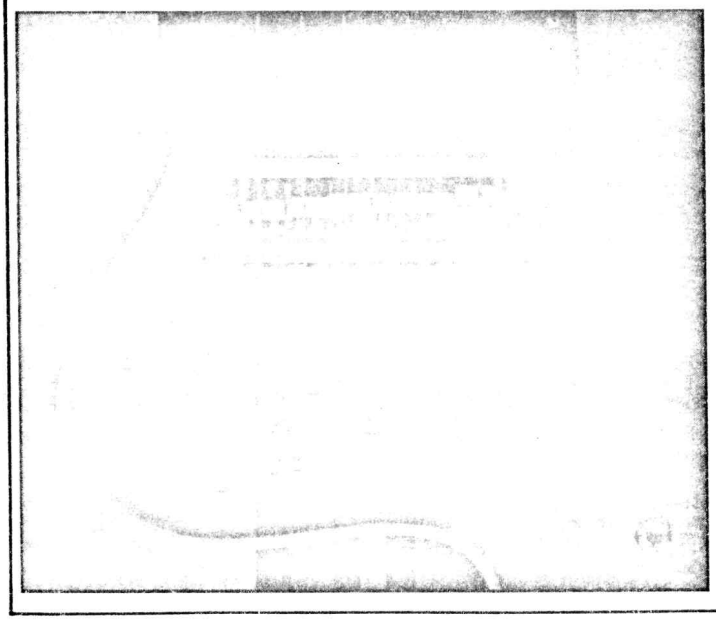
DAVID FRIEND
GUITAR SYNTHESIZERS
The Hexaphonic Pickup

In the first installment of this column [see *GP*, Apr. '78] we learned that the structure of a guitar synthesizer is based on two elements: (1) a pitch-to-voltage converter that translates the pitch of the signal coming from the guitar into standard synthesizer control voltage signals, and (2) a synthesizer (capable of producing a wide range of sounds), which is controlled by the pitch-to-voltage converter.

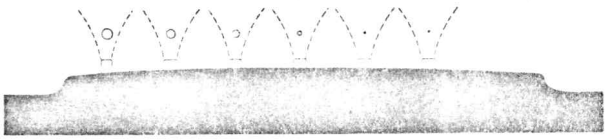
In the second installment, we looked a little closer at the problem of pitch extraction and its limitations. The important point was that a pitch-to-voltage converter needs to have a clean signal with only one pitch (not a chord) in order to do its job. We left off last month by saying that a standard guitar pickup sends the signals from all six strings out through a single wire, so that you almost always have a complex, composite signal representing the vibrations of several strings at once. The standard pickup is therefore not suitable for a guitar synthesizer.

The hexaphonic pickup differs from a standard guitar model in that it is actually six completely independent pickups with six separate wires coming out. There is one pickup for each string. Consequently, the signal from each guitar string is transmitted through its own wire. Since you can only play one note at a time on a single string, each of the six outputs has only a simple, single-note signal.

Before we get into how the hex pickup is used, let's look at how it is built and how it works. The trick in designing a hex pickup is to get good isolation between strings. For example, when you pluck your low *E* string, you don't want any of its signal coming out on the *A* string's wire. String-bending further complicates the problem, because when you bend a note even a semitone, the string moves a considerable distance. If you mounted a hex pickup where your standard pickups are mounted, bending the *E* string, for instance, would result in the string moving to where the *A* string was. Consequently, the *E* string's signal would move from the *E* string output to the *A* string output. To get around this problem, it is necessary to mount the hex pickup right up against the bridge, where the displacement of the string from bending is minimal. The photograph below shows a hex pickup mounted near the bridge of an Alembic guitar. The polepieces of the pickup are about a half-inch from the bridge.

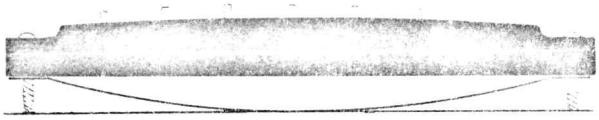


Because there is so little string movement close to the bridge, the pickup polepieces can be positioned very close to the strings, resulting in better isolation. The hex pickup uses focused magnetic fields above each polepiece to further enhance the isolation between strings.



The design of the magnetic structure in these pickups required the efforts of many engineers, and the final products have almost nothing in common with conventional guitar pickups. Because the hex pickup itself must be very small in order to fit on most guitars, the coils also have to be quite small. Hex pickup coils use wire which is so thin that a special machine is needed to handle it. Once the coils are assembled and tested, the whole pickup is permanently potted in a low-shrinkage glass-filled epoxy that holds all these delicate elements together in an almost indestructible structure. The cable coming out of the pickup shell contains six small wires (one for each string) and a shield. This cable terminates at the six-pin connector, which mounts on the guitar body.

The pickup itself mounts with a couple of wood screws and either a leaf spring or a coil spring (some units, such as the Roland GR-500, have a permanenly mounted pickup). The spring pushes the pickup away from the guitar body.



In mounting the pickup, you use a template supplied to position the screw holes. It's then a matter of backing off on the screws until the pickup polepieces are almost touching the strings. Individual polepieces can be filed down to account for irregularities in string height, or the saddles on the bridge can be filed. If the string spacing is not even, the saddles should be renotched so that the strings fall exactly over the centers of the polepieces. While any hex pickup can be mounted by the user, some companies recommend that this procedure be carried out by a guitar technician.

Let's get back to the electrical system for a moment. Because the signals at the six outputs of the hex pickup are each the product of single-note sounds, they are well suited as inputs to a pitch-to-voltage converter. All you have to do is select any one of the six outputs and connect the pickup to the pitch-to-voltage converter, and you'll be able to play well on one string of the guitar. However, most guitarists would prefer to use their synthesizers with all six strings. So the guitar synthesizer includes a circuit called an *audio multiplexer,* which automatically connects the last string plucked to the pitch-to-voltage converter. We'll look more closely at this part of the guitar synthesizer in next month's column. We'll also examine the difference in structure between guitar synthesizers incorporating one pitch-to-voltage converter, such as the Roland GS-500, ARP Avatar, and 360 Systems unit, and those including six pitch-to-voltage converters —so-called fully polyphonic instruments.