

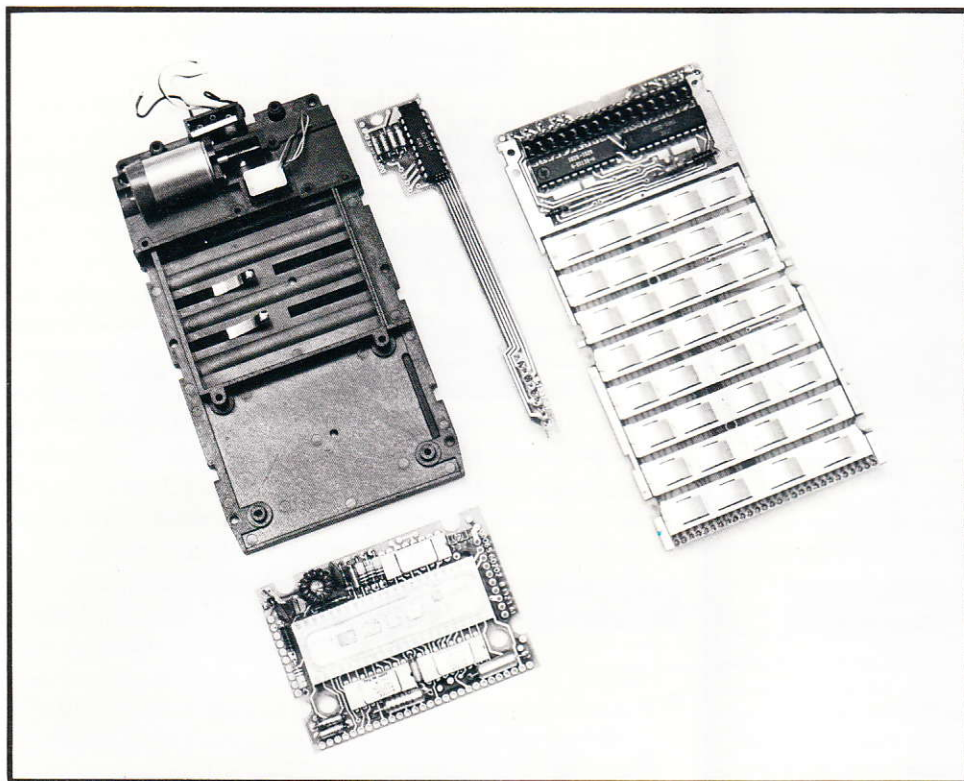


Fig. 4. Inside the HP-65.

has a data-register circuit. New in the HP-65 are a program storage circuit, a card-reader control circuit, and a card read/write circuit. Fig. 4 is a photo of the components and Fig. 5 is a block diagram.

The *data register circuit* is made up of ten addressable data registers of 56 bits each, enough to store 14 digits each. Data register 0 is used to implement a **LSTx** (last x) function and always contains the previously displayed number. Registers 1 through 9 are addressable from the keyboard. Addresses and data are transferred between the data register circuit and the arithmetic and register circuit by way of a bidirectional BCD bus.

The *program storage circuit* stores the user's program. Each program step is stored as a six-bit word. There are 100 words of storage.

The program memory is designed to act like a carousel. The memory is implemented in a dynamic shift register. Program words, a pointer, and a beginning-of-memory marker circulate continuously in this register, a complete circulation taking approximately $3\frac{1}{2}$ milliseconds. The pointer always points to the next program word and can move freely within the memory. Thus program steps can be inserted into the program or deleted from it at any point, without re-keying the other steps. Addressing is symbolic rather than absolute, and label-searching hardware is built into the program storage circuit.

When the calculator is in use, every keystroke places a corresponding keycode on the I_A (instruc-

tion address) bus. This code is stored in the buffer of the program storage circuit. If the calculator is in W/PRGM mode, the code is then inserted into the program memory. If the calculator is in RUN mode, the keystroke is executed.

When a stored program is executed, the pointer points to the next executable memory word and the buffer contains a copy of that word. The buffer contents are decoded and placed on the I_S bus as a microinstruction that causes the calculator to enter a subroutine in the ROM to service the key that was pressed.

Card Reader Circuits

The *card-reader control circuit* and the program storage circuit together form a complete memory circulation path. When the HP-65 is used as an ordinary calculator the card-reader control circuit merely short-circuits the data-in and data-out lines of the program storage circuit.

When a card is being read, the card-reader control circuit places the outputs of the head sense amplifier onto the data-in line of the program storage circuit. When a card is being written the card-reader control circuit takes the memory words in sequence and transforms them into recording signals for the head write amplifiers.

When two unsynchronized sequential memories like the program memory and the magnetic card are working together, timing and control are critical.