ELECTRONIC HARDWARE

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An exposed pc board might work but it's an awkward and vulnerable bit of electronics you're left with. Housing, clamping and decorating are the next steps which might require a bit of dexterity and patience — but the completed job should be well worth the effort.

THE SUCCESS OF any electronic project lies with the completed unit. Apart from working properly, the device needs to be able to handle the rigours of usage, be safe, and look the part. If the electronics of the device is not correctly housed, or incomplete, then only half the battle has been won. In this article hardware items such as cases, pc board mounting methods, labels, nuts and bolts, clamps and aerosol sprays are discussed. Breadboards and the techniques involved will also be looked at to give the beginner in electronics the full story on constructing a project.

Breadboarding, while not essential to the mechanics of electronics, is a means of getting a design 'off the ground'. Its inclusion here is in order to give those readers who wish to design their own circuits a starting point. As this series is for the tyro reader, it is not our intention to get too involved in circuit design, but merely to present information to allow the reader to 'get started'.

Future articles in this series will look at active components and fault finding. The topic of hardware now is a natural follow on from the previous issues discussing passive components.

Breadboarding

Many circuit designs start out on a breadboard. As described in Starting Electronics 5 (June '85) the circuit, once perfected, can be transferred to a printed circuit board. The making of a pc board was the subject of this previous article, and by combining it with the presentation here, a fairly complete description of the mechanics of circuit development will be achieved.

Various breadboarding systems are used by designers but the most popular is the solderless prototyping board. Other circuit development aids include various general purpose pc board cards containing a layout of tracks to allow a miscellany of design applications. Pre-drilled phenolic boards (matrix boards) allow components to be held with press fit pins and connected either by wirewrapping or soldering with wire links. These latter systems provide a finished product that is fairly permanent, but using them is more difficult, as component changing requires either resoldering or re-wire-wrapping of the new component.

Solderless breadboards are commonly available from parts suppliers, and are a very convenient method of implementing a circuit design. These boards are simply an arrangement of interconnected sockets spaced along a 0.1 inch grid format, which allows the insertion of ICs, along with all the usual components. The sockets are generally designed for lead sizes of 0.6 mm to 0.8 mm, and are made of spring steel coated with either nickel or a nickel-silver alloy, with higher priced units featuring silver or gold plating. Less expensive varieties use a phosphor-bronze contact. The contacts are held in a plastic framework, with some frames allowing the interlocking of other boards by virtue of lugs around their perimeters.

One style of breadboard provides an external connection to each line of interconnected sockets by having a solder lug for each line *beneath* the board. These would be used in conjunction with power supplies, signal generators and other support circuitry to provide a self-contained circuit development system.

Although the layout of a breadboard may vary, the general scheme is shown in Figure 1. Notice how each column is a series of five interconnected contacts, whereas a row is a

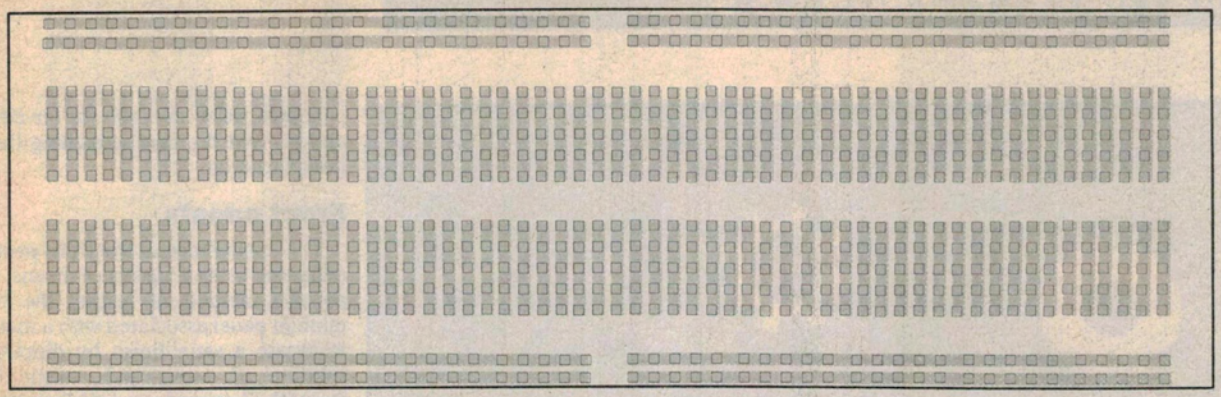
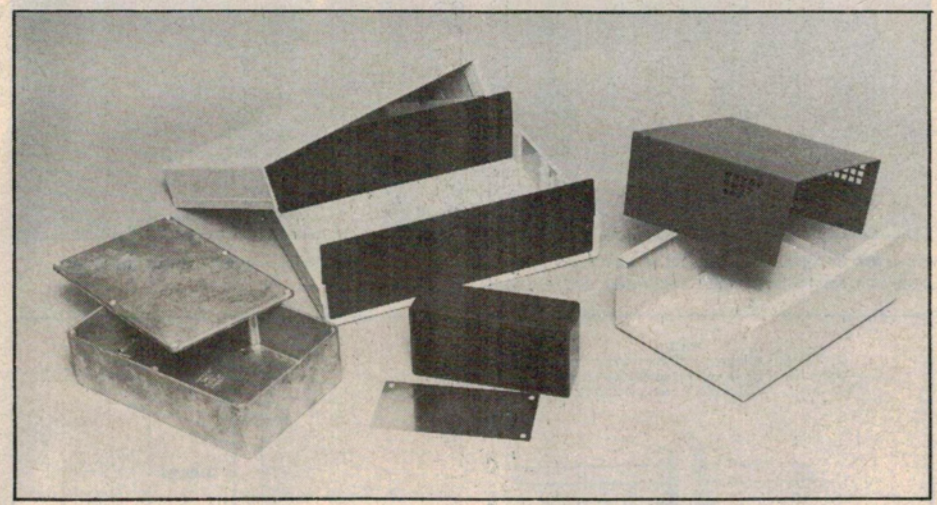


Figure 1. Internal connections of a breadboard.

line of many contacts. The rows are generally used as power supply rails and ICs are inserted across the central channel, the remainder of the circuitry being laid out using each column. Special breadboarding wire is available as are wire strippers to remove the insulation. Telephone wire is often used by experimenters, as a wide range of colours are available. The use of colours allows construction of a circuit that can be readily traced, even when it resembles the proverbial 'rat's nest'.

A breadboard is relatively expensive, but if care is taken, it will last a long time. Inserting leads or wires that exceed a diameter of 0.8 mm will force the contacts open, leaving that socket useless for future service. Also, wire that has been used many times before can often cause a bad connection, and the risk of it breaking off inside the socket increases. Insulation around the wire should be stripped using cutters that don't leave a nick in the wire, and enough insulation (around 7 mm to 8 mm) should be removed to ensure that the wire is connecting the contact properly. It is not uncommon for wires with bared lengths that are too short to end up with the insulation actually sitting in the contact, with no connection being the result, despite all appearances. Components should have lead diameters that don't exceed the capabilities of the socket, necessitating use of ¼ watt resistors and low voltage capacitors.

The layout of a design should be compact, but not so tight that it becomes impossible to remove a component should this be necessary. Avoid placing components over each other, and run the wires so that they are close to the board and formed to follow the most direct path. Cut each wire to its correct length and follow a colour coding *rigidly*. A procedure that often works is to lay out the circuit as it appears on paper, modifying the layout to suit as this becomes appropriate. Start by connecting the power supply wiring, and build the circuit in blocks, proceeding as each block is completed. Component leads should also be cut to length to avoid expanses of bare wire. Instances of Murphy's law abound in breadboarding, and a lot of care is necessary.



Left: diecast aluminium box. Centre top: plastic universal-mount instrument case. Centre bottom: plastic jiffy box. Right: enamelled metal instrument case.

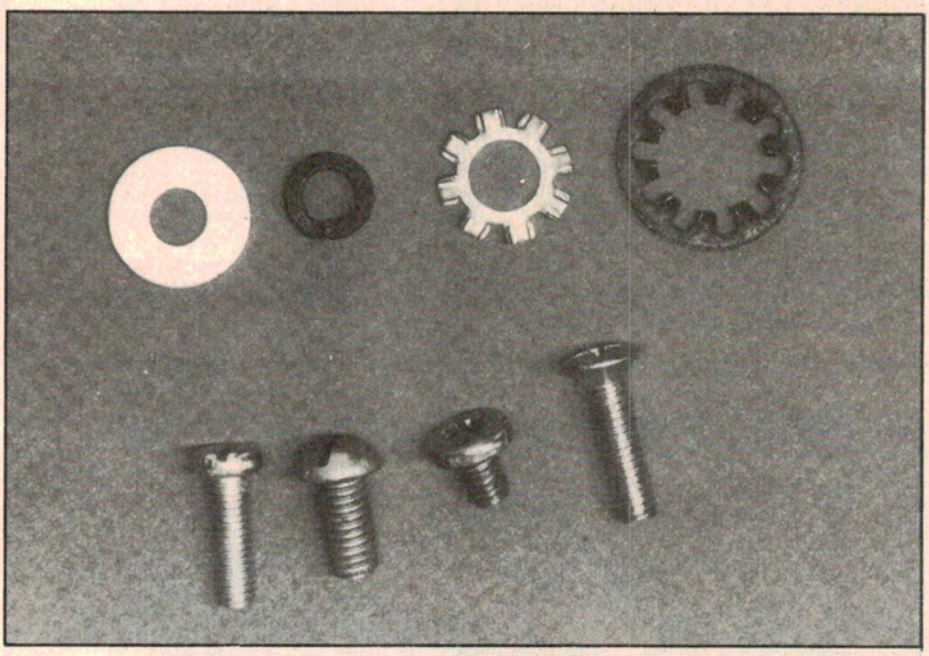
Housing

The choice of case is often dictated by the project itself. Where safety is essential, a plastic case should be used, but if rugged, weatherproof casing is required, then a diecast aluminium box may be more suitable. Other alternatives are aluminium boxes, fitted with a Marviplate or painted steel lid; some styles also include front panel protection handles. Further types include a range of internally ribbed plastic boxes with a flat aluminium cover, the ribs acting as possible pc board edge supports. Also available are various styles of instrument cases, generally made of plastic and often featuring carrying handles that can act as tilt feet. In general, commercial cases are designed for a multiplicity of uses, and the features in each case will vary.

A case varies in price, depending on the materials used to make it. Where heat generation is likely, a metal case may be necessary, although an abs plastic case can operate up to 85°C. Plastic has several advantages, including appearance and safety. If extreme heat conditions are likely, or if electrical screening is required, a diecast aluminium box is the best choice. However, special plastic boxes which provide electrical screening are also available, as well as some waterproof ones. Electrical screening is necessary if the circuitry either produces radiation that can interfere with other equipment, or is sensitive to external electrical fields. Magnetic shielding requires the use of steel, although this type of shielding is best done by shielding the actual component, rather than the whole circuit.

Where a suitable case cannot be found, building your own becomes necessary. For best results, sheet metal machinery such as a bender and a guillotine are required, with 16 or 18 gauge aluminium being the easiest material to work with. A lid, formed to provide the sides and top can be made from such materials as Marviplate (available in sheet form, complete with a wide range of finishes), enamel painted steel, or even timber. Aluminium lids are not usually suitable, as a finish is difficult to apply, although the budget conscious may consider the application of adhesive contact paper.

A final touch to any case is the feet. Rubber feet are available in either self adhesive types, or those requiring attachment with a screw, usually of the self-tapping variety. Rubber feet, apart from enhancing the ap- ▶



From left to right. Top row: flat washer, split spring washer, two types of star washer. Bottom row: pan head bolt, round head, half-round head, counter-sunk.

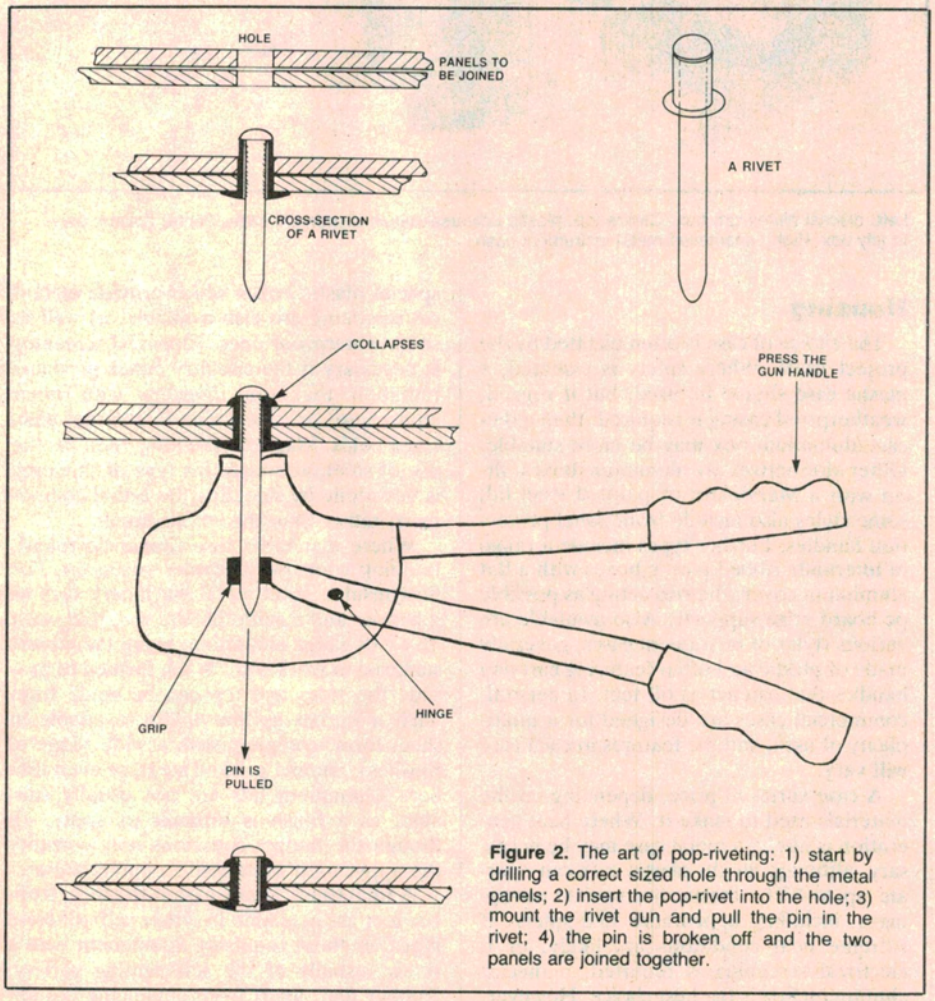


Figure 2. The art of pop-riveting: 1) start by drilling a correct sized hole through the metal panels; 2) insert the pop-rivet into the hole; 3) mount the rivet gun and pull the pin in the rivet; 4) the pin is broken off and the two panels are joined together.

pearance, raise the case for air circulation, and prevent the case scratching the surface it is placed on.

Front panels

The appearance of the front panel can be enhanced using a variety of means. An inexpensive method of testing the bare aluminium panel associated with a metal case is to create a satin finish by dipping it in a solution of water and caustic soda. A strength of around two tablespoons to a litre of water will cause the immersed aluminium to gain this finish after about five minutes. The aluminium should be thoroughly polished with steel wool and soapy water before its immersion in the solution. A rather obnoxious gas will be generated, so allow plenty of ventilation. After treatment, remove any residue from the panel by holding it under running water and wiping with a cloth. After drying, spray the panel with a clear spray lacquer such as is available from any hardware store. When this has dried, lettering can be applied using a commercial rub on lettering set. The panel should then be resprayed with lacquer, and allowed to dry before mounting the components. A very light spray should be applied first, to prevent the lettering from crinkling due to the lacquer.

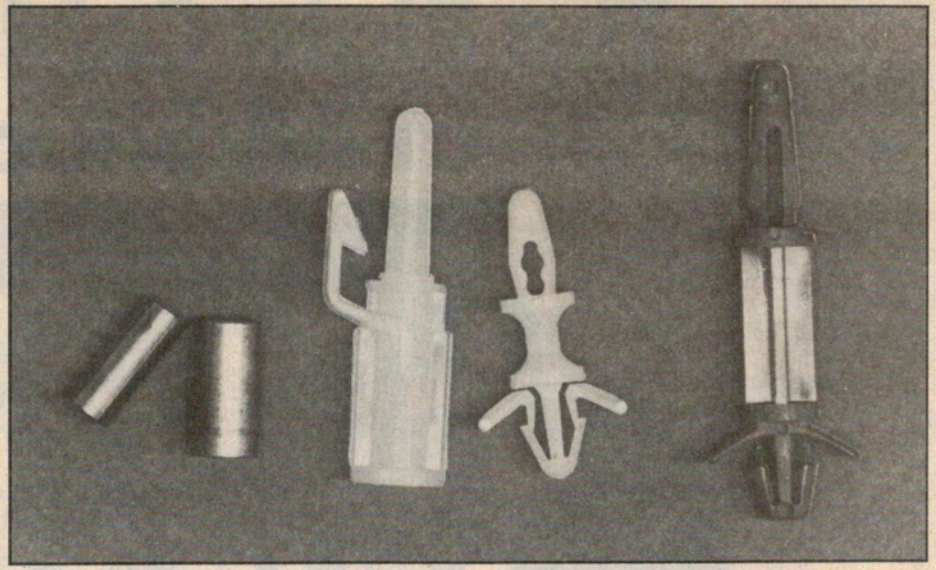
A more professional appearance will result if a photo-sensitive, self-adhesive label (eg, Scotchcal) is used. Requiring a negative of the panel design, the sensitised material needs to be exposed to a source of UV light through the negative. Special UV fluorescent tubes are required; an exposure time of around five to seven minutes is usual. After exposure, the design will appear once the material is wiped with the correct developer. This process takes around 30 seconds, during which the exposed areas will retain the colour, while the remainder should be wiped away to leave the base material.

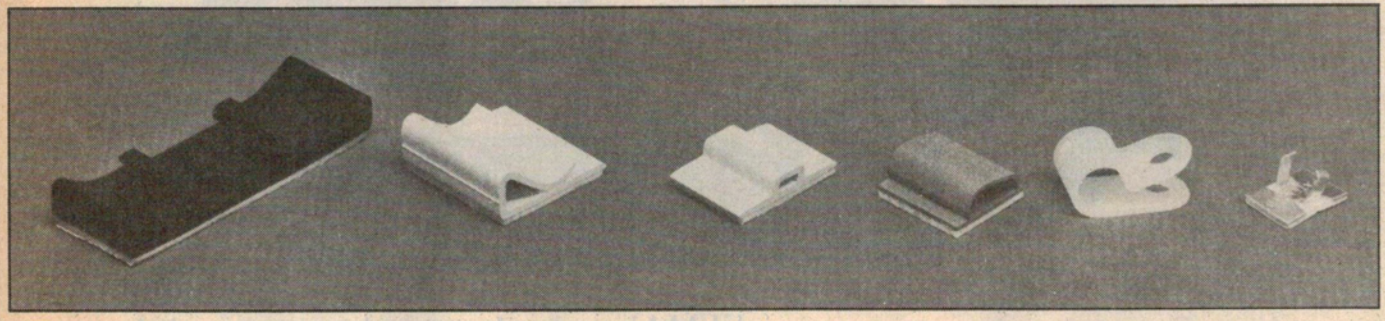
Available in various colours, on either an aluminum or clear plastic base, the finished panel can then be applied to the case. If the label is aluminium, it should be sprayed with a lacquer. Applying the label to the case requires care, as you only get one chance; the position of the label should be determined by alignment of suitable marks (eg, aligning holes on the front panel to centre punch indents on the label). Exposure film to allow the manufacture of the negative is readily available, requiring the same UV light source and developer as for the label.

Mounting the pc board

A pc board can be held inside the case by using spacers, edge supports, and the internal ribbing or other support means that may be provided within the case. Spacers can be made of either plastic or metal, with some

types having accompanying screws fitted top and bottom. Nylon pillars of varying designs are also useful, offering several advantages over spacers. Nylon pillar supports can have a self-locking mechanism that operates when inserted into a suitable sized hole in the pc board; the base of the pillar is designed for attaching to the case with a screw, an integral self-locking device or with its own adhesive. Other varieties allow the stacking of pc boards with the top board retained by a cap inserted into the pillar. ●





Right: Circuit board stand-off spacers used to mount and secure pc boards.
Below: Several species of cable clamps used to route and secure cables inside a case.