HOW TO SELECT

EM KEYBOARDS & CONTROLLERS

Types and availability for electronic music synthesizers

BY DON LANCASTER

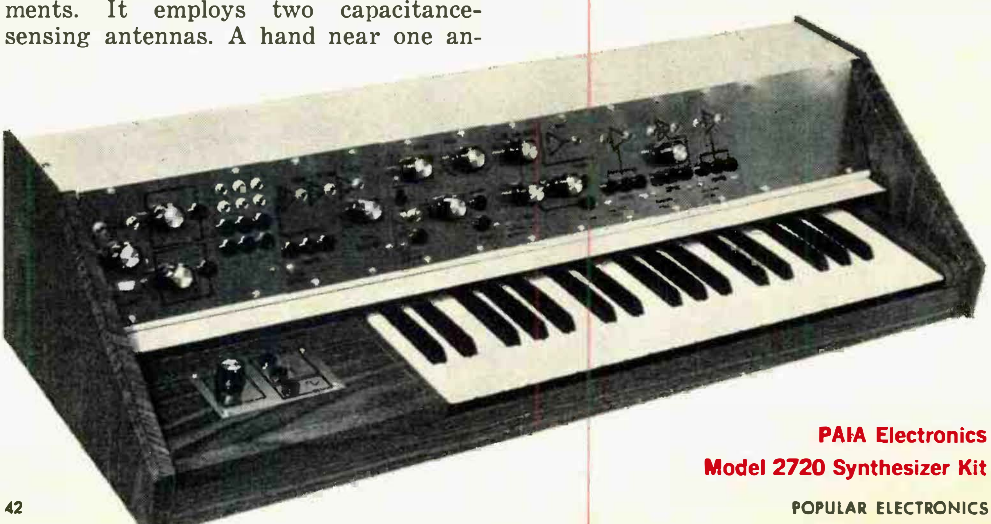
WE HAVE received a number of inquiries from readers about the types and availability of keyboards for use with music synthesizers. We have also gotten quite a bit of manufacturers' literature on the subject. We'll try, here, to answer some of the questions and also pass along information we have received.

Controllers. A controller is a device that provides some means of deciding when and in what sequence the notes are going to occur. It can also simultaneously set the frequency, duration, envelope, volume, and special effects. The most common—and obvious—controller is the keyboard, usually based on the traditional type used on pianos and organs with seven white and five black keys per octave. (The preferred size, shape, and locations of the keys are illustrated in the drawing on the next page.)

There are many other controller possibilities. For example, the theremin, dating back to the 1920's, was one of the earliest of electronic musical instruments. It employs two capacitance-sensing antennas. A hand near one antenna sets the pitch, while a hand near the other controls volume. The instrument is literally played in mid-air. The theremin was extremely popular in providing eerie background sounds on radio programs and in motion pictures.

A computer or a digital sequencer can also be used to set the sequencing, duration, beginning, and ending of a note. One obvious example was the "Psych-Tone" (February 1971) in which a pseudo-random sequence generator set the frequency and duration of each note. Other special sequence generators can be used for rhythm and accompaniment, forming a sideman or bandbox. Usually, a group of counters is suitably decoded to provide the desired rhythm pattern.

Some digital sequencers are mechanically or electronically programmable. The earliest example of this was the player piano, but today's minicomputers provide tremendous control possibilities, far beyond those offered by the player piano. Tape cassettes, too, offer all sorts of stor-



PAIA Electronics
Model 2720 Synthesizer Kit

age and control possibilities for electronic music.

Digital sequencers can be too regular or too random. Much of what we call music can be described as a sequence of expected surprises, regular sequences dominating, with changes and randomness essential but in a minority. Most of our music, consequently, consists of a 65 to 95 percent redundancy.

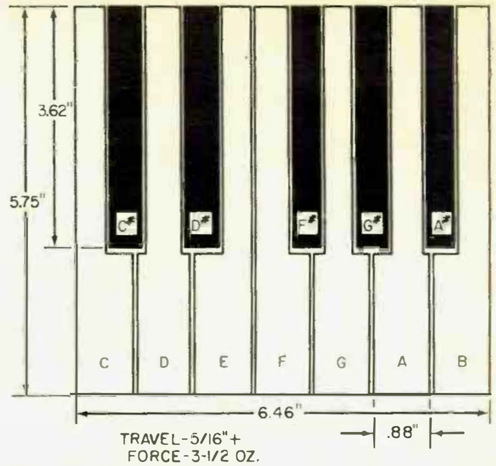
If everything is redundant, the sound is boring—a sideman that never changes or misses. Make it all random, and somehow it is not music. Any good digital sequencer must play the middle ground, perhaps by adding slight randomness to break up an "exactitude," or by having alternate sequences so elaborate that they do not bore.

It can be argued that traditional keyboards limit the flexibility of musical composition, making many effects (particularly loudness control) and glides and trombone slides difficult to obtain. But the piano keyboard is a product of hundreds of years of adaptation to the human mechanism. It has been so highly optimized that no other traditional instrument can come even remotely near it for range and flexibility of expression.

In the studio, we are free to custom-build each note and use multiple recording techniques and individual sequencers to build up a final sound image without a keyboard. To this end, we use patchboards, switches, punched or magnetic tapes or cards, scissors, etc. Interestingly, though, whenever an attempt is made to turn this into a real-time process, all patches and switches turn into stop tablets and the result is a keyboard.

Commercial Keyboards. There are two basic keying systems in current use. In *direct* keying, all notes go through the keyboard; this is the traditional electronic route, but it limits what can be done with attack and decay and contains cross-talk problems.

Most synthesizers and many newer organ circuits employ an *indirect* system in which only control voltages are routed through the keyboard. For example, the keyboard can send the supply voltage to an oscillator or keyer in the separate-voicing pitch-generation method. It can select a division ratio or route a command to an envelope generator or a digital pitch generator. On the other hand, it can select a fixed precision resistor for the vco method of pitch generation, or it can route a frequency reference to a phase-locked loop tracker pitch generator.



One octave of traditional piano or organ keyboard. White keys are different shapes in order to get a "piano" spacing in the front and even mechanical spacing at back.

Almost always, the equivalent of multiple contacts on the keyboard is desired. In a synthesizer, you might select a pitch resistor with one contact and at the same time generate a common command: "A note has been played in octave #3." In traditional electronic organs, you might sum up pipe voices onto 2′, 4′, 8′, and 16′ buses and provide for manual-to-manual coupling.

Perhaps, in your system, you might like to move up a fifth without changing key positions (done in groups for automatic chording) or be able to switch keys for transposition without moving all over the keyboard. To do this, the equivalent of a new set of contacts is needed for each desired effect.

As you can probably imagine, multiple contacts can become a headache. Commercial keyboards are available with up to eight contacts per key; but two, three, and five contacts are more common. A better route today is the use of electronic expansion or contact multiplication, using diodes or digital-logic gates to provide virtually any number of contacts per key. CMOS logic is ideal for this and can handle both digital and analog signals. Check out the CD4016 in particular.

Two general classes of keyboard systems are "regular" and "touch-sensitive." In the first system, the contacts simply close when a key is pressed. The closure is independent of the speed and force at which the key is closed. Loudness of the note or other special effects must be controlled by some other means. How fast the key is pressed in a velocity-sensitive keyboard or how hard it is pressed in a pressure-sensitive keyboard also initiates a separate electrical control-signal output.

An ideal velocity-sensitive setup would have some mechanism similar to that of a piano on each key. Its final velocity would be converted into an electronic signal and used for control. More reasonable methods can be imagined by using optical couplers or by using the fixed charge on a capacitor whose plates move together as the key is pressed. Alternatively, key motion or displacement can be sensed and used to establish velocity. Both velocity and pressure could be sensed in this manner.

In single-voiced instruments, one common velocity generator can be used for velocity or pressure sensing to eliminate key-to-key variations. An obvious way to sense pressure is to use conductive foam under each key, but the big problems include obtaining key-to-key uniformity and good wear properties combined with long-term stability.

Selecting a Keyboard. If you are an experimenter, chances are that you are considering making your own keyboard. You might save some money going this route, but be prepared to run into numerous obstacles. On the other hand, if you are serious about music and have the money to spend, a commercial keyboard may be more to your liking.

Commercial keyboards run from a minimum of $1.60 to more than $3.00 *per key*. At first glance, this might seem extravagantly expensive, but bear in mind that these keyboards represent a good deal of research, have a great deal of integrity, and are characterized by uniformity. In the long run, a commercial keyboard is the only possibility for the serious musician.

Many commercial keyboards are made by the 176-year-old Pratt & Reed Co. to the high standards set by the American Guild of Organists. They are professional units, custom designed for specific users; so, do not expect to find them as "off-the-shelf" items and at bargain prices. There are, however, other sources of supply to which you can turn as shown in the table below.

When last we checked, PAIA Electronics had the lowest price per key for a 37-note system. Even so, an AGO keyboard *without* velocity or pressure sensing is going to cost a minimum of $1.60 per key.

You might try to build up a simpler keying system for experimental use or initial setups. For the keyboard, you might want to use a surplus calculator or computer keyboard as is or rearrange it into a more "playable" setup. This approach will get your system operating for only a few dollars—even if it is essentially unplayable. If you plan on imitating the traditional key shapes, you can get keytops and sharps from Tuners Supply Co. (94 Wheatland St., Somerville, MA 02145); the white ones #531A sell for $7.20 for a set of 52, and the black #523L are $6.50 per set of 36.

Touch-sensitive foams and vinyls are available from Emerson and Cuming (604 West 182 St., Gardena, CA 90247). Their Eccoshield CLV vinyl and MOSFET foams might prove of interest. Another good conductive foam is #7611 Vellofoam available from Custom Materials Inc. (Alpha Industrial Park, Chelmsford, MA 01824). While the price per square inch of these materials is very low, the normal minimum order seems to run about $25, which will buy a large sheet.

Sealed key switches with integral return springs are available from Southwest Technical Products Corp. (219 West Rhapsody, San Antonio, TX 78216) at $4 per octave. They are single-contact high-quality reed switches with the normal range of travel and force.

Designing and building your own keyboard may be difficult, but it isn't impossible—else how could the commercial units have evolved? If you come up with something that is inexpensive, reliable, and suitable for professional use, let us know about it. ◈

SUPPLIERS OF COMMERCIAL AGO KEYBOARDS

Devtronix Organ Products
5872 Amapola Dr.
San Jose, CA 95129

Eμ Systems
3455 Homestead Road
Santa Clara, CA 95051

Newport Organs
846 Production Place
Newport Beach, CA 92660

PAIA Electronics
Box 14359
Oklahoma City, OK 73114

Schober Organ Company
43 W. 61st ST.
New York, NY 10023