

Computer Bits

By Jerry Ogden

A NEW BREED OF HOBBYISTS

FOR many years, the thought of having one's own digital computer was only a dream because they could cost anywhere from \$100,000 to several million.

But in the late 1960's, Digital Equipment Corp. announced its \$24,000 PDP-8, raising hopes of forward thinkers for that elusive home computer. With the 1970 introduction of the microprocessor IC (CPU-on-a-chip), representing the "heart" of a full-blown digital computer in a single IC package, they knew it was just a matter of time before prices dropped.

Not content to wait, amateur computer users banded together during the early '70s to share ideas and equipment. In fact, many of the successful applications of microprocessors on the market today owe their origination to these hardy souls, who experimented with building personal computers.

The breakthrough in low-cost microprocessors occurred just before Christmas 1974, when the January 1975 issue of *POPULAR ELECTRONICS* reached readers with the first relatively inexpensive unit—about \$400 in kit form—that competed in performance with much costlier commercial units. The aftermath is heartwarming to electronics hobbyists—CPU prices are plummeting, and at least one major manufacturer drastically cut the price of its microprocessor.

People interested in computers fall into three major groups: (1) Strong background in "hardware," the physical electronics equipment; weak in "software," the instruction programs needed to make the computer perform some useful task. (2) Strong background in "software," weak in "hardware." (3) Interested amateurs who have no experience in either sector, but find the world of computers an exciting challenge they'd like to tackle.

So it's not surprising to learn that

small hobbyist groups are springing up all over the country, where competent and enthusiastic programmers who cannot read a wiring or logic diagram share ideas with electronic engineers and technicians who work with computers daily, but still find the mysteries of software virtually a black art. For example, a recent letter addressed to *POPULAR ELECTRONICS* from Hal Singer (hardware editor) and Steve Diamond (software editor), Cabrillo Computer Center, 4350 Constellation Road, Lompoc, CA 93436, stated that they represent a user group of 300 hobbyists actively constructing microcomputers, and would like to encourage participation in their group by persons planning to build the *Altair 8800* computer that debuted in *POPULAR ELECTRONICS*' January 1975 issue. The group published four newsletters, which can be received by sending a self-addressed manila envelope with 50¢ stamp to the address above.

What's a Computer? A computer is a deceptively simple kind of device if you look at it from a "black box" viewpoint, not trying to understand all the electronic "innards."

All computers are fundamentally alike from the largest to the smallest. And the humblest of computers can perform the same work as a huge computer can, except that it takes more time to do it! With a suitable program (software) in its memory, a computer can be a game player, a home accounting machine, or an environmental controller; and in many cases, it can be all of these things at the same time.

No matter how large or small, a computer must have five basic elements, as illustrated.

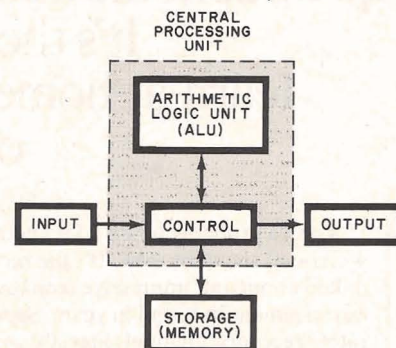
1. The Arithmetic Logic Unit (ALU) performs additions, subtractions, and all the other arithmetic and logical operations on the input data (something on the order of a super calculator). It is

the features of the ALU that determine the ultimate potential power of the computer.

2. The Control portion orchestrates the movement of data and instructions from one part of the computer to another by taking the operational instructions that were inserted (programmed) into the memory and using these to perform some function to change the input data to output data.

3. The Memory (more properly called Storage, but the two words are used interchangeably) is used to hold operational instructions for the computer, and store intermediate results, commonly used tables, and other pertinent data.

4. The Input Circuit allows the computer to accept data from the outside world. The actual input can come



Five basic parts of any computer.

from a single sensor, a two-wire system, or a complex network of things to be monitored. Anything that can be converted into computer-acceptable data can be used as the input.

5. The Output Circuit delivers the data generated by the computer to some form of device that does the appropriate work. Without output capabilities, the computer serves no useful purpose.

The ALU and Control circuits are often combined and called a Central Processing Unit (CPU). Years ago, the CPU was awesome—a few feet high, a couple of feet deep, and several feet long. With the advent of large-scale integration (LSI), a complex CPU can now be contained within a single integrated circuit having 40 or less pins. Interestingly, there are now over 25 microprocessors to choose from, if you elect to build your own computer.

All of the current microprocessors have been described in a publication called "The New Logic Notebook," issued monthly. Its premier issue included a "Microprocessor Scorecard" that summarizes the major features of all known CPU's (since publi-



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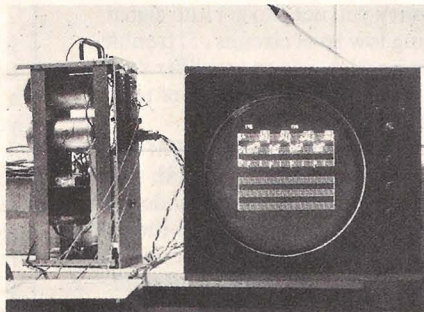
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cation, General Instrument introduced its CP1600, a 16-bit address chip). To obtain a free copy of the scorecard, write directly to Micro-computer Technique, Inc., 11227 Handlebar Road, Reston, VA 22091, enclosing a 9" × 12" self-addressed, stamped (10¢) envelope.

The Biggest Problem. It is not overly difficult nor expensive to build your own computer. The major problem that plagues hobbyists (and the computer industry as well), is an inexpensive and useful input/output device such as a terminal.

The first reaction is usually to sug-



Graphics terminal (above left), designed by Hal Chamberlain, can draw pictures of music scores or logic diagrams, as at right.

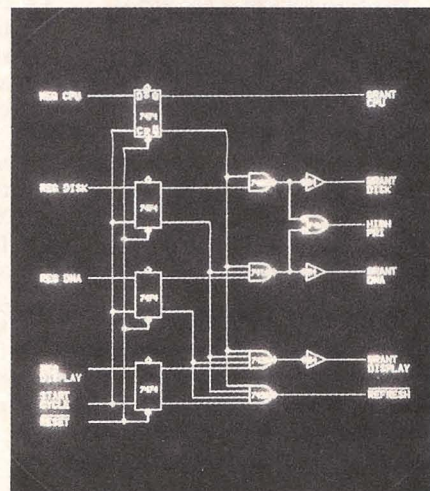
gest using a teletypewriter such as Teletype Corp.'s 33ASR. However, this means connecting a \$1200 device to a \$400 computer—hardly a desirable match from the point of view of cost. There are, to be sure, some inexpensive teleprinters on the surplus market, and many hobbyists have adapted them to computer use. However, there is still a major problem—this equipment is bulky, noisy, and slow.

The second reaction to the problem is almost always to consider using a TV set as the output display device and an inexpensive keyboard as the input medium. Connecting a keyboard to a computer is easy, of course, but driving a TV set with the output is a difficult task. At present, estimates run to a few hundred dollars to make this type of TV data display. (A couple of low-cost "computer terminals" are currently being advertised, but we have no experience with them to date.)

One solution to this problem has been the design of a graphics terminal by Hal Chamberlain, writing in "The Computer Hobbyist," Box 295, Cary, NC 27511. This terminal is controlled from an Intel 8008 microprocessor with as little as 1024 (eight bit) bytes of memory. In addition to alpha-

numerics, it is also capable of drawing pictures (for example: chessboards, music manuscripts and logic diagrams). When combined with a low-cost keyboard for the input device, this display can serve as the primary output device for a small computer.

Sharing. The sharing of hardware and software ideas depends upon common agreement as to symbols and media. Electronic circuits all conform to standardized schematic symbol rules. However, computer programs are usually too complicated to be so simply described. It is common,



therefore, for programmers to share and exchange programs.

If you obtain a useful program from a friend, you'll often be faced with the problem of transcribing it into computer form through a keyboard. Not only is that time-consuming, but it is error-prone. As one expects, most computer centers exchange programs on magnetic tape, but the tape transports cost upwards of \$5,000. Users of mini-computers tend to use punched paper tape from a Teletypewriter, but few hobbyists will have a paper tape reader.

So what is the poor computer hobbyist to do? A neat, inexpensive solution will be offered in this column next time around. ♦

Editor's Note. It is hoped that this quarterly column will serve as a clearing house for computer hobbyist groups and others with interests in the field. If you are a member of such a group, or want to be, write to Computer Bits, Popular Electronics, 1 Park Ave., New York, NY 10016.