TOOLS FOR ELECTRONICS EXPERIMENTERS

Today's components and circuit designs require some special tools and techniques.

BY A. A. MANGIERI

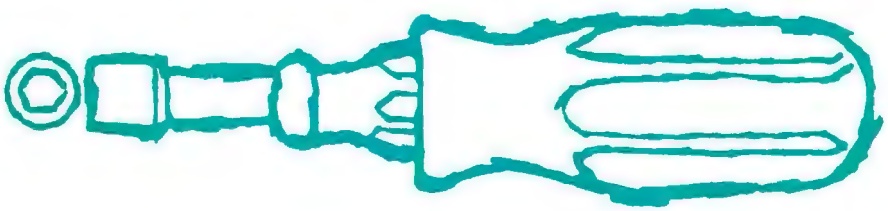
TODAY'S hobbyist/experimenter must cope with many problems that never existed before the advent of printed-circuit technology, integrated circuits, and other microminiature devices. In the old days, you could get along with a set of screwdrivers, longnose pliers, diagonal cutters, and a soldering iron or gun. Now, without the aid of suitable tools, and technical aids, you will find it difficult—if not impossible—to build a complex IC project.

Printed circuit boards alone have created a number of problems. Special tools are required to cut the boards to size, drill numerous tiny holes with bits that can't practicably be chucked into a massive electric hand drill, and solder components without lifting the copper or scorching the board material.

Even solid-state devices place demands on tools that the old tool lineup can't begin to meet. Heat-sensitive, and now even static-electricity-sensitive, transistors and integrated circuits can be permanently damaged by old-fashioned tools. Obviously, then, you need special tools to work with modern electric devices and techniques. Some of these tools are highly specialized; but if you do a lot of experimenting, they'll pay for themselves. Other tools can be used for a broad range of jobs. The main point is that if you need a special tool for a given job, you can't make do as you could in the past.

First, let's review some of the basic tools every hobbyist/experimenter must have. Then we'll describe a few tools that aren't essential but will be great time savers when you do a lot of experimenting. Finally, we'll discuss how to judge tool quality to make your investment pay for itself in long tool life.

Pliers and Cutters. At the very minimum, you will need longnose



pliers, wire cutters, and slip-joint pliers. These three plier-type tools will see the most service in assembling kits and projects. Start with standard-size longnose pliers and diagonal cutters. Then, if you anticipate doing a lot of work with miniature components, you can add miniature longnose pliers and diagonal cutters. As your budget allows, you might consider adding tip-cutting, end-nipping, and round-nose and flatnose pliers. Each tool you add can be used for special types of jobs, and most are interchangeable.

One type of plier tool that most people in electronics often overlook is the plier-wrench, commonly called "vise-grips." Not only is this tool excellent for applying brute torque for turning bolts and nuts, it also can serve as a "third hand" for holding small parts, printed circuit assemblies, and small circuit assemblies. For a light grip, you close the jaws on the work by turning the adjusting screw. Used with C clamps

to serve as legs, the visegrip plier will allow you to elevate and position the work as required.

Pliers should *never* be used on nuts and hex or square-head screws. At least that was the rule before Brookstone Co. came out with a plier specially designed for nuts. Resembling standard linesmen's pliers, this tool has two large sets of notches in its jaws that afford a slip-proof grip on nuts and screws.

The Brookstone, Jensen Tools and Alloys, etc., catalogs list several different kinds of plier tools of various

grades and functions. There are carbide-edged cutters, round- and box-nosed pliers, pliers with brass inserts in their jaws for mar-proof work, and even pliers made from surgical steel. Needless to say, you don't need all—or even a majority—of the pliers and cutters mentioned, but if you add a few of the special items to your tool lineup, you'll find your project and kit building a great deal easier.

Drivers and Wrenches. A minimum list of screwdrivers should include 1/8" (small with pocket clip), 3/16", and 1/4" slot-type and No. 1 and No. 2 Phillips-type drivers. Although you won't have as frequent a call for them as for standard-size drivers, a set of jeweler's screwdrivers is generally inexpensive enough to include in your basic list. Many shaft coupler and control-knob setscrews and the hardware on variable capacitors, etc., are so tiny that only a jeweler's screwdriver is safe to use with them.

Much of the machine hardware in commercial electronic equipment and the setscrews in about half of all control knobs use hex-head hardware. For these, you'll need a hex-key set. You can buy a set consisting of individual keys, individual keys in screwdriver-type handles, and even in fold-up "jacknife" sets. Prices range from very inexpensive to relatively inexpensive.

Nutdrivers are used in electronics work almost as often as are screwdrivers. Nutdrivers are available in both solid- and hollow-shaft configurations, as individual drivers with separate handles, individual drivers that plug into a common handle, and separate sockets that plug into a universal handle/shaft combination. The least expensive and most convenient way of putting together a set of nutdrivers is to buy one of the plastic-cased assortments sold by such companies as Xcelite, Vaco, X-acto, etc.

Stubby nutdrivers, such as Xcelite's No. PS-120 set, are handy to have when you must work in tight places; they even have an extra-large slip-on handle for increased turning torque. Large-size "nut" drivers for volume-control and rotary-switch hardware allow you to install the large hex nuts without the danger of marring the control panel. Supplement your nutdriver lineup with a set of miniature precision drivers. These are the nutdriver equivalent of the set of jeweler's screwdrivers.

Vaco has an interesting all-in-one self-adjusting nutdriver that fits hardware ranging from 1/4" to 7/16" (6.35 to 11.11 mm). You simply press the driver head against the nut to be driven, and the proper "socket" automatically fits over the screw. This tool can save lots of time that might ordinarily be wasted as you hunt through a separate assortment to find the right driver for a given nut. It also has the advantage of requiring the space of only a single driver in your tool kit.

You'll find that a 6" or 8" (15.2 or 20.3 cm) adjustable wrench will suffice for most of your nut and bolt turning operations. However, there always comes a time when your working space is so restricted that the adjustable wrench proves useless. In this case, you'll really come to appreciate an assortment of ratchet box wrenches. In general, you'll need only two rachet wrenches 1/4"-5/16" and 3/8"-7/16" (6.35-7.94 and 9.53-9.94 mm). You can, of course, buy individual box/open-end wrenches, but there is really no call for the added expense and the space and weight they will take up in your tool kit.

Soldering Equipment. Although it's not the only method of mechanically and electrically assembling a circuit, soldering still ranks as the most practical for the great majority of assembly projects. Since most modern

electronic components are small and either heat-sensitive or static-electricity-sensitive or both, the most practical soldering tool is a low-wattage soldering iron or pencil with a grounded tip. (If you have, or anticipate having to do, heavy-duty solder-

ing, figure on buying a 100/140-watt dual-heat soldering gun.)

Your soldering iron or pencil should be rated at 25 to 50 watts, with a good average rating of about 35 watts. Make certain that it is UL approved for safety insurance. Modular soldering pencils, with separate power handles, heat elements, and soldering tips, offer maximum flexibility. They allow you to change heat-element cartridges and/or tips to suit the work in hand. And if any one piece goes bad, only that piece need be replaced, which adds up to good economy.

Soldering tips are available in raw copper, iron-clad copper, and nickel-plated copper. The raw-copper tip is the least expensive but is prone to rapid pitting and wear and must be replaced fairly frequently. The plated tips, although initially quite expensive, last a long time and need little maintenance to keep them in good condition. Needless to say, plated tips are more economical and less troublesome in the long run than are raw copper tips.

Soldering tips are also available in a wide variety of configurations, ranging from a blunt pyramidal shape to a wide chisel to a very fine needle-like point. The blunt tips are best for heavy-duty soldering, using a 50-watt heat element. For more general soldering jobs, a medium chisel-point tip on a 35-watt element is best. But when you're dealing with IC projects where foil traces on the printed-circuit board and the component leads are very close, a fine chisel or needle point is best to minimize the possibility of solder bridges.

A starter soldering tool should include a 30-to-35-watt heating element and medium-chisel and needle-point plated soldering tips. You can build up a heat element and tip assortment as the need for them arises.

Most soldering irons and pencils do not have the grounded tips required for safe soldering of static-electricity-sensitive MOS devices. (Ungar's "Condensed Line" does.) However, it's a simple job to ground the tip of any soldering iron. Tightly wrap around the tip—away from the working point— a strip of 20-to-24-gauge copper and fasten to it with machine hardware a length of heavy-duty stranded hookup wire. Terminate the free end of the wire at earth ground, using a cold-water pipe.

Although the great majority of soldering irons are designed to be used on line power, there are now available a number of cordless irons. These soldering irons are powered by built-in rechargeable nickel-cadmium cells, which allows them to be used anywhere, even when line power isn't available. The cordless irons have small tips that heat up rapidly (5 to 10 seconds) and provide 100 or more solder connections, depending on the sizes of the connections. Although the tips attain a high temperature, the relatively small heating unit and tip greatly reduce the chance of lifting fine copper traces and pads from pc boards. Most cordless irons are equipped with a built-in work light and offer a limited variety of tip configurations.

For electronics work, use only 60/40 (percentage of lead to tin) *rosin* core solder. Select 16-guage solder for general-purpose and 18- or 20-guage solder for fine pc work. When solder-

ing any semiconductor device or heat-sensitive component, heat sink the component leads with spring clips, longnose pliers, locking forceps or tweezers, or alligator clips. Keep handy soldering aids with pointed, slotted, chisel, and brush tips.

For removing solder from crimped connections and pc boards, you can use a rubber-bulb-type solder sucker or a plunger-type sucker. The latter is generally the more efficient tool, though it is also the more expensive. The most thorough device for removing solder is the solder "wick" made of finely stranded untinned copper braid. When the wick is placed over a connection and heated, the capillary action, or "wicking," that occurs between the fine strands takes up virtually all solder and eliminates most of the risk of delaminating fine copper pads and lines on pc boards.

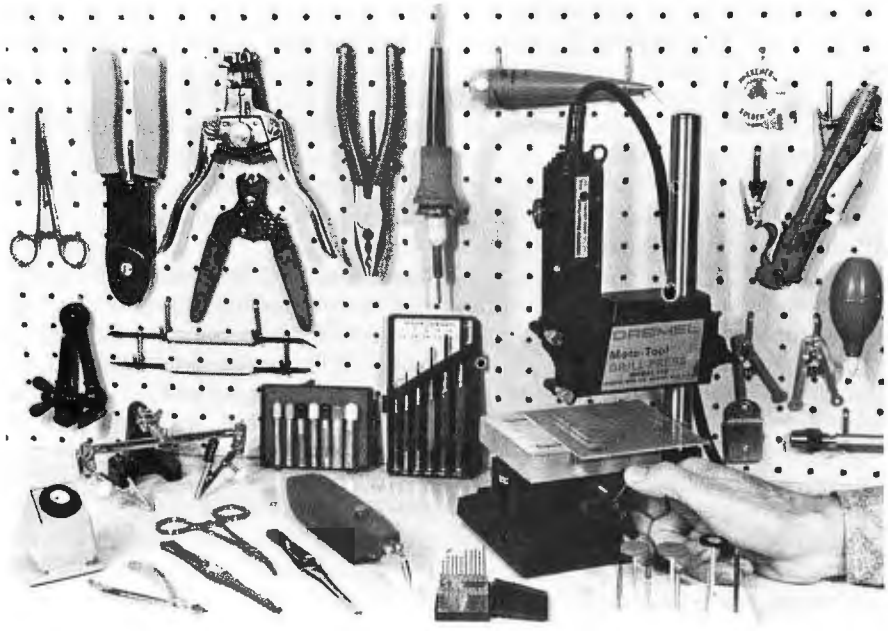
Tools For PC Boards. The wrong way to drill the fine holes required in pc work is with a standard hand-type power drill. You'll only succeed in breaking the fragile bits and possibly gouging the board. An excellent tool for drilling holes in pc boards is the Micro Electronics Systems Mini Drill that can be either AA-cell or line powered, the latter with an ac adapter. The tool accepts bits ranging from No. 80 to No. 54 (0.343 to 1.4 mm).

Another good tool for pc board work is the Dremel Moto Tool high-speed drill and grinder, which comes in

models ranging from the 0.5-ampere Model 260 to the heavy-duty variable 0.9-ampere Model 380. Light in weight, it is easy to manipulate and accepts drill bits ranging from No. 80 to No. 30 (0.129 to 3.26 mm), depending on which of three chuck collets are used. For maximum working convenience, you can convert the Moto Tool to a deluxe pc board drill press by mounting it in the No. 210 drill stand. Used in this manner, the Moto Tool will permit you to spot the bit on the smallest of copper pads with perfect accuracy.

An interesting new tool from Dremel is the Model 232 Moto-Flex, a high-speed drill and grinder with a 34" (0.86-m) flexible shaft and handpiece. This tool affords very precise control over hand-machining operations on the pc board. Its $^{23}/_{32}$" (18.4-mm) diameter handpiece has ball bearings and accepts all Moto Tool collets and accessories.

With many accessories, these tools permit you to cut, score, or notch circuit boards using steel saws; cut off potentiometer and rotary switch shafts and screws with the cutoff



Tools for a well-stocked electronics workbench. Both common and special tools ease project construction.

wheel; and grind, debur, and polish other items. You can, for example, make inexpensive ground-plane boards using the No. 9909 router bit and Vector No. P138C circle pad cutter. (See "Perfboard Wiring Techniques," POPULAR ELECTRONICS, April 1976 for details.)

Special Tools and Aids. The fastest and lowest-cost perforated-board wiring method is with one of the wiring pencils, which eliminates wire cutting and stripping. You can interconnect any nimber of terminals with a single unbroken run and cut off the wire with the tip of the tool. You simply solder terminals through the insulation, which instantly vaporizes when heat is applied.

Automatic wire cutters/strippers, although rather expensive, can be a real time saver when you have a lot of point-to-point wiring to do. These tools come with steel blades that do the cutting and stripping. If you don't mind first cutting your wires to size, one of the best strippers there is is the Alpha Model STRP-25 with *plastic* stripping blades. The plastic material is easily deformable to cut through insulation without nicking the wire. You can get thousands of strips from a single pair of blades. As the blades get used up on one size wire, they're still good for larger sizes. When the blades are finally used up, you simply inject new blades and start over again.

For holding and positioning pc boards and small electronic circuit modules, you can get a work-holding jig from X-acto or Brookstone. For detailed work, you'll want a work-inspection magnifier, preferably with a built-in flourescent lamp, like the Luxo Model LFM-1.

You can easily damage the pins on DIP IC's when inserting or removing the devices from sockets. To play it safe, you can use either the GC Electronics No. 9481 Pul-N-Sertic insertion/removal tool or No. 9227 removal tool. For round transistors and IC's, use the No. 9216 Quick-Pick sleeve-type grippers from GC. (Incidentally, the Quick-Picks also serve as excellent heat sinks for transistors and IC's during soldering operations.)

GC Electronics Quick Pick Tools (left) and IC remover (right), with Pul-N-Sertic semiconductor inserter and remover (center)–all very handy.

Among the handiest of tools, the locking forceps serve as both needle-nose pliers for light work and heat sinks when soldering. The GC Electronics tweezer forceps come in two lengths, with either curved or straight jaws. Three assorted tweezers are included in the GC No. 7960 kit, two of which are locking types to allow their use as heat sinks.

Building a project from scratch requires a number of tools not so far mentioned. These include a bench vise, set of drill bits, combination square, assorted files, hole reamer, center punch, nibbling tool, hacksaw, etc. Unusual tools, such as a pin vise, small hand vise, and razor saw, also come in handy. Many common and specialized tools are listed in the catalogs of Sears Craftsman; GC Electronics; Brookstone Co. (13 Brookstone Bldg., Peterborough, NH 03458); and Jensen Tools & Alloys (4117 N. 44 St., Phoenix, AZ 85018). Hobby centers are also good places to look for fine-quality precision tools.

A Word About Quality. Price and appearance are not always related to tool quality. High-grade hand tools are drop forged of various alloy tool steels, hardened and properly tempered. In the case of pliers, the tools should open smoothly and without erratic binding or looseness. Sight through and along closed jaws and cutting edges for proper alignment. Most pliers are made with the common lap-joint pivot that eventually loosens. You'll make a much wiser investment if you look for plier-type tools constructed with box-joint pivots that retain jaw alignment.

At all costs, avoid buying "bargain" pack tools or tools that are extremely low priced. Good and top-quality tools are rarely ever bargain priced; only tools that will fall apart or quickly wear out ever go on "bargain" racks. If you buy the latter, you'll only have to replace them in short order. It's better to buy the best when you can afford them than to build up a tool kit that will fail to do the job. A good rule of thumb is to stay with brand names that you know are of good quality. ◈