Make Your Own CUSTOM HARDWARE

These days, it appears that the active electronics experimenter needs a greater variety of hardware just as sources seem to be drying up. Why not make the hardware you can't find or afford?

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LIKE MOST READERS OF RADIO-ELECTRONICS, I WANT TO build 50% of all construction projects described in each issue, within their specifications and with "hardware to suit." But, to suit what? Certainly not my pocket book. If I buy a minimum quantity, I have to pay a king's ransom to complete the project; if I purchase the standard quantities all that extra hardware sits in my parts boxes. Ah, then the idea lamp lights up: I'll modify the hardware to suit special purposes. So I'd like to share my experiences on how I successfully modify specialty hardware and make it twice as versatile.

Some necessary tools

The Dremel Motor tool and its many accessories is very versatile. The 1-inch-diameter cutoff wheel with its mandrel holder is a fantastic item. The wheel is no more than a 1/16-inch thick, made of a carbide material and a powerful cutter. It is somewhat brittle, especially with any side pressure. Yet it will cut through stainless steel as if it were butter. When it comes to cutting epoxy boards, the cutoff wheel again acts very smoothly. I am impressed with how quickly it cuts, and I try to grind each wheel down to the smallest possible size without breaking the disc. Wear safety glasses as a precaution. Since the tool travels at 24,000 rpm, a breaking disc can send particles all over the place, especially toward your face and eyes.

Jewelers' files also come in handy, as well as a miniature anvil along with a small vacuum vise, emery cloth, pliers, cutters, and any other time-saving tool.

Star No. one

(I refer to any item that cuts down on time and expense as a "star," and feel perhaps you might agree.) The miniature tubular terminal, *model 1236* by Keystone Electronics Corporation, 49 Bleeker St., New York, NY, is able to hold securely wires from 0.010 to 0.050 in diameter, discrete components that can be inserted from either side of the terminal. They mount in a 1/16-inch hole (0.062 to 0.067) with a special insertion tool for hand usage. The terminal comes in quantities of 100 and 1000 and is ideal for both printed circuits, rats'-nest-type of building and even Wire-Wrap setups. Figure 1 shows how it would normally be used when inserted into a board.

To modify this little gem, drill the hole and insert the terminal with the tool. Figure 2 shows what happens when you cut it flush with the board, with the cutoff disc. The dotted lines indicate the material removed by cutting. There is no excessive material above the board and the top section has been hammered tightly down to the board (use a light tack hammer). The burrs have been cleaned out with a round jewelers' file, so the miniature tubing has been made even smaller.

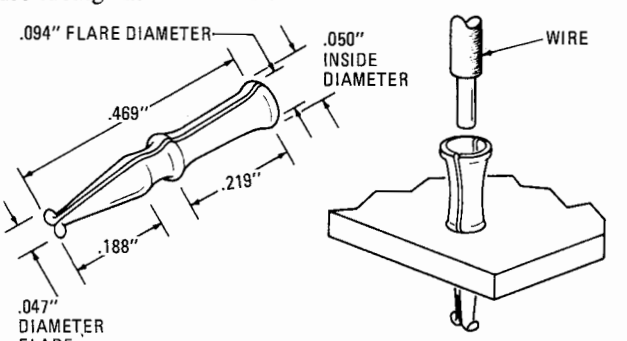

FIG. 1—MINIATURE TUBULAR TERMINAL fits snugly into 1/16-inch hole and can be used for component or wire connection.

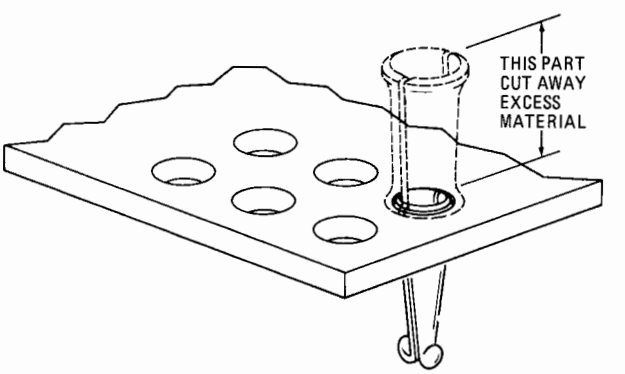

FIG. 2—HOW FLUSH-MOUNT SOCKET CAN BE MADE by removing the top part of a miniature tubular terminal and peening over.

What do you use this type of modified hardware for? Have you ever purchased large-size 0.0800 seven-segment LED's for a project, spent a small fortune for each, and just did not relish the idea of soldering them directly to boards or felt that socket mounting just did not fit the project? Well, next time try these tubular terminals, cut flush and matched up to the display leads;

each display is held firmly as if in a socket. With leads A to G, you can now use a minimum number of displays mounted without soldering to avoid possible damage. You can even remove them quite freely to use in another circuit without too much trouble.

Another use for this terminal (cut flush again) is to mount individual LED's without soldering the LED's directly to the board. You will need Vector's T-46 push-in pins, which are crimped to hold securely to the boards and sold in packs of 50. This pin has a rounded head, a crimped flange and fits a 0.042 drill hole. Remember the special tool to insert the tubular terminals? When you mount it in a vise upside down, it becomes a miniature setting tool supporting the PC board around the drill hole that will have a pin inserted into it. Merely place the board over the tool, line up the hole, insert the pin and, using a light hammer, hammer it home securely. Solder the round head to the circuit on either side to be sure of circuit continuity. Soldering is an easy way to set these pins. You can also try pushing the pins into the board holes with a pair of pliers. But the pins bend too easily this way.

With this type of LED mounting use the LED lens produced by James Electronics of 1021 Howard Ave., San Carlos, CA. This lens holds the LED securely, and the LED leads can be tied into the circuits. The holder fits a 1/4-inch hole, and does indeed hold the LED snugly. However, the LED leads must still be soldered to the circuit in which it will be used. Now we have the three parts that can be combined to make a neat and easily dismantled unit: the LED lens and holder, the Vector pins and the miniterminals.

Figure 3 shows a 1-inch long by 3/8-inch wide LED mounting

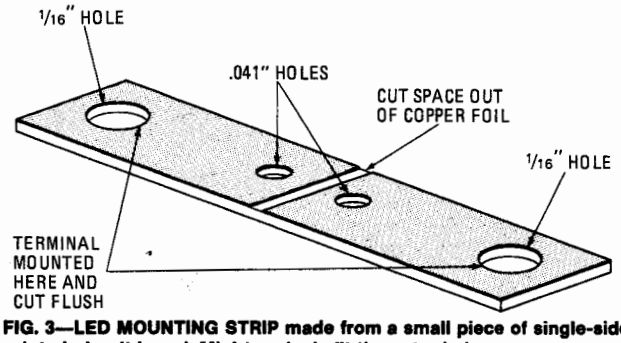

FIG. 3—LED MOUNTING STRIP made from a small piece of single-sided printed-circuit board. Mini-terminals fit the outer holes.

board made of copper foil. At the outermost points of the strip, drill two 1/16-inch holes, one on each end. In the direct center, drill two 0.041 holes spaced 0.100 apart. In between the holes, cut the copper foil in the center to make upper and lower sections that are electrically isolated from each other. Mount the miniterminals in the 1/16-inch holes. Use an anvil as a support to the board when you insert the terminals and push them all the way in. Cut off the excess tubing except for at least 1/16 of an inch, which can be spread apart with a nail and hammered flush with a tack hammer. Clean the holes for burrs with a jewelers' file and insert a wide needle to be sure the holes are open all the way. Where you want to mount a discrete LED, take the pattern strip and mark the centers of the 1/16-inch holes where the minitubes are. On the printed circuit board drill a 0.042 hole. At the dead center of these two holes, mark the board and drill a 1/4-inch hole (see Fig. 4). Leave room for the current-dropping resistor for the LED in the vicinity of the 0.042 holes, and be sure of the polarity of the line the resistor connects to; positive or negative. You can even install this resistor on the strip, but this will require an additional 1/4-inch length to accomodate it.

The Vector pins are placed into the 0.042 holes facing the same direction as the LED lens. Solder these pins on either the head side or the shaft side, or both sides, making the pin a part of the circuit. You even have enough space to wire-wrap and jump to another part of the circuit board, but it is best to keep the wrapping to only five turns. Mount the LED lens in the 1/4-inch hole, push the LED into the lens until it clicks into place;

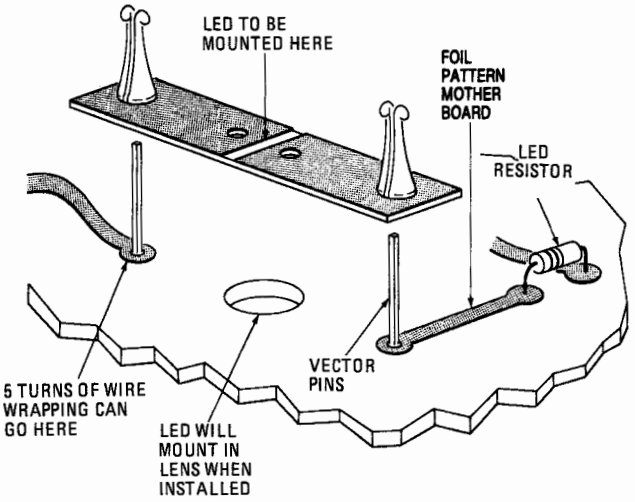

FIG. 4—HOW LED MOUNTING STRIP forms a plug-in connector when mated to suitable pins inserted into the PC board.

pass the LED leads through the holes in the mounting strip, making sure of the lead polarity; and push the strip down over the leads and the Vector pins until the strip fits snugly. To finish off, solder the LED leads to the mounting strip, and cut off the excess leads. You now have a removable LED from the lens that makes contact with the board circuit yet can be quickly replaced by another strip with a mounted LED of another color, a brighter output, etc. This system also lets you mount the LED lens on a front panel, not directly on the printed circuit board. Drill a 3/8-inch hole in the PC board behind the front panel. The lens will then pass through the PC board, and by using the LED

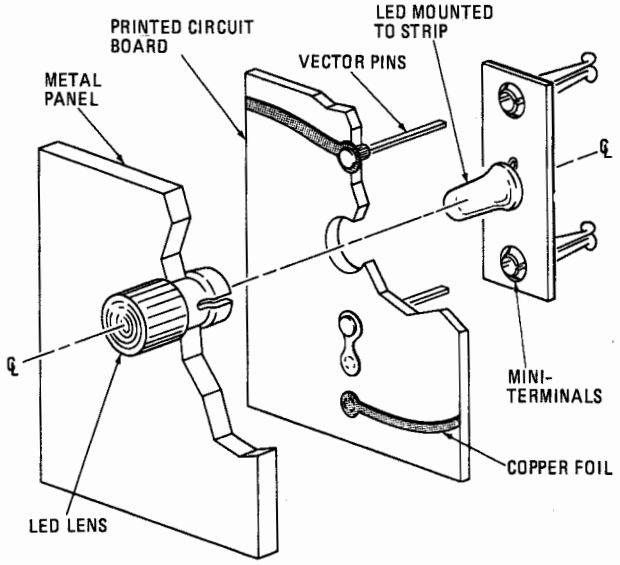

FIG. 5—LED LENS ON THE FRONT PANEL mates with the PC board and the LED on its mounting strip.

strips you can easily mount the removable LED's in the lens and show color through to the front panel. A front panel can now be serviced easily in case of trouble. Figure 5 shows the assembly.

Star No. two:

The No. K32 J-pin, marketed by Vector, is a perfect square wire used for wire-wrap connections or soldering into a printed circuit. It provides two points of contact, can be cut flush, bent at right angles, left as-is, can mount IC packages as if it were a socket, etc. (see Fig. 6).

To mount IC's directly without a socket, place J-pins one to each lead, and pass them through the mounting holes in the board; the pins will fit tightly against an IC lead in a 0.042 hole. The J-pin can face in either direction when it is installed next to the lead either up or down, depending where the lead will do the

most good for the circuit. Using the J-pin as a socket, you can remove the IC and place it back into the circuit if necessary.

A J-pin is used for terminal or tie points, in wire-wrap or PC systems and even in a rats' nest setup. This pin can be modified to take the place of many other hardware items, thereby saving money.

If you want a special IC socket, do the following: Take some Molex *Soldercon* IC pin connectors (another "star") and some J-pins; together they can be made into an IC socket of any pin size. Insert the Molex socket pins; push the J-pins next to the Molex lead; solder the Molex lead to the J-pin, top side and bottom; and you have a useful socket for wire-wrap circuits or

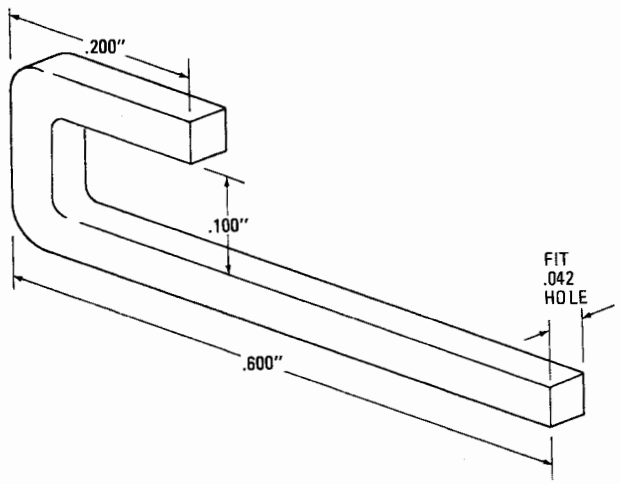

FIG. 6—THE VECTOR J-PIN is one of the more versatile of small hardware components. It's just over a half inch long.

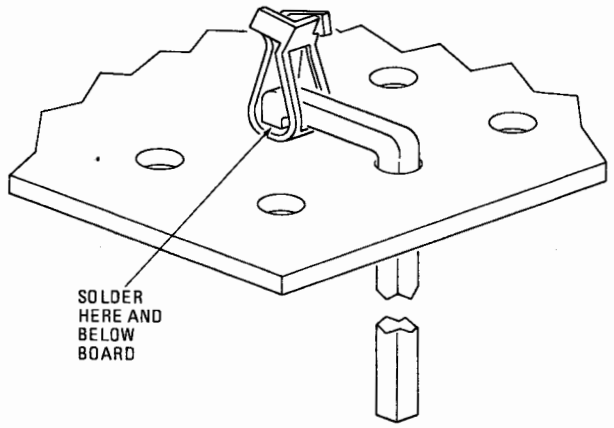

FIG. 7—HOW MOLEX SOLDERCON AND VECTOR J-PIN can be united to form one terminal of a socket for an IC.

rats' nests. Figure 7 shows J-pin and Molex *Soldercon* units used together to make a socket point. Using a miniature tubular terminal and a J-pin in pairs on a printed circuit board results in a mounting point for any discrete component. You have set up a specialty socket for wire-wrap circuits for the large seven-segment displays, which are now easily removed or replaced into the circuits.

Have you ever designed a PC board and found you needed to add several more IC's not provided for in the original layout, but you lack the room to add them directly to the board? Set some J-pins into the circuit board, trying to take off the power connections and the input or output connections of the original circuit. Try to keep the J-pin pattern as square as possible. Take a second copper board, make it match up to the square, mark off the J-pin points where they will come in contact with the second board, drill 0.042 holes, and check out the pin alignment. If it looks OK, either use these holes to mount the second board directly or set up your miniterminals to have a removable second board in case the original board needs servicing. The second PC board will mount the needed IC's to the first circuit. Be sure to allow additional space for other possible circuits. For added security provide for some 2-56 nut-and-bolt holes to hold the two boards together securely in place. Duplex circuit boards are very neat and take little effort to produce.

Want to try a right-angle connection instead of a duplex set-up? If the original board has enough space for a second board mounted at a right angle, the J-pins can be modified to act as a push-in connector to the new board, which will have PC finger leads coming to the end of the board, similar to an edge connector (see Fig. 8.) If the original board has a blank area, you

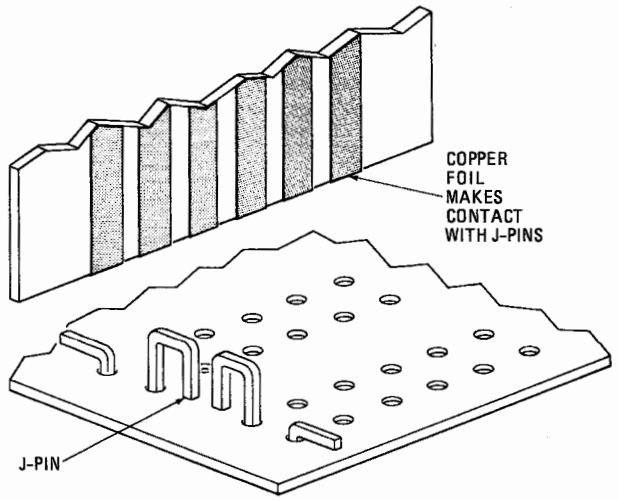

FIG. 8—HOW J-PINS CAN BE USED as edge-connector socket pins for a PC board.

can use a *Quik-Circuit* IC pattern to set up the pins. *Quik-Circuits* are copper foil, set up on a mounting strip with adhesive backing; they will stick securely to any clean portion of the board, have three holes for each contact point, and come in 36-lead strips. Note if only one IC is added to the original board, use the *Quik-Circuit* to make the connections.

If you decide to set up the right-angle second board to the first, then, using the *Quik-Circuit* pattern for the necessary number of contact points, press the pattern to the first board. Drill out three holes per lead for each lead. Place the J-pins as shown in Fig. 8; this will take up two holes. Then make the circuit connections to the third hole to the original board. You now have the edge connector for the second board match up to its outer copper leads. Also be sure to securely mount the right-angle board, using nuts and bolts. You can even twist some wire tightly to the two boards, but it will have to be cut if you have to separate the boards.

J-pins can be used as edge connectors in a motherboard setup. It is a little time-consuming to use them up in this manner, but they can save quite a bit of money. If you have time plan your next motherboard using J-pins. Then Star No. Four is a third type of edge connector you can use for these motherboard setups.

Star No. three

Figure 7 shows how the standard-size Molex *Soldercon* can be made into a wire-wrap type of connector using J-pins. Here are some other modifications you may want to try out:

Want to mount something to the end of a PC board that would require some form of right-angle connector? Merely set up the holes in the PC board, insert the Molex sockets, solder them securely to the board, and bend them to a right angle to the board. You don't have to mount them in a vertical position only. You can also use these sockets as edge connectors. Put a Molex socket on one board, and matching J-pins on the second board bent parallel with the board after soldering. The result is two boards that can be connected and taken apart from the ends without having to purchase special hardware.

Now for the best use. To add a piggyback IC, that is to mount a second IC directly to the first one, you can now mount two IC packages in the space of one by using the following method: This setup works nicely with memory IC's, since most of the leads are common to others in nature, except for the data lines or enable line if two circuits are separated. Start by drilling the IC holes for the base IC unit; then drill a second row of holes parallel to the base IC holes (see Fig. 9 for the pattern and spacing). Now

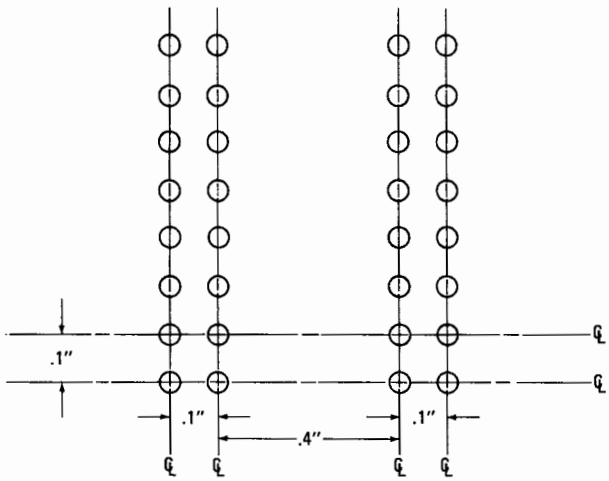

FIG. 9—THE STARTING POINT as you lay out PC board to take piggy-backed dual-in-line integrated circuits.

set up the printed circuit pattern to accommodate the common lines, the separate input and output data lines, and others needed for the two IC's. Figure 10 shows a pattern for a 2102 duplex-mounted memory IC. After etching the circuit, mount the first memory IC by soldering directly to the board. Then take a piece

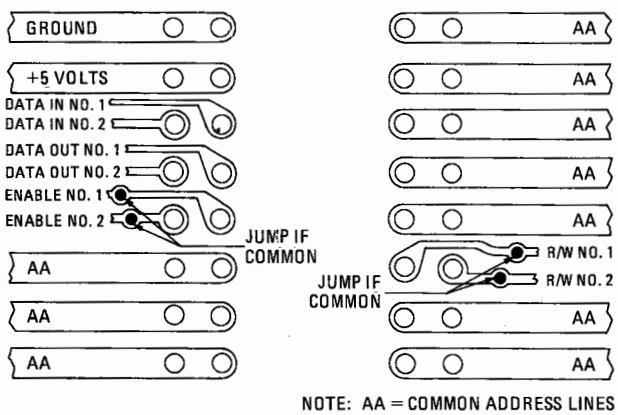

FIG. 10—HOW CONNECTIONS ARE MADE to the pins of piggy-backed IC's. Leads can be etched or Quik Circuit types.

of masking tape cut just to the lead size and place over the outside of the uncommon leads (data or enable lines). This is done to be sure no accidental connections will be made after the next step. Then insert a row of Molex *Soldercons,* solder in to all points of the copper foil, and bend the row as close as possible to the mounted IC in the board. The second IC, with its leads slightly bent outward, is then inserted into the Molex connectors and pushed firmly in (see Fig. 11).

Inspect for possible uncommon-lead shorting because these leads must be kept separate from each other. Common-lead shorting is OK as the circuit does this anyway. Just be sure of those leads requiring separate data information lines. It would be a good idea to paint these particular leads on the first IC after mounting it for additional protection and lead identification.

You now have two IC packages in the space of almost one. Consider also directly soldering a third IC to the uppermost IC mounted to the Molex pins. What a space saver this can be if you are hard pressed for room. If stackable IC sockets were

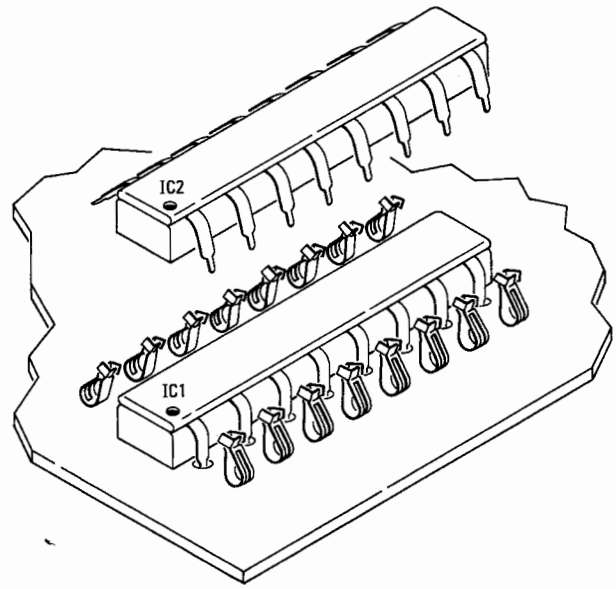

FIG. 11—HOW IC'S ARE PIGGY-BACKED. Pins on the top device are spread outward and then inserted into the Molex socket.

available you could avoid this type of modification. However, as yet they are not on the market, or if they are, a darn good secret has been kept from us "home-brew" users and builders.

Star No. four

This is a simple way to drill all those precision-spaced holes in the PC boards: Using predrilled perforated board with 0.100 × 0.100 spacing, place some double-sided Scotch-brand tape onto the perforated board section you will use as a drill guide. Press the perforated board over the PC board area, mark the drill holes, and just drill them as straight as you can directly by using the guide, the motor tool and the right drill-bit size. Remove the guide and, using blade No. 17 of an *X-acto* knife, you can easily remove any burrs left by drilling the board. No need to use any clamps as the sticking action of the double-sided tape holds the guide securely when you are drilling.

Star No. five

Are you tired of buying expensive edge connectors and wiring them to the motherboard to provide a backplane circuit? Here is a better way: AP Products, Box 110-Q, Painesville, OH, and Robinson-Nugent, 800 E. Eighth St., New Albany, IN, make and market male and female headers, both straight and some right-angle male headers (the female headers are not right angle). These 36-connector-wide headers can be broken into lesser sizes if needed. They match up beautifully when properly mounted in the PC boards and provide continuity of circuits from one board to another, without separate use of cable and connectors.

To use these headers to make a backplane board, use a board (made by Vero Electronics) which has 36 lines running about 18 inches long. If the Vero board is used with the female headers, two additional holes will have to be drilled for each header installed into the board. Just insert the female header and solder in place all 36 tabs, or less if all 36 lines are not used. Use as many female headers in this backplane board as needed for the circuit cards that will be made using the right-angle male header to mate with the header on the motherboard. I use this system in place of the standard 22-pin edge connectors. All I do is set up the general pattern for the motherboard, consider how many individual cards will use this board, install the headers as I go and work on my individual cards with the idea of matching up the circuits to the backplane motherboard. I also provide additional space on the motherboard for possible revisions or additions. Figure 12 shows the headers set up to the Vero board and how the individual male-header cards are to be inserted so circuits on the card and motherboard are interconnected.

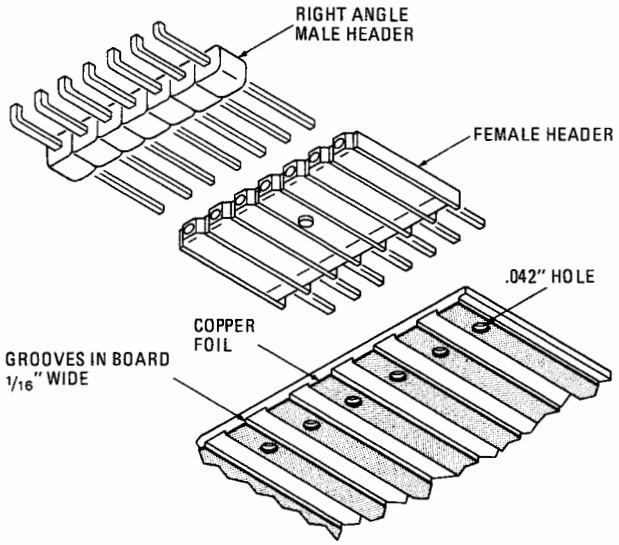

FIG. 12—HEADERS FORM CONNECTORS as auxiliary boards are plugged into the motherboard or main-frame.

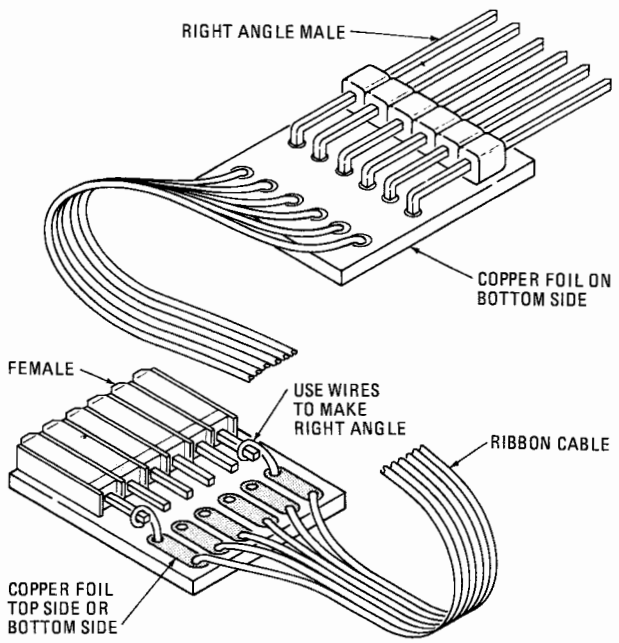

FIG. 13—RIBBON-CABLE CONNECTORS can be made from either male or female headers and small pieces of Veroboard.

Also I find I can make flat wire connectors with these headers. The female headers do require a slight modification, since they do not come with right-angle leads. Figure 13 demonstrates how to attach a female header at a right angle to a board using wires. All you need to build these cable assemblies is the Vero board (or equivalent); the necessary lines—8, 10, or up to 36; the flat ribbon cable; and male and female headers. Solder in the male or female header on one end of the strip, solder in the ribbon cable, and tape it securely; this completes one end of the cable assembly. Do the same at the opposite end of the wire cable or solder the wire directly to the circuit where it is to be attached. A matching male or female header will have to be provided in the circuit that has the cable connection attached to it. The foregoing method is an inexpensive way to use detachable cable assemblies in PC board layouts without buying special hardware. It is especially useful when you want to use cable between a main circuit board and a display panel.

Male and female headers can also be used as end board connectors, keeping in mind the right-angle modification for the females. The use for these headers is unlimited. Some readers who work with them will come up with other uses and modifications. From a simple motherboard and card connectors to cable assembly, they can help to keep overall hardware costs down.

Star No. six

Vector's No. T-44 pins. Normal usage is to mount these pins in perforated board with a 0.042 hole, and use for mounting discrete components; the extra long lead can be wire-wrapped or soldered. Do you want to mount discrete devices to an IC socket? Consider this setup:

In the PC board install an IC socket or Molex pins. Then, take some perforated board with 0.100 × 0.100-hole spacing, cut it to fit the socket, and insert the T-44 pins where the IC leads would go. Now you can solder any device into the parallel pins, cut the T-44 pin lead to fit the socket snugly, and you have an inexpensive base to mount these discrete devices. A ready-made base for this purpose would cost a hundred times as much. Also you can modify the T-44 pin by cutting off the component mounting portion to make a T-pin (see Figs. 14 and 15). This modified T-44-pin to a T-pin can replace the Vector T-46 pin.

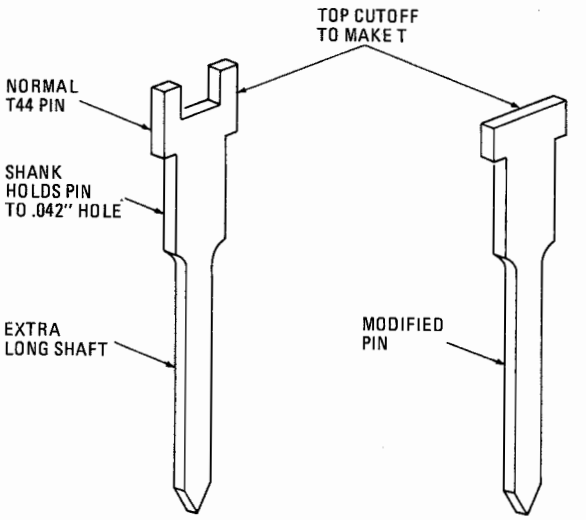

FIG. 14—MODIFIED T-44 PIN has notch section cut off forming a "T" pin substitute for the type T-46.

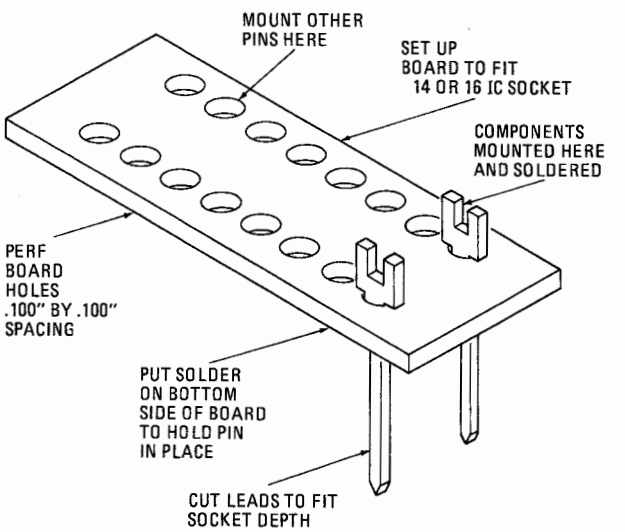

FIG. 15—VECTOR T-44 PINS AND PERFORATED BOARD can be used as a plug-in terminal strip for discrete components.

The T-section makes an excellent soldering base to hold the pin securely, and the extra long shaft length comes in handy.

A money-saving way to use IC test clips is to take the clip and carefully solder wires to each test terminal. After soldering and marking test lead No. 1, wrap up this end with electrical tape to strengthen the wire connections just made. Take a piece of perforated board, put in the T-44 pins, match up the wires to the

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IC lead pin, solder the wire to the T-44 pins, put in a strain relief, and again mark pin No. 1 on this socket connector. The Glomper clip now can fit itself to an IC socket, yet still has testing points as handy as the original unmodified Glomper test

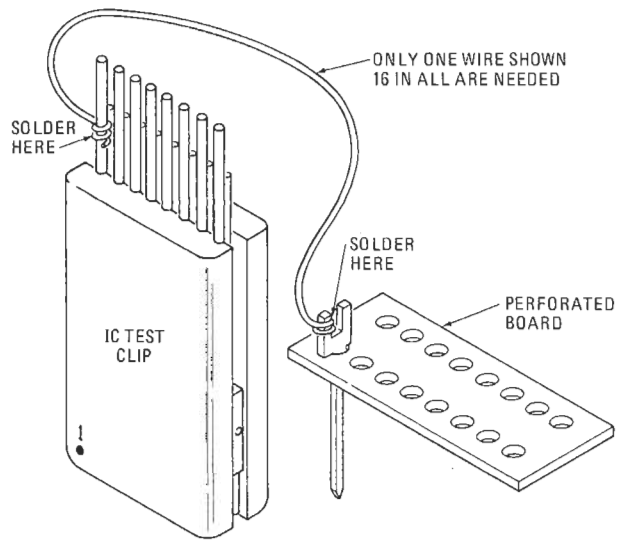

FIG. 16—IC TEST CLIP can be modified with a piece of cable and a home-brew jig to plug directly into an IC socket.

clip (see Fig. 16). The wire cable should be kept to under 36 inches, and 24 inches seems to work nicely. This same test clip prewired would cost a small fortune at the electronic shop, and for only pennies you have made the same unit.

Star No. seven

Just a helpful tip to those who use a great deal of solder wick to remove IC's and other components from boards. The cost of this wick is quite expensive. So, if you have some old zip cord, why not save some hard cash? Simply strip the cord to the braided wire, smear on some flux and use this in place of the solder wick.

Throughout this article I have given the names and addresses of makers of the special hardware stars I have introduced you too. Why not write them for their catalogs and try some of the ideas presented in the article next time you need a special situation device. Don't be afraid to try your hand at some modification of your own making, and let's hear from you through **Radio Electronics;** us home brewers have to stick together just to keep out of hot water. **R-E**