A New Tool for the Exploration of Unknown Electronic Music Instrument Performances*

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A modular tone and envelope shaping and modifying device as well as an apparatus creating an alternating sound pattern are described. Their performance in some selected examples is discussed.

BASICALLY, two trends can be observed in the design of electronic musical instruments:

1. The aiming towards simulation of conventional musical instruments and
2. The attempt to create new performance features.

In many known cases of electronic music instrument design compromises between these two solutions have been achieved; some of the obtained performance features represent a good or fair simulation of the typical parameters of conventional instrument sounds, whereas others are new—sometimes by chance, and mostly due to the implementation which has proven practical or economical in the overall design of the particular instrument.

The scientific methods which can be applied to obtain quantitative information necessary to simulate familiar sounds and conventional musical instruments have been known for quite some time. They include the application of harmonic analyzers, envelope recorders (also multichannel envelope recorders), the "Panoramic Analyzer," multichannel spectrometers and others.

The information which can be obtained with these tools, however, is limited because of the complexity of most of the conventional sounds. Therefore, the ear has to be final judge to assess the typical parameters, which are of prime importance for a satisfactory simulation. Because of this very fact, it will in many cases be practical to find the most acceptable results by the method of A to B comparisons with simulators.

In contrast to the possible analytical and empirical approaches for the simulation of conventional sounds, the achievement of novel performances will be made possible by empirical approaches only.

Evidently, the variety of new sounds is unlimited in contrast to the variety of known sounds; and in the absence of any standards (except for the achievements of others), the individual will have to limit himself only by deciding "how new is sufficiently new," what is aesthetically feasible and what is practical for a given application.

Conceivably, also, the variety of possible implementations for creating new sounds and performances will be practically unlimited, and for economical reasons one should therefore select tools that will be capable of performing a maximum of functions with a minimum of hardware.

Such a tool is a complex tone and envelope shaping and modifying device, which may be combined as an integral unit with an alternating sound pattern creating apparatus, both of which will be briefly described in the following outline. These devices comprise an arbitrary selection of modules, some of which are well known in audio and communication techniques, but many combinations of which represent unusual systems with interesting functions. These systems may be applied to modify one or several audio phenomena in order to obtain new performances, which, for instance, may be utilized for electronic musical instruments.

A relatively simple version of this type of modular assembly which has been built and used for the experiments (a few of which will be discussed), comprises the following units: 1. A dual channel filter, each channel comprising a low pass, a high pass, a tunable formant filter and a mixer capable of blending the low pass or high pass with the formant filter performance; 2. A ring bridge modulator; 3. An audio con-

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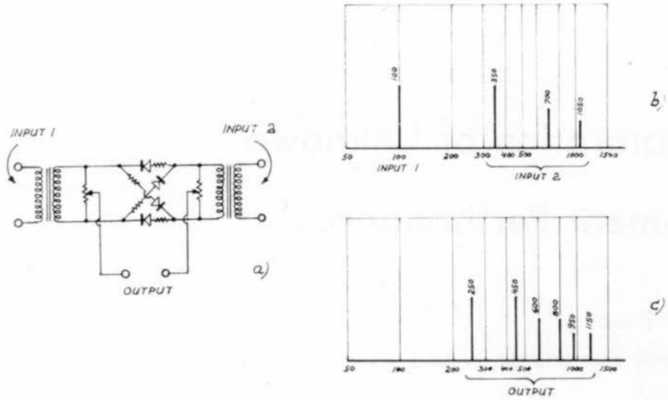

FIG. 1. Ring bridge modulator. a. Schematic diagram. b. and c. Tone spectra.

trolled or triggered gate and percussion unit; 4. A fundamental frequency selector; 5. A squaring circuit; 6. A binary divider; 7. A pre-amplifier; 8. A mixer; 9. A distributor; and 10. A tape loop repetition unit with several reproducing heads correlated to selective outputs and capable of creating rhythmic effects with alternating timbre patterns.

By way of example, Fig. 1a shows a schematic diagram of a ring bridge modulator; Fig. 1b shows the tone spectra of a single frequency applied to input No. 1 and a fundamental with two overtones applied to input No. 2. The resultant tone spectrum is shown in Fig. 1c. It will be noted that the frequencies obtained at the output of the ring bridge modulator are not harmonically related to each other any more, since, due to the function of this type of modulator, the input frequencies are cancelled and the output frequencies represent the sums and the differences of the input frequencies. Tone spectra of this kind are typical, for instance, for the sound of bells.

Generally, the application of the ring bridge modulator is not limited to audio frequencies only. One of the frequencies may, for instance, be subsonic, and may be used for achieving special periodic modulation effects. Another possibility is to feed white noise or filtered white noise with an emphasis on a selective frequency into one input, which yields tuned complex white noises at the output. Again, another application would be to feed percussive sound envelopes (or pulses) into one input in order to study percussive sounds at the output.

Within the scope of the discussed modular assembly, the ring bridge modulator represents one of the arbitrarily selected building blocks, which, in combination with one or more of the other modules, may yield more surprising results.

As another example, Fig. 2 shows a block schematic of an envelope-shaping module, which may be triggered or controlled by an acoustical presentation. Accordingly, this module has two inputs, one for the control or trigger signal and one for the information (audio program material). The control or trigger signal is being amplified in order to obtain sufficient control voltages (after rectification) to actuate the gate which is a variable-gain push-pull amplifier. With the switch in the position (No. 2) shown in Fig. 2, a function is selected by which the envelope of the control signal shapes the envelope of the audio program material in the desired way; for instance, in case the amplitude of the audio program material is constant at the input, it appears with the envelope of the control signal at the output.

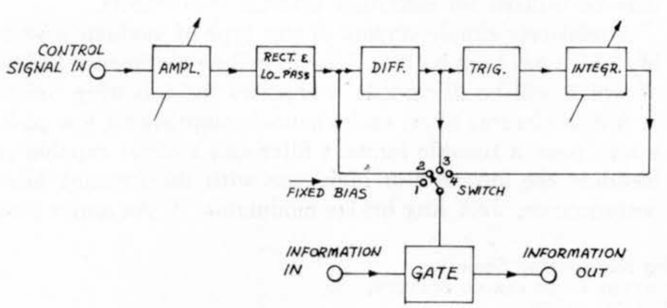

FIG. 2. Block schematic of an envelope-shaping module.

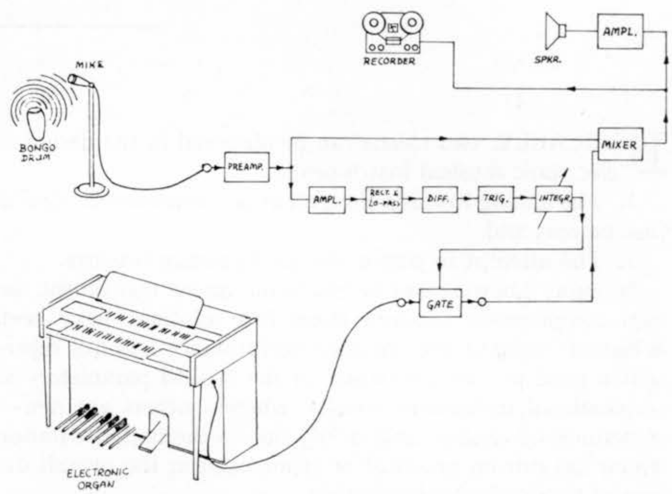

FIG. 3. Bongo drum and electronic organ as inputs of an envelope-shaping module: block schematic.

The module shown in Fig. 2 also provides a differentiator (subsequent to the rectifier) by the use of which (with the switch in position No. 3) the growth of the control signal would actuate the gate. Furthermore, there is a trigger circuit following the differentiator and finally an integrator which receives pulses from the trigger circuit, which, in turn, is actuated through the differentiator by any growth of the control (or trigger) signal. By means of the integrator and its associated circuitry, the control voltages for percussion effects with various growth and decay times may be obtained. These control voltages, when applied to the gate, will convert any sustaining program material into percussive effects synchronized with the control input signals.

Figure 3 demonstrates the practical application of an envelope-shaping module of the described kind with the audio signals of a bongo drum and an electronic organ applied to its inputs and with its outputs connected to a tape recorder and an amplifier and speaker. In deviating from the presentation of Fig. 3, the gate may also receive its control

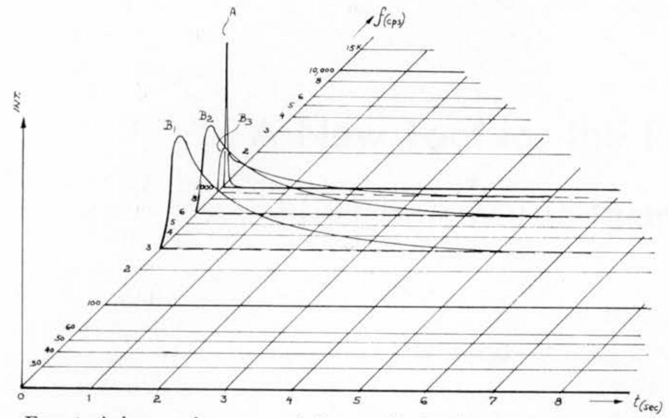

FIG. 4. A bongo drum sound (curve A) in time correlation to the gated sound produced in device of Fig. 3 (curve B_1 fundamental; B_2, second harmonic; B_3, third harmonic).

signals from the output of the rectifier, rather than from the integrator. In this case, the sound envelope of the bongo drum shapes the sound envelope of the organ tones, which, thus, will perform just as shortly as the drum and will be absolutely synchronized with the drum sound. In order to make the drums sound simultaneously, their signal is fed into one of the mixer inputs and the new percussive organ sound into the other.

Figure 4 gives a graphical presentation of sounds processed in the way demonstrated in Fig. 3. In Fig. 4 the short growing and decaying curve A is an arbitrary presentation of a bongo drum sound and the curves B_1, B_2, and B_3 represent the fundamental and the second and third harmonics of an organ sound, the envelope of which has been shaped by an integrator triggered by sound A.

Again, more features may be added to this entire presentation or parts of it, and again, for this purpose, further modules with other features would be required; such are available, for instance, in the modular assembly (Fig. 5).

This assembly has been built on two 7 in. $\times$ 19 in. rack panels, one comprising a tape loop repetition unit and the other the electronic modules. All of the modules or subassemblies have input and output jacks, and they can be interconnected with each other by patch cords in any desired order. By doing this it is possible to make up new systems with new performances.

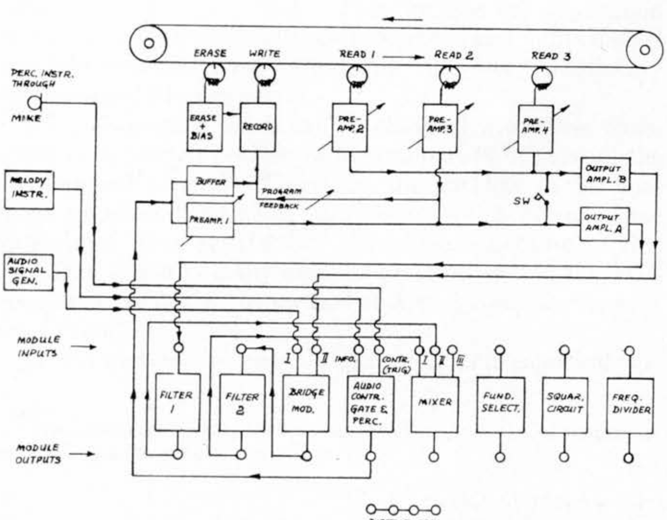

FIG. 5. Block schematic of a tone and envelope-shaping assembly with an alternate pattern creating device.

In the setup represented in Fig. 5 a microphone is connected to the control or trigger input of the audio-controlled gate and percussion module, which receives its program material (information input) from a melody instrument (for instance, the Solovox or Clavioline). Thus, when the sound of a percussive instrument is picked up by the microphone, percussive audio signals are derived from the output of the gate and percussion module. These are then fed to the record amplifier and to preamplifier No. 1 of a tape loop repetition unit with three playback heads. The recorded information will first be picked up by playback head No. 1, after that by No. 2 and finally by No. 3. It will be noticed that the preamplifiers 1 through 4 are correlated to two output amplifiers A and B and that, under these circumstances, preamplifiers 1 and 3 feed output A and preamplifiers 2 and 4 feed output B.

If now the tape speed and the head spacing are such that the created time interval between recording and playback, as well as between individual playbacks, is in the order of 160 ms (corresponding to the rhythm of an optimum vibrato frequency), the message is repeated at that frequency in an A-B-A-B pattern. In order now to obtain a really distinct ABAB pattern, output A is connected to the input of filter No. 1 and output B is connected to input No. 2 of a ring bridge modulator in which this signal is modulated by a frequency from an audio signal generator connected to input No. 1. The output of the bridge modulator is, in this example, connected to the input of filter No. 2 and both the outputs of filters No. 1 and 2 are connected with two mixer inputs, at the output of which the final result is obtained.

Obviously, the tape loop can be applied in many other ways than shown, for instance, as a delay device which permits a successive presentation of simultaneous phenomena, just to mention one example.

Many modular combinations other than that shown in Fig. 5 may be chosen, also incorporating sub-assemblies which have not been described. It will be understood that the study of new electronic music instrument performances should not be limited to organs, but should definitely include melody instruments. Therefore, the application of a fundamental frequency selector will be valuable, as it may be used in many applications such as in conjunction with a distorter and frequency dividers, or in order to obtain frequency-sensitive control voltages which may be used to initiate other and new functions.

Although the description of this modular tone and envelope shaping and modifying device and the alternating sound pattern creating apparatus had to be limited to the discussed examples, it will be evident to the reader that these devices would represent a suitable and economic tool for the exploration of unknown electronic music instrument performances.