For the handyman/experimenter:

A Frame Aerial & Tuner

This simple rather odd looking gadget has several novel applications. It can boost the performance of small portable radios, illustrate the elementary principles of direction finding, and form the basis of a simple crystal set for use with an amplifier or tape recorder.

To give the gadget a name, old-timers in the radio game would call it a "frame aerial". To it we will add a couple of other components, to extend its uses.

Besides illustrating certain fundamental principles:

- It can boost the long-distance performance of simple portable receivers.
- It can provide a radio signal for your tape recorder or amplifier.
- It can work as a self-contained crystal set, operating a pair of headphones.

The prototype was built from scraps of particle board, as per Fig. 1. Plywood or other non-metallic material could be used but particle board (eg Pyneboard) is readily available and simple to work.

The dimensions are quite arbitrary but, if you work to those shown, your unit should operate in a manner similar to the original, without need for modification.

Lay the pieces of particle board on the table so that you can judge the angles and file them as necessary with a wood rasp. Put a smear of glue between the surfaces and use some long, slender panel pins to hold the pieces together. Let the glue dry, if you like, but the frame should be rigid enough, with the pins in position, to carry right on with the construction.

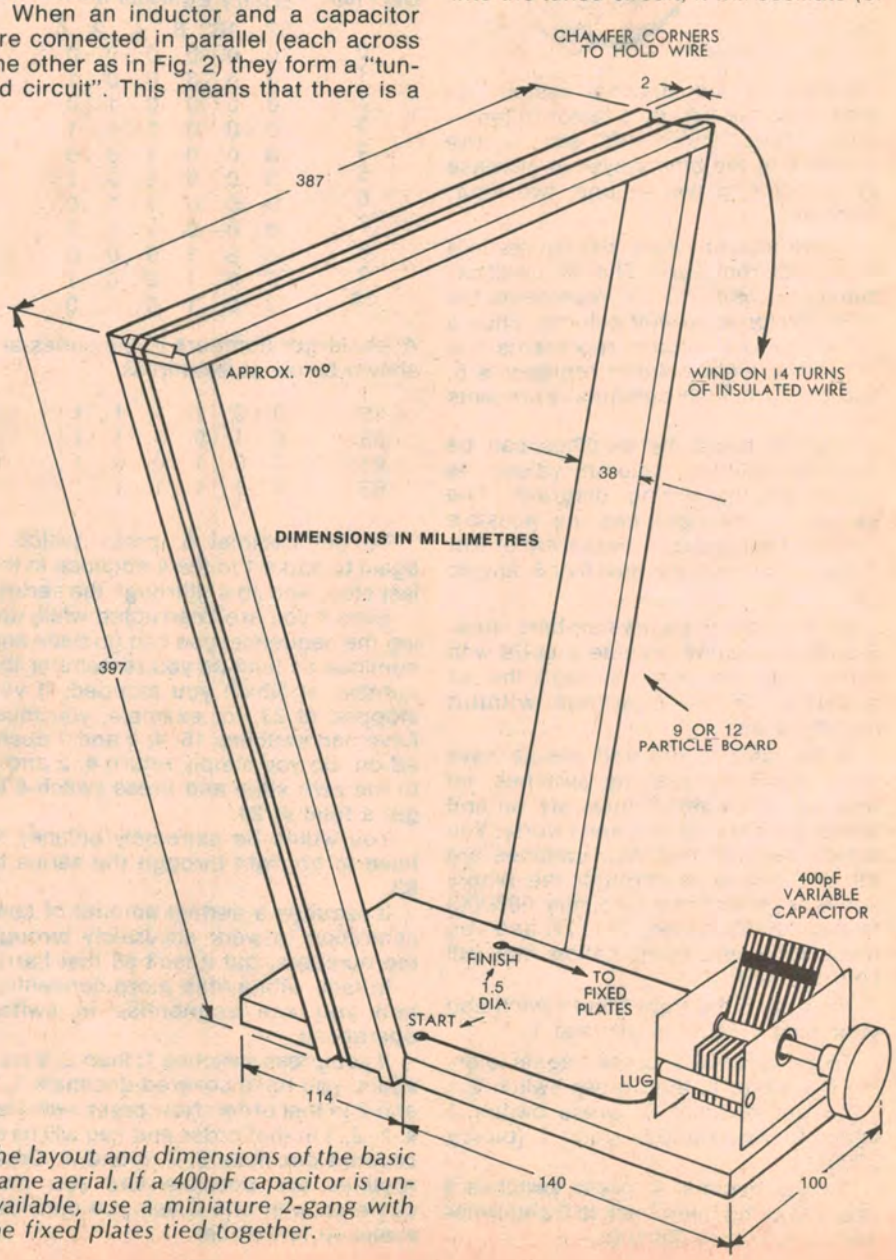
Wire has to be wound around the frame and, to keep it in position, all four corners should be chamfered with a rasp or sharp knife, leaving just the outer edges raised.

You will need about 20 yards (18.3m) of thin, insulated wire. The gauge and age of the wire is not important, provided the insulation is good. We used single-strand plastic insulated "bell-wire" bought from a hardware store.

Pass one end through a hole in the base-board and, keeping the wire reasonably taut and straight, wind on 14 turns, laying the turns neatly side by side. Pass the free end through a second small hole in the base-board and the first part of the job is done.

Using electronics terminology, you have wound a type of "coil" or "inductor". On its own, an inductor is not particularly useful for our present purposes. It needs to be associated with another electronic device known as a "capacitor". Old timers used to call it a "condenser".

When an inductor and a capacitor are connected in parallel (each across the other as in Fig. 2) they form a "tuned circuit". This means that there is a particular frequency of alternating voltage or current, to which the combination is most responsive. If energy at this frequency induced ie, (introduced) into the tuned circuit, it will oscillate (or



The layout and dimensions of the basic frame aerial. If a 400pF capacitor is unavailable, use a miniature 2-gang with the fixed plates tied together.

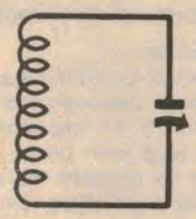
flow back and forth) between the inductor and the capacitor with the greatest facility.

By selecting suitable values for the inductor and the capacitor, a tuned circuit can be "resonated" (or made responsive) to any desired frequency. If either one is made variable, the "resonant" frequency will vary in accordance with it.

By having a suitable fixed inductor and a suitable variable capacitor, a tuned circuit can be made to respond to any frequency radiated by normal broadcasting stations within the frequency band of 525kHz (kilohertz) to 1600kHz.

To tune right across the ordinary radio broadcast band, you will need a variable capacitance having a maximum capicatance of about .0004 microfarads or 400 picafarads (pF).

Fortunately, the majority of variable capacitors that have been used in older broadcast band receivers have a maximum capacitance of about this value. You shouldn't have too much trouble in getting hold of an old one or a new one, though you may need to ask



The schematic diagram for a resonant (or tuned) circuit. The inductor (or coil) is on the left; the capacitor (or condenser) is on the right.

your local radio serviceman, or soneone who knows about such things, to verify that it is suitable.

While you are at it, ask them to verify for you the two connections you will need to make, one to the moving plates (usually via the frame) and one to the fixed plates.

Mount it on the baseboard of your frame inductor, connect one end of the inductor to the moving plates, and the other to the fixed plates and the combination wll have become a complete tuned circuit.

The tuning coils in radio receivers are normally quite small — most would fit easily in a thimble — and, for this reason, they cannot directly pick up much in the way of signal from a radio station. Consequently, many radio receivers have provision for the connection of an aerial wire, and perhaps an earth wire, by which signals are fed to the first tuned circuit.

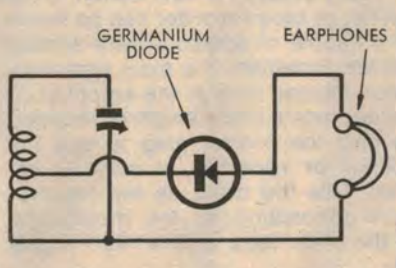
In portable receivers an alternative method is used, the first tuning coil being wound on a ferrite rod a few inches long. Energy from radio stations tends to concentrate in the rod and therefore in the coil which is wound around it. This provides enough signal pickup in

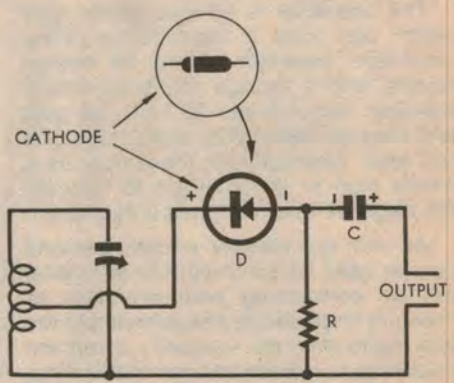
A frame aerial has obvious directional qualities. To get an accurate bearing on a distant transmitter, the frame aerial needs to be in the open, away from house wiring, metal roofing, etc.

areas not too remote from the broadcasting stations.

Because of its size, the frame aerial that you have just finished can also pick up signals directly. In fact, it will pick up signals rather better than the ferrite rod system in the more compact transistor portables. As a result, it can be used to assist very small portables to pick up weak and distant stations.

Frame aerials have directional qualities. They will pick up signals most effectively when they are positioned edge-on to the station. They show a deep null — or lack of pickup — from





Above: The simple crystal set hook-up. Right: A slightly more complicated circuit suitable for use as a tuner or with a crystal earpiece.

directions broadside on to the frame.

In fact, radio direction-finding devices make use of this fact. By selecting a particular radio station and rotating a frame (or loop) type aerial so that the signal is rejected, the operator knows that the particular station lies along a line at right angles to the plane of the frame. Some doubt remains because the station could lie — say — due east or due west. However, other factors are usually sufficient to resolve this ambiguity. For example, if a boat is cruising off the east coast of Australia, all Australian radio stations would have to be in a generally western direction.

It so happens that the ferrite rod aerials used in transistor portable receivers are also directional. They also tend to exhibit a null when the coil is broadside on to the transmitting site; this corresponds to the position when the ferrite rod through the coil is end-on to the transmitter.

To use your frame aerial to boost the signal pickup of a small set, rest the set on the base of the device so that its internal ferrite rod is at right-angles to the plane of the frame. (See Fig. 3) Rotate the frame so that it is edge-on to the direction of some distant, wanted station. Switch the set on and tune to the particular station.

Now rotate the tuning capacitor of your frame aerial and, at a particular point, you should hear the volume from the wanted signal increase. Tune the frame carefully and rotate it as necessary until you get the best result.

But it is essential to tune the capacitor carefully. If it is tuned to either side of the proper frequency, it may boost a nearby unwanted station and overpower your receiver's tuning circuits.

What is happening, under these conditions, is that the relatively large frame aerial is picking up a greater amount of signal and concentrating it inside the area of the loop.

Here it is coupled into the ferrite rod of the receiver and passed into the tiny coil wound around the ferrite rod.

Fig. 4 is the circuit of an elementary crystal receiver using the tuned frame aerial, a germanium diode and a pair of headphones. The frame aerial is shown as a coil on the left of the diagram.

Although the diode is drawn in a particular way, in the elementary circuit of Fig. 4 it really does not matter to the end result which way round it is connected. However, make sure to ask for a "germanium diode for use as a detector". The types most commonly available would appear to be OA90 and OA91. Older types which would nevertheless be entirely satisfactory include the OA70, OA71, OA80, OA85 and IN34.

The headphones, ideally, should be of the now old-fashioned type,

Frame Aerial & Tuner — continued

sometimes branded "High Impedance", sometimes marked with an impedance value typically between 2000 and 4000 ohms. You may be able to beg or borrow a pair from an old-timer who has no further use for them, or you may be able to pick up medium impedance phones from a military disposals store. (At the time of writing, ex-disposals headphones are available from A.C.E. Radio, 136 Victoria Rd, Marrickville, NSW 2204. Price $3.00 plus P&P $1.00 in NSW, $1.75 elsewhere).

Note that the detector is shown connected to a tapping only part way up the coil. This is usually necessary to prevent the detector and earphone circuit from loading the tuned circuit too heavily and so reducing its "selectivity" that it is unable to separate the stations clearly.

While the arrangement of Fig. 4 will work with ordinary headphones, the circuit we suggest in Fig. 5 is slightly more complicated but more universal in its application.

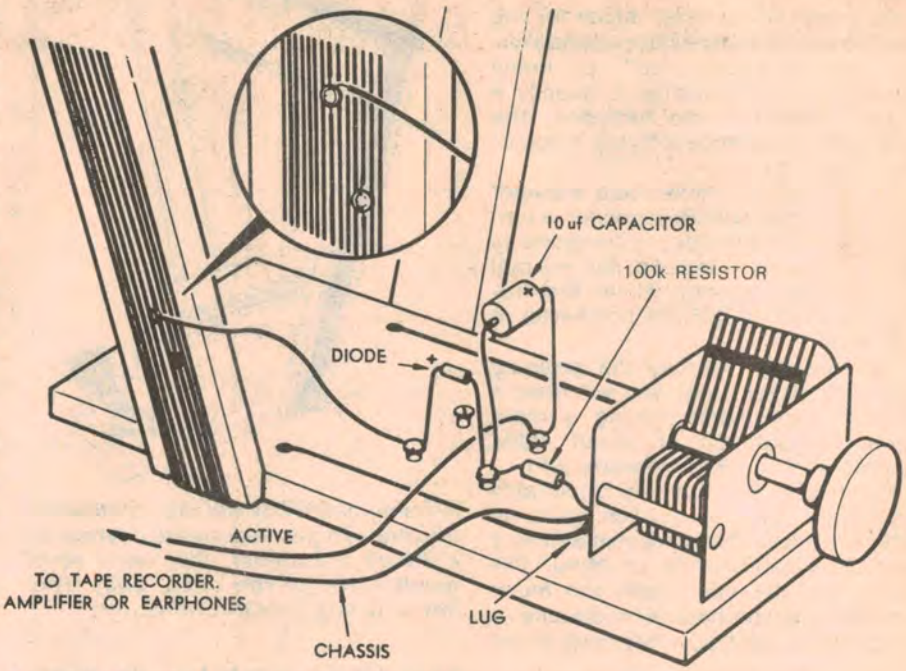
In this circuit it is necessary connect the diode with the cathode end towards the coil. The cathode end is usually denoted by a band of colour around the glass or the epoxy moulding. In some types the cathode lead is distinguished by being a softer wire than is used for the anode lead.

The resistor "R" is not critical and anything between about 47k and 150k would do. We used a 100k (100,000 ohms or 0.1 megohm). Wattage rating is unimportant and the resistor can be connected either way round.

The capacitor is an electrolytic type which can have a capacitance rating anywhere between 1 and 25 microfarads, and a voltage rating anywhere between about 6 and 25 volts. Its plus end may be denoted by a plus sign or a red spot. Alternatively, there may be a minus sign or black stripe to indicate the negative end. Connect it as shown.

As with the simpler circuit, this one can be used as a self-contained crystal set by connecting ordinary high or medium impedance headphones to the two leads marked "output". If you are unable to purchase phones of this kind, or you wish to avoid spending a lot of money, the set will work in the stronger signal areas with a simple crystal earpiece which can be bought for about 70c. Note that "low impedance" magnetic earpieces will not work at all well in a simple set like this.

While the frame aerial crystal set can be used as a completely self-contained receiver, it can also be used as a radio tuner in conjunction with an amplifier or a tape recorder. How well it will work in this role depends to a large extent on the location in which it is used but in urban areas within, say, 10 miles of the broadcasting stations it can perform very well indeed.



The complete receiver, ready to connect to headphones or an amplifier.

The wire connecting to the bottom of the coil (as drawn), to resistor "R" and to the frame of the tuning capacitor can connect to the chassis or metal work of the amplifier or tape recorder. The other wire can connect to the active input sometimes marked "Radio", or "Pickup" or "Auxiliary". It could be tried in the "Microphone" input but there is a possibility that the signal level from the tuner might be high enough to cause distortion.

In many cases, the connection to the amplifier or tape recorder can be made with a couple of scraps of wire twisted together. However, if a plain wire connection causes hum in the amplifier or recorder, use a short length of shielded wire and the proper plug to suit the amplifier or recorder, if such is required. Use the braid as the "earthy" circuit connecting to the metalwork, and the inner lead as the "hot" signal lead.

Fig. 6 shows how the additional components are added to the frame aerial. We obtained some small brass screws from a hardware store, polished the heads with a file and then screwed them part way into the particle board to provide anchor points for the components. This done, you can "tin" the heads of the screws with solder.

Now take each of the small components and grip each of the leads in turn close to the body of the component in the tip of pointed pliers. Bend the rest of the lead down so that it will be able to bridge between the necessary screw heads. Now grip each lead in turn with the pliers and tin the end with solder. Finally, still holding the leads with pliers, spot them in the appropriate places.

Using pliers to bend the leads avoids placing a strain between the lead and the tinny body of the component. Holding the lead with pliers while you solder helps to prevent the excessive heat reaching the component from the soldered joint.

Finally, there's the matter of the tapping on the frame aerial. This, too, can be made with the aid of brass screws. Push the wires aside slightly and drive a screw about half-way in, just under where turn 3 passes; put another screw under where turn 6 passes. Carefully scrape away about ¼-inch of the insulation and drop the turns into the head slot of the respective screws.

Now wedge or hold the adjacent turns away from the screws so that the insulation will not melt and solder turn 3 and turn 6 to the heads.

The tapping which will give the best results can be selected by trial and error. Turn 6 will tend to give louder signals but poorer selectivity. Turn 3 will give better selectivity but weaker signals.

In fact, there is no reason why you can't make additional tappings and experiment to your heart's content.

One more thing: If you need more signal, try connecting an outside aerial to one of the tappings and an earth to the end of the coil connecting to the frame of the tuning capacitor.

HINT: You can use the frame as an external aerial by connecting the three turns between the end and tapping respectively to the receiver's earth and aerial terminals. Point the frame towards the station you want and tune the capacitor for greatest signal strength.