Receiver Aerial Matching

THE input impedance at the aerial terminals of a communications receiver is generally chosen to match into some standard feeder impedance.

feeder, a good match results, at least at the receiver end.

When an end-on aerial is employed, or when a feeder cable with a characteristic impedance different to that of the receiver

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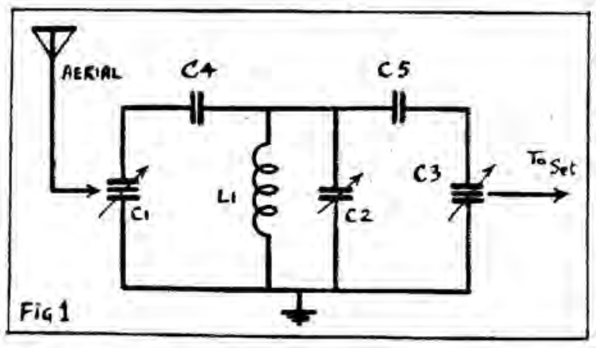
input is used, things are not so simple, as a few examples will show.

Assume the receiver impedance is 400 ohms and a low impedance feeder cable of about 80 ohms is used between the aerial and the receiver. The ratio of the impedances is 5 to 1, which will result in a certain amount of mismatch and a consequent deterioration in performance. On average to strong signals, the falling off will not be serious, but the intelligibility of weak signals will be adversely affected.

With an end-on aerial, the degree of mismatch will vary greatly according to frequency. When the frequency is such that the length of the aerial represents an exact quarter-wave length, the end will show a low impedance—about 40 ohms in an average case. On the other hand, when the aerial is an exact half-wavelength, the end impedance will be high—2000 ohms or more. At intermediate frequencies, the end impedance will vary between these extremes and, in the case of a long wire, the multiples of quarter and half-wavelengths and fractions thereof will further complicate matters. Only over relatively small bands of frequencies will the match be really good with a 400 ohm impedance, these points will occur when the aerial is slightly longer or slightly shorter than a quarter wavelength. Whatever the receiver impedance, it is not possible to ensure an accurate match over a wide range of frequencies, with an ordinary type of aerial. (It can be done commercially by using special aerial systems and untuned feeders.)

On amateur frequencies, the nearest one can get to obtaining a good match on each band is to use a Windom type of aerial, the latter, as usual, working either on the fundamental or harmonic nodes. For instance, an aerial 60 feet long, with the feeder tapped in about 11 feet from the centre, will give good results on the 28, 14 and 7 Ms/c bands. The single wire feeder possesses a medium impedance which will match quite well into the receiver.

An end-on half-wave aerial (or a multiple of half-waves) is actually about the worst one could use. The self-resonant properties of the aerial are largely nullified when the end, with its relatively



high impedance, is connected to the receiver terminal.

Construction of a Matching Unit

It is not a difficult matter to construct a small unit, with the aid of which correct matching can be maintained over a wide range of frequencies. In effect, this unit is a pre-selector, but one which does not require a valve, and therefore introduces no complications in the way of power supplies. It enables full advantage to be taken of the natural resonant properties of the aerial and ensures a correct match to the receiver at all times. Further, with a superheterodyne receiver, the additional tuned circuit reduces image interference, and, with any type of receiver, gives a measure of increased selectivity.

The circuit of the unit is shown in Fig. 1. Using the component values specified, any aerial up to 150 feet in length can be matched on any frequency higher than about 3.5 Mc/s. To be fully effective on frequencies lower than this, it is necessary to increase the value of C4 and C5 to about 20 pF. Conversely, at the higher frequencies—for instance, the 28 and 14 Mc/s amateur bands, some improvement will be obtained if C4 and C5 are reduced to 5 pF. Variable trimmers may therefore be used in place of fixed condensers for C4 and C5, where the interest lies over a wide range of frequencies.

The construction is straightforward and easy. Any convenient panel and chassis may be used. The differential condensers C1 and C3 should be mounted on insulated mounting brackets, since the spindles must not be earthed. One stator of each condenser is earthed—it is immaterial which—and the other stators connect to the tuned circuit, through C4 and C5. It is preferable to use standard Eddystone plug-in coils for L1, since the tuning range of each coil can be readily ascertained. Also, dials should be fitted to the variable condensers, so that the settings of various frequency bands or for different aerials can be logged for future reference. The dials fitted to C1 and C3 should indicate zero when the rotor sections are fully meshed with the earthed stators, corresponding to minimum coupling and low impedance.

Operation of the Unit

With the aerial connected directly to the receiver, first tune in a station on the selected frequency band. If an "S" meter is available to give a definite carrier strength indication, so much the better.

Then transfer the aerial to the appropriate stand-off insulator on the pre-selector unit and connect the receiver to the other insulator with a short length of wire. Plug in a suitable coil and tune C2 to resonance. Starting with C3 at zero, increase the dial reading in

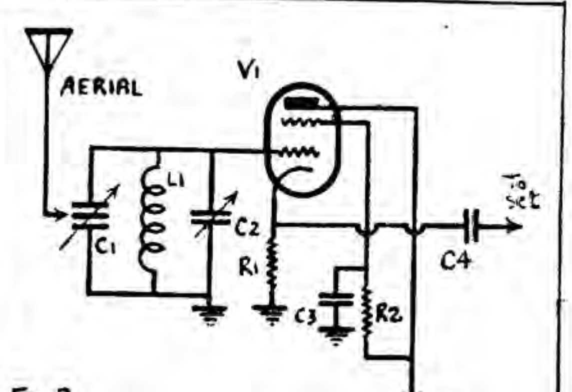


Fig.2.

small steps, retuning C2 each time (only a small movement will be necessary) until maximum strength results. The unit is now matched to the input impedance of the receiver.

Follow the same procedure with C1 (retuning with C2) until the aerial also is properly matched. Unless the match originally was good, a definite improvement will be noticeable. Thereafter there will be little need to touch C3, but

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AERIALS

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the settings of C1 and C2 will vary according to the frequency band in use. In general. the dial of C1 will be at zero when the EIGHT Crusader Press April 49 aerial length approaches a quarter wavelength or an odd multiple thereof, and near maximum, when the aerial is a half wavelength or any multiple.

A Second Method

A second method of ensuring correct matching is shown in Fig. 2. This involves the use of a valve, but cuts out one variable adjustment and is, on the whole, somewhat better where it is desired to cover a wide range of frequencies. The first portion is practically identical with that of Fig. 1. The signal is fed into the grid of a pentode valve, which is used as a cathode follower, the output to the receiver being taken from the cathode *via* a condenser, to prevent the bias-cum-load resistor being short circuited.

Normally, a valve with a high mutual conductance is specified for cathode follower applications, in order to bring the output impedance down to a low value (70 to 100 ohms). In the present instance, this is not necessary, and it will, in fact, be better to use a valve such as the EF37, EF39, 6J7, etc., possessing a medium mutual conductance, and giving a close match to the receiver input impedance.

It will not be easy to adapt the circuit for use with a battery valve. An R.F. choke will be necessary in each leg of the filament, since the latter must be held above earth potential as regards R.F. At the same time, there will be no need for the R.F. chokes to be so efficient as when used in, for instance, an electron coupled oscillator circuit, and if the reader is prepared to wind two chokes, having reasonably high inductance combined with low resistance, reasonably good results should be obtained.

In the circuit of Fig. 2 the output impedance remains constant, irrespective of frequency, but it is still necessary, of course, to match the aerial to the tuned circuit by adjustment of C1. One feature of the cathode follower circuit is the very high input impedance which, in effect, will sharpen the tuning of the L1/C2 combination and give added selectivity. Admittedly, the valve itself will not provide any additional gain, but the improved matching and the increased selectivity will result in a definite improvement in the performance of a receiver with which the unit is used.

Components List (Fig. 1)

C1, 3—25 pF Differential. Cat. No. 719. (Eddystone.)

C2 —60 or 100 pF Single. Cat. No. 582 or 585. (Eddystone.)

C4, 5—10 pF Ceramic or Silvered Mica. (But see text.)

L1 —Coil to cover appropriate frequencies.

Miniature Stand-off Insulators for aerial and receiver connections.

Components List (Fig. 2)

C1, C2 and L1 as in Fig. 1.

C3, 4.—.01 uF (preferably mica).

R1. —470 ohms ½ watt.

R2. —47,000 ohms ½ watt.

V1. —EF37, EF39, 6J7, etc.

MEVER

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not using the meter remove the leads, set volt and milliamp switches to the maximum range (this tends to reduce the chances of 250V. across the 5V. or 5MA ranges), and see that the switch S2 is in the centre position.

This unit, although possibly not as accurate as a commercial instrument, is quite accurate enough for service work. After all, there is a variation of 10 per cent. allowed on stock resistances (at least), and it generally takes a greater change than this to seriously affect a receiver's operation.

BRIDGE

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can keep our dial measurements reading in the same direction by employing a two-bank switch, which reverses the potentiometer connections constituting one-half of the bridge circuit with relation to the other half, made up by the standard component and that across the test terminals.

The standard condensers used in our circuit give us the following:

Switch position 1 = C x 10:
1 mmfd. to .1 mfd.

Switch position 2 = CX 1000 :
100 mmfd. to 10 mfd.

Switch position 3 = CX 100,000:
.01 mfd. to 1000 mfd.

Application

The component it is desired to measure is placed across the test terminals and the range switch rotated to its appropriate position. The calibrated dial is then rotated until the 6E5 null-indicator closes to a sharp line, the sensitivity control being advanced as balance is approached.

Faulty Components

Condensers with a high power ractor or low "Q" will cause the eye to be blurred on each side, the width of the blurr increasing with power factor.

The eye will open at the left end of the dial setting for shorts, and at the right end for opens. Intermittent components will cause the eye to flicker.