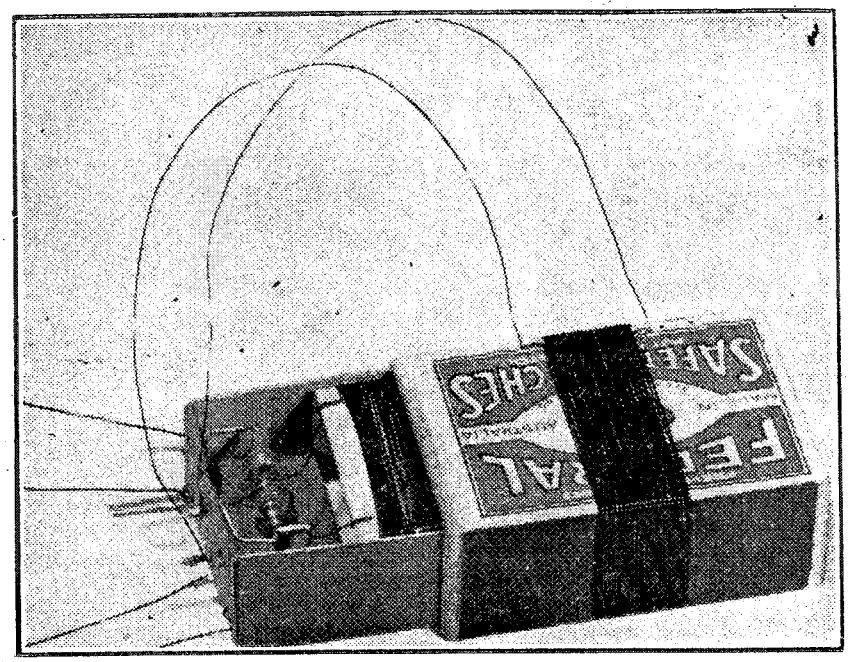


Here is the complete set all ready to start picking up stations. Tuning is done by sliding the tray inside the matchbox cover. Nothing could be simpler.

A MATCHBOX CRYSTAL SET

Here is a complete working radio receiver which can be built inside a matchbox. The parts could easily come from a friendly radio experimenter's scrap stock but, if you have pocket-money to spare, both crystal and capacitor can be purchased new for a few shillings. Good results are guaranteed and, by following the diagrams, you can put the set together in half an hour.

WHY put a set inside a matchbox? No particular reason—except, perhaps, that the parts for the slider mechanism are made and then, of course, such a tiny radio that can be made for next to nothing is a real novelty.

To be perfectly fair, we do remember having seen designs for matchbox crystal sets in other publications, notably American, but it is such a long time since one was described that few of our younger readers will remember.

There is no point in wasting time on preliminaries; we will start right in to give you an abbreviated idea of how a crystal set works, how it compares with other sets and then how to make this particular one.

We hear a lot about valves—1-valve sets, two valve sets, &c., but the heart of any radio receiver is actually the tuned circuit. Without the tuned circuit all the stations would be heard together and if two happened to be of about equal strength you wouldn't be able to get much enjoyment from either program.

The simplest set you can make consists of a tuned circuit to pick out the station you want and a crystal detector which makes the signal suitable for passing on to the headphones.

We won't worry about the theory right at the moment but this tuned circuit we have been talking about usually consists of a coil of wire and a variable tuning capacitor. A good coil is fairly easy to make but the tuning capacitor is a pretty big project. A factory-made one will cost you about £1.

On the other hand you can buy a fixed capacitor for about 1/- and make up a coil which has a variable inductance so that you can tune in the different stations. Nothing could be simpler!

The coil for this set is made up in two parts, one wound around the outside of the matchbox and the other around a former made from a piece of card which fits snugly inside the inner tray.

HOW TUNING WORKS

Depending on the way the wires are connected and the direction of the windings this coil, in two parts, will behave as a large coil or a small coil. A continuous range of intermediate steps can be obtained by sliding the inner tray in or out of the box by different amounts.

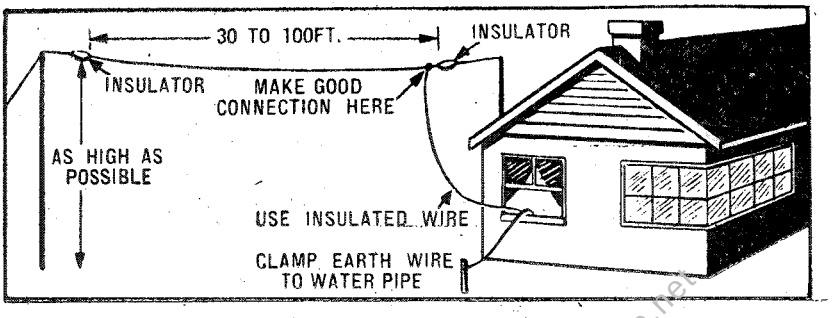
So, in order to tune in the stations you simply slide the inner tray of the box in and out. One extreme of the range will be found with the two coils one right inside the other and you will go toward the centre of the range by pushing the two sections of the matchbox apart, perhaps even until they are separated.

For the other part of the tuning range turn the tray around end to end and, without disconnecting the wires, push the two sections together. The other extreme end of the range is reached with the two sections of the matchbox fully together in the opposite direction to the first.

Low frequency stations are tuned when the two coils of wire are wound and connected so that they are assisting each other and high frequencies when the two coils are opposing.

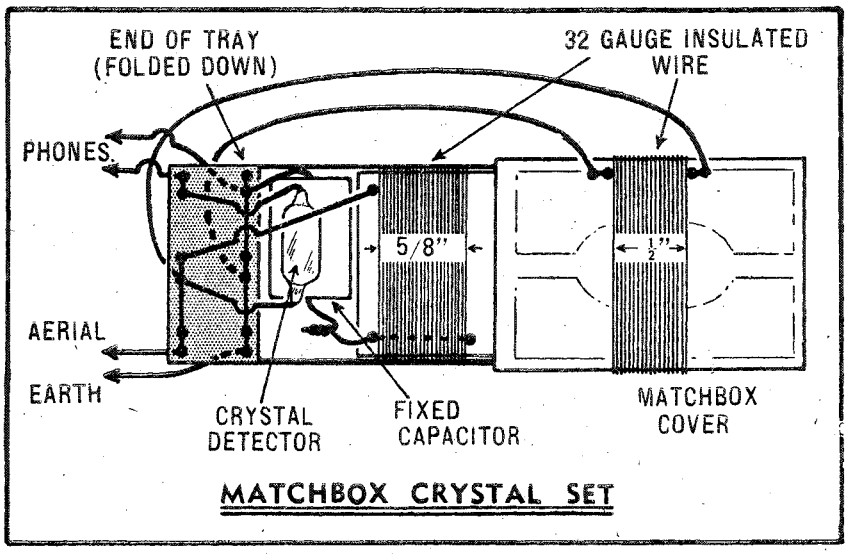
THE COILS

We have carefully worked out the number of turns on the coils so that the set tunes over the broad-



This aerial and earth system will work well with a crystal set. The supports don't need to be poles: buildings, trees etc. will work just as well.

HOW TO ASSEMBLE THE RECEIVER



This diagram shows every connection in the set just as you will make it. It doesn't make any difference which way around you put the coils, the crystal or the capacitor or in which direction you make the windings.

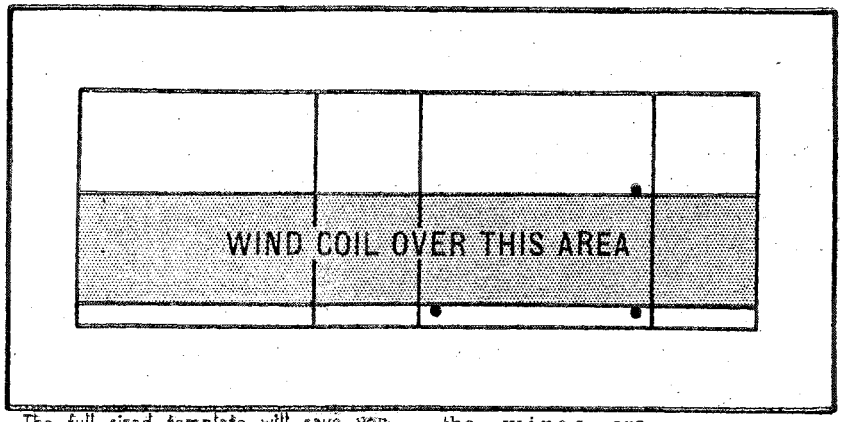
cast band and there is no need to worry about frequencies, &c., unless you particularly wish to do so.

We started making the set by winding a coil around the outside of the box. The wire used was 30 gauge B & S enamel, the enamel being to insulate the turns one from the other.

The gauge isn't very critical and if you use a different gauge of wire the only difference will be that the tuning range will be slightly different from the original. Some winding wire is insulated with cotton rather than enamel but this is quite in order, too.

We pushed holes ½in apart through the box with a pin to anchor the ends of the wire and another couple of holes about 1-8in outside the first two so that the wires could be twisted around and not come undone. This outer coil had 39 turns but if the gauge of wire is somewhere about right there is no need to count the exact number.

If the gauge of wire you use is greatly smaller or larger than 30 B & S enamel it would be best to count the number of turns as you wind them on making the pinholes accordingly even though the finished dimension may be different to ours. In other words, the number of turns has a greater effect on the characteristics of the coil than the length.



The full sized template will save you the trouble of working out the size of the former for the inside coil. It can easily be copied on a piece of thin cardboard.

After you have wound the coil, trim the two wires to a length of 6in and scrape off the enamel insulation 1in back from the end of the wire so that it can make good electrical contact. A knife or a razor blade can be used for this but a piece of sandpaper or emery cloth is better because there is less chance of nicking the wire and breaking it.

The inside coil is wound on a card former which is folded up from a piece of flat strip. The drawing we have made of the former folded flat is exact size and will save you working it out for yourself. Heavy paper would hardly be strong enough but there are plenty of food cartons with just the right sort of material.

The inside coil has a few more turns than the outside and the length should be about 5-8in. It can be terminated in much the same way as the outside coil except that the wires are brought to the end of the former nearest which the coil is wound. For other gauges of wire, the number of turns should be 48.

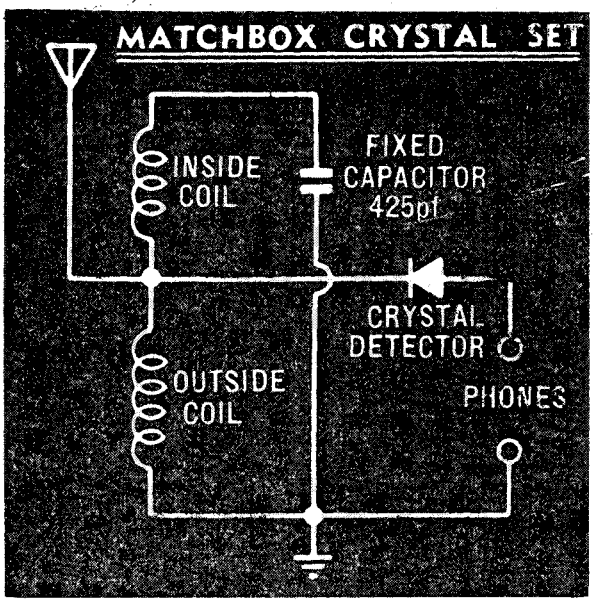
Trim the wires off, this time to about 2in long, and clean off some of the insulation in the same way as before.

Put the coil inside the tray of the matchbox so that the winding is in the centre and then try putting the box together. This is just to make sure that there is room and that the tray will slide without pushing the inside winding out of shape. If you have some cellulose tape, a couple of lengths around the outside of the tray and covering the wire may prevent the wire catching on the outside of the box and thus make it slide more easily.

The space at the end of the tray is to take the two other parts of the set being the crystal and the fixed capacitor.

The wires going to the aerial and earth, the headphones and outside coil are terminated on this same end of the box. Each termination can be effected by means of a pair of pinholes side by side.

For the details of all the connections we suggest you follow the diagram so that there is no possibility of making a mistake. So long as the



The schematic circuit diagram for the set. You don't need to understand it in order to wire up your set but it shows how symbols can be used to simplify matters.

enamel, cotton or other insulation is removed and the wires firmly twisted together there is no need to worry about soldering. Similarly, the wires going to phones and to aerial and earth can be twisted.

In the early days of crystal sets, a crystal detector consisted of a piece of galena and a fine wire called a cat's whisker. This fine wire was adjustable in position and often an elaborate mechanical device was used for this purpose. The idea was to find the most efficient point on the crystal by experiment.

Unfortunately the old crystal detector was a somewhat unstable device and a bump was likely to upset the adjustment.

Modern crystal detectors are quite different. They are small sealed units which are adjusted when you buy them and will retain their adjustment in the face of almost any knocks and vibration short of that required to break the glass.

Modern crystal detectors are given type numbers in the same way as valves but for this set the subtle differences between various types are not so important and practically any type will do. A few suitable types which come to mind are the GEX33, GEX44, 1N34, OA50, OA60, &c. If you buy one new, ask the dealer for the cheapest type.

Crystals do have polarity but in this set it doesn't matter which way round they are connected.

A new pair of headphones is a fairly expensive item and not many young experimenters will want to buy a pair especially for this set. Of course, if you feel that you may use the phones for some other purposes then their purchase may be justified.

On the other hand, there seem to be dozens of pairs of phones around experimenters' workshops doing little but collecting dust so that if you make inquiries of your friends the chances are that you will be able to buy or borrow a pair with little difficulty.

SUITABLE HEADPHONES

In the days when phones were used a great deal they were usually described by their resistance. Common values were 2000 ohms and 4000 ohms, and either would be quite satisfactory for this crystal set. The main thing is that they be in good condition.

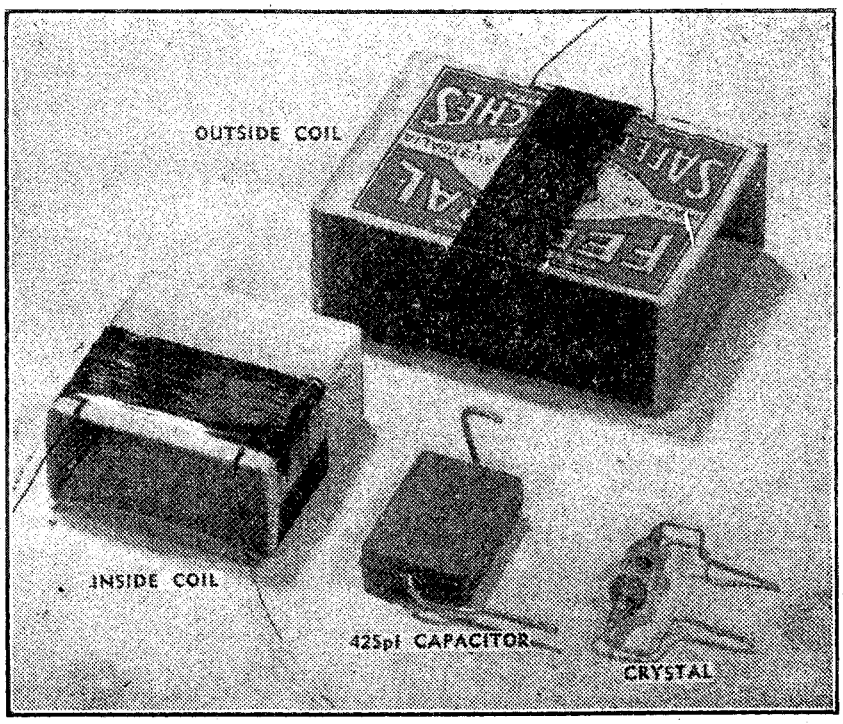
You can make a rough check by connecting the leads of the phones across a single 1½ volt torch cell. If the phones are in order there should be a sharp click when the connection is made or broken.

Disposals dealers may be able to supply you with phones for a few shillings but it is most likely that these will be of the low resistance type and although they will work, it is not likely that the signals will be very strong.

The difficulty can be overcome by using a transformer specially designed to match the low resistance phones to crystal sets and other high resistance devices. This takes away some of the novelty and simplicity of the little set but is a point to keep in mind if you are stuck for a pair of phones.

All the energy to work the headphones in the case of this little

CRYSTAL RECEIVER COMPONENTS



Here are the parts for the crystal set before assembly. The inside coil is bound with cellulose tape to prevent the turns catching while you are tuning the stations. Wires for the capacitor and crystal should be bent approx. as shown.

receiver is collected by the aerial which works in conjunction with an earth system. As you might imagine the amount of energy which is intercepted by a relatively small receiving aerial is not very great and if you are a long way from the station the signals may not be strong enough to be worthwhile.

DISTANCE FROM STATION

As a general rule it is considered that 15 miles is the maximum distance you can be separated from a station and still expect satisfactory results with a crystal set. Readers have sometimes written and told us of cases where good results have been obtained over greater distances but these are the exception.

In any case, the aerial should be as long and as high as possible. If you can find a couple of convenient poles or bulidings it can well be up to 50 feet long. The wire you use will depend on what is available but it need not even be copper. Any metal wire would work just as well for all practical purposes.

For a very temporary installation you could use the same wire as used to wind the coil for both the aerial and earth. The objection is that is is fairly fine and cannot be expected to last long in the wind.

Start at the most distant support and connect the aerial via an insulator. The usual porcelain insulators are fine but there are plenty of other materials which can be used to get the set working. For example, you could drill a couple of holes in each end of a bakelite strip or alternatively an old toothbrush handle cut in halves may make a couple of insulators.

The second insulator should be placed between the near end of the aerial and the support. A lead-in wire will come from the near end of the aerial down to the set. This may be the one unbroken wire from the end of the aerial to the set but if you have to make a join be sure to clean and twist the wires well because corrosion may make the connection poor after a short while.

The enamel insulation on the wire will not stand much rubbing which is the reason for using the insulators at either end. For the same reason it is desirable to provide some insulation for the aerial where it comes into the room to prevent it making electrical contact with the building.

You could use insulated wire for the last few feet of the lead-in or wrap some sort of insulation around the aerial at the critical points.

The set will not work without an earth wire. This is easier than the aerial because it does not need to be insulated. A water pipe makes an excellent earth and the idea is to clean away any corrosion which may be present and wrap the fine wire around it several times to make sure of a good connection.

If there is no water pipe handy a length of pipe or metal rod driven into the ground makes an excellent earth.

Don't get the idea that the little set does not work well. We made a direct comparison with a very elaborate crystal set and also with a simpler job using the conventional large diameter coil and variable capacitors and were agreeably surprised that the performance was by no means poor as crystal sets go.

(Continued on Page 53)

A TRANSISTOR AMPLIFIER FOR THE CRYSTAL SET

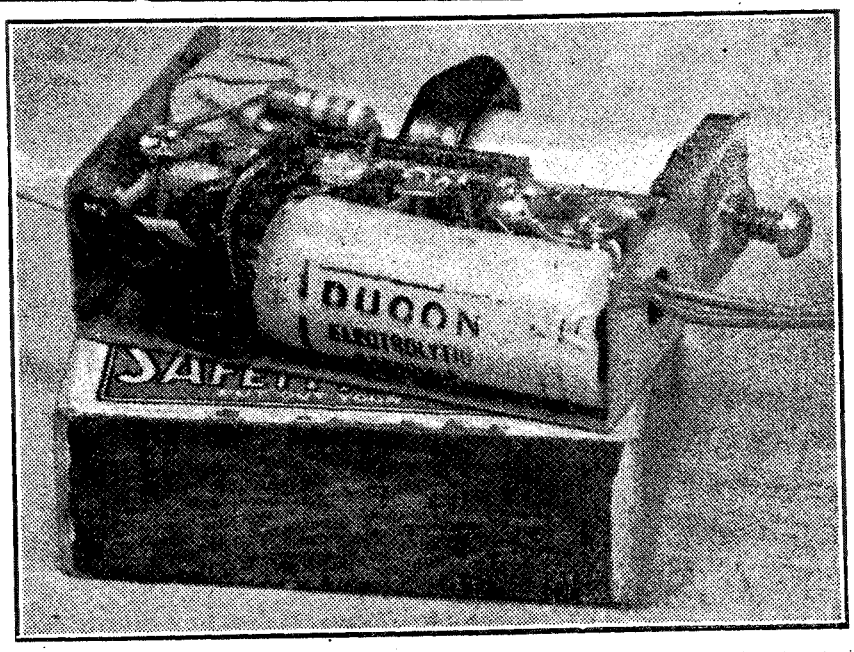
ONE of the main reasons for our describing the crystal set is that it costs next to nothing to build. Young chaps going to school can have all the fun of a radio of their own, and a very efficient one too, without mortgaging pocket money for months hence.

However, where money isn't so much of a problem, a very effective amplifier can be made with a transistor, a battery and a few other small parts. It may cost a couple of pounds or so, but at the same time you would get the crystal set plus transistor amplifier for less than a commercial crystal set and the results of the combination would be very much better.

Stations which can hardly be heard with the crystal set alone come up to listening level, when the amplifier is connected. When the stations are close together in frequency, selectivity can be improved by reducing the aerial coupling and the transistor amplifier can be used to make up for the loss in level.

Therefore, with the amplifier you stand to gain on two counts.

The physical form of the amplifier isn't important: there are no high impedance circuits to cause feedback problems with layout, nothing gets hot and the battery drain is so low that it will last for virtually its shelf life.



A matchbox amplifier for a matchbox crystal set is just the thing. The photograph shows how the component parts were fitted into tinplate tray of the same size as the original match tray.

A simple crystal receiver built around an ordinary matchbox is described elsewhere in this issue. This set inspired a member of our staff to work out a 1-transistor amplifier to make the signals louder. In order to match the set, the amplifier was also built inside a matchbox.

OUR MODEL

We show you how it can be fitted inside a matchbox, but, if you wish to lay the parts out on a piece of cardboard or in any other way, this will be quite in order.

The transistor used is the 0C71, a junction type which will work well on the single cell. As other transistors it has three connections being the base, collector and emitter. One of the first things you must do, therefore, is identify these.

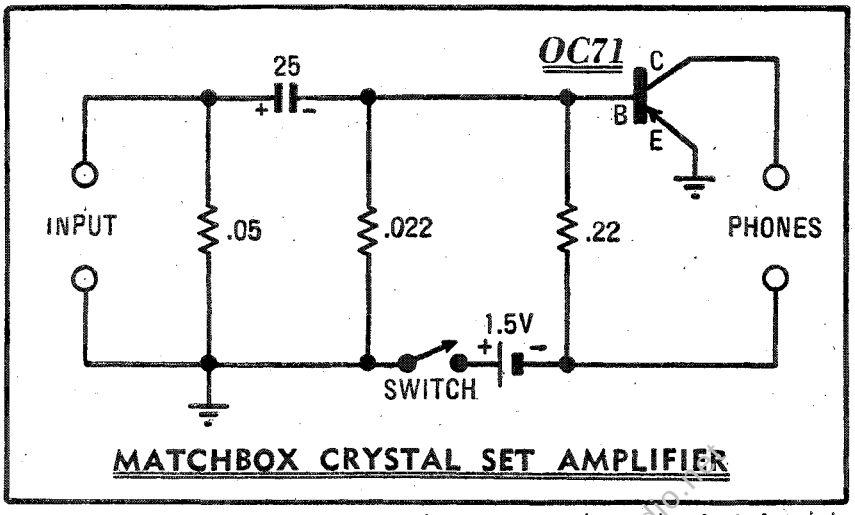
We have provided a drawing looking at the end of the transistor from which the leads come showing just the connections. The key for identifying them is that the emitter and base are close together with the emitter on the outside and the collector apart from the others and on the outside. The collector side is also identified by a red dot.

We made up a tinplate tray the same size as the original matchbox tray, and mounted a six-lug tag strip down the centre. One of the lugs also supports the strip, and is soldered to the bottom of the tray.

The battery fits snugly in between the tag strip and the side of the tray.

At the positive end is a piece of bakelite about 3-16 inches thick and ⅛ inch square, with a hole to take the positive cap. This positive cap isn't high enough to make contact with the tinplate tray normally, but by drilling a hole in the tinplate at this point and soldering a nut on the outside of the tray over the hole, a bolt can be screwed in with the fingers and act as a switch.

Most of the room on the opposite side of the tag strip is occupied by a 25 mfd capacitor with a ½ inch or so left for the transistor. The capacitor is an especially small type, which has recently become available and is actually smaller than previous units of half the ratings.



MATCHBOX CRYSTAL SET AMPLIFIER

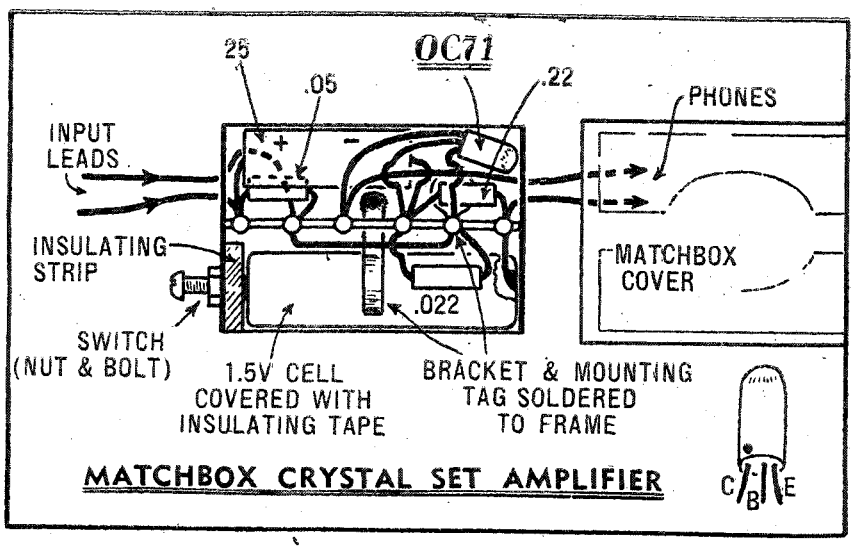
Three resistors, a capacitor, a battery and a transistor make up the circuit for what seems to be the simplest amplifier ever published on these pages.

TRANSISTOR IS DELICATE

Solder the transistor in according to the wiring diagram. The main thing to watch is not to allow the heat from the soldering iron to be conducted by the transistor leads and cause damage to the sensitive interior. As a matter of fact it is good practice to use a pair of long nosed pliers as a heat sink by holding each wire as it is soldered into place. There is no need to cut the wires short and in any case you may wish to use the transistor for another purpose at a later date.

The three resistors will have to be the new ½ watt types to fit in with our original layout, but of course other types can be used if you don't want the matchbox layout. The same applies to the other components.

With the simple crystal set, the headphones must operate with the minute power received by the aerial but when you add the transistor amplifier it is actually the battery



This diagram shows how to place the components to fit them into a matchbox. For a tryout it would not be necessary to use such a compact layout and mounting the components temporarily on a piece of stiff cardboard would do just as well.

power which moves the diaphragm. The power from the aerial controls the collector current of the transistors and it is this current which works the phones.

For this reason the characteristics of the phones are not so critical and although high impedance types will give the best results, many low impedance types will work quite well. Even the ex-disposals' 45 ohm phones will give some results although the strength is very much lower than wtih more suitable types.

Incidentally, the measured no-signal current drain of the transistor amplifier is 0.4 mA at 1.5 volts, making the power input to the transistor only 0.6 milliwatts. Even if you happened to go off to sleep with the headphones on, it wouldn't matter very much. When the battery is finally exhausted—or deteriorates due to old age—it can be replaced for a shilling or so.

There may be a considerable reserve of gain with the transistor amplifier and if you live close to a station it may even be that the signals are too loud for comfortable listening. The strength can be reduced by detuning and this won't make the signal as obviously distorted as may happen with a selective superhet.

On the other hand, you can trade volume for selectivity by wiring a capacitor in series with the aerial. The smaller its value the better will be the selectivity and the less the volume. For a start you could try about 100 pF but if you have a very long aerial, 50 pF or even less may be necessary to give the desired results.

If you can find an old tuning capacitor, the selectivity can be made continuously variable. Most of these capacitors can be varied between about 10 pF and 300 pF or even more, so that you can have quite a range. Connect the aerial to the moving plates and the aerial terminal of the receiver to the fixed plate.

With the plates fully enmeshed, the selectivity and volume should be little different to the condition when the aerial is connected directly. However, when the station is tuned in you can decrease the aerial coupling by means of the capacitor until the selectivity is as good as required. The coupling adjustment will have some small effect on the tuning.

The addition of the transistor amplifier and the variable aerial coupling arrangement get away form the oiginal idea of a very simple crystal set but they are interesting things you can try. They apply equally well to any more advanced crystals sets or even small valve sets you may try later on.

The transistor amplifier can also be used with a small valve set by connecting the input leads to the phone terminals. However, the power output is quite small and you may find that it is not able to supply as much volume as the valve on the louder stations. We mention this latter application only in passing because the crystal set is the amplifier's main application.

MATCHBOX CRYSTAL SET

(Continued from page 49)

In one location in Sydney it was possible to tune the eight local stations, all except about two at good listening level. At another suburban location with an aerial only 30 feet long, four of the local stations were received at good strength and separated cleanly while there were traces of some of the others.

When you have identified the stations, their positions can be marked on the side of the tray so that you can tune to them accurately and quickly when required.

If the set is built according to the data we have given, you will find it to be quite selective. However, if you happen to live close to two very strong stations which are close in frequency you may find that it is not possible to hear one without the other.

The selectivity can be improved by connecting the aerial to the set via a small capacitor. The smaller the value, the better the selectivity but at the same time the volume will drop. We suggest you try 50 pF or 100 pF for a start. The longer the aerial the smaller the capacitor can be without reducing the volume too much.