Antennas

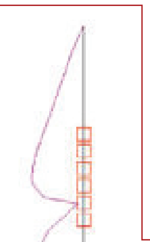
An alternative mode in HF mobile antennas

PHOTO 1: A Texas Bugcatcher antenna mounted on the tow bar on the rear a vehicle. It uses a single large inductance with tapping points and a wander lead to short out the unused sections of the coil.

SIMPLE MOBILE. The vertical whip antenna is the most popular antenna for mobile use. The easiest way to feed such an antenna is to make it a quarter wavelength long at the frequency in use, which allows it to be fed directly with 50Ω coax at the low impedance base. The resonant quarter wavelength is a function of frequency and is 1.48m (58.5in) on 50MHz, 2.5m (8ft 2in) on 28.4MHz and progressively shorter on the higher VHF bands. Quarter wave antennas on the 28MHz bands and higher are quite practical, but on the lower HF bands it is a different matter. Even on 21MHz, a quarter wavelength is 3.45m (11ft 2in) and on 14MHz is 4.99m (16ft 4in). It follows that a practical mobile antenna for the HF bands must be shorter than a quarter wave.

For a given antenna length, as the frequency of operation is lowered the feed point exhibits a decreasing resistance in series with an increasing capacitive reactance. In order to feed power to such an antenna it must be brought to resonance so that the feed point is resistive. This is achieved by adding some inductance and is known as inductive loading.

Each band requires a different value of inductance. This can be achieved using separate single band antennas with built in inductance or separate plug-in coils for each band. The most common method used now is by using one long coil and shorting out the unwanted inductance of the lower frequency bands not in use. The antenna on the rear of the vehicle shown in **Photo 1** is the commercial Texas Bugcatcher **[1]**. It uses a single large inductance with tapping points and a wander lead to short out the unused sections of the coil.



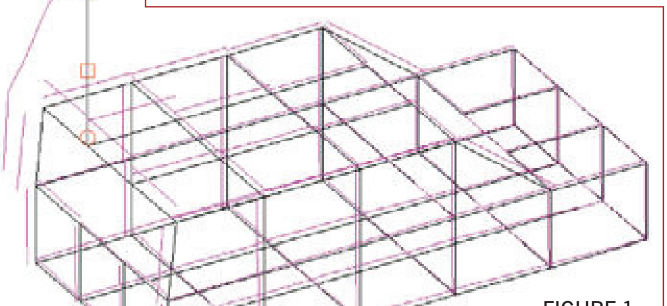


FIGURE 1: Computer model of an Outbacker Outreach antenna on 10m (28MHz) mounted on an estate car. The model is depicted with black lines and the current magnitude in magenta.

THE OUTBACKER. Another interesting method of the shorting out the unwanted inductance is used in the design of the Outbacker. These antennas come in several versions and the one I acquired recently is the Outbacker Outreach, which covers all bands from 160m to 10m. It is not possible to see how the inductors are formed but it is obvious they are wound continuously along the length of the antenna, in some ways rather like the Firestik CB antenna.

The Outbacker is made up of three sections: a lower section with the 160, 80 and 30m inductors; a centre section with the higher frequency HF band inductors and finally a whip (the 'stinger'). The centre section is shown in some detail in **Photo 2** because it is the basis of a discussion in this column. The inductances and physical lengths of the band inductances are also shown.

The inductors are selected using a wander lead terminated with 4mm diameter banana plugs, which fit very snugly into the 4mm inductor selector sockets. As you might expect, the higher frequency bands require progressively less inductance to resonate the antenna and the 15m band only requires 1.4μH plus the inductance of the wander lead, which is wrapped around the lower section of the antenna in a loose anticlockwise spiral (as recommended in the instructions).

However, you might have noticed that the 10m coil selection point is at the bottom of Photo 2. This indicates there is a total of 50μH of inductance in the antenna when 10m is selected. The 12m tapping point is located at the top end of the lower section (not shown in Photo 2) and includes an extra 14μH on top of the 50μH already mentioned.

The instruction book makes no mention of this oddity but the sales material **[2]** says "… 10, 12 and 15m are 5/8 wave". I think that only the 10 and 12m bands use the '5/8 wave' effect.

I had never seen any reference to 5/8 wave HF antennas. On VHF, a 5/8 wave antenna is quite common and comprises a full halfwave whip antenna matched to the feeder with a tapped inductance.

I constructed a computer model based on the data measured in Photo 2. The *EZNEC5* software allows effects of 'loads' (inductance, capacitance and resistance) to be modelled. Inductances are shown as small square icons in **Figure 1**.

The current distribution on the antenna shows a top section with a halfwave current distribution and a lower section with a near quarter wave current distribution. Note that there is current flow in the modelled vehicle body that shows that the vehicle also radiates during transmit and is part of the antenna system.

I made a further model using a full sized quarter wave antenna for comparison. The comparison elevation polar diagrams are shown **Figure 2**. I had to make a guess as to the resistive losses in the loading inductors so the diagrams in Figure 2 should not be taken as definitive. What is interesting is how similar they are. Note also that the total installation becomes quite directive when the vehicle is near to quarter of a wavelength long and the antenna is mounted at the end of the vehicle; with the lobe of maximum gain at the opposite end of the vehicle to where the antenna is mounted. This phenomenon has also been measured and documented in **[3]**. If the antenna is mounted in the centre of the vehicle then the system is omnidirectional.

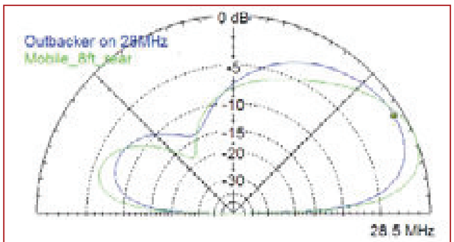


FIGURE 2: Model elevation plots of the Outbacker Outreach antenna (black) compared with a full size quarter wave antenna (green) on 28MHz.

It occurred to me that when the 10m or

12m taps are selected, with 60μH or more inductance above the tapping points, the antenna should also exhibit lower resonances. A frequency sweep of the antenna set at 12m showed that this was the case and a resonance occurred at 5.5MHz, as shown in **Figure 3**.

The impedance at the 12m resonance point was measured at over 100Ω, which resulted in an SWR of more than 2:1 – I initially though this might be due to the position on the vehicle where the antenna was mounted. On the other hand the conventional mode on 20m, see **Figure 4**, exhibited good matching characteristics.

THE TEXAS BUGCATCHER. This antenna has a good performance reputation, particularly on the lower HF bands. The reason for this is that it is a large antenna with a large coil wound on high quality, low-loss former. Some idea of its size can be seen in Photo 1. Its only drawback is that the SWR bandwidth is very small and the business of setting the wander lead taps can be tricky. Of course, the screwdriver type antennas overcome this problem but the construction of such an antenna is beyond the resources of my garden shed workshop.

It occurred to me that solutions suggested in an early edition of the ARRL *Radio Amateur's Handbook* (**Figure 5**) might make the adjustment less critical. **Figure 5A** is a simple sliding contact that shorts out the unused turns. (I am not sure how **Figure 5B** works: I would be interested in hearing from anyone who knows of this arrangement. There was no description in the text that came with these illustrations).

I modified the Bugcatcher coil to work much the same as Figure 5A. A movable contact arrangement was constructed as shown in **Photo 3**. It comprises a short length of 22mm copper tube drilled to fit the lower element of the Bugcatcher; the other end is drilled to take the 8mm copper tubing contact holder. The contact itself is made from a small piece of phosphor bronze draft excluder.

Regrettably, this arrangement was not an unqualified success because sometimes the sliding contact alighted on one turn and other times shorted out two turns. The result was an uneven inductance change with the slider position. Nevertheless, it allowed me to investigate other modes with the Bugcatcher antenna. One of the results shown in **Figure 6**.

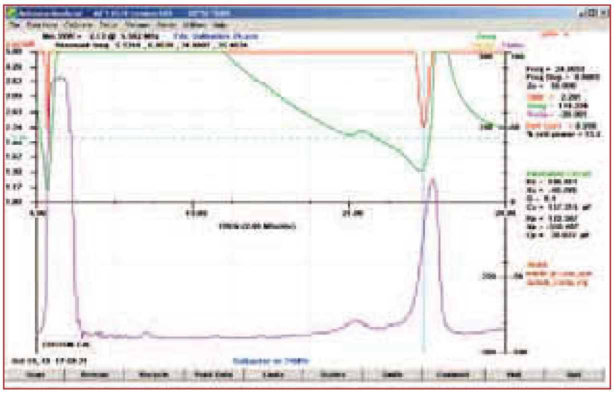


FIGURE 3: Frequency sweep of the Outbacker Outreach antenna on 12m using the AIM 4170. Note the lower resonance at 5.5MHz.

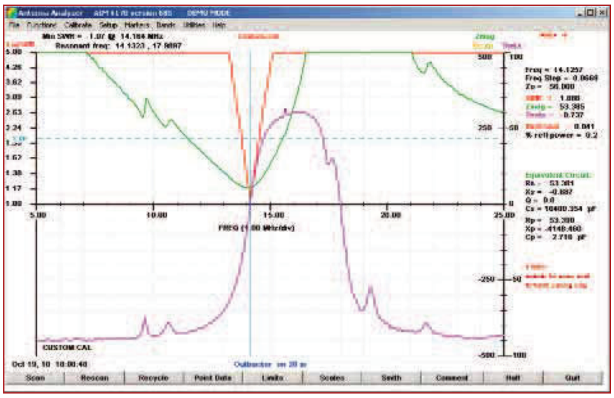


FIGURE 4: Frequency sweep of the Outbacker Outreach antenna on 20m using the AIM 4170. The off-resonance blips are due to strong out of band station interference.

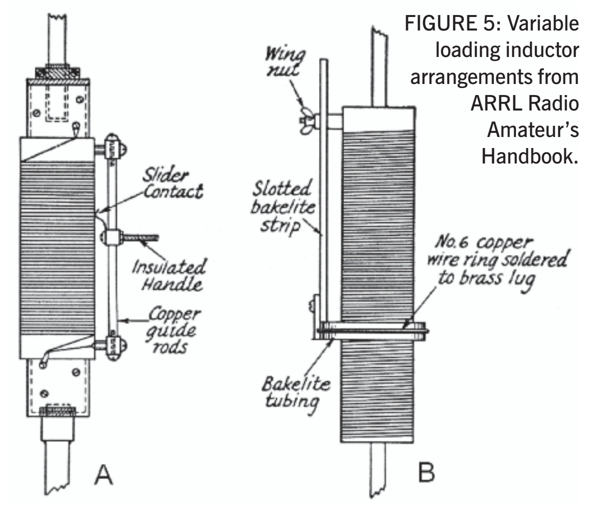


FIGURE 5: Variable loading inductor arrangements from ARRL Radio Amateur's Handbook.

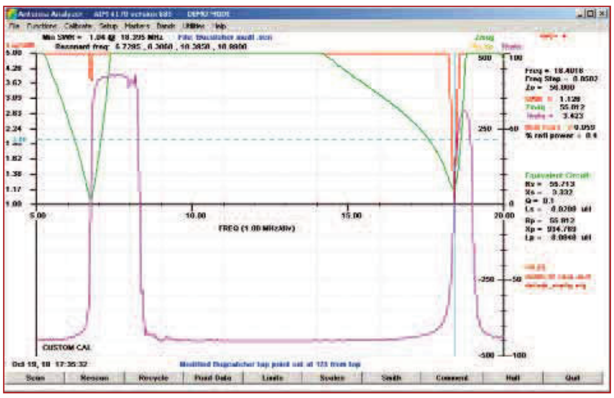


FIGURE 6: Frequency sweep of the Bugcatcher antenna on 17m using the AIM 4170. Note the lower resonance at 6.7MHz.

PHOTO 2: The centre section of an Outbacker Outreach antenna, with measured inductances for the bands 10, 15, 17 20 and 40m. The wander lead is shown with the 40m band selected.

PHOTO 3: Modified Bugcatcher coil with sliding contact.

WEBSEARCH

[1] GLA Systems, who manufactured the Texas Bugcatcher antennas, ceased production late 2009. An archived description of the Bugcatcher is at http://tinyurl.com/RC1102-bug
[2] www.adurcomms.co.uk/outbacker.htm
[3] Computer Modelling of the HF Mobile Antenna, Peter Dodd, G3LDO, *The ARRL Antenna Compendium, Vol 7*.