ELECTRONMUSIC

A Comprehensive Handbook

Robert A. De Voe

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this work is humbly dedicated to the first and greatest composer of them all: SHIVA, the Hindu creator/destroyer deity, whose music and dance awakened matter and energy from the sleep of Pralaya and brought the universe into existence.

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Chapter 7. Putting it all Together (cont'd)

chapter 1

ELECTRONMUSIC

what is it?

Some Basic **TRUTHS**

for Hard Core Musicians
on the subject of
ELECTRONMUSIC

(1) Get Primitive / Throw away your Union Card and your diploma... at least for a while. Experimental music seems to grow best when it rises from the very roots of musical expression. You have to re-discover for yourself the meaning of music.

Rudy Staffel, my ceramic instructor, once told me, "If you want to make a coffee cup; forget about all the millions of coffee cups people have made, and just think about the act of drinking coffee, and make a vessel to do that."

(2) Moog is not God! Although it may come as a surprise to Robert Moog and Walter Carlos, the universe of "NEW" music was not created in seven days 'by the synthesizer. Sure it's a beautiful machine; but so is a violin; and so, too, is a tin can. Anything that can make a noise is an appropriate source for music.

Picasso was working on one of his paintings and reached down for a particular shade of Red for a crucial passage. He discovered he was out of Red. So he said, "What the hell - Green will work just as well."

(3) Learn to Score a new way! This tool = 𝅗𝅥 just isn't enough anymore. Find new ways of depicting sounds and musical structures. And find new ways of reading music, too.

If they give you lined paper, write the other way.

In the past half century, a revolution has been going on in music. Electronic music has emerged as the voice of the twentieth century. The art and science of electronic recording has given the composer a new vocabulary of sound and sound modification that literally boggles the mind in its infinite potential. Electricity--the living vital energy of all matter--now sings for us in undreamed of colors and textures.

Lest we forget that it *is* the infinitesmal electron we're using as our instrument, I have coined the title: ELECTRONMUSIC, to identify the "New Music". I want to emphasize that we are using *that* profoundly mysterious energy to weave the fabric of our sonic designs--that we are in touch with life itself in our new music. When we lose the sense of wonder over that, we lose much of the sense of magic that ensouls our music.

With the development of musical notation, primarily in the Renaissance, a strange dichotomy developed in music that does not have a parallel in most of the other arts. The composer became a separate entity from the performer. Musical ideas were conceived on paper, and later interpreted by others. Performers became versatile technicians--sometimes little more than machines--and often were totally devoid of the creative insights of the composers whose works they performed.

ELECTRONMUSIC almost demands that the composer be the performer as well--often constructing, note by note, the composition he has conceived. His product is a tape - not a score sheet. In most cases, too, when he *does* use performing musicians, he expects from them a much wider range of creative interpretation than would be tolerated in traditional modes of musical execution.

Much more is demanded of both composer and performer these days. Almost everybody is a musician today, and the competition for excellence is heavy. With modern recording and marketing techniques, music is heard around the world almost immediately upon conception. Therefore, it is vital to strive to be different and to be better. It's easy to be lost in the chorus.

ELECTRONMUSIC, then, as I define it, is any music produced in which sounds are either electronically modified or electronically generated. It usually can not be performed live, although many pieces are produced using *live* musicians *in combination* with tape. If a rock group performs a piece using Wah Wah pedals, a solo synthesizer and amplified musical instruments, I don't call that electronmusic. If, on the other hand, the same group uses a pre-recorded tape of electronic sounds as a major part of their performance, *then* I call it electronmusic. That's a subtle distinction, I know, and probably not an important one; but it helps to clarify the basic premise of this book.

This is a manual for composers who want to learn the techniques of producing music on tape. It is my hope that this work will elaborate upon the essential knowledge built for us by such musical giants as Varese, Ives, Cage, Stockhausen and Partch. If you haven't heard the music of those people: DO IT RIGHT NOW. You don't have any right to call yourself a composer until you've been saturated with the unique madness of those creative titans of the twentieth century.

STATE OF THE ART

CURRENT TECHNIQUES USING ELECTRONMUSIC

Historians will probably remember the 50's and the 60's either with utter despair or total wonder. The arts either bottomed out or leapt skyward depending on your point of view. Electronmusic emerged from the bed chamber of Abstract Expressionism and Pop Art like a bastard child determined to be lawless in a world of artistic libertinism. Whether you like it or not the reckless abandonment of traditional musical forms by such composers as Cage, Varese, and Stockhausen (to name a few) was both a perfectly logical outgrowth of the music evolution of the prior half century and an affirmation of our space age technology. Such composers as Ives, Stravinsky, Schoenberg, Webern, Berg and Satie had long hence broken the Baroque shackles on Mother Music, and the new electronics were a garden of delights heady with the tempting perfume of the madness that is so irresistable to creative composers. The noise of our world surpassed the pain threshold to become a pleasure for the gifted and concerts became celebrations of <u>deus ex machina</u>.

In the 70's I see a trend toward a codification of new form principles in the new music we are hearing. The machine is less the subject and more the means. Classical formalism creeps irresistably back on stage. The re-interpretation of the Baroque and Classic masters by such modern electronic virtuosi as Walter Carlos and Tomita is symptomatic of the trend. But beyond the literal resurrection of the past I hear the <u>form</u> of the past in new compositions. Combined tape and live pieces are proliferating and sound for all the the world like chamber music. Composers seem to want to prove themselves again with subtlety and precision, instead of aural blasphemy.

In the late 50's I watched John Cage outrage and/or delight his audiences with chance combines of noise using table radios, microphone feedback and assortments of household utensils. Merce Cunningham wired his dancers with sensitive amplifiers to make "muscle rustle" (tiny voltages from muscle activity) loudly audible and they danced to the sounds their bodies made. The boundaries between the arts dissolved. Dance, theatre, music and art all became part of an "event". There were "Happenings". And then came the conceptualists. Everyone seemed to want to stretch the limits of artistic credibility, to make art just a little more absurd than the world about us. Funny thing, no matter what we do, art always seems to be nothing more than a small exaggeration of reality.

Now we see the pendulum swing the other way. We demand some intellectual, even academic foundations for our new work. We insist upon technical craftsmanship. The novelty of noise has worn off and we want the noise to mean something. Both we and our equipment have become more sophisticated and we may now be entering a golden age of music. Electronic music has graduated from science fiction movies to Sesame Street to the concert hall. Evidence of its acceptance as art may be found in Disneyland of all places! Go there and watch the Disneyland Electrical Parade of an evening. You will hear a seven channel electronic composition that is superb! Try it - it'll blow your mind *

Synthesizer technology has undergone an evolution that is expressive of the tone of the new music. The proliferation of rock performers seeking sensational effects has brought portable performance type synthesizers into a highly competitive market.

* A record is available from Disneyland.

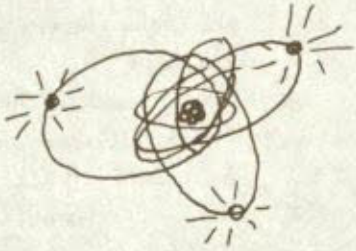
Many portable synthesizers are now polyphonic and have virtually eliminated "unsightly" patch cord connections. As convenient as they are however, most are little more than glorified organs. Studio synthesizers are masterpieces of electronic technology including in their components fully computerized programming units and sophisticated video displays. Every college music department worth its salt has a well equipped electronmusic studio, and -- most important -- emphasis seems to be shifting from performance training to creative composition.

The greatest danger I see at present is that the synthesizer voice will become stereotyped; that wah wah and portamento will become the total vocabulary of the new music. If we are not careful, electronmusic may well become simply synthesizer voicing and a row of synthesizers may replace the violin section of a symphony orchestra. My hope is then, to help develop composers of the new music who will go beyond the established vocabulary and continue to thrust back the boundaries of our conventional musical sense. Electronmusic is not just a new instrumentation; it is a doorway to other worlds.

Before you do anything else - Contemplate the miracle of the

ELECTRON

It's not just some little speck flying around the nucleus of an atom. Sometimes it acts like a particle, (when we accelerate it in a cyclotron and kick it like a ping pong ball through a cloud chamber). At other times, however, it acts like an electromagnetic field. We think it has a fixed and finite position in an orbit around a nucleus; but, paradoxically, it can move from that orbit to another one without being in between in the process. (That's a quantum jump.) So if it's not in some space somewhere in that fraction of a nanosecond, it has no physical substance. It's not a thing. It's a frequency - of what?! a field - of what?! Every way we use to describe it is simply a model of its behavior as we observe it with our crude tools. We don't really know what it looks like or what it is. We may never know.



Someday, we may discover that the universe is nothing more than an incredible Prelude and Fugue in the mind of Johann Sebastian Bach, and the electron is just a single musical note in that masterpiece. Believe me, that's as good an explanation of the ultimate mystery as any other I've heard.

As Krishna, Buddha, Blavatsky, Meher Baba and Baba Ram Dass say; THE UNIVERSE IS MAYA
there's NOTHING there.

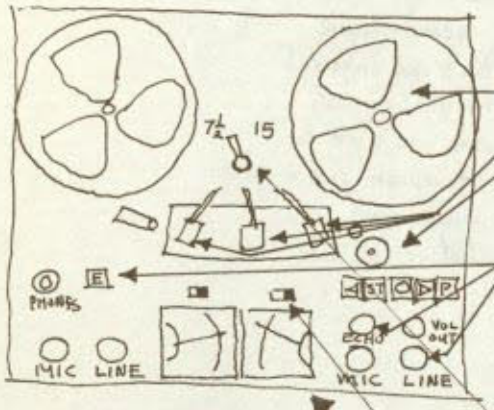
ABOUT YOUR TOOLS

The one tool you must have; the tool you must know and love; as valuable as your fingers; is your

Tape recorder

That's your instrument, and you should be able to play it like a baby grand. So that's where we start. The most incredible music in the world is useless if it has been produced on an el cheapo tape recorder. Don't cut any corners there.

When you go shopping for a tape recorder - take this along with you and demand the following things in your investment:

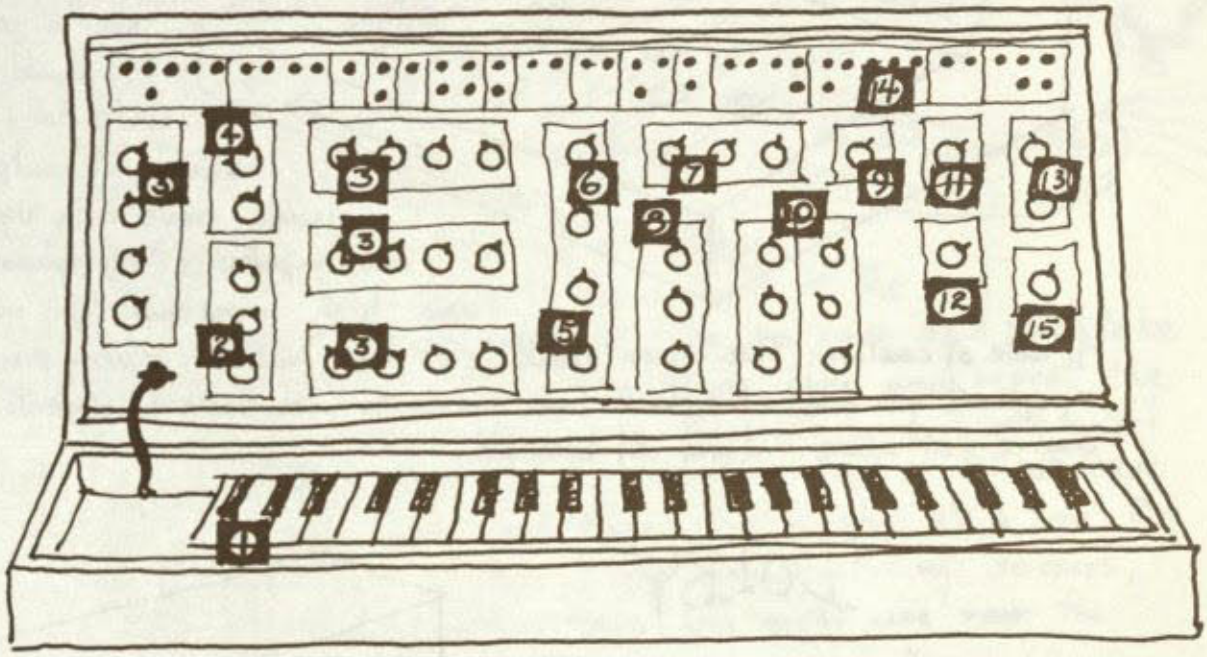


1. Three heads - separate record & playback.
2. Three motors - heavy mothers.
3. separate mic and line controls with full mixing capability
4. easy echo chamber capability on both line and mic.
5. easy cueing and editing controls. You should be able to rock the reels back and forth to precisely hear a sound you're looking for on the tape.
6. Half track (Two track) stereo or quarter track Quad. (No quarter track stereo - gotta be half track so you can play sounds backwards.)
7. Two (preferably three) speeds - 7½ & 15 ips. (+ 3¾)
8. Extra large VU meters. (no idiot lights)
9. Simul-synch recording capability.

And for all of that - be prepared to lay out more than a grand. But before you get upset about that, let me point out you'll probably need two tape recorders. However, your second one may be simply a player of rugged construction and good quality. $500 could probably get that one.

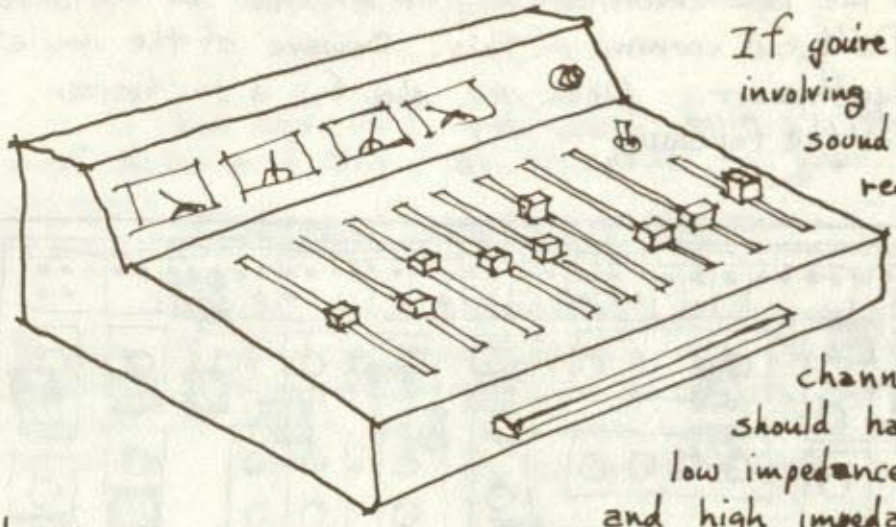
A SYNTHESIZER

second only to the tape recorder in your arsenal of tools is your synthesizer. Don't cut corners on this. Beware of the limitations of a "mini" synthesizer. When you shop for a synthesizer demand at least all of the following:



1. A two voice polyphonic keyboard
2. Keyboard controller with portamento + microtone capability
3. More than one oscillator independently tunable with multiple waveforms
4. Oscillator controller for vibrato and other pitch controls
5. White noise
6. Filter input mixer for controlling which audio signals enter the filter.
7. Band pass filter with variable Q
8. Filter control for using various automatic controls
9. Ring Modulator
10. Envelope generators - at least two
11. Voltage controlled amplifier
12. Sampler for producing random note patterns
13. Output mixer - preferably with pan controls for stereo output
14. Patch panel - for independent connection between modules
15. Input preamplifier for connecting other sound sources to the unit.

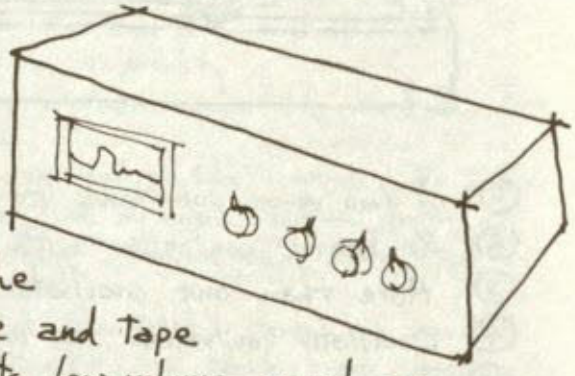
A MIXER



If you're doing any work involving more than one sound source or tape recorder, you should have a good mixer. It should have a meter for each channel of output. It should have both high and low impedance microphone inputs and high impedance tape inputs.

A note of caution: The mixer should be of high quality. Every piece of equipment you add to the chain from source to final tape is a potential source of noise. Avoid El Cheapo.

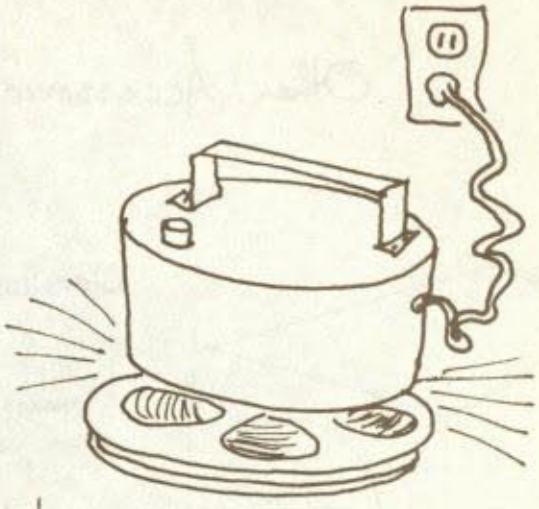
DOLBY



Speaking of noise, a noise reduction unit, commonly called a Dolby A* or Dolby B* is designed to increase the ratio between the signal level and the residual noise inherent in most tape and tape recorders. Essentially, a Dolby boosts low volume sound as it is being recorded, and reduces it in playback. (Tape hiss and other noises tend to show up most strongly in soft passages.) Thus, when the tape is played with a Dolby, noise is reduced by as much as 10 D.B. However, Dolby will not remove noise from a tape that is already recorded without the Dolby compensation. If your tape recorder does not already have Dolby built in a separate unit may be a desirable part of your arsenal.

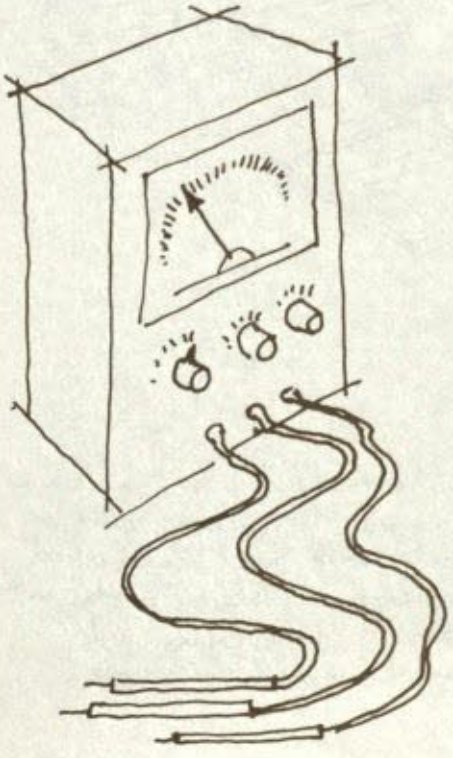
* Dolby A is the professional version. Dolby B is the kind most often used in home recorders. The "A" type works on both ends of the audio spectrum.

BULK ERASER



Useful for clearing a tape instantly. WARNING: Keep the bulker at least 10 feet away from your good tapes.

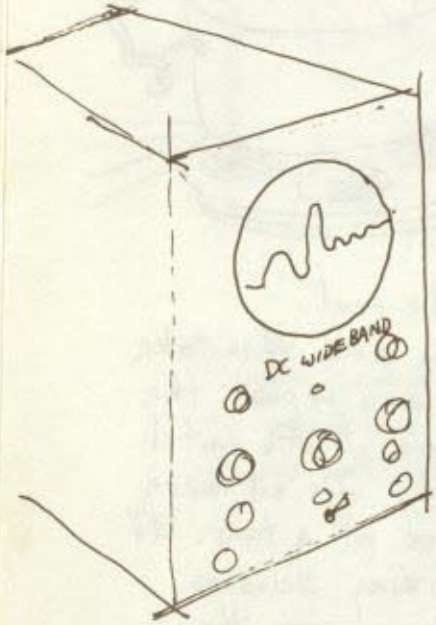
When erasing a tape turn the device on about three feet away from it and bring it slowly closer until you contact the surface of the reel. Then move it slowly around like an iron and then take it away slowly. Turn the tape over and repeat the process for the other side. Do not turn it off until you are three feet away from the tape. Do not leave the bulker on for more than five minutes at a time. It'll burn itself up! Use it for demagnetizing scissors, razor blades and other tools you might use near the heads of your recorder.



VOLT-OHMMETER

A vital tool if you plan to do any electronic projects to augment the ready made equipment you're using. You owe it to your craft to learn something about electronics. This device, plus an oscilloscope, will be an excellent teacher for you. It should be a sensitive instrument capable of measuring A.C. and D.C. voltages, resistances and current.

Other Accessories and Tools



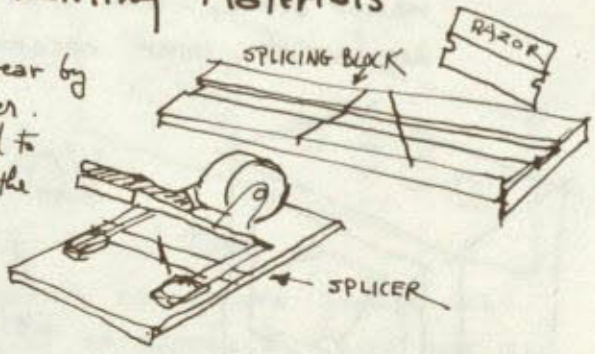
Oscilloscope

While a scope is not a vital necessity - it certainly makes things a lot more comprehensible. With it you can see the shape of the sounds you are making and study the effects of modified sounds. It's an education in sound by itself, and well worth the investment. You can buy them in kit form from EICO or Heathkit for $100 or less. But if you've never put an electronic kit together before, don't start with this.

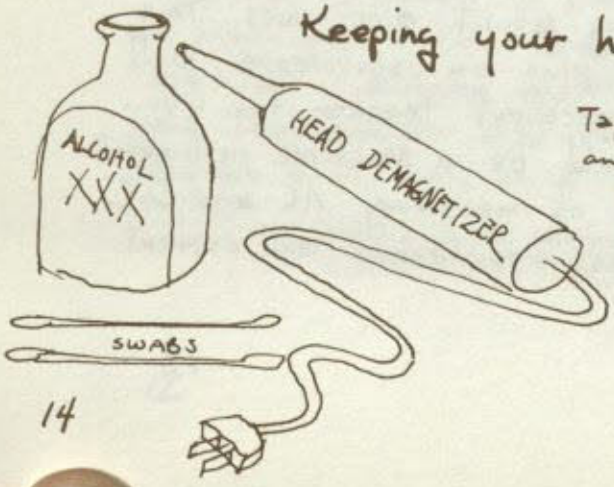
Also, by connecting one side of your stereo amplifier to the vertical amplifier of the scope and the other to the horizontal you've got a light show that will keep you hypnotized for hours.

Editing Materials

Absolutely essential! Purists swear by the editing block - but I go with the splicer. You really need both. And you really need to practice splicing until you can do it with the ease and speed of a paper stapler.
Always use genuine splicing tape - Never - regular scotch tape.



Keeping your head



Tape heads, like human heads, get mucked up and magnetized by all the vibrations going by. Get a good professional head demagnetizer and use it regularly. (Details on that in the following section) Dirty heads and magnetized heads <u>can ruin your tapes</u>.

CHAPTER I

CLASS PROBLEMS

1. Record a half hour of your environment. Pick a time and place where you would least expect to hear anything of musical interest. Play it back, highly amplified, and in a different environment. Listen to it as if it were a performance of a work by a composer. Hear it as music. Try to analyze it as you might the work of any classical composer.

2. Listen to records of the music of Harry Partch, Charles Ives and Edgar Varese (IONIZATION). Discuss the relationship between these three composers. (None of the works is electronic) What is the relationship between these works and ELECTRONMUSIC?

3. If you presently write music, deliberately write a piece which violates everything you hold sacred in music. Write anti-music.

— or —

write a piece for an instrument that is deliberately humanly impossible to perform. For example; a piece for trumpet written in the double-bass register with some notes sustained for three and a half minutes and, of course some 4 & 5 note chords thrown in.

Then find a good musician and see if he can play it.

chapter 2

VIBES

sound & acoustics

VIBES

The Art of Making Noise

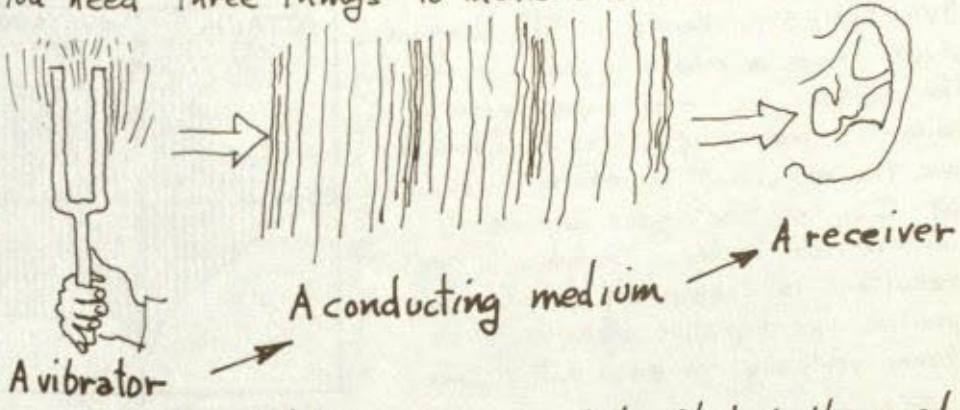
Think about this for a moment: Feel the air around you. Run your hands through it. YOU ARE BEING BOMBARDED ON ALL SIDES BY VIBRATIONS!

Literally billions of vibrations are washing upon the shore of your being. There's sound, light, radio waves, radar, cosmic rays, nuclear radiation, and what have you. As a composer, your job is to control some of those vibrations; so you ought to understand something about them.

DON'T YOU DARE SKIP THIS CHAPTER!

It won't hurt you to know something about sound and acoustics. So listen while I make some visual noises on these pages.

You need three things to make a sound:



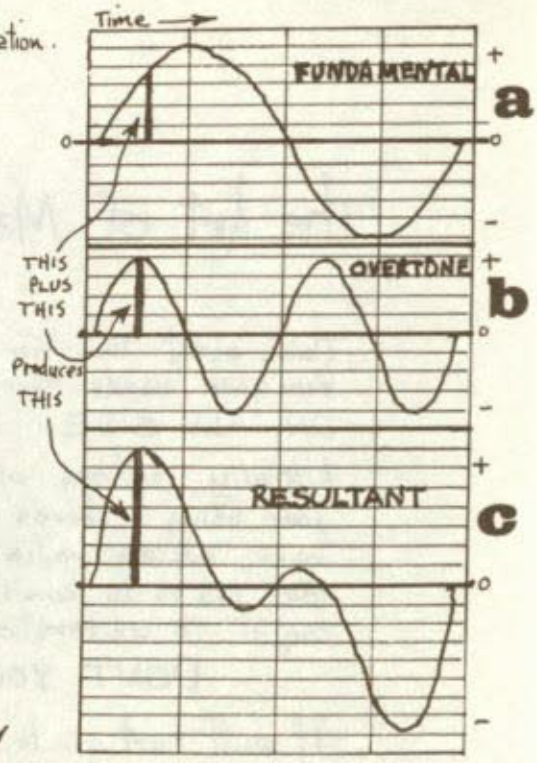
The vibrator must oscillate and communicate that to the medium which passes it on to the receiver which must oscillate in response to it.

A Sound Vocabulary

WAVELENGTH = 1 complete cycle of oscillation.
Symbol: λ

FREQUENCY = Number of cycles per second - (Nowadays called Hertz [hz] a symbol I reject.)
Symbol: f c.p.s.
(also called pitch)

AMPLITUDE = Volume of sound — usually measured in decibels.
Symbol: D.B. or V.U.
decibels volume units



A basic FORMULA:

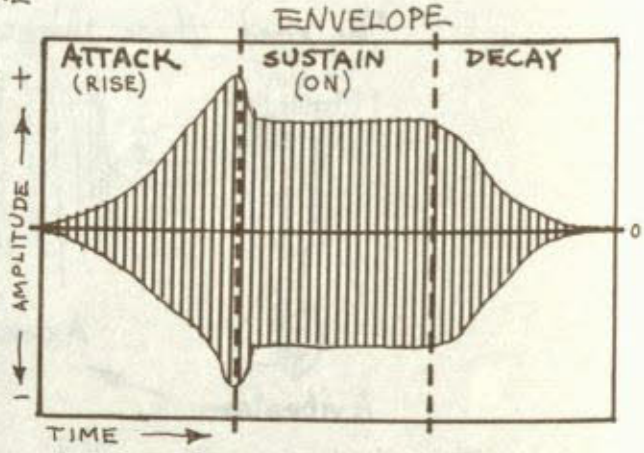
$$\text{(wavelength) } \lambda = \frac{V_s \text{ (velocity of sound)}}{f \text{ (frequency)}}$$

EXAMPLE:

$$\lambda = \frac{1130 \text{ f.p.s. (velocity of sound in air)}}{260 \text{ c.p.s. (Middle C)}}$$

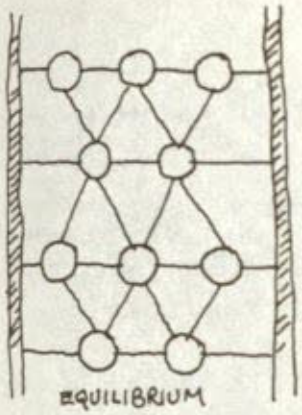
$$\lambda = 4.35 \text{ ft.}$$

Most tones produced by instruments are complex structures made up from a FUNDAMENTAL (the lowest or loudest frequency) plus OVERTONES (or Partials). The diagram above shows a relatively simple one. The overtone, in this example, is exactly twice the frequency of the fundamental and the resultant waveform is shown at C. Overtones give a note its texture or timbre. Graphically, the resultant is drawn by adding the positive and negative values of the tones vertically for each unit of time.

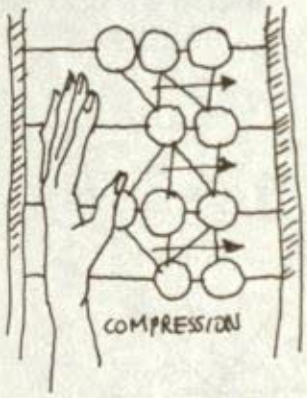


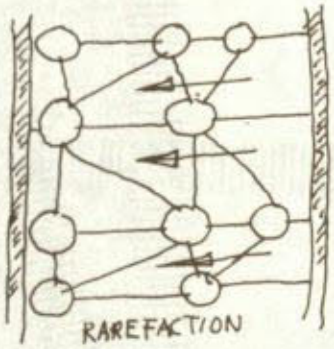
ENVELOPE:
the envelope of a particular sound is another characteristic which helps to give it its unique quality. It is the variations in volume while a single note is being sounded. When a note is struck, it rises in volume over a period of time to full amplitude = ATTACK. It is usually held at nearly that volume for a period of time called SUSTAIN. Then it declines in volume to zero = DECAY. Each instrument has its own characteristic envelope; except the synthesizer which may generate any shape.

The Sound of One Hand Clapping



Air is an extremely elastic material. Imagine a room filled with ping pong balls tethered to each other by rubber bands. That's the way air molecules act. If you push them to one side they will spring back the other way and will continue to swing back and forth until their original equilibrium has been restored. When they are pushed together, we call it compression. When they are spread apart, we call it rarefaction.



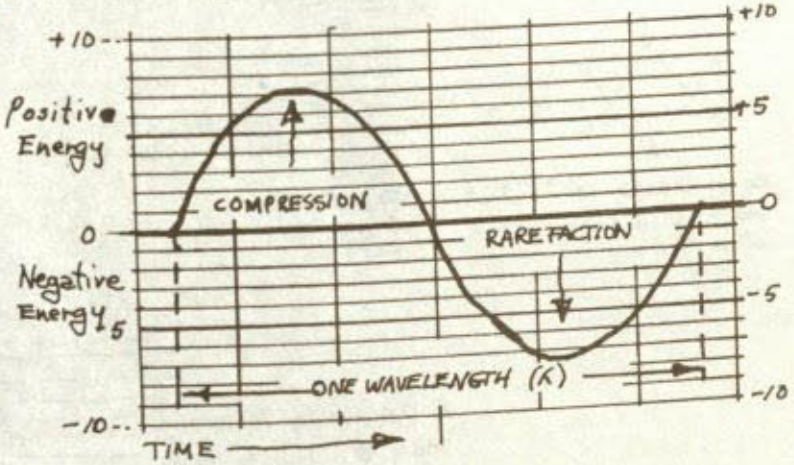


This alternating state of the density of the air may be called:

OSCILLATIONS:

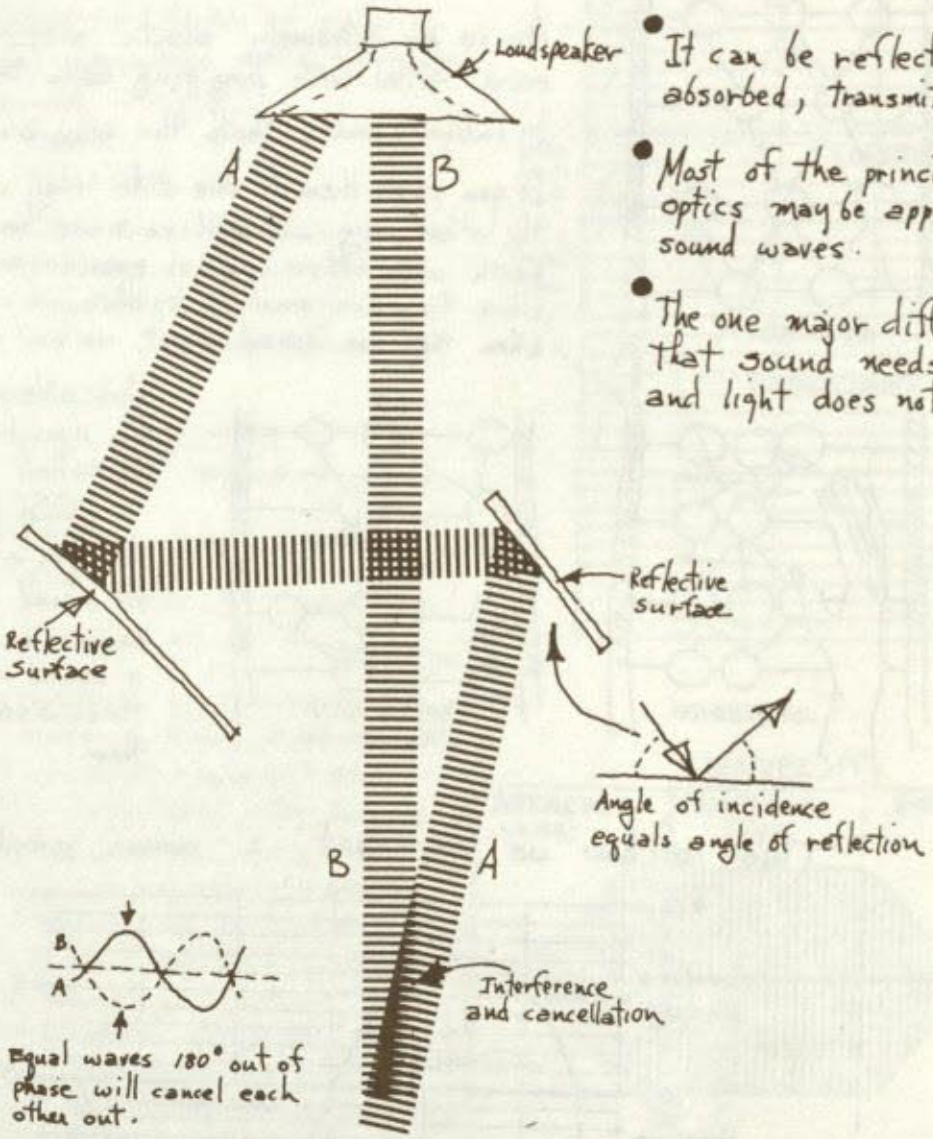
the yin and yang cycles of sound waves. If they happen more than 20 times a second and less than 20,000 times a second we can hear them.

This is how we represent a sound graphically

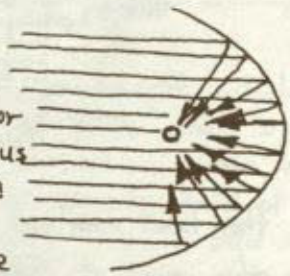


In the final analysis; sound is nothing but moving air — interpreted by the mind. It's all MAYA. The music is in your head!

In Many Ways Sound acts like Light

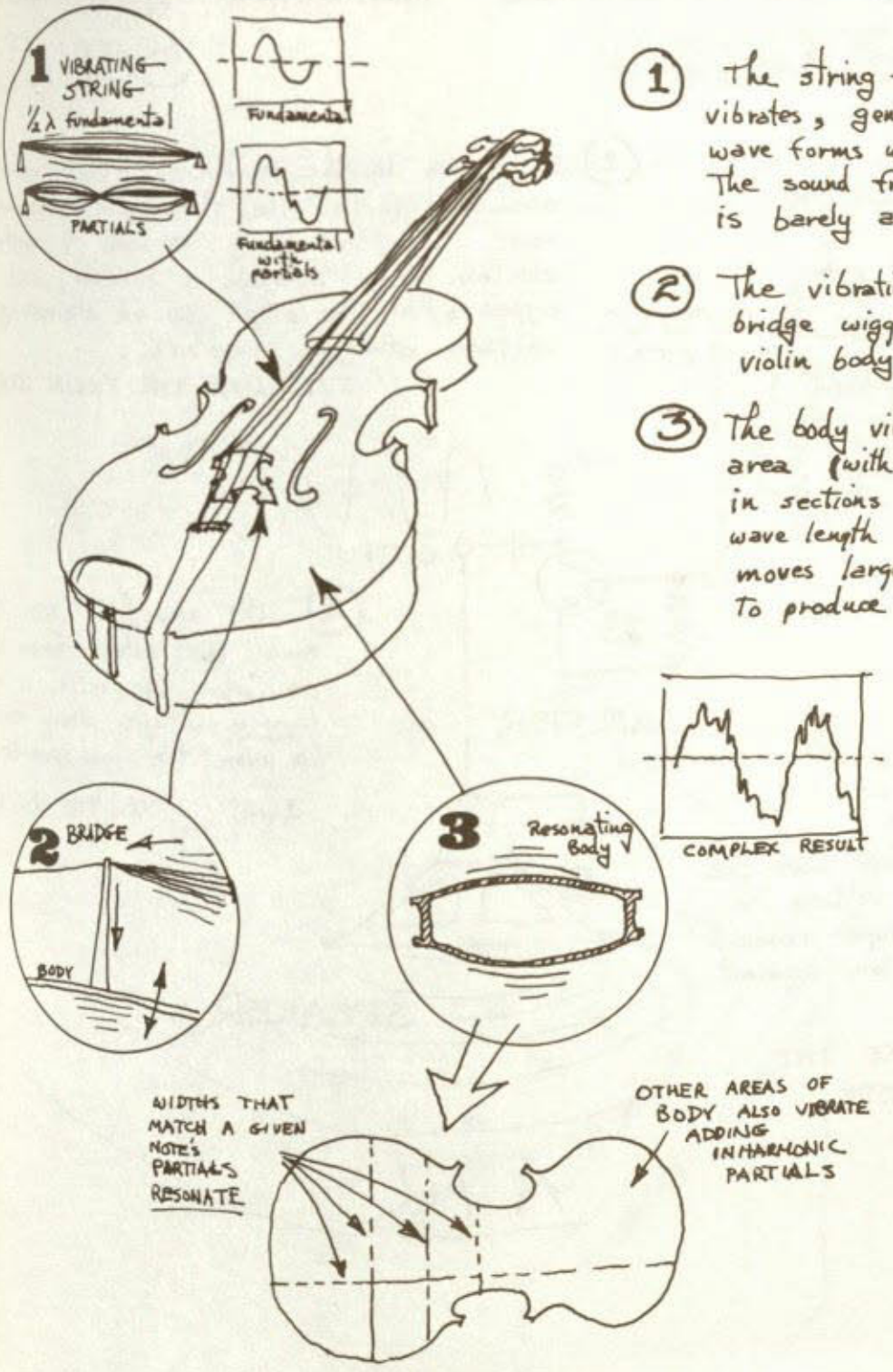


- It can be reflected, refracted, absorbed, transmitted.
- Most of the principles of optics may be applied to sound waves.
- The one major difference is that sound needs a medium and light does not.



A parabolic reflector may be used to focus sound waves on a microphone - in exactly the same manner that you would make a solar furnace with light rays.

How a musical instrument generates a SOUND

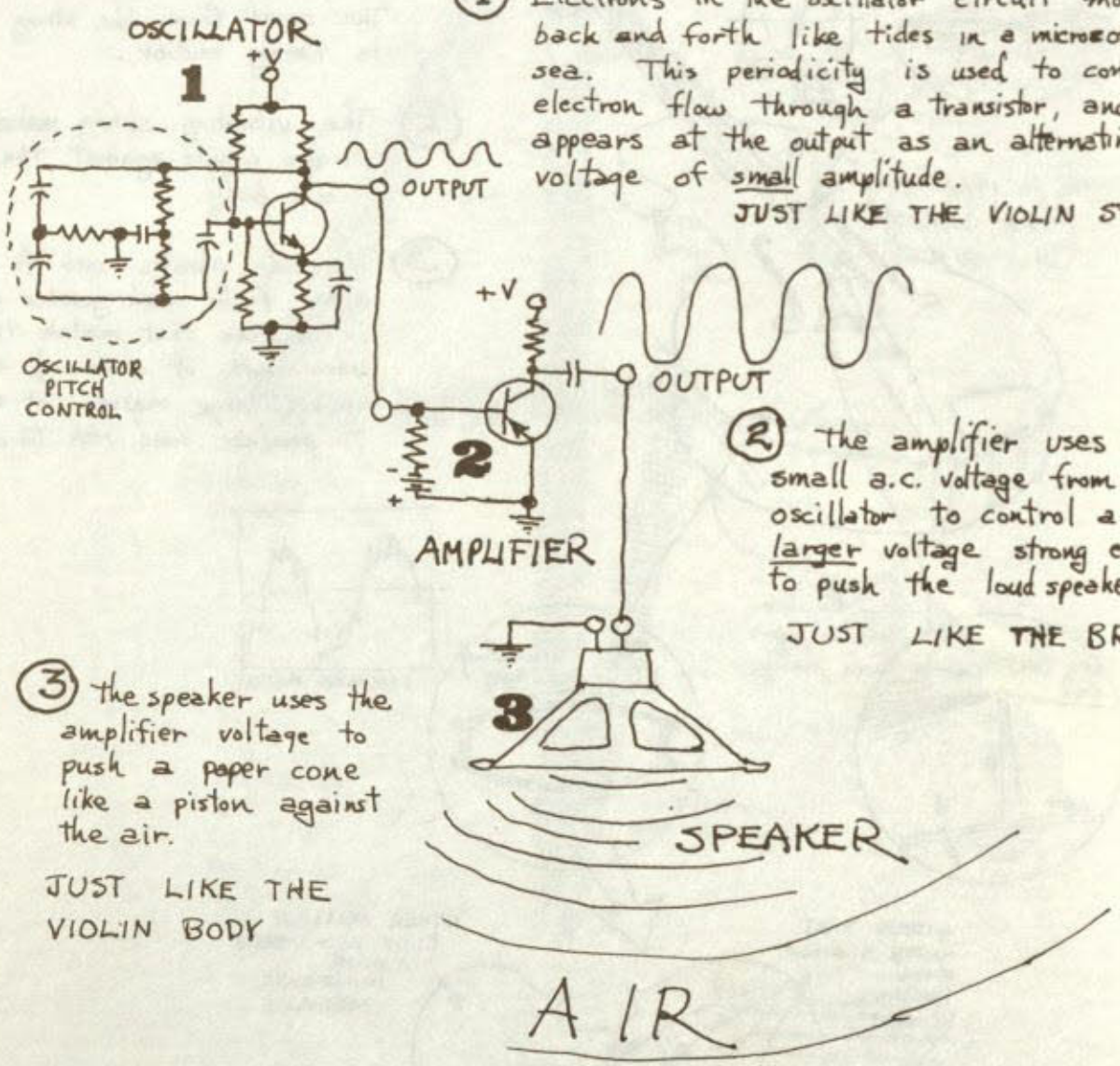


(1) The string – plucked or bowed – vibrates, generating simple wave forms with a few partials. The sound from the string itself is barely audible.

(2) The vibrating string makes the bridge wiggle against the violin body.

(3) The body vibrates over its entire area (with much greater strength in sections that match the wave length of overtones) and moves large masses of air To produce loud, rich tones.

How an Electronic instrument generates a SOUND



(1) Electrons in the oscillator circuit move back and forth like tides in a microcosmic sea. This periodicity is used to control electron flow through a transistor, and appears at the output as an alternating voltage of small amplitude.

JUST LIKE THE VIOLIN STRING

(2) the amplifier uses the small a.c. voltage from the oscillator to control a much larger voltage strong enough to push the loud speaker.

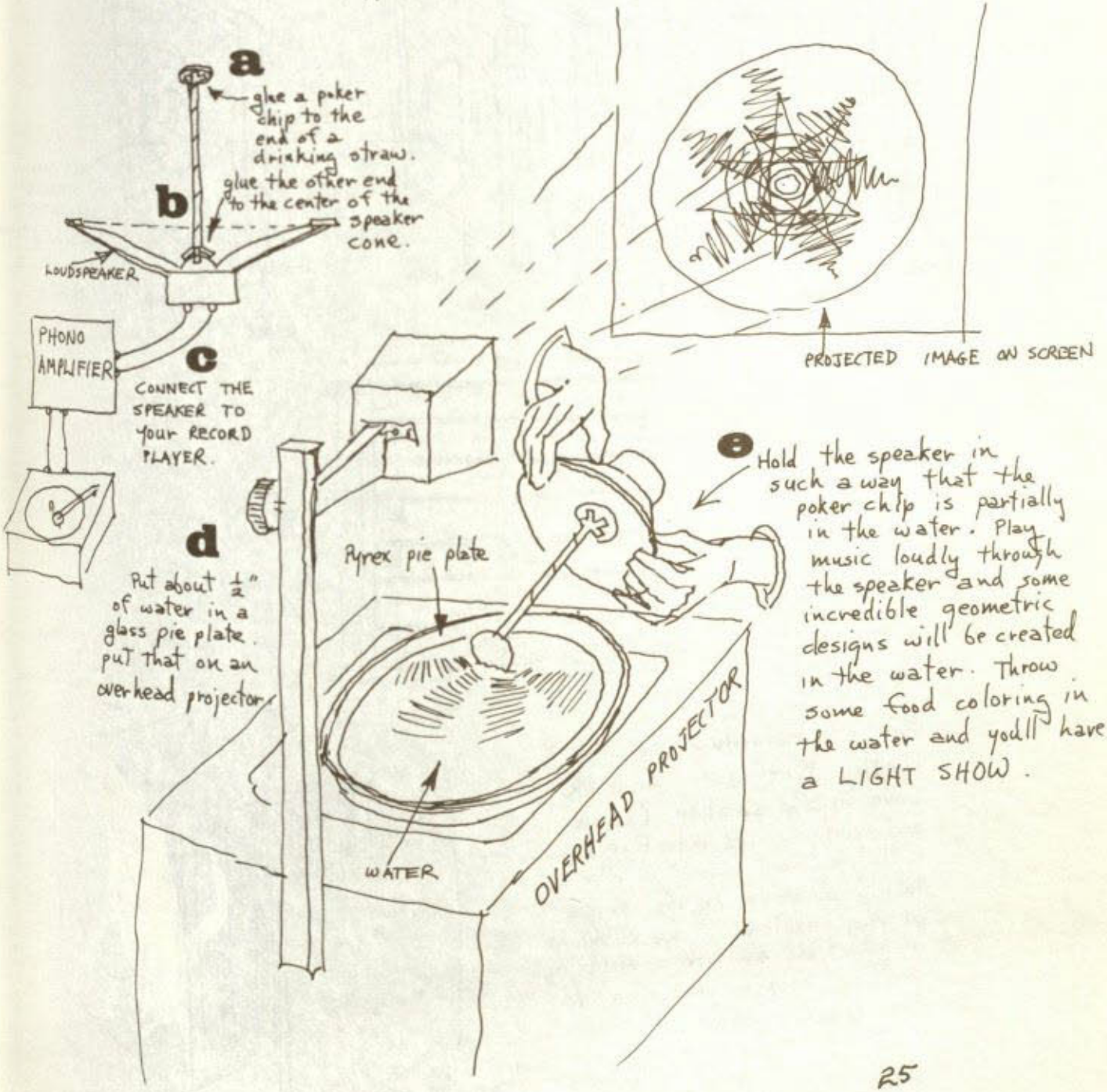
JUST LIKE THE BRIDGE

(3) the speaker uses the amplifier voltage to push a paper cone like a piston against the air.

JUST LIKE THE VIOLIN BODY

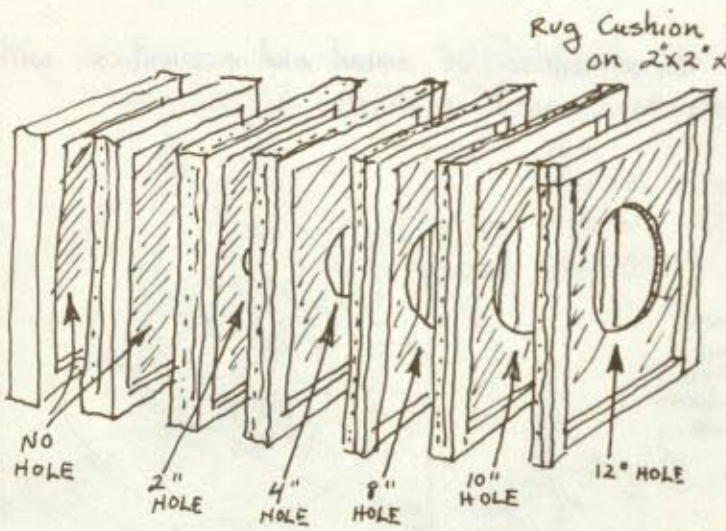
How to make musical sound **VISIBLE**

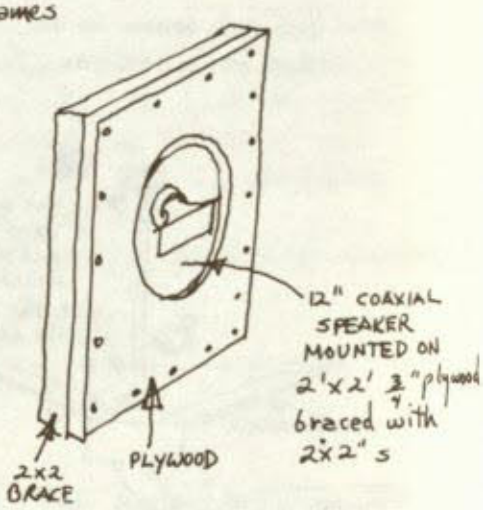
You can learn a lot about the principles of sound and acoustics with this variation on the ripple tank used in physics.

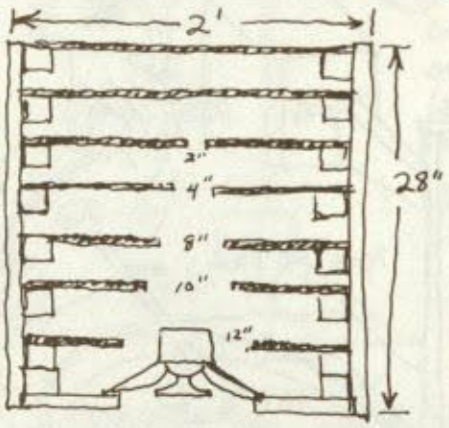


The **Perfect** Speaker Cabinet

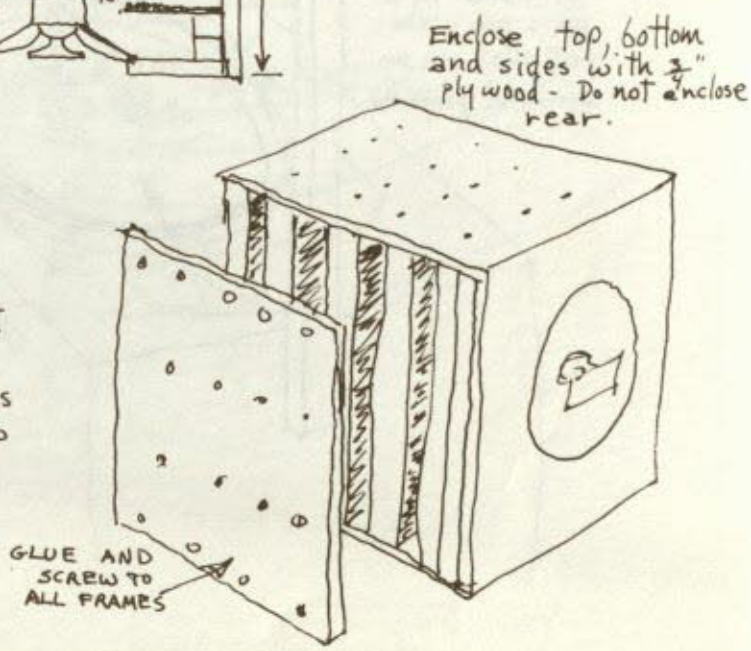
Oh, I know there is no PERFECT speaker; but this comes damn close to it. And this at a price you can afford.



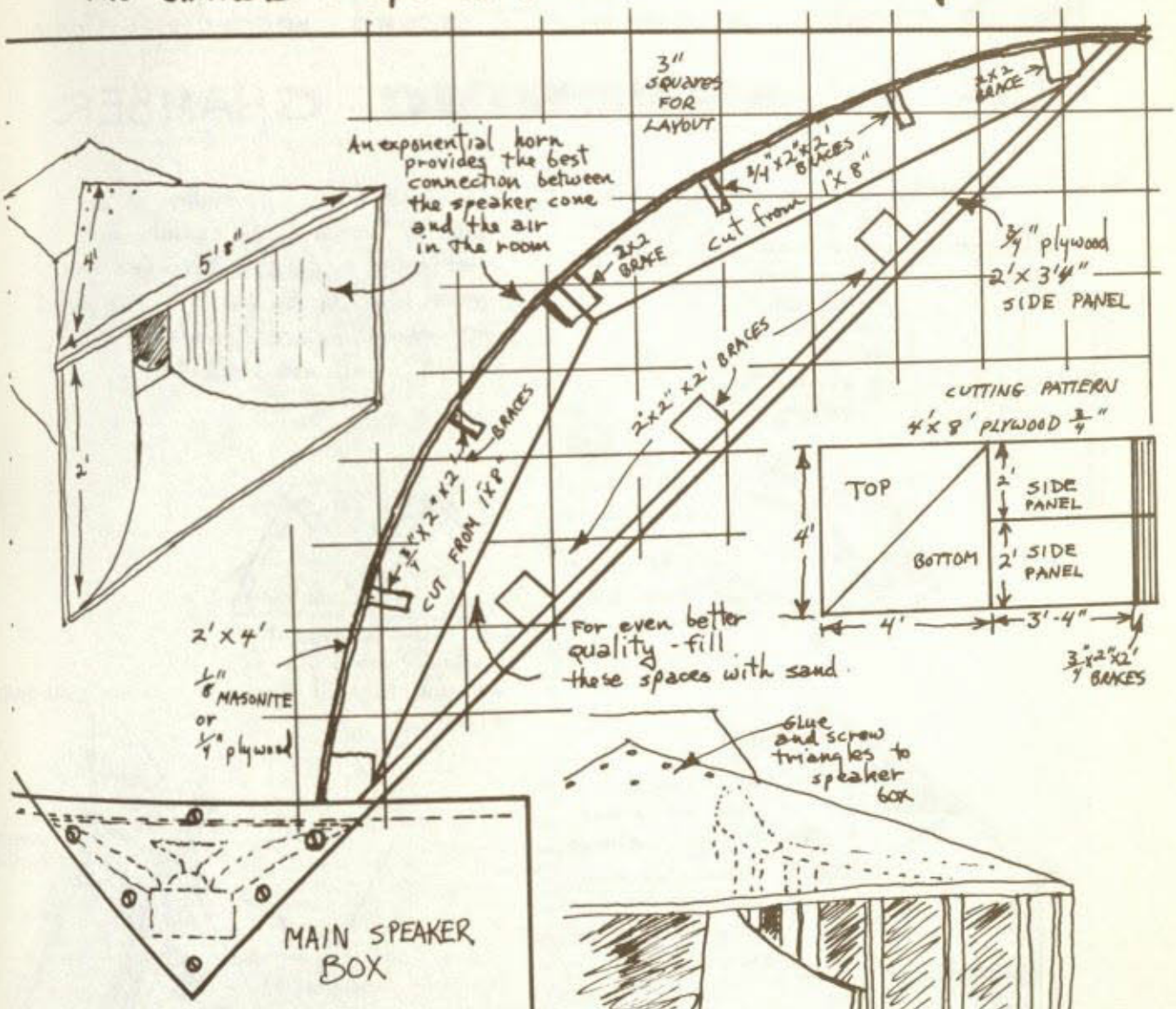




This is a variation on the Hartley "Boffle". The back wave of the speaker, (which ordinarily would interfere with the front wave) is almost totally absorbed by the series of rug cushions. The cushions also act as an air spring to provide proper damping to the speaker cone.



The Ultimate Exponential Horn For Your Speaker



MAIN SPEAKER BOX

Use the pattern above to lay out forms on plywood triangles Make sure it fits tight against face of speaker box. Caulk all seams.

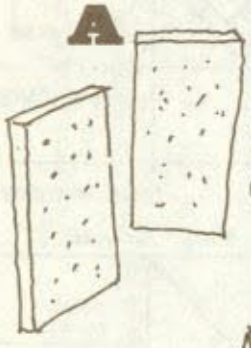
How to create a perfect sound recording studio.

MAKE AN **ANECHOIC** CHAMBER

An anechoic chamber is a DEAD room. No sounds are reflected. All are absorbed upon impact with the walls. The perfect recording space should be totally silent and non-reflective.

You will need exactly 3 times as many tiles as are needed to cover your walls and ceiling. Cut a bunch of acoustical ceiling tiles in half. ($\frac{2}{3}$ of your total supply)

A



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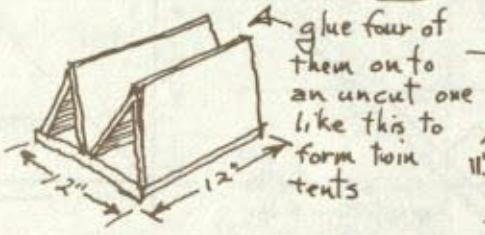
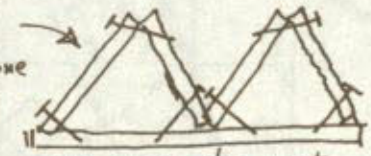
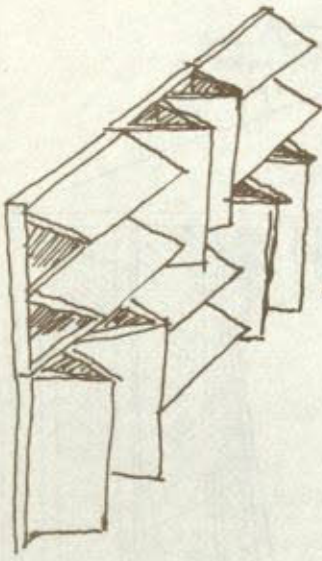


glue four of them on to an uncut one like this to form twin tents

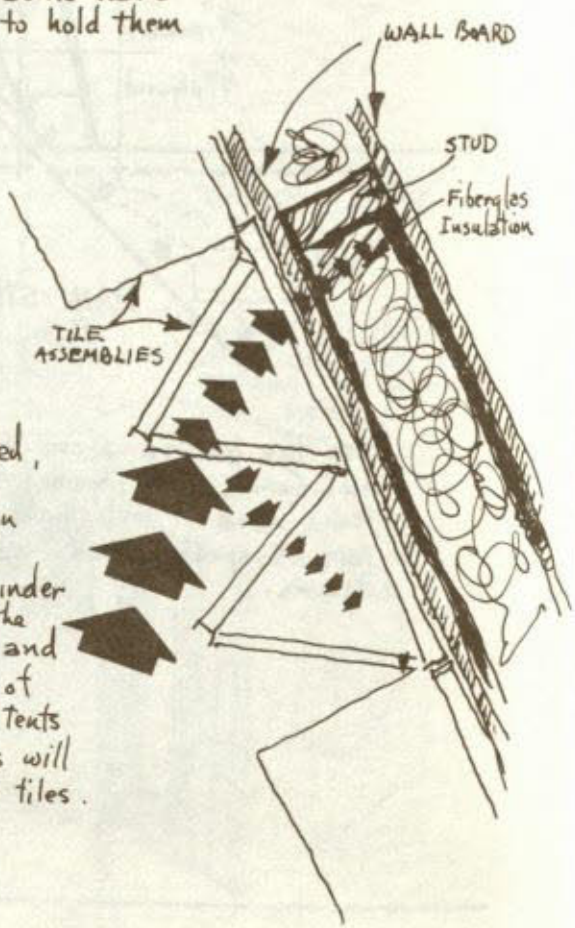


you may also want to stick some nails through to hold them better.

C

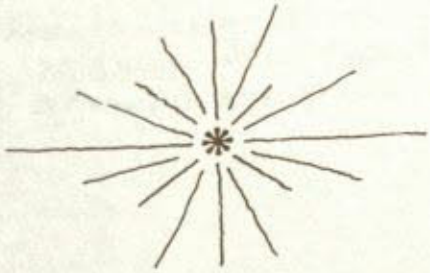


Glue them on your walls and ceiling in alternating horizontal and vertical positions. Put deep pile carpet on your floor.



If your wall is insulated, most sound waves will be absorbed upon impact with the tile assemblies. The remainder will be absorbed by the layers of wallboard and insulation. Because of the angle of the tile tents any reflected sounds will be absorbed by other tiles.

In a **DEAD** room your sounds will come alive! There will be no spurious reflections to distort them. It will be as if there are no walls there at all. You will be in infinite sonic space where the tiniest whisper will shine like a first magnitude star in the blackness.



CHAPTER II
CLASS PROBLEMS

1. Build a ripple tank, (any high school physics text will show you an example) and study the effects of enclosures on sound waves.

2. Invent an acoustic musical instrument which makes use of a resonating body or chamber. Build it and play it. (Take a look at some of the instruments of Harry Partch first.)

3. Using cardboard and cheap loudspeakers, build model speaker systems which make use of a folded horn enclosure; a ducted port, reflex, dummy resonator - etc. (Research speaker enclosure design in the library)

4. Build a small enclosure which totally absorbs the sound of a loudspeaker placed inside it. See if you can blow out the speaker before you hear anything.

5. Study waveforms on an oscilloscope. Using an audio generator and a taperecorder, start with simple sine waves and overdub harmonics to produce complex waveforms.

6. Do a study of the mystical and occult properties of sound. Start with <u>mantras</u> and magical incantations. There's an unexplored universe there

chapter 3

TAPERECORDER
husbandry

Tape recorder HUSBANDRY

Or: How to find Peace and Tranquility Thru a perfect communion between man and MACHINE!

N.B.: Your taperecorder is your instrument. In modern experimental music, the score is rarely the end product of the composer. His product is usually a piece of tape - a hand crafted performance. You owe it to yourself and your craft to fully understand the tape recorder. This chapter is devoted to that machine. It starts from ground zero. Study it thoroughly; But, more importantly, study your machine.

ANATOMY

The tape recorder is a living organism - a peculiar animal. Its physiology is composed of three parts:

1 TAPE TRANSPORT: The bones and muscles of the system. This must be precise and rugged. It must take the tape past the heads at an absolutely constant speed, always.

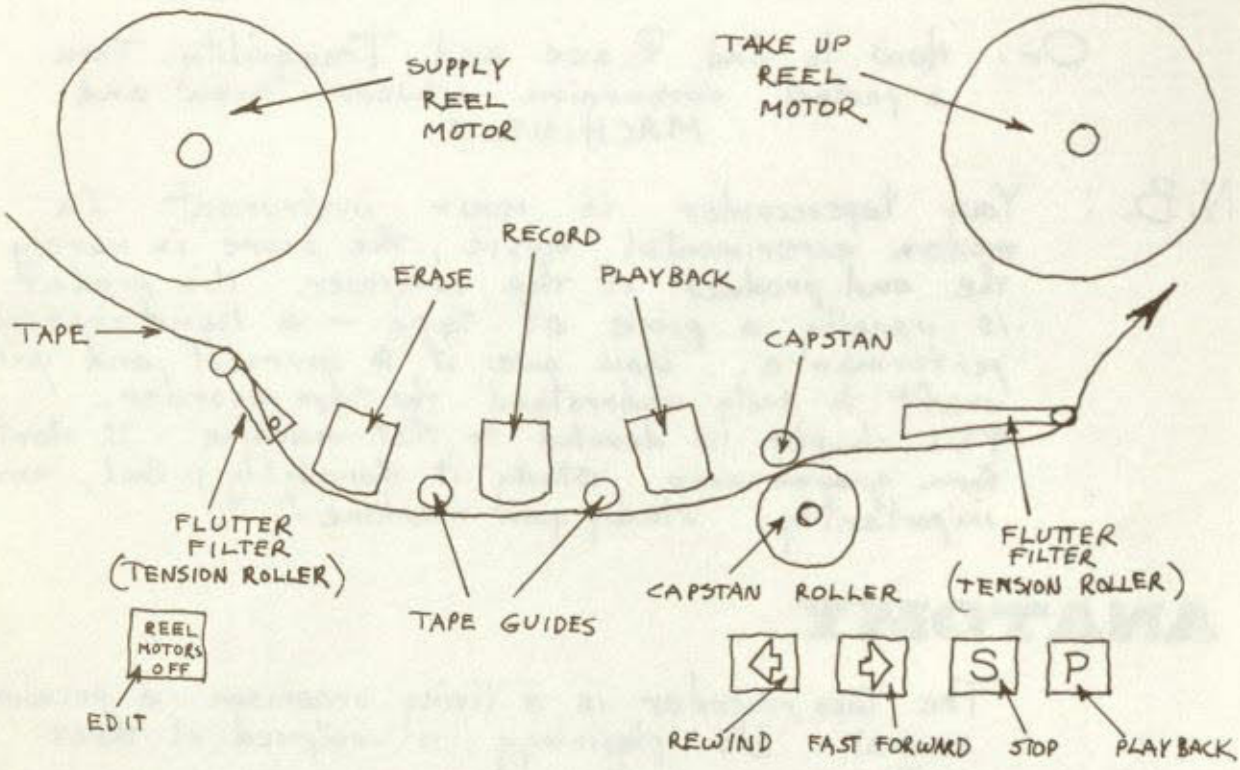
2 THE HEADS: the sense organs of the system. These must be perfectly aligned -- always clean -- with no residual magnetism (bad vibes).

3 Electronics: the brain, and nervous system, of the machine. These should supply a clean signal to the heads, and take a clean signal from the heads. No hum - No hiss - No distortion.

On the next few pages we shall consider each of these in detail.

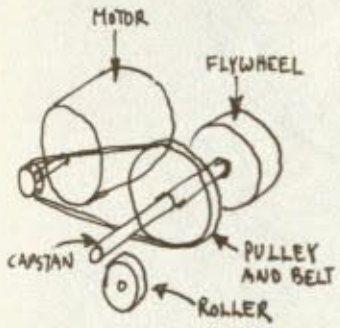
1 Transport

N.B.: While this is a diagram of a typical recorder, it is by no means universal.



MOTORS: Supply and Take-up. These have two functions: rapid transport of the tape and braking. These should be Hysteresis Synchronous motors. So what's a hysteresis synchronous motor? Very simply expressed, it's this: The alternating current (110 volts A.C.) coming from your wall plug alternates its polarity 60 times a second. These motors operate *because* of that constantly changing polarity, and will *not* operate without it. Further, their speed is a multiple of that cycle. If you apply a D.C. voltage to these motors it will lock them so they won't move. Thus, when you apply 110 volts A.C. to one of these motors, (By pushing either the fast forward or Rewind buttons) they will revolve at great speed to move the tape. But, while you are recording or playing back, a small D.C. voltage is applied to the supply reel motor to act as a brake to take up tape slack. It's just enough to drag but not enough to stop it. When you push the stop button, a larger D.C. voltage is applied to both reels.

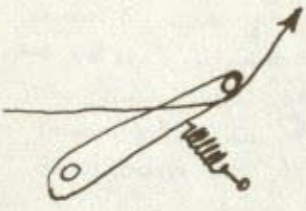
The Capstan Motor: This motor, in conjunction with the capstan and capstan roller, pulls the tape through the head assembly at a constant speed. This should be a hysteresis Synchronous motor, too. In most recorders it operates at a high speed and is connected to the capstan by a speed reducing belt and pulley system. When you push the PLAY or RECORD/PLAY button, the roller moves up to press the tape tightly against the capstan. The diameter of the capstan times it's R.P.M determines the speed of the tape travel. The flywheel helps to keep that speed constant through inertia.

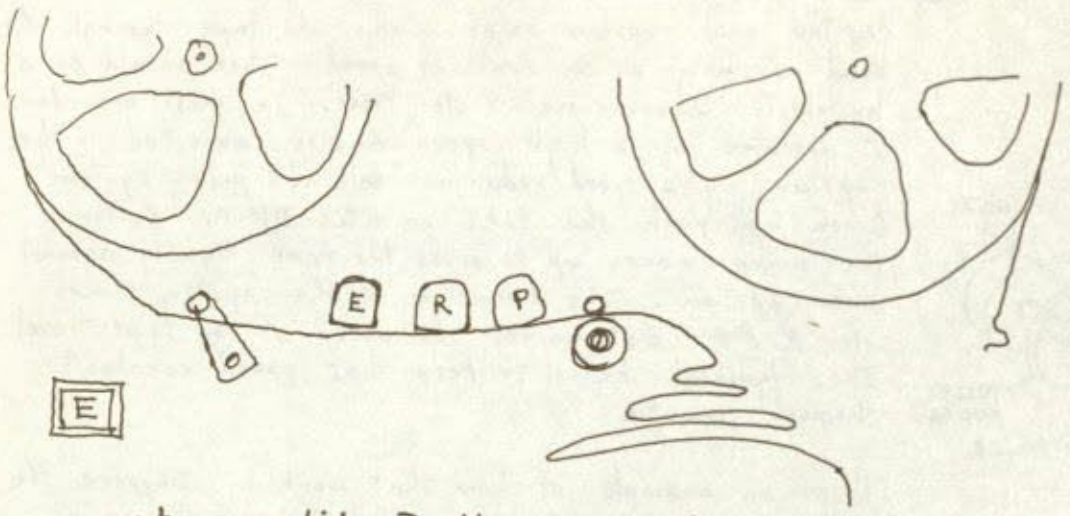


Here's an example of how that works: Suppose the motor is running at 1600 R.P.M. and it has a one inch pulley. That pulley is connected to the capstan pulley by a belt. The capstan pulley is two inches in diameter and is, therefore, revolving at 800 R.P.M. The capstan is .25 inches in diameter, and is therefore .785 inches in circumference. (Approximately). Thus, at 800 R.P.M. the tape will be moved at 628 inches per minute, or about 10.5 inches per second.

This is the vital component of the transport system. the capstan and roller should be kept meticulously clean. Use alcohol. Never get oil or grease near them.

FLUTTER FILTERS (TENSION ROLLERS): These vary widely from recorder to recorder. On some, they are simple fixed posts. On others, they are spring loaded levers or rollers. They are there because the tape does not always come off the supply reel or enter the take-up reel evenly. Without them the tape would tend to flap against the heads causing an audible flutter in the sound. The ideal tape recorder would have such perfect braking and capstan control that no flutter filter would be needed. But with such vide variety in tape reel sizes and weights such an ideal has never been achieved. Sometimes these flutter filters are also used as end-of-tape sensors to turn off the machine when there is no tape running through it. When there is no tape tension on the filter lever it springs back to flip a switch to turn off the motors.



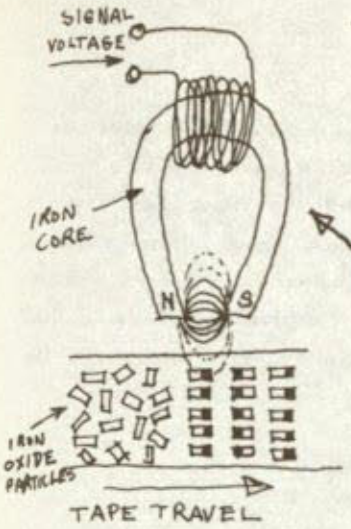


The Edit Button: Editing facilities vary widely with various tape recorders – but, essentially, it should do this: It should turn off the reel motors so that you can rock the tape back and forth past the playback head by hand. (Some recorders have soft enough brakes so that you can perform that operation without that button). It should also allow you to cut the tape and feed out unwanted tape. Without a reel motor switch, the take-up reel would spin like hell; an annoyance to say the least.

Important: Editing is a vital skill in composing with a tape recorder. You should be able to move the reels back and forth slowly by hand so that you can find the beginning of a sound you wish to remove. As soon as you hear the sound you know that it is at the playback head. Put the scissors on the right of the playback head and cut. (Be sure your scissors are not magnetized).
If the passage you're removing is a long one (3 seconds or more) put the end of the tape between the capstan and roller and turn on the play mode. The tape should spill onto the table. Push STOP when the unwanted sound has all passed through and cut with the scissors on the left of the playback head.

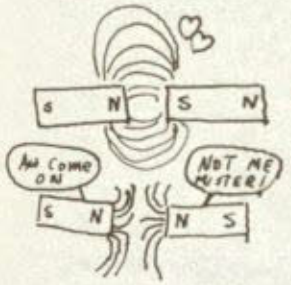
Unwanted sounds – like roof leaks – always get worse. Cut them out. They'll haunt you if you don't.

2 The Heads



Theory of the Record Head: A very basic and important concept in electronic recording principles is the principle of electromagnetism. You don't have to be an audio engineer - but you ought to understand some basic facts of life about electricity.

FACT ONE: When you put an electrical current through a coil of wire you also generate an electromagnetic field. If you put a piece of iron near that coil (it doesn't have to be touching it) the magnetic lines of force from the coil enter the iron and turn it into a magnet. If the current is strong enough the iron will be permanently magnetized. If it is weak, or keeps changing directions (alternating current) the iron is only temporarily magnetized.

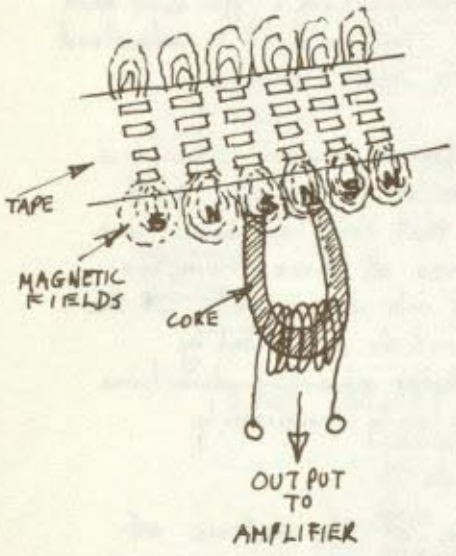


FACT TWO: There is no evidence of the existence of homosexuality among magnets. While no moral message is intended or implied, this fact simply says that opposites attract and likes repel. You can count on it. This is not vital knowledge for understanding tape heads but it is important for understanding phono cartridges, microphones and loudspeakers.

FACT THREE: A magnet moving next to a coil of wire (without touching it) will generate an electrical current in the wire. This is particularly important for understanding playback heads.

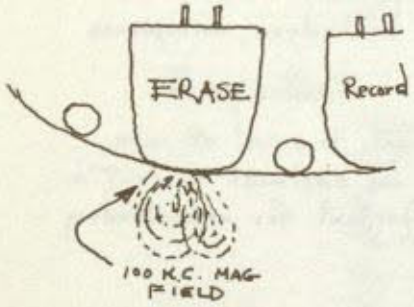
Now: here's how the record head works. The sound to be recorded has been transformed by the electronics section into an alternating current. This is called the signal voltage. That signal voltage is applied to the coil and induces magnetism in the iron core. For example: a 400 cycle sound becomes a 400 cycle alternating current causing the poles of the core to change magnetic polarity 400 times a second. Recording tape is simply a ribbon of plastic with billions of iron particles glued on it. As the tape moves past the heads, the particles become magnetized by the magnetic field. In effect - they are permanently re-arranged -- where they were random before - now they are organized like rows of permanent magnets. Thus, the changing current has been recorded in the ordered arrangement of the iron particles on the tape.

Theory of the Playback Head:



Remember Fact three? Well, all those particles on the tape are magnets now generating little magnetic fields. As those particles move past the poles of the core of the playback head, their magnetism creates a sympathetic magnetism in the core which, in turn, induces an electrical current in the coil. That current is then amplified by the electronics in the amplifier.

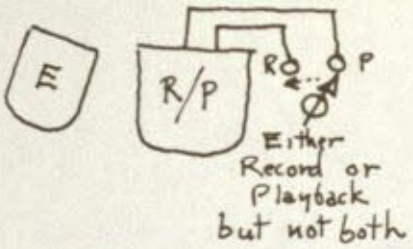
Theory of the Erase Head:



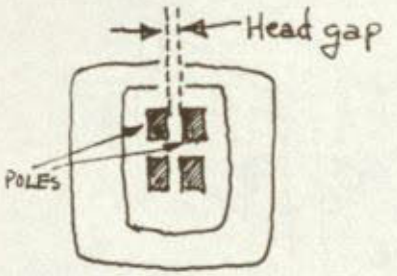
The erase head uses the same basic principle as the record head. A BIAS OSCILLATOR in the electronics section provides a high frequency signal (usually 100,000 cycles). This bias signal is applied to the tape when the record button is activated. Since 100 K. cycles are well above the limits of audibility we are, in effect, using a silent signal to cancel all audible sounds on the tape.

A NOTE OF CAUTION: Although you are not likely to do this -- someone might; so it's worth mentioning. If you record something at 15 I.P.S. (inches per second) and play it back at 7.5 I.P.S., the bias frequency may still be present on the tape and would be playing at 50,000 cycles (½ the original). Slow the tape down again to 3.75 I.P.S. and the bias is now playing at 25,000 cycles - So far so good -- still not audible. But slow the tape down to 1-7/8 I.P.S. and the oscillator signal on the tape is playing back at 12,500 cycles: well within the range of audibility. Remember: the limits of our hearing range from 20 cycles to 20,000 cycles.

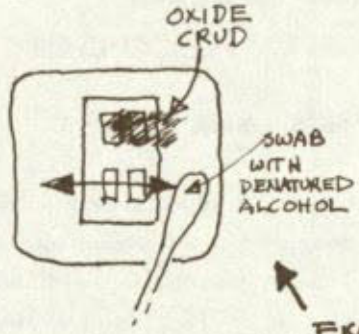
Head Gap and Head Care:



"EL CHEAPO" taperecorders have what are called combination record/playback heads -- which means that the same head is used for both record and playback functions. It also means that you cannot listen to the tape playback as you are recording: a serious disadvantage for creative recording.

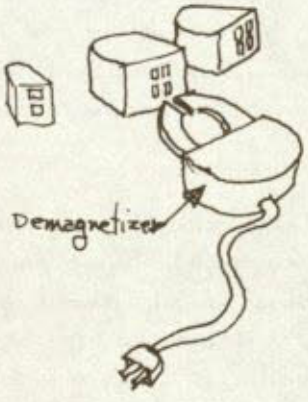


For best fidelity, the head gap (space between the poles of the magnet in the head) should be different for recording than it is for playback. Don't ask me why -- it's true. While acceptable results may be achieved using a playback head to record -- or a record head to play back -- these violations of good practice are sometimes used for some special applications which I will explain later. But, normally, that's a no no.

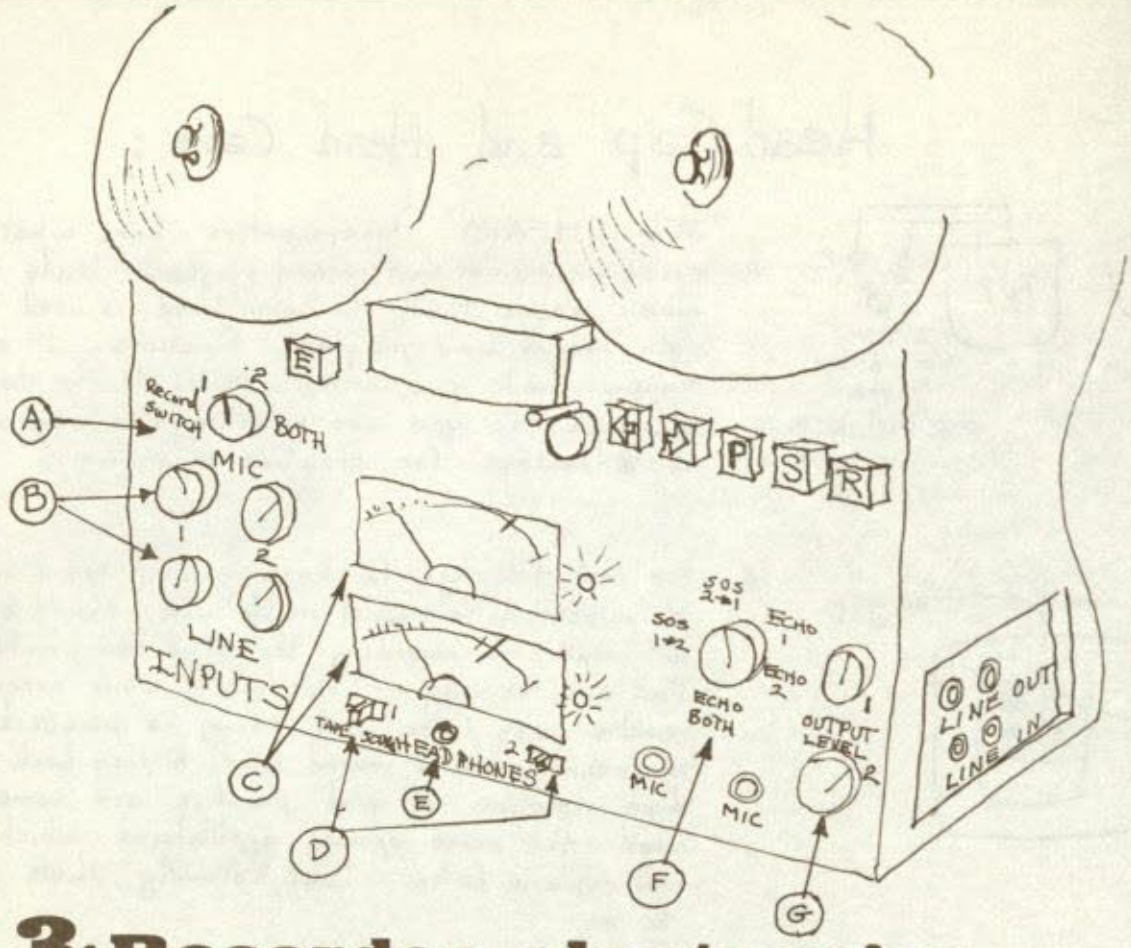


Tape for recording has iron oxide particles on it. Even with so-called "lubricated" tapes, the oxide has an abrasive action on the poles. Dust doesn't help either. Look at your heads with a strong magnifying glass. If there are any visible signs of wear, you're losing fidelity because the head gap is changed. Replace them.

Exorcism:



Once every 1000 miles you should clean your heads gently with a cotton swab saturated with alcohol. Oxide and other crud tends to accumulate on them seriously reducing their performance. If you seem to be getting poor high frequency response, and your tapes are sounding dim; your heads may have become magnetized. Turn everything off. Move your valuable tapes into another room, and begin the rites of exorcism. Plug in your head demagnetizer. Turn it on about a foot away from the tape recorder; then move it slowly in until it is barely touching the face of your head. Move it slowly up and down over the face and withdraw it slowly. Do the same for all heads. (Intone a mantra while doing this)



3: Recorder electronics

The Brain of Your Tape Recorder

Or: How to enjoy those Freudian Dials and Knobs

Assume a meditative posture before your tape recorder. Focus your mind upon the lower portion of the machine. Like some other members of human kind the brains of tape recorders are most often found in the lower extremities of the device. This is the preamplifier control section. You and I know that you merely glanced at your instruction manual when you got the machine -- then you lost the manual -- and now you don't understand it at all. Now let's compare your machine with the one depicted above. Let's explore the possibilities and limitations of both.

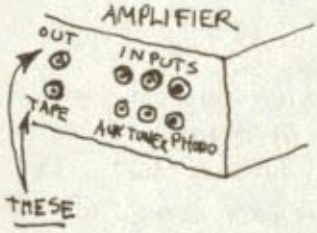
Look first at your recording control section. There should be a switch (or switches) to select which track will be recording. -(A) There should be separate Line and microphone input level controls which permit you to mix from both sources into each track. -(B) There should be large illuminated meters to show you the volume levels of your recording or playback - (C) You should have switches to permit you to listen either to the sources coming in - or the recorded material on the tape - (D) a headphone jack for monitoring either source or playback - (E) controls for recording sound on sound & echo - (F) and output level volume controls. (G).

(A) Record selector switch:

This one is simple. It should allow you to record on either track monaurally, or on both in stereo. A more sophisticated machine would also allow you to send all four input sources to either channel 1 or 2.

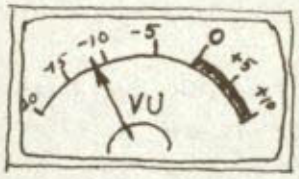
(B) Line/Mic input volume controls:

Line inputs are usually called high impedance sources. Generally, what that means is that you can connect the line output of another tape deck, a mixer panel, an amplifier or a tuner to your deck. This is also the right place to plug a synthesizer in. A good rule of thumb is: plug anything except a microphone into the line inputs - and never plug anything except a microphone into the mic input.



On the back of your High Fidelity amplifier you should find a pair of R.C.A. Jacks -- usually separate from the input jacks -- and labeled "line out" or "tape output" or "recorder output" or even "aux out". Running a cable from that to the line input of your tape deck will allow you to record anything going through the amplifier on tape. Never use a microphone to record anything from your Hi Fi system Never use the speaker connections on the back of your amplifier as line connections - they are low impedance.

(C) The V.U. meters



Proper use of V.U. meters (Volume Unit) is essential in the recording process. If you look at your meter you will notice the dial is divided into two parts = the plus side on the right (usually red) from 0 to +10 DB. (decibels -- units of sound volume level); and the minus side on the left - running over two thirds of the dial from 0 to -20 or 25 D.B.. A good tape deck allows you to play through an entire source of sound (a record for example) while watching the meter without actually recording. This gives you a chance to set the input volume controls for the best overall position to accommodate both loud and soft passages. The needle should not go into the red + DB range. The recording will be distorted if it does. The best range is from about -3 db. for loud passages to -15 for soft passages.

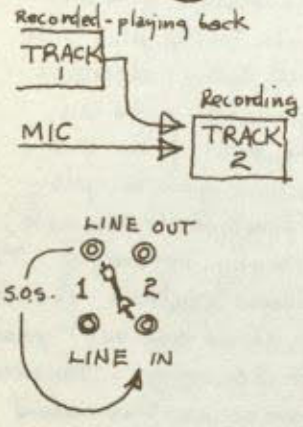
(D) Source/Tape Switches:

This should allow you to listen to either the source or the final recording while you are making the recording. Essentially, all it does is determine whether the outputs are receiving their signals from the recording preamp or the playback preamp. Better tape decks allow you to make that choice independently for each channel. This switch is also used on many decks to assist in making sound on sound recordings as well as echo chamber effects. For example: To take a previously recorded sound from Track 1 and add it to new sounds on track 2, the switch for Track 1 should be in the "Tape" position.

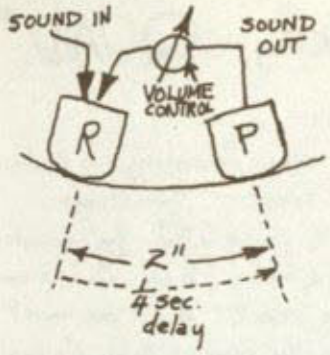
(E) Headphone Jack:

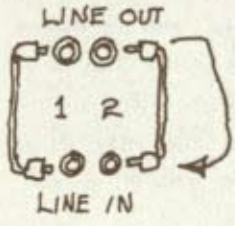
One should always monitor the recording process with high quality headphones. It's also a good idea to switch back and forth from source to tape during that. If you can hear a difference between what's going into the tape recorder and what's coming out, something's wrong. Never have loudspeakers on in the same room with live microphones. You get screetching feedback that way.

(F) Sound on Sound and Echo:

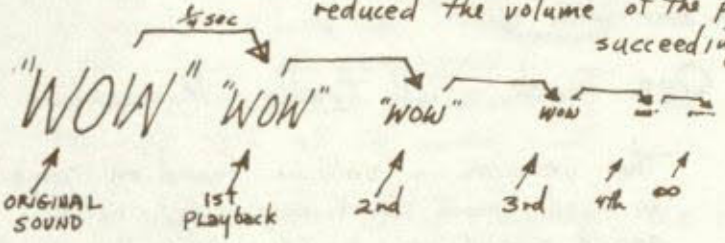


Very few Tape decks have an actual switch for these effects mainly because -- if the deck has all the other controls I've specified -- sound-on-sound and echo can be achieved by making proper connections by cable from your outputs to your inputs. If yours does have such a switch it is a convenience where those cable connections are made internally instead of externally. For sound on sound from Track 1 to track 2, the line output from track 1 is plugged into the line input of track 2 and mixed with the microphone input. the record select switch is set on track 2 recording, and the source/tape switch for track 1 is set at tape. Thus, you can record something on track 1 and a duet with that on track 2. You can keep going from track to track like that adding new lines.





To produce an echo chamber effect you need to understand your heads and your input/output pathways. Suppose we record a word; "WOW!" with a microphone. The word appears at the record head and goes on the tape. The tape is moving past the heads at 7½" per second. The heads are 2" apart -- so approximately ¼ second after we record the word it will appear at the playback head. If we have the output of the playback preamp connected to the line input of the recording preamp and we reduce the volume at either output or input "WOW" will re-appear at the record head exactly ¼ second after we said it into the microphone. That gets recorded too, and will appear at the playback head ¼ second later and go through the cycle again. If we have properly reduced the volume of the playback signal, each succeeding "WOW" will be of less volume. That's what you would call a controlled feedback loop. Remember: The source/tape switch must be in the tape position to do this.



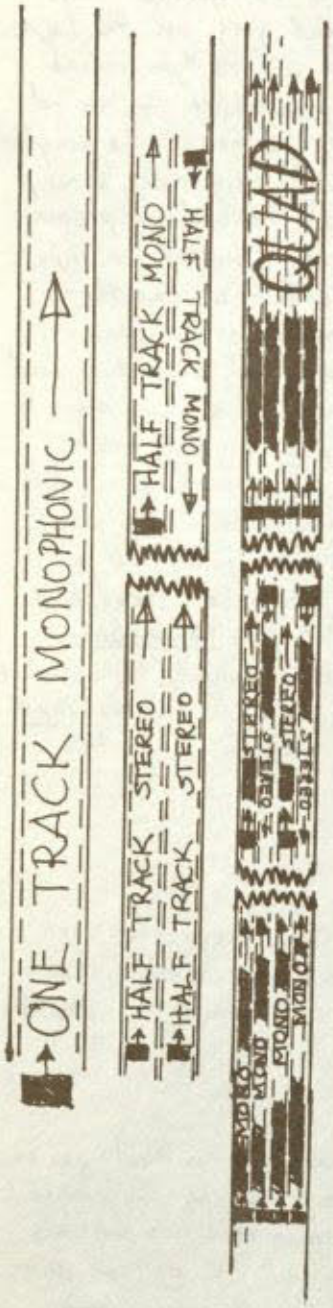
Ⓖ Output Level controls:

These control the volume of your output preamp. they are useful for sound-on-sound and echo level controls and are also used to properly feed an external amplifier and speaker system.

ABOUT "SIMUL-SYNC" RECORDING:

The disadvantage of the usual SOUND-ON-SOUND recording is that you are limited to monaural results. That is - when you are mixing the playback from one track with the recording of another - while the two signals will be in perfect sync on the new track - they will be out of sync by ¼ second with the old track. With SIMUL-SYNC, however, you record something on channel 1; wind it back; turn the switch for simul-sync for that track; (that switch makes the record head act as a playback head) play it back while you are singing along with it into channel 2. Since the record head is performing both record and playback functions, the signals will be together on the tape - exactly parallel on 2 channels - instead of separated by ¼ second.

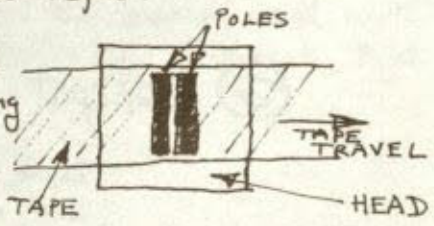
One Track, Two Track, Four Track, QUAD*



One of the most difficult mysteries of tape recording to explain to the novice is the concept of tape tracks. Sometimes, they're called "channels"; sometimes designated by numbers; sometimes by "left, right, front" and "rear", and God knows what else. Most mystifying is the fact that on most recorders, if you record a reel to the end -- take the reel off and put it in the supply position and record again -- the first recording has not been affected. If this is all strange to you, you need this section badly. Even if it all seems perfectly understandable to the rest of you, there are some valuable facts here for you, too. So bear with me.

One Track - Full Track Monophonic Recording:

This version is seldom found on home recorders, and is used most in filmmaking or other professional sound applications. It means this: the poles of the record head are large enough to cover nearly all of the surface of the tape.



If you record on this kind of tape recorder, you are using the entire area of the tape oxide. Turn the tape over and play it and you will hear everything backwards.

Full Track recorders generally give you the strongest output and superb fidelity simply because large masses of oxide are used for every unit of recorded message.

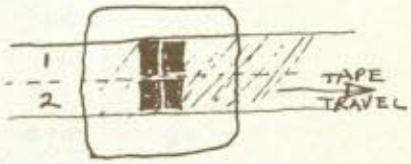
* Whisper the title for this page softly over and over again while snapping the fingers of your left hand. If you do this for fifteen minutes every day during lunch, people will tend to leave you alone.

Two Track - Half Track stereo and mono recording:

Earlier versions of tape recorders (remember the Wollensak, the Webcor and the Revere) used half track monophonic heads. Thus, the head looked like this:

Now, if you imagine that the tape is divided into two halves -- the upper and lower -- you can see that, while recording in one direction, the poles of the head will be in contact with the upper half; track 1. If you turn the tape over; what was the lower track (Track 2) will be in contact with the poles. Thus, you can record in one direction -- monophonically -- and then in the other direction; but not both at the same time.

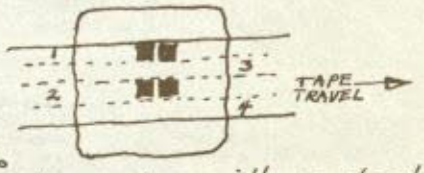
With half Track stereo, however, the head looks like this:



Now you can record in stereo using both upper and lower halves of the tape. If you turn the tape over and play it back, Track 1 will be playing backwards from the bottom poles, and track 2 will be playing backwards from the top poles. This can be an advantage for some applications. For best quality, fidelity and output, I recommend ½ track stereo heads.

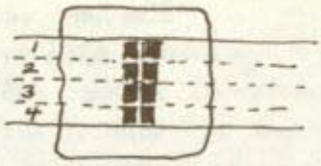
Four Track stereo (¼ Track)

Now things get a little hairy. By definition; "stereo" means two channels of sound simultaneously recorded or played. So what's four track stereo? Lets look at the head again:



The poles of the head are in contact with the tape in two places: 1 along the top edge, and 2 just below the center. The tape is divided into 4 tracks. When you turn that tape over, tracks 3 and 4 are in contact with the poles. So while there are 4 tracks, you can only record or play with 2 tracks at a time, and you can't play anything backwards.

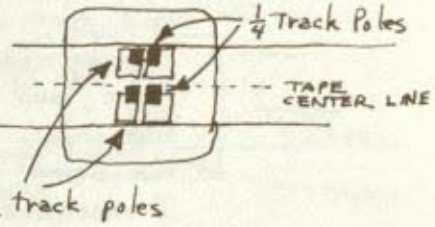
Four Track Quadrophonic (¼ Track):



Well, let's look at the head again: While this one uses the same four tracks as the stereo version above, it is recording on all four channels. Turn this one over and you'll hear all four channels going backwards -- but coming from different positions: (Track 1 from 4, and 2 from 3, etc.) Note, also that the track numbers may be differently designated between stereo and quad decks - For example: in this quad arrangement, (a TEAC) track 3 is the same as Track 2 was on a ¼ track deck (REVOX)

General Information:

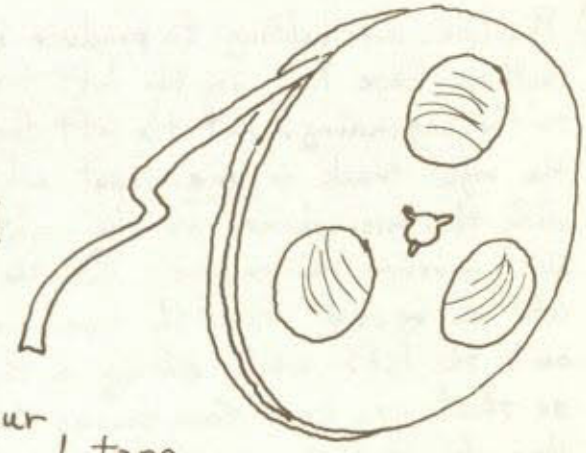
If you play a tape that has been recorded in ¼ track stereo on a ½ track deck, track 1 will sound good, but track 2 will be noisy and lower in volume. If we superimpose a diagram of the two heads together, you'll see why: ½ track heads are designed with the poles close to the tape edges with a wide separation in the middle. ¼ track poles must be squeezed closer to the mid line of the tape. thus, while the edge poles, (track 1) superimpose completely, track 2 is only half on his big brother.



CAUTION: Never use magnetized tools near your tape heads. Heads easily pick up magnetism, and good tapes can be damaged by magnetized heads.

Use a proper demagnetizer for your heads. I've heard people say that you can use an electric soldering gun to demagnetize heads. DONT DO IT! you can destroy the heads from the heat. Keep Loudspeaker and headphone magnets away from them, too.

About TAPE



Audio tape is improving constantly. At this point all tape has some residual noise in it. You hear it as tape hiss and even Dolby A will not entirely elminate it. I believe our ultimate hope is in improved tape rather than electronic devices. Here then are some unimpeachable truths about tape:

1. Always use professional quality low noise "Mastering" tape, i.e: Scotch 206, Maxell U.D. or B.A.S.F.. Do not use bargain surplus tape or el Cheapo.

2. Never use "long play" tape. Use 1½ mil tape. 1 mil and ½ mil tape will stretch, slip and print through. Several tape recorders I have used go beserk in the presence of thinner tapes. The capstan pressure is not enough to prevent slippage on thin tapes, and the brakes are strong enough to stretch it. Printthrough is a phenomenon which occurs when the sound on one layer magnetically penetrates the backing of the next layer creating audio ghosts.

3. Valuable tapes that you store for prolonged periods should be wound "Tail out" (on a take-up reel) and kept in a cool dry place. Do not refrigerate them. Excessive moisture condensation will damage them.

Chapter III
Class Problems

Your tape recorder came with an INSTRUCTION MANUAL. somebody stuck that in a drawer somewhere. FIND IT. Read it and put the tape recorder through its paces.

(1) Practice overdubbing to produce a quartet. For example: Record a rhythmic base line on the left track with a microphone. Now go back to the beginning. Put the left track on playback and feed it to the right track on line input while you are recording a second part with the microphone on the right track. Monitor it on headphones. Now reverse the process. Put the right track on playback and the left on record. Play the two voice combination of the right track on to the left while adding a third voice with mic. Do it again so that you have four voices (or instruments) on the right track. Now play it back on a good amplifier and speaker (right track only). Listen critically for noise level and balance of voice levels. Even with a good taperecorder you will notice that the background noise has been multiplied at least 3 times.

(2) Find out how you can produce echo with your machine. Can you put echo on stuff coming through line? (you have to have two line inputs per channel or an external mixer to do that) Don't use a  connector to do that. You're liable to get distortion and noise. A "Y" connector is not a good mixer.

(3) Record some sounds of common environmental noises at a fast speed and play them back at a slow speed; and vice-versa.

(4) Play a piece on a piano an octave lower than it is written and at half the tempo (slower). Record it at the slow speed and play it back fast. YOU'RE A VIRTUOSO!

chapter 4

CREATIVE TAPE WORK

the soundsmith

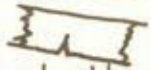
splicing

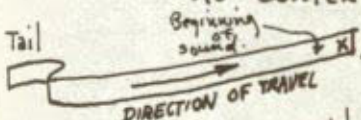
Become a master of the splice. A true soundsmith can forge a masterpiece from a multitude of tape fragments.

Cueing: Some people use a marker or a grease pencil to indicate the exact spot for a splice* If your tape recorder is a good one you should be able to locate the sound you want to cut and stop the machine within an inch or two of it. Then, "rock" the tape (turn the reels back and forth by hand) until you hear the sound in your headphones. At that point it is at the playback head. If you are the marking type put a mark on the back of the tape right on the playback head.

"ROCKING"

Personally, I prefer not to mark the tape. I cut with scissors on the right hand side of the head ½" away from the center of the head (If I'm eliminating the sound) or on the left hand side if I'm including the sound.

Sometimes you want to cut a piece out of a tape that is a long passage. Mark the tape, or nip  it, at the beginning of the passage and play through to the end before you actually cut. Then run the tape back by hand until you feel the nip or see the mark. This is a good way to keep a piece in its context until you are sure it's exactly what you want.



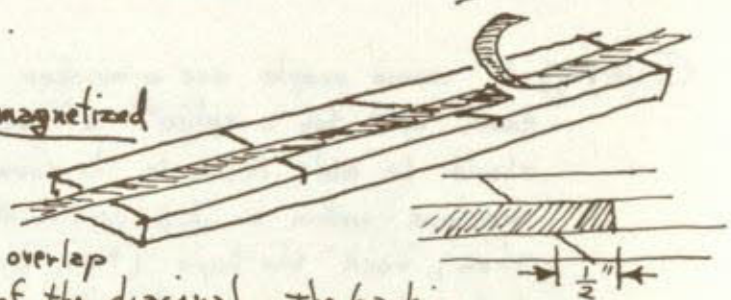
If you are cutting a lot of pieces it's a good idea to mark the head of each tape so you'll know your head from your tail when you splice them together.

* Marking can gum up your capstan roller as well as the next layer of tape. Watch it!

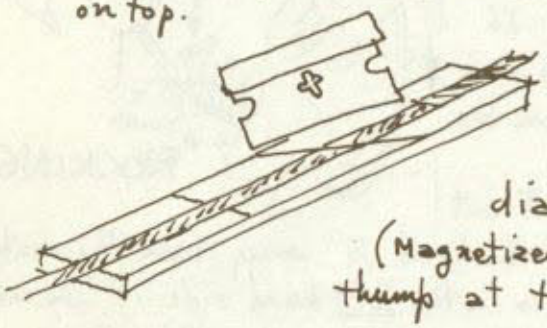
[Take your head cover off for precise cueing]

How to Splice

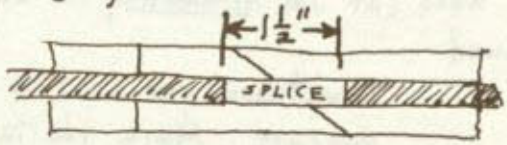
N.B. Diagonal splices give smooth noiseless transitions. Butt splices should be used only when you need an absolutely sharp transition.



(1) Cut the tape with demagnetized scissors leaving ½" of excess. Press the tape in the groove of the block gently with an overlap of ½" from the longest part of the diagonal. The backing should be up — oxide down. If you are left handed put the right tape on top.



(2) Demagnetize a single edge razor blade. Use a fresh sharp one and slice the tapes along the diagonal. Get rid of the top tail. (Magnetized blades will produce a click or thump at the splice.)



(3) Cut a piece of splicing tape (¼" wide or ready made splice tabs) and lay it down on the tape so that it covers the seam evenly. Burnish it with a dry finger or a hard eraser.

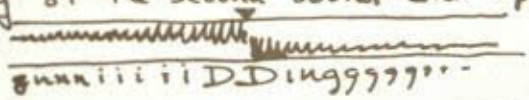
(4) To remove the tape —

Do not peel it out of the block

Grasp it on each side of the block and snap it out — GENTLY!

TRANSFORMING LIVE SOUNDS

Splicing: Aside from playing the tape backwards or at different speeds or using tape echo, there are other ways of transforming sounds. For example: Record a bell sound twice on one track of a half track stereo recorder. Cut the tape at the beginning of the second sound and splice it backwards head to head like this:

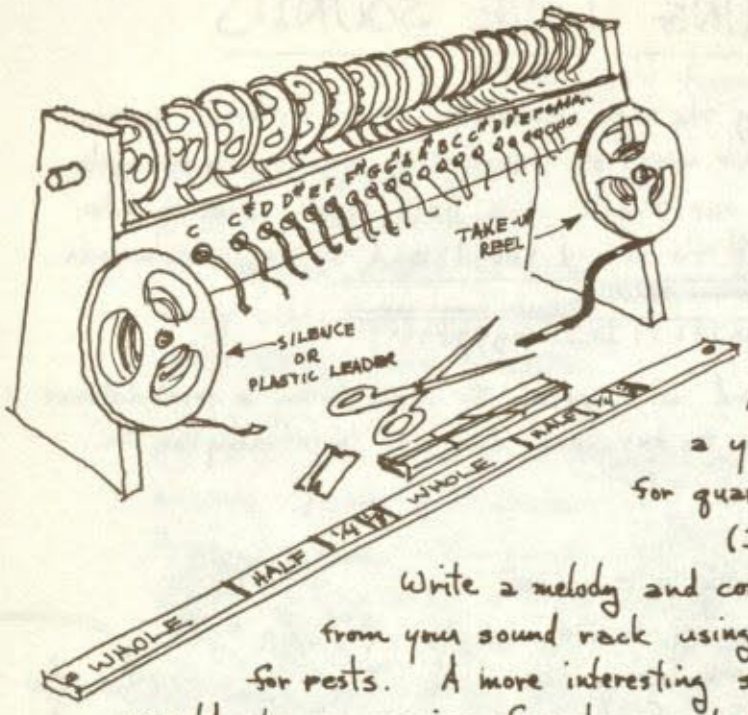


Played on stereo speakers the sound will appear to come from a great distance away on one side, fly across the speakers and out to infinity on the other side.

Acoustic Distortion: Using a cardiod microphone, point it into an empty metal garbage can and sing into the can. Also try carefully touching the metal of the can with the microphone while singing. You should hear some interesting distortion.
Try sticking a microphone into one end of a long hose (20 feet or so) and a funnel in the other end. Sing into the funnel.

Tuned Feedback distortion: Hold a microphone near a stringed instrument. Turn the amplifier volume way up and pluck the string. If you turn it up loud enough a feedback whistle of the same pitch will be heard on the loudspeaker. Keep the volume high enough to sustain the feedback and listen to the way both timbre and pitch change.

SPLICE MELODIES



At left is a useful set up for a studio. Record 5 or 10 minutes of each note of two octaves from an organ or a synthesizer. Put these on separate small reels and thread the reels on a rod over your table. Label them according to pitch. Fasten a yardstick on your table with markings for quarter notes, half notes, etc.

(If a whole note equals 1 second of time = 7½")

Write a melody and construct it note by note by splicing from your sound rack using plastic leader or non-recorded tape for rests. A more interesting source of sounds for your rack would be a series of reels recorded from loops (see next section) of the desired pitches but unrelated sound sources, i.e., Train whistle at C, electric saw at c#, car horn at D, etc. OR use a synthesizer to produce your two octaves, but use a different patch for each note.

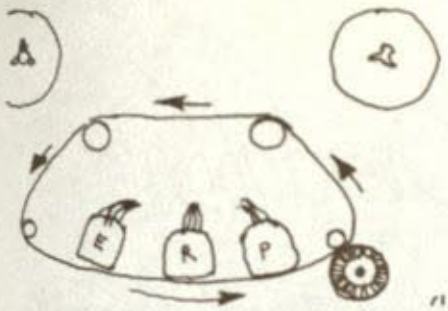
[Avoid any smaller note values than a ¼ note if you're working at 7½" per sec. - or ⅛ note for 15" per sec.]

Another method is to hunt for the specific pitches you want on a phonograph record of a work performed by an orchestra or a group. Cut the notes from that piece and re-arrange them in the order of your composition.

These may seem like tedious methods but much of the early electronmusic was produced in this fashion and there are effects which can only be achieved this way.

Try playing your melody backwards, faster and slower for thematic variations.

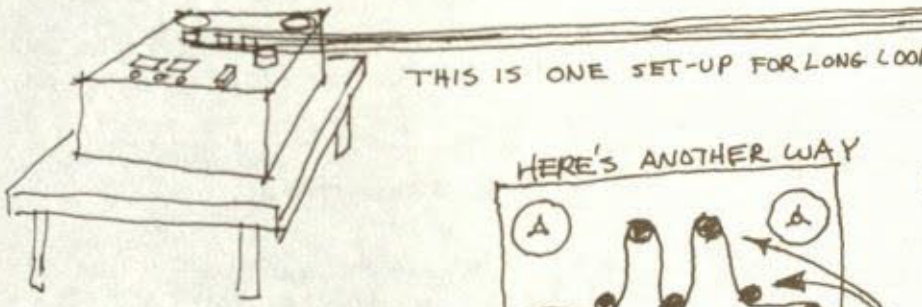
TAPE LOOPS



A convenient source of repeated patterns, loops are a valuable tool in creative tape work. Try this: Whisper this phrase close to a mic and record it;

"TUM TI TUM TA DUMPA SWAHHHH"

Now cut the tape close in to the beginning and end of the sounds and splice that piece together head to tail. Thread it on the tape recorder without reels and turn off the reel motors. Use your fingers (or rollers) to keep tape tension. Turn it on and the phrase will become a percussion rhythm which can be recorded on another machine. If you're going to make an overdubbing of more than one loop rhythm, measure the exact length of the first one before you splice it and be sure subsequent loops are equal or appropriate multiples of the first.

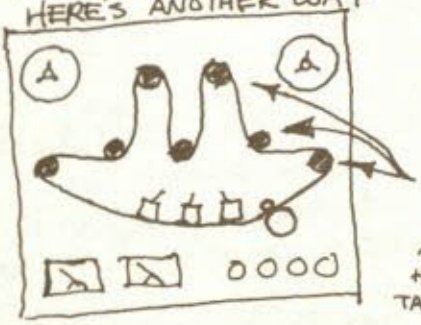


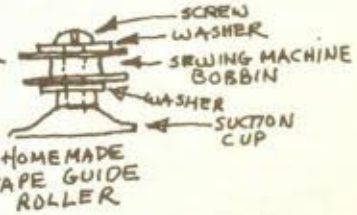
THIS IS ONE SET-UP FOR LONG LOOPS

Empty Adhesive Tape Spool

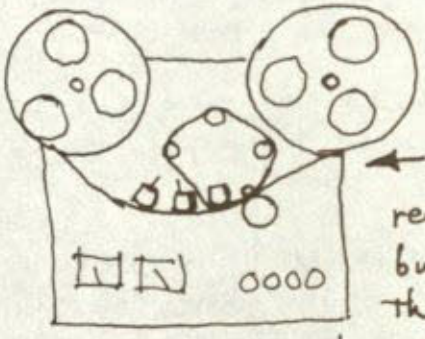
Movable Stand

HERE'S ANOTHER WAY





HOMEMADE TAPE GUIDE ROLLER



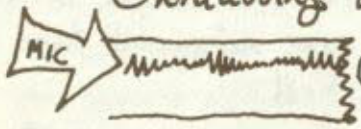
← To record from a Loop when you have only one recorder. First thread the loop on the machine but only around the playback head and the capstan. then thread a blank tape normally. Turn it on and send the playback signal to the record head.

Mixing and Overdubbing

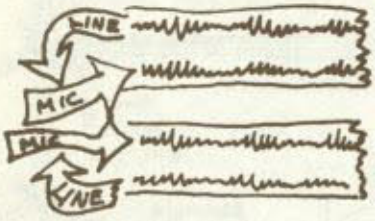
Overdubbing: — adding tracks sequentially

Some confusion exists over features of recorders described as "sound on sound", "sound with sound", "sound over sound" etc.; Don't try to figure it out! Different manufacturers mean different things with the same terms

Overdubbing with a stereo recorder —



① Record one instrument on track one.



② Record second instrument on track two and add track one while doing so.

③ Record on track one and add track two at the same time.

You can keep doing this indefinitely — but — there are certain limitations in this process you ought to be aware of:

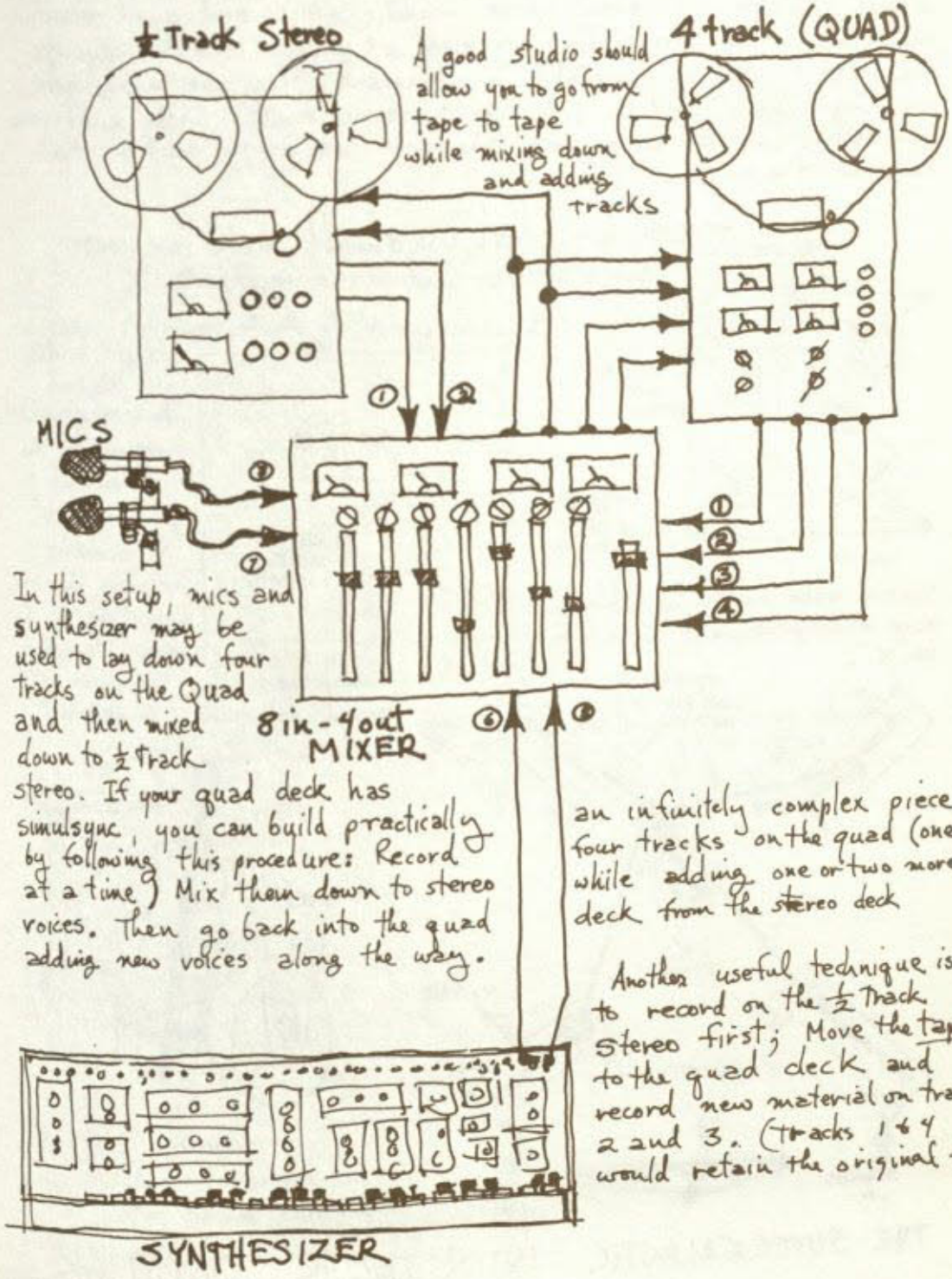
the final result will be monophonic because each new track is behind the previous one.

The more cycles you make, the more noise you will add - and the more the earlier tracks will deteriorate.

An advantage of this system is that you can re-do a track over and over again until you get it perfect before you move on to the next cycle.

(Note: See also class problem one for chapter III)

A Good Basic Mixing Studio



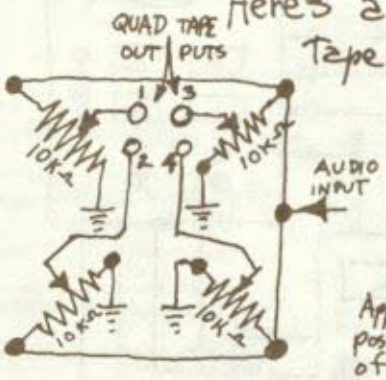
In this setup, mics and synthesizer may be used to lay down four tracks on the Quad and then mixed down to ¼ track stereo. If your quad deck has simulsync, you can build practically an infinitely complex piece by following this procedure: Record four tracks on the quad (one at a time) Mix them down to stereo while adding one or two more voices. Then go back into the quad deck from the stereo deck adding new voices along the way.

Another useful technique is to record on the ¼ Track stereo first; Move the tape to the quad deck and record new material on tracks 2 and 3. (tracks 1 & 4 would retain the original.)

A JOY STICK FOR QUAD

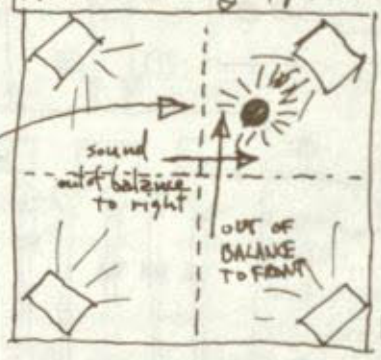
One of the real joys of Electronmusic is the fact that you can construct a total sonic space — that you can locate and move sounds in that space as you wish. The composer is thus also a sculptor of sonic space. While stereo and quad recording techniques were originally conceived as means for reproducing accurately the performance environment, they are much more exciting when used in free spatial experiment. With quad you can make sounds crisscross the room and occupy positions that enhance the music.

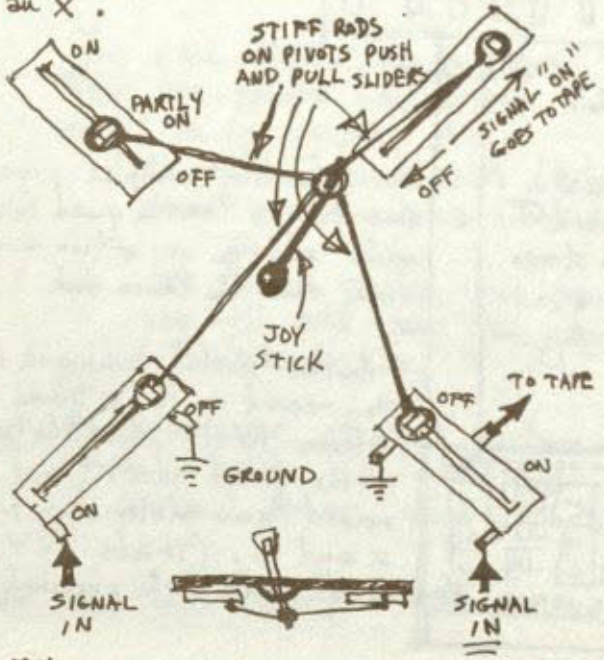
Here's a gadget you should make for your tape setup and quad recording.

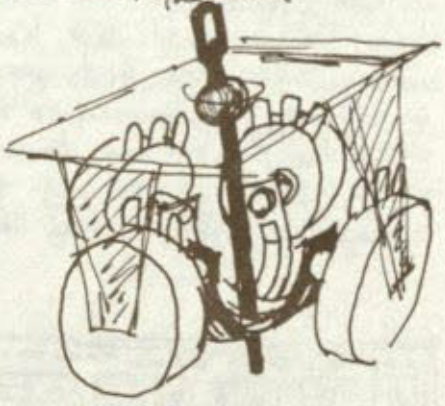


You can make one by mounting four slide potentiometers to form an "X".

A Joystick controlling 4 potentiometers takes a single audio signal and delivers appropriate amounts to the four inputs of a quad recorder. The recording delivers similar proportions of the signal to four Loudspeakers. The proportion of sound determines the apparent position of the sound.







Commercial joysticks are rigged up as above using regular round pots.

THE SUPERGALACTIC INTERSTELLAR JOYSTICK

CHAPTER IV
Class Problems

Each of the pages in this chapter is a problem. However, some additional suggestions are listed below.

1. Record an innocent conversation between two people. (For best results, record at 15 I.P.S.) Now edit and alter that tape until one or both of the people have said extremely wicked things. If you're successful in this venture, no one should be able to detect your splices, and you may easily earn your way through college.

2. Take a piece of recorded classicel or popular music, record it at 15 I.P.S., and cut up the tape into individual notes. Re-assemble them into two part harmonies with the original. (This one is a lot easier said than done.)

3. Record natural sounds - Birds, etc. - Slow them down several octaves (or speed them up) until they are unrecognizable. Re-assemble them into music.

chapter 5

SYNTHESIZER HUSBANDRY

the sonic connection

Before you do anything else, stand up in the presence of your Synthesizer, raise your right hand, and repeat after me:

The Oath

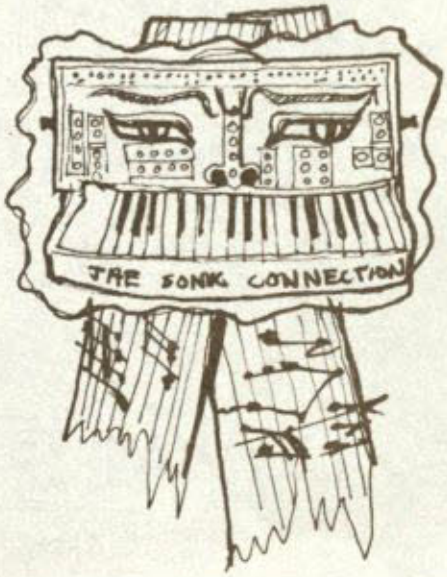
I do solemnly swear under threat of the wrath of Shiva and the vengeance of Beethoven that I will read the manual for this synthesizer from cover to cover, and that I will abide by it.

I swear further that I will study this chapter of ELECTRONMUSIC with equal vigor until I know more about this synthesizer than the people who made it.

I further promise to make surf, wind, siren and gunshot noises only once with this synthesizer and get those little cliches out of my system.

Signed:

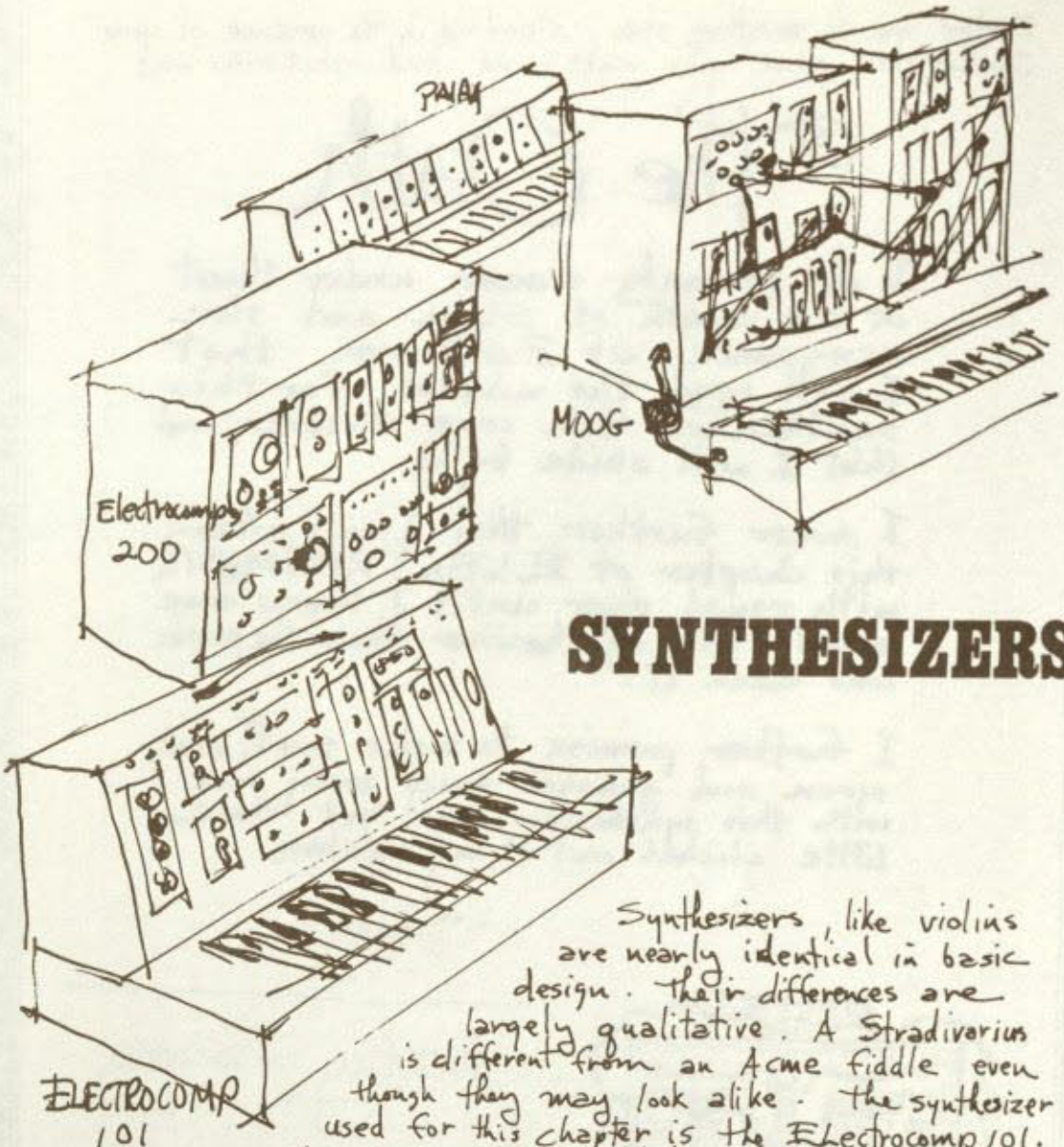
Trustworthy Disciple



That's step One.

Now if you haven't already done so, sit down with the synthesizer and try everything on it at random. just to get that out of your system.

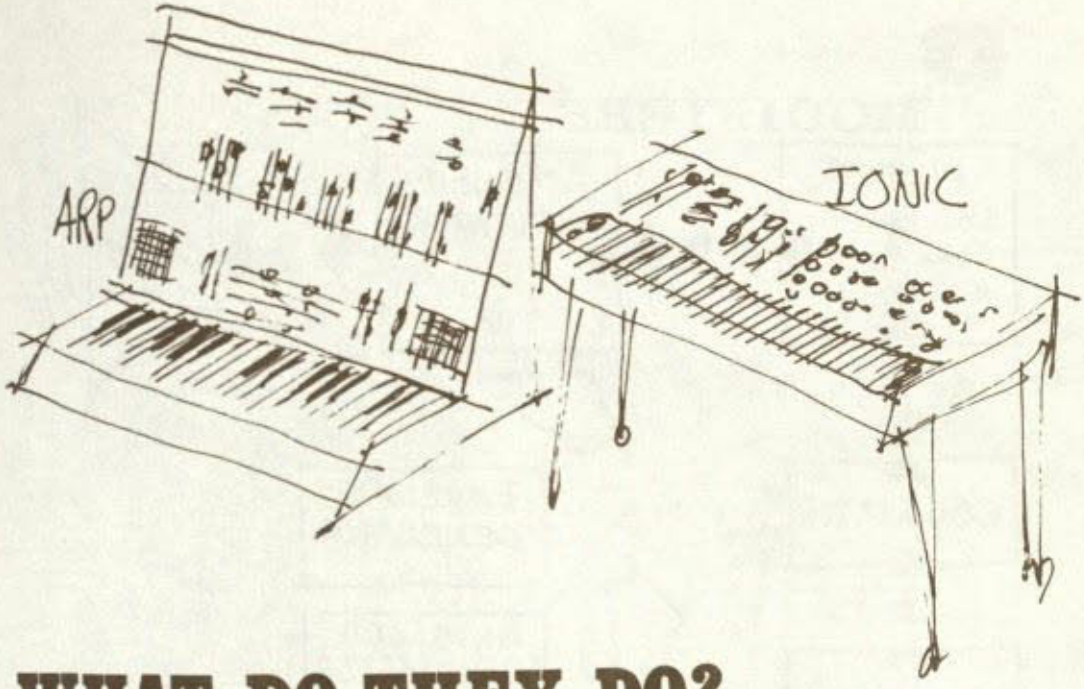
Now we're ready to get to work.



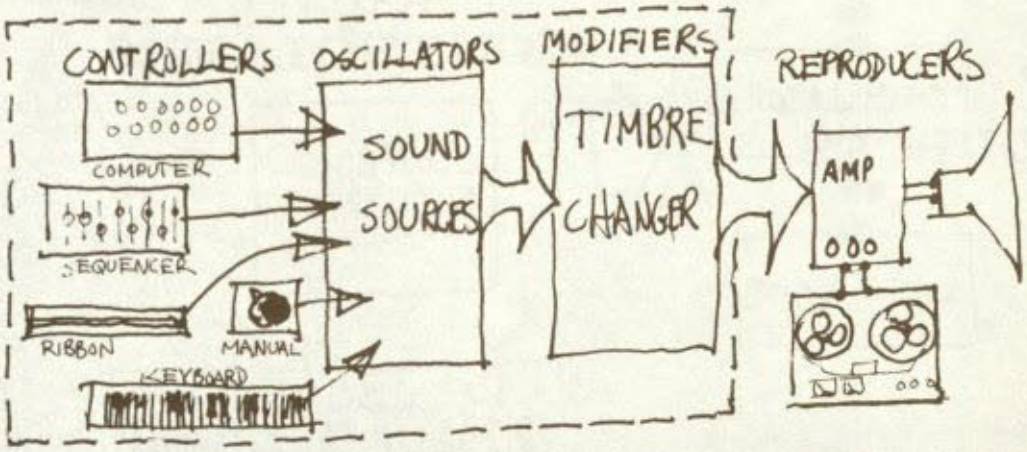
SYNTHESIZERS:

Synthesizers, like violins are nearly identical in basic design. Their differences are largely qualitative. A Stradivarius is different from an Acme fiddle even though they may look alike. The synthesizer used for this chapter is the Electrocomp 101. It is an easily operated, high quality, truly professional instrument. I believe it is one of the best at any price.

A SYNTHESIZER IS THE ULTIMATE

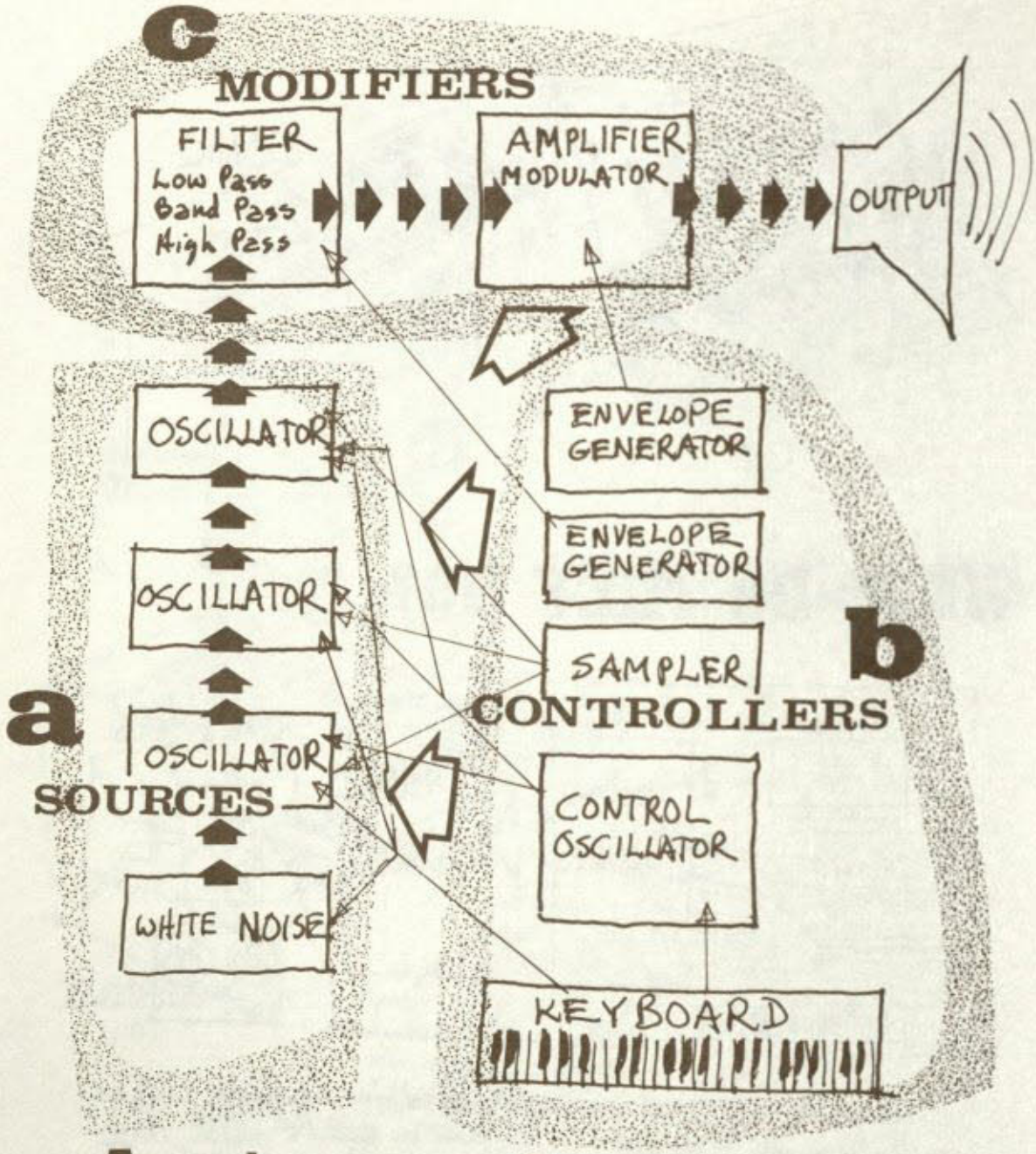


WHAT DO THEY DO?



They use any of a variety of controllers -- keyboards - ribbons - computer terminals - sequencers -- to turn on sounds which they then alter and modify to create new sounds. While they can imitate nearly any other instrument, their highest function is to produce brand new sounds.

SONIC CONNECTION!



Anatomy of a SYNTHESIZER

A synthesizer generates sounds electronically and permits you to control and modify those sounds over an almost infinite range.

While the synthesizer used and illustrated in this book is an Electrocomp 101, all synthesizers are nearly identical in their basic anatomy.

A synthesizer is a voltage controlled sound studio. It gives the composer a nearly infinite pallette of colors.

IT HAS THREE MAJOR FUNCTIONING SECTIONS

a SOURCES: the oscillators and white noise generators - provide raw sound in a variety of wave forms.

b CONTROLLERS: these are voltage sources which may be used to affect the raw sounds. they control the pitch, the loudness, the duration as well as other parameters. they also control the modifiers.

c MODIFIERS: these essentially change the timbre of the sounds. they filter out parts of the harmonics of notes - emphasize others and create an envelope for the final sound.

Oscillators are the main sound source. they produce a variety of waveforms. Generally, they range from a sine ∿ wave or a triangle ⋀ wave to square ⊓ waves to sawtooth. the output of multiple oscillators can be combined to produce more complex waveforms.

Controllers are usually oscillators, too. However they are set at sub audio frequencies to create vibrato, tremolo or other effects. A keyboard is also a controller supplying a different voltage to the oscilletors for each pitch.

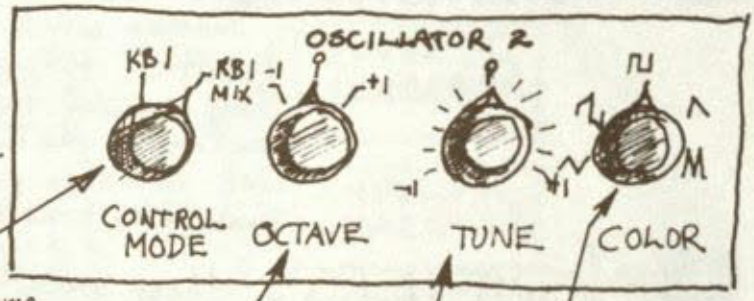
Modifiers are usually filters. they are means for selecting portions of the sound and suppressing others. Modulators are Modifiers too. Envelopes are created by Amplitude modulation. Pitch variation is created by Frequency modulation.

In the next few pages we will study each component separately.

OSCILLATORS

The very HEART of a synthesizer, the oscillator is the vibrating string.

Sit down in front of your synthesizer. Find an oscillator. It should show you the wave forms it creates. Let's see what it does:



This is a switch to determine what controller will supply pitch voltages. On some synthesizers this may be a phone jack.

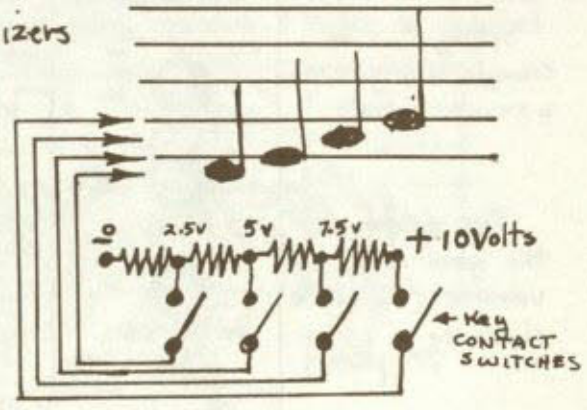
This selects major pitch position. You can set the basic frequency up or down an octave with this control.

This precisely tunes the oscillator to the exact pitch you require. It varies by an octave plus or minus.

This selects the wave forms the oscillator will produce. Generally, the triangle wave is soft and the sawtooth is rich with harmonics.

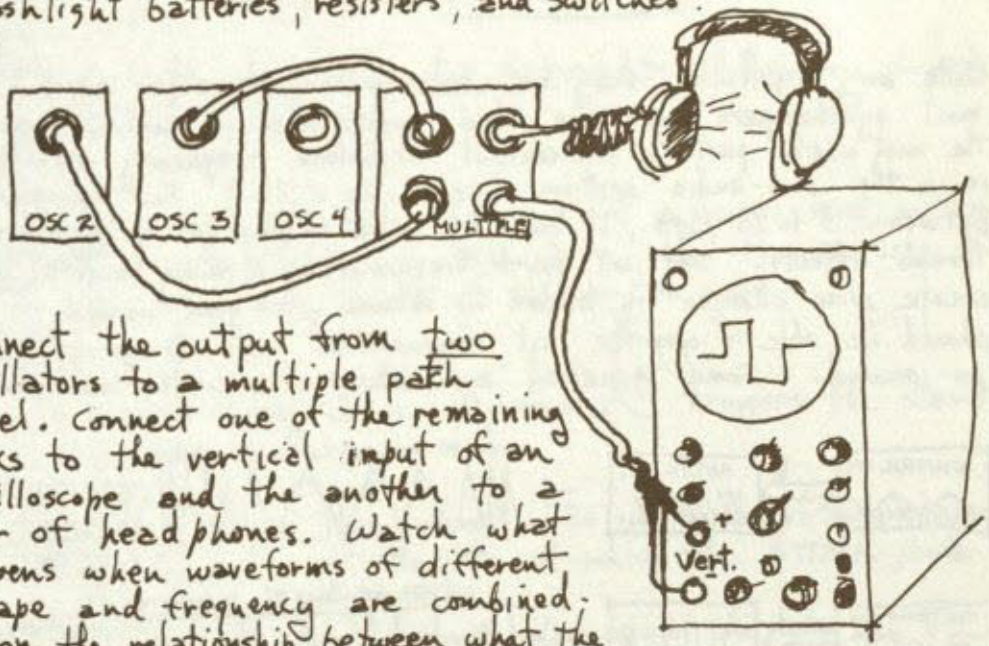
Make a connection between the oscillator output and an amplifier or headphones. Set the control mode switch to KBI (that's Keyboard control of Pitch). Press a key and you should hear a sound. Pressing different keys should change the pitch of what you hear. Turn the color control to the triangle wave form. It should sound a little like a flute or oboe. Rotate it to the sawtooth form and it should sound more like strings. But remember, what you're hearing is an unprocessed sound. It's raw. It has potential for much more.

An oscillator derives its pitch from voltage. Thus a low voltage produces a low note and a high voltage produces a high note. A keyboard is essentially a precision voltage divider switchboard which delivers different voltages for different keys. Understanding the basic idea of voltage controlled oscillators can be very usefull because there may be a time when you want to be able to plug in some other voltage source to control pitch. Most synthesizers have phone jacks connected to their oscillators for external control of pitch.

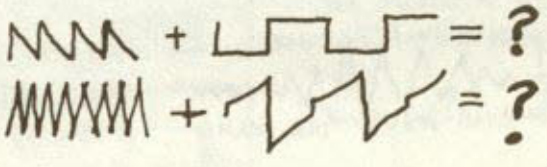


(the 101 has two such jacks. the sequencer jack and the "ext. osc. control" jack).

You could conceivably rig up a hybrid controller with flashlight batteries, resisters, and switches.

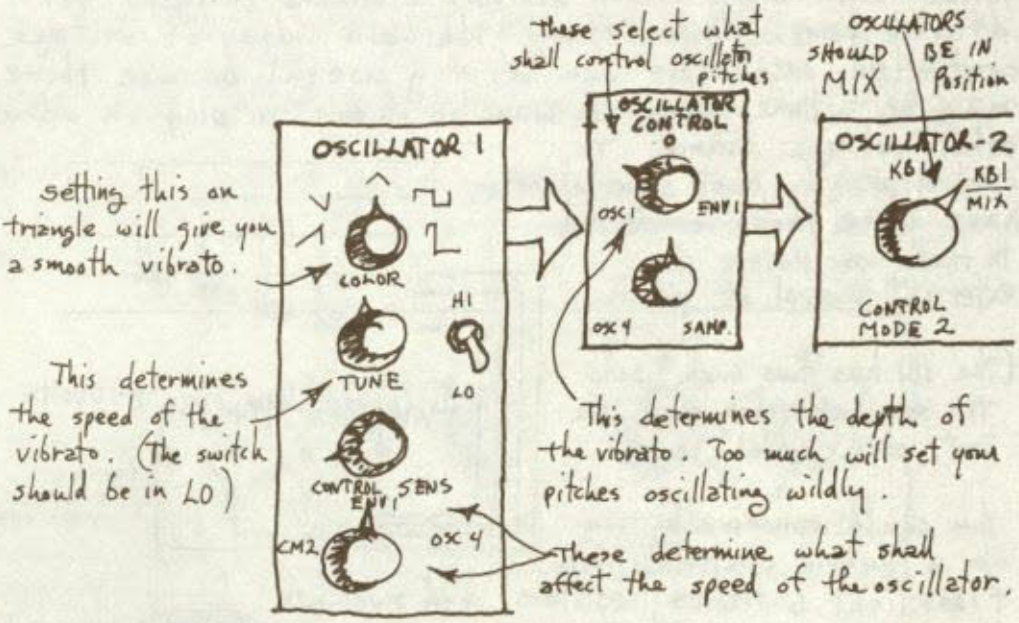


Connect the output from <u>two</u> oscillators to a multiple path panel. Connect one of the remaining jacks to the vertical input of an oscilloscope and the another to a pair of headphones. Watch what happens when waveforms of different shape and frequency are combined. Learn the relationship between what the sounds look like and their timbre. This can be more instructive than a thousand textbooks.

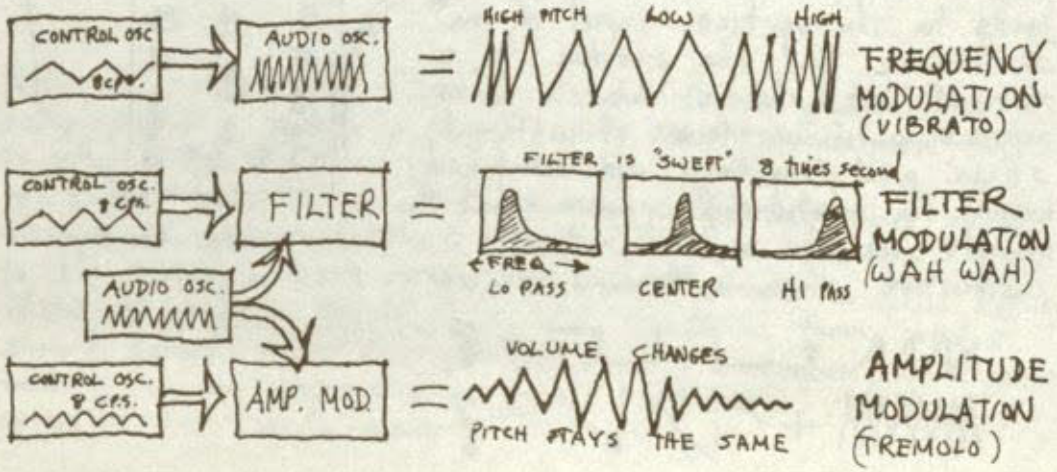


Control Oscillator

the source of vibrato, Tremolo and other effects

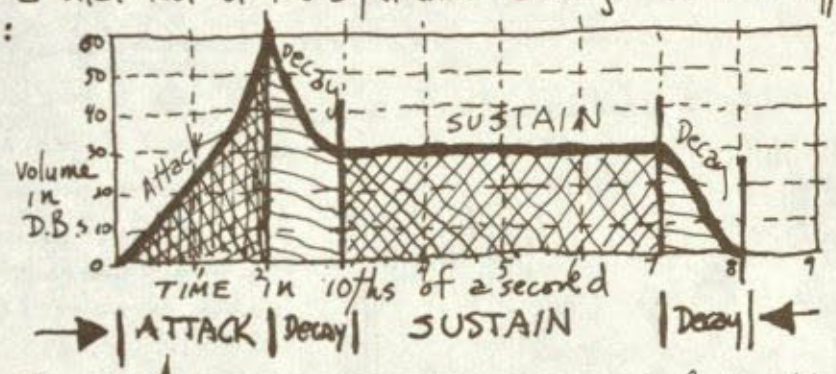


While any oscillator may be used to control other oscillators, most synthesizers have one which specializes in control applications. The most useful part of the control oscillator's frequency spectrum is in the sub-audio section. (below 20 C.P.S.) Set somewhere between 5 to 10 c.p.s., it may be used to produce vibrato and tremolo effects. Set at lower frequencies, it may be used to create slow changes in timbre or volume. A good control oscillator should be able to operate at frequencies as low as $\frac{1}{5}$ a cycle per second. Some general applications of a control oscillator are:



The Envelope:

You should already be aware of the fact that various instruments owe their difference in timbre at least in part to the characteristics of their amplitude envelope. A plucked string, for example rises quickly to full volume, then decays slowly until the string stops vibrating. Each instrument has its own characteristic envelope, and the control of the envelope of synthesized sound is a vital tool of the synthesizer array. Heres a typical envelope:

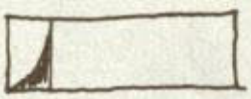


Attack control determines speed of rise time

Decay determines the rapidity of drop from the peak of the rise.

Sustain holds the volume at a pre-set level as long as the key is held down, and then releases it to decay the rest of the way to zero.

When you press a key down a pulse ⌐|¬ triggers the start of the envelope cycle —

A 

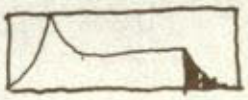
The volume rises in the amplitude shaper at the rate at which the ATTACK knob was set.

B 

the volume decays at the rate set by the decay knob to the pre-set sustain level.

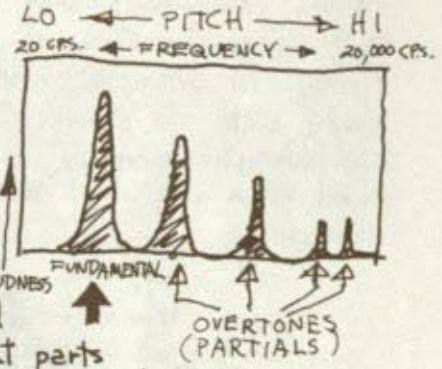
C 

the sustain continues to hold the note until the key is released.

D 

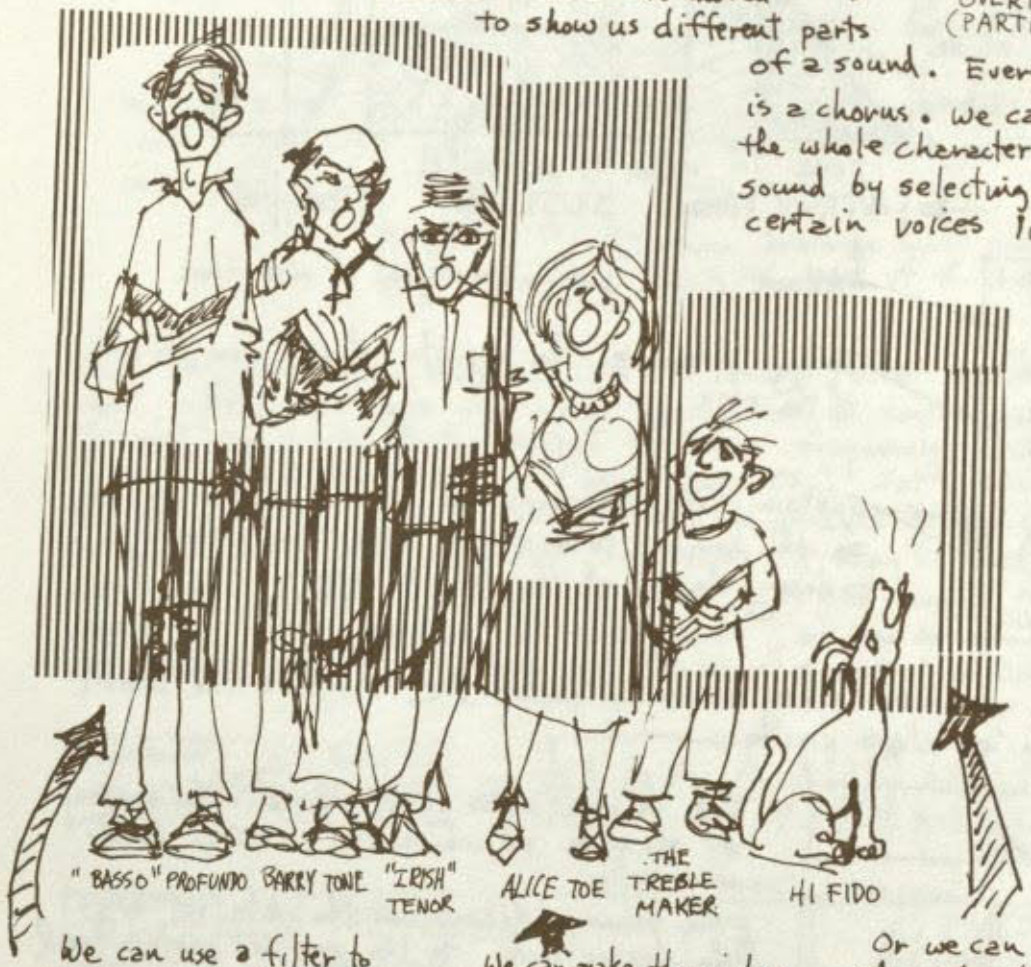
then the note continues its decay to zero.

FILTERS



As you know, most musical instruments have sounds which are comprised of a fundamental pitch plus overtones, or partials. Thus, when we look at a sound we ought to be aware of the presence of a full spectrum of sound.

A filter is like a **window** which can be moved to show us different parts of a sound. Every note is a chorus. We can change the whole character of its sound by selecting out certain voices like this:

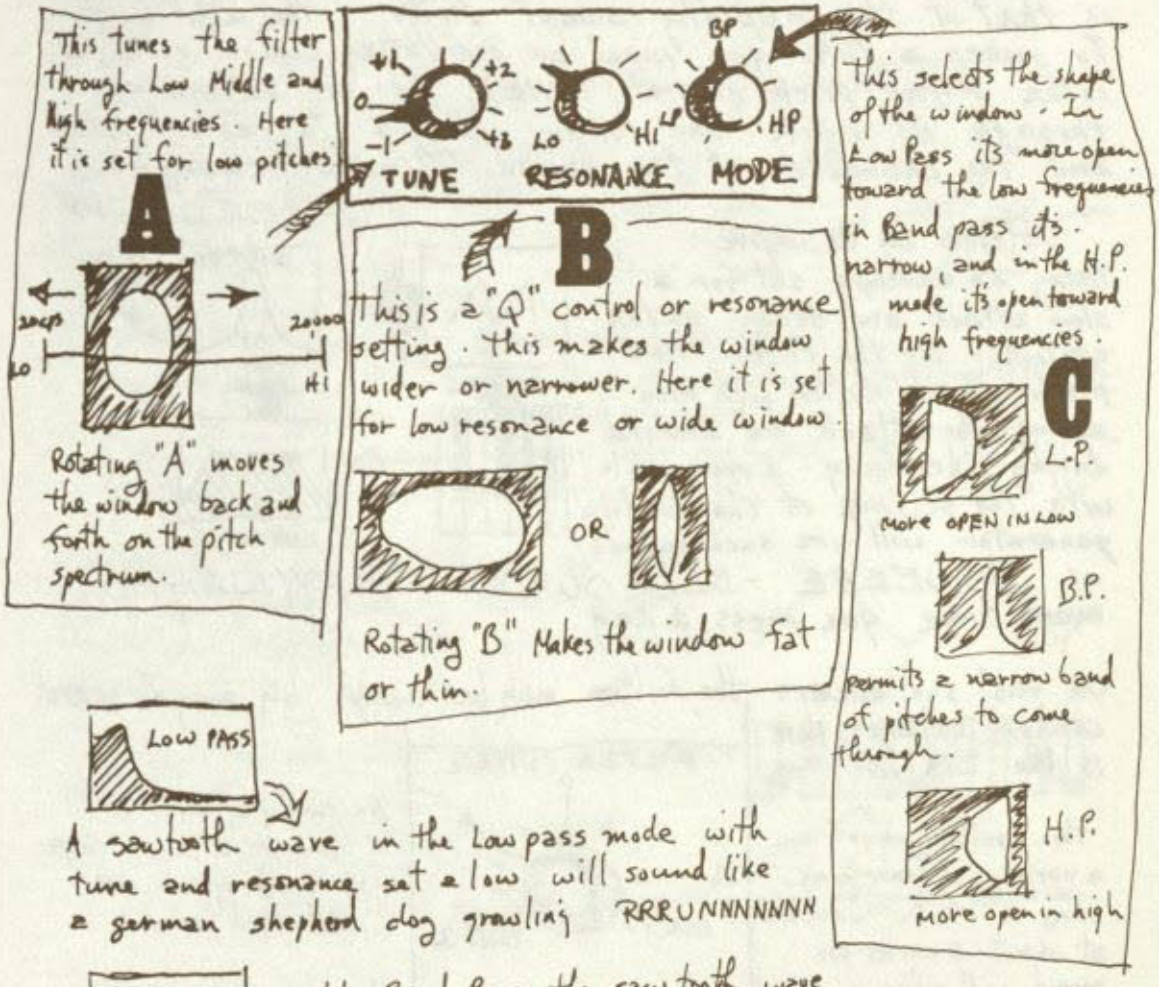


We can use a filter to "see" only the fundamental plus the first few overtones. That's a LOW PASS Filter.

We can make the window very narrow and "see" only one or a few of the voices. That's a BAND PASS Filter with a high Q or resonance.

Or we can move the window to the other end and "see" only the high pitched sounds. That's a HIGH PASS Filter.

The Filter on the Electrocomp 101 is remarkable in that it is three filters in one. Here's how they work:



A sawtooth wave in the Low pass mode with tune and resonance set a low will sound like a german shepherd dog growling RRRUNNNNNNN

set to Band Pass the saw tooth wave will sound like NNUHHHHHHHH

set to high pass the saw tooth wave will sound like NAZZZZZZZ

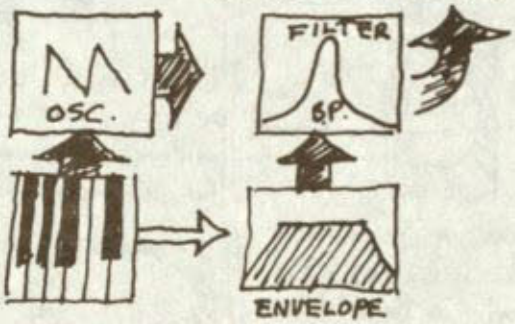
Some synthesizers have separate band pass, Low pass, and high pass filters. If the synthesizer does not have band pass, the two L.P. & H.P. filters may be connected to accomplish the same thing.

Sweeping the Filter

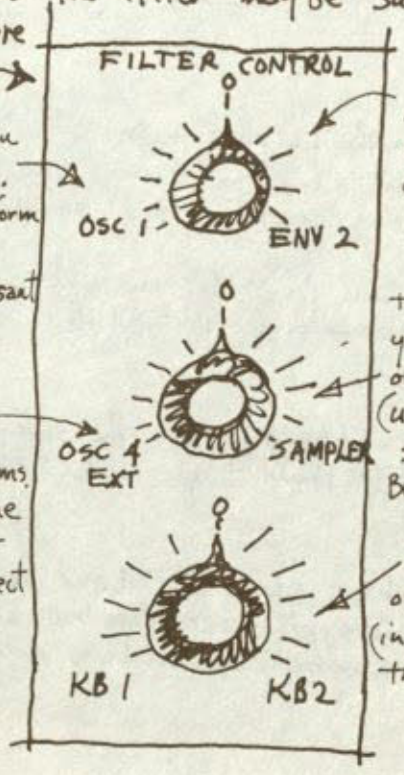
The most characteristic sound of the synthesizer is that of the rapidly swept filter -- the WAH WAH. To sweep a filter you input an oscillating control voltage to the Filter pitch control (TUNE). As the voltage goes through its cycle the filter changes its "center" pitch and the character of the sound filtration changes.

"WAHEEOWWW"

Here's an example:
Using an envelope set for a slow attack and decay as the controller for the filter, the pitch of the filter will rise during the attack and descend during the decay. Experiments with the settings of the envelope generator will give such sounds as BOWEEEE - BEEEOWWW - AHHWAHHH every time you press a key.



On most synthesizers the filter may be swept by any of several control voltages. Here is the EML 101 →



This setting gives you a variety of waveforms. Using a ⋀⋀ waveform at about 8 cycles per second will make a pleasant form of vibrato.

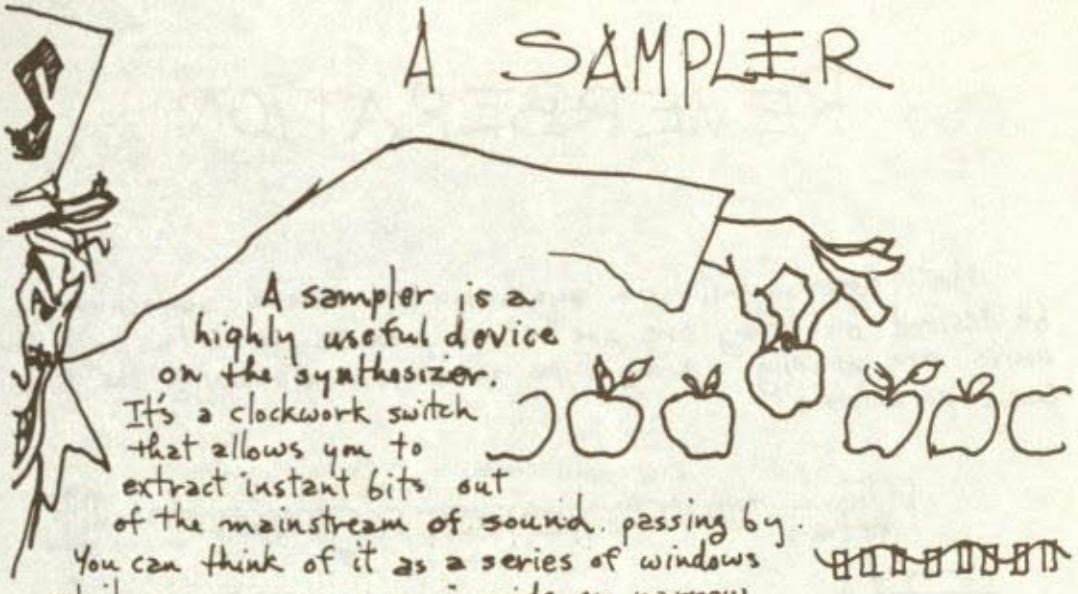
This gives you an alternative oscillator with different waveforms. Combine oscillators one and four at different frequencies and the effect is unusual.

An envelope gives you a slow cycle in a shape you can program - as illustrated above.

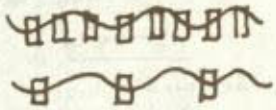
The sampler can give you regularly stepped or random filtration (using Osc. 1) which can sound like this: BOOP Beep Bip Bah Bo Beep

This allows the upper or lower keyboard note (in a chord) to control the filter sweep.

A SAMPLER



A sampler is a highly useful device on the synthesizer. It's a clockwork switch that allows you to extract instant bits out of the mainstream of sound passing by. You can think of it as a series of windows which you may arrange in wide or narrow spacing. Through these windows you may "see" the audio signal in some special ways.



For example: If you set your oscillator's pitch rising and falling from a control oscillator triangle wave at 1 cycle per second —

Then set the sampler clock at 4 pulses per second —

and what you will hear will be four discrete tones ascending and descending in pitch in a regular fashion.

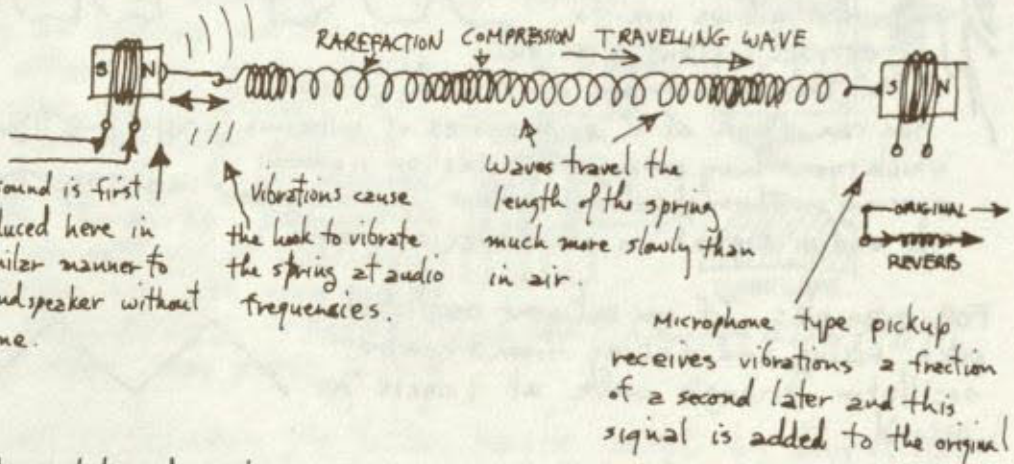
To get random pitches is easy. If the cycle of the oscillator is out of sync. with the sampler clock, the windows will show you pitches that seem to have no order.

A sampler may also be used to give you random filtration by sweeping and sampling the filter

Book Beek Bik Book Bak Book Bik

REVERBERATION

Most Reverb units on synthesizers leave something to be desired but they are useful components none the less. Such units are usually spring type arrangements using the following basic principle:



The delayed echo effect of the Reverb gives the impression that the sounds are bouncing off the walls of a very large room. In small doses it adds a good dimension to the sound of synthesized notes. It can help to give the hollow woody chambered sound of violins, cellos and basses, for example. Tape recorder echo is less subtle, with a longer delay between the sound and it's "reflection".

Disadvantages: Every time you tap the chassis or hit a note hard you'll hear the reverb springs like the old screen doors back home. Reverb springs resonate at several frequencies causing spurious sounds. They also take up a lot of space.

HOWEVER; With all these disadvantages I prefer to use Reverb and Tape echo to artificially create the room tone for my recordings. I prefer to work in an anechoic space and electronically shape and fill that space.

WHITE PINK RED? NOISE

Definition: White noise like white light contains all frequencies. "Pink" noise has the lower frequencies emphasized. Thus noise is random sounds produced simultaneously across the entire audible spectrum!

Noise generators on synthesizers vary considerably in their sophistication. I've seen one that is nothing more than an (intentionally) improperly wired transistor. It's an interesting paradox when we spend a considerable amount of money on low noise transistors and noise reduction circuits only to turn around and invest similar sums in a module which will generate noise.

When we don't want it - we call it "HISS"
When we synthesize it - we call it "NOISE"

Technically it's a random pitch oscillator giving extremely short bursts of sound at all frequencies, and it sounds like the wind in the trees in the fall. Judiciously used, it can whisper a sea breeze or imitate a brushed cymbal.

Adding a little touch of noise to the synthesizers' mainstream gives the sound a breathiness that is useful.

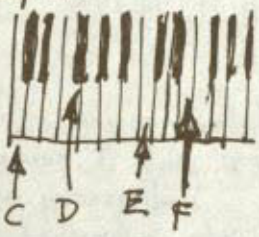
Adding a little high pitched sawtooth (g') to a lot of white noise - and using an envelope with a very sharp attack and a long decay will give you a cymbal. Experiment with filter settings.

Put some headphones on and listen very closely to white noise for a while. You'll hear voices - beings singing in the electric wind. Try it.

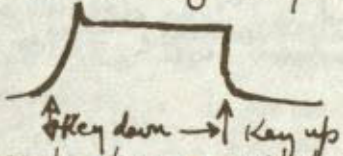
the KEYBOARD

Of all controllers for the synthesizer, the keyboard is at once the most versatile and the most familiar interface between man and instrument. Somehow, the machine is much less threatening if the keyboard looks and feels like any piano or organ keyboard. But that similarity should not lure you into thinking they are identical. The keyboard on a synthesizer can perform a variety of functions:

Its most common and vital function is to provide a precisely stepped series of voltages which can be used to produce pitches tuned to the standard twelve tone scale. On most synthesizers the voltage intervals between keys may be adjusted, however, to produce microtone intervals. With such an arrangement you can spread a normal octave over three or four octaves of keys and have three or four discrete steps between C and D for example:



A second valuable function of the keyboard is to give a trigger impulse to other modules on the synthesizer. In most cases the trigger voltage of the key comes on quickly as you strike the key and is sustained as long as you hold the key down.



this makes each key a switch to turn on various control modules. Most commonly this initiates the envelope generator, but it may be used for a variety of other functions.

The keyboard also has a memory. It remembers the last key (voltage) pressed and holds on to that voltage.

It usually has portamento (glide) capabilities providing slow or rapid transitions from pitch to pitch.

this is usually done by switching in a variable capacitance to the keyboard voltage output. the larger the capacitance the slower the glide.

POLYPHONIC V.S. MONOPHONIC KEYBOARDS

"Hey man — I can't play no chords on this!"

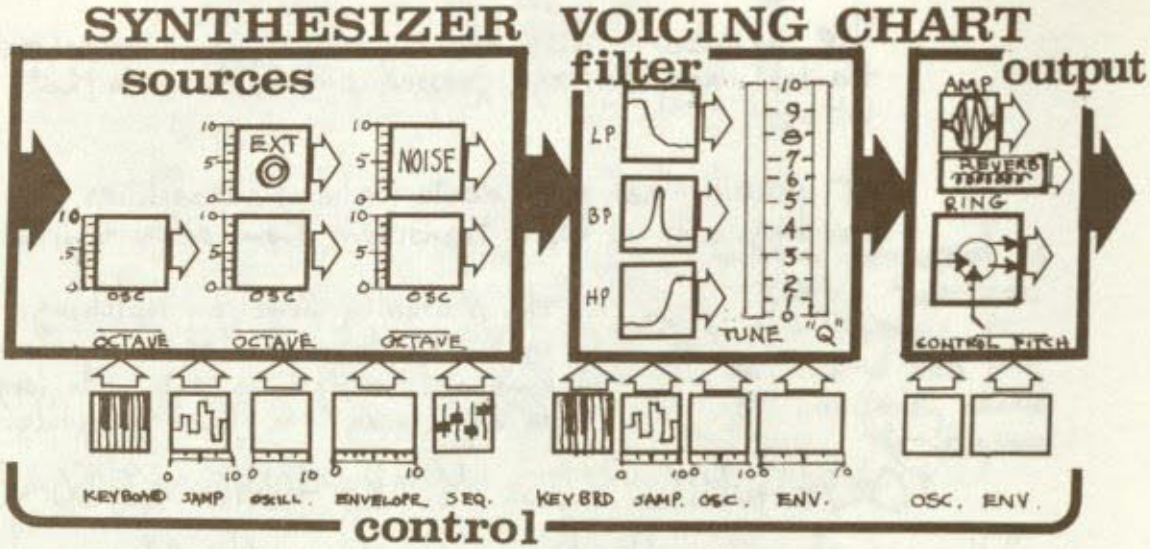
A keyboard musician is usually shocked on his first encounter with a synthesizer when he finds he cannot play three and four note chords. Our keyboard tradition is firmly rooted in polyphonic performance. Why is it — you may ask — most synthesizers are monophonic? Or if they are polyphonic, why is it a very limited capability - usually 2 notes at a time? Here are some answers to those questions.

1. Since a synthesizer gives you practically unlimited overtone capability; each note is capable of being an extremely complex non harmonic configuration. When you put together two or more such notes, the possibilities of odd cancelling, beating and intermodulation distortion become staggering. In other words many notes would be too distorted for human ears.

2. Synthesizers would have to have separate oscillators for each key making for a prohibitive cost.

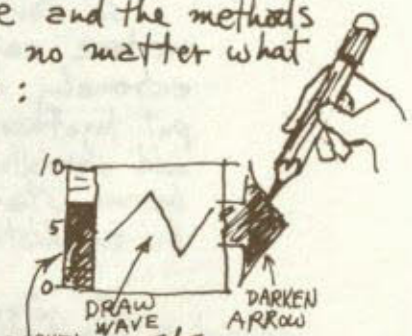
3. Composing and recording with a synthesizer usually involves doing two and three part harmony using multitrack recording, and using different voices for each part. The resultant chords are richer and far more distinct when built in such layers. I think there's much to be said for that method.

If you've gotta have polyphony — Go buy an organ.



SIMPLE Synthesizer S.O.P.

The chart above is a shorthand notation system for any synthesizer. It covers the most common connections you are likely to make. Going from left to right you mark your actions and choices on the chart by darkening in the arrows or drawing the waveforms. You'll learn quicker if you keep a record of what you're doing. Using the chart above and the methods below should greatly simplify the process no matter what instrument you are using. Here's How:



- Step one: Select your sound sources and/or oscillators. Draw the wave forms and mark the levels you are using. Darken the arrow.
- Step two: Choose pitch controls. Draw the wave and darken the arrow for these.

- Step three: Choose a filter and darken it's arrow. Mark the levels of pitch and resonance (Tune & Q).

- Step four: Choose filter controls and draw the wave forms and indicate levels.
- Step five: Choose modulator mode. A standard envelope is indicated by darkening the arrow on AMP.

- Step six: Choose output control and draw appropriate wave form. NOW YOU'VE GOT IT ON PAPER AND IN SOUND!

PATCHING

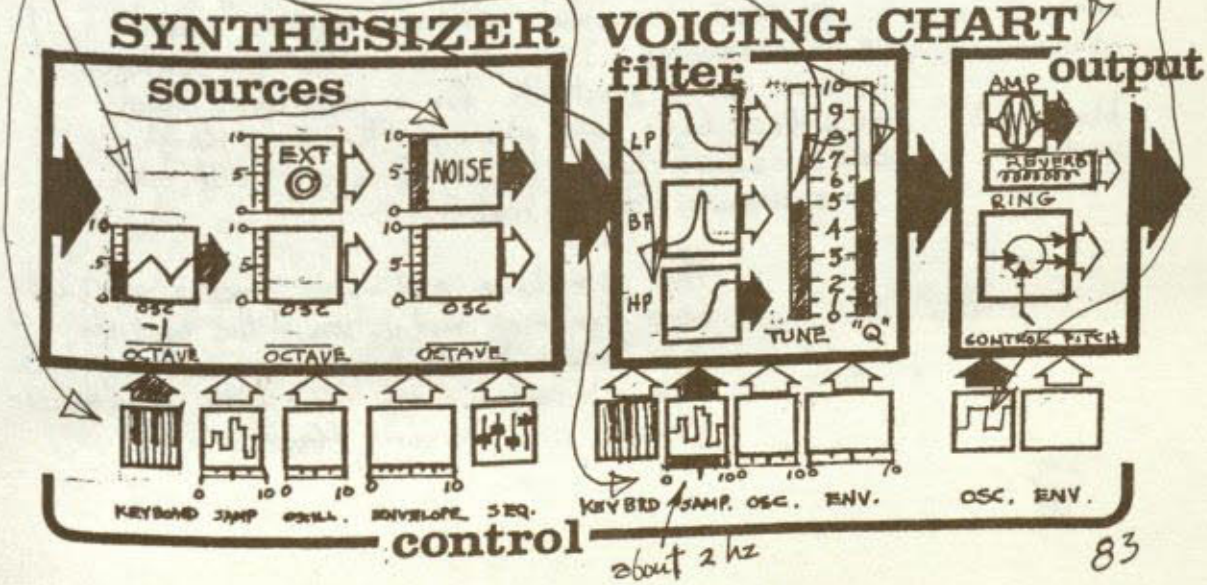
Synthesizers grew up as modules that were "patched" together by cables like a telephone switchboard. Creative procedures are still greatly facilitated by these "patch cords" even on synthesizers which have abundant switched and internal inter-connections. And the tradition still remains that the way you route the signal and the control voltages is called your "patch". The sheets which come with your synthesizer are called "patch diagrams". The voicing charts on these two pages are also "patch diagrams" but are not specifically meant for any particular synthesizer. There's an advantage in using these instead of the charts that came with your synthesizer. Here's why: While you're fooling around with your synthesizer you'll sometimes get a sound you really like. You quick get one of those "patch" sheets and copy every dial setting you've got. Now - even though you've got a record of that "patch" you don't have any idea how you got it or what to change to improve it. With the VOICING CHART, however, you are visualizing the process and prescribing it. You'll learn faster.

NOW TRY THE "PATCH" BELOW: Here's what you're doing:

① You're using noise as your principal source - with a little low-frequency triangle to give it a low pitch emphasis.

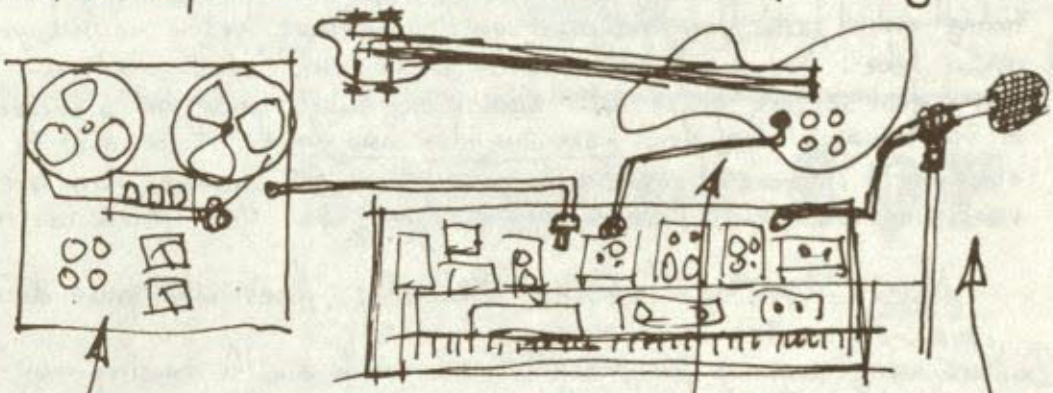
② You're activating it by keyboard and sending it to the HIGH PASS FILTER which has been tuned to middle frequencies with resonance at middle Q.

③ Now you're sweeping the filter with the sampler set very slow - and you're modulating your output with a square wave. It should sound like Cha cha cheechee Chuh Chuh



The Synthesizer as a SOUND LAB

People tend to think of the synthesizer as a super organ - probably because of the keyboard and its imitative voicing capability. They forget that a synthesizer is also a sound processing studio.



Things to plug into your synthesizer

A tape recorded piece may be "processed" through the filter and reverb sections of a synthesizer. You can also do some audio modulation (ring or amplitude) of the piece.

An electric musical instrument may be "processed" in the same way. I do not advise that the synthesizer be seen as a substitute for a WAH WAH pedal or a fuzz box or a phase shifter, even though it can do all of these -- I would hope it would find more sophisticated application.

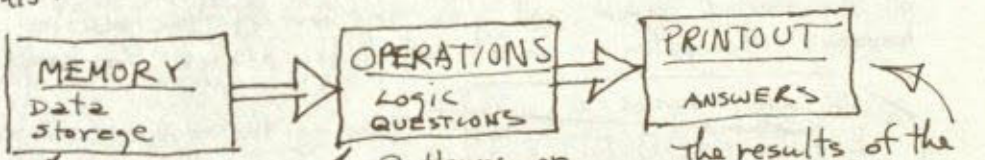
The microphone and voice process practically begs for ring modulation. The mystical man/machine relationship comes through with that. Mixing a singing voice with a synthesizer passage can be very effective.

doing it
BY THE NUMBERS

MAKING MUSIC WITH SEQUENCERS AND COMPUTERS — CAMP

Let's invent a word; after all it's the "in" thing these days. "C.A.M.P.": It stands for Computer Assisted Music Production. Now we can add our word to the list of similar abbreviations and contractions like Fortran or G.R.I.N.. Thus C.A.M.P. includes any use of computer hardware in the production of music. And that's what this section is all about. At one end of the spectrum you could list the template system used for setting patches on some synthesizers, or the punched card system used on the SYNKEY. That's Low CAMP. In the middle of the spectrum is the sequencer; and at the other end is the full-fledged I.B.M. computer. That's High CAMP. The trend in recent years has been to move toward the middle: the sequencer. Availability of smaller, more sophisticated logic components has made the sequencer much more capable. I have the feeling that the computer will become -- in music production -- simply an academic exercise in the near future, and the sequencer will dominate the CAMP world.

WHAT IS A COMPUTER? It's a process and it works like this:



Information is stored in some patterned way which makes it easily retrievable.

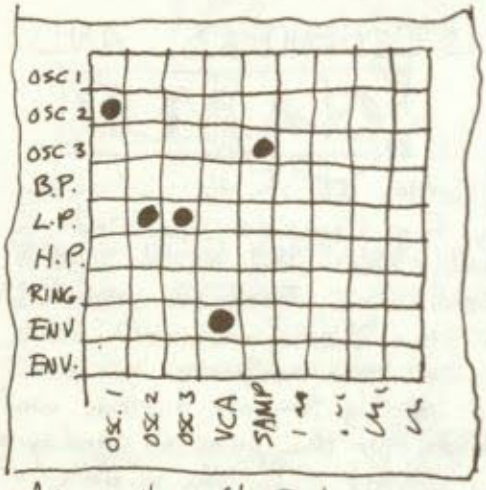
Patterns or logic systems use the data in storage in ordered ways to produce a result.

The results of the patterned data are used to control the behavior of some external device.

Obviously there's more to most computers than this would imply, but this simplification is a helpful way of looking at the computer process.

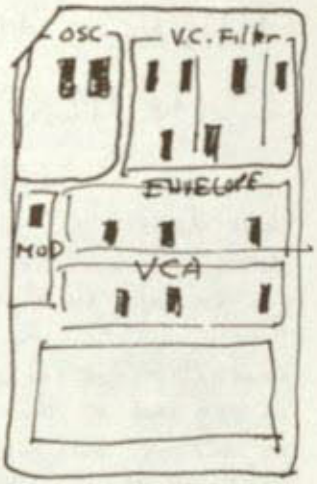
Let's start with the memory system. Tying a string on your finger is a memory storage system. Making a patch diagram is a memory system. Even a musical score is a memory system.

HERE ARE A COUPLE OF EXAMPLES OF THE SIMPLEST OF MEMORY SYSTEMS.



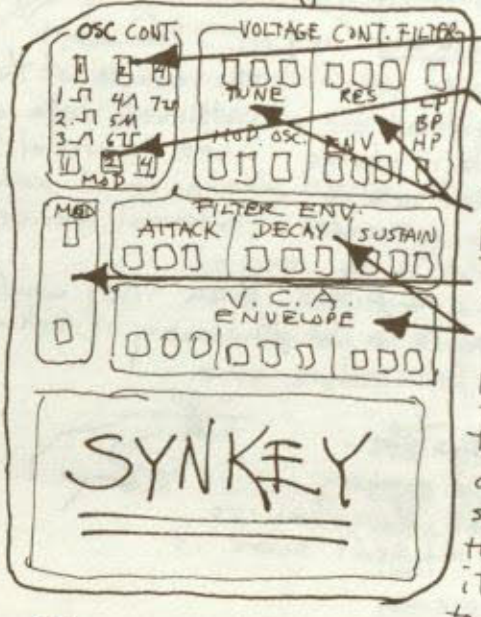
This is the old Putney Matrix card. You punch holes in the proper grids to "remember" a patch. Then, when you want to use that patch you put the card on the matrix panel and fill the holes with pin plugs.

LOW CAMP



The Synkey uses plastic punch cards to "remember" patches. When the card is inserted in the synthesizer contacts press through the punched holes to activate various patch circuits.

Patch memories are the most elementary of computer techniques. They are one small step beyond a patch diagram. It should be remembered that what they control is the parameter of the sound and not the pattern of the music. Nothing happens -- generally -- until somebody plays the keyboard.



Punching the appropriate numbers here will give you a root waveform.

Modulator oscillator is punched in to the desired strength for vibrato.

Punching numbers here is like selecting numbered positions on dials to control the filter.

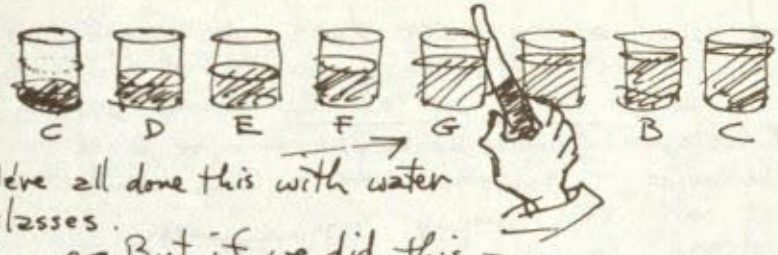
The shape of the modulation oscillator is determined here.

You have two envelope generators to program: one for the filter and one for the amplifier.

This patch memory does not include control of overtones, volume, portamento etc. For some of these, the settings are so critical that a quantized punch system can't handle it. For others, the choices must be made to suit the circumstances.

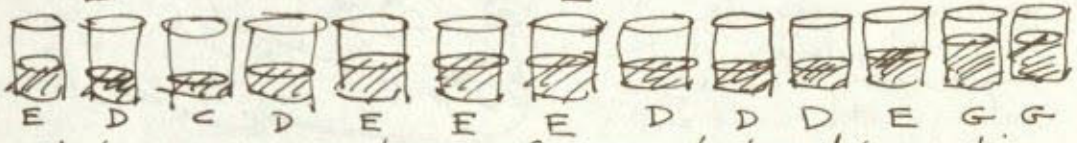
SEQUENCERS

PROGRAMMING IN TIME AND TIMBRE



We've all done this with water glasses.

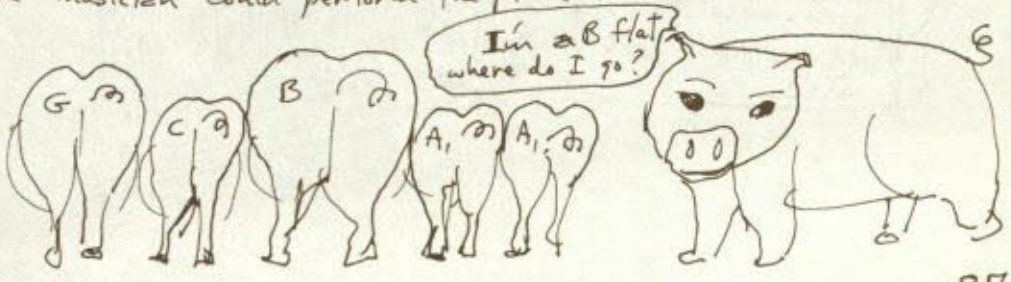
But if we did this →



we'd be using more glasses, of course, but we'd be creating a sequencer that has been programmed to play a phrase from MARY HAD A LITTLE LAMB. An advantage is that anyone can play the sequence, and much faster than an accomplished musician, simply by running a stick rapidly along the glasses from left to right. Running the stick the other way gives you a perfect retrograde permutation. A sequencer is like this -- but instead of filling glasses, you move sliders, or press keys, or punch cards.

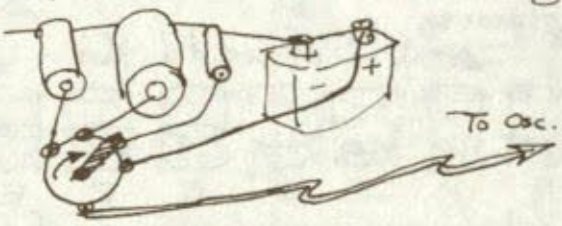
A Player Piano is a sequencer — HIGH **CAMP** - TOO!

Someone told me about an early instrument popular in Germany during the 18th Century known as the Pigaphone. Twelve pigs were lined up in stalls to form an octave of different pitched squeals. The musician played the instrument by running back and forth behind the pigs yanking the proper tails to generate the correctly pitched squeals. Playing a Bach piece could easily wear a man out! But if the pigs were lined up according to the pitch sequence of the melody, the musician could perform the piece in one run.



WHAT DOES A SEQUENCER DO?

To understand what a sequencer does, we ought to go back to one of the first essential principles of the synthesizer. A synthesizer is a VOLTAGE CONTROLLED sound system. Any source of voltages (under 20 volts) may be used to control the behavior of a synthesizer. One could string up a series of batteries of different voltages to produce a sequence of different pitches on the synthesizer. Turning a rotary switch would switch each voltage on in turn.



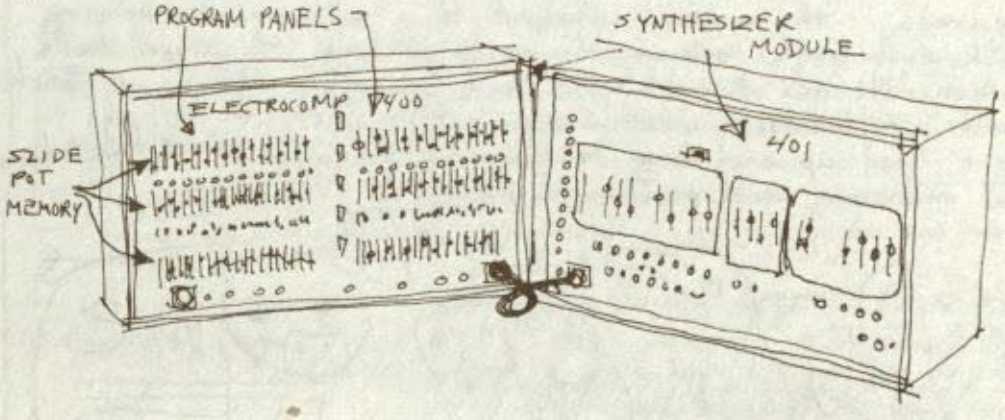
It's crude but true.

A sequencer starts there. It has a series of storage units which may be set to hold selected voltages.

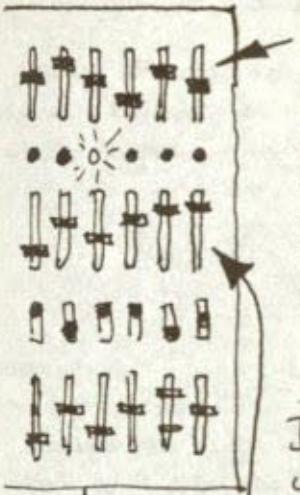
It has a clock which determines when a unit is "on" and for how long.

It has a traffic controller to direct control voltage flow to affect timbre pitch and duration.

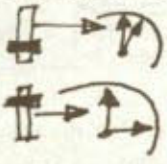
On most sequencers the "memory" consists of setting by hand a series of slide pots. The general idea of a sequencer is that it can be used to program a series of notes (in pitch timbre and duration) and play them at any tempo you desire. It's a super player piano.



USING THE EML 400 AS AN EXAMPLE - WE CAN STUDY THE SEQUENCER CONCEPT.



In the first row of the panel a series of slide pots give you a series of control voltages according to the setting of each slider. Normally, these voltages are used to "step" the clock. The "seconds" of our internal electric clock are determined by the voltage applied to them -



If the slider is set to zero voltage the clock will skip a beat. If the slider is set to 100% voltage the clock will stop and wait.

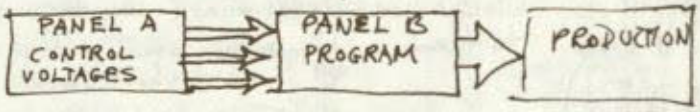
The second row of slide pots also provides a series of voltages. These may be used to select pitches. Here a device called the quantizer comes into play. You see, a potentiometer (the slide pot) provides a continuous gradient spectrum of voltages. If these are to be translated into the discrete pitches of our standard twelve tone scale they must be made into "quantum" steps. The quantizer "reads" the setting of the pot, and if it's above a certain threshold it adjusts to the specific voltage required for the nearest pitch. If it falls below that threshold it adjusts the voltage downward to the next semitone level. The effect is an octave in semi-tone steps. Indicator lights help you set each note.

The third row provides a series of voltages which may be routed to control the filter, the envelope or other parameters. Thus, as each note is sounded in the sequence a voltage appears from this row to be applied to the modifiers.

All three rows may have their voltages applied in different ways -- but using them in this standard way -- you can choose the duration, pitch and timbre of sixteen notes. Coupled with the second program panel you can do the same with 32 notes. With more interesting patches you can produce permutations and combinations in non-repeating series in the hundreds.

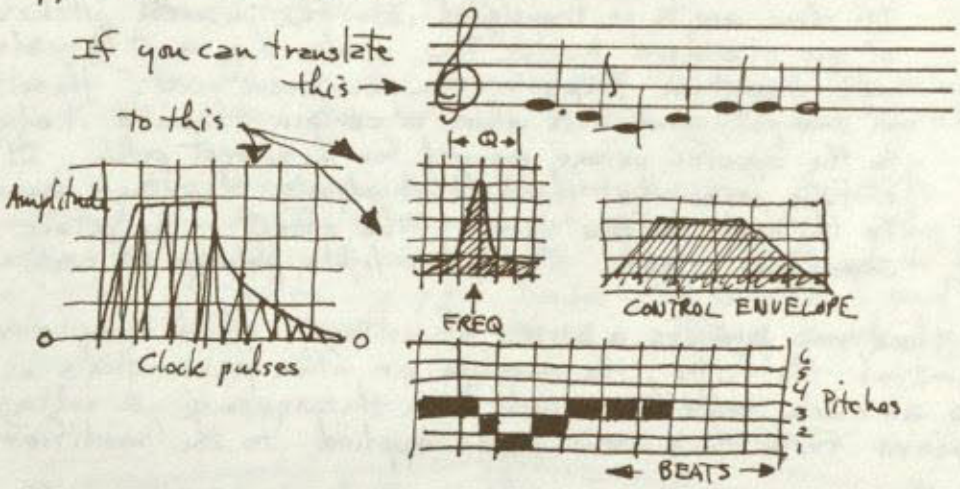
SOPHISTICATED SEQUENCING
HIGH CAMP

the more interesting applications of the sequencer come into play when the available voltage rows are used in more creative ways to manipulate figures or to compose a la Schoenberg and the serial system.



Here we come closer to a classic computer system. On a sequencer like the EML 400 you have two independent 16 station panels. When one is used to instruct or control the other, a melodic figure or a tone row may be manipulated and permutated practically endlessly. On some sequencers you can perform such procedures as inversion, retrograde progression, retrograde inversion, transposition, etc. Most of these may be accomplished by properly programming one panel to control the other.

Some very interesting patch diagrams may be found in the appendix for these.



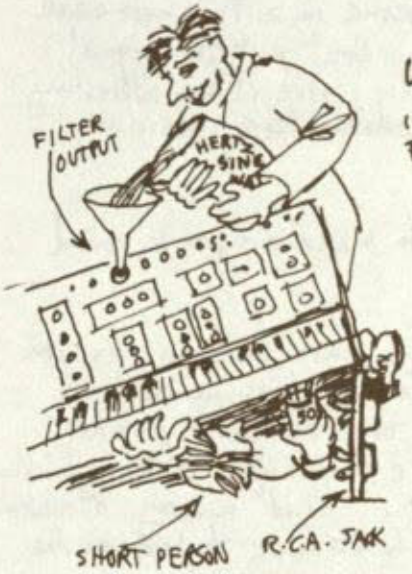
You can program music on a sequencer or a computer. the graphic material is a way of understanding the music in mathematical terms. The sequencer must have these translated into slide pot settings. A computer may have to be spoken to in Basic Fortran. An excellent description of large computer production of electronic music may be found in ELECTRONIC MUSIC SYNTHESIS by Hubert Howe, Jr.

Look for "Music 4BF"

ROUTINE MAINTENANCE

Every April 1st. the following operations should be performed by the owner/operator and will insure a long trouble free life for your synthesizer. It may also guarantee institutional care for you!

BACKWASHING the FILTER



Unfortunately, your manual seldom gives detailed instruction for this vital maintenance chore. Follow these 3 easy steps:

1. Lift the right end of the synthesizer with a double R.C.A. jack. (A single jack is not strong enough because of all the heavy vibes in your synthesizer.)

2. Send for the royal SHORT PERSON and have him get under the synthesizer with an empty 50 M.F.D. Condenser (Elec.)

3. Now, as you pour sine waves into the output of the filter, have the royal SHORT PERSON catch the overtones in the condenser.

Other Important Routine Maintenance ACTIVITIES INCLUDE:

1. Check the notch filter for burrs along the inner edge.

2. Check for erosion of the footings of the Wheatstone Bridge.

3. Check the ring modulator for worn or crooked rings. If the ring is out of shape a few taps with a leather mallet on a ring mandrel should true it up.

4. Check for dull saw tooth waves in the oscillator.

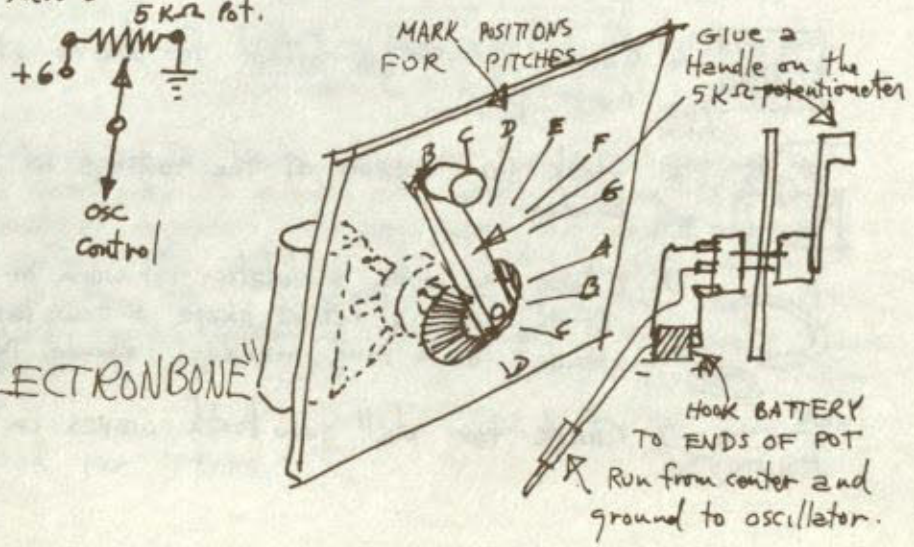
Chapter 5 - Class Problems

1. Using an oscilloscope, trace the evolution of a sound through the synthesizer. For example, start with a sawtooth wave from an oscillator. Draw or photograph the waveform from the oscilloscope at each stage. Add a square wave an octave higher and half the amplitude. Now use a control oscillator at eight cycles a second in a triangle wave to frequency modulate it - (Vibrato). Next put the signal through a high pass filter. Finally, give it an interesting envelope. Experiment with various parameters, recording each stage visually and sonically.

   It might be worthwhile to make a super 8 sound film of these stages.

2. Develop the habit of writing down your patches as you make them. A valuable project for a class would be to develop a notation and file system for synthesizer patches. It's particularly important to be able to change patches quickly in the middle of a live performance. Find a way of making patch notes on 3x5 cards which can be taped on the edge of the synthesizer when you're working.

3. Find other means for controlling your synthesizer. For example: Take a voltage from somewhere - say 5 or 6 volts from a battery - and make a gadget like this:



AN "ELECTRONBONE"

chapter 6

HOW TO SCORE

visualizing sound

Why Score at all?

In the tradition of music and music notation - the composer has usually not been the performer -- which means that what he wrote was a set of instructions for someone else to carry out. The earliest scores were intended to precisely preserve the intonation of the liturgy of the mass. Thus, scores have traditionally served to:

Tell someone how to make the music
and/or To record it for posterity.

DO THESE NEEDS STILL EXIST?

Thinking of the score as instructions for someone else — In all of the arts, this process is unique. With the exception of Playwrights, no other artist/creator was so far removed from the actual execution of his work. For example, it would be unthinkable for a sculptor to hand a piece of paper to a group of craftsmen with instructions for carving a masterpiece. Composers were different animals from performers. The performer/interpreter became an "artiste" with a special talent for translating the written code of music into sound. Now — a score is more likely to be instructions written by the composer for himself as he proceeds to execute the work on synthesizer and tape. Maybe the score ought to be different for that purpose.

THE NEED FOR SCORES STILL EXISTS - BUT THE LANGUAGE HAS TO CHANGE WHEN YOU'RE INSTRUCTING YOURSELF — OR A MACHINE —

The language of notation developed around the technology of musical instrumentation. the five line staff for example, may well have risen out of the fact that we have five fingers with which to pluck strings or cover holes. Our choice of scales, natural pitch and harmony was developed out of our understanding of the harmonic overtones of a vibrating string - the natural harmonic series. the notation system that rose from that became a beautifully evolved code of language that served us very well — very well that is until the age of ELECTRONICS. Now - the technology is different -- we're talking to ourselves -- and the works are recorded for posterity on tape.

With the new spectrum of potential opened by ELECTRONMUSIC - the traditional notation system does not appear to be adequate. As we have said, the composer is often also the performer, constructing his work in layers on tape. He's not writing instructions for someone else. He's carving his own sonic sculpture.

So why write it down at all?

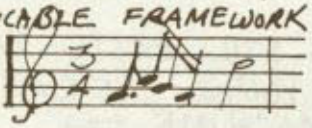
I think we should - but for new reasons - and we should re-think the whole concept of notation.

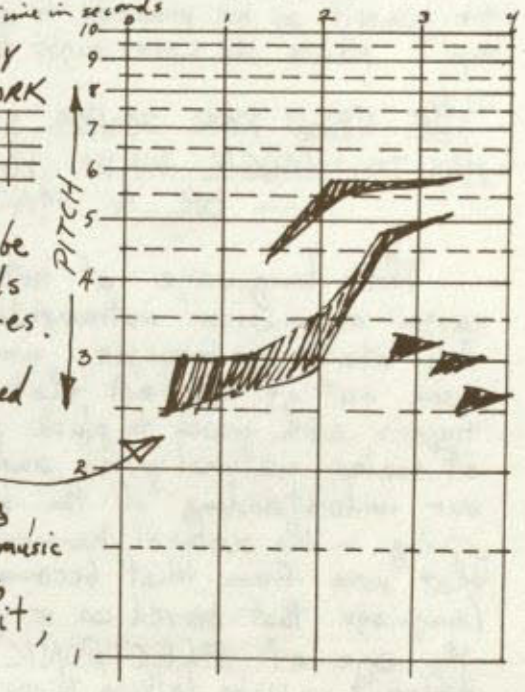
Personally, I think it would be a shame if we totally lost the writer-performer relationship. I'd like to see what happens to a musical concept as it is passed to other generations and new technology.

~~Then - too~~ - SCORES ARE PLANS - sketches - and the complexity of sophisticated multilayered music can demand a carefully designed chart or road map even when you're producing it yourself.

What I'm suggesting is - that we need a scoring system as much as we ever did even if our utilization of it has changed. We need a new way of describing music -- of instructing our machines and ourselves in the realization of a concept.

A LOGARITHMIC GRAPH MAY BE A MORE SERVICABLE FRAMEWORK THAN THE 5 LINE STAFF.





Perhaps time should be described in terms of seconds instead of beats and measures.

Perhaps - notes should be pictured differently

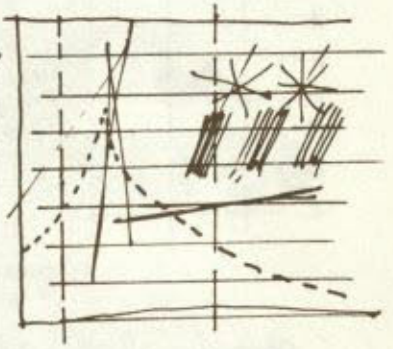
We need to go back to the beginning start from scratch - rediscover music how to describe it; and to whom; how to conceive it - how to make it; and perhaps how to hear it.

We need to understand that the modern idea of the score is that it is a POINT OF DEPARTURE, a stimulant for highly creative, very individual interpretation! A score today may simply suggest large conceptual blocks within which the performer improvises with extremely wide latitude. Scores which are specific, detailed and precise are most likely to be intended for computers — rather than performers.

BASIC Fortran or CREATIVE VISUALIZATION?

We have to know the intent of the composer and be prepared to accept either the automatic emotionless performance of the computer — or the totally individual "reading" of a liberated performer/constructor.

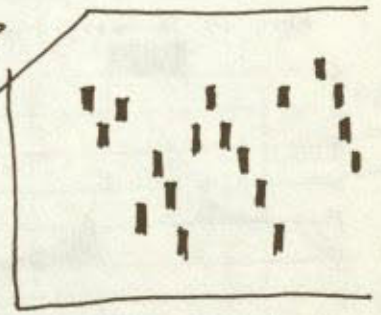
How do you read this?



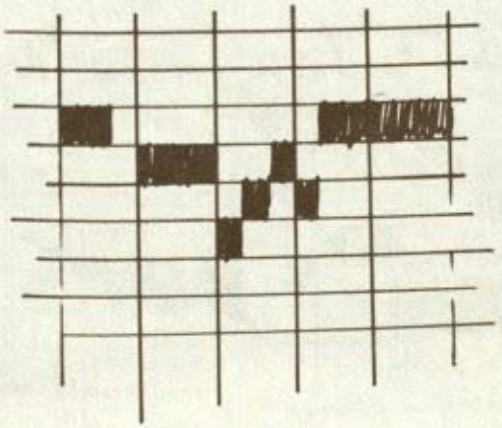
OR this?

```
      Subroutine initl
      Common P(480),SR,N
      Dimension A(13,6),I(6)
      Data A/78*0./
      Real Linens
      Return
      entry setup.
      A(1,N) = P(4)
```

OR THIS?



OR THIS?



We can no longer accept anything as gospel. What's so sacred about reading from left to right, for example?

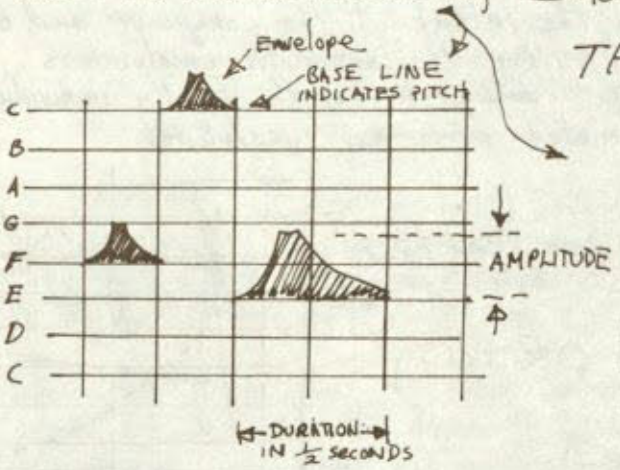
LET'S RE-DEFINE THE NOTATION PROCESS - CREATE A NEW LANGUAGE FOR MUSIC.

Notes

So let's look at some different and possibly some new ways of visualizing music; and ask ourselves some searching questions. Many modern composers have done just that.

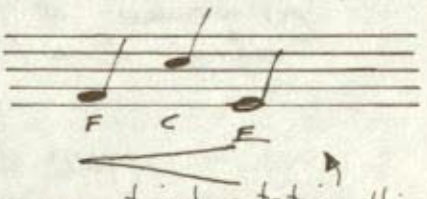
SHOULD A MUSICAL NOTE DESCRIBE MORE THAN THE PITCH AND DURATION OF THE SOUND? SHOULD IT SHOW THE ENVELOPE?

These two describe the same thing



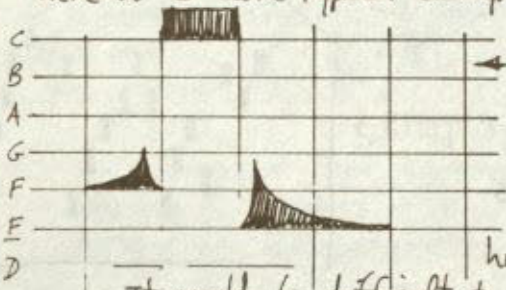
SHOULD IT SHOW TIMBRE?

THE WAVEFORM?



In conventional notation this reads two quarter notes and a half note with a crescendo on the last note.

Obviously, if there are no frequent changes in envelope or amplitude, as in the case above, the traditional method is fine. But here is a more typical example of electronmusic.



Now, the first note has a slow attack and a rapid decay. The second note is an abrupt burst of tone with neither attack or decay periods; and the last has a sharp attack, high amplitude and a long decay.

It would be difficult to describe that in conventional notation.

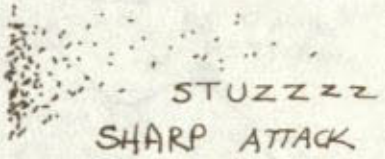
HOW ABOUT THIS?

The first note dips down in pitch and then glides up to the second note - with medium amplitude first - small amplitude in transition, ending at medium amplitude in the second. The third note starts below pitch with a sharp attack, decays slowly into a diminishing vibrato while rising in pitch.

How would you write that?

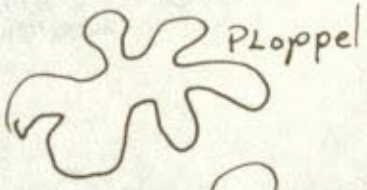
SHOULD NOTES LOOK LIKE SOUNDS?

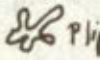
HOW ABOUT WHITE NOISE?

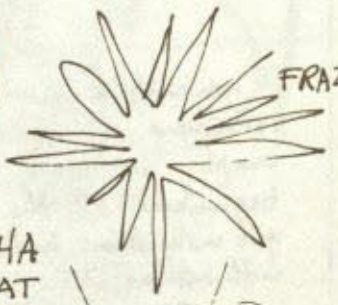


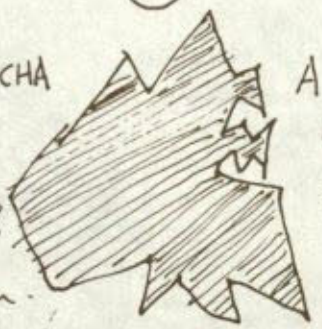
HOW ABOUT THESE?

SOUND SHAPES



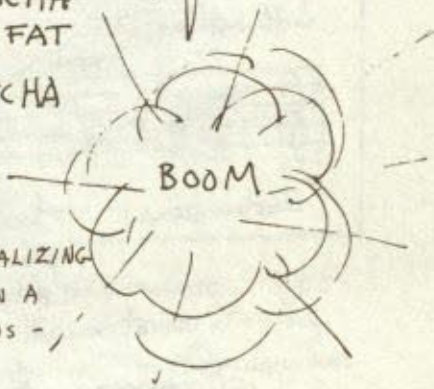






Q. What do you feed a 400 pound SKUNCHA?

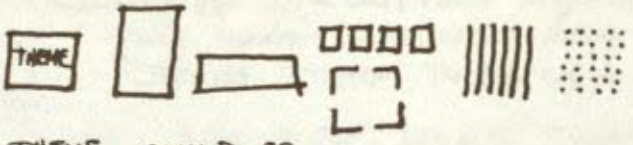
A. Anything he wants, Man.

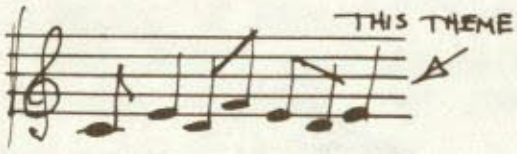


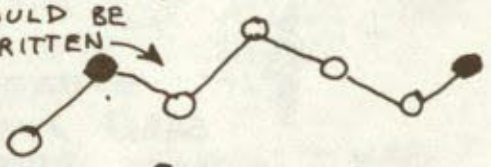
TRY VERBALIZING SOUNDS ON A CROWDED BUS -

DA DA DA FRIZZBOOM Dinggg

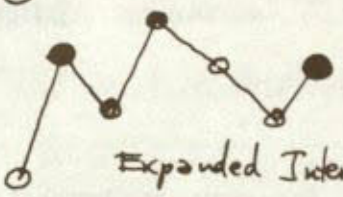
THEME AND VARIATIONS

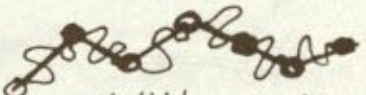






Traditionally, thematic material like this might be manipulated in a lot of ways. Such variations can become more obvious if we picture them differently.

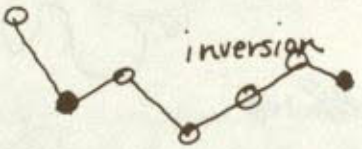




THEME

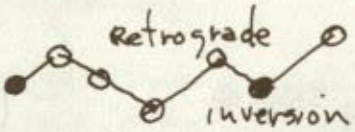
THEME

THEME

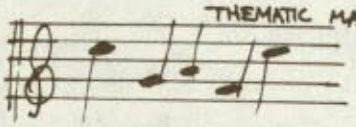


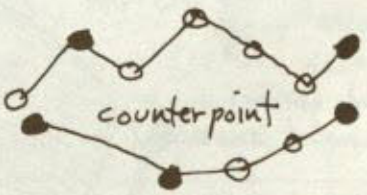
⊥HEWE

ƎNƎHT⊥



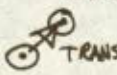
If you establish a vocabulary of variations, it may be convenient to simply articulate the theme at the beginning of the score - and thereafter give instructions and codes for variations without notation. FOR EXAMPLE:

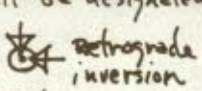


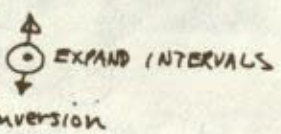


Instructions: Theme shall be rendered straightforward at points designated thus: (center dot indicates pitch)

Variations will be designated thus:







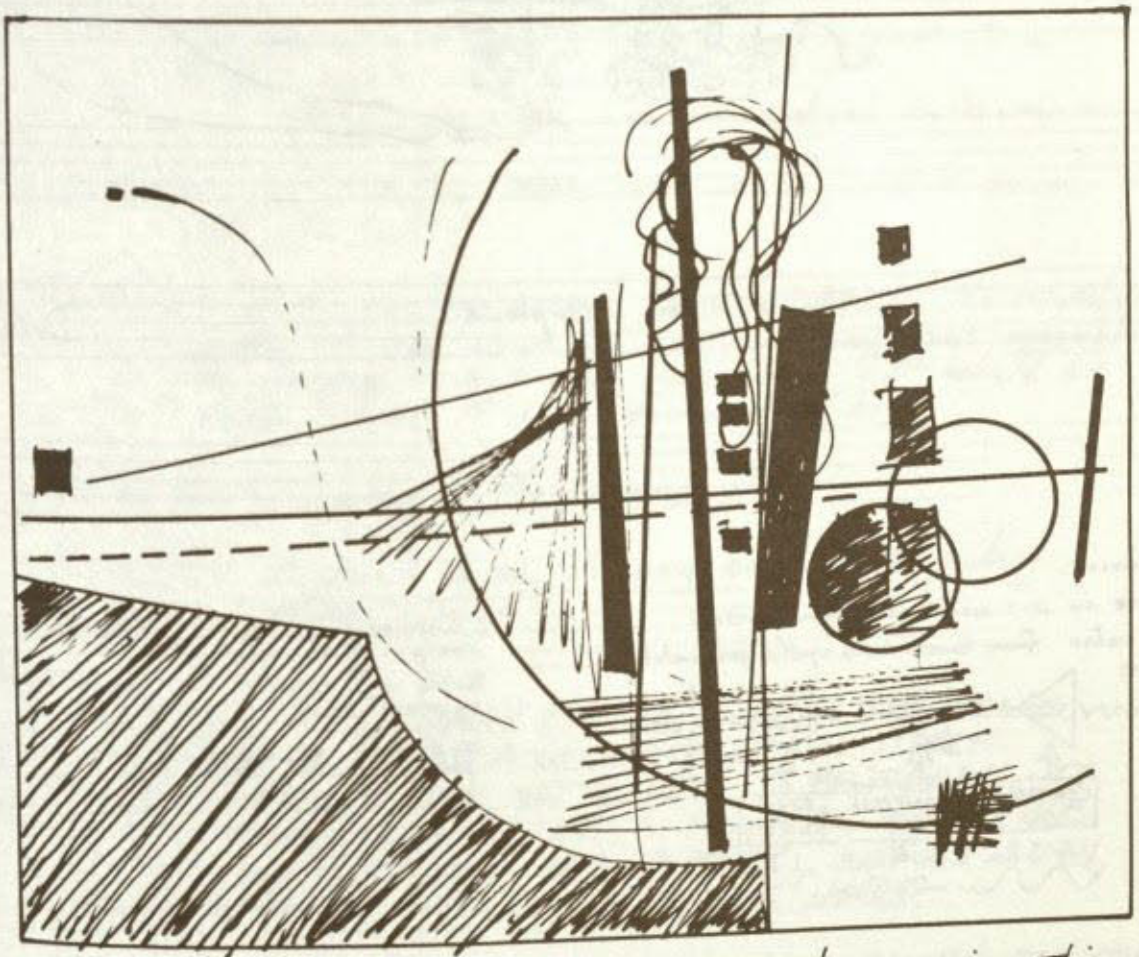
INVENT! VISUALIZE! DARE!

THIS IS A SCORE?

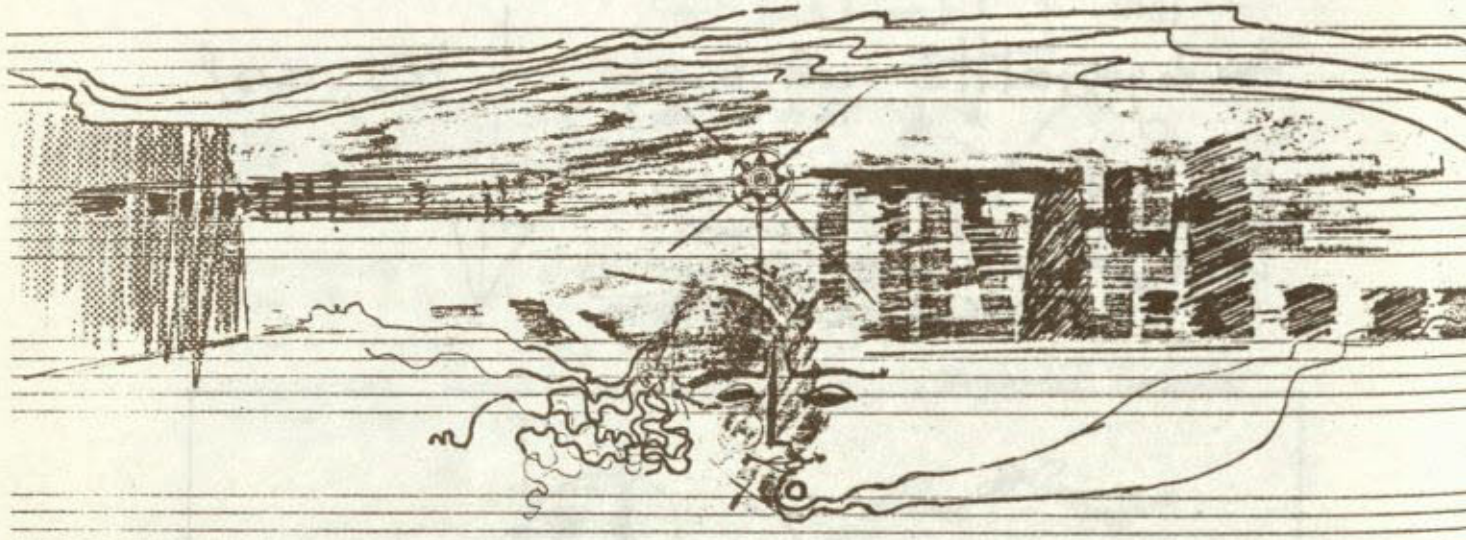
How do you read it? Left to right? Top to bottom?

YES, IT IS!

YOU DON'T "READ" IT - YOU COMPREHEND IT AS A VISUAL WORK OF ART AND TRANSLATE IT TO A SONIC WORK OF ART.



This is a vital concept for understanding modern music. This requires a creative esthetic sense. It requires a daring departure from the note for note training of most musicians. You have to "hear" the visual work and "see" sounds. No machine yet devised can do that!



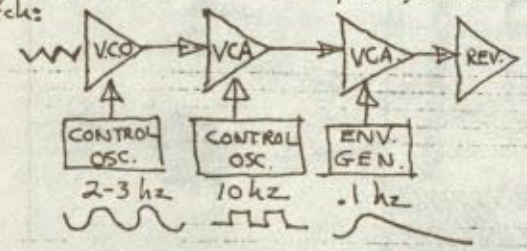
theme for Orpheus.

Sound Sources:

White noise in 2-3 second oscillation - SUSTAIN

Gurgling water from brook with synthesized imitation

Use patch:



Whispered unintelligible female voice should emerge from waters.

Entry and exit to sonic space should be imperceptible.

Synthesized or actual fog horn melody should provide reality base.

Audience should be submerged in phonic ocean.

Time: 4 minutes to 10 minutes

THIS IS A SCORE, TOO!

Even though it was produced on music paper it has no relationship to the standard pitch designations the paper implies. the only reason it's on music paper is to remind us it is a score for music.

AS YOU CAN SEE, SOME DIRECTIONS HAVE BEEN GIVEN FOR A 'SYNTHESIZER PATCH', BUT MOST OF THE INSTRUCTIONS WOULD APPEAR FACETIOUS OR AMBIGUOUS TO THE ARCH CONSERVATIVE MUSICIAN.

This piece has been produced and is part of a larger work called PRALAYA.
Yes! the work has been produced by the composer.

QUESTION: If someone else produces it, will it sound like the first?

ANSWER: If the "performer" is sensitive to the subjective content of the score, it will, in many ways, resemble the original -- but only resemble. It would be rare indeed if they sounded alike.

QUESTION: Shouldn't they sound alike?

ANSWER: I can't think of any good reason why they should!

IN THIS, AS IN MANY MODERN WORKS, THE SCORE IS CONCEIVED AS A WORK OF ART IN ITSELF. ITS DESIGNS ARE NOT CODES TO BE "READ". IT IS A VISUALIZATION OF A MUSICAL EXPERIENCE. THE INSTRUCTIONS ARE POETRY, AND AS SUCH, GUIDE THE HEART NOT THE HEAD.

THE BURDEN IS UPON THE PERFORMER/CONSTRUCTOR— AND THE RESULT IS AS MUCH HIS CREATION AS THE COMPOSER'S.

Celestial Pavan ~ Composition for electronic tape ~ score

DeVoe

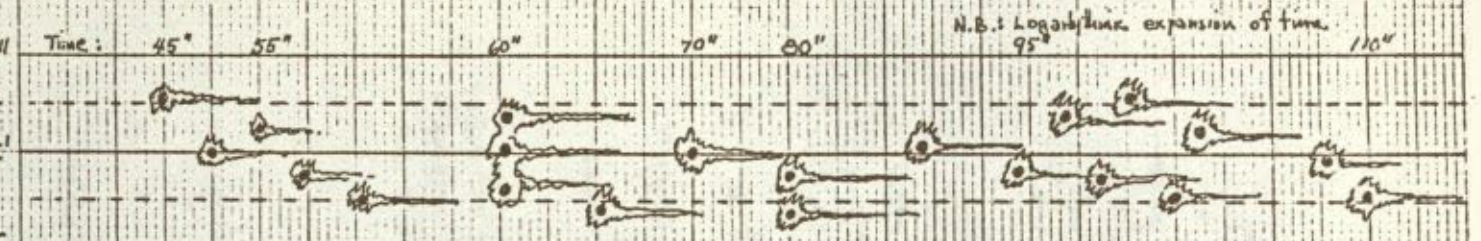
90/

A

Thematic Material:

Choral voices (female)

Pitches programmed and modified according to chart at right:



Tape echo on each note
pass signal from channel to channel four times
To produce rotating intermodulation distortion.

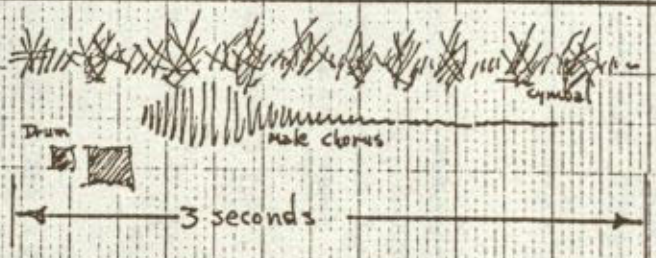
Pan at random across stereo channels.

Above configuration is an approximation of the themes manipulation of above figure; may be continued at the discretion of the performer/recordist.

B

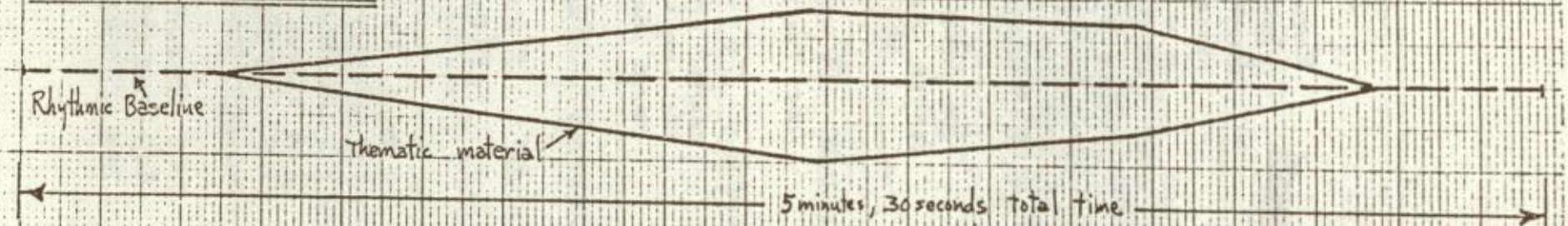
Rhythmic Baseline

Tape loops: echoed—drum; male chorus and brushed cymbals



Sustain Baseline throughout composition

Overall Amplitude Schematic



Composition conceived, written and executed: 1965

Robert A. DeVoe

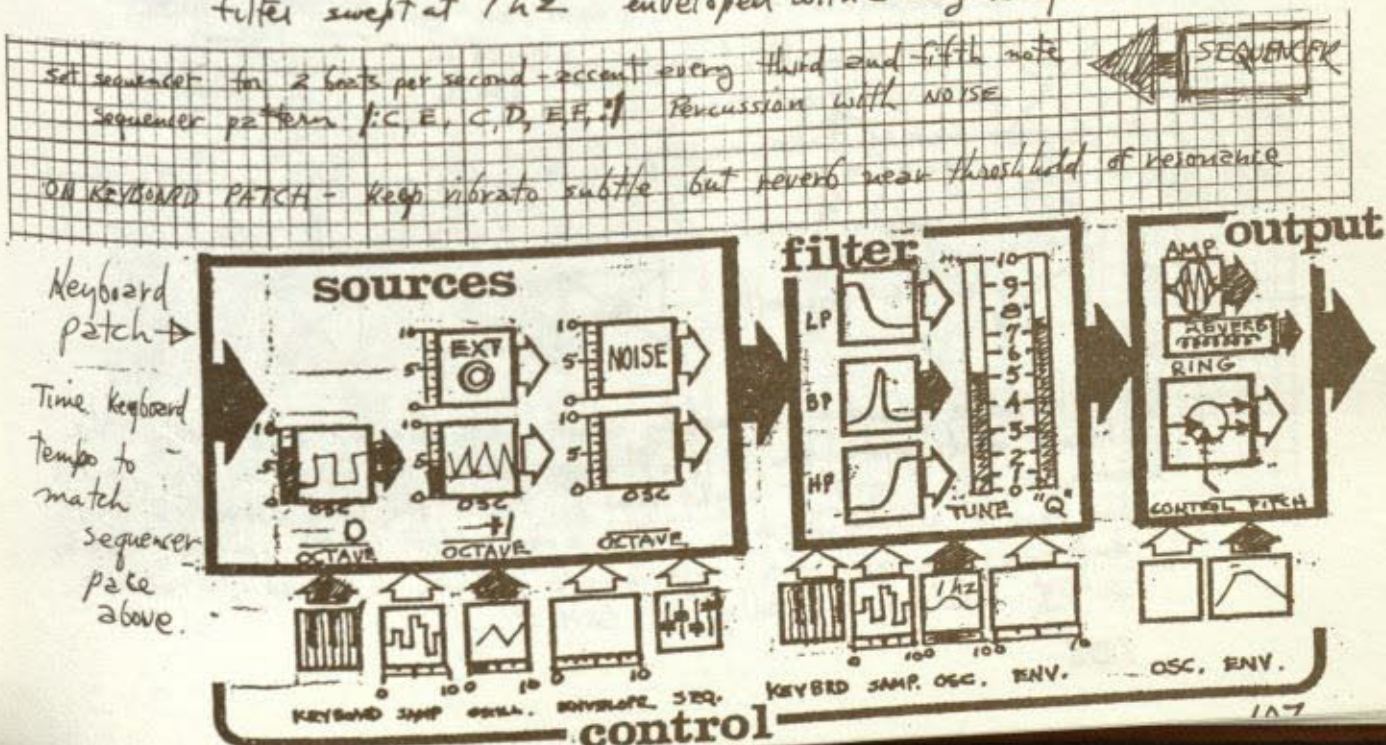
CELESTIAL PAVAN is a different kind of score. Certain larger parameters are well defined. Details are quite vague. Notice the logarithymic expansion of time; the pictured sounds.

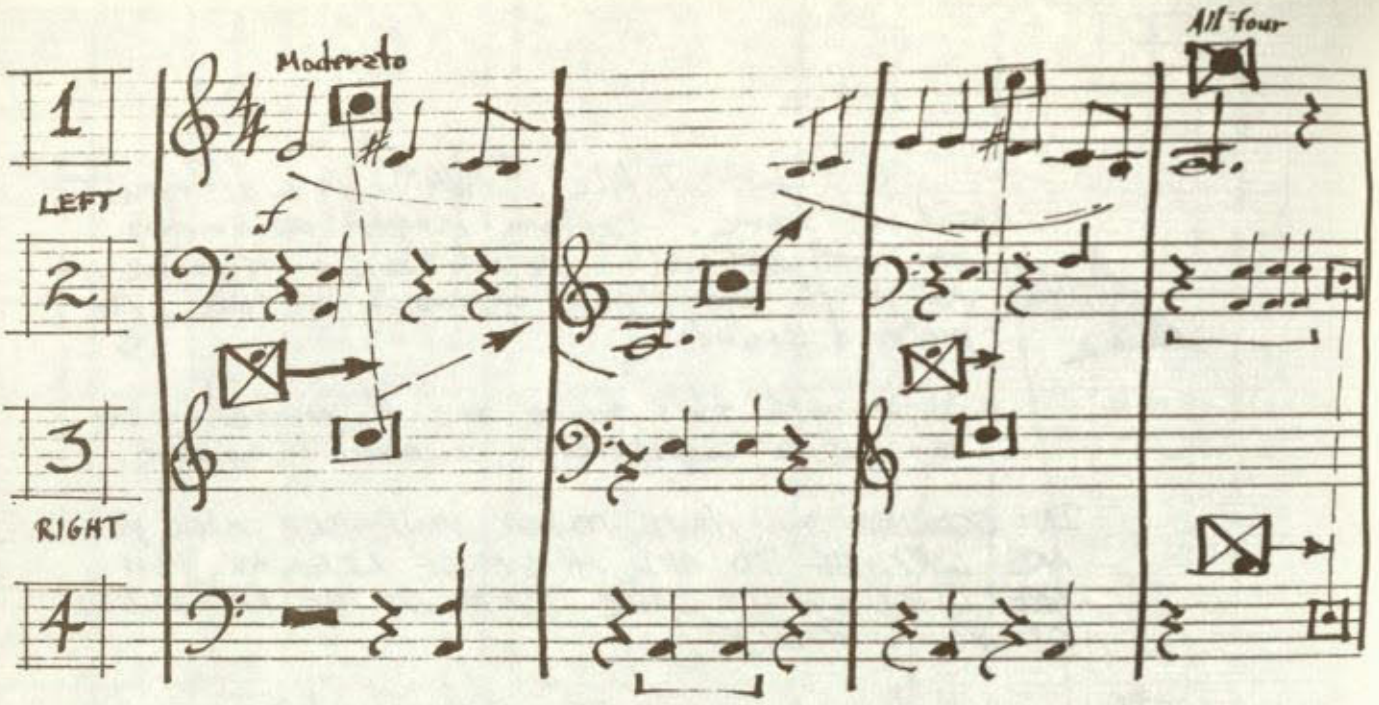
With both this score and the preceeding one an entire composition is conceived on one page.

IN SCORING YOU HAVE TO ASK YOURSELF WHO YOU ARE WRITING TO AND HOW MUCH LEEWAY YOU ARE WILLING TO GIVE THEM IN THE PRODUCTION OF YOUR PIECE.

If you wish to be very specific, conventional notation is still not the answer in most instances. Essentially, the things you want to be able to designate with precision are PITCH TIME (Tempo) AND TIMBRE. Other kinds of score paper may serve those needs better. Most modern scores need a kind of legend at least on the first page. I like to use the synthesizer voicing chart as part of my legend with other specific instructions nearby. For example:

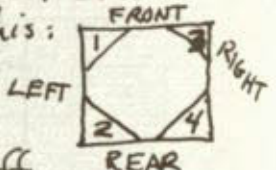
This legend calls for a sequencer percussion cycle against which the keyboard passages are played. Note that the keyboard patch is explicit with oscillators set at square and triangle waves run through a band pass filter swept at 1 hz enveloped with a long decay and reverb.





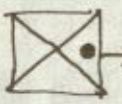
SCORING FOR QUAD

Here's a special kind of spatial syncopation. In this case traditional notation has been modified for a quadraphonic situation. The four tracks are numbered as they appear on the tape deck - one staff assigned to each track. In the listening space they would be heard like this: Thus by writing on different tracks the sounds are spatially organized.

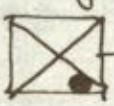


This symbol  placed anywhere on the staff, and connected to another by a dashed line, indicates that the notes should be heard from both channels —

THIS symbol indicates the position the sound should take in the quad space. The dot in the example shows the sound coming from channels 1 & 3 equally.



3 & 4 equally



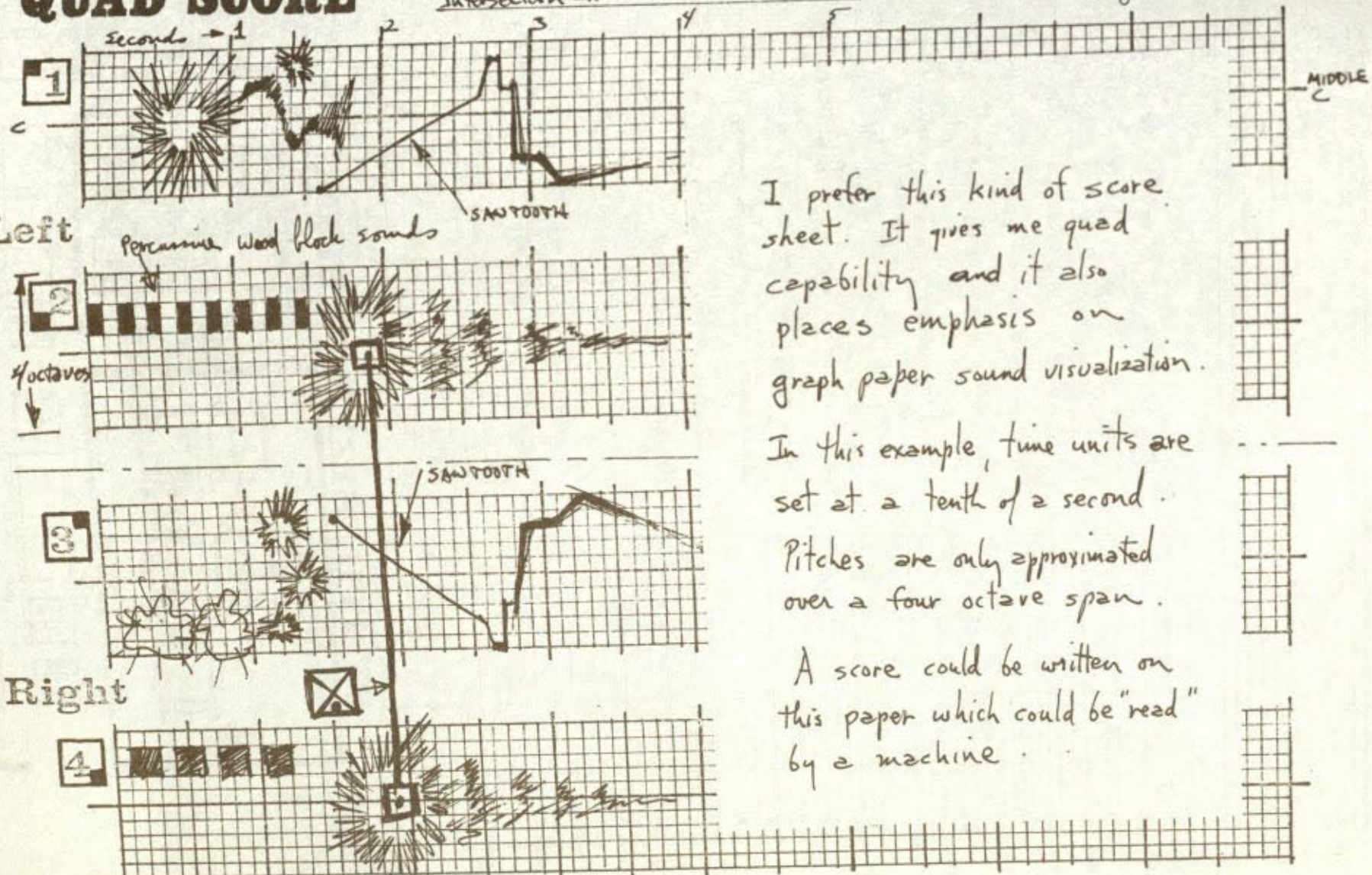
2 & 4 But mostly 4

In the piece above - the melody starts equally on 1 & 3 (Front). The phrase ends alone on 2 (left rear) while the bass line has jumped from 2 to 4 (left to right rear). Then the bass straddles 3 & 4. The phrase starts again on track 1, (left front) spreads to 1 & 3, and ends on all four. Meanwhile, Bass has been straddling 2 & 4 ending equally on both.

QUAD SCORE

Intersection II

Page No.



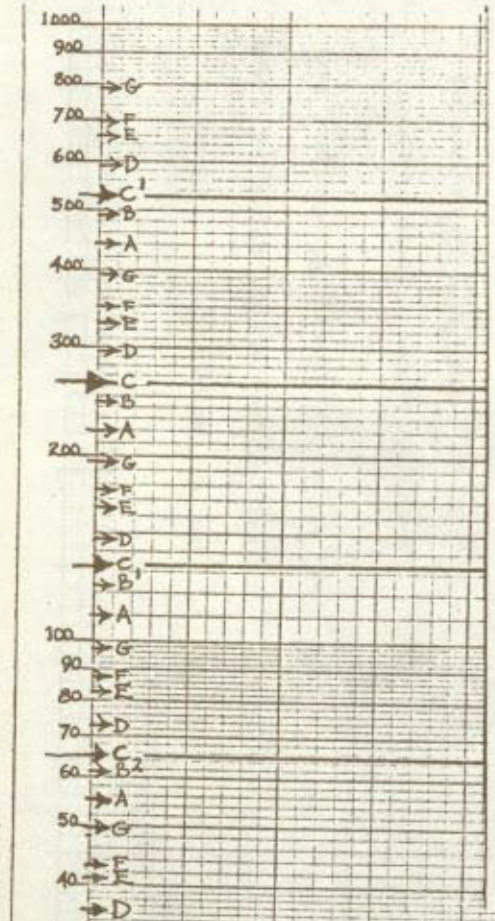
I prefer this kind of score sheet. It gives me quad capability and it also places emphasis on graph paper sound visualization.

In this example, time units are set at a tenth of a second. Pitches are only approximated over a four octave span.

A score could be written on this paper which could be "read" by a machine.

SCORE SHEET

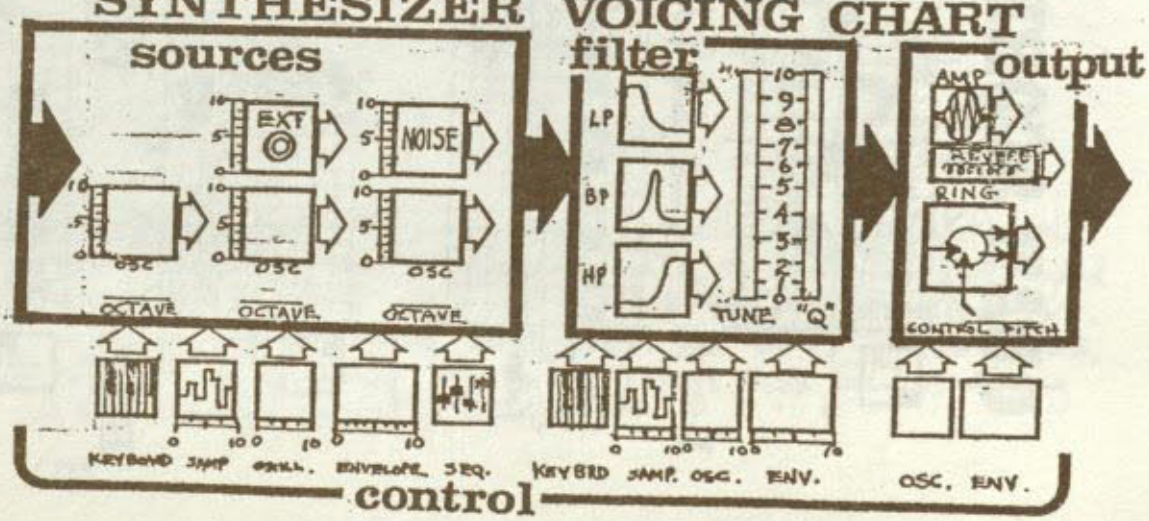
Page

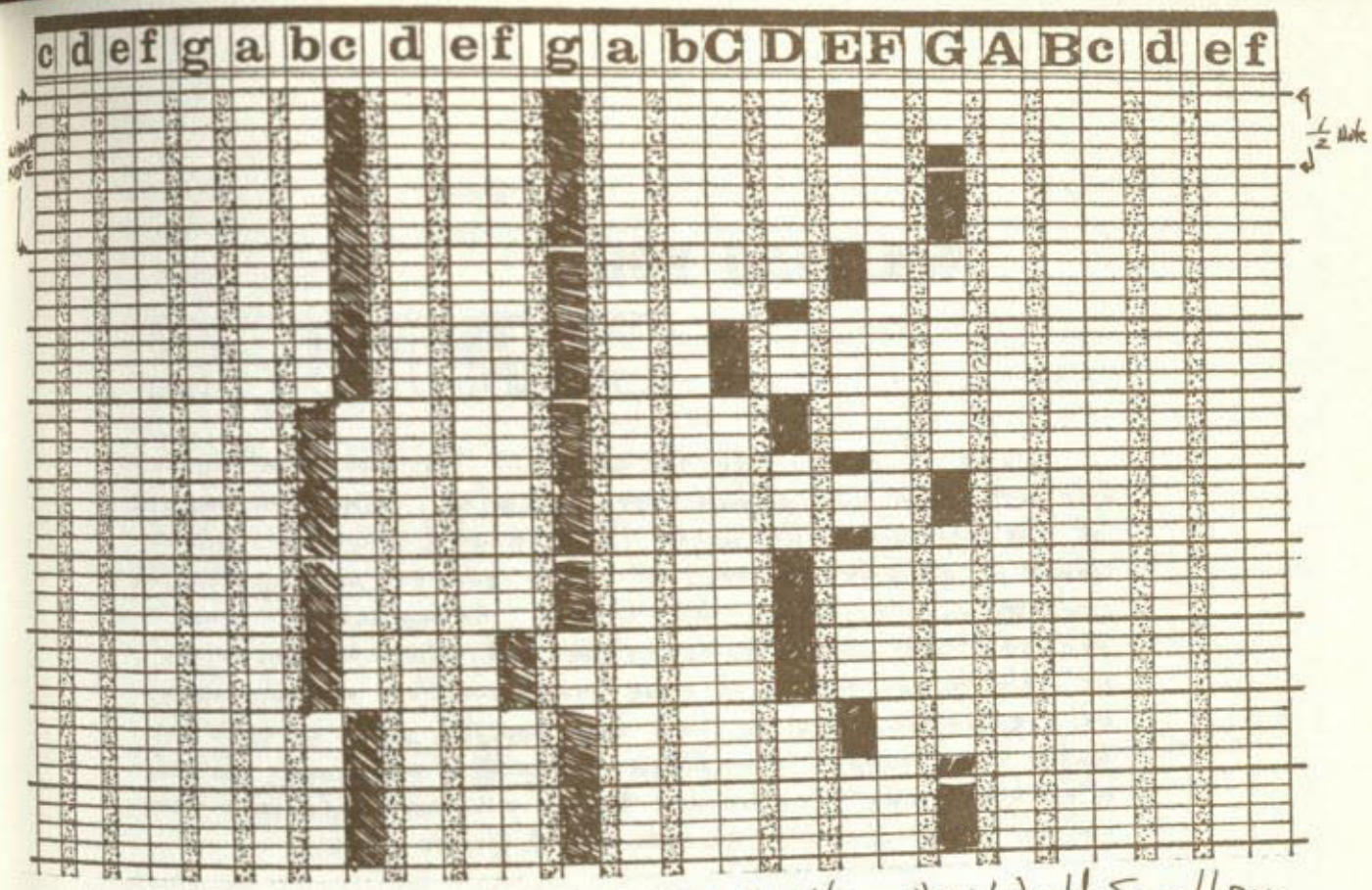


This kind of score paper let's you eat your cake and have it, too.

The five line staves at the top give you a traditional space to define a melodic figure. The semi-logarithmic paper in the center gives you a graph of the most likely to be used part of the sound spectrum. It's a four and a half octave spread if you use the legend supplied. This should help you to visualize other electronic effects in close pitch relationship to the melodic figure at the top.

The voicing chart at the bottom may, of course, be used for the melodic figure or the supporting electronic orchestration.

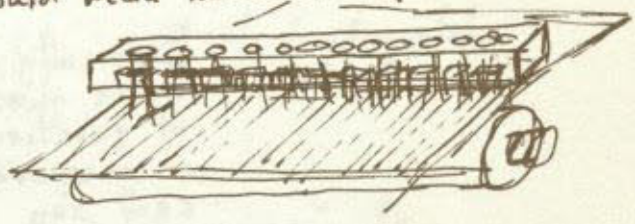


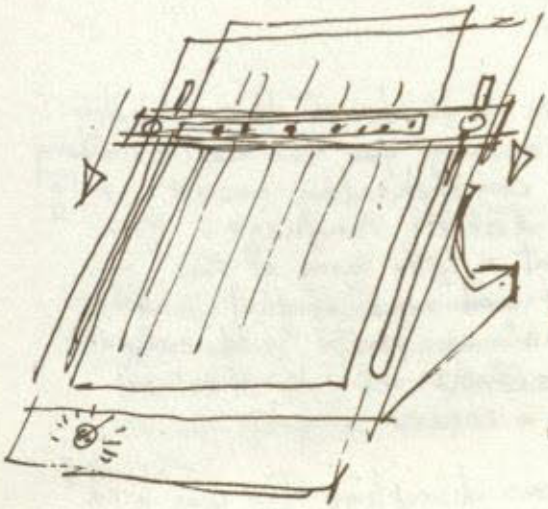


THEME FROM ANTONIN DVORAK'S New World Symphony

Maybe music for keyboard ought to be written on this kind of sheet. For keyboard beginners this would seem to be a logical way of writing. You read from the top down, and the black marks show keyboard finger positions. Time is shown by the horizontal lines. Obviously this score paper lends itself to being "read" by a machine

An array of lights and photocells could "read" the score.





You could put the score in a controlled reader device like they use in reading labs to practice tempo.

WRITING FOR COMPUTER

While it is outside the scope of this book to attempt to give instruction in computer programming, some comprehension of the approach one might take toward computer synthesis would be valuable. Essentially, to address a computer, the composer must simplify his thinking, be methodical and precise. We may, as creative subjective human beings, be able to conceive with ease some complex musical concepts; but we seldom realize just how complex such concepts are until we attempt to explain them to a machine. To tell a machine what you want it to do, you must subdivide your concept into discrete quanta of digestible data.

A parallel example may be seen in the actions of a basketball player. Imagine the incredible coordination of mechanical functions involved in dribbling the ball as he runs toward the basket, leaping with ball in hand to project it at the top of his leap into the basket and catching it on the rebound. Most of us can do that with ease; but could you write a series of instructions for a robot to do it? You would have to divide the process into minimum steps or "bits". Music notation has always involved a certain degree of that skill; but the need for quantizing, extrapolation and sequencing is heightened in computer music.

Basically, you have to think of the computer as a questioner asking you the most elementary of questions and comprehending answers only in unequivocal and discrete language. You can't say "I want a little more of this" or "sometimes we could add some of that." When you say "pianissimo" or "presto", the computer wants to know how soft or how fast in relation to what.

If nothing else - it's marvelous discipline for your head!

Therefore, the procedure for writing for computer should involve entering into a dialogue with the machine in which you answer these questions:

Tell me about time: How fast do you want my clock to tick? Do you want me to emphasize any of the ticks? By duration or amplitude?
Tell me when you want each sonic event in relation to my ticking clock.
Tell me which events you want to have happen simultaneously (chords) and which you want in sequence (melodies).

Tell me about sound: What waveform should the fundamental of the first sound look like?
what partials should I add to it? How many?
At what intervals?
and what amplitude?

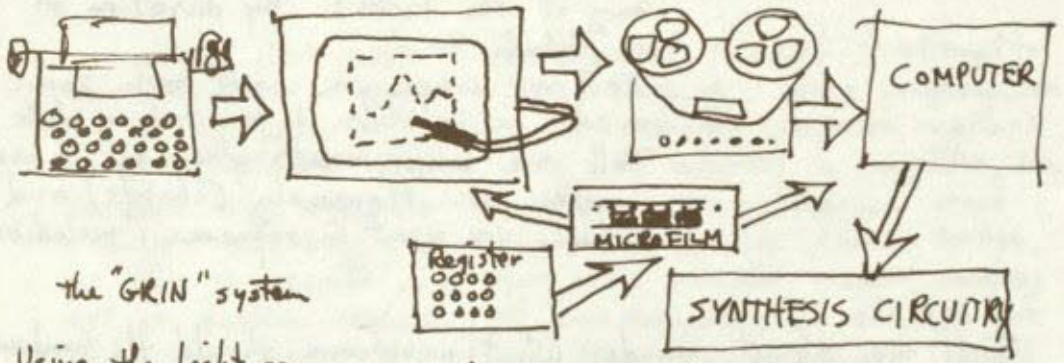
May I use those instructions to create the second, third and n sounds in your series, or must I stop after each sound to receive new instructions?
- or -
May I use those instructions for each note unless that note is preceeded by a signal to make a change?

What pitch shall the fundamental be in each sound you order?

ETC. ETC.

Various computers "understand" various "languages". In other words, your answers to the questions above must be presented to the computer as binary bits or basic Fortran or as graphic designs, or combinations of these.

Perhaps the most convenient man/computer interface is a complex called the GRAPHIC 1 CONSOLE. With this array you have a video screen with a light pen, a tape memory, and a typewriter keyboard all connected to a computer with microfilmed programs.

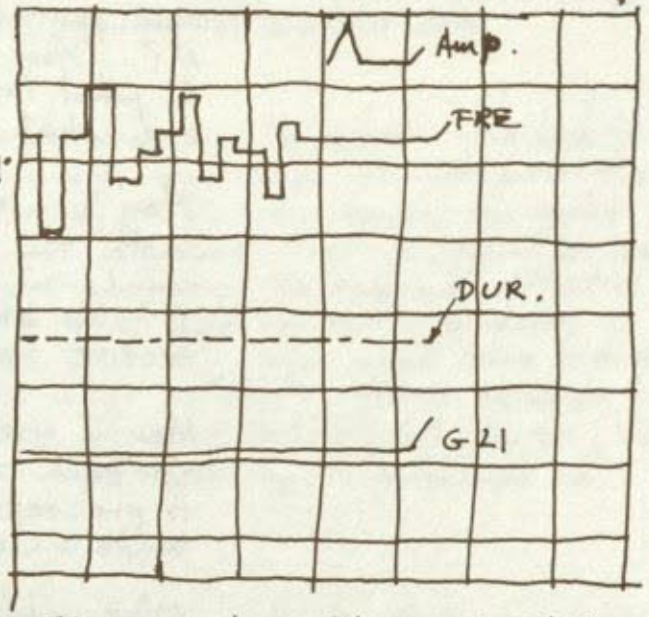


the "GRIN" system

Using the light pen, the composer "draws" his composition on the screen. Various parameters are displayed on the scope simultaneously.

At the bp the desired amplitude curve is displayed. Pitches are designated next as "FRE" Duration is next showing the on time for each note. Finally, Glissando is indicated graphically (here it is zero).

↓ A TYPICAL "GRIN" DISPLAY ↓



You draw it - You hear it - you change it - and finally you register it in the program.

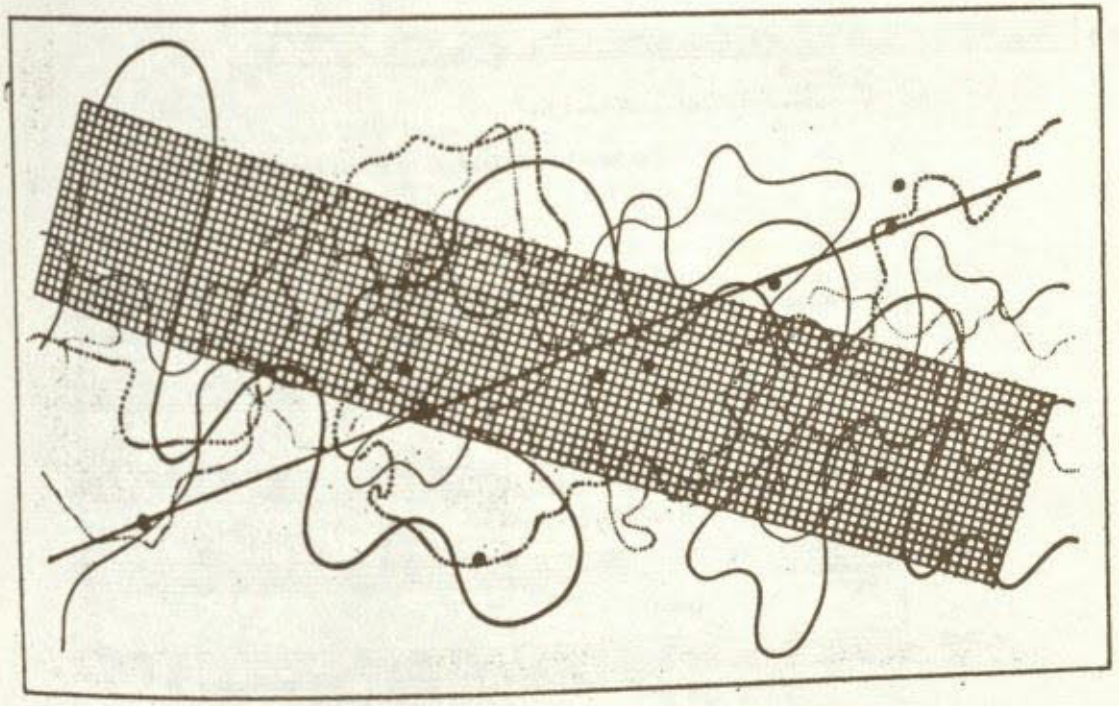
This has the advantage of being an immediate graphic display capable of being stored magnetically as a tape memory or photographically as a microfilm. Literally, what you see is what you get. The computer does not interpret nor exercise esthetic judgment. But for a flawless performance, you can't beat it.

SCORES by other composers

IN THE FINAL ANALYSIS, EFFORTS TO CODIFY NOTATION TO COVER ALL THE CONTINGENCIES OF THE NEW MUSIC HAVE ENDED IN A HOPELESS MORASS OF SQUIGGLY MUTATIONS OF CONVENTIONAL NOTATION. COMPOSERS HAVE SOLVED THE PROBLEM FOR THEMSELVES BY DESIGNING THE TOTAL SCORE FRESH FOR EACH PIECE.

Here's an example by John Cage.

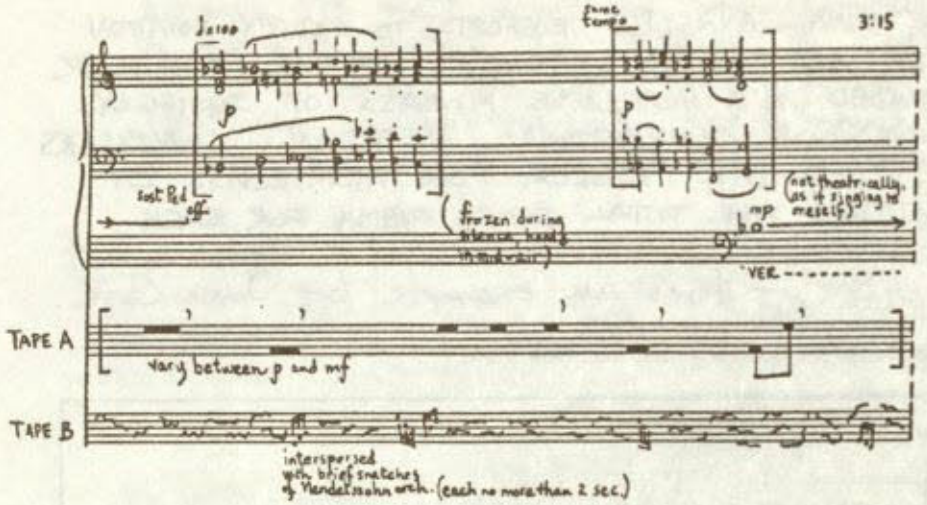
Fontana Mix, 1958. Copyright Henmar Press, Inc., New York.

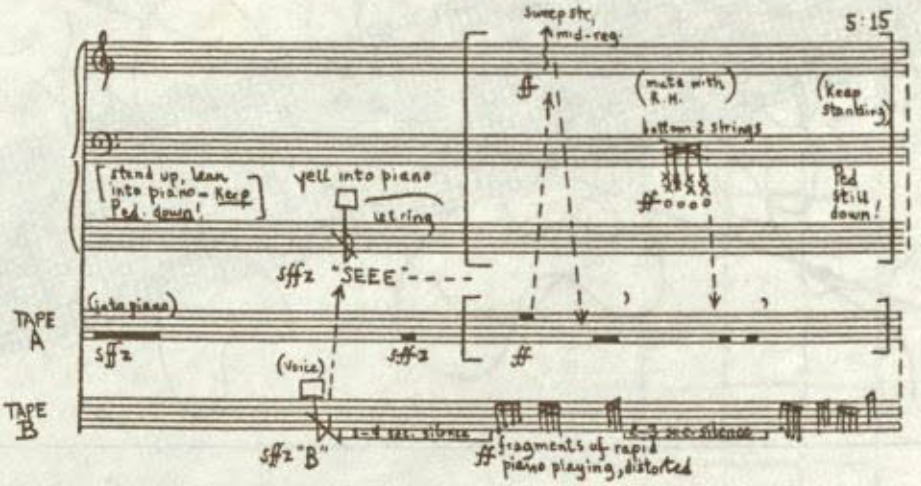


And here are a couple of useful Rules of THUMB:

Do not change the meaning of standard notation symbols. In other words, ♩ should be a quarter note and the 5 line staff – if you use it – should have the accepted pitch designations. Use new invented symbols for non-standard sounds. Nobody will argue with new symbols – changing old established friends is unacceptable.

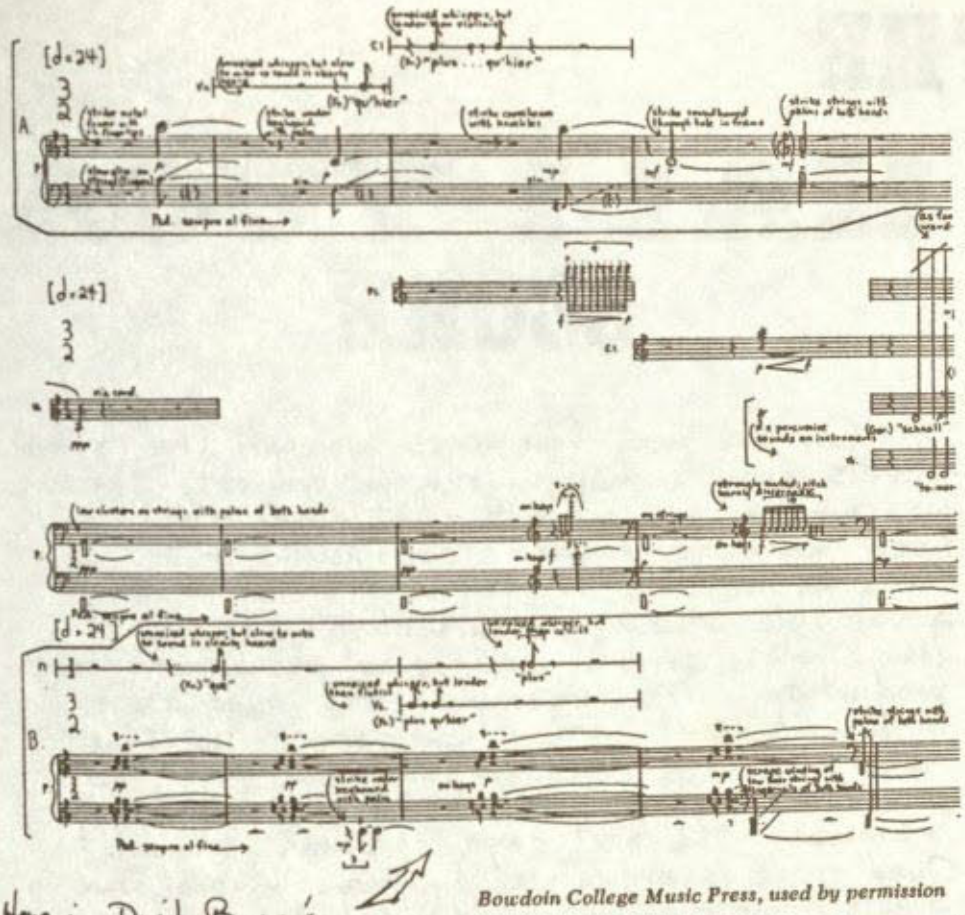
Don't be afraid to explain what you want in writing on your score. There just may not be an appropriate symbol. For example – to instruct someone to smash a violin at a certain cue, it's better to explain it than to picture it. The Cage score above should have some verbal explanation with it – even if you're as mad as Cage.





Here are two examples from Elliott Schwartz's "Music for Prince Albert on his 150th Birthday". The first two staves in each example are for live piano performance. The third is a vocal track; and the last two staves are pre-recorded tapes.

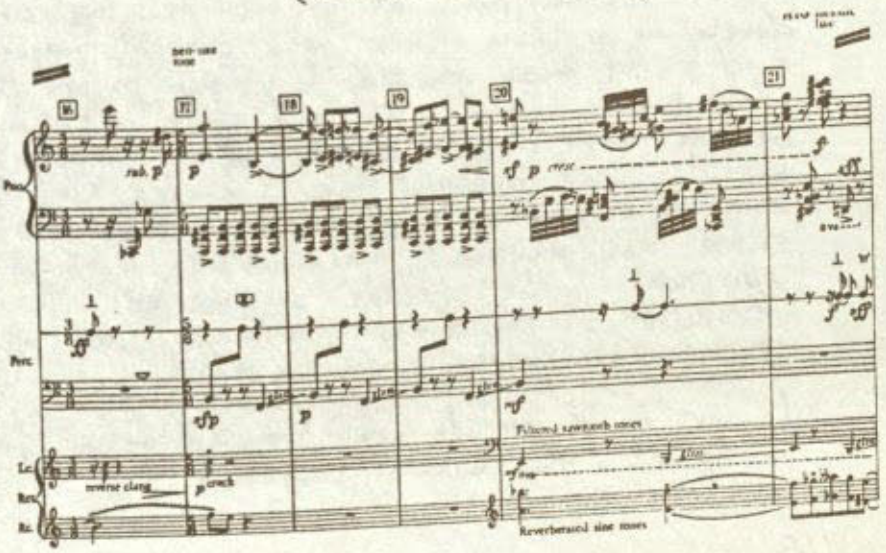
On the Tape A staff it should be noted, the notation does not represent specific sounds. It represents the duration and stereo position of activated tape playing. Thus, the tape recorder is turned on and off by a tape "performer" during the performance. Tape B runs continuously through the performance.



Boudoin College Music Press, used by permission

Here in David Burge's Aeolian Music a live group of five players performs the middle parts of the score against tape tracks A & B which they have pre-recorded themselves.

And in Lejaren Hiller's Machine Music the live musicians perform against a precisely notated stereo tape of electronic sounds. (Bottom two staves)



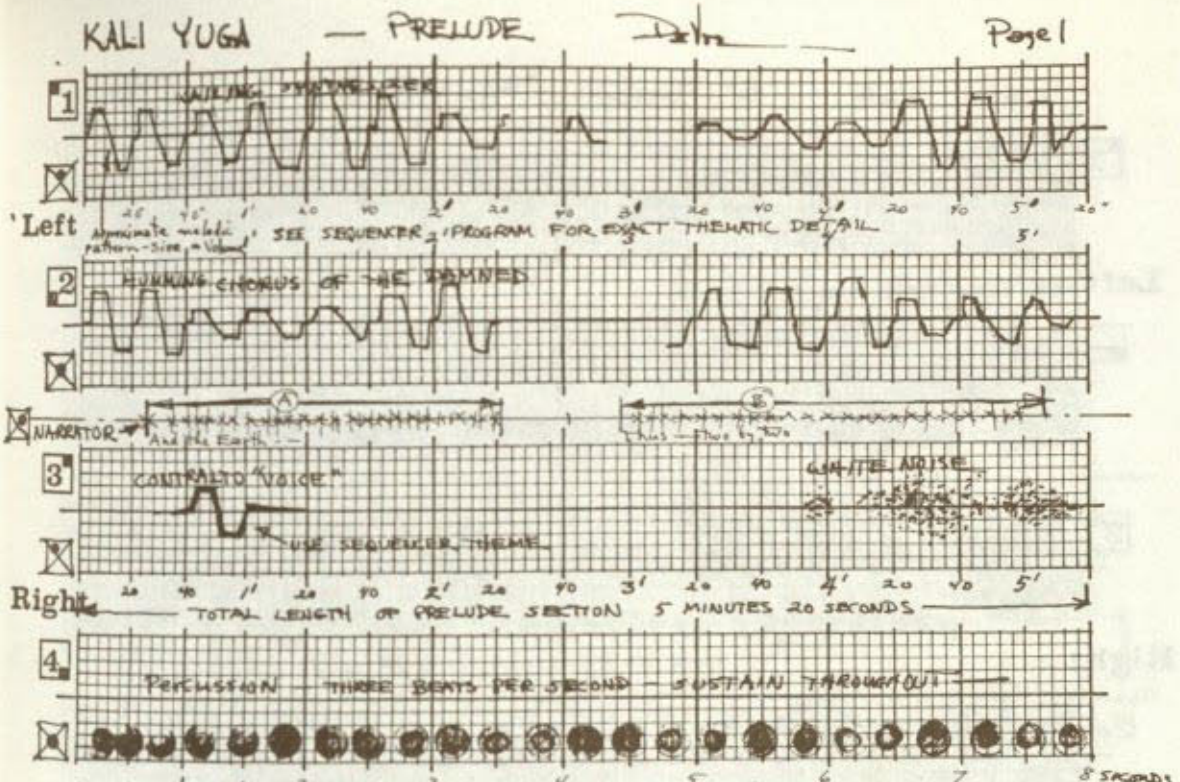
THE KALI YUGA SCORE

On the next few pages you will find a few sheets from a major work in progress. The score was written for myself - but every effort has been made to provide clear enough instructions for someone else to "realize" it. It should be a valuable study for this chapter because it demonstrates several techniques peculiar to tape production. For example; the quad staff system is used with graph paper. The time notations vary considerably; one page, the prelude, contains 5 minutes and 20 seconds of material. The next page contains 8 seconds! Quad space is articulated by some unusual sonic events. For example; a disembodied voice seems to wander through the audience begging to be touched.

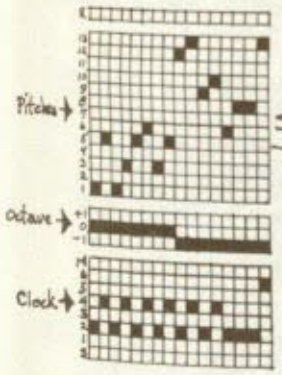
KALI YUGA - literally means Iron Age. It's a Sanscrit term rising from the Hindu Cosmology which says: that Man has lived on this planet for millions of years, evolving and developing. There have been several major cycles of man on Earth; four prior to our present one. And with each cycle man has become more deeply enmeshed in the physical world. Our present age is called Kali Yuga and is supposed to be the time when Man is the most physical, most violent, the least spiritual. The prelude summarizes that evolution. The first movement illustrates man's immersion into the flesh.

The text for the prelude comes from an ancient Tibetan scripture: the Book of Dzyan.

KALI YUGA — PRELUDE



Drawings above do not indicate pitches except in the most general way.
Cycle of Sequencer thematic material is 20seconds long. Drawings show cycles and amplitude.



Sequencer Program thematic material used throughout.

TEXT: (From the Book of Dzyan)

NARRATOR: And the Earth said, LORD of the Shining face, (A) my house is empty. Send thy sons to people this wheel.

After great threes, She; Mother Earth; cast off her old three and put on her new seven skins, and stood in her first one. She created from her own bosom, the water men; terrible and bad. She herself created them from the remains of others. From the dross and slime of the first second and third she formed them.

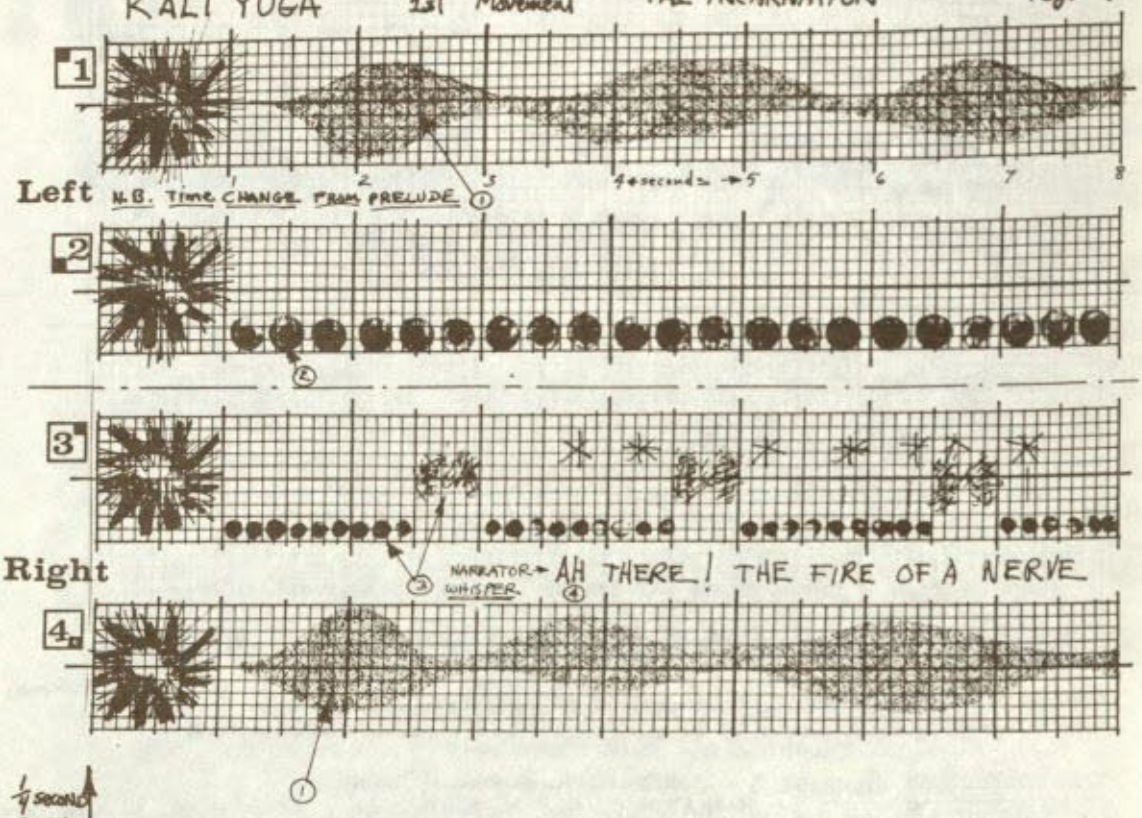
The GODS come and looked. Displeased they were. Our flesh is not kore! No fit rupas for our Brothers. No dwellings for the lives. Pure waters, not turbid, they must drink.

The flames came. The fires with the sparks. The night fires and the day fires. With their heat they quenched them. They slew the forms which were two and four faced. They fought the goat men, and the dog headed men, and the men with fishes bodies. When they were destroyed, Mother Earth remained bare. And so it was that Mother Earth did fashion men again and again. Monsters all, and failures. Animals. Until the GODS gave minds to the men of the FOURTH Race. Then all men became endowed with MANAS. They saw the sin of the mindless. The FOURTH Race developed speech.

(B) Thus two by two, on the seven zones, the third race gave birth to the FOURTH Race men; the GODS became no-gods; the Sura became A-SURA. The first on every zone was moon coloured; the second yellow like gold; the third red; the fourth brown. The the FOURTH became tall with Pride. We are the kings, it was said; We are the GODS. They took wives fair to look upon. Wives from the mindless, the narrow headed. They bred monsters; wicked demons, male and female with little minds. They built temples for the human body. Male and Female they worshipped. Then the third eye acted no longer. They built huge cities. Of rare earths and metals they built, and out of the fires vomited, out of the white stone of the mountains and of the black stone, they cut their own images in their size and likeness, and worshipped them. They built great images nine yatis high, the size of their bodies. Inner fires had destroyed the land of their fathers. The water threatened the fourth.

The first great waters came. They swallowed the seven great islands. All of the Holy were saved; the Unholy destroyed. With them most of the huge animals produced from the sweat of the earth. Few men remained: some yellow, some brown and black, and some red remained. The MOON coloured were gone forever. The Fifth produced from the Holy Stock remained; it was ruled over by the first Divine Kings who began KALI YUGA.

Here, Now, this is KALI YUGA - the IRON AGE



½ SECOND REST BETWEEN PRELUDE AND HERE

Special Instructions

the tracks above - run for 60 seconds - although the first 8 seconds have been shown.

the first sound should be four separate explosions sounded simultaneously on four tracks.

① Heavy breathing - slow synthesized rolls of white noise combined with human breathing. Should sound as if it were recorded inside the human body. Amplitude modulate a white noise with a sine control wave - sweep the filter at same frequency. (Low pass)

② Percussion is the same as used on prelude - sustain throughout. Sine pulses.

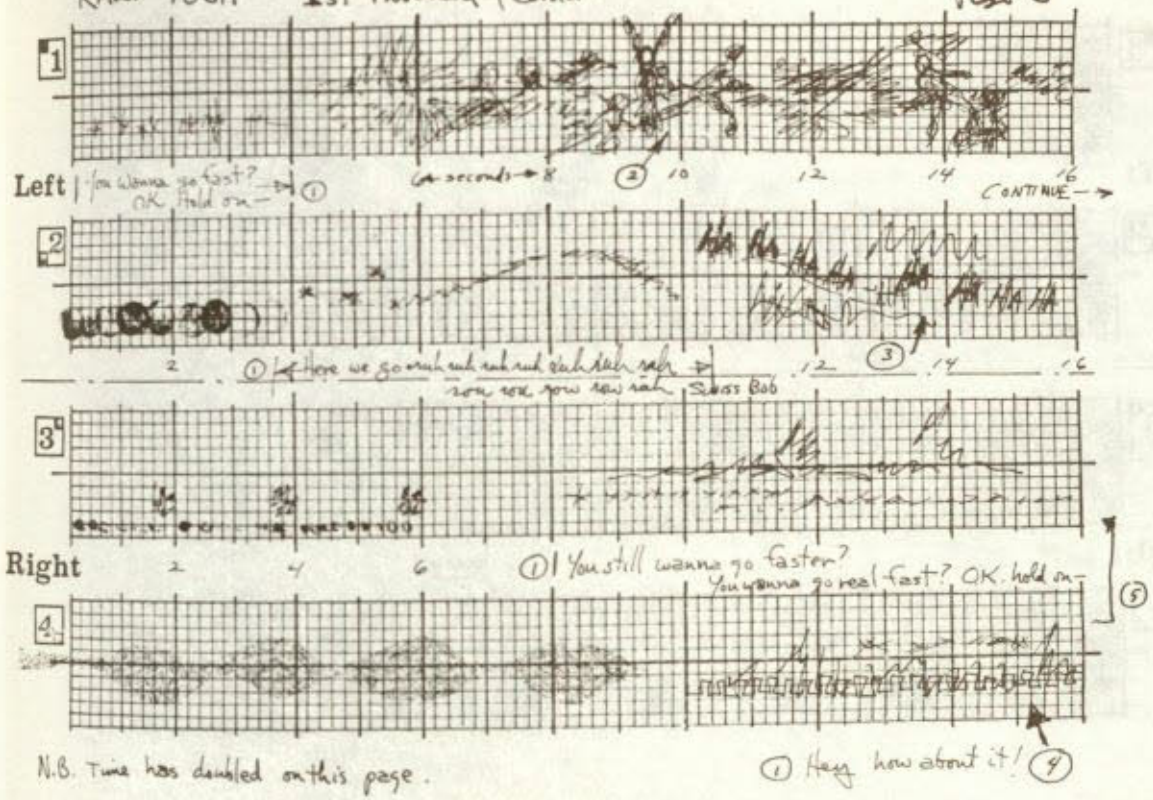
③ Percussion here is sine wave pulses at twice the tempo of the first accented by white noise to sound like brushed cymbals

④ Narrator - WHISPER - WITH A TOUCH OF ECHO
May be positioned either left rear or right front of Quad space.

Narrator's text:

Ah there! the fire of a nerve,
So real!
How vividly this robe of flesh
Articulates a form;
The lens of an eye
Turns the SELF
Into a billion lights on the sea
Cast by a single sun.
There! the glove of being!
Electric wonder machine
THIS BODY!

KALI YUGA 1st Movement (Contd) Page 3



N.B. Time has doubled on this page.

Special Instructions

① Voices are carnival barkers You can record them live at Seaside Heights Amusement park or use equivalents.

② Sounds of swimmers - human noises slowed down to sound like articulate whales. (NOT THE REAL WHALE SOUNDS THESE ARE BEAUTIFUL - THIS SHOULD SOUND LIKE YOU IMAGINE WHALES SHOULD SOUND)

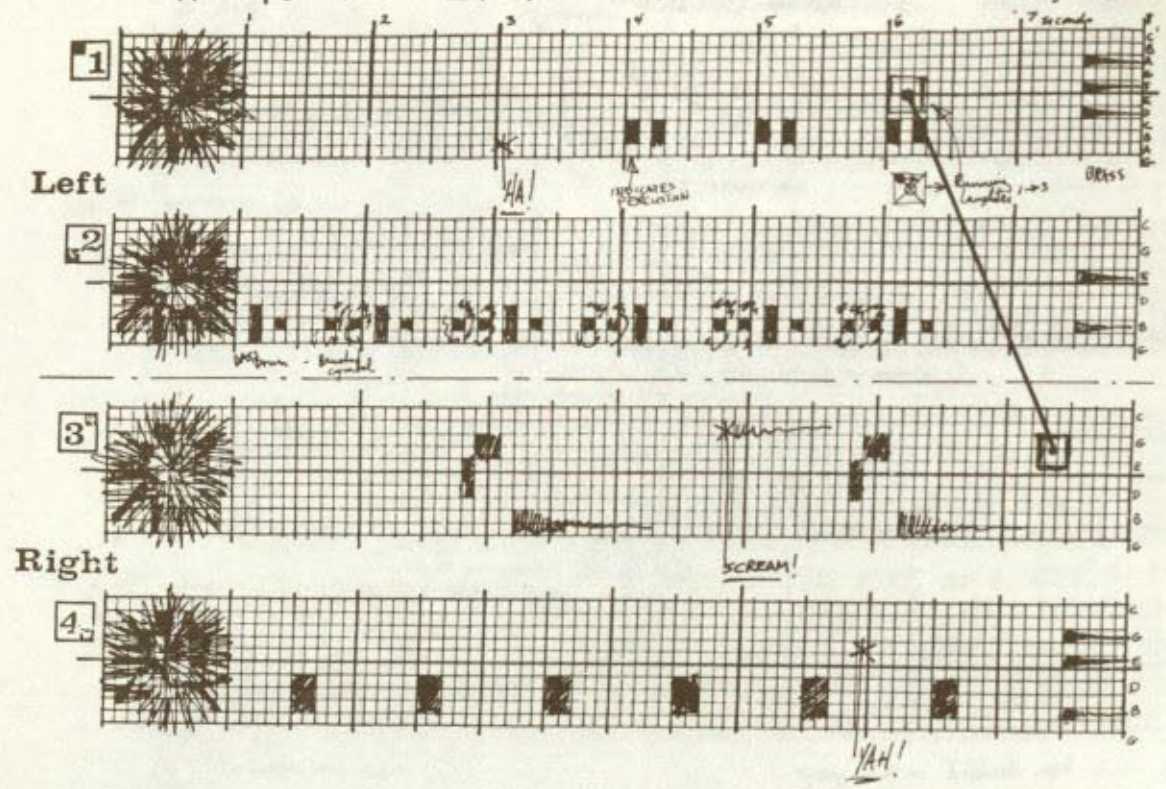
③ General carnival noises with pronounced laughter. this should be a loop repeating every few seconds.

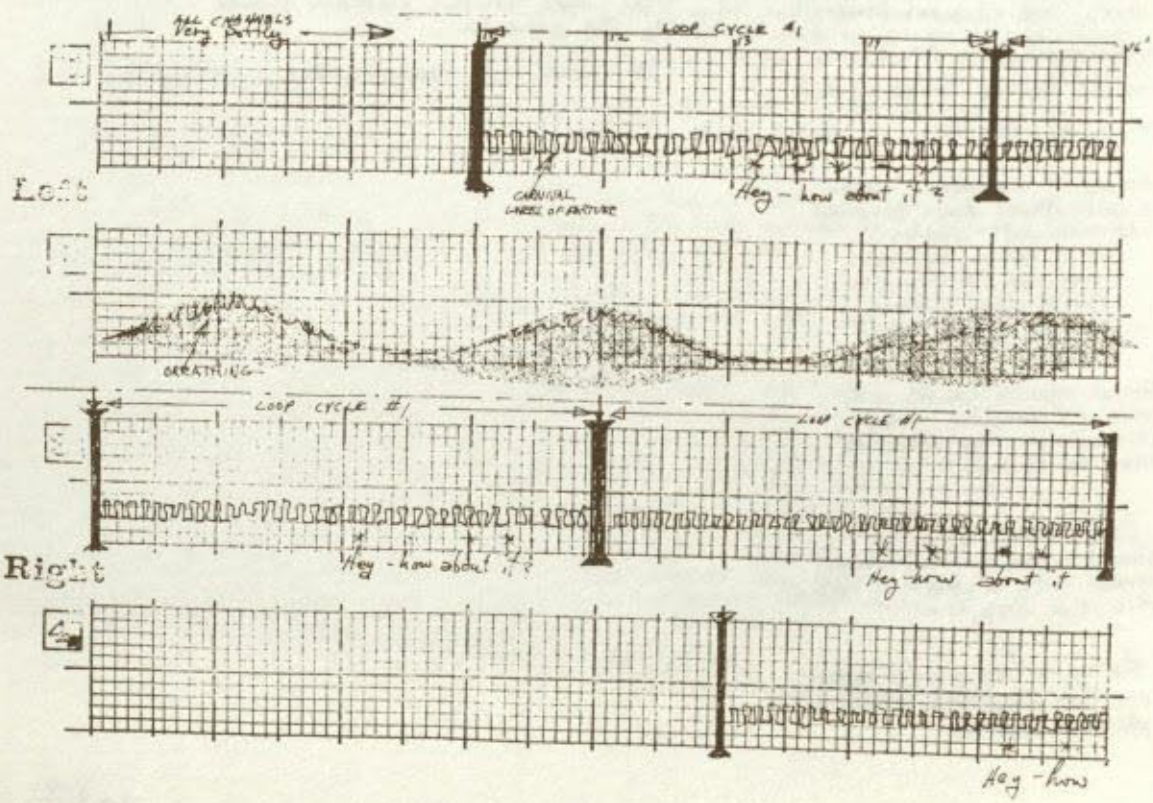
④ Background and voice should come from a carnival barker with a wheel of fortune. this is a loop, too.

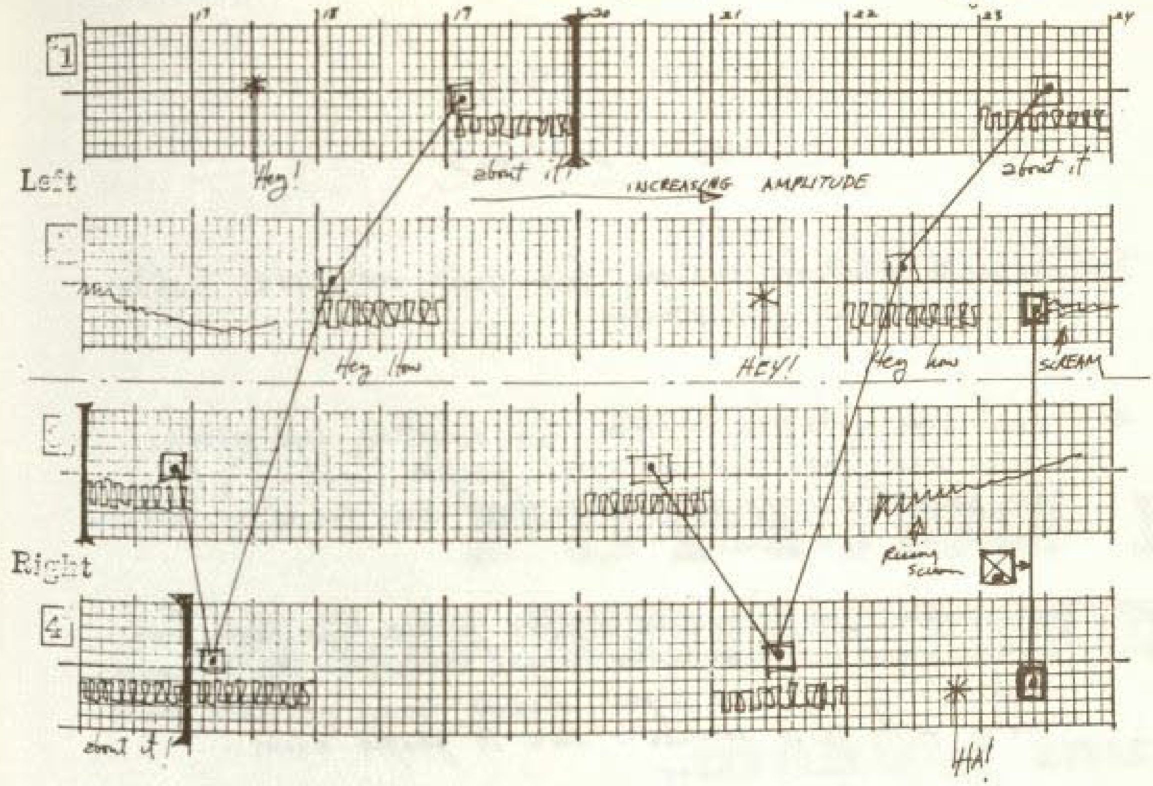
⑤ the same loop should appear on this channel after the phrase shown.

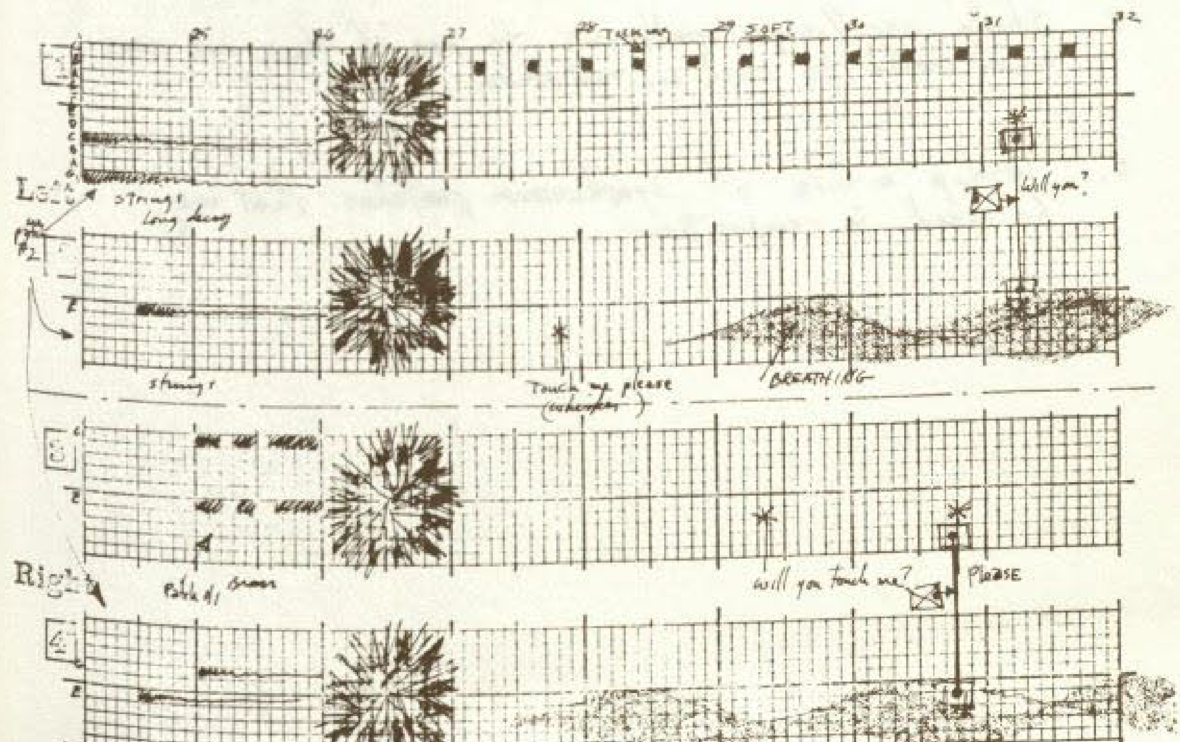
while this shows 16 seconds the total time for this passage should be 30 seconds.

It should be quadraphonic BEDLAM!


1
Left
2
3
Right
4
YA!
SCREAM!
YAH!


Left
Right
Hey - how about it


1
Left
Hey!
about it!
INCREASING AMPLITUDE
about it
Hey How
HEY!
Hey how
SCREAM
Right
Rising Scream
4
about it!
HA!


1
Left
strings
Long decay
2
strings
Touch me please
BREATHING
Will you?
SOFT
Right
4
will you touch me?
PLEASE
strings

CHAPTER SIX

Class Problems

1. Devise a notation system for your own use. Codify the practices in your studio.

2. Test your notation system by selecting one person's work and have several other people "realize" it. No one should be allowed to hear any one else's version until all are finished.

3. Experiment with sound shapes to see if you can find some universally accepted sound images. For example, make films or video tapes showing forms you have devised along with their sounds. See if people agree.

   or

   ask people to draw their impression of sounds and compare the result looking for some common patterns.

4. Study oscilloscope patterns to see if there are some which could be used in notation.

5. Develop a file of synthesizer patches that may be used in compositions.

chapter 7

PUTTING IT ALL TOGETHER

making music

ABOUT PUTTING IT ALL TOGETHER

This chapter has two parts:

STUDIO ORGANIZATION

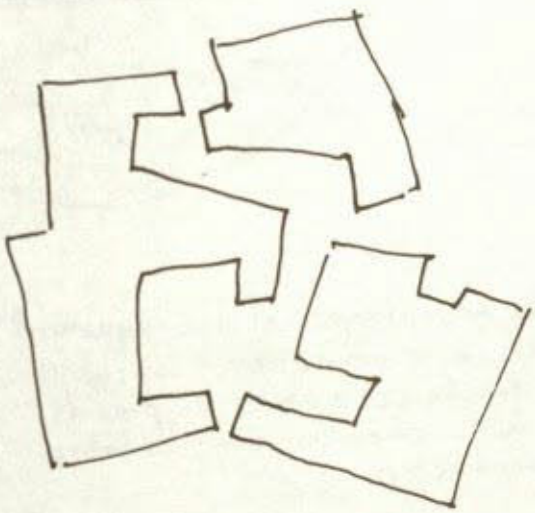
In "THE ULTIMATE STUDIO" you will see the "Druthers" system. I will be describing the studio system I would have if I could have my "Druthers". It may never exist as a reality - but it could. It's a system that ought to be.

Instead of describing a practical, economical minimum system; I assumed that having an ideal to shoot for you might go a lot farther than with a lesser goal.

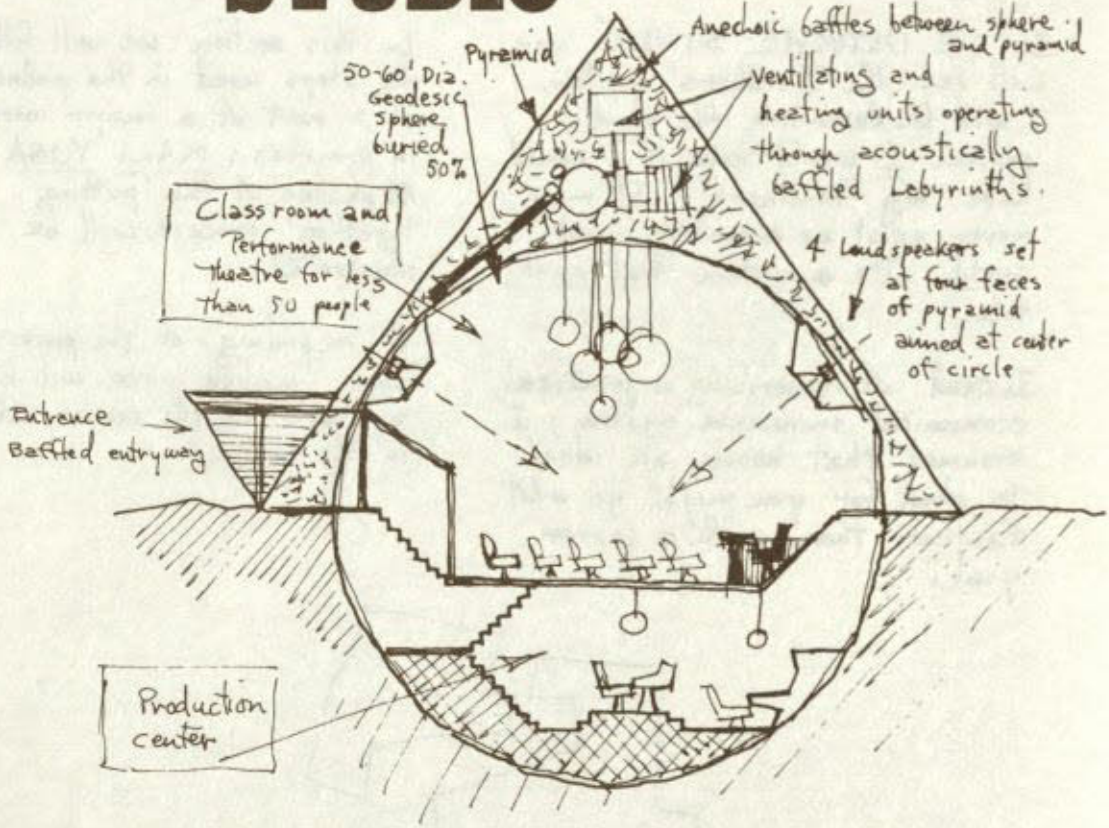
COMPOSITIONAL TECHNIQUE

In this section we will follow the steps used in the production of a part of a major work in progress: KALI YUGA. All phases of the "putting together" process will be illustrated.

A recording of the process and finished piece will be available in the series offered in the book.



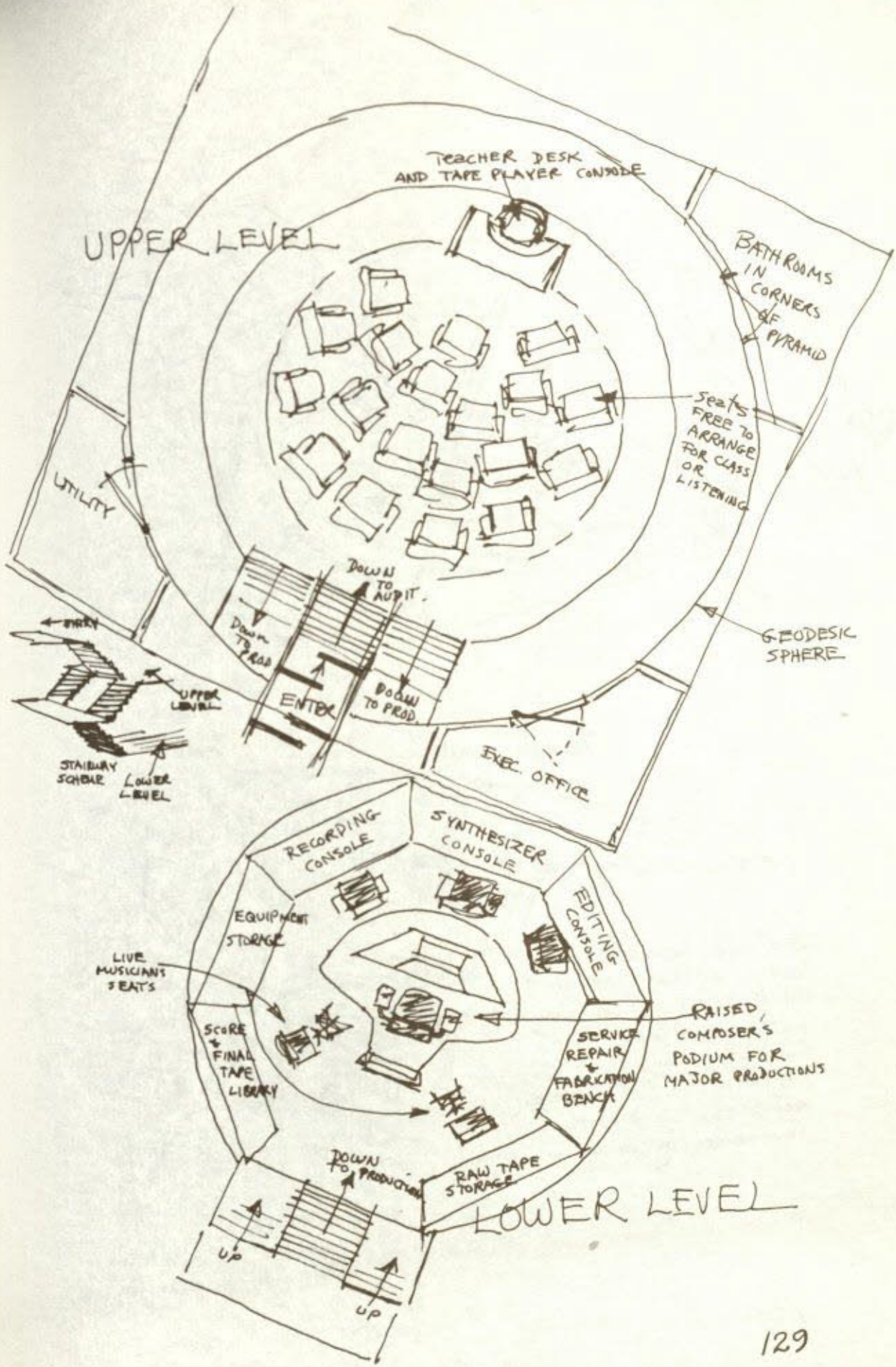
THE ULTIMATE STUDIO

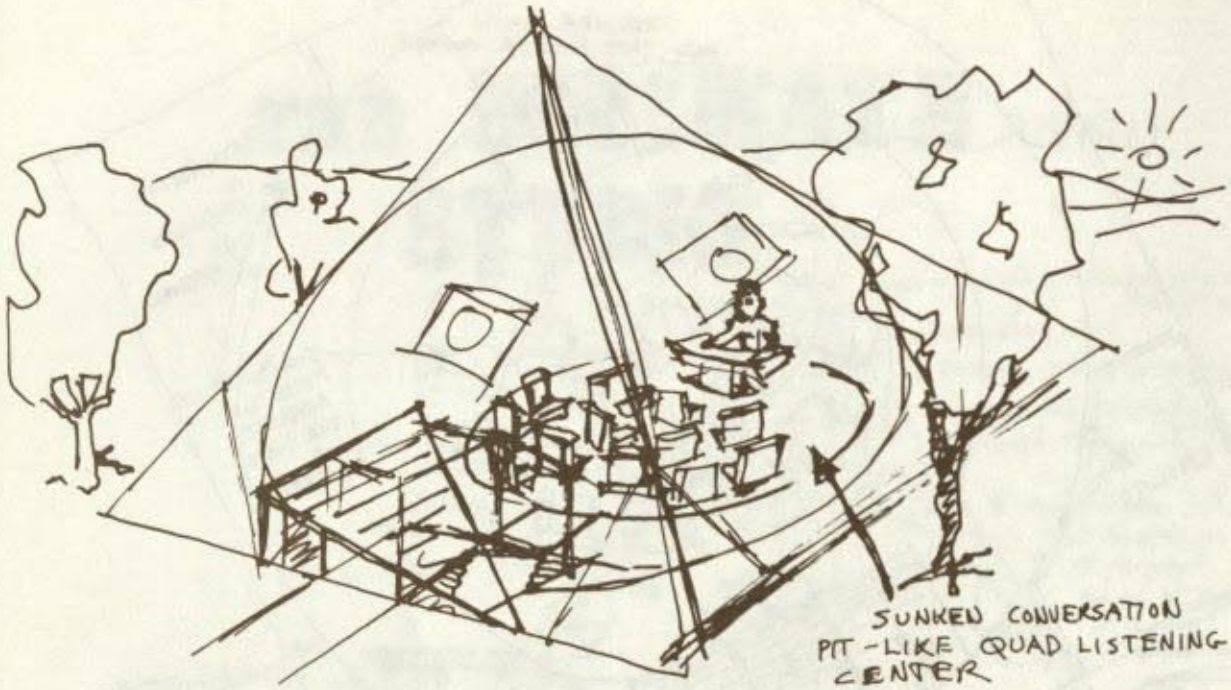


Here, the advantages of the pyramid: [structural strength, mysterious pyramid energy, plus eternal symbolism.] are used in combination with Fuller's Geodesic space to provide an anechoic chamber for creative sound production.

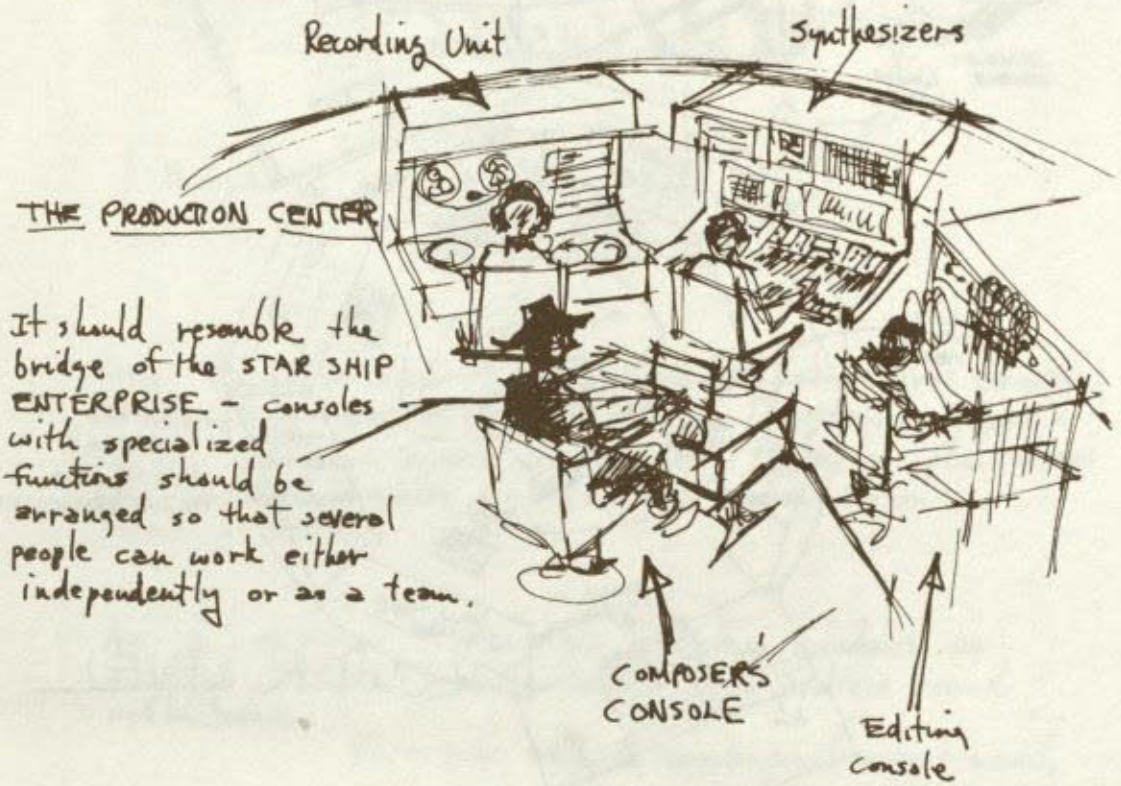
As a composer, I have no use for windows or sunlight, or even marble halls with endless sound reflections.

NO - give me a bomb-proof silent womb and wake me in 2076.


UPPER LEVEL
TEACHER DESK AND TAPE PLAYER CONSOLE
BATHROOMS IN CORNERS OF PYRAMID
SEATS FREE TO ARRANGE FOR CLASS OR LISTENING
UTILITY
DOWN TO AUDIT.
DOWN TO PROD.
ENTRY
UPPER LEVEL
STAIRWAY SCHOOL
LOWER LEVEL
GEODESIC SPHERE
EXEC. OFFICE
RECORDING CONSOLE
SYNTHESIZER CONSOLE
EDITING CONSOLE
EQUIPMENT STORAGE
LIVE MUSICIANS SEATS
SCORE & FINAL TAPE LIBRARY
RAISED COMPOSER'S PODIUM FOR MAJOR PRODUCTIONS
SERVICE REPAIR & FABRICATION BENCH
DOWN TO PRODUCTION
RAW TAPE STORAGE
UP
UP
LOWER LEVEL



SUNKEN CONVERSATION PIT-LIKE QUAD LISTENING CENTER

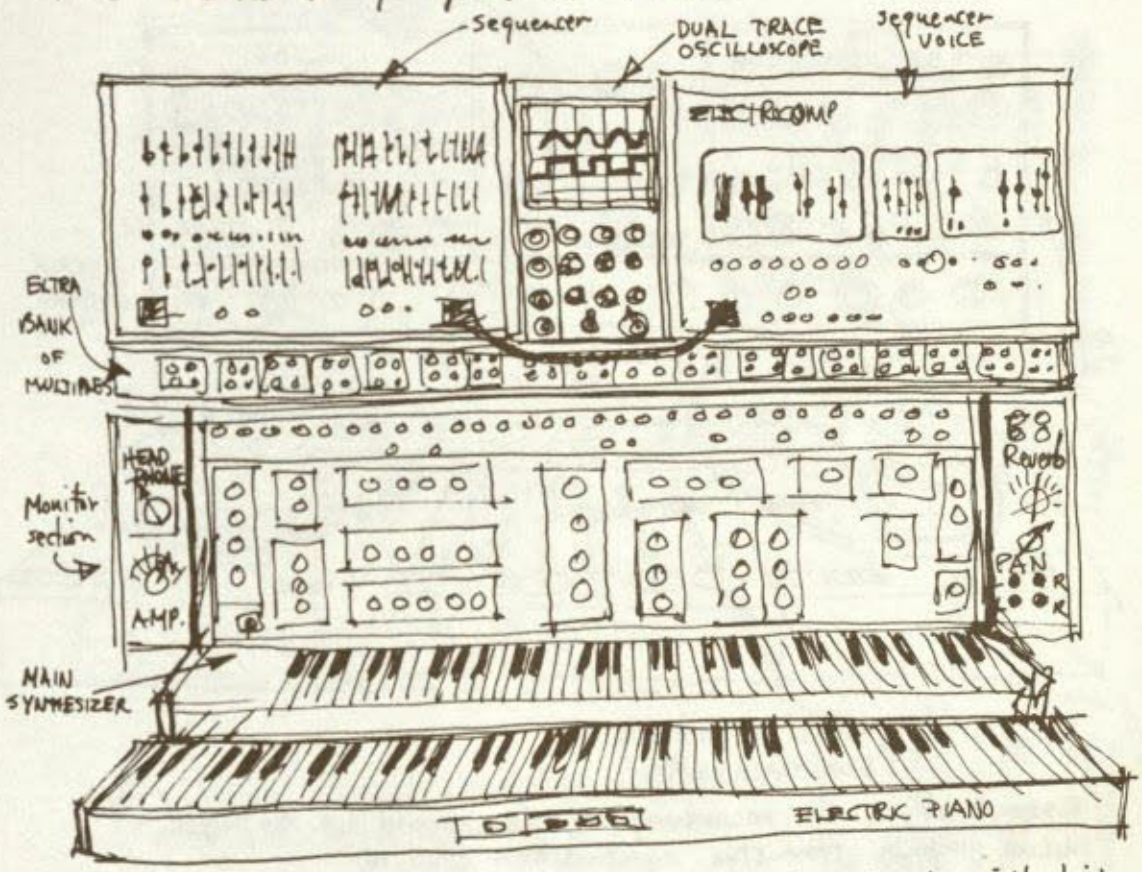


THE PRODUCTION CENTER

It should resemble the bridge of the STAR SHIP ENTERPRISE - consoles with specialized functions should be arranged so that several people can work either independently or as a team.

THE SYNTHESIZER CONSOLE

Even though you can't quite manage to build the ULTIMATE STUDIO, whatever space you do have will work better if you create consoles for your production center.



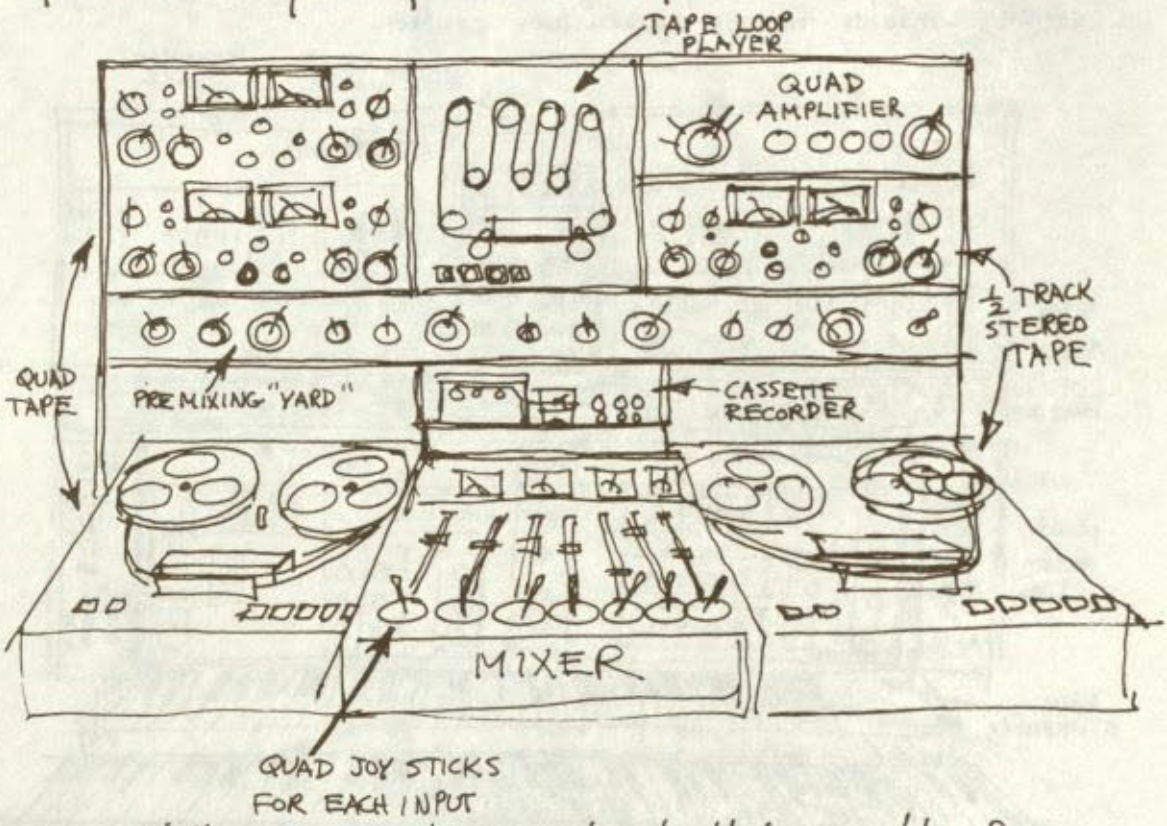
Most people seem to want a stand up production bench with high stools. I don't know why people think they'll produce more or better if they're standing. I prefer to sit in a comfortable swivel chair. I would augment the synthesizer with an electric piano or organ keyboard connected so that the output of the second keyboard may be processed along with the regular synthesizer output. This gives you full chord capability - with limited voicing - along with monophonic unlimited voicing.

Other accessories which should be included with the synthesizer console are:

- ☑ A dual trace oscilloscope to compare waveforms and monitor sounds.
- ☑ Reverb unit
- ☑ Pan Control with simple mixer.
- ☑ Extra set of multiples for patching.
- ☑ Headphone amplifier for monitoring.

THE RECORDING CONSOLE

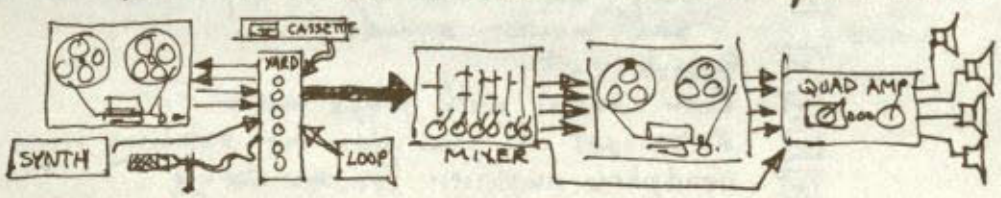
This should be an independent unit capable of making professional quality master tapes.



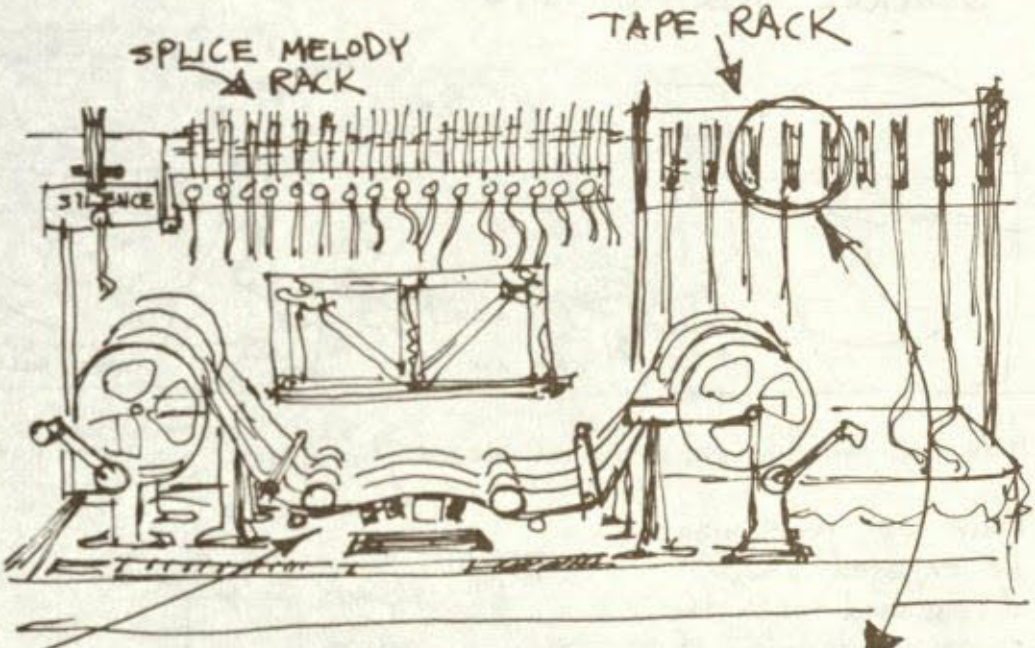
Essentially, the recording console should be capable of mixing inputs from: the synthesizer console
live instruments
other tapes and tape loops
and store all of this on four tracks. Joy sticks should allow sending any input to any position in quad space on the four track system.

It should also be possible to send either the recorded signal or the original sounds through the quad amp to the listening space.

The "yard" is a series of switches to select inputs for the mixer.



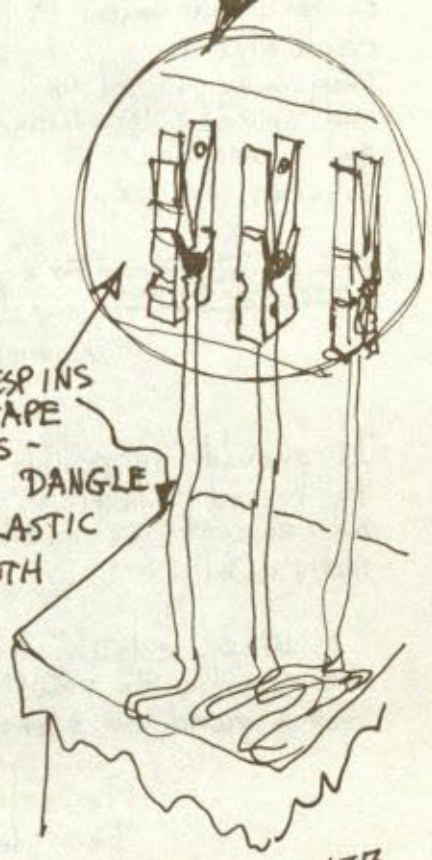
THE EDITING CONSOLE



FOUR TRACK EDITOR SYNCHRONIZER

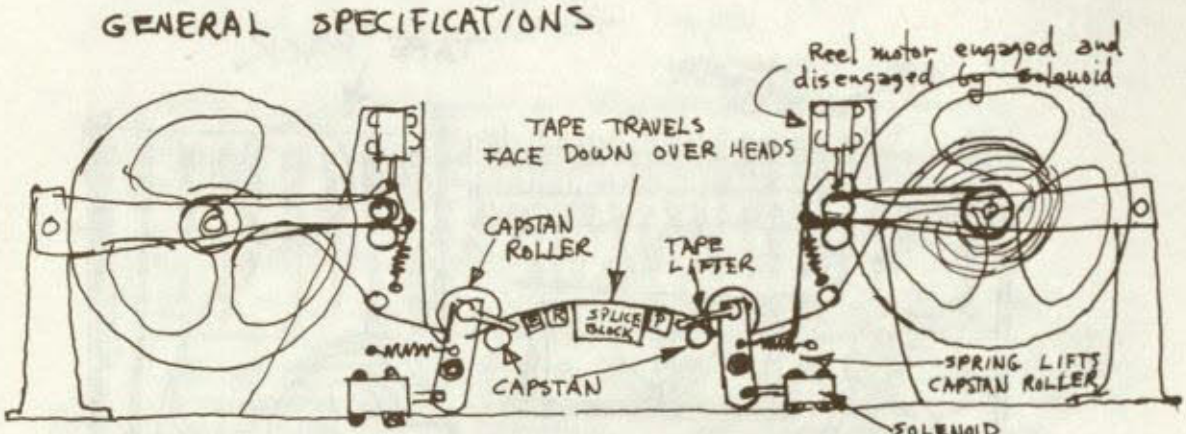
The editing console includes devices I have never seen anywhere before. But they should exist. Similar devices are basic to filmmaking.

One should be able to fabricate four separate tapes for synchronized application to the final master tape.



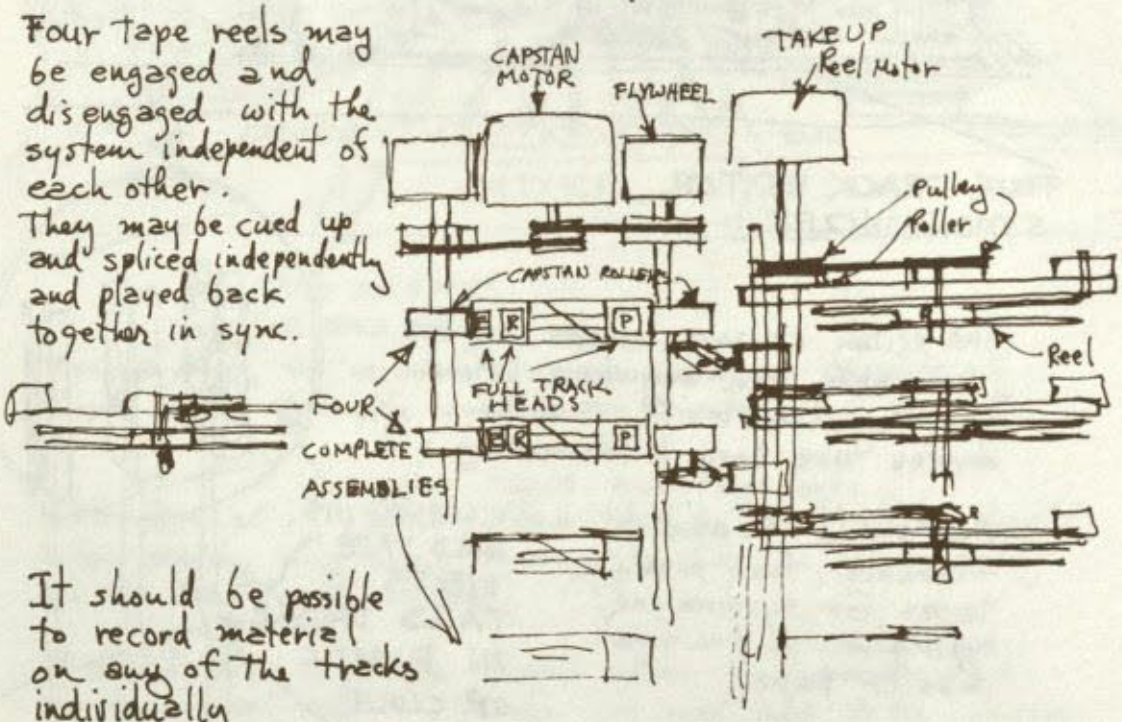
THE "DRUTHERS" EDITING BENCH

GENERAL SPECIFICATIONS



Have your friendly local mechanical wizard build you one of these!

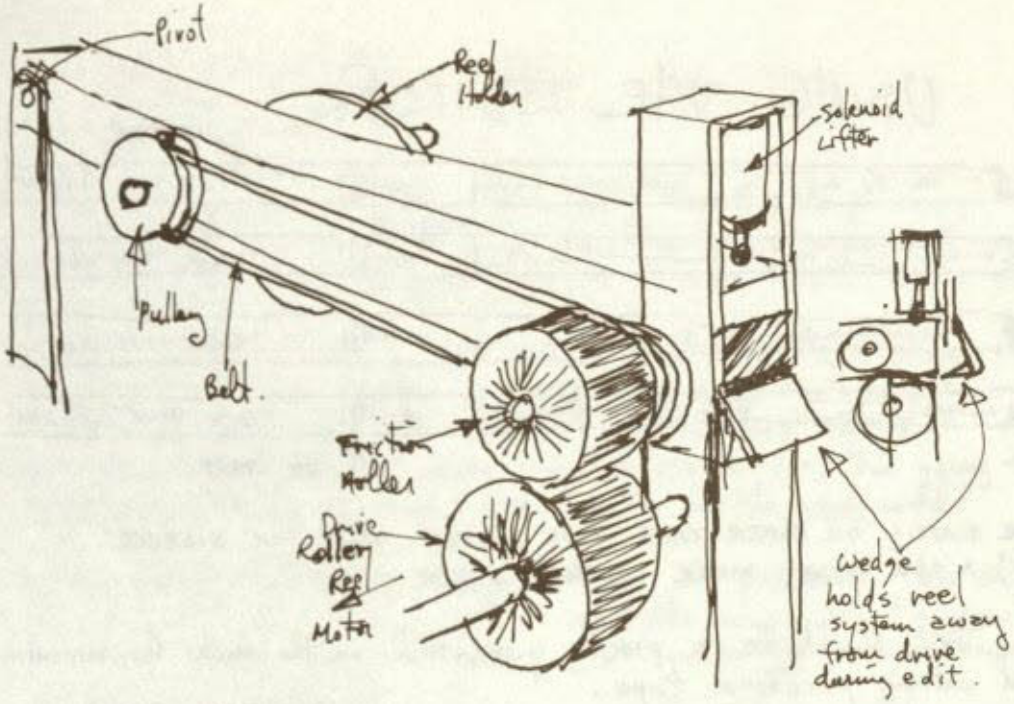
Four tape reels may be engaged and disengaged with the system independent of each other. They may be cued up and spliced independently and played back together in sync.

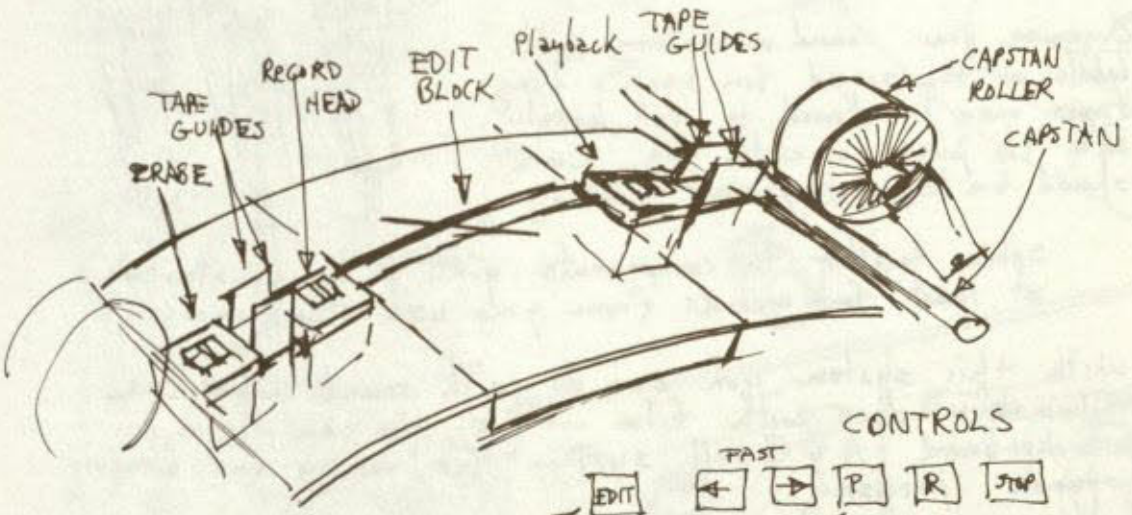


It should be possible to record material on any of the tracks individually

When editing is complete on all four tracks, it should be possible to send the four tracks to the mixing board for a quad or stereo dub.

Precisely variable speed control would also be desirable.





CONTROLS

When edit button is pushed, solenoids holding capstan rollers down are released. Reel motor drive brackets are lifted. Tape is free for rocking — electronics to playback head are on for cueing.

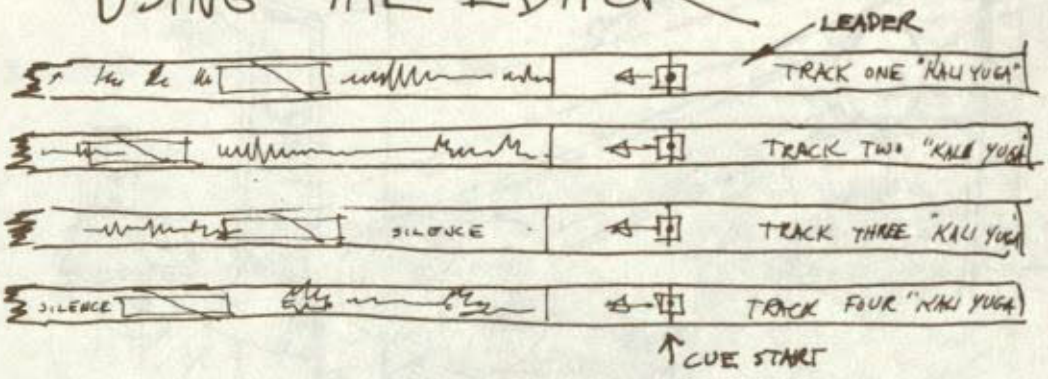
when play is pushed, all four tapes are moved by the same drive system.

Any tape may be recorded independently

"DRUTHERS"

MORE DETAILS OF THE EDITOR

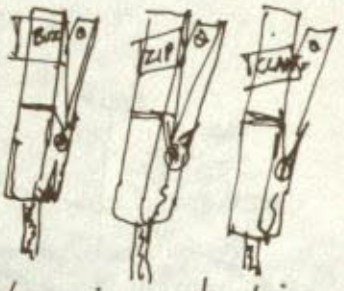
USING THE EDITOR



USE PLASTIC OR PAPER TAPE FOR LEADER AND FOR SILENCE.
PUT A CUE START MARK ON THE LEADER

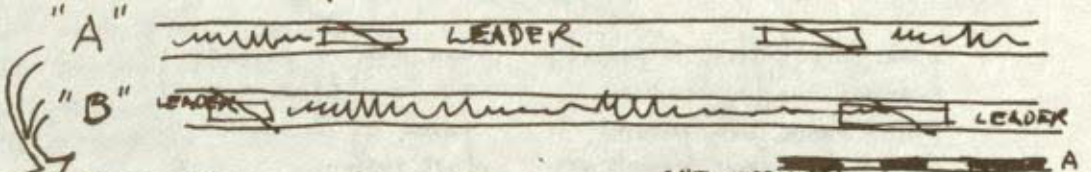
There should be a precise yardstick on the bench for measuring and cutting pieces of tape.

Organize your sound vocabulary with labels on the sound bin rack. Long tapes may be allowed to fall loosely into the plastic or cloth bag. Care should be taken to prevent knotting.

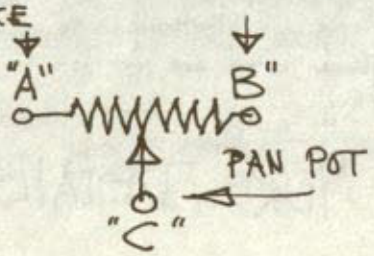


Splice together the components you'll be using starting at least four seconds from your cue start mark.

With this system you can do with sound what the filmmaker does with film — i.e. You can use a checkerboard A & B roll system for mixing and blending sounds precisely.



OVERLAPPING SOUNDS ARE PANNED FROM ONE SOURCE AND THE OTHER TO A "C" TRACK.

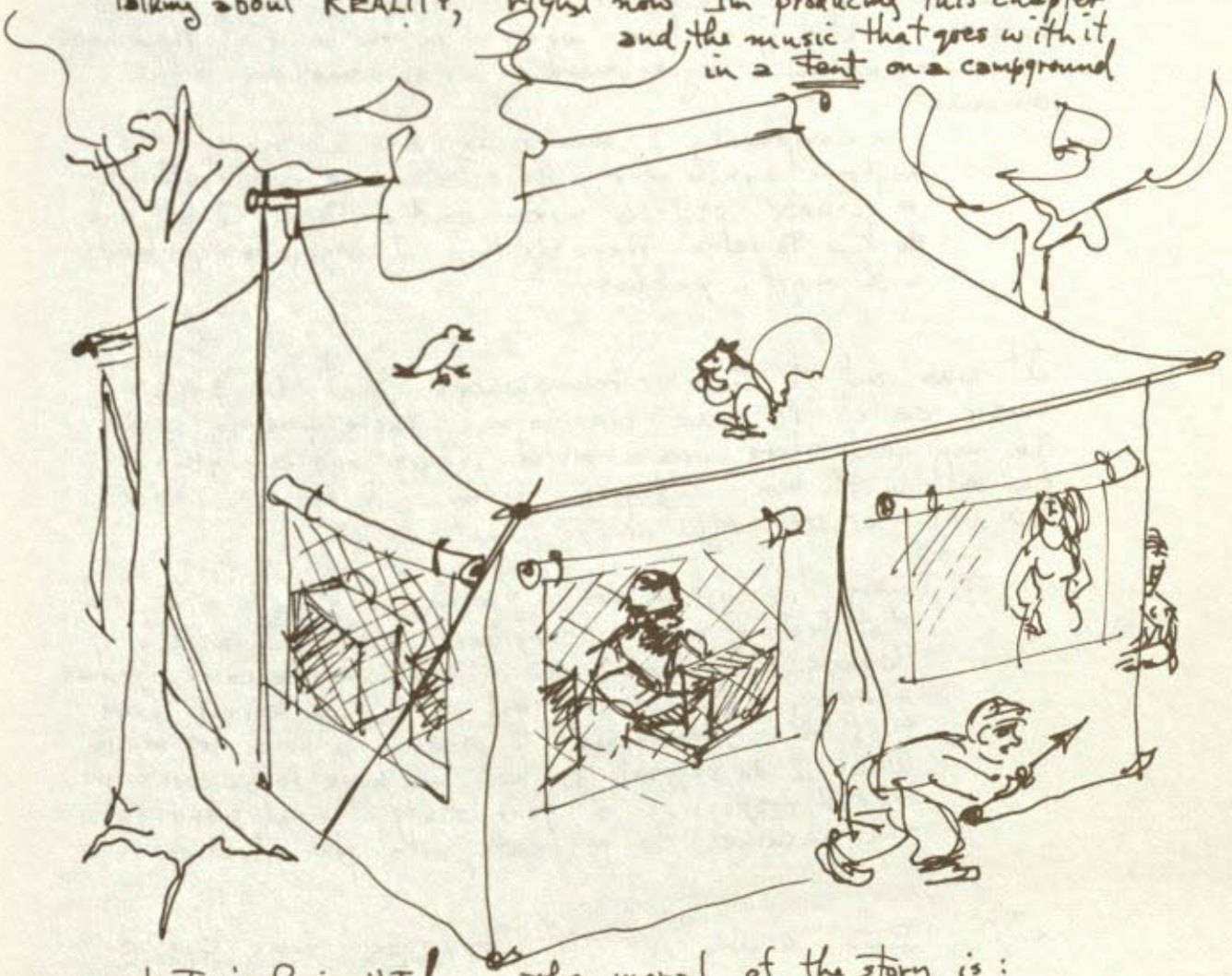


MAKING THE MUSIC

"Oh Sure," you're saying, "It's easy for you to produce Electronmusic. You're sitting in the anechoic bowels of your pyramid with girls dropping grapes in your mouth while you work."

NOT SO! Let me remind you that these first few pages of this chapter represent a VISION not a reality. As of this writing the "DRUTHERS" system does not exist. Now that you've seen it and know what to strive for, I'm going to show you how I put my music together in the real world.

Talking about REALITY, right now I'm producing this chapter and the music that goes with it in a tent on a campground at Toms River, NJ! The moral of the story is: YOU WORK WITH WHAT YOU'VE GOT. IF YOU WAIT FOR YOUR "DRUTHERS" YOU'LL NEVER PRODUCE AT ALL.



SO WHAT YOU DO IS - ASSEMBLE YOUR ASSETS AND USE YOUR WORLD. How do you put a piece of music together? Where do you start?

HERE'S AN EXAMPLE:

CREATING — POTOMAC

I start with a relationship -- a setting, an ambiance -- . You see, what I produce as a soundsmith is woven within the design of the warp and weft of my life experiences. I had just taken a long drive with my camper bus filled with my family and my equipment, and arrived in Potomac, Maryland. at the home of my relatives. I set up a working studio enclave -- a kind of electronic womb -- in the belly of their house and curled up with my keyboard to see if something might germinate.

For equipment I was using an Electrocomp 101 keyboard synthesizer, the Electrocomp 200 synthesizer, a SONY MX-16 mixer and a Teac Quad tape deck. To relax from the trip I began to experiment with rhythm patches.

It was out of these circumstances that the piece of music called "Potomac" was born. There was no score. In my head there was a melodic figure and a rhythm -- but only in the most embryonic form. A MUSICAL CONCEPT DID NOT - AT THAT MOMENT - EXIST.

There did exist in me, a feeling; a state of mind; and that feeling was a fertilized seed which would, through the interaction of man and machine, produce a song. I don't suggest that you have to drive to Potomac, Maryland to produce a piece of music. What I do suggest is that you have to be sensitive to and responsive to your state of mind; and get the machines to resonate with your vibrations.

SO LET'S LOOK AT THE STAGES THIS PIECE WENT THROUGH

It is probably most appropriate that the first piece I am describing here has no score. What I want to emphasize here cannot be shown in a written score - or an illustrative drawing. "Potomac" rose out of a relationship not a plan. Primarily, it was a relationship with the machines.

As a composer you should learn to "listen" to your instrument. You have to develop a belief that your synthesizer has a mind - a spirit - a soul; that sometimes it is you who is being played, and the machine is the master. Get over your paranoia about machines. Listen to them - interact with them.

Experimenting with the two synthesizers, I was exploring interconnections. I came up with this:

I used the master oscillator of the 200 to produce a beat of about 3½ pulses a second. (SQUARE WAVE OUTPUT) I was using a slow tempo from the master oscillator to control chromatic sounds on the 101.

I was also using the envelope generator on the 200 to shape the amplitude of some of the sound.

the control oscillator of the 101 was used with the sampler to control the filter.

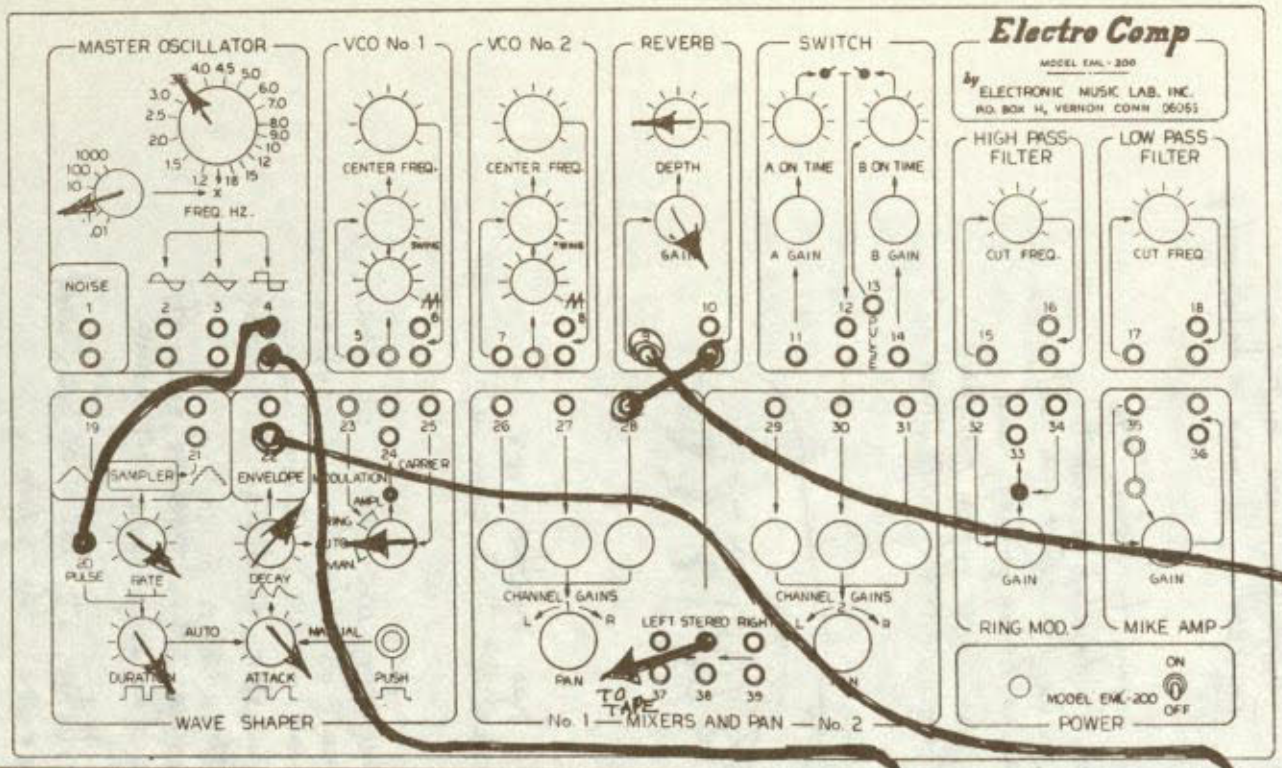
I sent the output through the reverb and thence to the pan control.

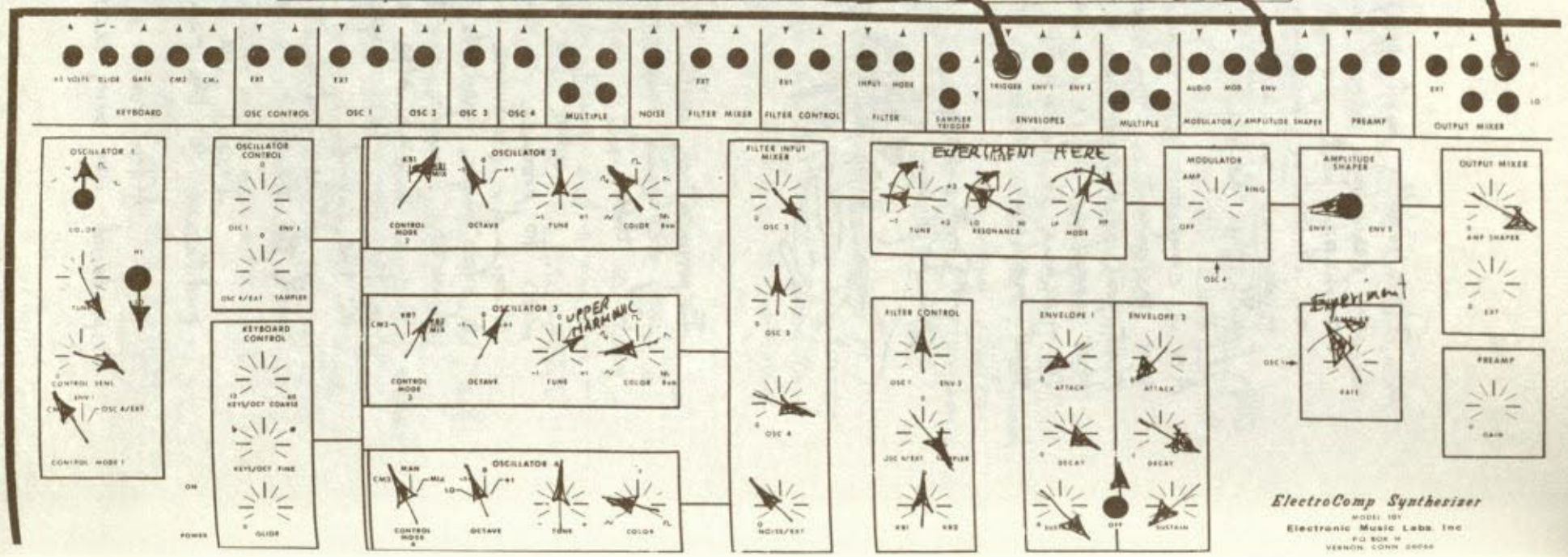
After some adjustments the rhythm this produced was very exciting

SEE PATCHES →

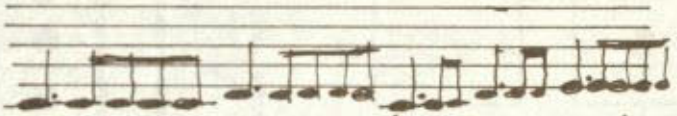
POTOMAC
CHROMATIC
PERCUSSION
BASS LINE

Please note:
A close approximation of this can be achieved using just the 101.
See the appendix





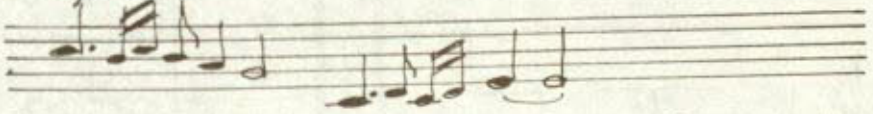
I played a little bass line figure with this patch; something like this:



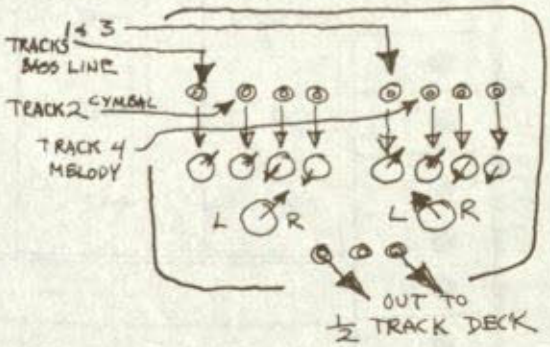
and recorded it on tracks 1 and 3 of the Teac quad deck. I played around with that theme for about 10 minutes. What I was doing was preparing a bed for other material to come.

It needed some contrpuntal emphasis before it would be ready for the melody. Don't ask me how I knew that! I felt it. I worked up a patch on the 101 for cymbal crashes that was chromatic. the patch I used is on page 142. I recorded that on track 2 while listening to tracks 1 and 3 on simulsync.

Finally I was prepared to add the melody line. I searched the 101 for a voice to sing the song that was now materializing in my head. I could hear it as I was recording the bass line. Essentially, I was working with this figure:

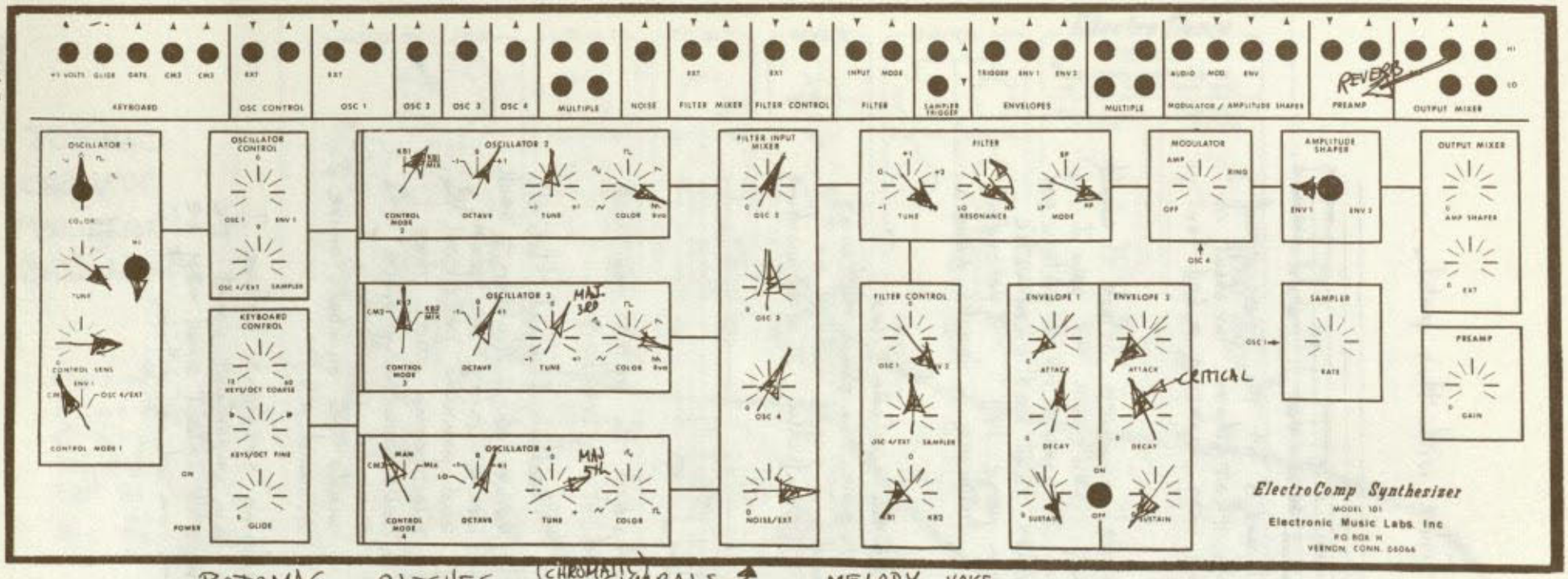


I freely manipulated that and used the patch for voice shown on page 142. I recorded it on track 4.

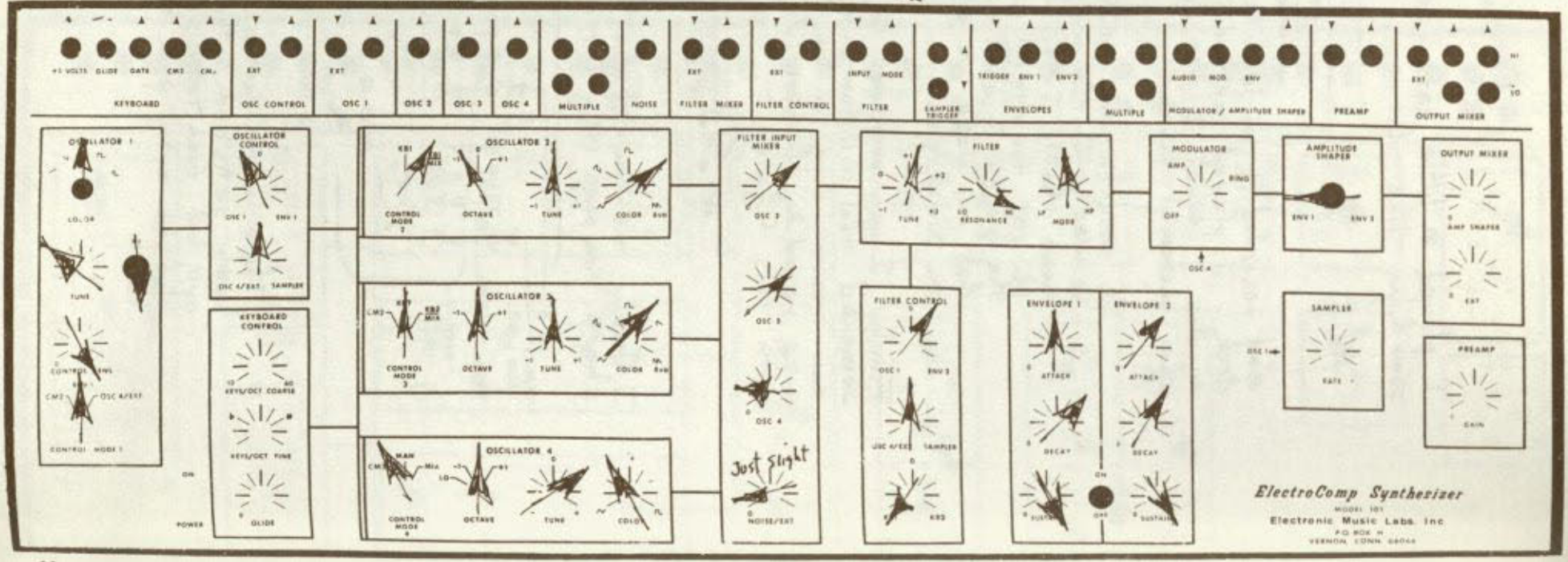


Finally, I mixed this all down on a Pioneer ½ track deck using the mixing and panning panel on the Electrocomp 200. Thus, I could spatially "place" the sounds in stereo. I made the cymbals more around a bit.

There were several "dubbing" sessions before I was satisfied. that's an important point. the original four tracks are still intact and may be dubbed again and again on ad infinitum if I wish.



POTOMAC PATCHES (CHROMATIC) CYMBALS → MELODY VOICE



CONSTRUCTING
KALI YUGA

As compositional problems KALI YUGA and POTOMAC are two entirely different procedures. While POTOMAC was a happy improvisational event, KALI YUGA is a deliberately conceived and executed opus. Thus, to derive the maximum benefit in your own work from this chapter you need to be exposed to both extremes of my working process.

KALI YUGA, as you may have seen from the last chapter, is a philosophical, metaphysical musical conception; in the tradition, perhaps, of Scriabin. I'm not sure how to categorize it. I suppose we could call it a musical drama like Stravinski's Noah and the Flood. Whatever you went to call it, it is designed with the following overall scheme:

1. It has a prelude and three movements (or episodes).
2. Thematic material which appears in the prelude re-appears in various guises in the three movements in much the same way that an overture for an Opera will contain samples of thematic material throughout. (Ritornello)
3. It is scored for quadraphonic presentation with many "non-musical" elements perceived as musical and spatial events.

   For example: A disembodied voice seems to wander through the audience space asking -- in a stage whisper -- to be touched. A carnival barkers voice and spinning wheel of fortune circle the audience several times. Explosions occur simultaneously in four corners of the room; and at one point the audience is totally immersed in a carnival.

LET'S LOOK, THEN, AT SOME OF THE TECHNIQUES I EMPLOYED IN THE CONSTRUCTING OF KALI-YUGA.

THE CONCEPTION:

I was seeking a musical vocabulary -- a SONIC base metal -- to describe the Hindu concept of our age; the IRON AGE; the BLACK AGE; this miserable materialistic human episode that has run for the last 5000 years or so. In that time, we have swarmed over the globe; murdered, pillaged and raped the land and ourselves; first with stone and bronze and ultimately with Uranium. We have steeped ourselves in the mud-flesh of being; all in the name of evolution; a Darwinian survival of the fittest mechanism used to perfect the species.

Somehow we are expected to emerge better -- cleansed -- from the blood bath. And I cling to the belief that it has been purposeful -- that evolution has been served -- that we shall emerge cleansed in the AQUARIAN age. I would, at least, prefer that belief than to think it has all been pointless.

In the ancient Tibetan Scripture, the BOOK OF DZYAN*; we are told that the Pitris (those gods who were to ensoul man) embarked on a grand "experiment" to prepare the Earth for the development of humanity; that several attempts to create man failed before worthy human forms developed and an orderly evolution could begin. A necessary stage of that evolution was -- and is -- KALI YUGA, the Iron Age in which Man perfects his mastery of matter. That's what this piece is all about.

How pompous -- how presumptuous -- one may say, that I should seek to render in musical terms so profound a conception. "shades of Charlton Heston and Hollywood's version of the Bible." Since I did not know that it could not be done, I did it; and here are some of the stages of that process.

* First translated by H. P. Blavatsky in 1875. Her translation is the foundation of her book "The Secret Doctrine", a document that ought to be required reading for all composers.

STAGE ONE: SOUND GATHERING

Carnivals, amusement parks and fairs have always seemed to me to be the essence of our life and times -- perfectly expressed. It is as if all of the lusts, the greeds, the fears, the dreams of everyman were suddenly made audible and visible in full three dimensions. The Hindus have a word for it as usual: Kama Loka -- (KAMA = desire, LOKA = world) What seems so remarkable to me about it is, that the carnival world, Kama Loka, is precisely where the Madison Avenue Executive's head is; it's where the Arkansas housewife's head is; it's where your head is, and mine. It is far more expressive of our real consciousness than even rock music!

So I went to Seaside Heights with a Nagra tape recorder and gathered sounds. There's little to say about that from a technical point of view except some of the following suggestions:

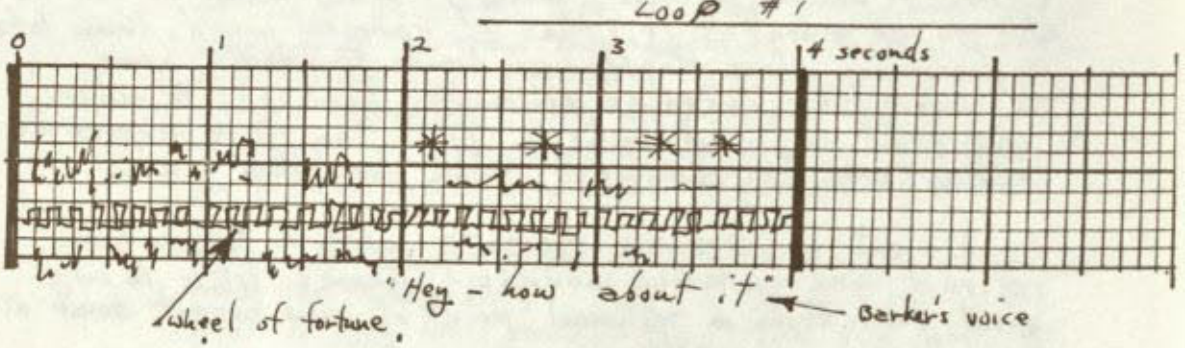
① When you go sound gathering on location use a good tape recorder. Avoid a cassette recorder if you can.

② Do not use ~~automatic~~ automatic gain control with compression for your mic input. In places where there are sudden loud noises and occasional unexpected silences, automatic gain control will do terrible things to your sound quality. It will add noise to the quiet places while the electronic circuit tries to "Listen" for sound and amplifies background noise, and cut out completely when it is surprised by loud noises.

The crowd noises, the screams of people on rides, the barkers, the machines were pure poetry. I was strongly tempted not to violate the sacred beauty of that by cutting it up and mixing with anything else. I wanted to give it a title and sign it as my work. I had either too much integrity or too little guts to do that -- We'll never know. However, I compromised - the second movement of KALI YUGA, is entirely created by juxtaposing four un-edited tracks of that amusement park.

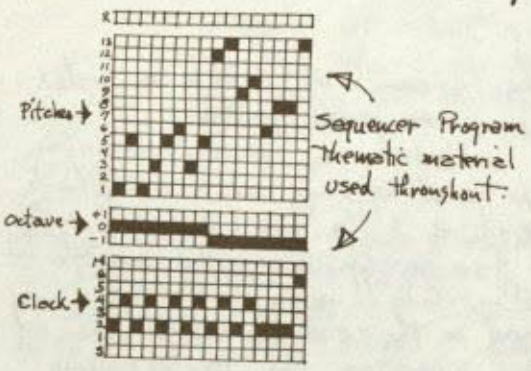
THE SCORE:

When I brought the tape of gathered sounds back to the studio, I listened to it critically and extracted some little pieces which I made into loops. I made a rough notation for each loop, timed it, and hung it up to wait its use in the final work. Here's an example:



Then I wrote the score, (several pages are shown in chapter Six.) based on some actual sounds on tape and many others which would have to be synthesized.

For thematic material I "borrowed" (as composers seem to like to do) a figure from Bach -- a fragment from his Passacaglia and Fugue in C Minor -- and freely manipulated it for my purposes. I developed a notation chart for the sequencer which established precisely the note pattern as well as the tempo.

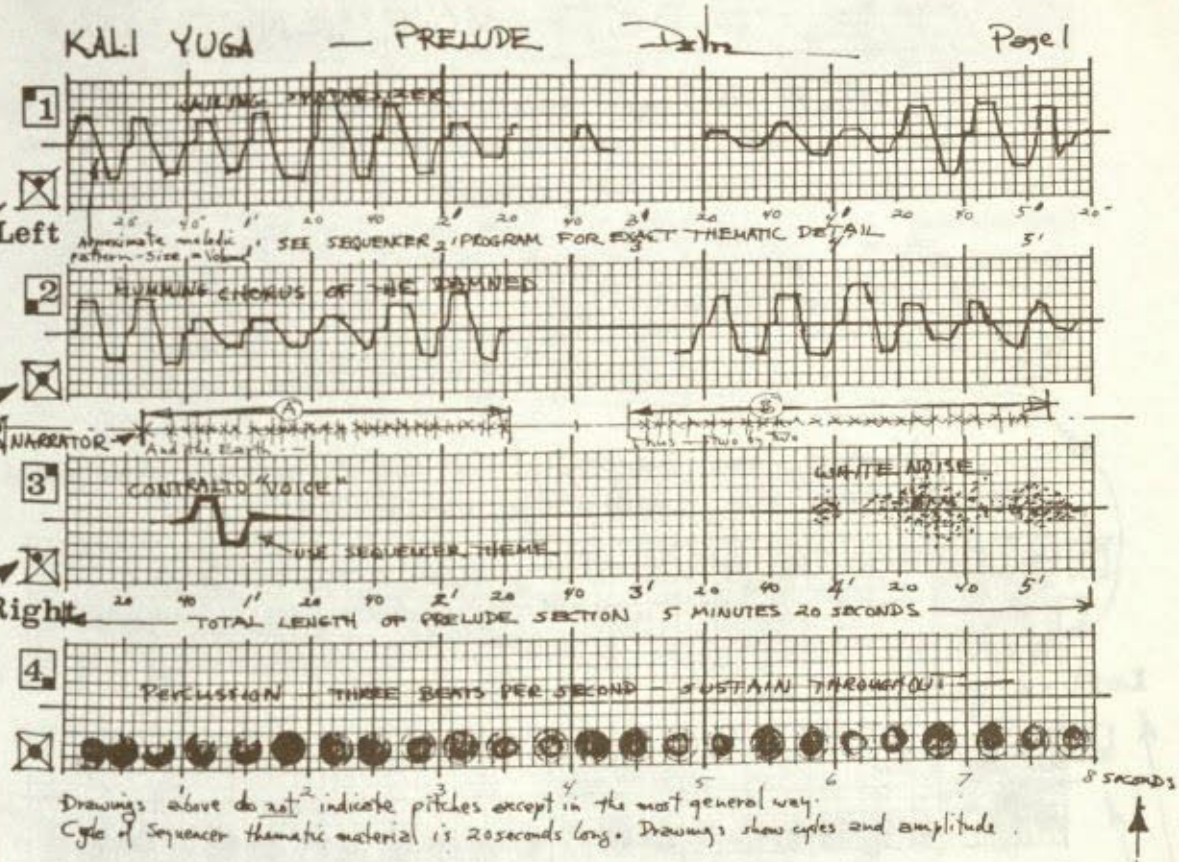


I was thus free to expand and contract time on the notation paper in order to express other things more graphically.

The theme was thereafter generally shown:

a very approximate rendering of the melody, and its height was an indication of volume.

Looking at the Prelude, perhaps we can translate some of its instruction:



Track One is supposed to be placed in the center in front of the audience. The only other instruction of importance is that it should be a "wailing synthesizer". I could have prescribed a particular patch for this, but left that to the sensitivity of the performer.

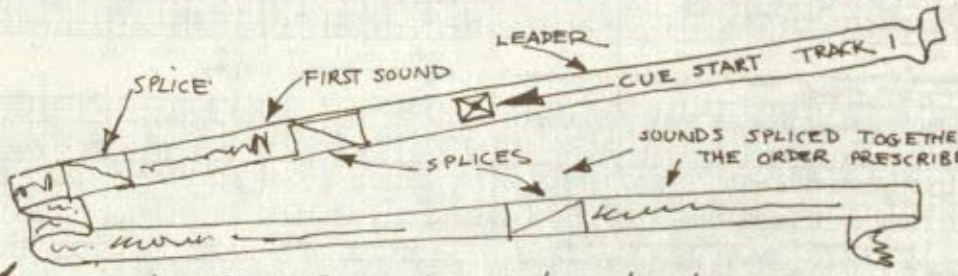
Track two should be right in the audience center and should sound like a chorus of voices humming the theme. When I produced the piece I synthesized those voices.

Track three comes at us from the left front and gives us a statement of the theme in the mode of a contralto voice. For most of the rest of the time that track is silent except for some "winds of hell" white noise during the last minute or so.

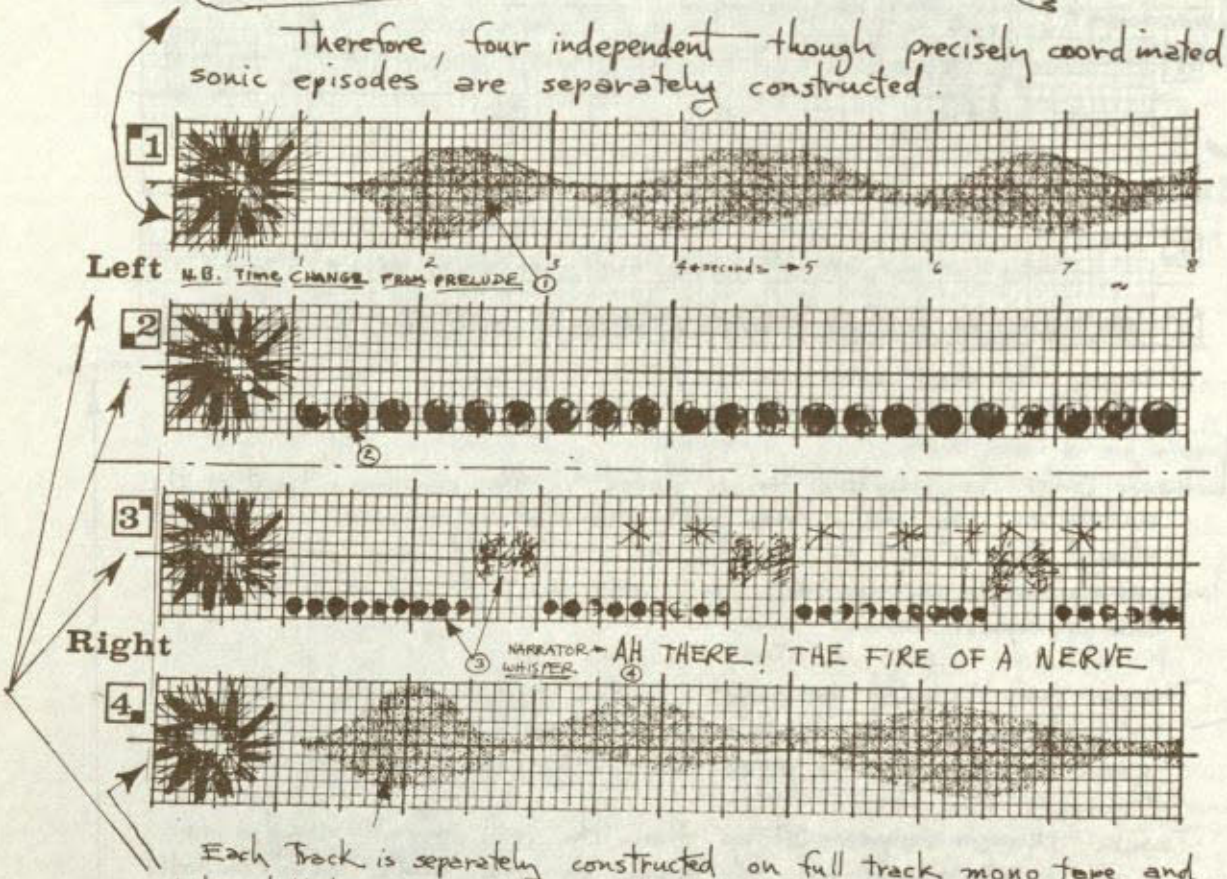
Track four is a percussion sequence accomplished by using Control oscillator one on the Electrocomp 101 to trigger an envelope for oscillators two, three and four. Note that the time for track four is only 8 seconds in the score but is sustained throughout.

THE FIRST MOVEMENT:

A different technique has been employed here. Most of the first movement is constructed on four distinct tracks.



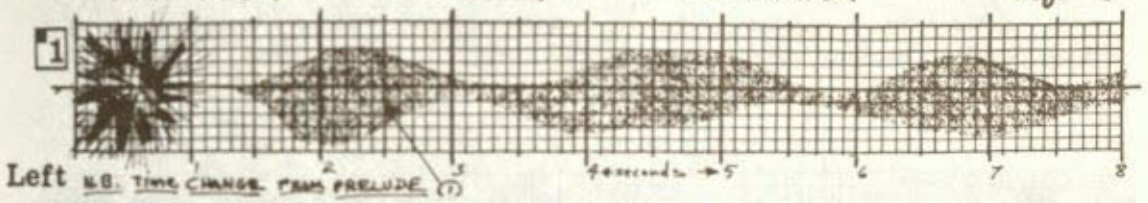
Therefore, four independent though precisely coordinated sonic episodes are separately constructed.



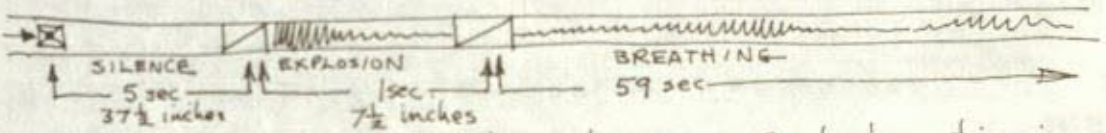
Each Track is seperately constructed on full track mono tape and later dubbed one at a time on the qued deck.

A cue start mark (⊠◄) on the leader, 5 seconds before the first sound facilitates dubbing in synchronization. In this piece the passages so constructed are 90 seconds long. Trying for good synch beyond 90 seconds is pushing it - but possible.

KALI YUGA 1st Movement "THE INCARNATION" Page 2

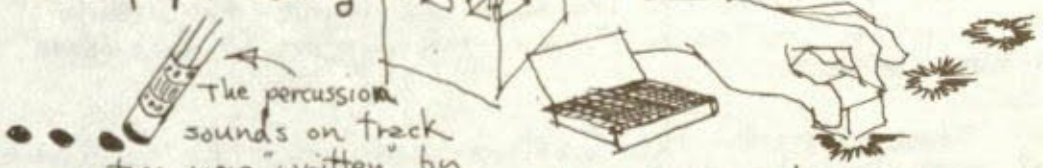


Looking at track one, we begin by splicing in an explosive sound. (I recorded fireworks at the amusement park.) The total envelope for the explosion is one second so the first 7½ inches of the track were devoted to that.

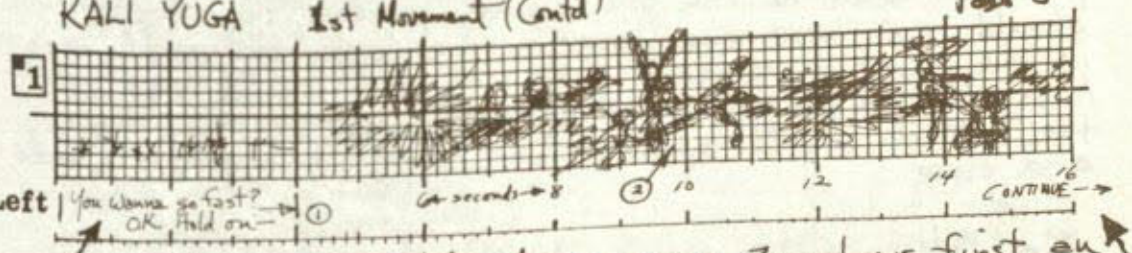


(This is shown the reverse of actual practice in splicing tapes. As you know by now, the tape is spliced from right to left.)

To notate an explosion, I cut an art gum eraser to form a design and stamped it on the score paper using a stamp pad.



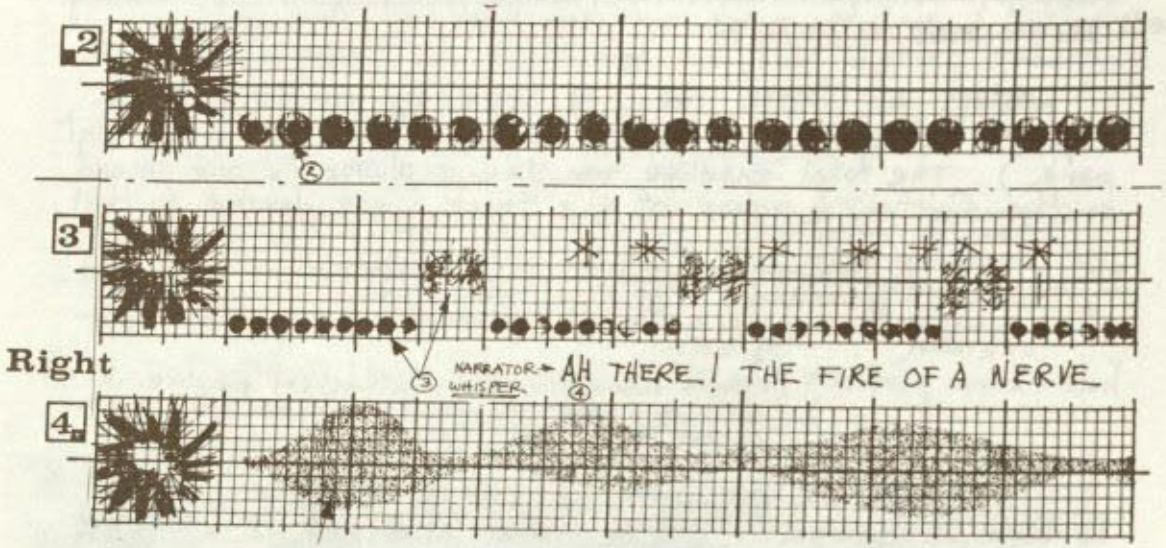
KALI YUGA 1st Movement (Cont'd) Page 3



Track one--continued on page 3--shows first an excerpt from the Seaside sounds: a carnival barker regaling a crowd on a ride. This is immediately followed by the sounds of people in a swimming pool splashing and screaming. I recorded this at 15 inches per second and slowed it down. Surprisingly, it sounded like sick cattle struggling in mud.

These two sections were spliced together to make the final 30 seconds of this passage.

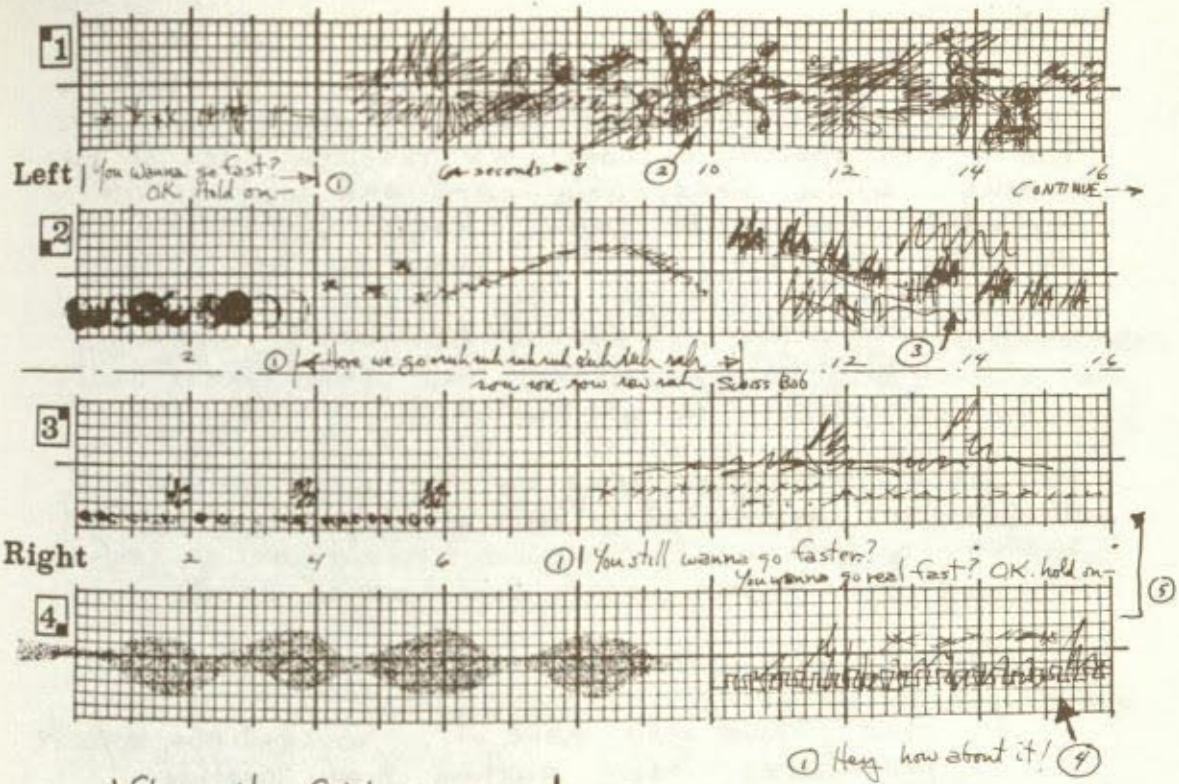
Throughout the first minute of this section, tracks one and four are nearly identical. the breathing cycles are sufficiently out of phase to make the breathing have a tidal quality.



The rhythm on track 3 is double the tempo of the rhythm on track 2 and interrupted by a brushed cymbal effect.

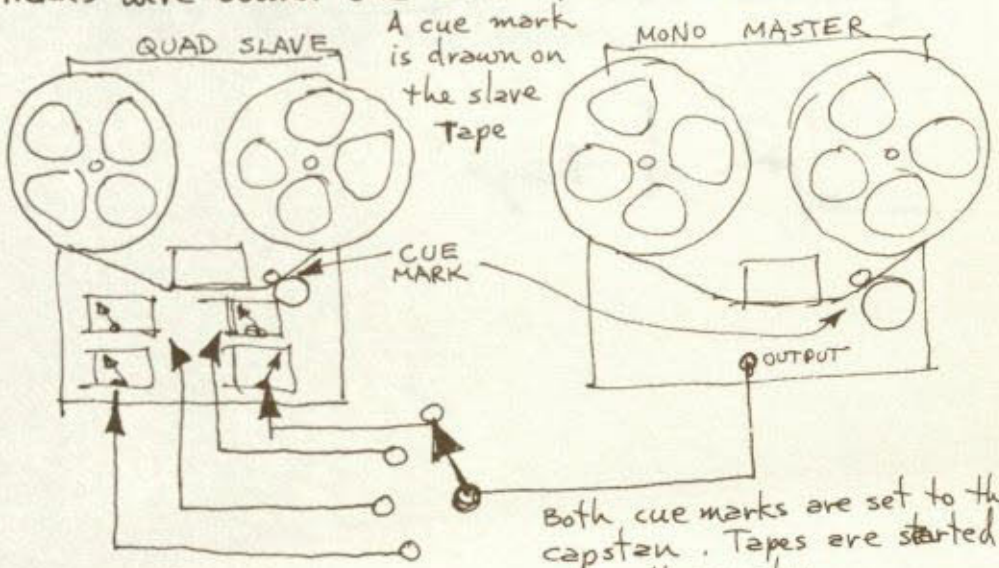
Thus -- after the first explosion -- the four tracks set a sustained rhythmic sub strata for the whispered voice of the narrator. Note that the narrator in the prelude need not be the same person; in fact, should not have the same voice quality as the voice in the first movement. the former should read his lines like a priest reading scripture from a pulpit; the latter should speak in a stage whisper -- intimate and close.

NB.
✳ Modern notation recommends the use of this symbol to represent the speaking voice. Its position in the staff may be used to indicate pitch. ✳ I have used this symbol to indicate approximately the temporal position of speaking voices.



After the first 60 seconds progressive bedlam begins to appear. this is accomplished by introducing more segments of the amusement park noises Carnival barkers add --one after another-- to the chaos. Loops of various lengths play the voices of the barkers against each other in changing relationships.

To dub these on to the final tape, the seperate tracks were wound one after the other on a reel.



Both cue marks are set to the capstan. Tapes are started simultaneously.

the first track is recorded on track one of the Quad slave. then the slave is rewound to the cue mark and switched to record on track two. this procedure continues through each of the tracks. With reasonable care and good quality recorders, the final tape should begin and end exactly together.

Obviously it would be easier with a DRUTHER editor; but until one is built, I'll do it the slow way.

the same technique may be employed for the rest of the first movement. the assemble and construct system is slow - but offers extremely precise control over highly complex sonic and spatial events.

And there you have it; two entirely opposite procedures for putting it all together. I'm sure various combinations and permutations between the two extremes will occur to you, and apply more directly to your needs.

Remember: All's fair in composition. Anything goes, that works.

Some Final Thoughts

As of this writing it appears to me that synthesizers are being over-used in some common applications. Pop and Rock groups now seem to use synthesizers with almost the same purpose and voice as the Sitar from India. Saturday morning Kiddie shows on T.V. have discovered that the synthesizer is a super sound effects machine. Thus, the synthesizer, and Electronmusic, are in danger of becoming a stereotyped image in the minds of the public.

I earnestly hope that those who use this text hold music more dearly than that.

A principle I use to guide myself may be of some value to you. I like to think of each tape I produce as a time capsule that will be dug from the earth 3000 years from now. I try to create something of such universal meaning that archaeologists of 7000 A.D. may find beauty in it.

Make your music worth listening to in the next millenium.

Robert A. DeVoe

APPENDIX

A: GLOSSARY

B: SCORE SHEETS

C: PATCHES

GLOSSARY

AMPLIFIER: An amplifier increases the loudness of a signal. Sometimes called a power amplifier, it takes a small signal and makes it strong enough to drive a loudspeaker.

ATTACK: In music this term refers to the initial "Turning on" of sound from an instrument at the beginning of each note. Attack describes the time required for the sound to reach full volume. It is the first part of the ATTACK, DECAY, SUSTAIN, RELEASE cycle of a note and its envelope.

CHANNEL: A term often used interchangably with track in tape recording. Ordinarily it refers to a discrete pathway for an audio signal, and most commonly to left or right pathways of stereo. Thus, left channel may refer to any part of the audio signal from microphone to loudspeaker on the left side.

CURRENT: Electrical term referring to the volume of electricity flowing through a circuit. It is measured in amperes.

CUT-OFF FREQUENCY: Generally refers to a filter, being the frequency at which the filter begins to attenuate the signal. For example, a low pass filter might be eliminating all frequencies above 500 Hz. Thus 500 Hz would be its cut-off frequency.

DECAY: A dropping in volume in the sound of a note towards zero. A drum has a short decay and a gong has a long decay. stage 2 of the envelope.

DECIBEL: Smallest discernable difference in sound level. 100 decibels of sound is very loud, almost annoying.

DUB: Probably derived from duplicate --means To produce a copy on one tape from another.

ECHO: the effect of hearing a sound reflected back from a great distance and then hearing the reflection reflected, etc. It is accomplished on tape by way of a feedback loop from the playback head to the record head.

ENVELOPE: Refers to the shape of a musical sound: how quickly it rises to full volume -- attack; how quickly it drops to a secondary volume -- decay; how long it remains at that level -- sustain; and how long it takes to decay to 0 -- release. Some synthesizers use a 3 stage envelope: Attack, Sustain, Decay; a trapezoidal envelope. All instruments have their own characteristic envelope which helps determine their timbre.

ENVELOPE GENERATOR: An electronic circuit designed to modulate or control other circuits at sub-audio frequencies. Some times called a timbre gate, it usually controls the amplifier.

FEEDBACK: In Cybernetics, the use of a portion of the output to control the machine - self control. Literally, a tapping off and feeding back of a part of a signal to be used again in the mainstream.

FILTER: An electrical circuit which refuses passage for certain frequencies. Thus a low pass filter allows low frequency sounds through but rejects high frequencies. A band pass filter permits only certain bands of frequencies to pass while rejecting others above and below that band. A notch filter does the opposite: it rejects a narrow band while passing others above and below.

FREQUENCY: Is the number of cycles per second of a note. Frequency determines pitch. Thus, Concert A has a frequency of 440 cycles per second. Recently the standard abbreviation for frequency: C.P.S. has been changed to Hz. meaning Hertz to honor one of the pioneers of oscilleting current theory.

FREQUENCY MODULATION: In small doses, we call it VIBRATO. It is the use of an oscillating control

voltage to vary the frequency of a sound. 5 to 10 Hz. at a low level will produce a good vibrato.

FUNDAMENTAL: the root tone of a sound. Most notes have a root or fundamental frequency plus overtones or partials. Usually the fundamental is the loudest, thus determining the basic pitch we hear in the sound.

GAIN: A measure of the degree of amplification in an audio circuit. How much the energy of the signal is increased.

GENERATOR: Usually refers to a specific kind of generator like audio generator, envelope generator, etc. It is a circuit which produces a changing voltage in a prescribed pattern on demand. In electronic test work, a function generator produces sine, square, triangle or ramp waves at frequencies from 1 c.p.s. (Hz) to 30,000.

GLIDE: In music this refers to portamento; a smooth gliding from one pitch to another. On a synthesizer this knob allows you to control the time of the changing pitch from one note to another. At 0 the change is instantaneous; at 10 it's a full Montovani sweep requiring several seconds.

GLISSANDO: Often confused with portamento and glide. Usually reserved for piano keyboard notation, it is the piano equivalent of a glide where the player runs his fingers over every key between one note and the next--thus sounding each pitch between.

HARMONICS: the natural overtones of a fundamental pitch. Pythagores discovered the natural harmonics of a vibrating string and our modern musical scales were derived from them. The presence or absence of harmonics determines some of the character and timbre of an instruments sound.

IMPEDANCE: the total resistance effect of a circuit to the signal flow, measured in ohms. It is important to match impedances when

you are connecting components. For example a low impedance microphone (Low Z) should not be connected to a high impedance jack. An 8 ohm speaker should not be connected to the 4 or 16 ohm jacks of an amplifier.

JACK: the female receptacle in an electrical circuit. An RCA Jack looks like this:

A phone or phono jack is larger. The male of the species is called a plug.

LINE INPUT/OUTPUT: As contrasted with microphone inputs a line input is used for "direct wire" transfer of a signal. It is usually high impedance (10KΩ) and is always preferable as a recording pathway.

MIC: An abbreviation for a microphone channel.

MIL: One thousandth of an inch; a unit of measurement applied here to tape thickness. One and a half mils is the best in tape.

MIXER: A circuit which combines two or more signals. A passive mixer, like a "Y" cable, is where two signals are connected to the same jack. An active mixer usually allows you to separately control the levels of each signal entering.

MODULATION: Essentially a form of control over an audio signal. Amplitude Modulation uses a control voltage to affect the loudness of the audio signal. Frequency Modulation affects the pitch of the signal. Modulation is the superimposition of a pattern over a signal.

NOISE: Random rapid bursts of sound at all frequencies It sounds like hiss. White noise. Pink Noise emphasizes the lower frequencies.

OSCILLATION: A cyclic repetition of an electronic or sonic event. In sound we call it a vibration.

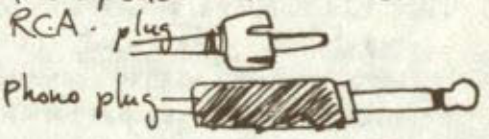
OSCILLATOR: An instrument or electronic circuit which generates alternating current with various wave forms.

OSCILLOSCOPE: An instrument which displays the oscillations present in a circuit.

PAN: A control which allows you to move a signal from one channel to another in a smooth transition. X → XY → Y

PATCH: A term applied to the process of interconnecting modules or electronic components by means of cables with plugs at both ends. May also refer to any program or pre-set of a synthesizer.

PLUG: the male of the species - the connector at the end of a cable. RCA plug



POT: (Potentiometer) A variable resistor used as a controller in electronic circuitry.

PRE-AMPLIFIER: Usually a control center in an audio system having input selectors, tone and equalization controls, volume controls, etc. It prepares the signal for the power amplifier.

PRINT THROUGH: When the magnetism of one layer of tape is strong enough to transfer to the next layer; An evil most commonly found in ½ mil and 1 mil tape.

"Q" Refers to the width of the band of frequencies at which a band pass filter operates. High Q means it has a narrow, sharply defined, band. Low Q means it has a wide band. Generally it refers to the efficiency of the filter.

RELEASE: the final decay in the envelope of a sound.

RESONANCE: the ability of one vibration to trigger or enhance a similar vibration elsewhere. In filter circuits a feedback system uses resonance to emphasize a particular band of frequencies.

REVERB: (Reverberation) Sound reflecting usually from the walls of a large room conveying a sense of space -- not quite the same as echo since the reflections are faster.

RING MODULATOR: An electronic device which produces an output of the sum and difference between two input signal frequencies. Most often used for the voice of robots in Science Fiction flicks.

SAMPLER: An electronic circuit which "reads" discrete quanta from a continuous signal. It may be set at various time intervals between readings.

SIMUL-SYNC: A tape recorder switch system which allows you to use the record head of one channel as a playback head while recording on another channel to assure that the new voice is in synchronization with previously recorded material.

SEQUENCER: An electronic circuit which makes use of computer modules to "remember" and process a series of notes through a synthesizer.

SIGNAL: the term is generally applied here to the audio voltages -- the message line -- as contrasted with control voltages.

SINE WAVE: A perfectly smooth fundamental oscillation with no overtones 

SUSTAIN: the holding of a volume level in the envelope of a sound.

TAPE LOOP: A recorded sound on tape is spliced end to end to make a circle. When played on a tape recorder, it repeats the passage over and over again.

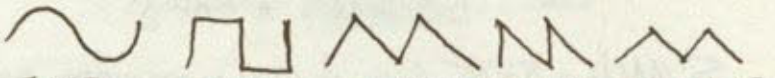
TIMBRE: the overall quality or tone color of a sound. Timbre is created by the presence of overtones and the shape of the envelope.

VOLTAGE CONTROL: Generally applies to synthesizer components which are <u>controlled</u> or effected by small voltages.

V.C.A. = Voltage controlled amplifier
V.C.O. = Voltage controlled oscillator
V.C.F. = Voltage controlled filter.

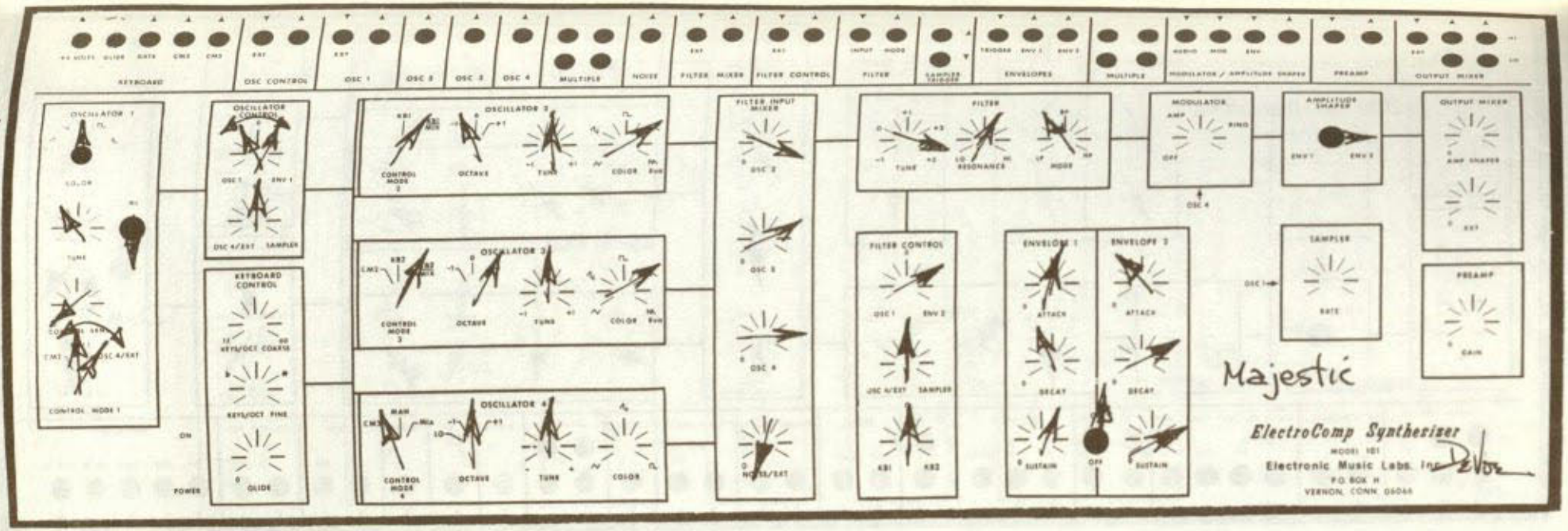
V.U. METER: A <u>Volume Unit</u> meter measures the amplitude of sound signals in decibels.

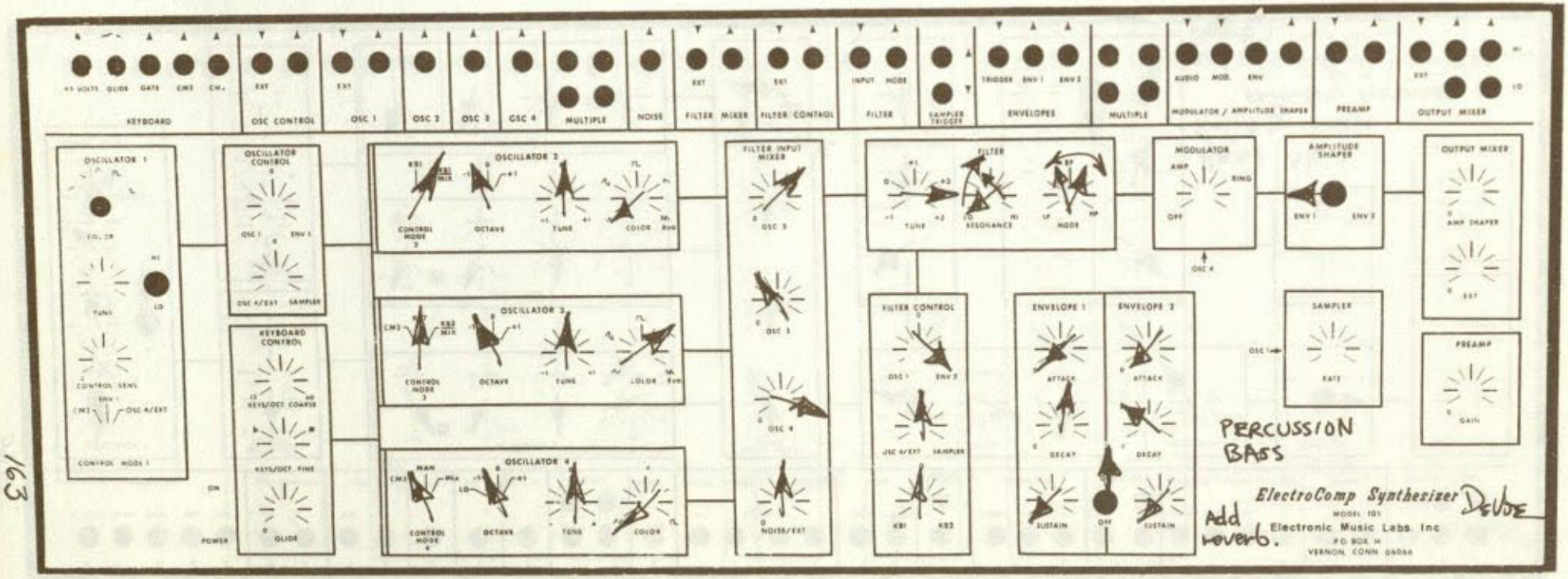
WAVE FORM: the characteristic shape of a sound vibration. Common ones in synthesizers are:



(These two are often confused with each other)

"Z": Impedance - the overall resistance of a circuit.





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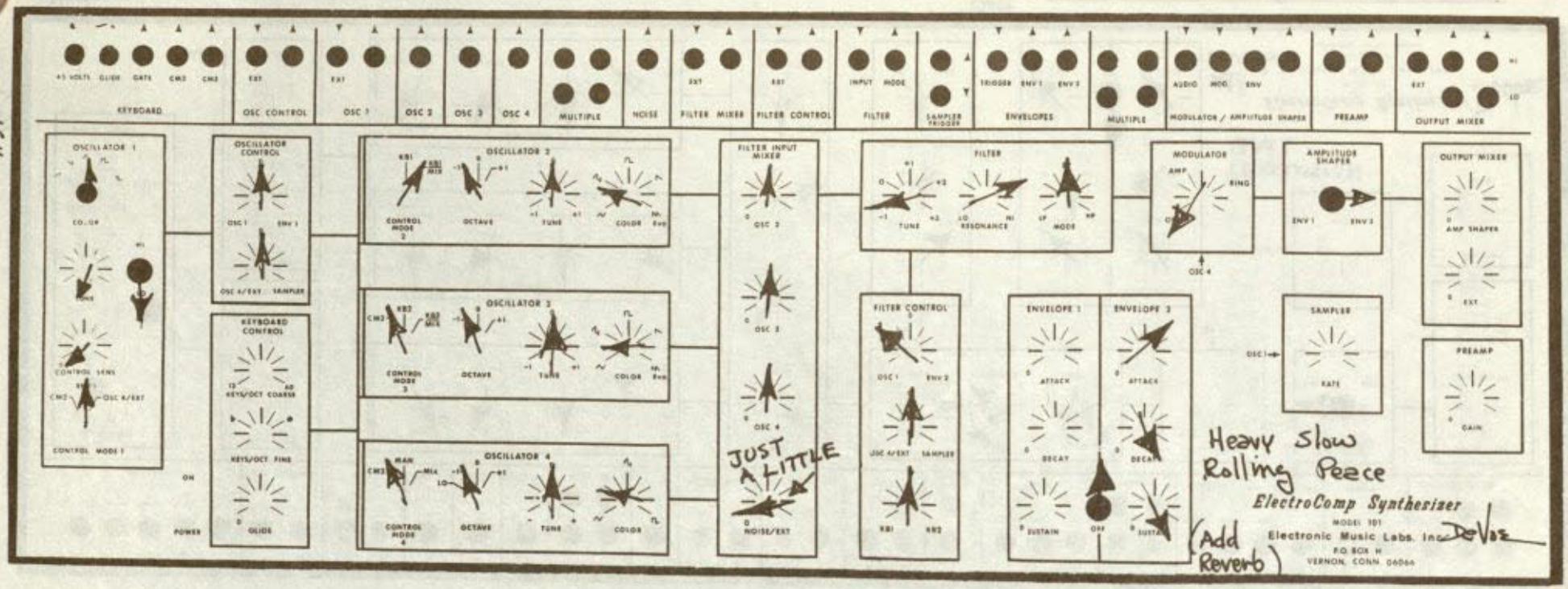
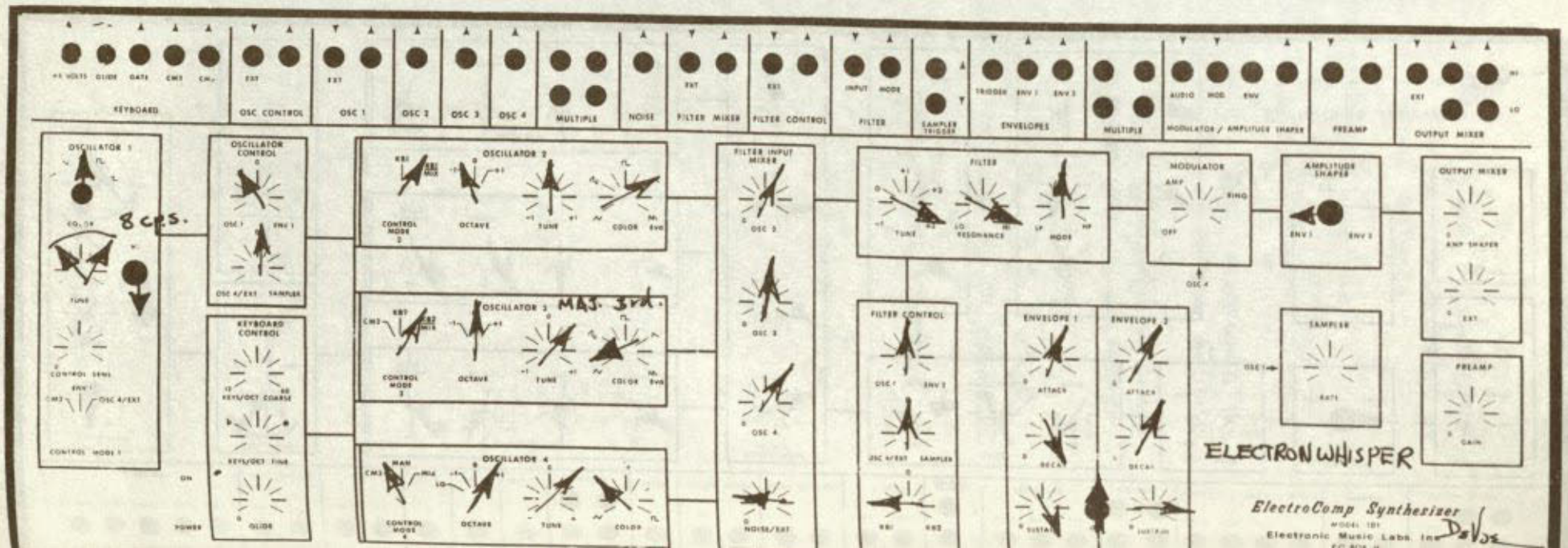
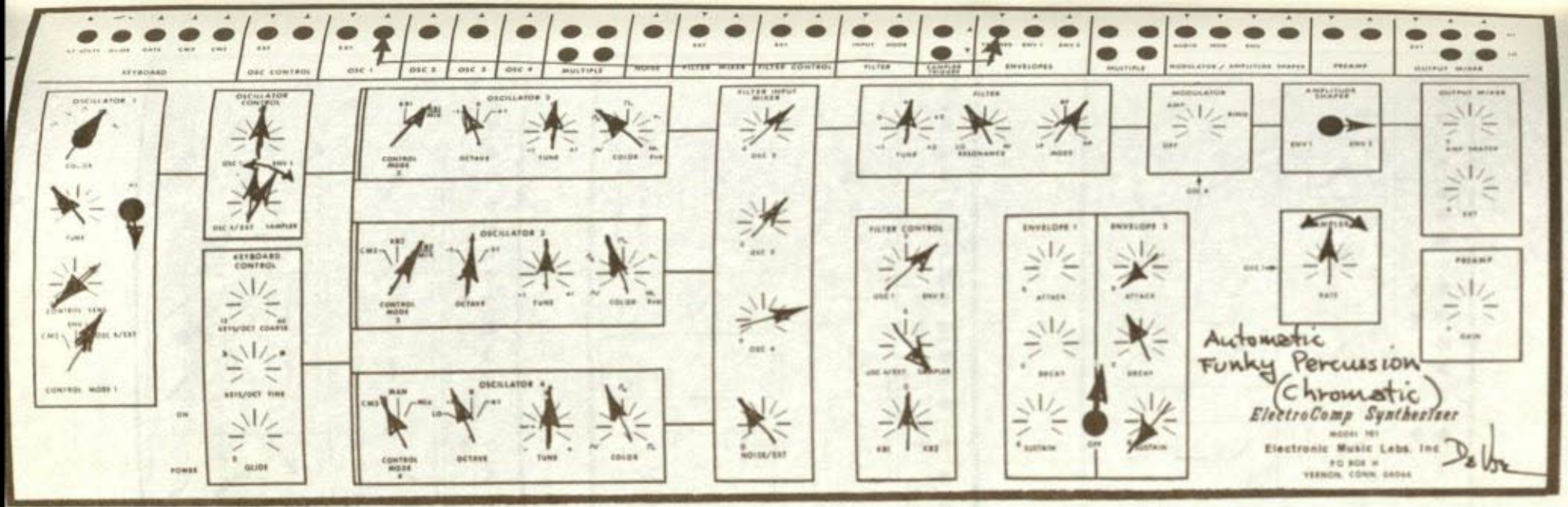
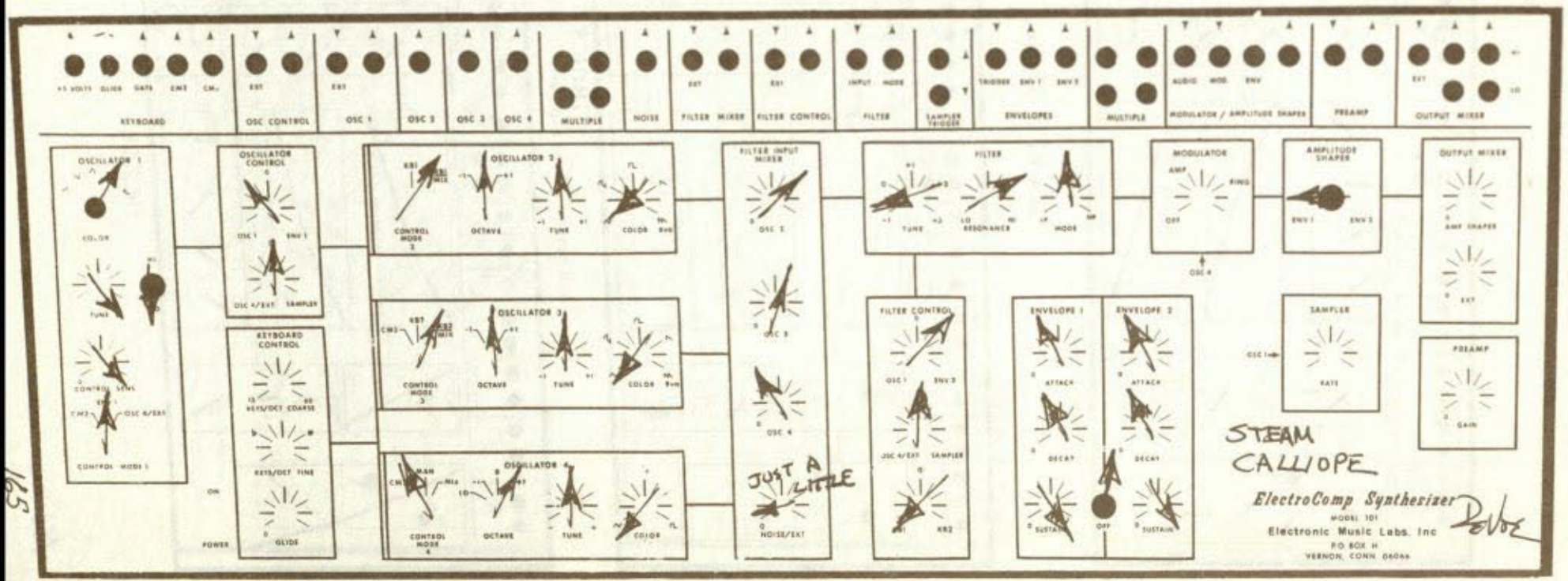
Name _____ Date _____


KEYBOARD
OSC CONTROL
OSC 1
OSC 2
OSC 3
OSC 4
MULTIPLE
NOISE
FILTER MIXER
FILTER CONTROL
FILTER
ENVELOPES
MODULATOR / AMPLITUDE SHAPER
PREAMP
OUTPUT MIXER
OSCILLATOR 1
OSCILLATOR CONTROL
OSCILLATOR 2
OSCILLATOR 3
OSCILLATOR 4
KEYBOARD CONTROL
FILTER INPUT MIXER
FILTER
MODULATOR
AMPLITUDE SHAPER
OUTPUT MIXER
FILTER CONTROL
ENVELOPE 1
ENVELOPE 3
SAMPLER
PREAMP
JUST A LITTLE
Heavy Slow Rolling Peace
(Add Reverb)
ElectroComp Synthesizer
MODEL 101
Electronic Music Labs. Inc.
P.O. BOX H
VERNON, CONN. 06066
DeVoe

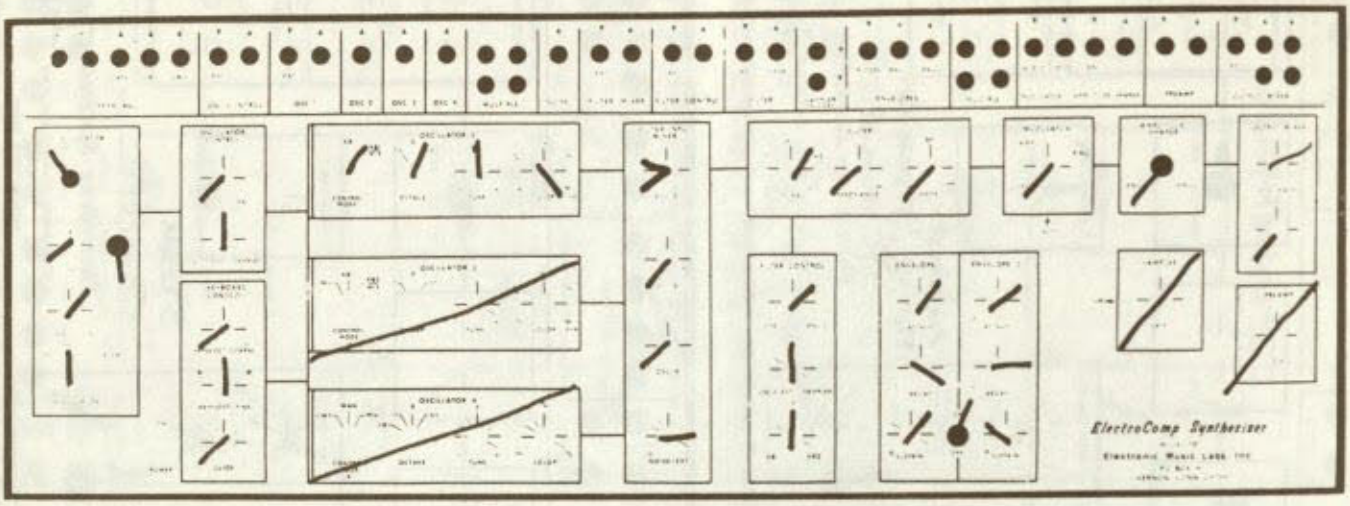

KEYBOARD
OSC CONTROL
OSC 1
OSC 2
OSC 3
OSC 4
MULTIPLE
NOISE
FILTER MIXER
FILTER CONTROL
FILTER
ENVELOPES
MODULATOR / AMPLITUDE SHAPER
PREAMP
OUTPUT MIXER
8 cps.
MAJ. 3rd.
ELECTRON WHISPER
ElectroComp Synthesizer
Electronic Music Labs. Inc.
DeVoe

Name _____ Date _____

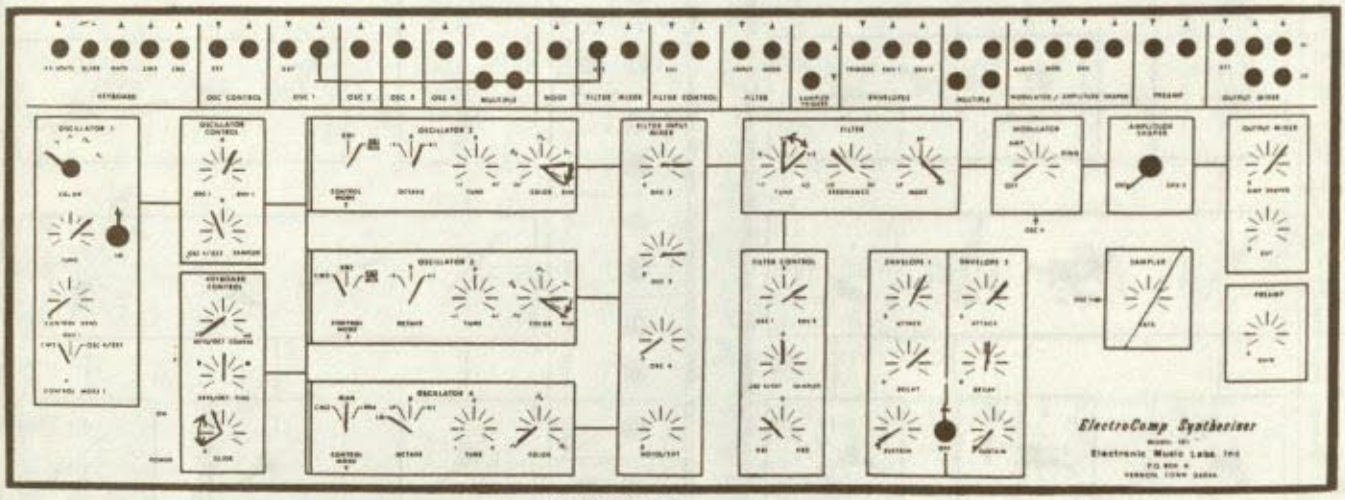




Name _____ Date _____

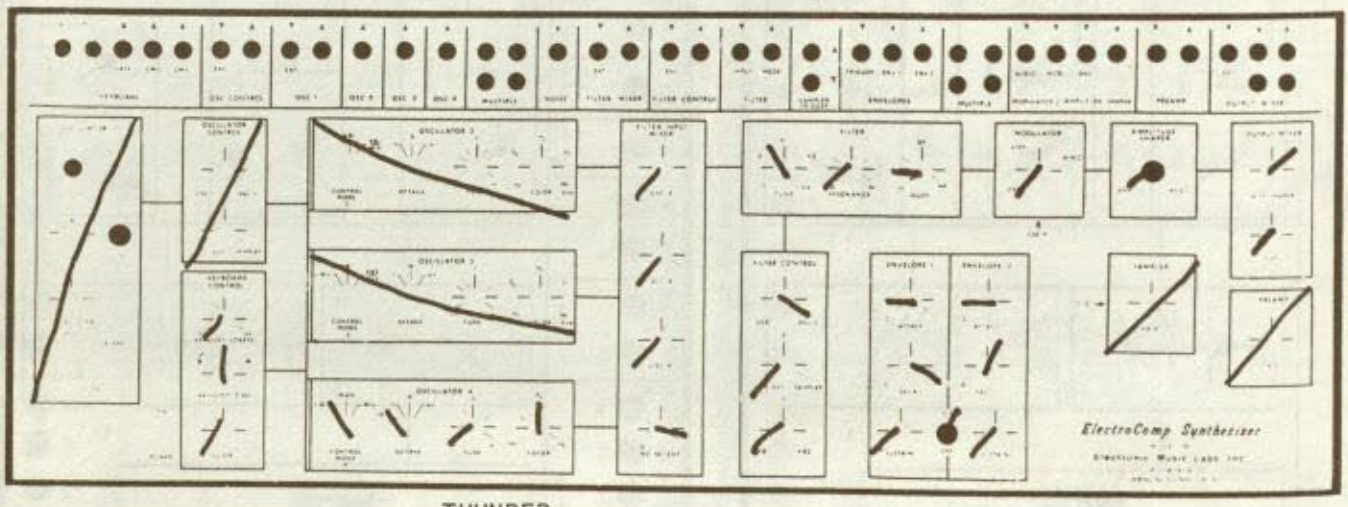


SEA WITH BIRDS

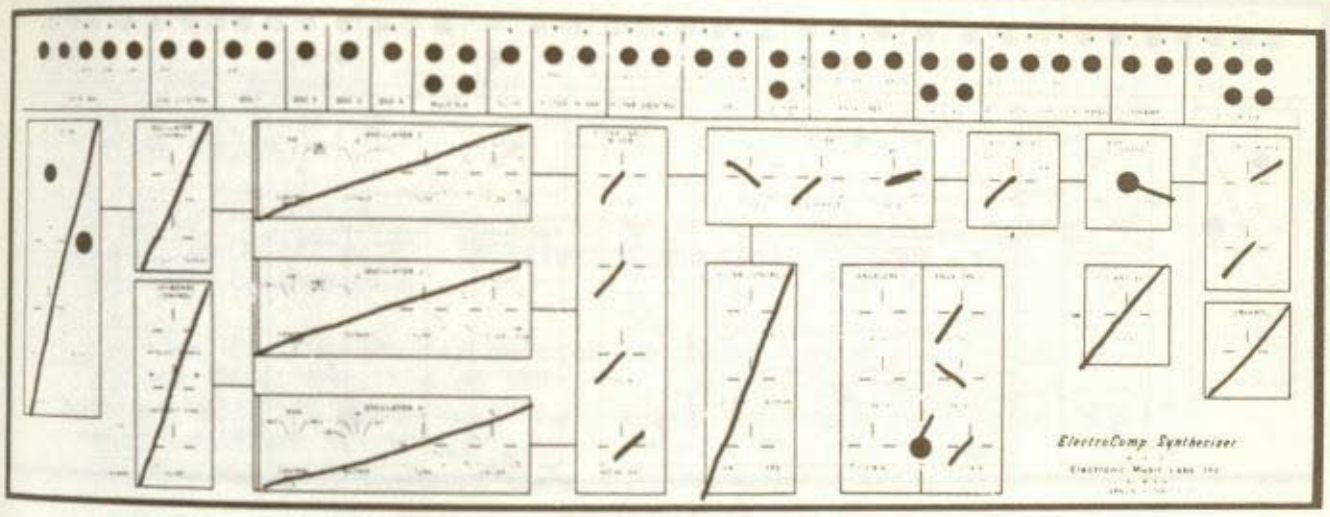


STRINGS

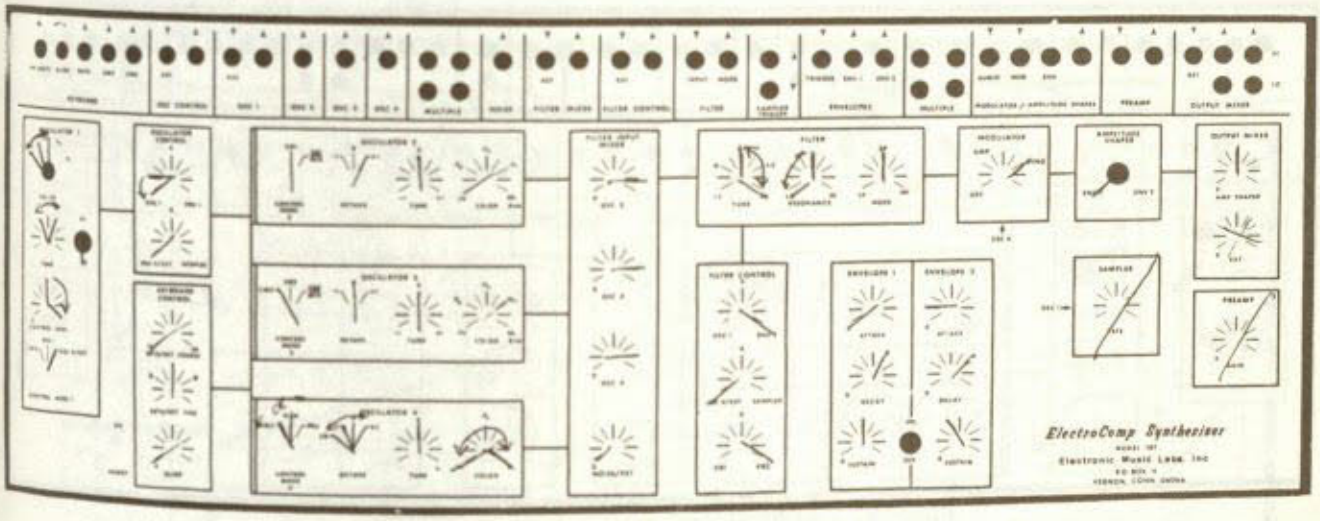
(Use high register & some reverb. Let envelopes work for you.)



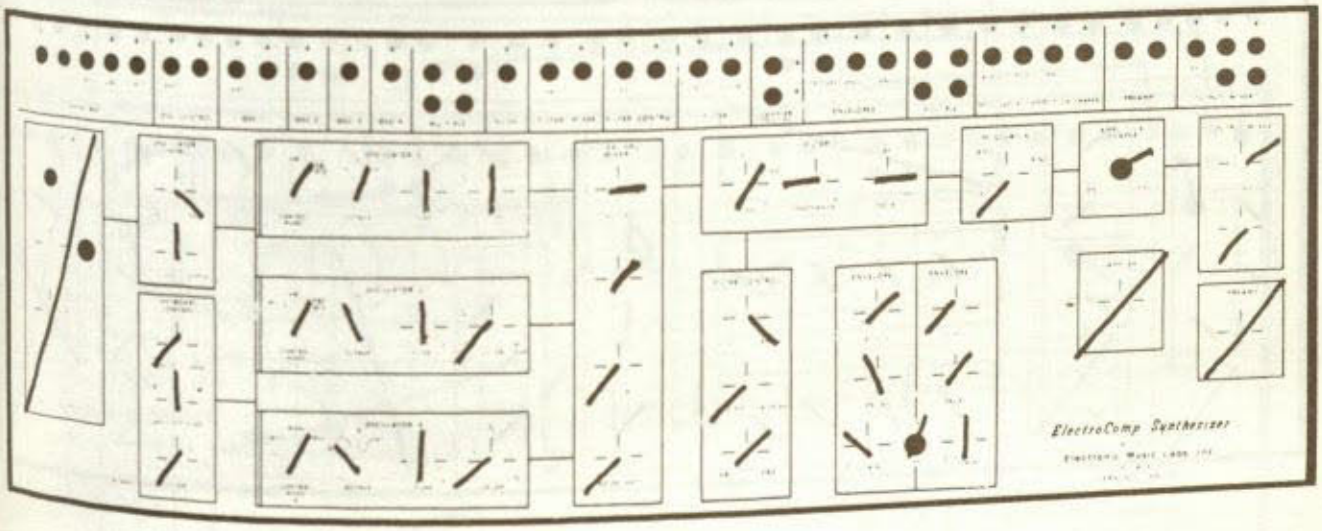
THUNDER



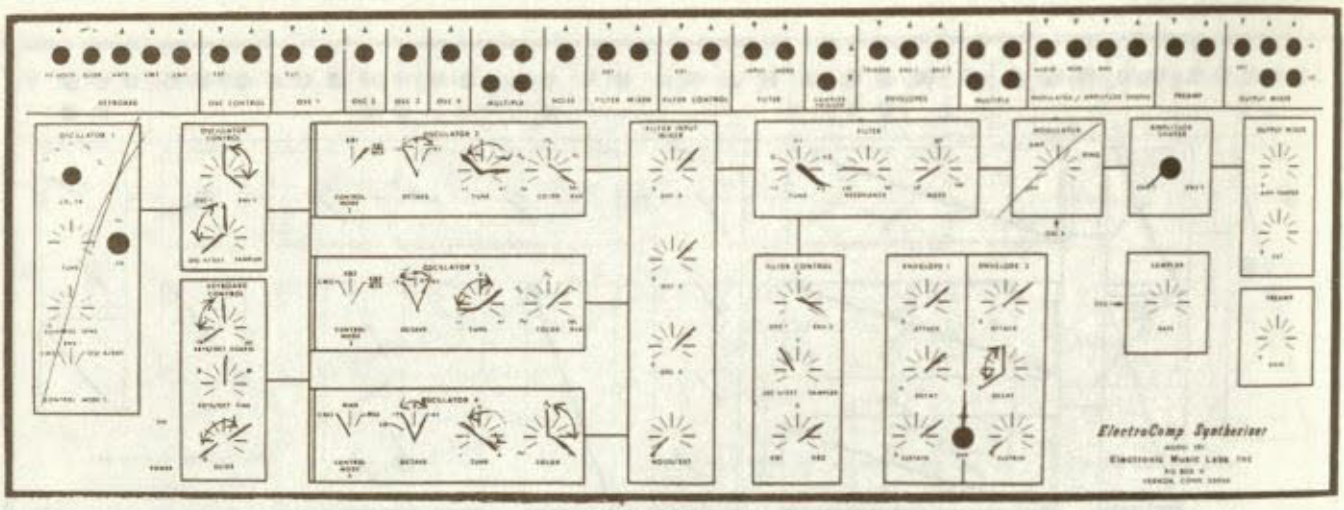
SNARE DRUM



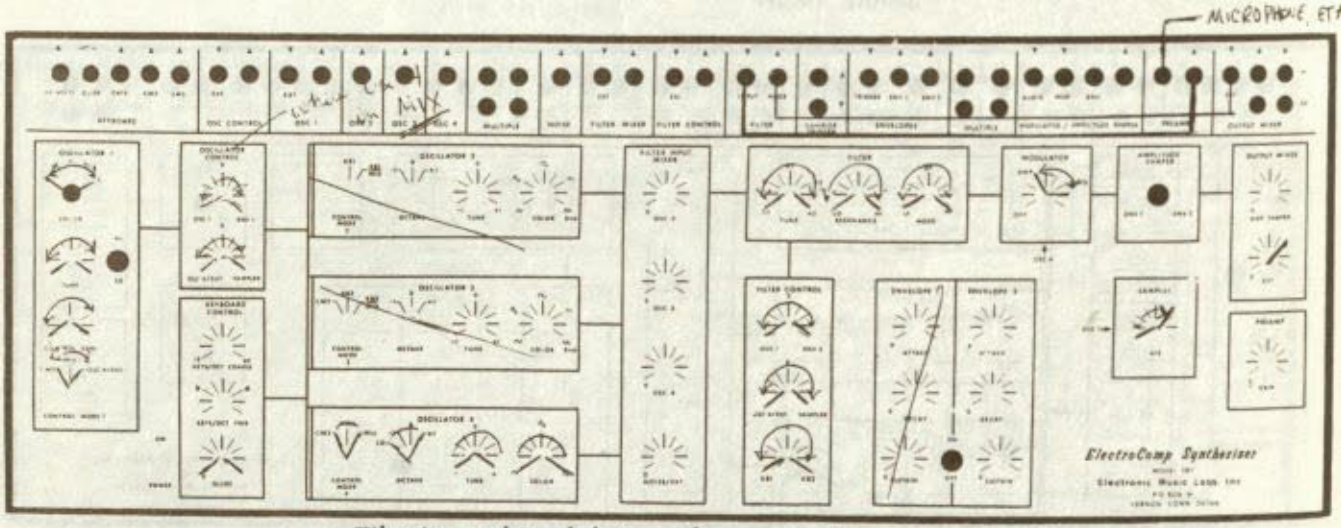
FANTASY #2



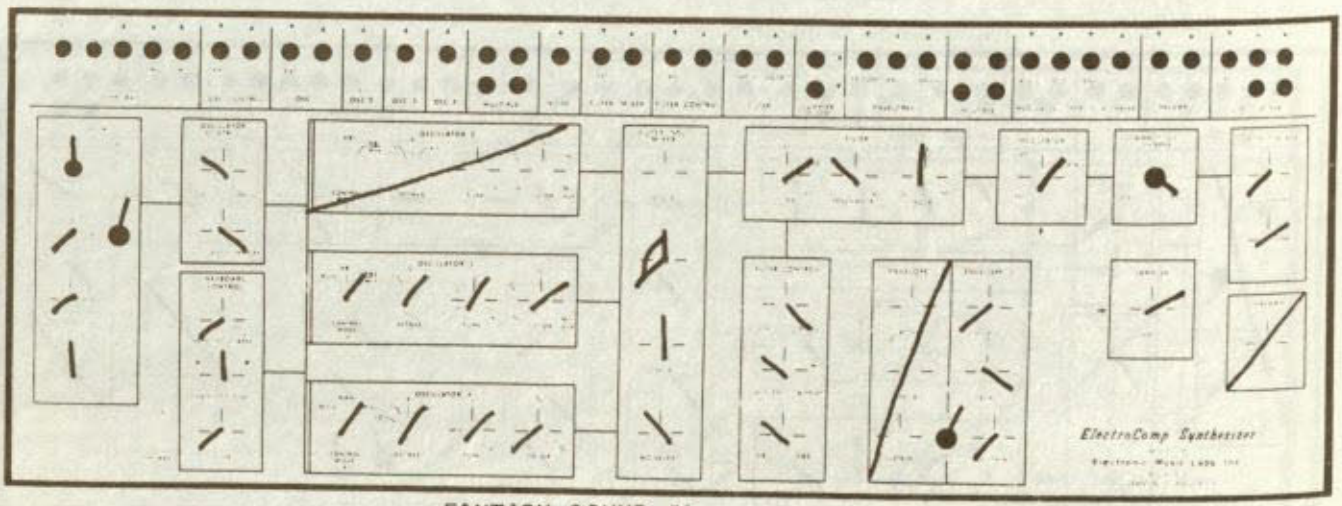
FANTASY #3



FANTASY #4



Filtering and Modulation of an external source.

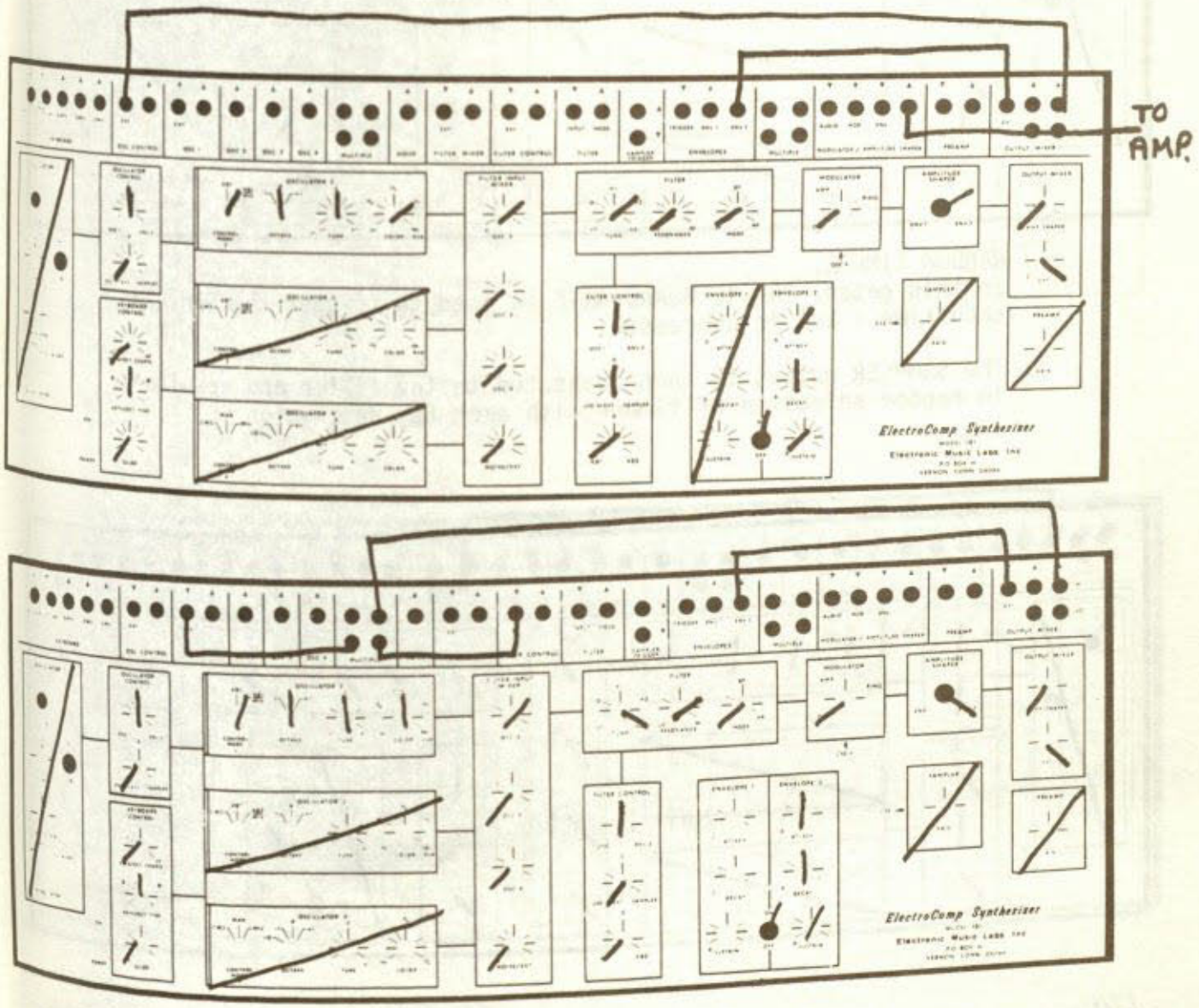


FANTASY SOUND #1

INVERTING ENVELOPE.
The OUTPUT MIXER may also be used to invert the ENVELOPE GENERATOR's output.

Normally the ENVELOPE when connected to the OSCILLATORS causes the pitch to increase. If inverted the ENVELOPE will cause the pitch to decrease.

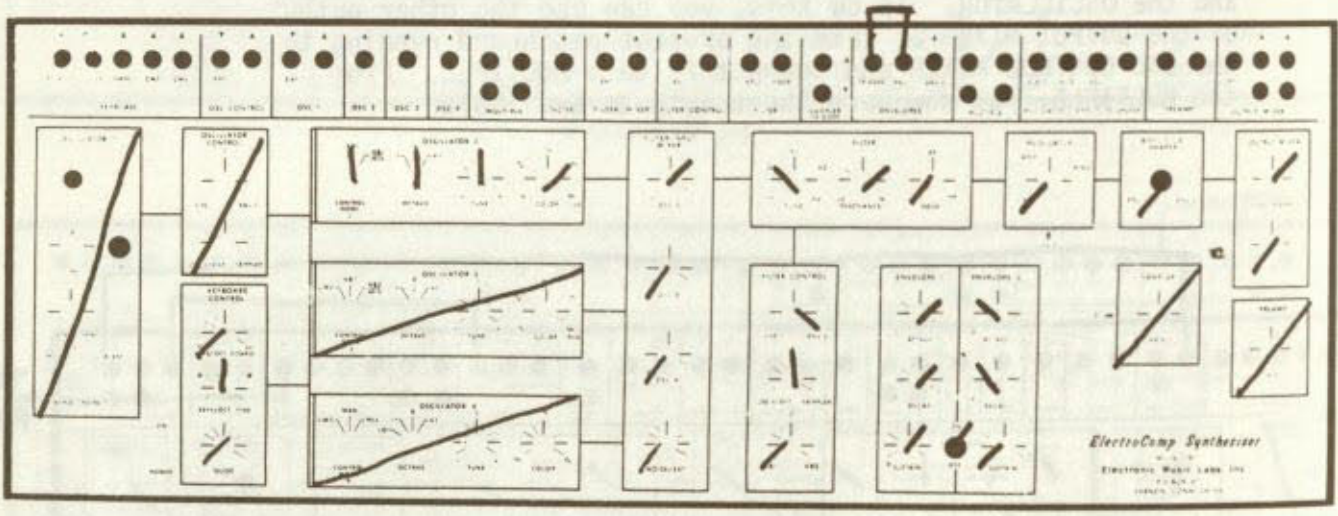
The inverted ENVELOPE can be used to control both the FILTER and the OSCILLATOR. To do this, you can use the other output of the OUTPUT MIXER or take the present patchcord running to the OSC CONTROL MIXER and connect it to a MULTIPLE. From the MULTIPLE, you now have three outputs available.



DELAYED ENVELOPE.
This patch demonstrates the ability of ENVELOPE 1 to trigger ENV 2.

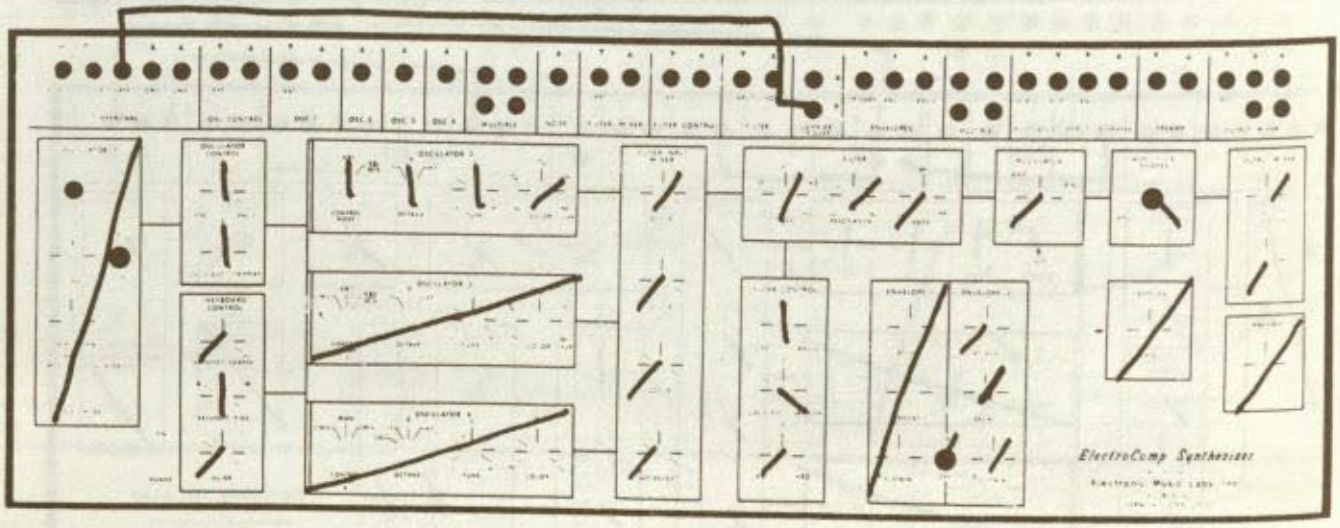
In this patch ENV 2 will not occur until ENV 1 has reached a preset amplitude level.

This fact permits you to use the ATTACK control of ENV 1 to determine when ENV 2 will occur.

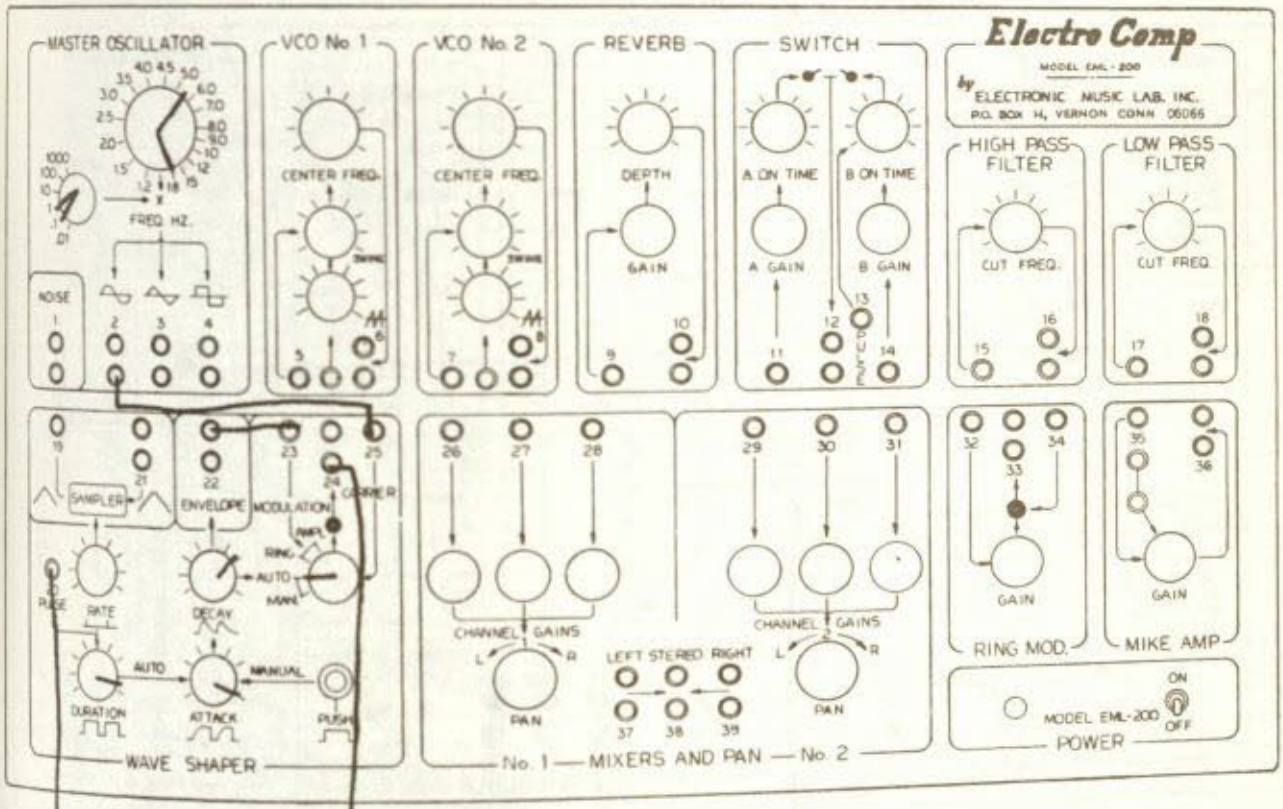


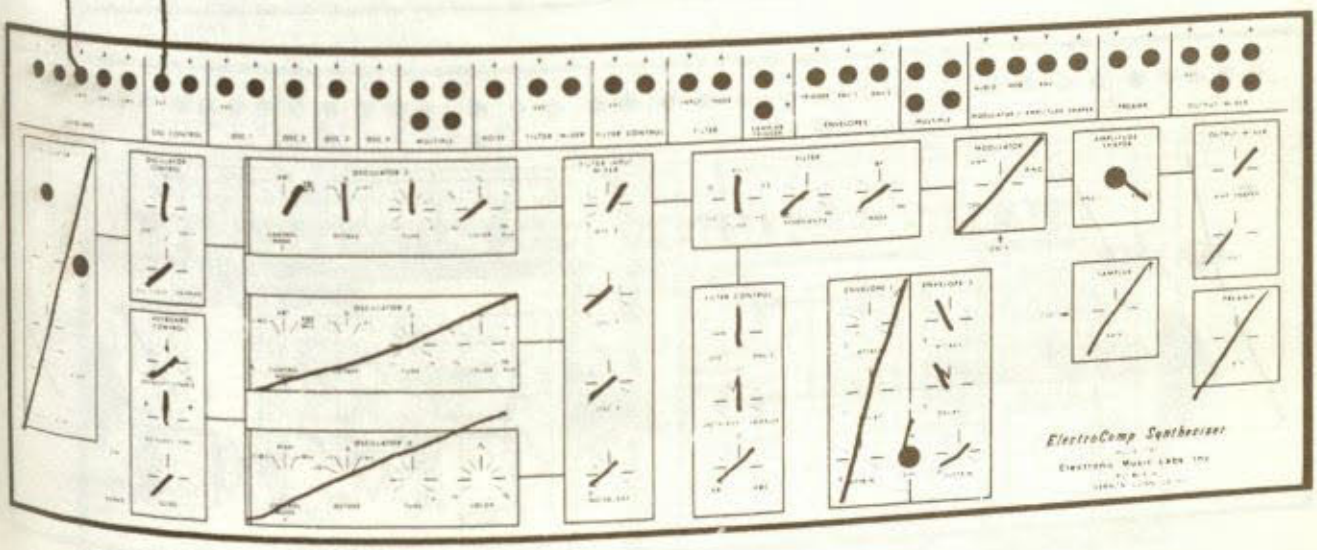
RANDOM TIMBRE.
In this patch, the KEYBOARD GATE is used to trigger the SAMPLER each time a key is depressed.

The SAMPLER output is then connected to the filter and results in random selection of timbre with each key depression.

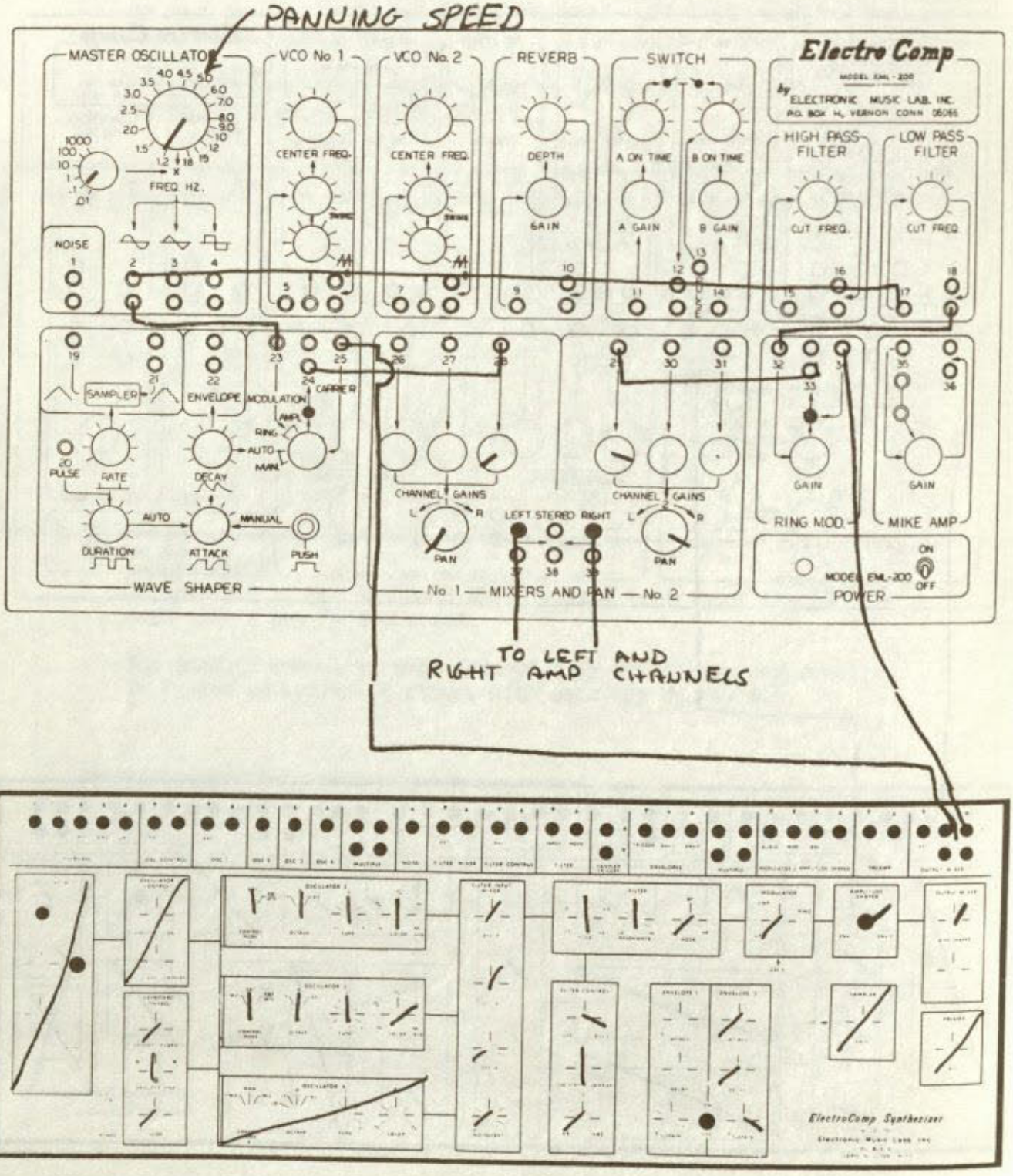


This patch gives you vibrato where the amount of vibrato (amplitude) varies as the note decays.



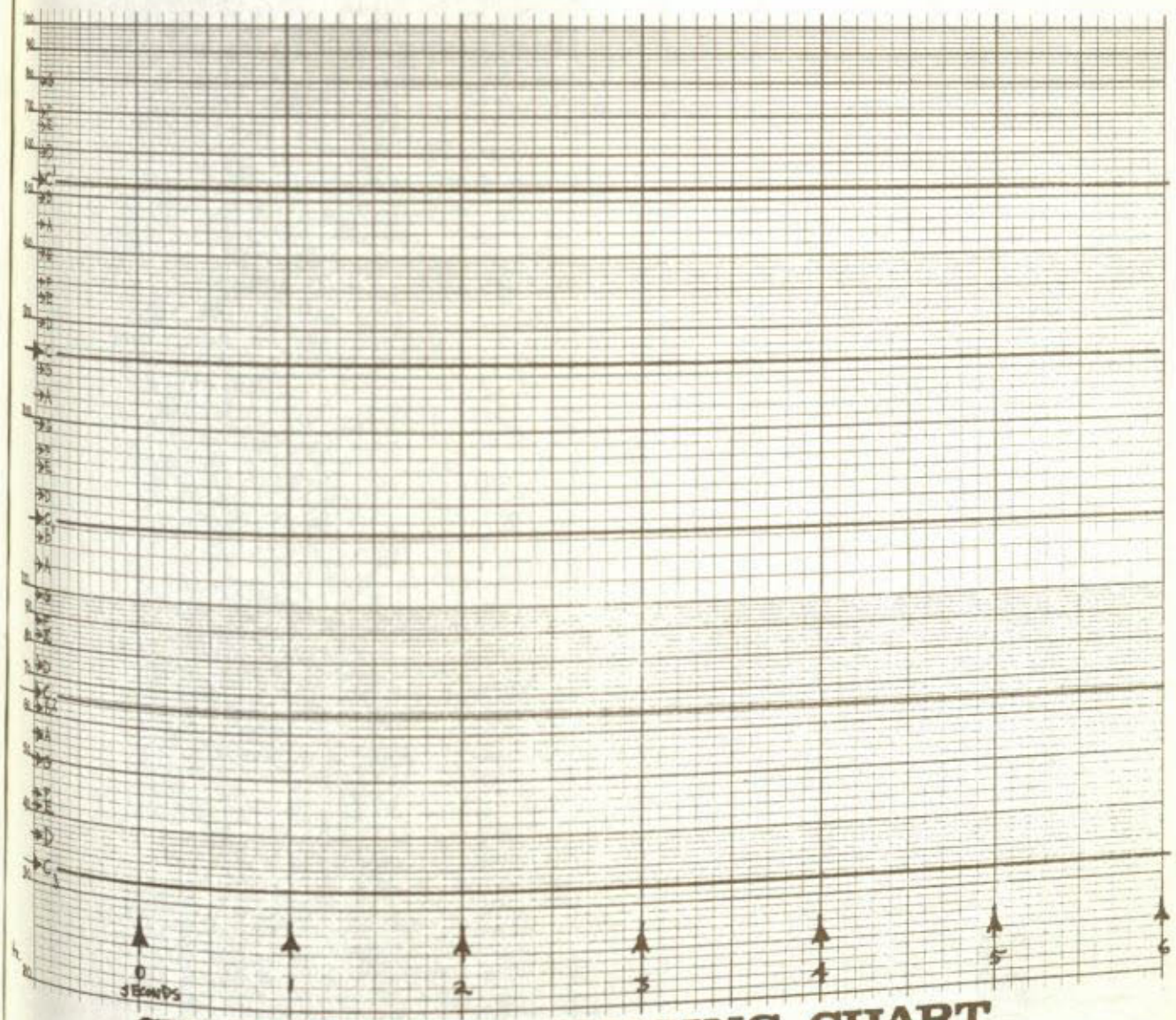


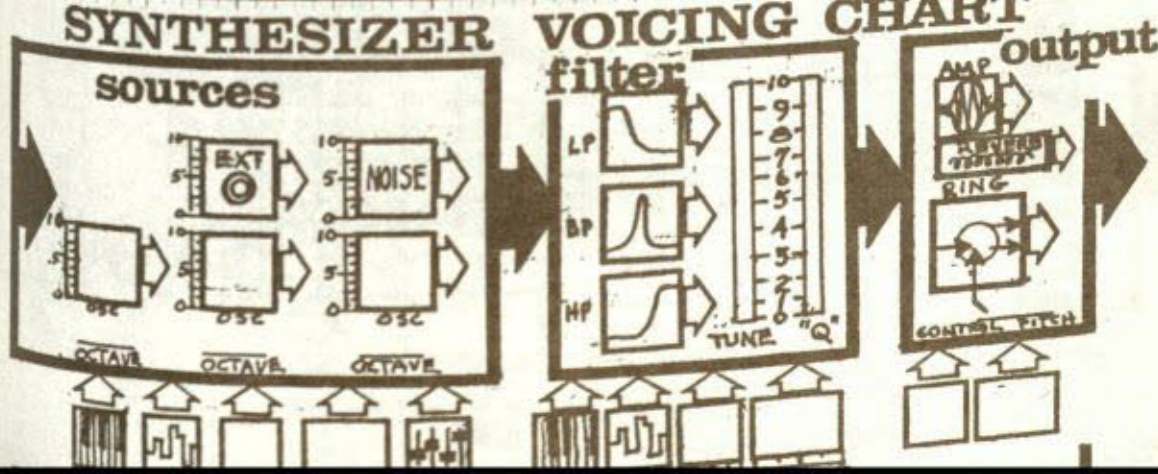
AUTOMATIC PANNING.



SCORE SHEET

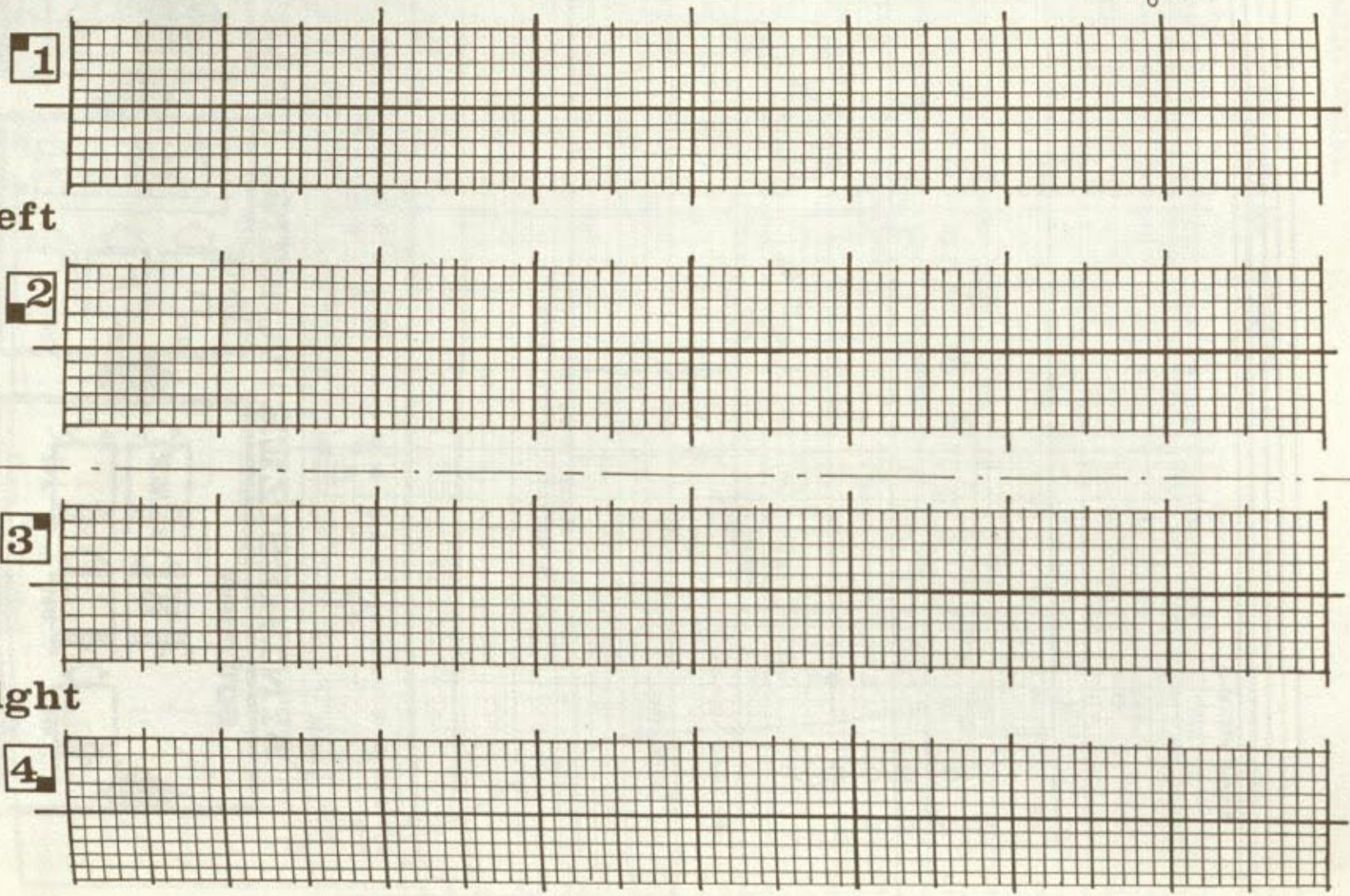
Page



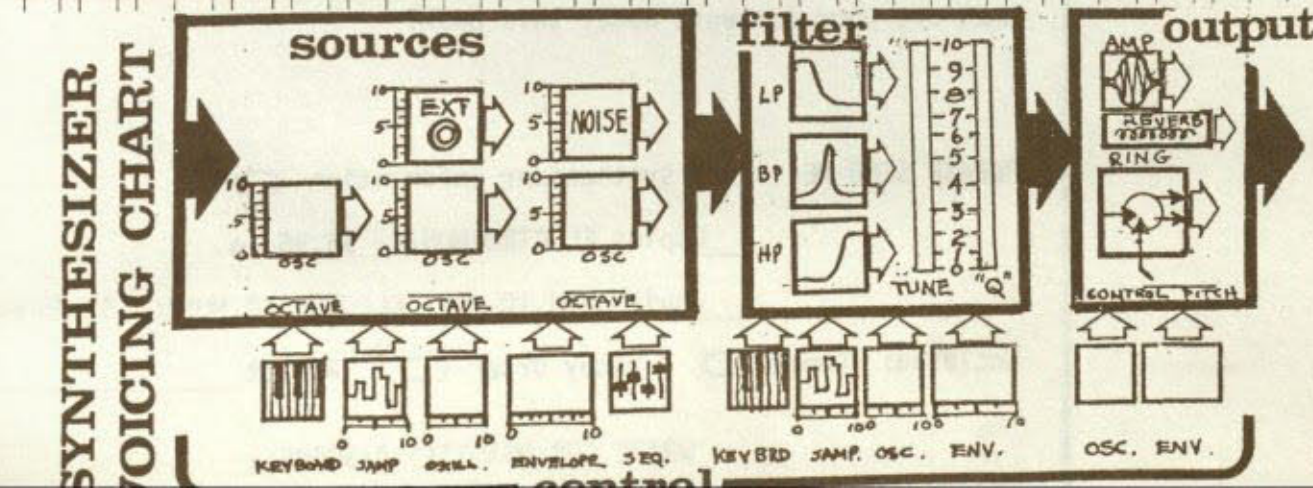


QUAD SCORE

Page No. _____



c d e f g a b c d e f g a b C D E F G A B c d e f



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