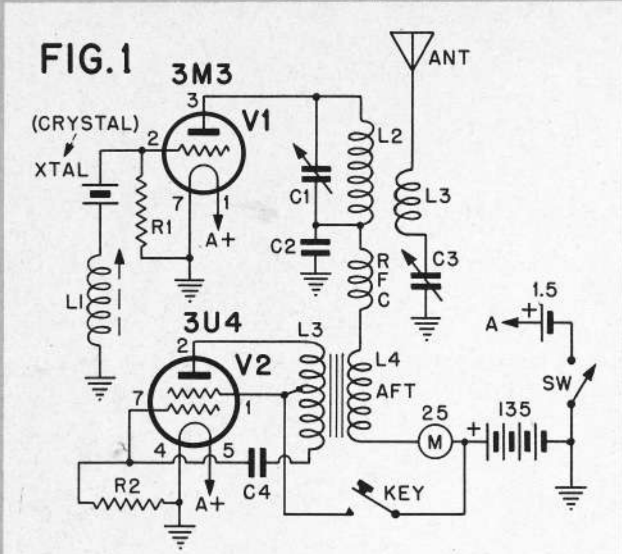


Figure 1 represents a "for-instance" triode crystal-controlled oscillator with tetrode modulator. Article explains terms.

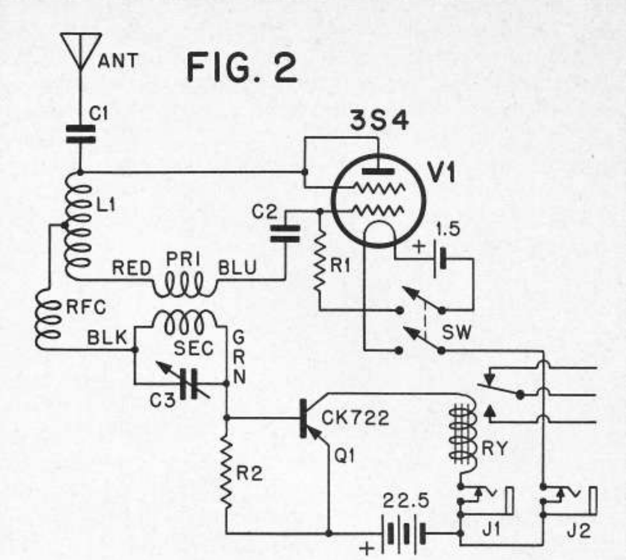


Figure 2 is a typical single hard tube receiver with transistor amplifier. Neither circuit is a "working" one; just for study.

Know somebody just starting out in R/C plane-boat-car activity and plenty bewildered by all the specialized "inside" language and symbols? This is for him!

Basics of Radio Control

BY HOWARD McENTEE

■Even though an aspiring R/Cer intends to purchase all his equipment he still has to connect most of it up, and thus, he should know how to read basic circuit diagrams. Some manufacturers have made it as easy as possible showing on their diagrams an actual representation of each component, rather than the conventional symbol. Thus, a battery would be drawn as a battery, a switch as an actual switch. This is all right, but it takes a lot of time—and it can get confusing, for there are many types and sizes of batteries, switches, etc. . . . especially the et ceteras! Circuit symbols are a form of "shorthand"; they greatly speed the drawing (and reading) of circuits. A condenser is shown on a circuit by the correct symbol, often with the value indicated alongside of it; the actual condenser used in the unit might be any of a dozen or more sizes or shapes, all of which could have the proper electrical characteristics for that particular use. If a designer wants to specify an individual make, size or other characteristic of the condenser, he usually does so in a separate parts list or within his article or information sheet.

Actually, there aren't such a great number of these circuit shorthand symbols that you need to know. We show most of the main ones that you'll encounter in R/C systems.

Take condensers, for example. Most of those we use are "fixed", and have the symbol shown at A, which indicates the two plates of the unit. You will also see a fixed condenser with one curved plate; in this case, the curved plate can indicate the outside foil of a tubular paper condenser. At B we have a variable condenser (the direction of the arrow doesn't mean a thing); in the curved plate symbol, the curve shows the movable plate or plates. The electrolytic condenser symbol should always have positive indicated, since it makes a difference "which way round" you connect these units. Dual section variables are sometimes used in transmitters, the symbol shows two individual sections tied with a dotted line; the dotted line means they are tied together mechanically but not electrically. A similar dotted line is also used in switch symbols for the same purpose.

Two common symbols for the simplest switch, the SPST—single pole-single throw—is seen at C. Three other common forms of switches are also indicated. Note dotted line to show operation of two switch sections from a single knob or lever.

A single cell, whether it be the "dry" type or some form of storage battery is always indicated by a long and a short line. *Usually* the long line is the positive terminal. Since this isn't universal, it is common practice to mark the positive side of the cell with a "plus" sign. The negative side is sometimes indicated via a "minus". When several cells are connected in series (or in parallel, for that matter) we have a battery. While we could show the actual connection between the numerous cells of a battery, as seen at D, the intercell connections are usually omitted, so we get the symbol at E. While this would seem to show three series-connected cells, actually, no great effort is made to draw a long and a short line for *every* cell in a battery, otherwise the symbol for a high voltage battery would get too bulky. But a single cell is usually shown as indicated, while higher voltage batteries have three or four sets of long and short lines. A tap on a string of cells can be indicated as at F. This tap is a direct connection to the long line as indicated, *also* to the short line directly below it (the short line above it is the other pole of the same cell).

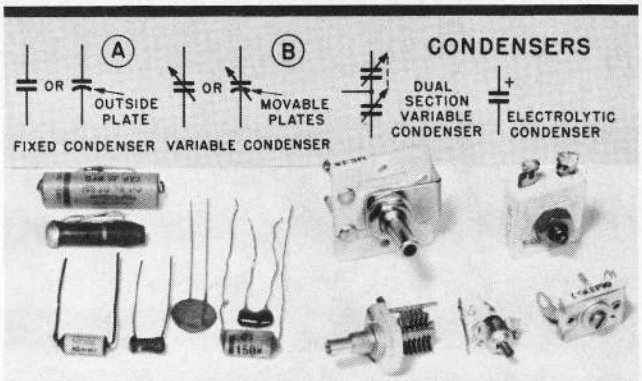
Meters and motors are both shown by circles, but the latter usually have some sort of special termination of the two connecting wires, to indicate brushes. In R/C work, you often see the circles with a letter inside, which can indicate a particular servo motor in the control system. Note that the "aileron motor" symbol could be mistaken for that of an ammeter. The numeral next to a meter symbol shows the full scale reading possible; the symbol nearest G indicates a milliammeter with 5-ma full scale reading.

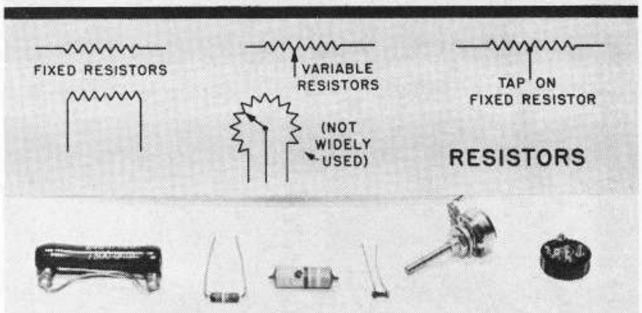
The term "coils" takes in a lot of territory, as they can be inductors, inductances, chokes, or transformers. Cores, indicated by two or three solid lines which mean a solid iron core, show that the unit it for low frequency use. One or more dash lines usually means a high frequency unit. An arrow on one end of the latter means a variable core, used for tuning purposes. Either type of core can run lengthwise through the middle of the turns, or be placed at either side—this is simply a matter of individual preference. Since on paper an RF choke looks just like an inductance (which it is) so it is usual to label such a unit RFC. An inductance with solid iron core, as at H, is usually called a "choke". Any coil can have the leads going off in endwise or sidewise—it makes no difference and is merely a matter of convenience in drawing the circuit.

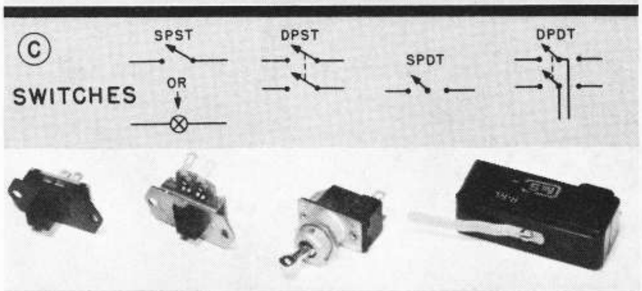
Two (or more) coils placed side by side constitute a transformer. We have drawn both RF and AF transformers in the two complete circuits that head up this report. The RF transformer will have no core at all, or it may have a dotted (powdered iron) core; the AF transformer always has the solid lines.

There are dozens of tube types and many different styles of transistors. The tube at I is called a "tetrode" since it has four internal elements; the one to its right is also a tetrode, but the elements are drawn a little differently. There is no real difference in the two—again a matter of style. Quite a few of our R/C tubes are "pentodes" with a third grid in addition to the two shown in 1. This grid is called the "supressor" but since it is almost always tied internally to the filament, it is often omitted in circuits. The tube type number will tell if it is a tetrode or pentode by reference to the maker's specs. Triodes have only three elements, as at J; this particular one has a black dot, which means it is a gas tube, rather than a high vacuum (or hard) type. Neon tubes have only two electrodes or elements, and so are diodes.

Most diodes employed in R/C are not vacuum types, but the so-called semi-conductors, a classification which also embraces transistors. Most transistors are triodes and are drawn without a circle around the elements as at K or with such a circle, as at L. Note that there is another difference between K and L; K has the arrow head on the emitter *toward* the base, and is thus a PNP type. At L the arrow head goes the other way making it an NPN unit. This is a vital difference in transistors. Semi-conductor diodes seldom have a circle around the elements, but there is often







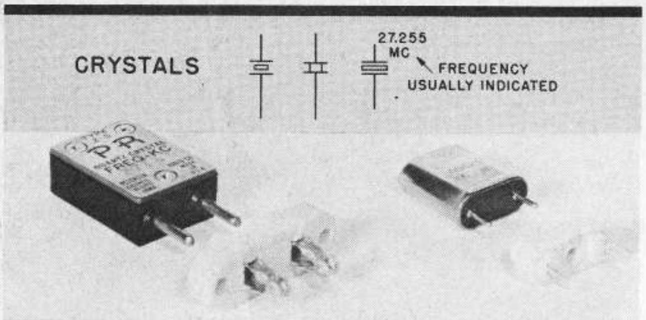
a K to indicate the cathode terminal, as at M.

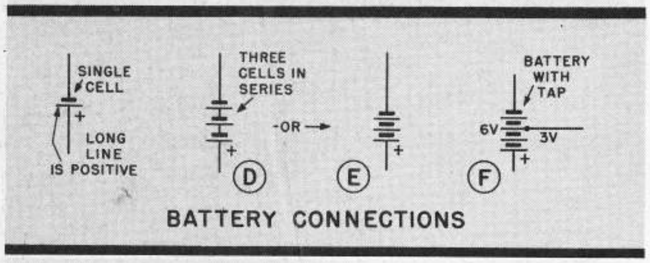
Most R/C relays have a SPDT contact arrangement. You often find the two fixed contacts (arrow heads) marked "NC" and "NO", the former meaning "normally closed"—the condition when there is no current in the coil—and the latter, "normally open". Relay armature can be shown two ways; N indicates a relay with the armature pivoted at one end, similar to the Gem; O shows a center-pivoted armature such as the Sigma 4F. This distinction is not often made in circuits.

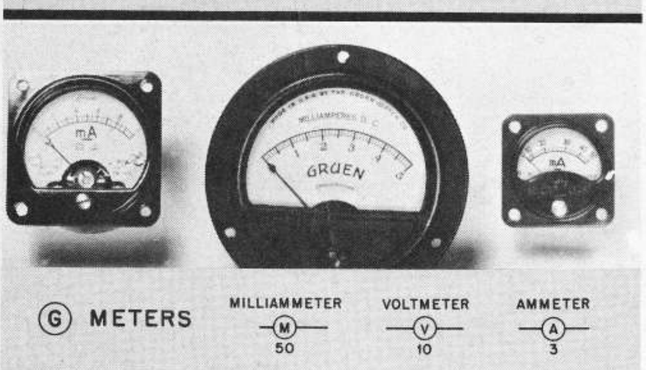
Two jacks are shown at P, with a plug that fits either of them at the right. The body or frame of the jack is the part with the hole into which the plug fits; the outer sleeve of the plug makes contact with this jack frame.

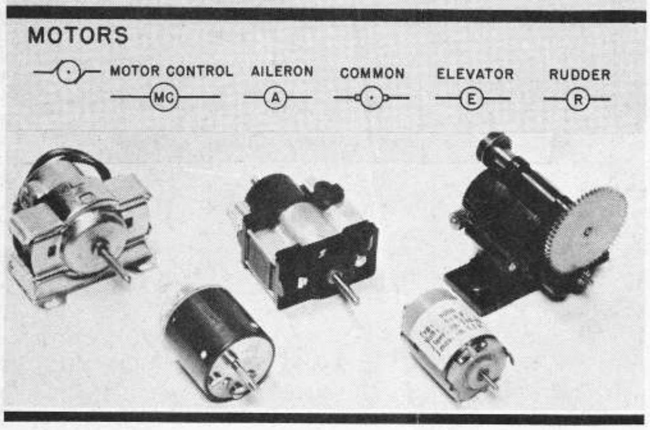
Another type of "plug" is implied when we consider connectors. Q shows round and oblong connectors, which may have from one to 25 or more circuits through them. Note that the contacts of the plug are usually shown solid, while the connectors have circles. Tube and transistor sockets are also shown with these circles, when they are indicated on circuits (but they are usually omitted).

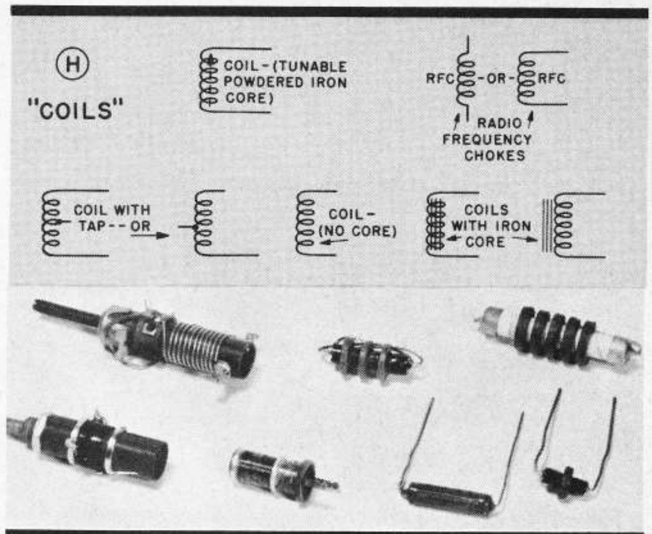
At R we see two symbols used to show "ground". That word is in quotes, since there is seldom a connection to actual earth; ground simply means a common connection in the equipment. If there is a metal chassis, as in many transmitters, this is often considered as ground. In receivers with tubes, ground is often the junction between the A and B batteries. In all-transistor circuits it could be either the plus or minus side of the battery. Ground is usually a sche-

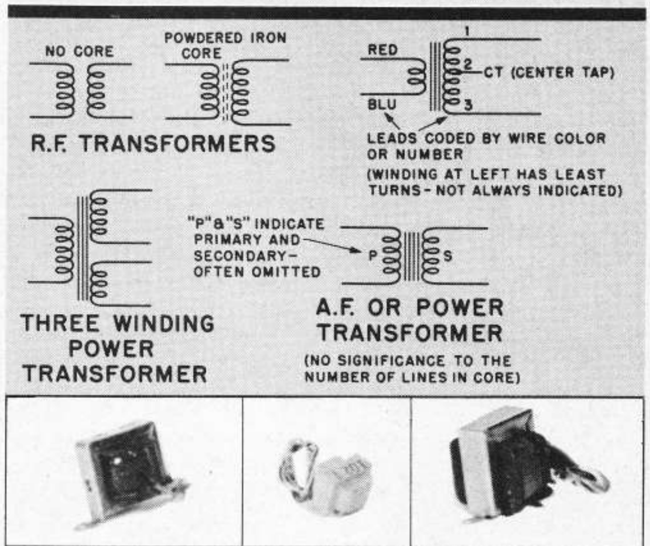


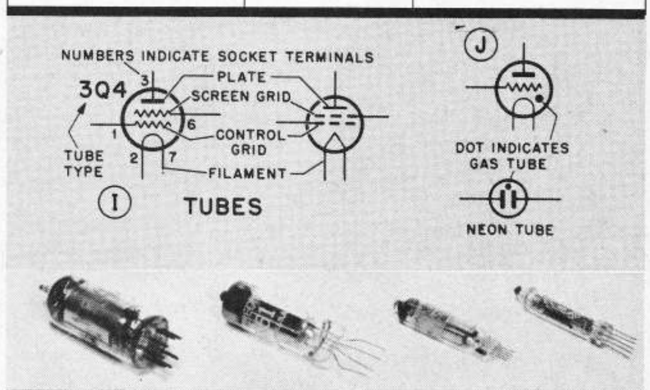


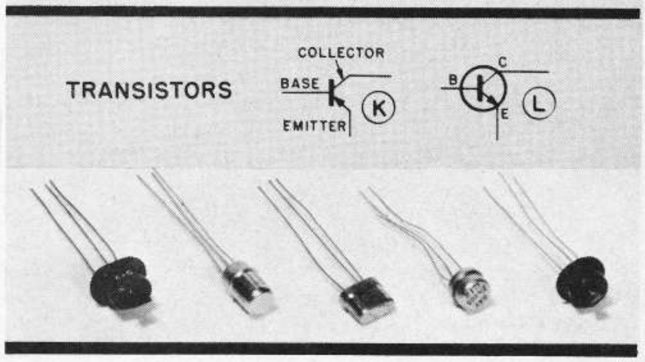








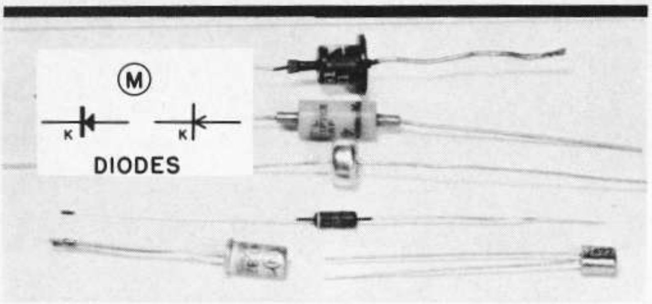


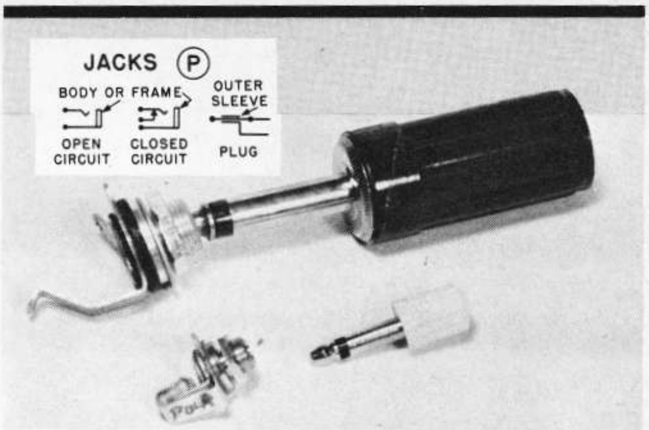


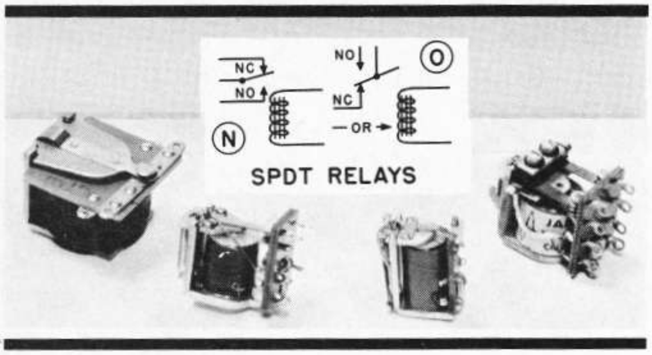
matic shortcut; you don't have to draw so many wires.

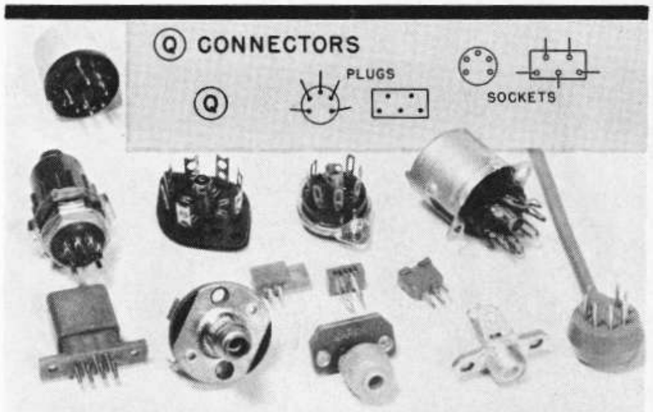
Now, how do we connect all the parts together? With wires which may be connected or may cross each other without connection. S shows connections, while T shows non-connected cross-overs. Here we have a possibility of confusion; some circuit draftsmen such as AM's put black dots where there are to be connections made, others don't. Some draftsmen show a semicircular "jumps" for a crossover, others don't. In AM circuits we try to make doubly sure, by using dots for all connections, and "jumps" where there are not supposed to be any.

A look at a couple of representative circuits will show how all these components are connected, and will introduce a few new ones too. These are not necessarily workable circuits—they are to show the elements we wish to include. Fig. 1 is a transmitter with a triode crystal-controlled oscillator and a tetrode modulator. Note that all "R's" are resistors, "C's"









are condensers (also called capacitors), "L's" are inductors or "coils", V stands for tubes, Q for transistors. Actual circuit values are often put right on the diagram, but if C and R numbers are used, as is the case here, then you will find the values and other info on these items in a separate parts list omitted here.

Fig. 2 is a typical single hard tube receiver with a transistor amplifier. Unit T is a transformer with no iron core; Pri and Sec don't mean much here, but usually the primary of a transformer is the input side, and the secondary the output. Lead colors of transformers are often important, and are indicated by the color abbreviations shown. See if you can spot and identify each circuit element in the two circuits.