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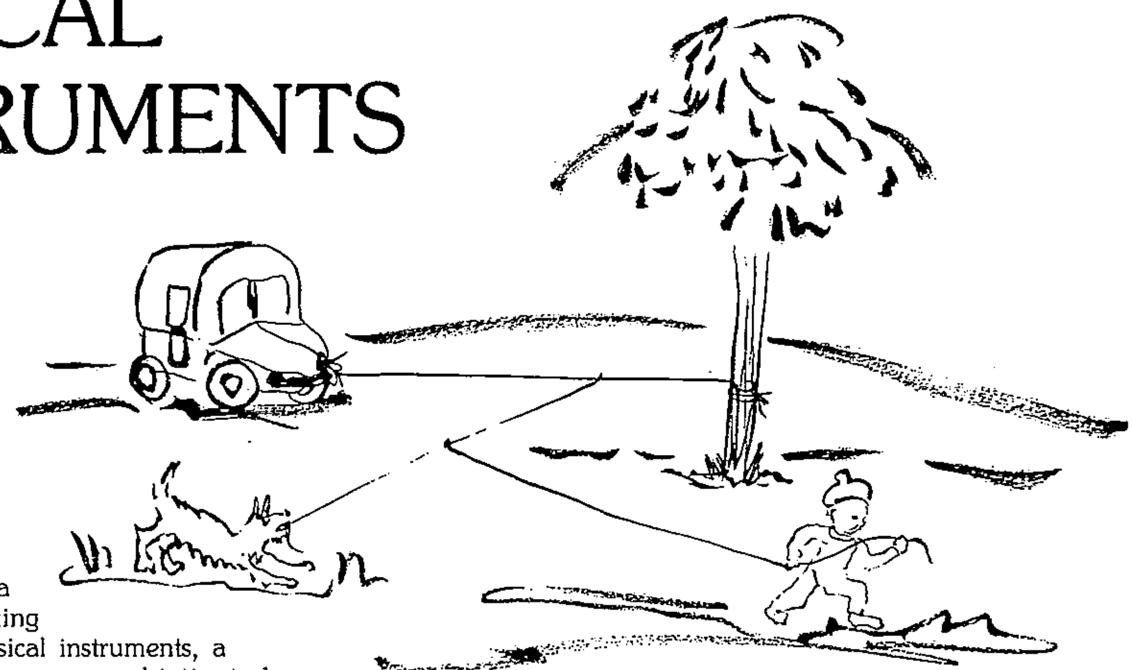
FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF UNUSUAL SOUND SOURCES

EXPERIMENTAL MUSICAL INSTRUMENTS

THE SIMPLE SOPHISTICATE

As always, we have a goodly mix of subject matter for our readers in this issue of **Experimental Musical Instruments**. Included are a look at the musical possibilities of sets of conjoined strings, a discussion of patenting for inventors of musical instruments, a description of a very sophisticated electroacoustic prepared piano, an account of the work of a near-forgotten instrument designer and maker from the 1930s, an approach to tunings and chordings for 19-tone fretted instruments, and the usual complement of additional treasures and throw-aways.

We begin with to the prepared piano.



ABOVE: Conjoined string systems. See the article on page 12. Drawing by Robin Goodfellow

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THE ACOUSTISIZER

by Bob Fenger Icon

The Acoustisizer (ACU), simply defined, is a miniaturized prepared piano with guitar pickups and speakers built into the unit, capable of producing prepared piano-generated feedback loops, sympathetic vibration processing and sound-stimulated kinetics. The idea for the ACU developed organically over a period of about five years. As an electronic music composer during the early '70s, I was perplexed at trying to combine and integrate electronically generated sounds with acoustic sounds. Synthetic sounds have an animated or cartoon-like character requiring special handling with their juxtaposition to "real" or acoustic sounds. My first experiments engaged a Pignose amplifier/speaker propped up underneath the family's 1927 Steinway through which I would play my ARP Odyssey. I had a couple of years in which to discover and integrate prepared piano into my experiments before the old grand was finally rebuilt and completely off limits

(coontinued on page 4)

THE ACOUSTISIZER

by Bob Fenger

Bob Fenger formulated the idea and constructed the Acoustisizer as a graduate student at Cal State University Dominguez Hills from which he received a Bachelors in music in 1981, and a graduate degree in a special interdisciplinary program in 1983. He has been featured as musician, inventor and performance artist in several periodicals dealing not only with the Acoustisizer and his Mobile Sculptural Units, but also his alternative life style, which has involved transforming an unused area of industrial Los Angeles into a habitable green living space. Currently, he is pursuing a Ph.D. in Systematic Musicology at UCLA, where he plans to do more in-depth research on the instrument featured here as well as pursue performance art from a systematic musicology perspective.

(continued from page 1)

to me. It was not until I acquired an old Humbucking guitar pickup that my experimentation paid off. With the piano strings prepared and the Humbucking feeding these sounds into the Pignose amplifier/speaker lodged underneath the piano, a sort of sound wash was created through which pure acoustic and pure electronic sounds, with the help of sympathetic vibration, could find common elements of timbre compatibility.

Eventually I added delays, chorusing, flanging, overdrives, EQ devices, and a Serge Modular system including envelope followers, slope generators, positive and negative slews, phase shifters, and bi-directional routers; sounds manifested through a series of multi-timbral effects, triggered by a computer-interfaced event synchronizer and blended or processed with the Acoustisizer.

BUILDING PROCESS

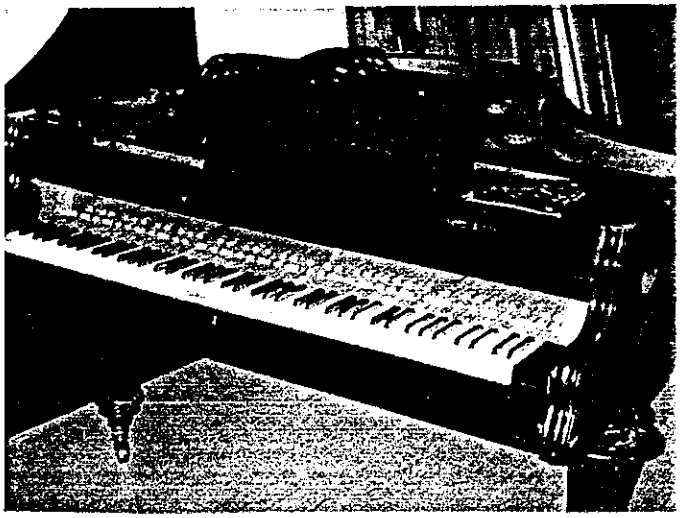
My experiments became increasingly complex and it became evident that a dedicated instrument was needed to maintain the necessary consistency and control. The majority of requirements for these experiments could be met on an instrument half the size of a grand piano. I began investigating a number of options including adapting a Frank Hubbard fortepiano kit and even building the instrument from scratch (an engineering feat which would have taken two years longer and as much as sixty thousand dollars). The fortepiano was also impractical because of its fragility. I needed to find a grand piano which would lend itself to reinforced restructuring. The restructuring and reinforcement were to be achieved by using lag bolts and fiberglassing the sides and underbody, which was necessary because of the potentially high levels of volume and vibration generated during the experiments. It took six months of climbing through stacks of old pianos in warehouses all over Los Angeles looking at infrastructural supports and plate configurations, taking notes and making sketches until I came upon an old Viennese piano with a near perfect structural configuration for the project. The infrastructure was made up of workable 90 degree angles; the plate configuration was a simple design and the action was segmented in the right places. The only drawback involved adding a costly metal support to the plate in the bass register. Nevertheless, it was by far the best candidate for the project.

Prior to this project I had never built, cut up, or reconfigured an acoustic musical instrument. The process was painstakingly slow because there was no blueprint or master plan to work from. I had to develop my own method using an evolving sketch pad approach. I jotted down ideas and sketches concerning any aspect of the process and let the idea develop naturally. Every effort possible was made to consider problems which might occur at every step incorporating mockup situations when and wherever possible. All I had to begin with was a vision and a concept which included reducing the size of a grand piano, adding speakers to the underbody and pickups to the strings. But all these modifications were dependent upon the instrument itself and its idiosyncratic construction.

Before disassembling the piano I took a few reference pictures, careful notes and measurements: string height from sounding board, bridge proximity to plate, height of the plate, the amount of down-bearing, damper distance from strings (depressed and relaxed), string gauge sizes and tightness of the tuning pins. Then I followed the Reblitz* procedures for de-stringing and removal of the plate and sounding board which if done incorrectly can result in disastrous consequences, i.e., broken plate, cracked sounding board, pin block damage.

Once the piano was disassembled I drew my lines, triple checked and began cutting with a good hand saw. I cut the long straight side of the piano first so the extra support needed could be added to maintain the integrity of the instrument when the curved side was cut. The pin block was marked and cut with a skillsaw 3/4 of an inch longer so that a matching cutout in the first plywood layer could act as structural support for the pin block (FIG. 1). This first layer of plywood was veneered with white spruce on the side facing the inside of the instrument and held in place with seven 3- and 4- inch lag bolts. Four more 3.5 inch bolts, nuts and washers secure a 2x2 shelf inside the instrument for the sounding board and plate (FIG. 2). The second 3/4 inch plywood skin was applied with wood glue and lag bolts as well. Lag bolt positions for both skins were calculated to work together for maximum strength before either skin was applied. The same procedures for cutting the long side applied to the small side. Once both sides were glued and lagbolted in place, I restructured the front underbody which housed the keyboard action using 90-degree rabbet joints. I then stripped the curved section and filled, sanded and shaped the sides together. Any little crack, crevice or separation in the wood needed to be repaired before applying the fiberglass. Repairing the separating laminations on the curved side presented a problem which was resolved by situating the instrument so that its own weight held the curved laminated area in place while the glue dried. A variety of different sized wood wedges helped to apply pressure at vital points.

The prep work prior to fiberglassing was critical as fiberglass tends to magnify any flaw in the wood. I chose to use Dynell fiberglass cloth and Cal System two-part epoxy resin because it is easier to mix and the set-up time is consistent. I did the easier long flat side of the instrument first. The inside was masked off, the cloth cut and laid in place and the



The piano before the saw.

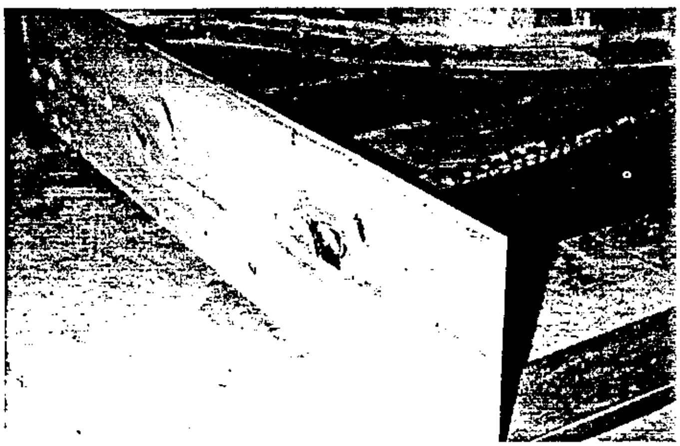


FIG. 1: Pin Block cut out.

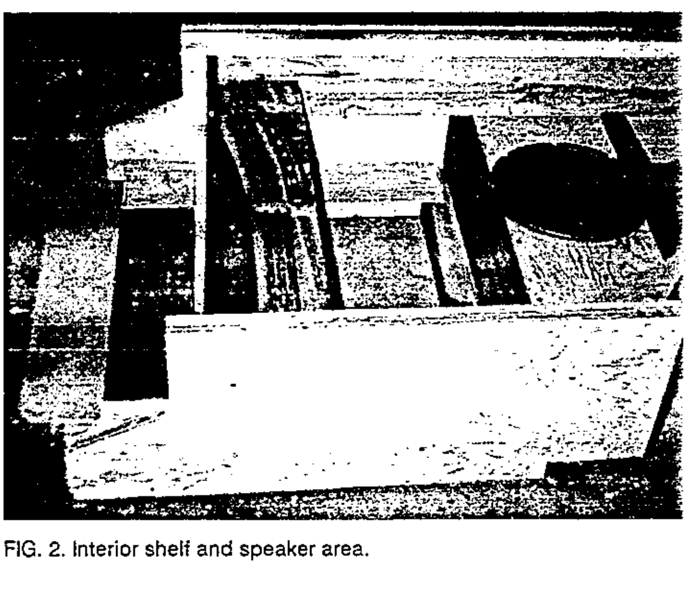


FIG. 2. Interior shelf and speaker area.

resin applied. Every bubble had to be removed before the resin set (12 minutes). The curved side was more difficult. After the resin had set, the borders were cut and cleaned and the masking tape removed before the tape itself turned into fiberglass. The final prep took many hours of polyfilling and sanding before the sun yellow epoxy paint was applied (i.e., mixing epoxy with micro-spheres, applying it to pitted areas, letting it set, then sanding it). Finally, epoxy finishing paste and fine emery cloth were used to finish the surface. I found a professional painter to spray on the final coat of epoxy paint. A professional painter can prevent you from wasting hours of prep work and many spray nozzles, as epoxy paint is expensive and extremely difficult to work with.

Once the plate was free of all piano wire and felt rings, it was cut by a machinist and sand blasted. A 23.5 mm mid-range hitch pin section was left unsupported as a result of the cut, so a 1.5 mm x 32.8 mm case-hardened piece of stainless steel was attached supporting this hitch pin section to the section above it. The plate was painted radiation purple then pearlized in order to soften and add depth to the color.

The sounding board required the most time and care in preparation. The easy part was cutting it down and repairing the cracks; Reblitz is quite thorough in his discussion on this subject. The problem began when I realized that I had reduced the area of the sounding board and thus the question of the rib size became an issue, since the ribs reinforce the sounding board. Too much support could alter the way sound acted upon the sounding board and potentially deaden the sound. I resolved the problem by calculating the amount of mass removed from the two sides of the sounding board and removing approximately the same amount from the rib structures, thus scaling the sounding board down proportionately. The last step in preparing the sounding board was applying the proper finish. It is generally accepted by expert piano rebuilders that varnish is the best finish for sound boards because it remains more flexible after it dries than shellac or lacquer, and does not restrict the vibration of the sound board as much as the other types of finish do. I applied only one coat of varnish to the top and bottom, ribs included.

The keyboard action in the instrument is considered a Vienna action, originated in 1717 by Christoph Schroter, a contemporary of Bartolomeo Cristofori. Schroter's action was later improved upon by Gottfried Silbermann and his pupil Johann Andreas Stein. Silbermann did away with the special escapement lever and extended the hammer butt beyond the axis, using this extension for escapement. Stein added the "hopper" by aid of which the annoying "blocking" of the hammer was overcome, at the same time improving the touch. The action is considered a single escapement and is quite simple in comparison to the modern day double escapement actions (FIG. 3A). This action dates the piano at somewhere between 150 and 200 years old.

I cut off exactly 2 octaves of the action from the bass and one note less than 2 octaves from the treble. Once again, I marked all the parts, then dismantled the action. The cuts were made leaving an inch and a half for the side supports which were cut and shaped out of a 2x6. The relative simplicity of the action

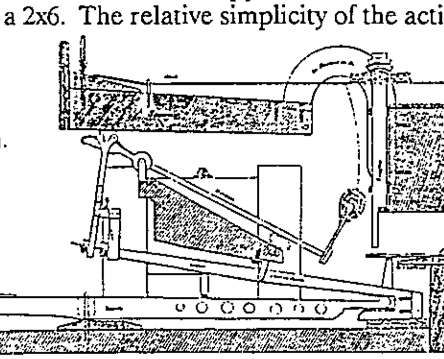


FIG. 3A: Improved Schroter piano action.

*Arthur A. Reblitz' book **Piano Servicing, Tuning and Rebuilding** (Vestal Press, Vestal, NY 13850) is a standard resource for the piano technician.

made this task easier than expected (FIG. 3B).

The speaker cabinet built into the underbody of the instrument is split in half by a 90-degree support brace. One section houses one 12-inch speaker; the other section houses four 4-inch speakers, one 4 inch JBL LE 25 mid-range and one 3-inch high frequency horn (FIG. 4A). Originally, the seven speakers were tied together through one passive crossover (FIG. 4B). Recent experiments have incorporated a patchable multi-channel system in an effort to achieve discrete feedback zoning, allowing a number of prepared strings to feedback independently of one another. This process involves an isolated transducer above the string and a speaker focused below the same set of strings with its own amplifier. An audio mixer with filter parameters help control harmonic accentuation, optimizing feedback perpetuation of the prepared string and eliminating the sometimes annoying high pitched squeal normally associated with feedback.

The final phase involved assembling all the parts. I was immensely relieved to find that the nosebolts which ran up through the bottom support, through the sounding board and through the plate maintained their alignment. Again, I followed the Reblitz book for stringing the instrument. This involved bringing the whole instrument up to relative pitch gradually, but because my primary interests were in creating electromagnetic sounds and noises, traditional tuning systems have no application. I inevitably tighten and loosen strings at every stage of the process when searching for sounds with a new preparation.

Final touches involved lining the bottom and keyboard action compartment with acoustic carpet, hinging on a 2-part half-inch plexiglas lid, and imprinting the Acoustisizer logo to the flat black pin block front.

Originally two transducers (guitar pickups) were connected to flexible microphone arms attached to the inside wall of the ACU. This system was eventually replaced by simply attaching legs to the pickups and resting the legs on the soundboard (FIG. 5). Presently plans are in the works for a series of experiments involving home wound pickups, some of which will be ten times larger than guitar pickups with a multi-versatile mounting system incorporated into the design (the basis for this modification will be discussed in greater detail in the section on ACU preparations).

ACOUSTISIZER PREPARATIONS

In 1977, Richard Bunger wrote a series of informative articles for **Contemporary Keyboard Magazine** on the history and safe technique of piano preparation ("Prepared Piano: Its History, Development, and Practice," in **Contemporary Keyboard** Vol. III #7, July 1977, Cupertino, CA). He cited the 300-year parallel evolution of pianos and mutes consisting of felt, leather and paper which contributed to the piano's ability to assume various tone colors and allowed such composers as Maurice Ravel to transform an ordinary piano into an insect-infested harpsichord. John Cage, attributed with the invention of the "prepared piano," acknowledges his mentor, Henry Cowell, and his use of hand muting and finger string manipulation. Cage confesses openly that the prepared piano was the result of space limitations at a given venue involving dancers and an African motif. By 1981, Richard Bunger and his Extended Piano Resource Project had documented over 200 works that feature piano-string preparation and muting, representing about 200 composers throughout the world.

So where does the ACU fit into this concatenation of events? In **The Well Prepared Piano** (Santa Rosa, CA: Litoral

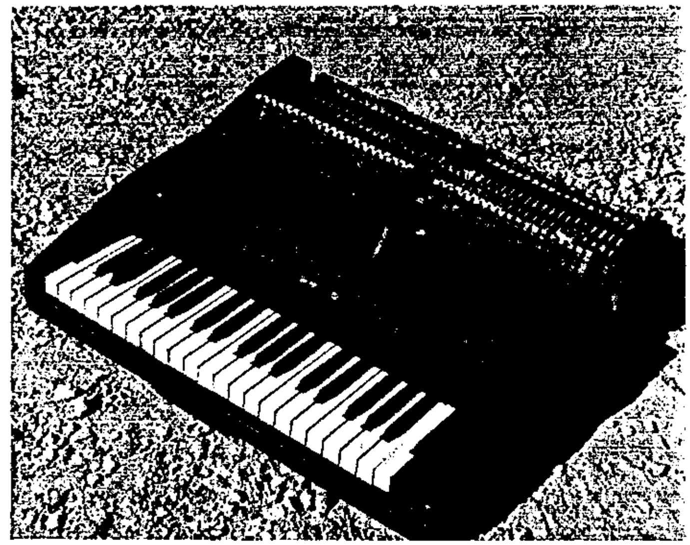


FIG. 3B: Finished ACU action.

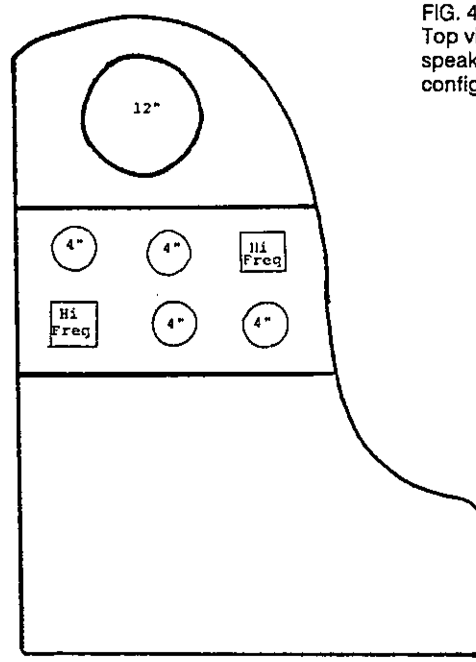


FIG. 4A: Top view – speaker configuration.

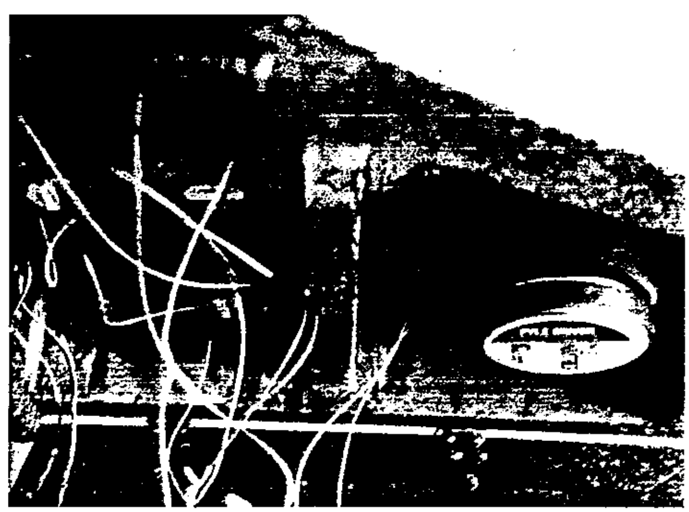


FIG. 4B: Bottom view – speaker network.

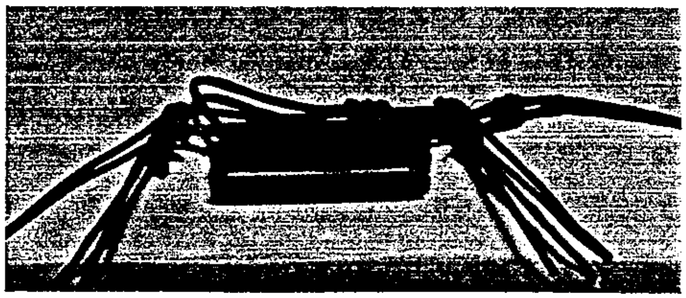


FIG. 5: Pickup with legs

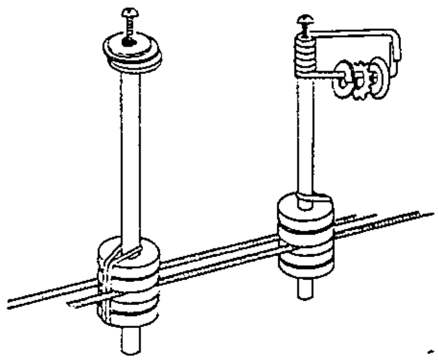


FIG. 6: A hybrid string preparation

Drawing by R. B. Evans

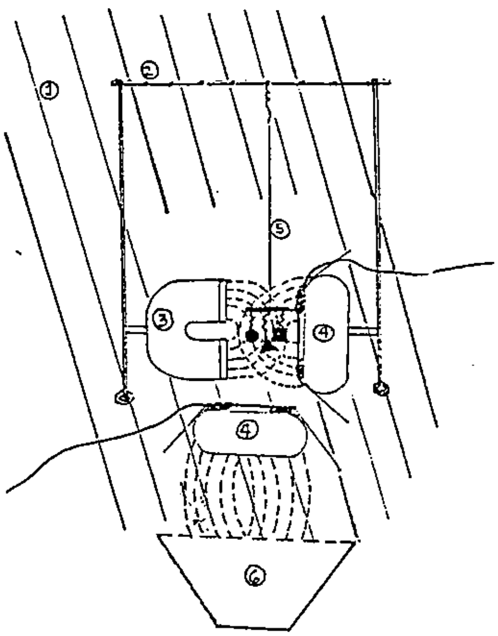


FIG. 7: Suspended objects within opposing magnetic fields.
1. piano strings
2. bridge tree rack
3. magnet
4. pickups
5. kinetic oscillator
6. speaker

Drawing by Jowee Jiao

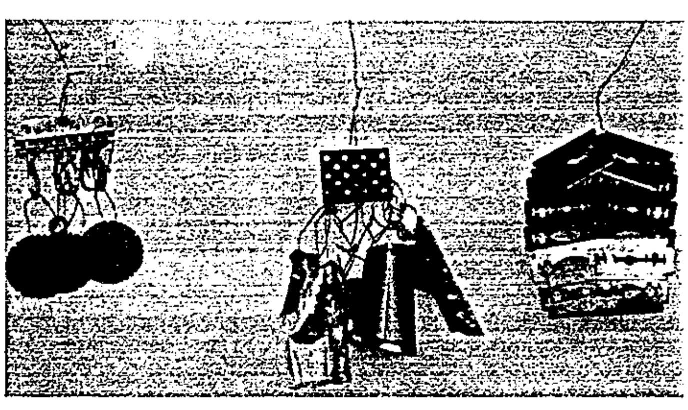


FIG. 8: Kinetic oscillators

Arts Press, 1981), Richard Bunger has succinctly described many of John Cage's original preparations and designated them into five groups: A) metal: bolts, screws, washers, coins, wire, u-bolts and metal strips; B) wood: bamboo, clothes pins, paper and cardboard; C) cloth: various felts; D) rubber and plastic: canning jar washers, piano tuners rubber mutes, rubber pencil erasers, wiring insulation, foam rubber, sheet plastic, rubber and plastic washers; and E) hybrid preparations, combining a number of the items from the first four groups, connected to the strings and extended above the strings (FIG. 6). It is from these hybrid preparations that I drew inspiration and secured the ACU's logical sequential position.

In the beginning of this article I mentioned the ACU's use of feedback loops. The feedback aspect of the ACU is best defined in the context of the electric guitar, and is actually a by-product of amplification and overtone accentuation causing electro-magnetic perpetual oscillation of a given string. Sound from the string is picked up by a guitar pickup consisting of a wire coil wrapped around a magnet, then fed to an amplifier and finally to a speaker, where the sound continues to perpetuate the motion of the string, whose motion is once again sensed by the pickup. The intensity of the electromagnetic perpetuation of the oscillating string is controlled by the volume level through the speakers or, in the case of the guitar, the proximity of the guitar to the speakers. Touching the string with your finger will either mute the process or allow one of the overtones to sound in isolation. Because of the potential precision control over the vibrating string as a link in the electromagnetic chain, this effect adapts itself nicely to musical applications. This is exemplified in the opening crescendo of Jimi Hendrix's "Foxy Lady" (from the record album **Are You Experienced**, Reprise Records, a division of Warner Bros. Records, Inc., Burbank CA and New York).

In the ACU, speakers are located in the underbody and point up towards the sounding board. Magnetic pickups are suspended above the strings. This close proximity between the speakers and the pickups creates a reflective or cyclic magnetic field causing strings and objects in or around the strings to vibrate. Another type of vibration can be induced in objects by grouping a number of guitar pickups together and using a strong opposing magnet. Two magnetic sources of the same polarity generate magnetic fields which repel each other and in the process agitate objects suspended between them (FIG. 7). I call the suspended objects *kinetic oscillators* (FIG. 8) and the objects to which the magnets are connected and the kinetic oscillators are suspended, a *bridge tree rack* (BTR). The BTR is made up of two twelve-inch-long #8 or #10 threaded rods bridged together with a windshield wiper frame and bolted to the strings. The windshield wiper frame works well because of its lightweight open looped construction allowing easy kinetic oscillator suspension (FIG. 9).

Sounds produced by kinetic oscillators are similar to the buzzes, jingles, rattles, and scrapes of John Cage's preparations except the generation of the sound is not limited to a single keyboard activated event. Kinetic oscillators vibrate continuously as long as the opposing magnetic fields remain intact and the amplified sound is regenerated through the pickups which are pointed towards the strings and speakers. These suspended objects or kinetic oscillators must contain some sort of light weight metal component in order to vibrate within the agitated magnetic field. Kinetic oscillators which do not contain metal components must rely on their proximity to vibrating strings for sound generation.

Using guitar pickups grouped together as described above

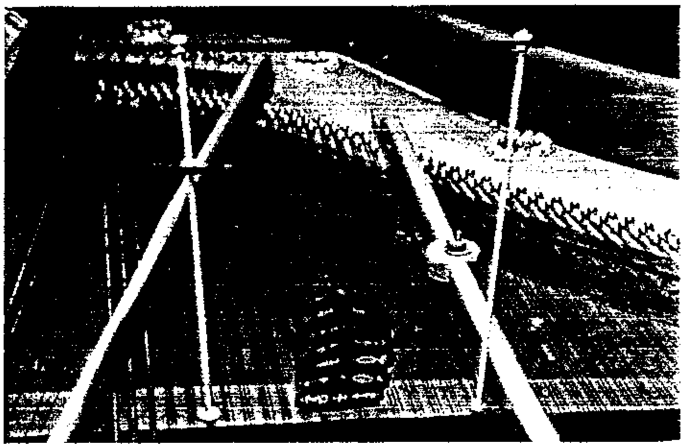


FIG. 9: Kinetic oscillator suspended from bridge tree rack.

does create some significant limitations: a) the grouping is somewhat cumbersome and hard to manipulate; b) the agitation created within the magnetic fields is limited, which in turn dictates the size of the kinetic oscillator. These limitations should be overcome by increasing the size of the magnet in the pickup and therefore increasing the strength of the magnetic field. This will reduce the number of pickups required to produce the agitated magnetic field and allow more precise placement of the field.

Almost anything imaginable can be used in the construction of a kinetic oscillato depending upon the desired sound: different sized brass tubing, rubber bands, paper and combs, double-sided razor blades wired together and even cellophane or aluminum foil folded, spindled or shredded into a sort of mixed media origami. Muting selected vibrating surfaces within the kinetic oscillator with string or scotch tape can achieve fine tuning and eliminate unwanted extraneous sound. Scotch tape can also clean up unwanted vibrations produced by the standard woven coin preparation (wedging a coin between three strings by weaving it over one, under the next and over the next). Just wrap a piece of tape around the coin before weaving it into the strings. This technique was first introduced to me by a pianist named Shirley Hoffman during her preparation for a performance of Richard Bunger's "Money Music" in Los Angeles in 1982. You can actually use all different kinds of materials for muting besides string, scotch and drafting tape, including: cotton balls, felts, cloths, alligator clips with taped teeth, video head cleaning swabs, and, in rare cases, silicon adhesive and hot glue.

The challenging factor in this kinetic sound game is the extraction and amplification of specific vibrating surfaces within the kinetic oscillator. There always seems to be some tantalizing sound just out of reach of amplification. I have thought about selective enhancement through sampling, but fear the subtleties achieved through hands-on interaction with the magnetic fields could be lost to limited sampling lengths. In many cases the longer hand-manipulated aperiodic sound events are the most interesting.

With a little imagination, a scaled down version of the ACU and the kinetic properties described herein could be applied and experimented with at home. Possibly an old electric guitar, acoustic guitar, dulcimer, etc. could be butchered, I mean transformed into some kind of kinetic feedback generating device. Read back issues of EMI, there are all kinds of instruments and ideas with infinite possibilities just waiting to be acoustisized.

ACOUSTISIZER KINETIC INSTALLATIONS

Initially the ACU was developed as an answer to an electro-acoustic composition and performance problem. It was through further work with the instrument that the kinetic aspects were revealed. These aspects, in combination with the instrument's unique aesthetic appearance, prompted a series of art gallery installations. Eventually, installations involved performance and evolved beyond the confines of the gallery and theater.

The first ACU installation was in November of 1982 and involved the discarded cut off parts of the instrument on one side of the stage and the ACU on the other. Suspended above the strings was a mobile made up of wood, metal and plastic pieces attached by strings to the inside of a series of small speakers suspended from the lid. Sounds from the mobile pieces making contact with the strings inside the instrument were amplified and directed back to the mobile's speakers and then to the house speakers creating a crude self-perpetuated electromagnetic kinetic sound sculpture. The second part of the program consisted of processing electronically generated sounds through the Acoustisizer and then amplifying the sympathetic vibrations through the house speakers.

After a series of ACU installations over a span of about a year a radicalization of approach was mandated by painful reality. Not only was the ACU heavy and cumbersome to move, it also required a minimum three-hour setup time. The principle of consistency and predictability on which the ACU was originally based was gravely jeopardized by a complicated tedious setup. I decided after an installation at Angel's Gate art gallery in which the ACU and six anvil cases were carried up a flight of stairs, that some sort of mobile unit was necessary in order to maintain the ACU and its peripherals as a mobile integral unit. I had to work fast if I was to enjoy a functional back beyond the age of thirty-five.

In November of 1986, I introduced a number of friends from Dominguez Hills to friends at UCLA and organically formed a collective/art task force entitled Group of People (GOP). GOP staged a number of guerrilla performances around LA and in the process developed a spontaneous mobile theater. I shared my mobile unit idea with the group, and in January of 1987 located and purchased an old beer truck for $200. I began cutting and shaping it into a semi-trailer with stage extensions on the sides, front and roof. By September the unit was ready. It assumed the name "Mobile Sculptural Unit" (MSU) and was used extensively by GOP in a series of strategically located Fringe Festival performances throughout Los Angeles. Performances coincided with concerts at the Triforium Plaza (John Cage Celebration), Lhasa Club and various dance performances held at lofts downtown as well as performances at MacArthur Park.

Presently, the unit is undergoing changes once again to serve the ACU more specifically with modifications which will broaden the ACU kinetic concepts to include found acoustic spaces around LA and expose the beauty of the decaying urban landscape.

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