JESSE KLAPHOLZ

C—Duced

A c-ductive new pickup that looks like a piece of tape? C what it's all about.

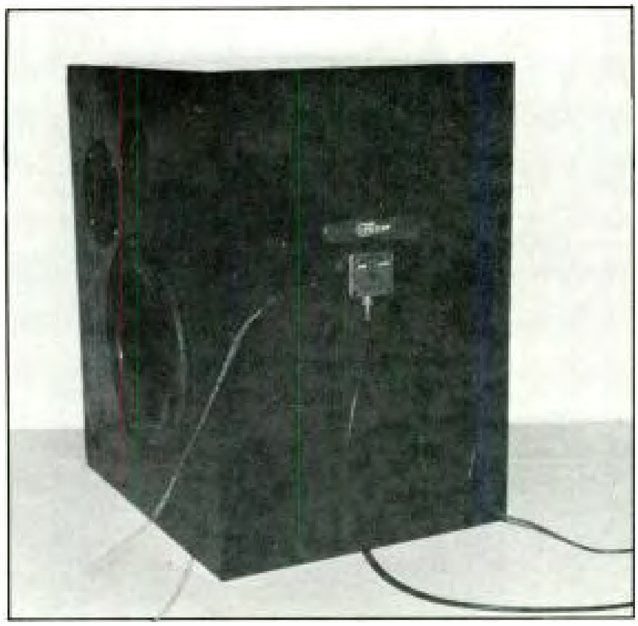
I WAS FIRST introduced to C-Tape Developments' C-ducers in 1980 by Bernie Kirsch at Carnegie Hall in New York City. Since there were no microphones or pickups in sight for the reinforcement of the piano, and this was Chick Corea's gig, the conversation of the day naturally started with "Wheeere's the mics?"

Kirsch told me about a most bizarre pickup from England that he was using on (or should I say under) the piano. It obviously couldn't work. How could a 30-inch piece of tape, stuck underneath the piano keyboard with a cable sticking out of it, actually reproduce this nine-foot instrument at all, let alone with any degree of accuracy?

The sound check proved that the pickup did indeed work, and that evening's performance certainly made a believer out of me. In fact, there was no one at the concert who could detect the amplification of that beautiful piano, and that is quite a statement in itself.

Several years went by until this mysterious tape was heard of again around this neck of the woods. All of a sudden an ad appeared with an 800 phone number, asking us to call. So we did, and a C-ducer was on its way for our evaluation.

Jesse Klapholz is a regular db *columnist.*



THE TAPE

The C-ducer is a vibration transducer system comprised of a flexible tape 3/32-in. thick by 3/4-in. wide and eight inches long (optional, three inch length), and a preamp. FIGURE 1 shows the cross-sectional view of the tape. The tape is coaxially constructed, with an outer foil electrode functioning as both a shield and as one plate of the sensing capacitor. The inner foil electrode is a conductive element coated with layers of piezo-electric plastic (primarily for insulating purposes). The air gap

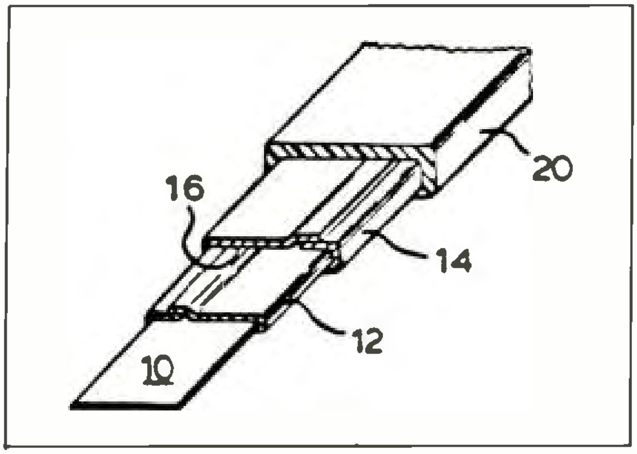
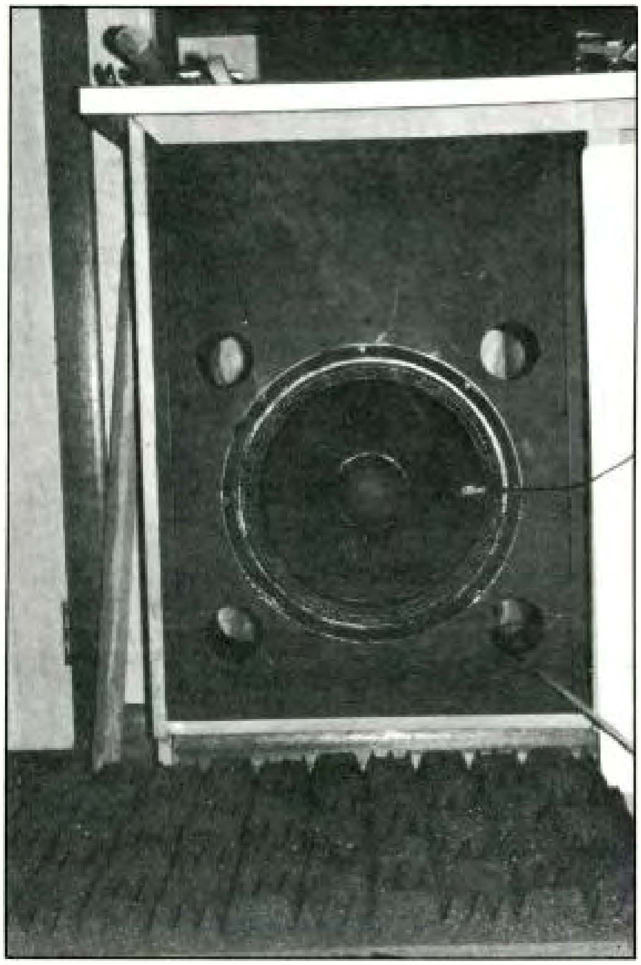


Figure 1. Cross-sectional view of the tape.

between the inner and outer foils, when in contact with a vibrating surface, produces a change in capacitance proportional to the physical spacing of the two foil electrodes. An interesting enhancement to the capacitive elements of the transducer is the emf voltage generated by the foil's piezo plastic layer. Therefore, the tape-transducer operates on a hybrid of piezo-electric properties and the effects of change in capacitance.

What we know so far is that the tape works on two principals: the rate of change in capacity between the inner and outer foil electrodes, and a piezo-electric



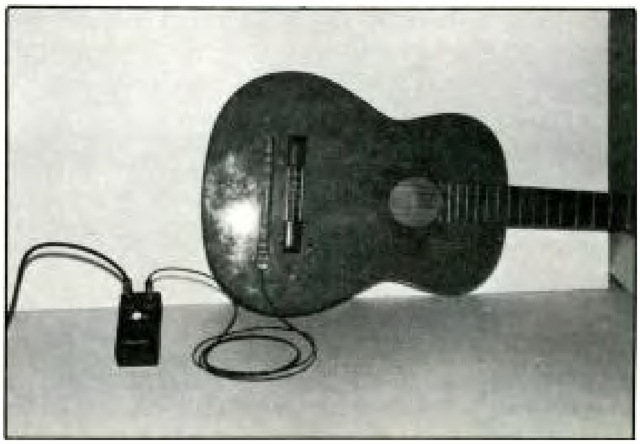
enhancement from the polymer coatings. Therefore, the C-ducer (capacitive-transducer), for all intents and purposes, operates as an acceleration and velocity transducer. Since the primary resonance is near the GHz region, its frequency response is practically flat to 5 MHz, and it responds down to 0.1 Hz. The C-ducer effectively integrates all vibrations coherently over its entire length (six square inches for the eight-inch tape and two and a quarter square inches for the three-inch tape). Therefore, it "samples" a much greater area of a vibrational surface than the typical discrete-point contact pickup.

The C-ducer has essentially no inductive component, and is basically a pure voltage generator in series with a pure capacitance. However, due to its piezo-electric contribution, the capacitance as measured on a bridge (the static capacitance) is different than the effective capacitance when the transducer is set in motion. Another way of looking at this is that the pure voltage generator in series with the capacitance has basically a negative impedance. Since the series impedance is so low, the usual problems of cable-generated noise and other high-impedance difficulties are virtually eliminated.

The tape is terminated with a seven-foot-long coaxial cable that has, in addition to its braided shield, a conductive plastic one as well, with 100 percent shielding properties. The tape is very quiet and has no RF pickup or cable-induced noise problems. The dynamic range output capabilities of the tape are extremely wide. Nominal output levels in the 30-millivolt range are typical of acoustic string instruments. However, fastening the tape on a table and then striking the table with a light blow can produce output voltages from the tape in the 20-to 30-volt range. Outputs of up to 100 volts without clipping have been reported in specialized testing applications.

THE PREAMP

With the hybrid characteristics of the tape and its output's dynamic capabilities in mind, the preamp is critical in the implementation of the transducer system. The preamp is a capacitor-balanced-input design; in the "Pro" version, with 600 ohm balanced output(s), it requires 24-48 volt phantom power. The capacitor-balanced-input approach is basically comprised of a differential input amplifier with a capacitor balancing the tape signal to the second half of the input stage. As a side light, the performance of many commercial capacitor (condenser) microphones have been improved by changing the high impedance FET amplifier to a balanced-capacitor-input.



The rest of the preamp buffers the signal, and, in the Pro version, provides transformerless balanced output(s) matched to 600 ohms, buffered Hi-Z output(s), and gain that is variable from mic to line level via a rear panel trim pot for each channel. The input and buffering stages in the high-impedance and low-impedance preamps are identical. However, the high-impedance preamp has a front panel knob for output level adjustment. There are three different Pro preamps available: one input, two input, and six input configurations.

MEASUREMENTS

Measurements of such a radical new concept are a formidable challenge. It is difficult enough to decide on how to present data on "conventional" transducers, especially when the AES Standards Committee have not been able to settle on transducer specification standards themselves! With this in mind, we are not attempting to present any data as "the real picture." However, we feel that some of our in-house test results should be interesting.

For our first experiment, we attached a C-ducer to a cone loudspeaker, and measured the speaker's on-axis response to a test pulse with a mic. The C-ducer was electrically "off" at this point. However, it was hooked up so that any damping taking place would appear in both curves. With the mic's response curve in computer memory, we measured the C-ducer's response to the test pulse, and plotted the two measurements for easy comparison in FIGURE 2. An interesting experiment that anyone can try is to monitor the output of the C-ducer (a test signal into an analyzer, or music into headphones can be used) and change the position of the tape on a loudspeaker. The contributions of all the different parts of the loudspeaker to the total sound output can be simply demonstrated in this way.

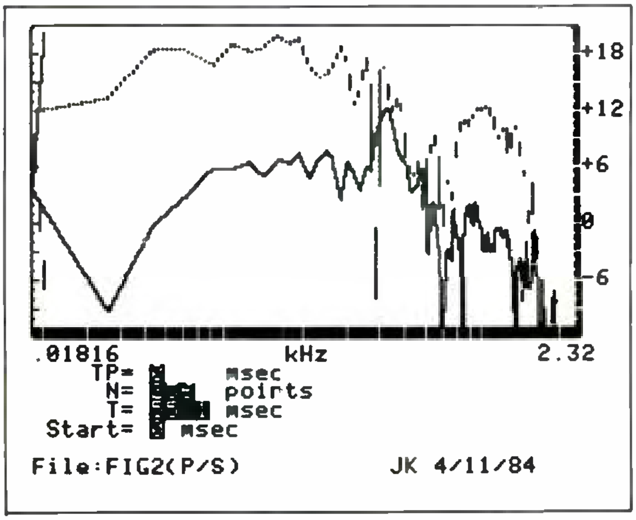


Figure 2. Response of a cone loudspeaker as picked up by the C-ducer (upper dotted trace) and by a microphone (lower solid trace).

For our second experiment, we attached a C-ducer to a classical guitar and analyzed the response of the plucked open A string with a test mic. With the mic's response curve in computer memory, we measured the C-ducer's response to the plucked open A string, and plotted the two measurements for comparison in FIGURE 3. A single note was used for this guitar test since it could produce an uncluttered display for ease of comparison, and could easily be repeated without any practical deviation.

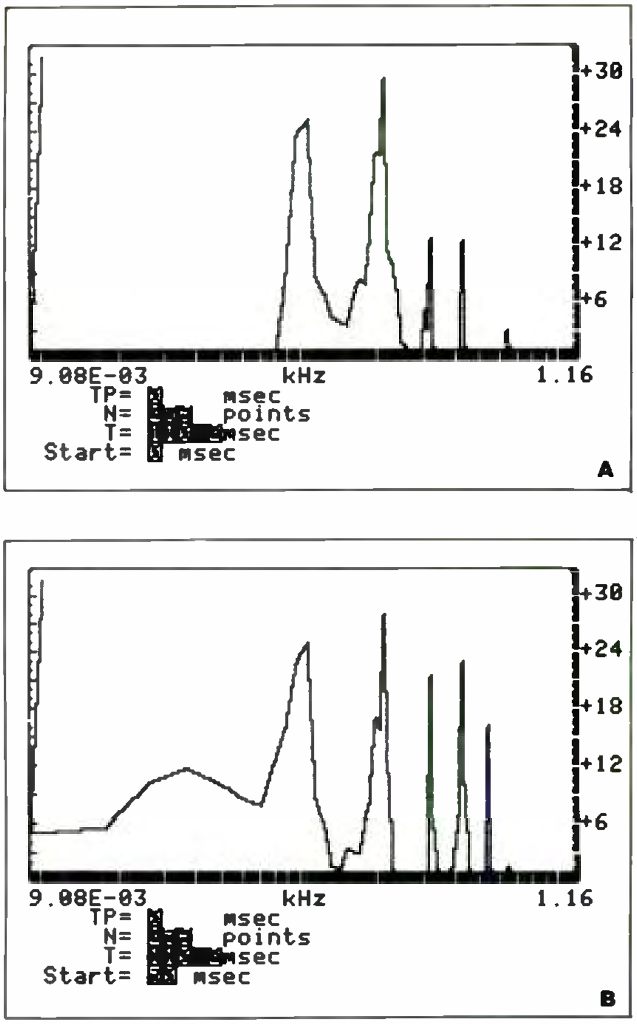


Figure 3. Response of a plucked open "A" guitar string as picked up by a microphone (A) and by the C-ducer (B).

FIGURE 4 shows the comparison between the pickup of loudspeaker cabinet resonances with a standard piezo-type industrial vibration pickup and the tape. Since the tape behaves as both an accelerometer and a velocity transducer, its response bandwidth far exceeds that of the industrial accelerometer.

An interesting observation made through some of our testing was that the structure of the tape enables the

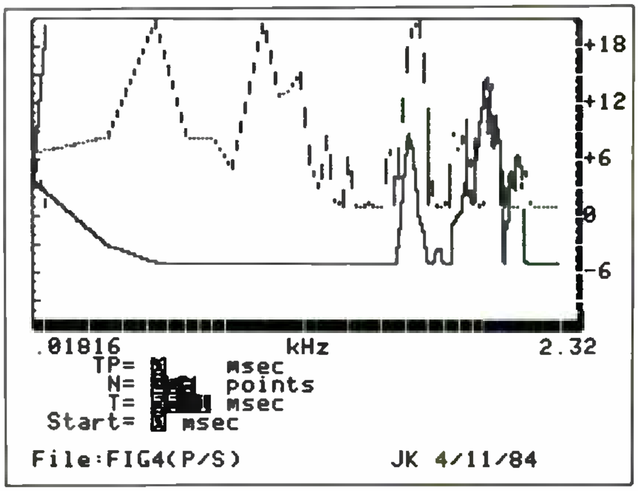


Figure 4. Pickup of loudspeaker cabinet resonances with a standard piezo-type industrial vibration pickup (lower solid trace) and with the tape (upper dotted trace).

pickup of vibration patterns in selective areas; this allows us to locate the nodes and peak displacement areas of vibration. Using basic geometric triangular relationships, the "epicenter" can be found, since maximum sensitivity will occur when the tape is perpendicular to the incident wave front and aligned with it.

APPLICATIONS

The most popular use of the C-ducer has been on the piano; however, applications range from drums to strings and everything in between. The list of people using C-ducers reads something like a "who's who in music." Part of the list includes Chick Corea, Joni Mitchell, Stevie Wonder, Crystal Gayle, Abbey Road Studios, the Royal Opera House, UB40, Swiss Radio, North German Radio, the BBC, Eric Clapton, Pink Floyd, Duran Duran, Dire Straits, Culture Club, Jon Hiseman, Linda Ronstadt, Jose Feliciano, Anne Murray, Willie Nelson, Baryshnikov Ballet, the Grand Ole Opry, and Resorts International Casino in Atlantic City.

Joe Marchione, the lead sound tech at Harrah's Casino in Atlantic City, was first introduced to the C-ducer by Greg Kirkland, Neil Sedaka's sound engineer. Marchione has since replaced the PZM 30-GP mic in the Yamaha grand piano in Harrah's Atrium Lounge with a two channel C-ducer. Says Joe, "The C-ducer not only eliminated the pickup of the waterfall in the lounge, it also sounds a lot more like a real piano!" Similarly, in the theatre, Joe is now using a C-ducer in Harrah's nine-foot Baldwin Grand with great results, both for monitors and mains: "...better sound and more gain before feedback than mics, and much more realistic and even reproduction of the piano than the Helpinstill."

On the other side of the fence are those who have tried the C-ducer and havn't been satisfied with its results. A typical example is a rock group currently using a grand piano on a stage with amplified instruments whose average sound levels are in the 115 dB range. With such high sound levels in the proximity of the piano, this sound field will obviously be induced into the soundboard of the piano. The piano soundboard is acting as an acoustic transducer, converting airborne sound energy into mechanical resonances. When a C-ducer is attached to such a soundboard, it will faithfully reproduce all vibrations within it.

When such a piano is amplified via a C-ducer, so is the loudspeaker's sound; hence the complaint of, "There's no separation." After being involved with and having heard many different groups and pianos through live PA, I believe the bottom line is, "Why even bother to use a grand piano with a pickup system/technique that makes that piano sound inferior to an electronic piano?"

COMMENTS

Back over on the C-ducer side of the fence, if a piano's sostenuto pedal squeaks, or if a kick drum's pedal creaks, a can of WD-40 or Teflon spray can be very helpful in eliminating such mechanical noises. You piano tuners out there better keep on your toes!

The tape is a very low mass device. Therefore, it does very little in terms of damping the surface to which it is attached. The exceptions to this are: drum heads (which may be desirable), eight-inch tapes on small and light cymbals, eight-inch tapes on small diameter/lightweight loudspeaker cones, and in general any situation where the ratio of the mass of the tape to the mass of the surface to which it is attached is high.

The first time I tried the C-ducer in a musical context was in an A/B comparison with the Underwood pickup on a friend's acoustic bass at a small club date. The Underwood is a split pickup design, restricted to a mounting position in the bass' bridge. The flexibility of being able to place the C-ducer almost anywhere on the instrument allowed us to achieve many different "voicings." With this "voicing" capability, the applications are only limited by the imagination and creativity of the user.

Through our evaluations in applying the tapes to various surfaces, we found the tape's flexible construction to be pretty convenient in terms of minimizing the restrictions of its placement. The "low tack" double-sided adhesive tape contained in the kit presented no problems with musical instrument finishes. We also found that as long as the surfaces were kept clean, the tape could be repositioned many times, removed, and even re-applied before having to replace the adhesive strip. As with mic placement technique, *where* you apply the tapes is important, but you'll find them a lot more forgiving than you'd expect. In our experience and conversations with other C-ducer users, the general consensus is to use eight-inch tapes when C-ducing an instrument; the use of the three-inch tape usually only becomes necessary when the size of the surface prohibits the use of the eight-inch tape.

The C-ducer manual and accompanying application notes provide good starting points. In most cases, the tapes won't need much adjusting. The timbre of the instrument, as far as the tape hears it, may be adjusted by moving the tape in relation to the resonating surface and vibrating medium (strings vs. body, drum head vs. shell, etc.). However, remember that sound travels through wood over 10 times faster than through air!

Several notes of caution: Poor tape-to-instrument contact will degrade the signal transfer process. Any material and/or air space introduces a mechanical impedance mismatch, which modifies the transfer function in terms of both level and frequency. When using the C-ducer with percussion instruments, input levels need to be monitored judiciously. Because of the wide dynamic range of these instruments and the C-ducer system's capabilities of swinging high peaks without clipping, an input meter may hardly budge even though console input clipping may be taking place.

A SUBJECTIVE OPINION

One experiment with a single eight-inch tape on an upright Steinway was quite interesting. The piano was on a deep pile rug and couldn't be moved easily, so the pickup was "blindly" placed on the bottom of the soundboard at the low end of the keyboard and was recorded on a Sony SL-5200 Beta Hi-Fi VCR. The results? The playback sounded like a studio recording of a large concert grand, very even and natural. Natural? In this day and age when guitars are designed to sound like synthesizers, and synthesizers are made to sound like guitars, who is to say what sounds right? The word "natural" is taking on new meaning as the instruments we use become more mechanized. With the four-track mini-studio becoming a popular household appliance, what's next? Who will be the first manufacturer to sell a console that does it all? Just as our PZMs from Ken Wahrenbrock's kitchen back in '79 were a great addition to our mic kits, we feel the C-ducer is a revolutionary addition to today's "bag of tricks." ■