RIGHT—*From the Start*

PART 2: WIRING

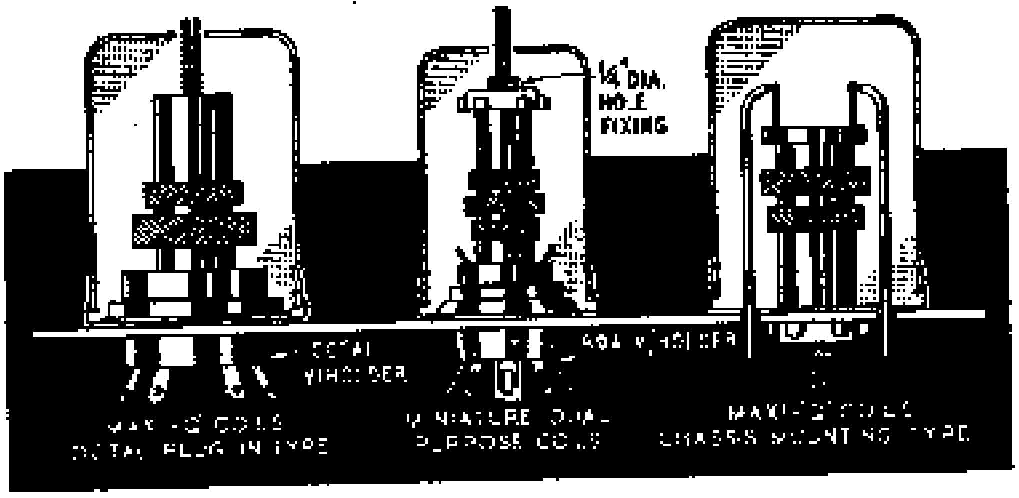
by A. P. BLACKBURN

LAST MONTH I TALKED ABOUT SOME common circuit symbols and what they meant. They are not so mysterious as they first appear, after all. We can, therefore, move safely on now to a more interesting stage: translating a circuit into a working model.

For this purpose we can take the simplest type of receiver—partly because it is a receiver and therefore a more absorbing subject; partly because it will cover most of the types of components we discussed last month.

One thing is important to remember, however. A lot of careful thought *before* you reach for the soldering iron saves a lot of heartbreaking dismantling afterwards. No one leaps straight into the design of anything; they sit and stare into space for hours, worrying the problem before even picking up their pen. This is as true of radio as anything else, but it is especially true if no component layout has been suggested to the constructor.

Deciding on a layout is not child's play: it requires a lot of skill, and very often experience, if "extensions" on the chassis are to be avoided. However, for guidance there are certain rules which can be used as a basis on which to work.



Three types of tuning coil, with screening can.

The Circuit

The circuit of a simple receiver is shown in Fig. 1, and contains 2 valves: V_1, a triode, and V_2, a pentode. We need not worry too much at this stage how the circuit actually works. We can go into the theory more fully later on. For the moment, let's accept the fact that the first valve V_1, and its associated components, forms the detector stage. This stage converts the incoming signal into voltages suitable for amplification and connection to a loudspeaker.

The second stage, comprising V_2 and its associates, is responsible for the amplification of the signal received by the first stage; it also drives the loudspeaker.

Although there is no hard and fast rule, and no one but a purist will get upset if you decide against it, it is a generally accepted practice to draw circuits with the aerial on the left and the loudspeaker on the right, this being the direction, of course, which the signal takes between aerial and speaker.

Working from the left, the first thing we meet that is unfamiliar is C_1, to which the aerial is connected. This symbol was not included in last month's batch: it is another, and miniature, form of variable capacitor, called a "trimmer." From C_1 the signal passes to L_1. Now all three coils—L_1, L_2 and L_3—would be wound on the same former, and these become what is virtually an air-cored transformer, indicating that the signal appears in L_2.

The components C_2 and L_2 form the

"tuning circuit" in which C_2 is the control used to tune in the wanted signal from the front of the set. The signal has now arrived at the grid of the triode valve V_1, via the fixed capacitor C_3. The position of C_3 and R_1 earn them the names of grid capacitor and grid leak (R_1) respectively.

The valve V_1 "detects" the signal, as we already know. (It also has an amplifying effect on the signal, but this is not its real job, and is really poaching on V_2's ground.) The extra winding on the coil L_3 is a reaction winding, used to increase the sensitivity of the receiver. Capacitor C_4 is the reaction control. We can conveniently defer further explanation on this subject until a later article.

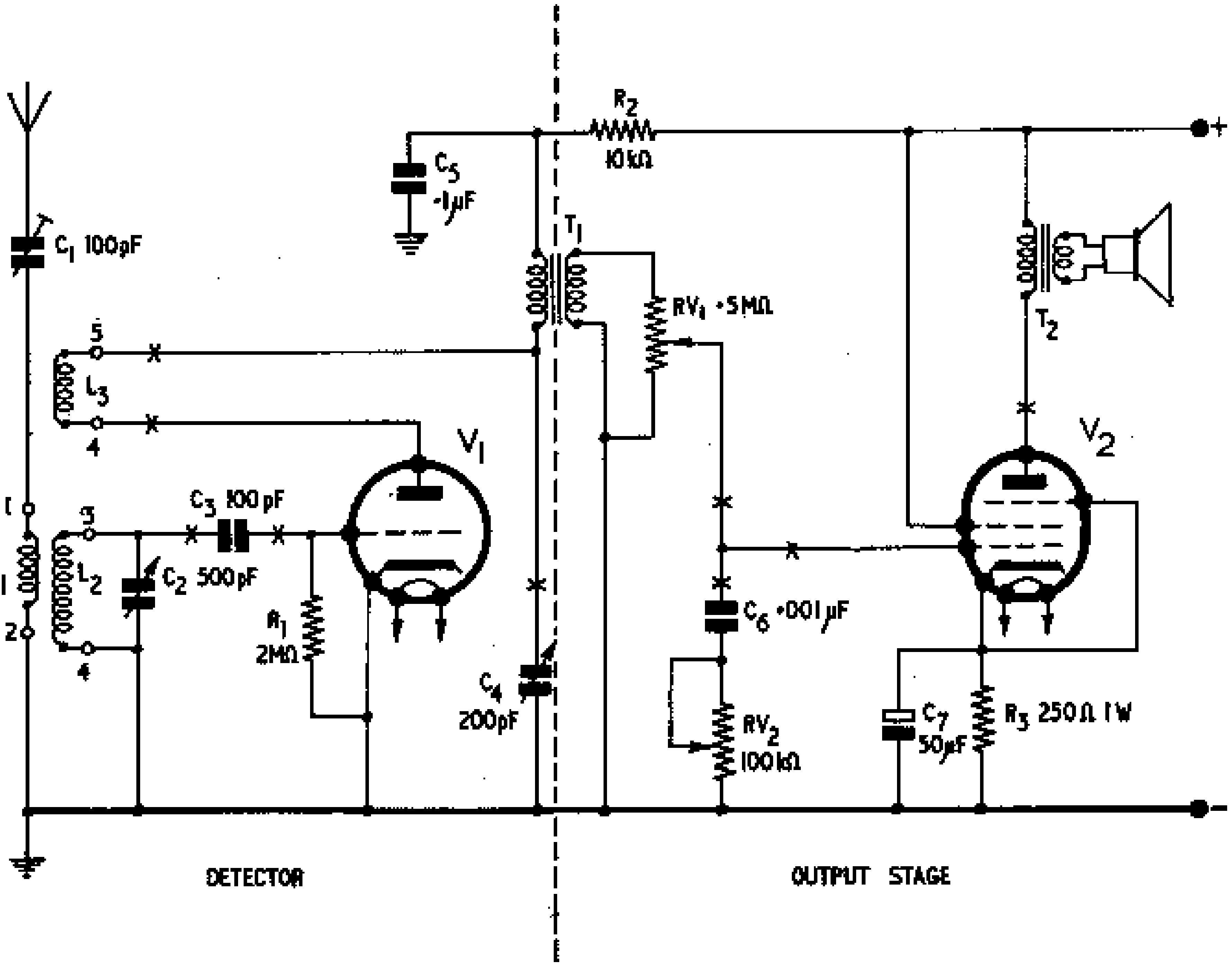


FIG. 1.

The transformer T_1 couples the output of V_1 to the grid of V_2 by way of the volume control potentiometer RV_1. The tone control circuit is formed by C_6 and RV_2. We know that the pentode V_2 amplifies the signal and also drives the loudspeaker. In the cathode circuit of V_2 an electrolytic capacitor is used to by-pass the resistor R_3. As we discussed last month, the component values are marked on the circuit to conform with convention.

The description of this circuit is necessarily brief and some terms I have used have been left unexplained. However, I did not intend to explain the working of the circuit in detail, but only to get the reader familiar with the use of symbols in circuit diagrams.

Layout and Wiring

No doubt you will find, when you start to make your instrument, that although the circuit is given, no suggestions are made for layout or wiring, these details being left to the constructor's discretion.

Of course, no single layout will do duty for every variation of an instrument; the requirements will differ from type to type. There are, however, some important basic principles, which must be closely observed. The first of these is the matter of long leads.

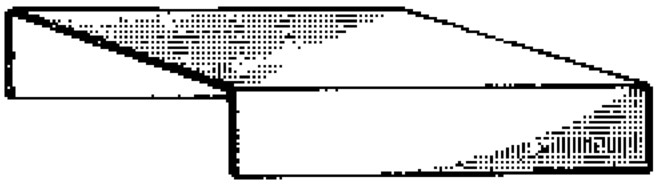


FIG.2.

A common mistake, which can be fatal to the finished product, is to spread the circuit out. This involves using long lengths of lead to connect up the various components, which done indiscriminately has a disastrous effect on performance. To ensure the best results, the circuit should be laid out logically, the general direction of the signal being followed through.

Obviously, that rule can't be rigidly applied, and the art lies in knowing which leads must be kept short and which can be left long. The really important connections—which must be *short*—are marked with a cross in Fig. 1. With medium wave receivers and most amplifiers, earth leads and cathode, heater and h.t. leads can be left quite long without affecting the operation of the circuit. Grid and anode leads *must* be short.

While we're on the subject of grids and anodes, there is one most important point which should never be overlooked, and that is: never run these two leads parallel for any distance. It may be easier to remember this rule if you can learn to identify the grid as the input and the anode as the output; input and output leads of any circuit must not travel together for any distance. This is illustrated in Fig. 1, where the anode wiring of V_2 is kept well away from its *own* grid, but at the same time it should not, under any circumstances, mix in with the wiring of V_1 grid.

Another advisable precaution, with valves whose heaters are fed with alternating current supplies, is to keep the heaters away from grid and anode wiring as much as possible.

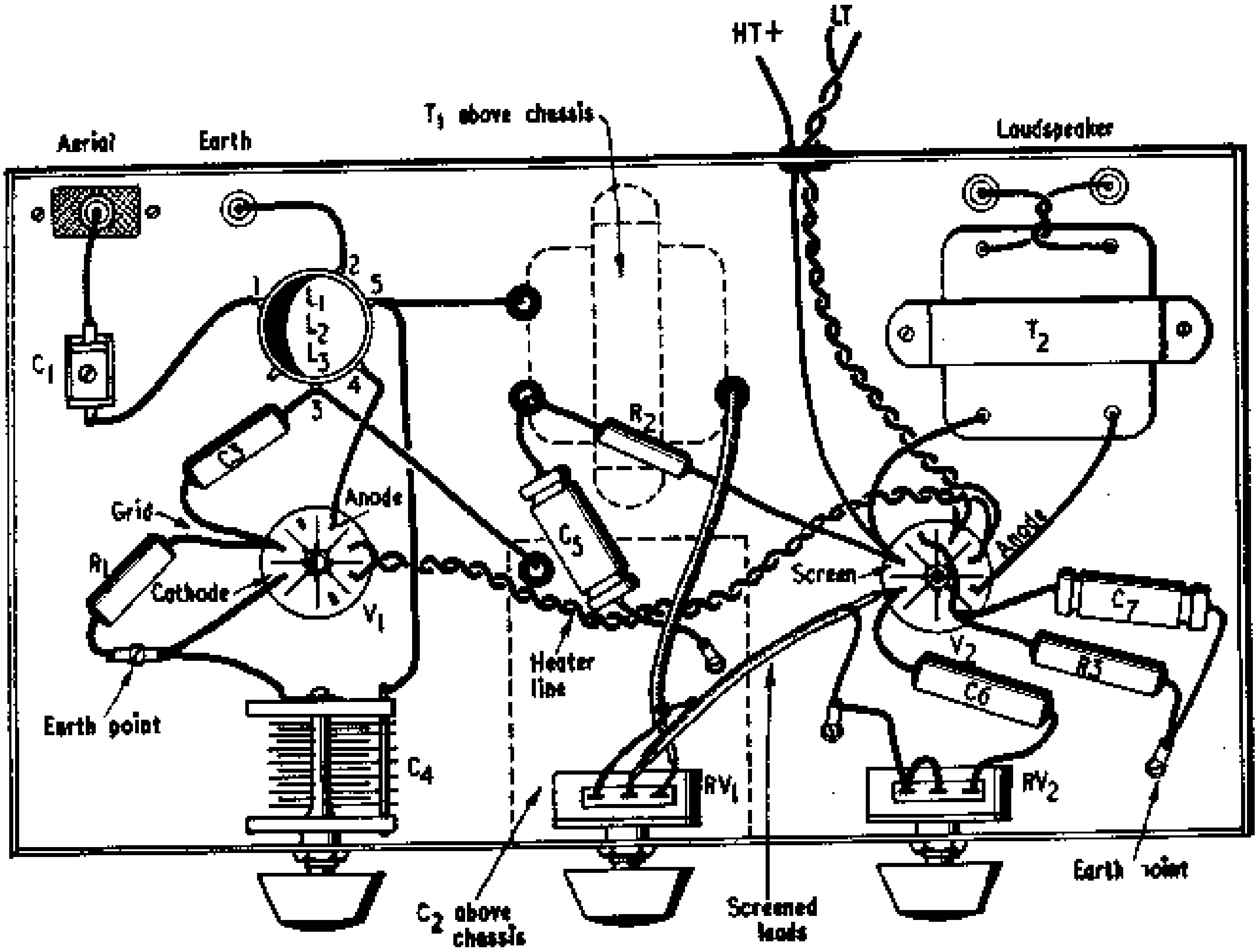


FIG.3.

Very often, of course, the aggravating situation arises when, having carefully and methodically planned the ideal wiring arrangement, you find that it will have to be modified to allow the controls to be placed symmetrically on the front panel. Under these circumstances, the compromise between wiring efficiency and aesthetic considerations can become a problem of disproportionate magnitude. Clearly a decorative set that defies all attempts to get it working is not so fruitful a labour as one which, although not particularly attractive, goes like a bomb. The moral is, therefore, not to worry too much about sacrificing performance to looks (your attitude to the fair sex could be an excellent guide here).

The Chassis

Nowadays, it is normal practice to build everything on a chassis. Fig. 2 shows a simple type. As you can see, the ends may be closed or left open; without the end pieces, the construction is even more simple: the metal is merely bent in two places.

Suggestions for a possible layout of the circuit shown in Fig. 1 are sketched in Fig. 3. It has been laid out specifically to illustrate the compromise between efficient operation and symmetrical front panel design.

One method is to stretch the lead connecting T_1 and C_4 well across the chassis. This can, of course, be avoided if the whole layout is re-designed, with T_1 placed close to C_4. Such an arrangement would mean that T_1 would be some distance from V_1 and the coil. The layout shown is, however, perfectly satisfactory.

In Fig. 3, the components C_3, C_5, C_6, R_1 and R_3 are all sufficiently small and light to be supported on their own wire ends, and this is true of many parts used in such instruments. However, C_7 may be large enough to require a clamp to secure it to the chassis. This would depend on the manufacturer.

The aluminium chassis acts as the earth line, which has been drawn heavily in Fig. 1 to emphasise the fact. You will see in Fig. 3 that R_1 and C_4 are earthed at one point and C_7 is earthed elsewhere. There is nothing wrong with that idea, providing the circuit diagram specifies nothing different. An example of a circuit where "single point earthing" is required is shown in Fig. 4. This particular method of drawing means that L_1, C_1, R_1, C_2 and C_3 ,must all be connected to chassis at the same earth tag. It is a practice very often encountered in very short wave receivers and television receivers.

Tolerances and Types

Now there is one stumbling block which nearly every constructor building his first receiver will fetch up against. He will set out with a list of components, having special values, and to his annoyance he may very likely find that in his particular area his specified types aren't available. His local dealers will glibly offer alternatives. Not unnaturally, the customer experiences suspicion and uncertainty. He is determined that the components and their values are obtainable somewhere, and he continues his search.

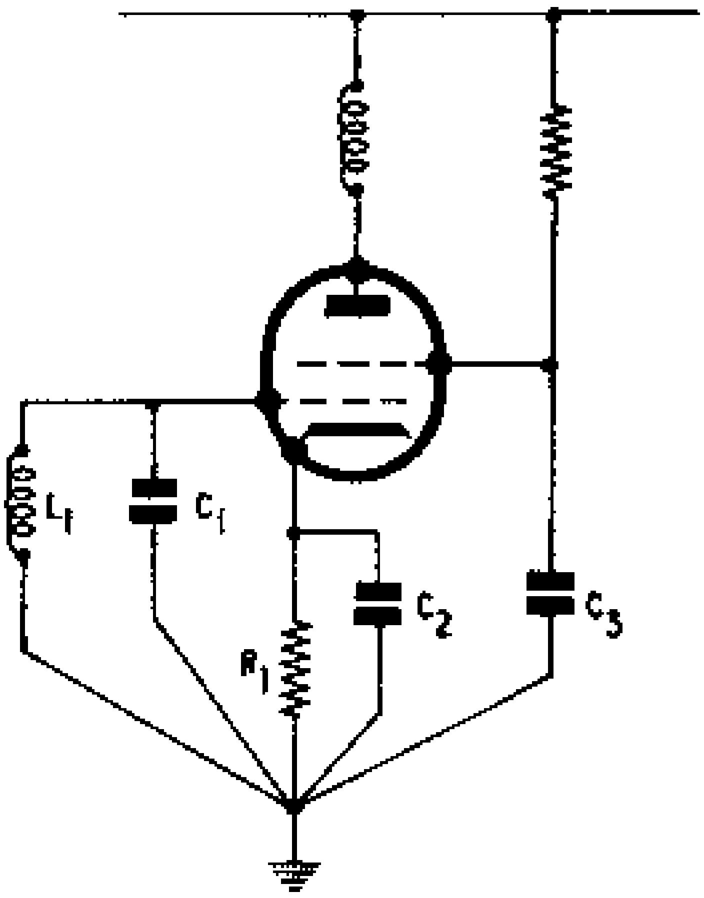


FIG. 4.

If he takes this attitude, it is clear that what he does not appreciate is that, in a well-designed circuit, there should be few critical components. Resistors, for example, are made with tolerances ranging from ±1% to ±20%. Most receivers and amplifiers only require ±20% tolerance resistors. Look at R_1 in Fig. 1, specified as 2MΩ. A ±20% component could have any value between 1.8 MΩ and 2.2 MΩ.

The circuit is unaffected by such small discrepancies in value, and if a 2.2 M resistor only is available, well then it can be used quite happily with no ill effects. Don't forget, though, that a 2.2 MΩ resistor would itself have a tolerance of ±20%, which means its value may be anywhere in the range of 1.98 to 2.42 MΩ. The same applies to capacitors—in fact, nothing is exact, every component has tolerances!

Not so easily dealt with are the other ratings. Take C_5 in Fig. 1, for example. It should be a 250V working component. A 200V working capacitor will not therefore be suitable, but a 350V one will. Then again, R_3 should be a 1 watt resistor, so nothing below 1 watt should be used. This will, of course, be somewhat confusing to start with, but practice will soon sort it out until you are picking the right value almost automatically.

With electrolytic capacitors you are completely at sea. They often have tolerances of +100%–0%; in other words, they can have any value between that marked on the case to twice the amount. Really, your first reaction might be, why bother to mark them at all?

However, unless it is specifically stated on the circuit that close tolerances *must* be used, it is quite safe to assume that ±20% is good enough. But on no account be lulled into believing that unlimited licence can be taken with a circuit, otherwise your performance and operation will suffer acutely for it.

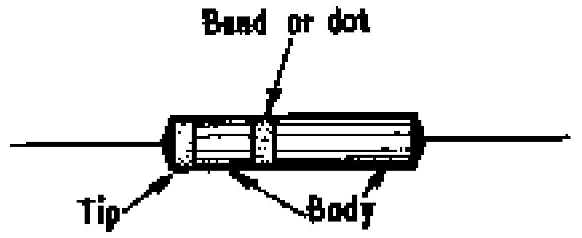


FIG. 5.

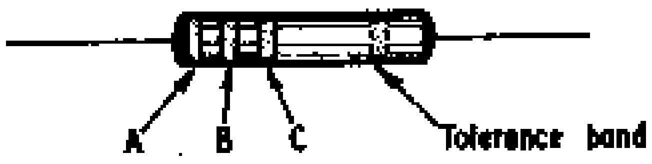


FIG. 6.

The Colour Code

This is a very crafty but at first confusing system for marking the values on resistors. The value is seldom printed on these components nowadays, and instead it is striped and spotted according to a carefully devised code. Once the code has been memorised it becomes second nature to identify the values—and saves tedious peering and uncertainty at minute figures half obliterated by wear. A typical resistor and its marking is shown in Fig. 5.

There is a definite order of reading the colours which must be strictly observed. This is: body, tip and band. Sometimes the band is not used, but a dot. Then the reading is: body, tip and dot. The table of colours is as follows:

Colour	*Figure*
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

The first (body) colour gives the first digit, the tip colour the second digit and the band (or dot) colour the *number of noughts.*

So, a resistor having a brown body, a black tip and a yellow band has the value of 100,000 ohms, or 100 kΩ. Yellow body, violet tip, red band means 4,700 ohms, or 4.7 kΩ.

If the band is omitted, it is to be assumed that it is the same colour as the body. For example, brown body and black tip means 100 Ω.

An alternative method of marking is shown in Fig. 6. These are read in the order: A, B, C. If A were blue, B grey, and C yellow, the value would be 680,000 ohms, or 680 kΩ. On this type a further band is sometimes included. This band marks the tolerance (silver, ±10%; gold, ±5%); they are quite distinctive colours, and are never confused with the value markers.

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This article is the second in this series. Do not be discouraged by the spade work. If you are impatient, and anxious to skip the first few lessons because it seems perhaps a little too elementary, you will find that the basic principles are later taken for granted, and much of what you are trying to learn will be meaningless. It is more difficult to unlearn wrong conceptions than to start from scratch and learn the right ones.

Once learned, the elements of radio stay in the memory, and there is no need for you to consciously remember them. They are there to stay, with no more effort on your part. This leaves you with plenty of room to learn new things, and puzzle out complexities.

NEW MULLARD LINE OUTPUT PENTODE FOR 90° SCANNING

The Mullard PL36 is an output pentode primarily designed for the line timebases of television receivers using picture tubes with a deflection angle of 90°, and 16kV e.h.t. The new valve is octal based, and has a 25V, 0.3A heater, suitable for series operation.

NEW MULLARD RECTIFIER VALVE

The Mullard PY32 is a new half-wave power rectifier valve for use in television receivers with series-connected heaters. The valve has a maximum rated output current of 275mA, a typical d.c. output voltage being 190V when the valve is supplied direct from a.c. mains, 200V.