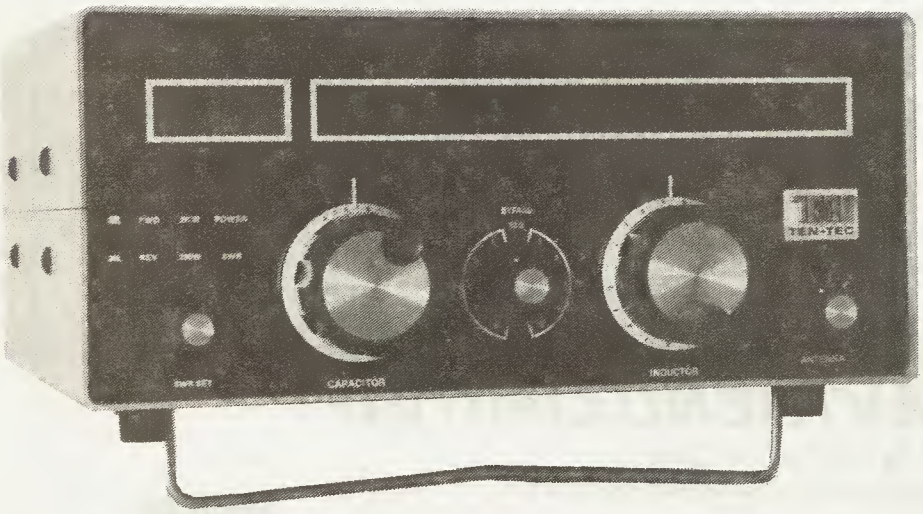
Ten-Tec 229B ATU Review



Chris Lorek G4HCL finds that L has all the best tunings.

For many amateurs operating on the HF bands, particularly 80m and 160m, an aerial tuning unit or ATU is an absolute necessity. This matches the impedance of the aerial system to the output impedance of your transmitter, giving maximum power transfer into the aerial system, and possibly more importantly safeguarding your expensive power amplifier devices from blowing up!

The KW ATU

Veteran HF operators will know the KW 'Eee-Zee' match ATU well, on sale many years ago and regarded by many amateurs as the ultimate of the day. The latest KW ATU is featured in the Ten-Tec range as their Model 229B, and is claimed to match virtually any unbalanced load, at all the power the law will allow, from 1.8MHz to 30MHz. We thought it would be a good idea to try it out, even to the extent of loading up the house drainpipes and having worldwide QSOs.

Offerings

The aerial tuning unit comes in a large metal case, 139mm × 330mm × 279mm, its physical size together with the large tuning controls giving you an idea of its quoted power handling capabilities of 2kW. The output matching range is specified as at least 10:1 SWR, at any phase angle, with a maximum input impedance at full power of 3000 ohms. A modified 'L Match' arrangement is used (more of this later), with a large tuning capacitor of 3.5kV voltage rating and a silver plated multi-turn roller coaster coil of 28μH to provide a continuously variable inductance. A sliding cursor along the front panel window together with a calibrated adjustment knob gives an indication of the inductance in circuit, the capacitor knob graduated with a 0-10 scale to show the amount of variable capacitance in circuit.

Four SO-239 aerial input sockets are provided, a front panel switch being used to select these in use. One of these sockets is internally linked to a screw terminal to allow a long wire aerial to be connected in place of aerial connection No.4 if required. An optional balun may also be internally fitted, to allow a balance input to be matched to a 50ohms unbalanced line to feed your transmitter. A large screw connection is also provided on the rear of the case to allow connection of an RF ground, very important and of course essential when using long wire aerials.

A front panel meter gives a readout of switched forward or reverse power, with full-scale ranges of 200W and 2000W. A further rotary 'SWR SET' potentiometer is provided, to allow direct SWR readings to be given following adjustment to match the forward power level. Applying a DC supply provides internal backlighting of the meter scale and inductance position cursor.

Circuitry

The matching circuit is basically an 'L' network using an inductor-capacitor arrangement in an L-formation. This arrangement does have the advantage that only two adjustable components are used rather than three. Because there are no internal nodes in the network, the maximum circuit voltages and currents that occur in the ATU are never greater than those present at the input or output connections. Also, because there are only two components to adjust, there is only

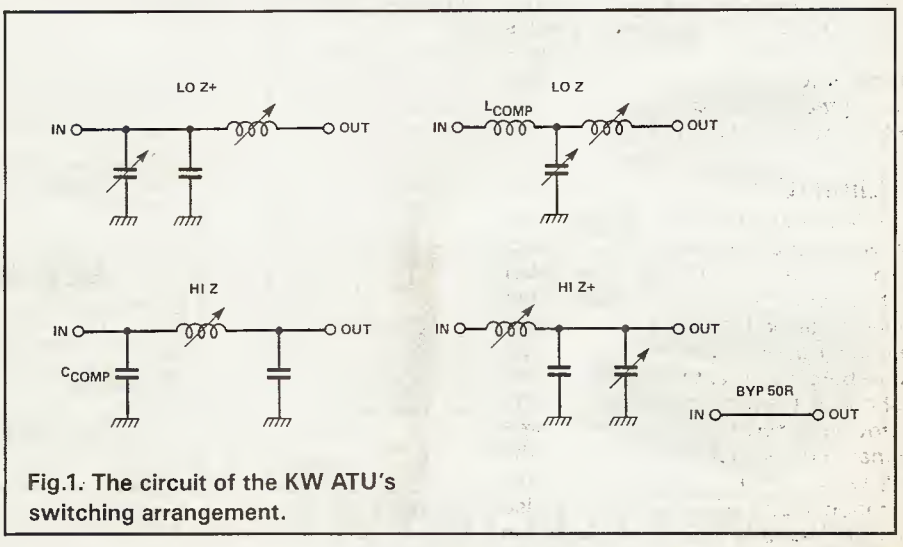
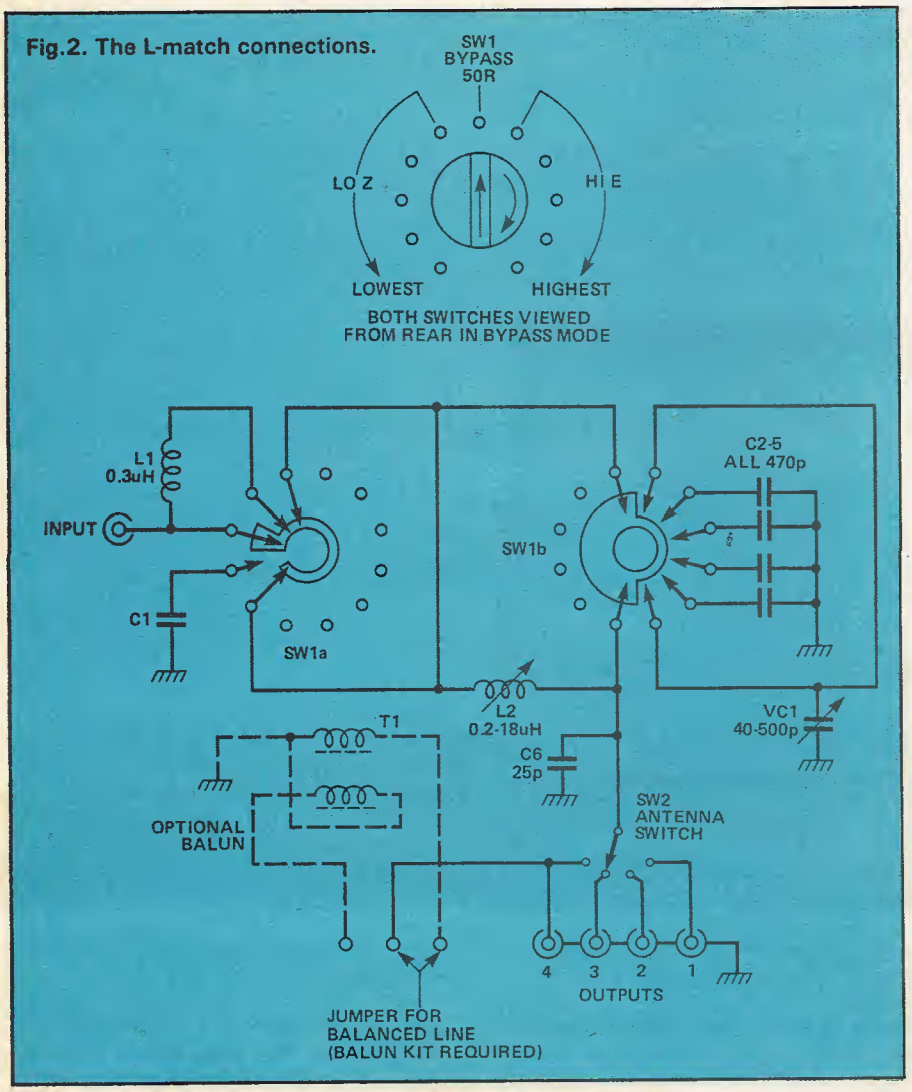


Fig.1. The circuit of the KW ATU's switching arrangement.

Fig.2. The L-match connections.



one setting of each that will provide a perfect match, providing a quicker method of tuning up in practice. The fundamental low-Q network provided gives lower circulating currents hence lower loss for a given power level, and also provides a reasonably broad bandwidth when compared with other networks using essentially higher Q. The inductor in the L configuration is always in series with the transmission line, providing a natural low-pass filter effect hence reducing the levels of any harmonics from the transmitter power amplifier.

Limitations

Life is not all roses, unfortunately, and as with most things the L configuration does have its disadvantages. First of all, it can only match impedances either higher, or lower, than the 50ohm output depending upon whether the capacitor comes before or after the series inductor, as shown in the accompanying diagram. To provide this switching function a large internal cermic switch (SW1) is used in the ATU, with a corresponding front panel indication of LO or HI. This switch is also used to place additional capacitance in parallel with the variable wide-spaced tuning capacitor, to provide a greater degree of impedance matching range, four 470pF ceramic capacitors being used. On 160m though, some low impedance may require more than the 2400pF total provided in the ATU with the variable capacitor at full mesh. Under these conditions, a further 1000pF 1kV capacitor, supplied with the tuner, may be soldered into circuit as required to provide extra capacitance if needed.

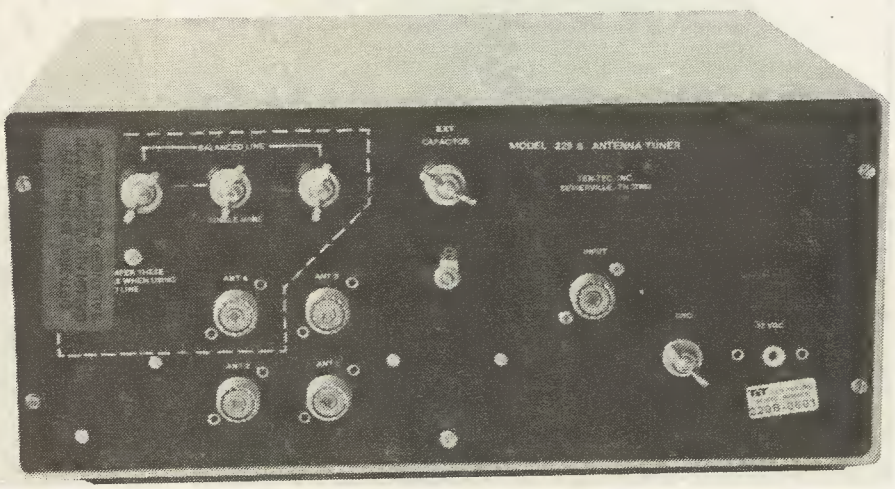
Stray Reactances

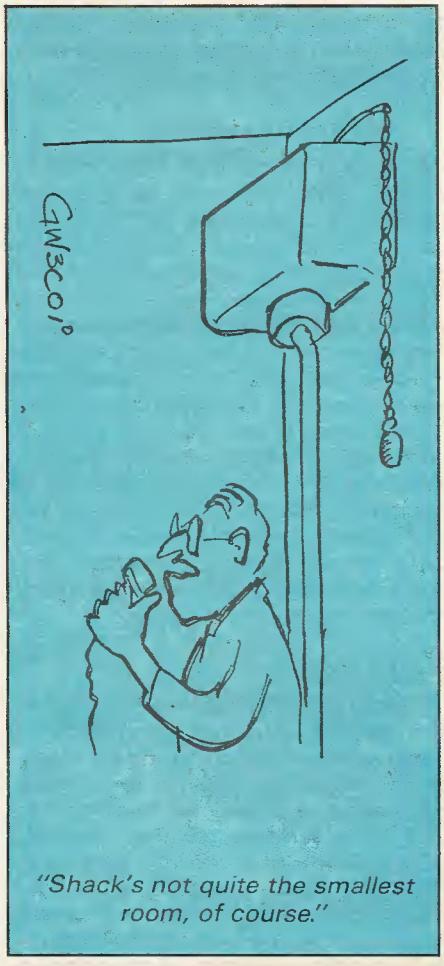
At high frequencies, in the case of only a slight mismatch as the load impedance approaches 50 ohms, the values of inductance and capacitance required for matching become small, and the stray inductance and capacitance present in an ATU circuit may exceed this. Rather than simply switching to Bypass mode on the KW ATU to directly connect input to output, the designers seem to have thought of everything by adding a small compensating capacitor of 25pF and inductor of 0.3μH into the circuit to counteract this problem, shown as C7 and L1 on the accompanying circuit of the tuner section of the ATU. Hence fine-tuning adjustments may be made to low values of mismatch, if needed.

In Use

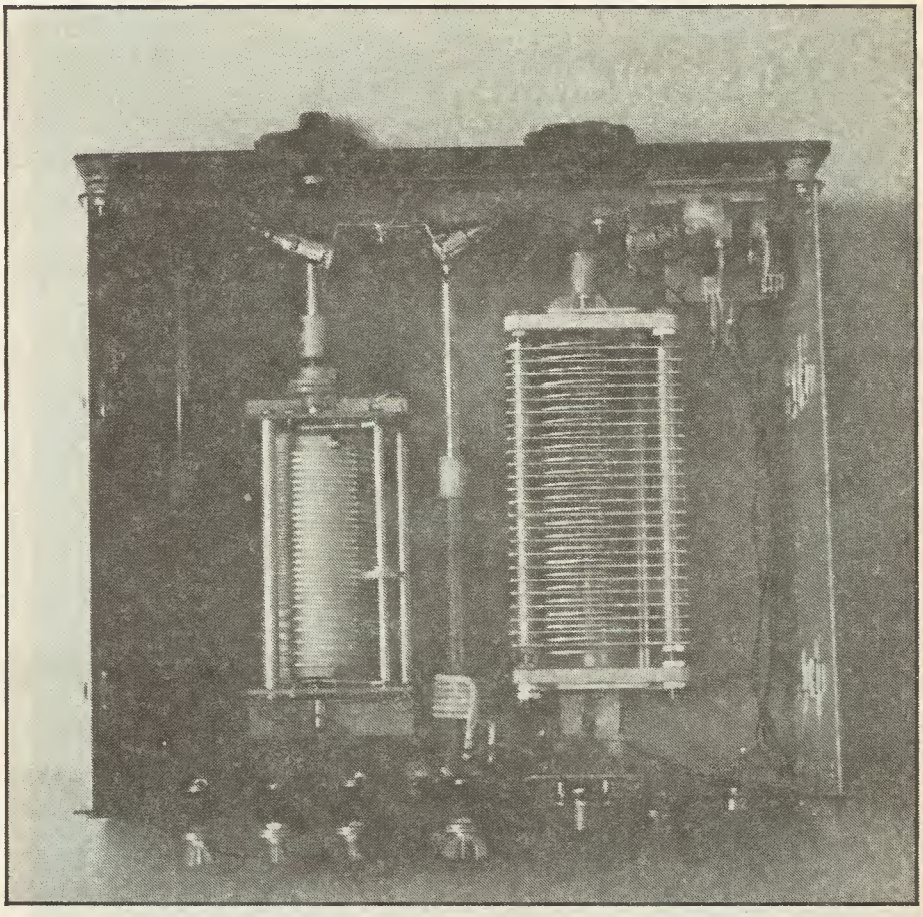
I have used several types of ATU in the past, my usual one being simply a Japanese type matching my HF transmitter lineup, which tends to get used more as an aerial selector than anything else. With perfectly matched resonant aerials, there is of course little need for an ATU, but many amateurs, myself included, do not have this ideal on all bands. I used the KW ATU in two forms, firstly to fine tune the impedance of my resonant aerials when I shifted in frequency from one end of the band to the other, and secondly as a true complex impedance transformer to tune a non-resonant aerial system.

All aerials have a resonant point, when using high-Q aerials such as trapped verticals the VSWR raises as you approach the band edges. In my case inserting the ATU allowed this to be corrected right down to a VSWR of 1:1 to feed my transceiver, this ideal match giving the benefit of better PA perform-



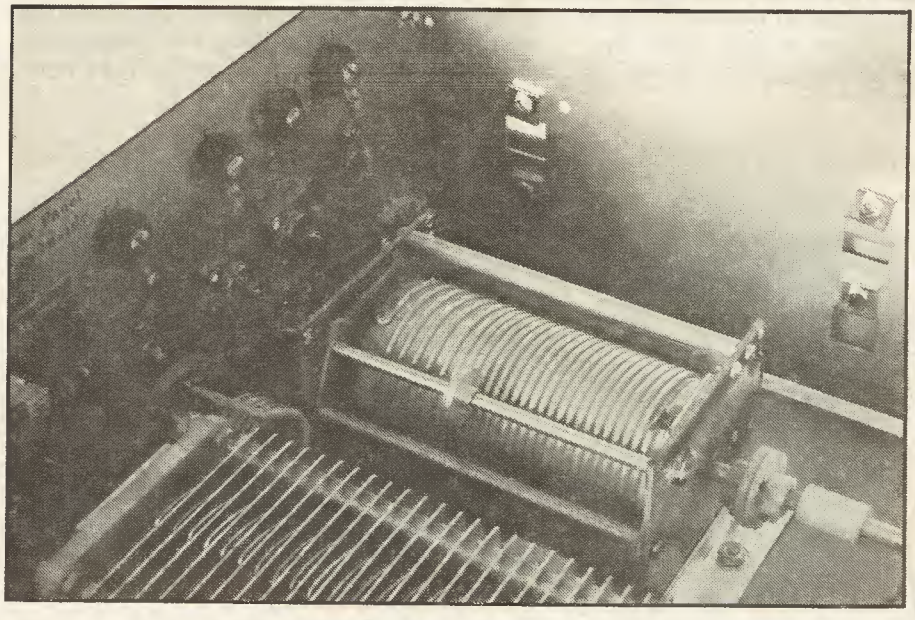


"Shack's not quite the smallest room, of course."



ance such as linearity and power transfer. It is important to note that the VSWR still remains at the aerial itself and along the coax feed line to the ATU, hence using such a tuner at the transmitter end only improves the match to the transmitter itself.

After some garden work laying new turf, I took advantage of the situation by burying over 50 copper earth radials of various lengths stretching towards the extremities of my garden. Living in a residential area with the need to reduce the visible aspect of my aerials as much as possible, I thought I would try the ATU at loading up a top-loaded vertical aerial, this being a wire disguised behind the plastic drain guttering of my two-storey house. This idea is actually described in the *ARRL Antenna Book*, using bonded metal guttering. In my case, one downpipe at the base of the radial system was the vertical section, while the horizontal guttering at the roof provided the top loading. The ATU was placed indoors about a metre from the vertical and ground feeds.



In use, the ATU provided a very good performance, matching the wire system right down to a VSWR of 1:1 on all bands. I was very impressed. A coax feed led from the feedpoint to the shack, where my Ten-Tec Hercules HF solid-state linear amplifier was used to power the system up. The aerial performance when fed with this system is of course not relevant to the ATU's matching capabilities, but I was certainly impressed with the results obtained on 20m when compared to my two other resonant 20m aerials in use at the time, this being another story!

Even when using the legal maximum power of 400W pep, I never experienced any 'flashover' in the ATU which I have found under some high-impedance matching conditions with other ATUs even when using lower powers. This improvement is due to the L match arrangement used. The ATU was used for several weeks on the well-used 14MHz port of my packet radio node, to ensure a good test, and gave unfailing performance. What more can I say?

My thanks go to HRS Electronics for the loan of the Ten-Tec Review equipment.