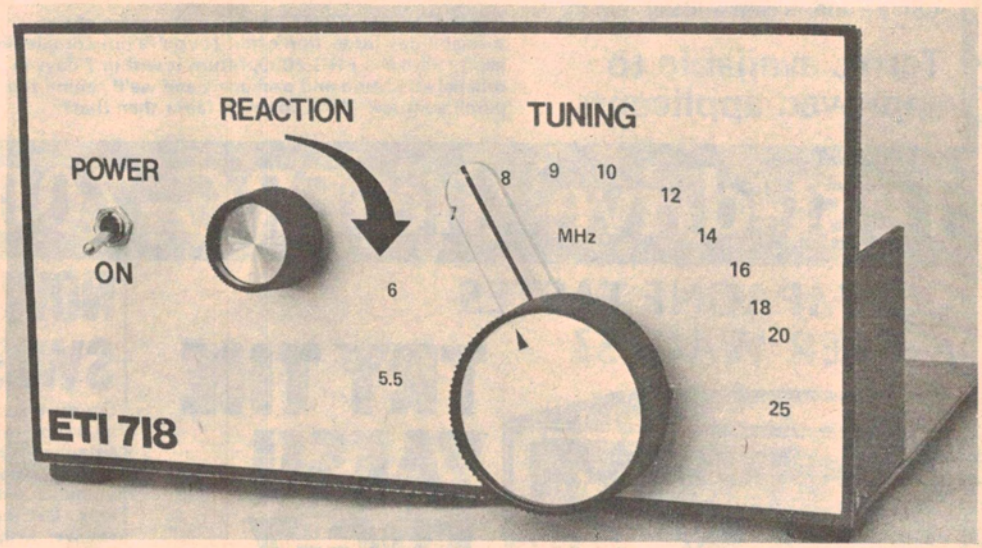
Project 718

SHORT WAVE RECEIVER

Maybe you can't afford a super-radio like some of those mentioned in our other SW Radio article this month, but we've got the answer. . .



APART FROM THE very early sets, which were based upon coherers and other devices you never hear of today, the first radios were very straightforward designs totally unlike today's sophisticated superhets. The early Tuned Radio Frequency (TRF) sets were simply a tuning circuit with some gain and a detector circuit, but later designs used positive feedback, in the form of reaction, to increase the performance. It is still possible to get a lot of fun from sets of this type.

By using modern solid state components a very simple reaction set can be built which offers surprisingly good performance at low cost. The Field Effect Transistor has almost identical performance to the earlier valve and is the basis of this design.

The circuit of fig. 1 uses an MPF 131 dual gate MOSFET as a regenerative detector, followed by a BC548 audio amplifier stage which is capable of driving a crystal ear piece, high impedance head phones, or being fed to the input of an amplifier. The frequency coverage is approximately 5.5 to 25 MHz, or 54 to 12 meters.

This coverage includes many interesting features such as the international broadcast bands at 49, 31, 25, 19, 16, and 13 metres, as well as amateur bands at 40, 20, and 15 metres.

Operation

Satisfactory operation depends on the proper use of regeneration, which unless operated correctly will result in poor performance and interference to neighbouring sets.

Initially, set C1 about half closed and increase the regeneration until a point can be found where signals are heard when tuning. Increasing the regeneration will increase the volume, until a point is reached where a whistle is heard when tuning across a station. The most sensitive point is where this whistle just fails to arise.

Regeneration has to be adjusted in conjunction with the tuning, because the setting of RV1 will change as the set is tuned across the band. The tapping position of the coil also influences regeneration, and may have to be lowered to obtain correct operation on some frequencies. The tapping point found to give the best results will also depend on the length of antenna used. As a starting point, try the middle tap and then move the tapping point up or down the coil to give the strongest signals, while still able to achieve regeneration.

Reception of CW signals is possible by using the regeneration control so the set is just oscillating, while the tuning gang is set so that a beat note is heard. This can also be done for SSB signals but the tuning will be very critical.

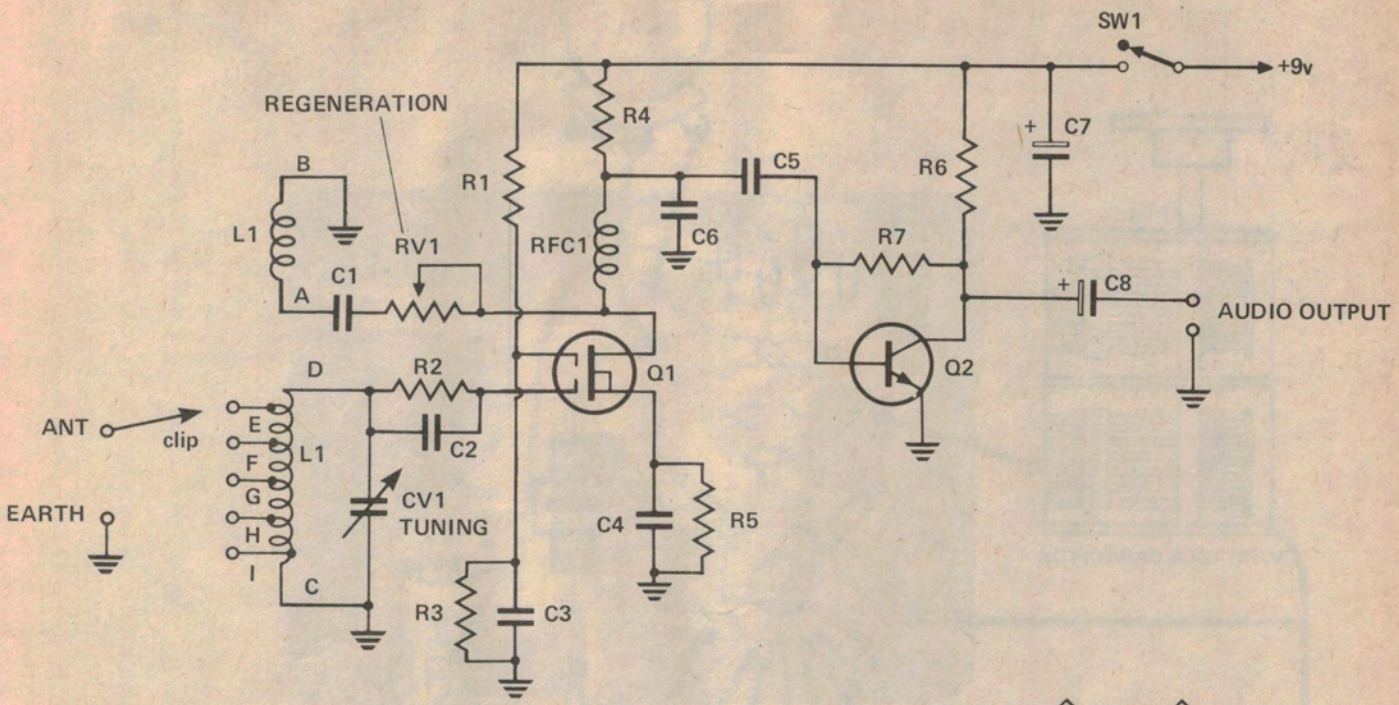
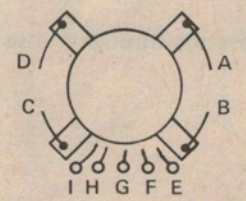


Fig. 1. Circuit diagram of the receiver.



HOW IT WORKS – ETI 718

Signals from the antenna are coupled into the tuned circuit (L1, CV1) via the clip lead and the coil taps. The tapping point is varied to give the best match from the antenna to the circuit, yielding the best performance.

The tuned circuit acts as a filter, only letting the desired frequency through to the FET (Q1), since the tuned circuit resonates at a frequency set by the position of the variable capacitor, (CV1). As the value of the capacitor is varied, so the resonant frequency of the tuned circuit, and the frequency of reception, is varied.

The radio frequency signal at the desired frequency is then fed to the FET (Q1), where it is amplified and appears at the drain. Because the radio frequency choke (RFC1) presents a high impedance (or near open circuit) to radio frequencies the signal passes through C1 and RV1 to the regeneration coil wound on L1. Some of this signal, the amount determined by the setting of RV1, is coupled back to the tuned circuit.

For regeneration to occur, the signal fed back to the input must be the same polarity or 'phase' as the incoming signal. A phase reversal occurs in the FET, so a second phase reversal is necessary. This is achieved by connecting the feedback to the reaction coil upside down (i.e. to the bottom of the winding, and the earth to the top). In this condition of positive feedback the circuit can be made to oscillate.

The feedback signal now passes through the tuned circuit again to the FET, although this time it is 'detected' before it is amplified once more. Detection recovers the audio information from the signal before audio amplification. The radio frequency choke looks like a short circuit to the low frequency audio signal which passes through it. It cannot however pass through resistor R4, but is coupled to the audio amplifier (Q2) via C5, where it is amplified before being fed to the output. Any unwanted RF signal which happens to get through the RF choke is shorted to earth by a small value capacitor (C6).

Maximum circuit gain, and therefore maximum audio output, occurs when the regeneration control is advanced so that the circuit is just not oscillating. This point also yields the best 'selectivity', or the ability to distinguish between close stations.

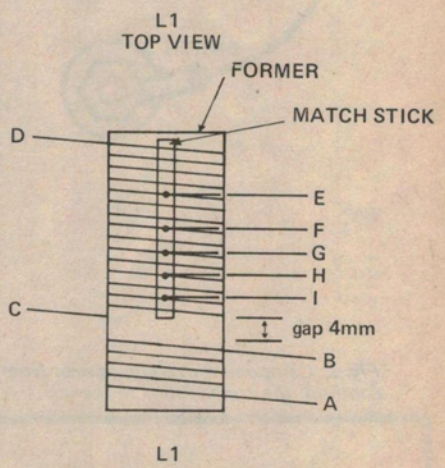


Table 1 – Coil Winding Details

Reaction coil: 4 turns of 24 B & S enamelled wire, closewound at the base of the former in a clockwise direction.

Tuning coil: 15 turns of 24 B & S enamelled wire, closewound, starting 4 mm above the top of the reaction winding in a clockwise direction. Taps at 2,4,6,8 and 11 turns from the bottom of the winding. Turns which are tapped are raised over a matchstick.

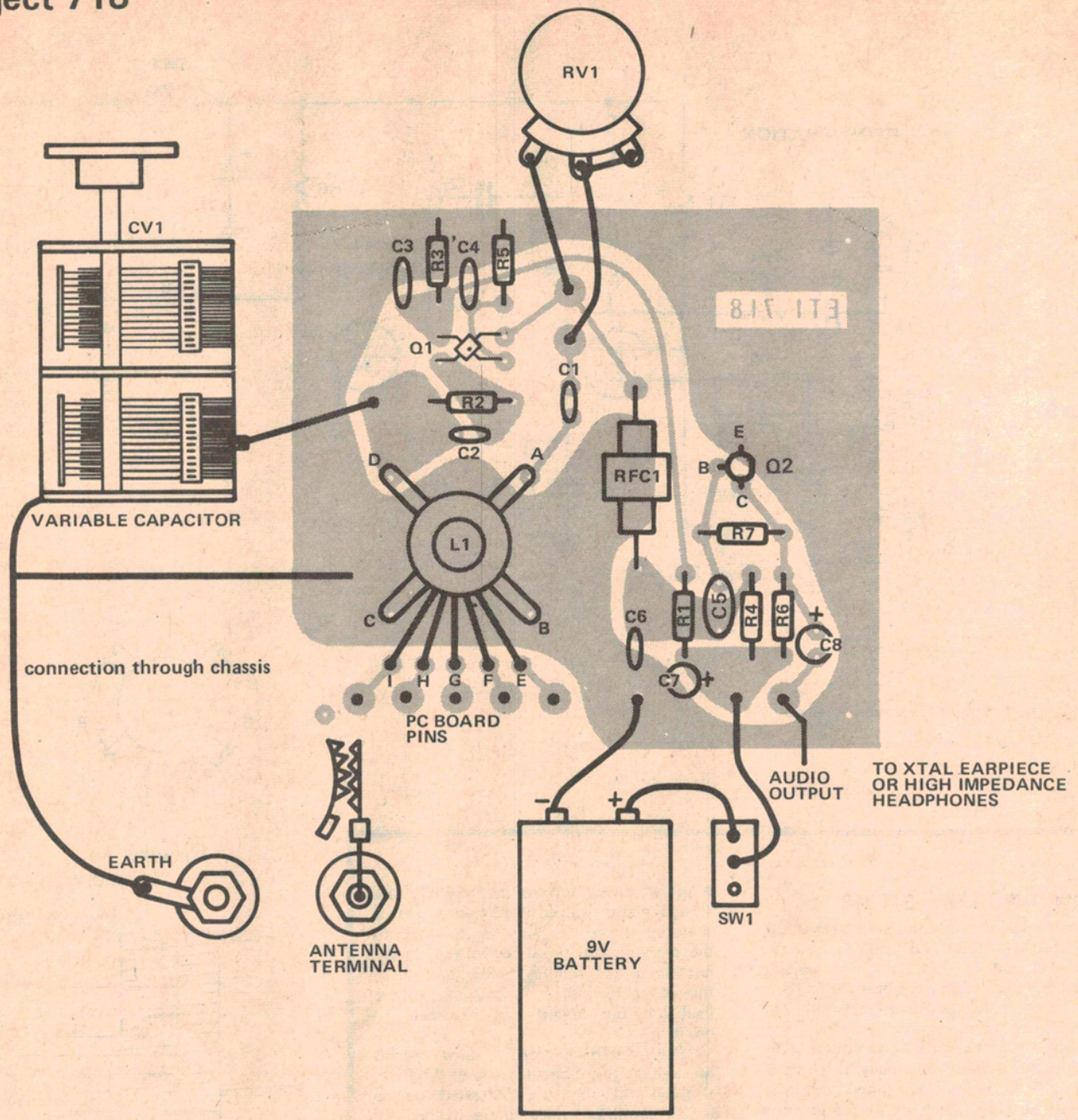


Fig. 2. Component overlay, as seen from the component side of the board. Note carefully the connections to the coil.

PARTS LIST – ETI 718

Resistors all ¼ W, 5%
- R1 . . . . . 4k7
- R2 . . . . . 1M2
- R3 . . . . . 10k
- R4 . . . . . 2k2
- R5 . . . . . 1k
- R6 . . . . . 10k
- R7 . . . . . 4M7

Potentiometer
- RV1 . . . . . 2k lin pot

Capacitors
- C1. . . . . 10n ceramic
- C2. . . . . 270p ceramic
- C3,4 . . . . . 100n ceramic
- C5. . . . . 100n greencap
- C6. . . . . 1n ceramic or greencap
- C7. . . . . 10µ tantalum 16VW
- C8. . . . . 4µ7electro 16VW

Variable Capacitor
- CV1. . . . . 415p tuning capacitor or similar (see text)

Semiconductors
- Q1 . . . . . MPF131 dual gate MOSFET
- Q2 . . . . . BC548 or similar

Miscellaneous
- pc board . . . . . ETI 718
- pc board pins
- coil former. . . . . 12 x 30 mm air cored Dick Smith Cat. No. L-1110
- RFC1. . . . . 2.5 mH RF choke Dick Smith Cat. No. L-1824
- box to suit . . . . . (see text)
- SPST on/off switch
- planetary drive, 5 to 1 reduction
- length of 24 B&S enamelled wire
- 9 V battery and battery clip
- knobs, rubber feet, crystal earpiece or high impedance headphones, headphone socket

Construction

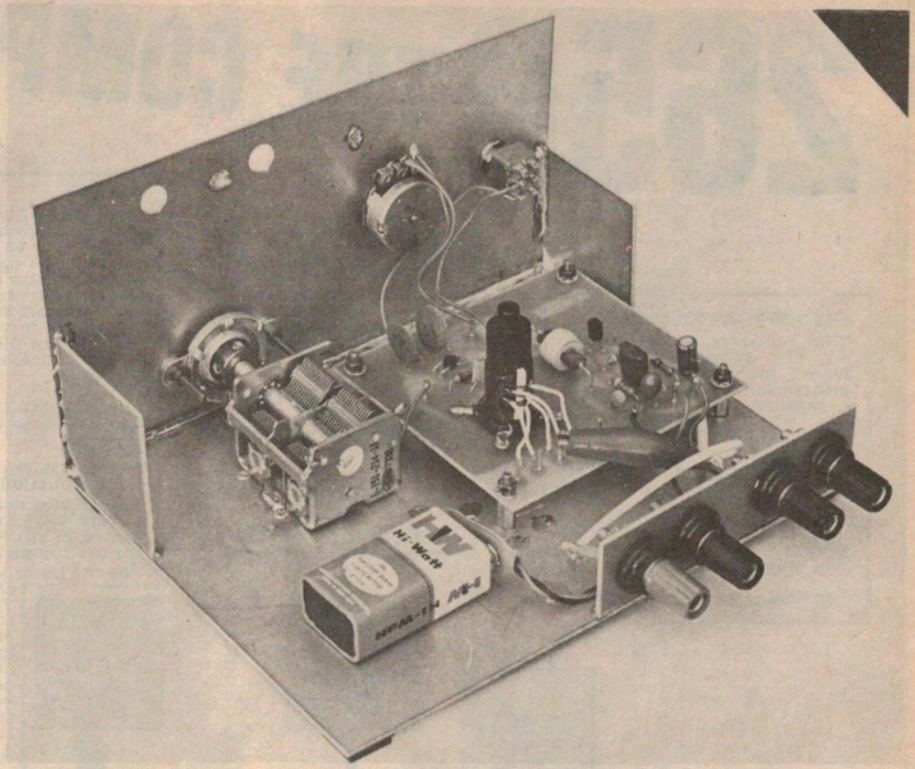
All the components except the tuning capacitor are mounted on a printed circuit board, (see fig. 2). Other types of construction such as vero board can be used but may not offer the same repeatability of results. The coil (L1) is wound separately as in Table 1 and later mounted on the PC board. If the type of former in the parts list is used, the solder lugs on the former will line up with holes in the PC board and the former can then be held down onto the board by its connections. Short lengths of wire are used between the coil taps and the PC board. Printed circuit pins are then soldered into the tapping points and the tap changed by means of the alligator clip from the antenna terminal.

In our receiver we used one section of a second hand dual tuning gang. Most gangs from an old radio will do as long as only one section is used, the lowest frequency of operation depending on the value of capacitance.

The chassis is 175 by 90 mm and 140 mm deep, and is constructed entirely from single sided PC board (copper side inward). This method is both cheap and easy, the front panel being soldered onto the base plate. Squares of PC board are soldered into the ends for rigidity of the front panel.

A planetery drive mechanism is used with the tuning capacitor and is attached to the front panel with two nuts and bolts. A plastic cursor can be cut from a sheet of thin perspex and attached to the outside of the drive mechanism with Araldite to provide a dial pointer.

The regeneration potentiometer and the ON/OFF switch are also mounted on the front panel, with the antenna, earth and output connections mounted on a small piece of PC board at the rear. All wiring should be kept as short as possible, especially to the regeneration control and the tuning capacitor.



Rear view of the completed unit. We used one section of a dual gang tuning capacitor. The terminals from left to right are: Antenna, Earth, and the two output connections.

Antenna and Earth

Although some signals can be heard with a small indoor antenna, an outdoor antenna is much better. The antenna should be as long and as high as practicable, running perhaps from the house to a tall tree or other building. Figure 3 shows a typical antenna installation which will give good results. The leadin from the antenna should be kept as short as possible, so a good position for the set would be close to a window.

An earth is not essential but is generally worthwhile, since it can help to avoid the effects of hand capacity by grounding the metal chassis. The set can be earthed to a water pipe or run to a metal spike driven into the ground.

Performance

The number of short wave signals that can be heard depends upon the time of day, early morning, late afternoon and night being the best. After a few periods of listening at various times you will know what to expect. Using an indoor antenna we were able to receive strong signals throughout the day and the number of stations heard rapidly increased towards dark.

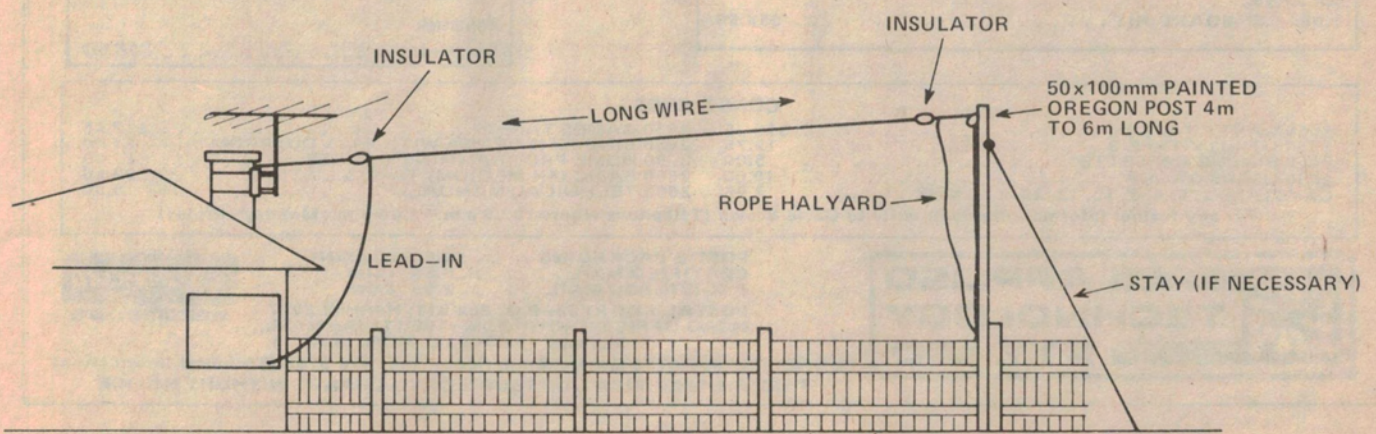


Fig. 3. A typical Long Wire antenna. The Lead–in should be as short as possible