Technicalities

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Making coils and matching

Those of our readers with a slight technical bent will probably have noticed the large number of ferrite transformers, baluns and inductor type devices which feature in many of the designs. There's no apology to be made for the sheer quantity which our projects specify — they are an incredibly useful impedance matching gizmo — but some explanation could be due about how the transformer etc winding and core details are arrived at. But first, a little bit about why the are so useful.

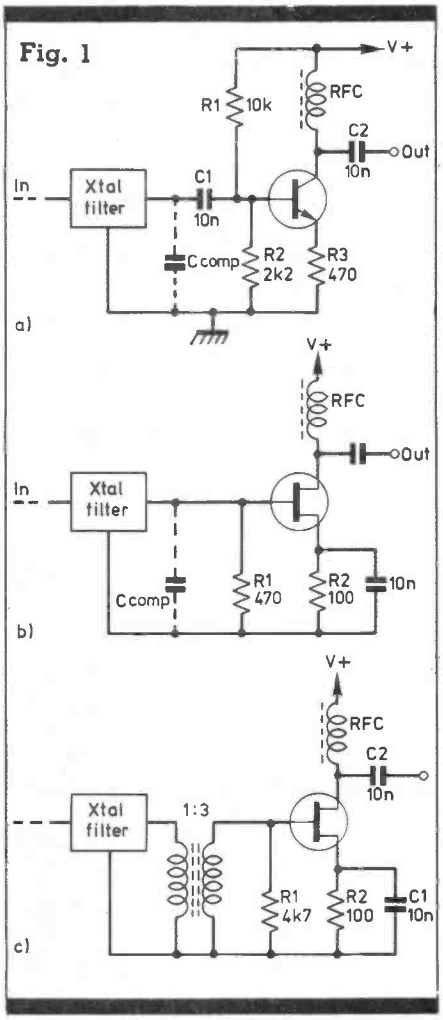
Matching on a blind date

The thing about RF circuit design is that things are not always what they seem. You can't dovetail little parts of circuitry together to make a complete radio system without a compatible interface between the various building blocks. Take your average crystal filter for instance. It presents a resistive termination only at a single frequency. At all others, there will be a greater or lesser degree of reactance ie, it looks to the rest of the circuit as though its got either a capacitor or inductor connected across its terminals. Although the frequency/impedance characteristic is peculiar to say the least, it expects the circuit to which it is coupled to exhibit a constant resistance over a wide frequency range. If the conditions aren't right, then the level of passband ripple will rise to unacceptable proportions.

There are a number of ways of matching a filter to a subsequent piece of circuitry. **Fig. 1** shows three options. For the sake of argument, the crystal filter shown has an impedance of about 500 ohms.

Option a) shows the unit coupled directly into a bipolar transistor amplifier stage. This circuit might present a resistance of 500 ohms to the filter depending to a considerable extent on the exact characteristics of the transisor. Since the manufacturing spread is relatively wide, the input resistance

Fig. 1



presented to the filter will be all over the place.

Option b) offers a totally predictable input circuit to the crystal filter. Because the FET input impedance is so high, the actual characterisitcs are those of R1. The capacitor comp is the required input capacity specified by the crystal filter manufacturer minus the gate capacitance of the FET — typically about 5pF. The main drawback of this circuit configuration is that the noise performance is rather poor. At frequencies around 10MHz, the optimum input resistance which the FET itself needs to 'see' will be several kilohms. This contrasts with the 500 ohms of the filter.

The answer of course is Option c) which uses a 1:3 ratio step up transformer to raise the input impedance to 4k5 (9 x 500). Because the transformer is inherrently broadband, this circuit meets both the requirements of both the crystal filter and the FET.

How many turns?

The crystal filter example was just a single instance. In practice, ferrite transformers and associated components are used whenever some broadband matching condition needs to be fulfilled. In addition, they can be used to produce special conditions such as antiphase signals for balanced mixers and unbalanced to balanced transformations. The question arises, whatever the application, about how many turns to use and what size to select the core. This sort of thing can be predicted (it is claimed) by some fairly complex mathematics taking in such things as core area, core volume, magnetic path length, permeability, maximum magnetising force and your inside leg measurement. In practice, when you select half a dozen greyish looking little objects from some equally greyish looking stallholder at a mobile rally, any attempt at scientific design and calculation goes right out the window.

What you must do is this. Decide what impedance transformation you would like to make and translate this figure into a turns ratio. For the record, the turns ratio is the square root of the impedance ratio. Next, you need to find something out about the core material. More specifically, you want to find out the number of turns required on the core of your choice to reduce reactive loading on the external circuit to negligible proportions. For HF frequencies, I recommend this approach. Using a standard HF receiver tune into a medium strength signal (eigher off air or from a signal generator) at the lowest frequency which you want