH recommends using a suitable antenna analyser.

The antenna should have a good match i.e a voltage standing wave ration (v.s.w.r.) of better than 1.5:1, and a bandwidth of >20kHz to the 2:1 point and >30kHz to 3:1points. Minor adjustments to the matching frequency can be made with a suitable antenna tuning unit (a.t.u.). Alternatively by bending the radials of the capacity hat downwards, the antenna will tune further up the band, so a range of between 3.6 and 3.8MHz should be achievable.

Once tuning has been completed you should then check all the sections are well soldered, that the pipes are firmly cemented together and any other fixtures are well secured. Finally, cover the exposed sections of the coils in *pvc* tape and spray a clear lacquer over the coils to improve the waterproofing. Then your antenna should be complete!

Table 1

Frequency Band (MHz)	Base loading Section (turns)	Tube Dia (mm)	Tap Point (turns)	Loading Coil (turns)	Tube Dia (mm)	Whip Length
1.8MHz	40	42mm	20	270	42mm	1.3m
3.5MHz	20	42mm	10	80	42mm	1.3m
7MHz	20	42mm	10	80	42mm	0.2m

** Antenna analysers are very useful indeed. I know of several clubs who have purchased antenna analysers for their members to use in their own workshops. A small charge covers the loan and after several years use, it's paid for and club members borrow it free of charge!* ***Editor.***

A 7MHz Variant

Once you've built and tuned the 3.5MHz antenna it's simple to make a 7MHz (40m)version. To start, cut a short section of stainless steel whip about 250mm long and replace the 3.5MHz whip section. Check the resonant point – using the antenna analyser – and it should tune on the low side of 7MHz.

Next, carefully reduce the length of the whip until a frequency within the 40m band is achieved. Don't worry that the whip section looks very short, this is a truly resonant antenna and is therefore efficient! If you don't believe this, try matching the 3.5MHz antenna on a signal around 7.05MHz using an a.t.u. and compare it to the 40m antenna made above without the a.t.u. I'm sure you'll be amazed by the difference in signal strength.

A 1.8MHz Version

Using exactly the same construction techniques, but winding the matching coil and loading coils as follows, a 1.8MHz (Top Band) version of the antenna can be made. The base matching coil is made from 40 turns tapped at 20 turns, using 20s.w.g. enamelled copper wire on a 42mm OD *pvc* pipe former.

The centre loading coil is made up from 270 turns using 20s.w.g. enamelled copper wire on a 42mm OD *pvc* pipe former. The helical section and whip sections are as for the 3.5MHz version.

Enjoy the DXing with your antennas and I look forward to working you on the bands! ●