For the newcomer:

How to read circuit diagrams

Many people who are newcomers to electronics find circuit diagrams or "schematics" rather hard to follow. Here's an easy to understand explanation of what all those mysterious symbols mean, and what a circuit diagram can tell you once you get the hang of things.

by JIM ROWE

When you first start getting interested in electronics and building up projects, circuit diagrams can look rather daunting with all of those little symbols — most of which don't look much like anything you've seen before. It's tempting to try side-stepping the circuit diagram and putting the project together using whatever other information may be given, like photographs and wiring diagrams.

The only problem is that things like wiring diagrams aren't always given — and even if they are, it isn't always easy to work out how each of the parts is connected. Even photographs don't always help, perhaps because they aren't big enough or taken from the right angles.

There's another disadvantage of relying on wiring diagrams and photographs, too: they may show you how to wire up something, but generally they don't help much at all in understanding how it works. And that's exactly where circuit diagrams, or "schematics" come in.

In fact the whole idea of circuit diagrams is to show you, as simply and clearly as possible, how a collection of electronic components are connected together from a *functional* point of view. That is, in terms of what they actually DO, rather than what they happen to look like or how big or small they are physically.

That's why a circuit diagram doesn't have little drawings of the actual components themselves, but represents them simply by standard symbols according to the job they do.

Because of this, it's generally a lot easier to see from the circuit diagram how the parts are being used together to achieve the desired result.

And this tends to apply whether you're looking at a circuit produced in Australia, the USA, Europe or even the USSR - because circuit symbols and diagrams are *reasonably* standardised the world over. Not fully standardised (what is?), but generally close enough that once you're fairly familiar with one 'dialect', you can usually find your way around most others.

So in a very real sense, circuit diagrams are the "Esperanto" or *lingua franca* of electronics, a kind of international shorthand way of describing circuits. That's why it really is a good idea to master them as soon as you can, whether you're planning to make electronics either your hobby or your career.

Mastering them isn't as difficult as you might think, either. The symbols used to represent the various kinds of component are generally fairly logical, once you get the basic idea.

For example resistors are basically parts used to make the flow of current "more difficult", by presenting a path that's effectively "longer" than a plain wire. So generally to suggest this *longer current path*, they're shown as a small zigzag line symbol, as you can see in Fig.1. That makes reasonable sense, doesn't it?

Similarly capacitors essentially consist of two electrodes which don't make direct contact at all, but instead "look at each other" electrically across an insulating barrier. So they're basically shown as two thick parallel lines with a gap between them, as you can see. Again it's pretty logical, when you think about it.

When it comes to inductors, most of these are coils of wire, wound on either a ferrite or laminated iron core, or on a non-magnetic former so they're "air cored". So it's logical for them to have a simplified *coil* symbol, as you can see again from Fig.1.

A transformer being basically two or

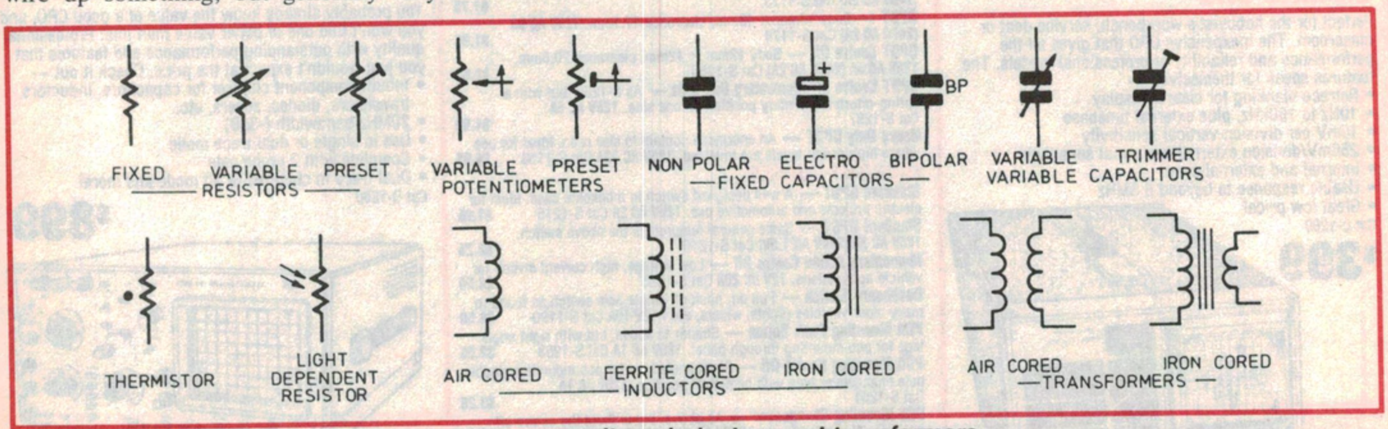

Fig.1: The basic circuit symbols for resistors, capacitors, inductors and transformers.

more inductors wound on a common core, or otherwise placed near each other so they can interact with each other magnetically, it's also logical to show them as two coil symbols (or more). And so it goes. Each symbol is designed to show the *function* of the kind of part concerned, as simply and clearly as possible.

Of course, there's a little more to it than that — isn't there always? But that's the basic idea, at least, and once you grasp it you really won't find the rest all that difficult.

Now let's look at some of the details. Turning again to Fig.1, you've probably already realised that the general way to show that a component is *variable* in terms of its resistance, capacitance or whatever is to show an arrow through its symbol. So a variable resistor (what the old-timers called a "rheostat") is shown as a zigzag with an arrow through it, and a variable capacitor (like the tuning capacitor in most radios) as a pair of thick lines with an arrow through them.

A slight variation on this idea is the symbol for a potentiometer (or "volume control"), which is essentially a resistor with an adjustable *tapping* connection able to move from one end to the other. As you can see, this is shown as a zigzag line with another line at right angles, touching it with an arrow head. Often a second small arrow is shown to indicate which way the tap connection moves (functionally) for *clockwise* rotation of the pot's shaft and knob.

Of course not all variable resistors, pots or variable capacitors are made to be adjusted via a control shaft and knob. Many are "preset" or "trimmer" parts, intended to be built inside equipment and used only for initial setting-up or occasional later adjustments. This kind of component is symbolised by means of a small line with a "T" head, rather than an arrow head.

Another little complication with capacitors in particular is that some of them (like electrolytics) are *polarised*. That is, they must be wired into circuit with a particular end connected to the more positive side of the position concerned. This is generally shown by adding a small "+" sign near the appropriate end of the basic symbol, as shown again in Fig.1. As you can see the bar representing the same end is often shown in outline form rather than solid, for increased emphasis.

The special "bipolar" electrolytic capacitors made for use in AC circuits are indicated by the letters "BP" alongside the basic symbol. Sometimes with these parts *both* bars are also shown in outline form, for further emphasis.

With inductors, the basic coil symbol is used alone to indicate an air-cored type. If on the other hand it is wound on a ferrite rod or core (or the older "iron-dust" core), this is shown by a pair of dashed lines alongside. Similarly if it is wound on a laminated iron core, this is shown by a pair of solid lines alongside.

The same basic convention is used for transformers, too. An air-cored transformer (as used for RF) is shown simply by two adjacent coil symbols, but if the windings are wound on a ferrite core a pair of dashed lines is shown between them. Similarly if they're wound on a laminated iron core, a pair of solid lines is shown between them.

Again there's often a slight variation on this if the transformer is essentially an air-cored type, but is fitted with adjustable "slugs" of ferrite (or the older "iron dust" type). Here the slugs are generally shown as a small pair of short dashed lines at either end, possibly with a small arrow to indicate that they're adjustable.

Before we leave Fig.1, notice that a temperature-dependent resistor or *thermistor* is shown as a basic resistor zigzag, but with a small round "blob"

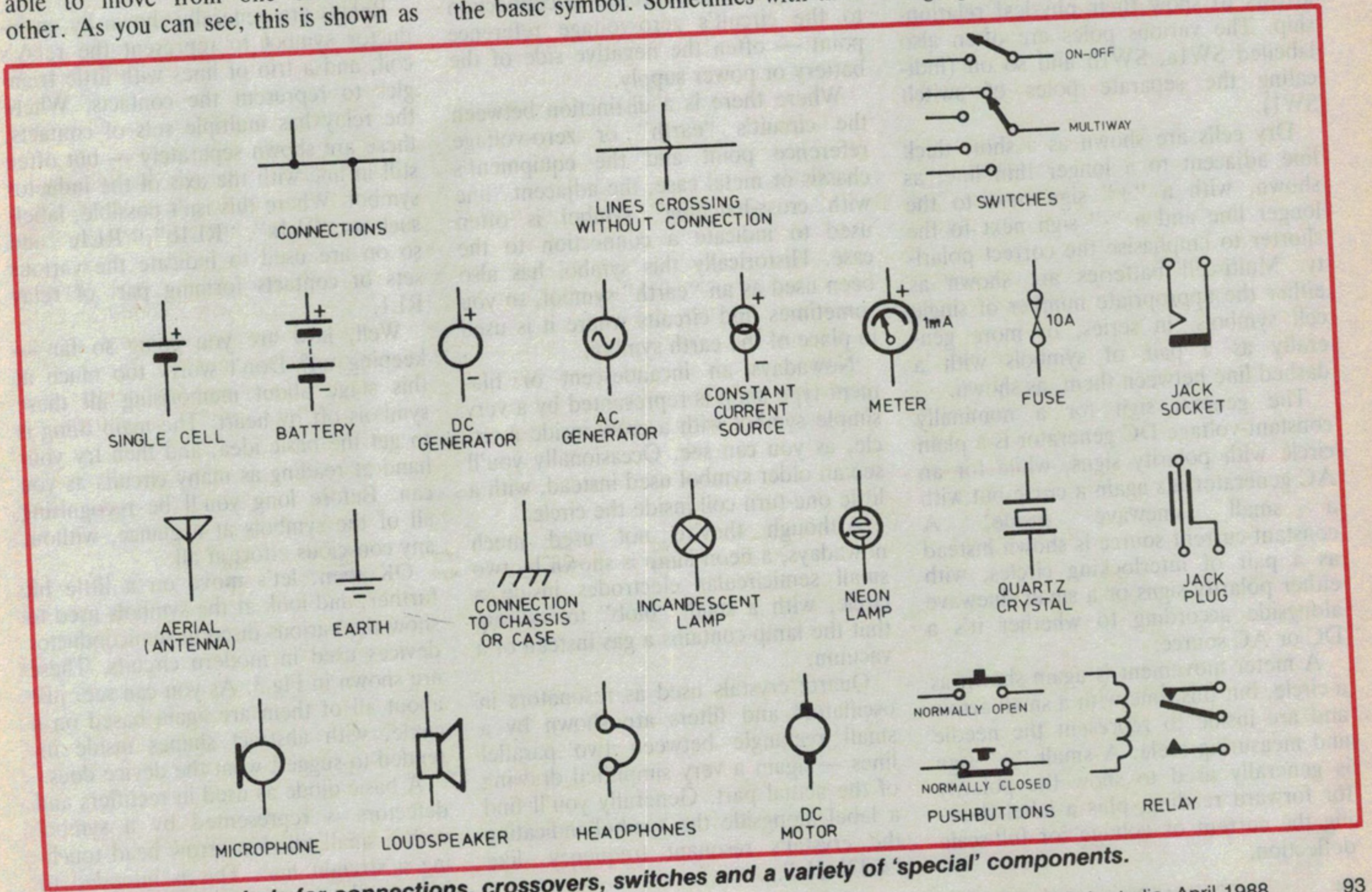

Fig.2: Circuit symbols for connections, crossovers, switches and a variety of 'special' components.

added to the side to indicate its temperature dependence. Similarly a light-dependent resistor or *LDR* is shown by a zigzag with a pair of small arrows symbolising the effect of light photons.

Now let's turn to Fig.2, which shows many of the other symbols you'll find in circuit diagrams. We'll discuss these briefly in turn, starting at the top left and working down.

First there's the way of showing connections, compared with the way of showing two lines on the diagram that need to be drawn crossing one another, with no connection implied. As you can see, actual connections are indicated by solid "blobs" where one line meets another, while a crossover with no connection is shown by a small semicircular "bridge" in one line or the other (it doesn't matter which).

Switches are shown very simply, with small circles used to indicate the various connections and a short line with an arrow head used to show the moving "pole". To symbolise multi-pole switches with a number of separate poles moving together (or "ganged"), a number of similar symbols are used, with a light dashed line linking the pole arrows to show their physical relationship. The various poles are often also labelled SW1a, SW1b and so on (indicating the separate poles of switch SW1).

Dry cells are shown as a short thick line adjacent to a longer thin line, as shown, with a "+" sign next to the longer line and a "-" sign next to the shorter to emphasise the correct polarity. Multi-cell batteries are shown as either the appropriate number of single cell symbols, in series, or more generally as a pair of symbols with a dashed line between them, as shown.

The general sign for a nominally constant-voltage DC generator is a plain circle with polarity signs, while for an AC generator it's again a circle but with a small sinewave inside. A constant-current source is shown instead as a pair of interlocking circles, with either polarity signs or a small sinewave alongside according to whether it's a DC or AC source.

A meter movement is again shown as a circle, but this time with a small arrow and arc inside to represent the needle and measuring scale. A small "+" sign is generally used to show the polarity for forward reading, plus a label showing the current or voltage for full-scale deflection.

A fuse is shown as two small circles with a pair of crossed lines between them, the narrow crossover in the centre intended to represent the "weak point" of the fuse itself. Generally there will be a label alongside showing the fusing current in amps or milliamps.

The symbol for a jack socket (as used for headphones, etc.) is essentially a very simplified drawing of an actual part, as you can see. The same applies for the matching jack plug, with its circle to represent the plug tip and two lines to represent the sleeve.

Other types of connector are generally also shown by very simplified drawings of the connector itself — often just a circle or rectangle, with smaller circles to represent the individual connection contacts. In many cases a symbol for a plug or "male" connector has filled-in circles for the individual connections, while that for a socket or 'female' connector has hollow circles.

For radio circuits, an aerial or antenna is generally represented by the triangular symbol shown. Similarly a connection to earth or ground is shown by the trio of parallel lines, tapering in length. This latter symbol is also more widely used in almost every kind of circuit diagram, to represent a connection to the circuit's zero-voltage reference point — often the negative side of the battery or power supply.

Where there is a distinction between the circuit's "earth" or zero-voltage reference point and the equipment's chassis or metal case, the adjacent "line with cross-hatching" symbol is often used to indicate a connection to the case. Historically this symbol has also been used as an "earth" symbol, so you sometimes find circuits where it is used in place of the earth symbol.

Nowadays an incandescent or filament-type lamp is represented by a very simple symbol with a cross inside a circle, as you can see. Occasionally you'll see an older symbol used instead, with a little one-turn coil inside the circle.

Although they're not used much nowadays, a neon lamp is shown by two small semicircular electrodes inside a circle, with a small "blob" to indicate that the lamp contains a gas instead of a vacuum.

Quartz crystals used as resonators in oscillators and filters are shown by a small rectangle between two parallel lines — again a very simplified drawing of the actual part. Generally you'll find a label alongside the symbol indicating the crystal's resonant frequency, like "4.43MHz".

A microphone is shown as a circle with a small tangential line, as you can see. This is probably a simplified drawing of an early type of microphone. Similarly a loudspeaker is shown by another very simplified drawing, with a rectangle to represent the actual transducer and a truncated triangle to represent the cone.

The same approach is used for the symbol for headphones, which as you can see is merely two small circles linked by a semicircular arc to represent the headband.

For a conventional DC motor, the symbol is again based on a circle, but with two small filled-in squares to represent the brushes. You don't find AC motors represented much in electronic circuits, but when you do they're usually shown by a combination of a circle for the rotor, and inductor coil symbol(s) for the stator winding(s).

There are two symbols for pushbuttons, depending on whether they're normally open circuit or closed-circuit (that is, before you press the button). As you can see the symbols make this pretty clear, although sometimes you'll find the labels "N/O" or "N/C" alongside just to make sure.

Relays are generally shown by an inductor symbol to represent the relay's coil, and a trio of lines with little triangles to represent the contacts. Where the relay has multiple sets of contacts, these are shown separately — but often still in line with the axis of the inductor symbol. Where this isn't possible, labels such as "RL1a", "RL1b", "RL1c" and so on are used to indicate the various sets of contacts forming part of relay RL1.

Well, how are you going so far — keeping up? Don't worry too much at this stage about memorising all these symbols off by heart. The main thing is to get the basic idea, and then try your hand at reading as many circuits as you can. Before long you'll be recognising all of the symbols at a glance, without any conscious effort at all.

OK then, let's move on a little bit further, and look at the symbols used to show the various discrete semiconductor devices used in modern circuits. These are shown in Fig.3. As you can see, just about all of them are again based on a circle, with abstract shapes inside intended to suggest what the device does.

A basic diode as used in rectifiers and detectors is represented by a symbol with a small filled-in arrow head touching a straight line. This is intended to indicate the fact that the diode is essen-

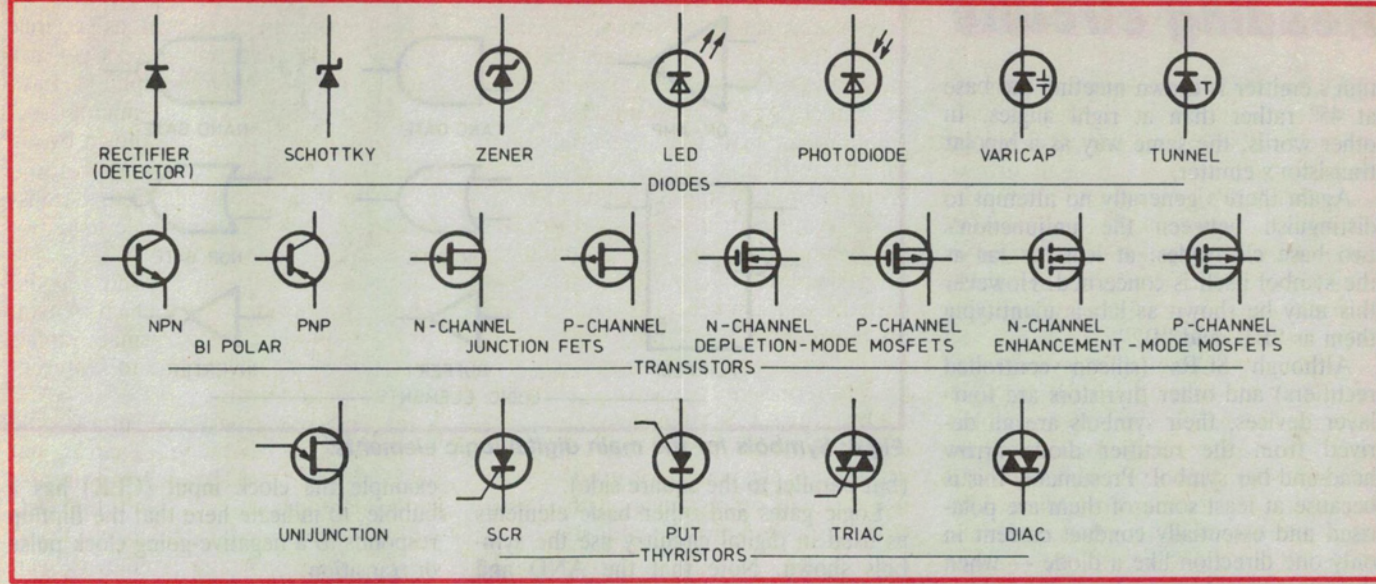

Fig.3: The symbols for the main discrete semiconductor devices - diodes, transistors and thyristors.

tially a "one-way" device, conducting current only in the direction of the arrow (at least in terms of conventional current flow). The arrow head side is the anode, while the line is the cathode.

For a Schottky or "hot-carrier" diode, the straight line is given two small "tails" at right angles. These are apparently meant to represent the sharper conduction "knee" exhibited by this kind of diode.

Most other kinds of diode are also derived from the basic diode arrow-and-line symbol, as you can see, but generally enclosed in a circle and with minor embellishments. A zener or voltage-regulator diode symbol is similar to that of a Schottky diode, but with the little "tails" at about 45° to the straight line rather than at right angles.

You'll sometimes come across an alternative symbol for the zener diode, with a circle enclosing basic diode symbol together with two lines at right angles — rather like a long upside-down "L". This is meant to show the way the diode's current suddenly increases at its reverse breakdown voltage.

Don't forget that because a zener diode is used in reverse breakdown mode, the "line" side of its symbol becomes the anode (connected to positive), and the "arrow" side the cathode.

LEDs and photodiodes have a basic diode symbol again, but with a hollow arrow head and with two small arrows outside to indicate light photons either leaving the diode (for a LED) or entering it (for a photodiode).

A varicap diode is mainly used as a variable capacitor, so its symbol shows a little capacitor inside the circle alongside the basic diode symbol. Occasionally the little capacitor is shown just outside and alongside the circle, instead.

And finally there's the tunnel diode, which you don't come across very often. When you do, it's generally shown by the symbol shown, with a small "T" inside the circle — perhaps because noone could think of any other way to symbolise what a tunnel diode does, or how it works!

Now for transistors. As you can see from Fig.3, the symbols for these are all based on a solid rectangle inside a circle, again with embellishments for the various types and varieties.

For bipolar transistors, the rectangle represents the base, with its connection joined to the centre at right angles. The collector and emitter leads are shown touching it at 45°, as a kind of simplified drawing of the very first point-contact transistors. Two distinguish between the two, the emitter lead is given an arrow head — pointing away from the base for an NPN transistor and towards it for a PNP type.

For junction FETs, the rectangle represents the transistor's channel region, with the source and drain electrodes shown as lines meeting it at right angles near the ends. Note that generally no attempt is made to distinguish between the two, as in many devices they're interchangeable. The gate is shown as a third line with an arrow head, pointing towards the channel for a P-channel type and away from it for an N-channel FET.

The symbols for MOSFETs vary a little, depending on whether they're of the *depletion mode* (normally conducting) or *enhancement mode* (normally off) type.

For depletion mode devices, as you can see, the symbols aren't too different from those for junction FETs. The main difference is that the external gate electrode is shown ending in a "T-bar" instead of an arrow head, and doesn't actually touch the channel rectangle. Sometimes the line representing the gate electrode is drawn meeting the short and firmer gate line at one end, rather than in the centre, making it an "L-bar" instead of a "T-bar".

There's still an arrow-headed line meeting the centre of the channel rectangle, but now it's on the other side and is meant to represent the transistor's substrate. Generally this is shown connected to the source electrode, either internally (inside the circle) or externally.

To indicate that enhancement-mode devices don't actually have a continuous channel region until bias is applied to them, their symbols don't have a long solid rectangle for the channel. Instead they have a "dashed" rectangle, as you can see — made up from three smaller and shorter sections with gaps between them. Apart from that, they're very similar to the symbols for depletion-mode MOSFETs.

By the way, the symbols for *dual-gate* MOSFETs are very similar to those shown for the single gate type. The only difference is that there are two "T-headed" gate lines side by side, instead of just one.

The symbol for a unijunction is not all that much different from that for an N-channel JFET. However to distinguish between the two, the arrow-headed line representing the unijunction's emitter is drawn meeting the base at 45° rather than at right angles. In other words, the same way as a bipolar transistor's emitter.

Again there's generally no attempt to distinguish between the unijunction's two base electrodes, at least as far as the symbol itself is concerned. However this may be shown as labels identifying them as "B1" and "B2".

Although SCRs (silicon controlled rectifiers) and other thyristors are four-layer devices, their symbols are all derived from the rectifier diode arrow head-and-bar symbol. Presumably this is because at least some of them are polarised and essentially conduct current in only one direction like a diode — when they do conduct, that is!

The symbol for the standard cathode-gate SCR itself is just a diode symbol in a circle, with the gate lead shown touching the "bar" at 45°, near the cathode lead.

Similarly the PUT or programmable unijunction, which is basically a sensitive anode-gate thyristor, is shown again as a diode but with the gate lead coming in at the anode end and meeting the arrow head at one "point". The same symbol is used for an anode-gate SCR.

A fancier symbol is used as the basis for the more elaborate bipolar thyristors, like the Triac and Diac. Here the basic symbol is essentially two diodes in reverse parallel, as you can see - to indicate that these devices conduct in both directions.

For the Diac this basic symbol is used alone, while for the Triac with its additional gate electrode the symbol is provided with a line joining the "bar" at one end at 45°.

That's about it for the main component symbols you're likely to meet in circuits. Now let's look briefly at a few symbols used for integrated circuits and parts thereof. These are shown in Fig.4.

The symbol for an op-amp (or to give it the full name, *operational amplifier*) is basically an elongated triangle, as you can see. The inputs are shown as lines entering the "square" side, while the output is the line leaving the "point". Generally the inputs are marked as shown with polarity signs, to indicate whether the op-amp's output signal is in phase or out of phase with that input. Other connections to the op-amp such as power supply leads, frequency compensation and bias nulling terminals are generally shown as additional lines entering the sloping sides of the triangle

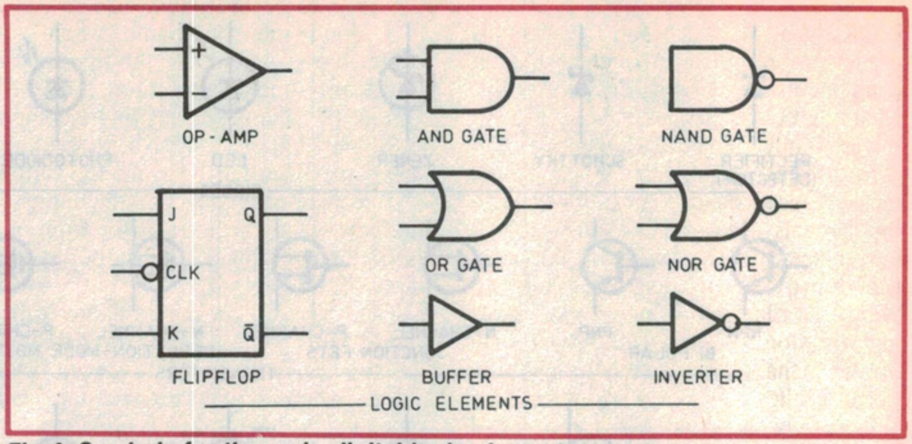

Fig.4: Symbols for the main digital logic elements.

(but parallel to the square side).

Logic gates and other basic elements as used in digital circuitry use the symbols shown. Note that the AND and NAND gates have a "square" front and a half-round back, while the OR and NOR gates have a concave front and a pointed back. A non-inverting buffer and an inverter both use a basic triangle symbol, rather like that for an op-amp.

Note too that with logic elements such as these, the only difference between the symbols for those which invert the signal and those which don't is the small circle or "bubble" shown at the output, for an inverting element. This convention is in fact widely used in most digital circuits: the bubble on the end of a line means that the signals at that point conform to negative logic.

Many of the more elaborate digital logic ICs contain so many transistors inside and are so complicated in terms of what they do, that no attempt is made to show this in the circuit symbol. Instead they're shown as a simple rectangle, with various inputs and outputs joining to the sides. Labels are then used to identify each connection and its function.

An example of this is the remaining symbol in Fig.4, that for a flipflop. As you can see, the symbol is basically just a rectangle, with the three main functional inputs and two main outputs are labelled as necessary. Note that in this example the clock input (CLK) has a bubble, to indicate here that the flipflop responds to a negative-going clock pulse or transition.

At this stage the one main type of electronic component that we haven't discussed is thermionic valves (or what our American friends call "tubes"). That's because you don't really come across them much anymore!

However just for the sake of completeness, the symbols for a few different types are shown in Fig.5. The two smaller ones are for indirectly heated triode and pentode amplifier valves, while the larger symbol is for an electrostatic-deflection cathode ray tube or "CRT". This is in fact the one you're most likely to meet nowadays, in circuits for oscilloscopes or CROs.

The four bar electrodes arranged in a square near the end of the narrow section are the deflection plates, of course.

A very similar symbol is used to represent the picture tube in a circuit for a TV set or video monitor. The main difference is that these tubes generally use electromagnetic deflection, so you won't see the deflection plate bars inside the symbol. Instead you'll see two inductor coils nearby, representing the windings of the deflection "yoke". With colour tubes the symbol will have not just a single cathode and set of dashed grids, in the narrow section, but three (for the three colour guns).

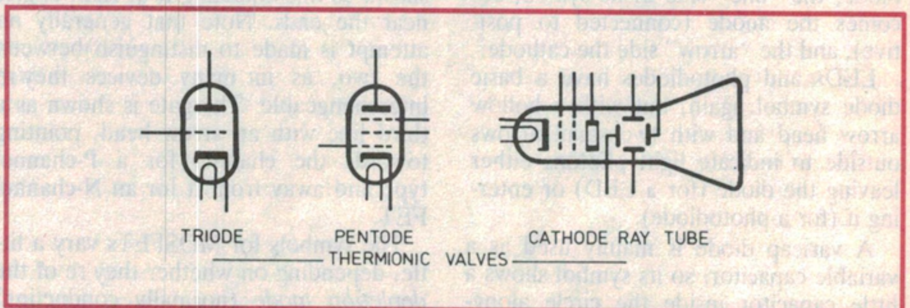

Fig.5: Symbols for the main types of valves you're likely to meet.

OK then, so much for the symbols used to represent most of the common components in circuit diagrams. But what about the actual diagrams themselves — how do you read them?

In a sense, it's a bit like reading music. Once you become familiar with the symbols used, the rest tends to fall into place. Like a piece of music, a well-drawn circuit diagram tends to "flow" in a logical manner, almost leading you along as you follow the course of the signals which pass through the circuit itself.

Generally speaking, circuit diagrams tend to be drawn so that whatever signals the circuit may handle, generate or process, they are brought in or produced at the left, and leave the circuit at the right. So as a rule of thumb, you'll find the *input* circuitry to the left, and the *output* circuitry to the right.

Most circuits need various supply voltages to function, so you'll tend to see various *supply voltage rails* on the circuit diagram. Generally these will be drawn as horizontal lines above and below the main signal-processing part of the circuit, and labelled with such markings as "+9V" or "-12V". By convention the more *positive* supply voltage rail(s) is (are) generally shown at the top of the circuit, and the more *negative* supply rail(s) at the bottom.

A point to remember is that the more negative supply rail, if there are only two, or the "zero" volts rail if there are more than two, may not actually be drawn as such. Instead it may be implied, by showing the connections to it via individual "earth" symbols as shown in Fig.2.

Similarly it may not always be possible for all connections to a particular supply rail to be shown as lines connecting to a single unbroken "rail line". Some of them may be shown connecting instead to a short horizontal line, labelled to indicate that it really represents part of the main supply line.

The power supply circuitry itself is generally shown underneath the main circuitry, as it is in a sense secondary. The main exception to this is where the source of power is a battery or batteries; in this case they are frequently shown over on the far right.

As for reading the main signal-processing part of the circuit diagram itself, it's not really possible to give you any hard and fast rules because there aren't any. Each different kind of circuit tends to have its own distinctive pattern, and you'll gradually learn to recognise them.

A good rule of thumb when you come across a circuit for the first time is to identify the supply lines, then try tracing the main signal path from input to output, left to right. Needless to say the path will often be from the output of one transistor stage to the input of the next stage on the right, or from one IC op-amp or logic gate output to the input of the next.

Then see if you can find any other signal paths leading back, from right to left — either around the circuit as a whole, or around smaller sections, even individual transistors or op-amps. If they're present, these signal paths will generally represent *feedback* circuits.

Again it will usually be very useful to try working out whether these feedback paths, if they're present, are achieving *positive* or *negative* feedback. Generally the best way of doing this (at least roughly) is to work out how many phase reversals will occur around the circuit "loop" affected by the feedback. A phase reversal will tend to occur in every normal common-emitter or common-source transistor amplifier stage, but not in common-collector ("emitter follower") or common-drain ("source follower") stages. Similarly there will be a phase reversal in op-amp stages where the signal enters via the "-" input, but not where it enters via the "+" input.

If there are an even number of reversals inside the feedback loop, so they cancel out, the feedback will probably be positive. On the other hand if there's an odd number, producing a net reversal, it's probably negative feedback. This isn't an infallible rule, because it doesn't take cumulative phase shifts into account. However it can be a useful guide.

Remember too that positive feedback tends to imply that a circuit is designed to oscillate, or at least exhibit increased gain and narrower frequency response. On the other hand negative feedback tends to imply a circuit designed for lower gain and noise, greater stability and broader frequency response — i.e., linear amplification.

Let's look at a very simple example, to illustrate at least some of the principles we've discussed. The circuit diagram we'll examine is shown in Fig.6.

First of all, you can see that over on the right there's the symbol for a 9 volt battery. As this appears to be the only source of power, it's a fair bet that this powers the circuit. The positive side of the battery is shown connecting via a switch to the rest of the circuit, so this

Reading circuits

is undoubtedly the power switch. And the horizontal line to the left of the switch, labelled "Vcc", is obviously the circuit's positive supply rail.

Note that the negative side of the battery is shown connecting to the circuit's earthy side, and many other parts of the circuit are shown with similar connections. From this you can deduce that this circuit is one where "earth" is used as the negative rail.

Now then, to try and trace the signal flow, which will probably be from left to right. Over on the left near the top there's an aerial symbol, and below it an earth. These are shown connected to the primary of an air-cored transformer, as you can see. The full secondary winding of the transformer is then shown connected to a 415pF variable capacitor, labelled "TUNING".

Fairly obviously, we have here the front end of some kind of radio receiver, with signals from an aerial and earth setup being coupled into a parallel tuned resonant circuit. OK so far?

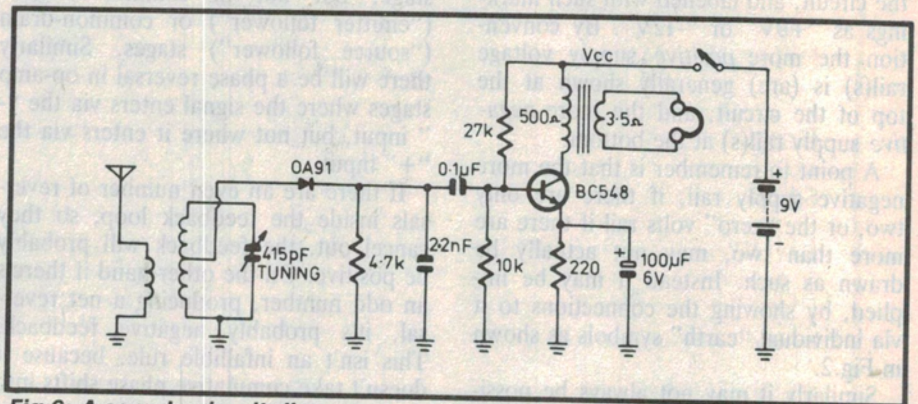

Fig.6: A sample circuit diagram, to try yourself out on (see text).

Right. Now there's a tapping connection shown on the secondary of the air-cored transformer, with a connection to the anode of a diode marked 'OA91'. The cathode of the diode is shown connected to earth via a 4.7k resistor and a 2.2nF (.0022uF).

If you remember your theory, this is basically a half-wave rectifier setup. So in the context of a tuned circuit and signals from an aerial, it's likely to be a simple RF detector — with the 2.2nF capacitor providing some smoothing of the RF ripple.

So far then, we seem to have something very like a simple "crystal" radio set. But there's obviously more of the circuit left to come, so let's look further.

At the heart of the remaining section there's an NPN bipolar transistor, as you can see, with its emitter taken to earth via a resistor and capacitor in parallel. The audio signal produced by our diode detector circuit looks as if it's being coupled into the transistor's base, via a 0.1uF capacitor, while the collector of the transistor is connected to the Vcc supply line via the primary of an iron-cored transformer. And the secondary of the transformer is connected to a pair of headphones.

In other words, it's fairly clear that what we have here is a common-emitter audio amplifier stage, boosting the signals from the diode detector so they will produce louder sounds in the headphones. Without a doubt the 27k and 10k resistors connecting to the base of the transistor are to supply it with the correct DC bias voltage, while the 220 ohm resistor connecting the emitter to earth is to introduce a small amount of negative current feedback to improve the stage's DC stability. The 100uF electrolytic capacitor connected across the resistor will be to provide a low impedance AC path from emitter to earth, to prevent any AC negative feedback.

So there you have it: our circuit diagram example is nothing more than an amplified crystal set, a very simple radio receiver. And we've been able to deduce this simply by working through the circuit diagram itself, in a logical manner!

I hope this simple example gives you at least a basic idea of how circuit diagrams are read and used. Hopefully from here on, now you're familiar with the basic idea, you'll be able to work your way through others. Like most skills, it's mainly a matter of practice — so try to wade through as many as you can, and you'll make rapid progress.

The main thing to bear in mind is that a circuit diagram is basically intended to show you how the circuit concerned *works*, not what the parts look like, either separately or when they're connected together.