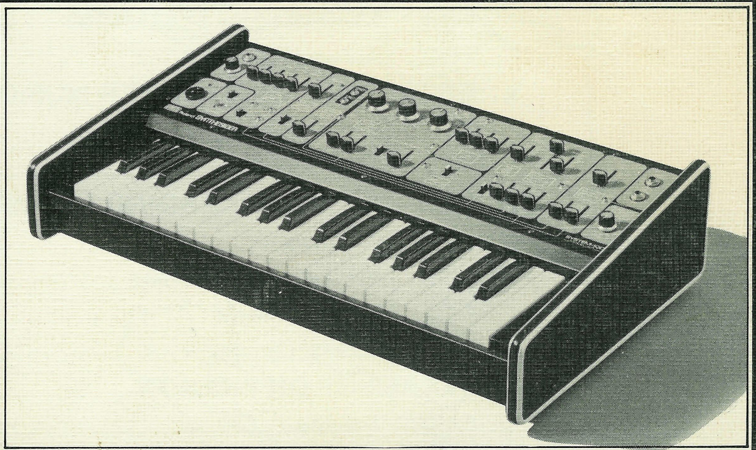
Roland Synthesizer

SYSTEM 100

SYNTHESIZER

MODEL **101**

INSTRUCTION MANUAL



Roland

CONTENTS

INTRODUCTION

This manual presents a great deal of material.

There's no getting around it, the synthesizing of even simple sounds can be a rather complicated process. However, like any complicated process, if it is broken down into its basic elements and these elements are considered one at a time, the whole project becomes much more manageable.

But still, you won't be able to take it all in with just one reading. There may also be parts which you just can't seem to follow at all, but don't worry about that too much. When you come to one of these parts, read it through, then continue, coming back to it later, or even tomorrow. Often, difficult parts become clearer after reading later paragraphs or after a suitably digestive time lag.

And don't be afraid to experiment. Remember that it is impossible to damage this instrument with any combination of control settings or patch cord arrangements; there are no forbidden connections.

Only one caution: If you find some wild sound you like, it would be a good idea to make a diagram of it so you can find it again.

1. THE ELEMENTS OF THE SYNTHESIZER

1-0-1 **Before we begin . . . . .**
Move all the slider controls down to the "0" position, plug in the power cord, and turn on the POWER switch. The red pilot light above the switch should go on.

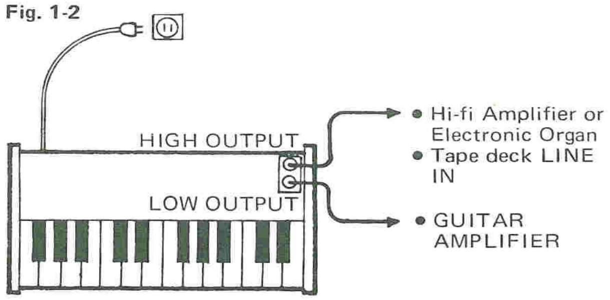
Fig. 1-1

1-0-2 **Patching the synthesizer . . . . .**
The settings of the controls to arrive at some sound is called a patch. You'll find the patch diagrams in the separate MODEL 101 SYNTHESIZER PATCH BOOK.

Set Patch 45 (Sine Wave). This patch generates a tone which you can use as a test signal for connecting your amplifier.

1-0-3 **Connecting the amplifier . . . . .**
Just about any amplifier will work. Fig. 1-2 shows the connections.

Fig. 1-2



1-0-4 **Stereo headphones . . . . .**
The PHONES LEVEL control has no effect on the output at the LOW and HIGH OUTPUT jacks.

Fig. 1-3

1-0-5 **Sound . . . . .**
A musical instrument produces vibrations which are transmitted through the atmosphere and set the ear drum to vibrating. This we hear as sound.
The pitch of the sound depends on how fast these vibrations occur; the faster the vibrations, the higher the pitch. The rate of vibration per second is called the frequency.
The unit of measure for the frequency is the Hertz (abbreviated Hz.), named after Heinrich Rudolf Hertz (1857-1894).

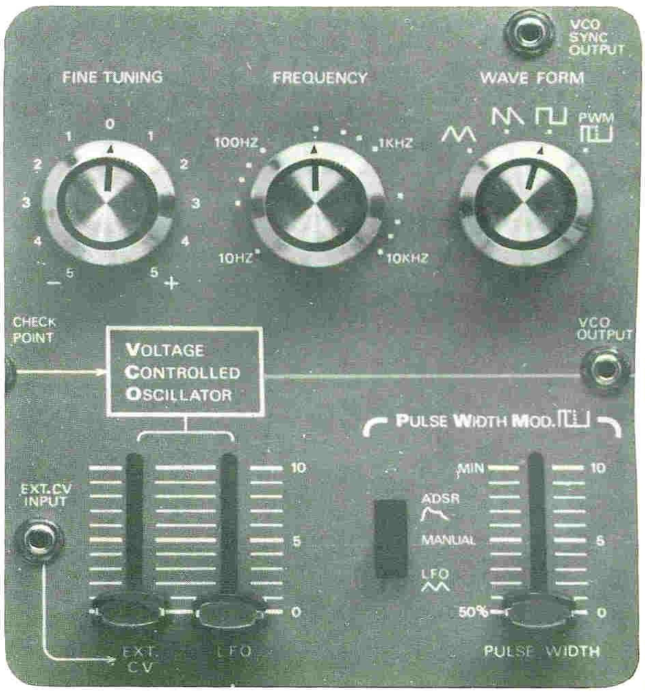
1-1-0 The VCO or VOLTAGE CONTROLLED OSCILLATOR

The VCO or VOLTAGE CONTROLLED OSCILLATOR is the heart of the synthesizer.

An oscillator is simply an electronic circuit designed to generate a wave form, or in the case of the synthesizer, to generate sound.

"Voltage controlled" simply means that the frequency or pitch of the output is controlled by means of a DC (direct current) control voltage; the higher the voltage, the higher the pitch.

Fig. 1-4



1-1-1 Let's try that . . . . .

With Patch 45 (Sine Wave) set, try turning the VCO FREQUENCY control back and forth. Turning this knob changes the DC control voltage which controls the VCO, thus changing its frequency or pitch.

1-1-2 Try the FINE TUNING control . . . . .

This control does the same thing that the FREQUENCY control does but to a lesser degree. From –5 to +5 covers about one octave.

1-1-3 The tuning fork . . . . .

The vibration of a tuning fork is shown in fig. 1-5.

If this tuning fork is tuned to A above middle C, then it vibrates at a rate of 440 cycles per second, or in other words, its frequency is 440 Hz.

1-1-4 The sine wave . . . . .

Fig. 1-5a shows a diagram of the vibrations or the wave form produced by one of the prongs. This wave form is called a sine wave. It is the purest of all sound and is the sound which you hear coming from the speaker with Patch 45 (Sine wave).

Set up Patch 48a (Wave Forms) by moving the VCF CUTOFF FREQUENCY control to "0".

1-1-5 The triangular wave . . . . .

If there were some instrument or object which vibrated like the diagram in fig. 1-6, then it would produce the sound you now hear.

Change the VCO FREQUENCY control and listen to the sound quality in the different ranges. Notice that it sounds quite reedy in the lower range and a lot like a toy flute in the upper ranges.

(Patch 37 (Whistler I) is an example of a patch which uses the triangular wave.)

1-1-6 The sawtooth or ramp wave . . . . .

Set up Patch 48b (Wave Forms) by changing the WAVE FORM switch to the ⋀⋀ position.

If there were an instrument or object which vibrated as shown in fig. 1-7, then it would produce the bright brassy sound you hear now.

The sawtooth wave is very often used as the basis for creating the sounds of brass instruments.

(Patch 19 (Horn) is a good example of using this wave.)

1-1-7 The square wave . . . . .

Set Patch 48c (Wave Forms) by changing the WAVE FORM switch to ⊓⊔ . This position produces the wave diagrammed in fig. 1-8.

It sounds very much like a clarinet; indeed, the wave form actually produced by the vibrating column of air in a clarinet looks very much like this square wave. (See fig. 1-25.)

(Patch 8 (Clarinet) is a good example of using this wave).

Fig. 1-5 The tuning fork

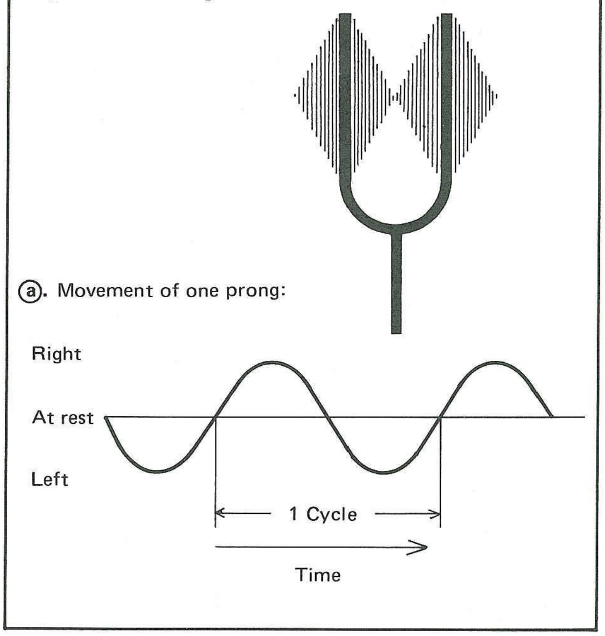


Fig. 1-6 Triangular wave

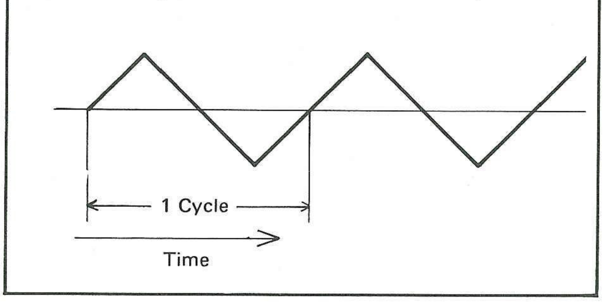


Fig. 1-7 Sawtooth or ramp wave

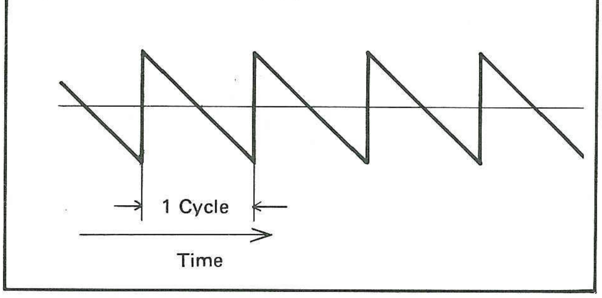
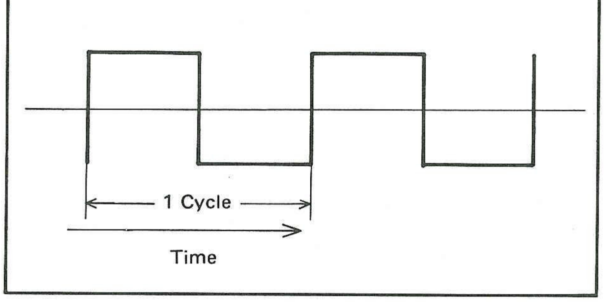


Fig. 1-8 Square wave



1-1-8 **The pulse wave . . . . .**

With the PULSE WIDTH control set at MIN, set Patch 48d (Wave Forms). The sound you now bear is diagrammed in fig. 1-9. It is a rather nasal reedy sound.

(Patch 23 (Saxophone) is a good example of using this wave.)

Moving the PULSE WIDTH control down increases the length of the pulses as shown in fig. 1-10.

When the control is all the way down at the 50% position, the wave is exactly the same as the square wave in Fig. 1-8. Try moving the WAVE FORM switch back and forth between ⊓⊔ (with the PULSE WIDTH at 50%) and ⊓⊔ . The sound is exactly the same.

1-1-9 **The two output jacks . . . . .**

The VCO OUTPUT jack is primarily used with the Model 102 Expander Unit.

The VCO SYNC OUTPUT jack has a square wave output used to synchronize the frequency of the Model 102 Expander Unit VCO with the frequency of this VCO. (See 1-2-5, MODEL 102 EXPANDER UNIT INSTRUCTION MANUAL).

1-1-10 **And the rest . . . . . .**

The other VCO controls depend a great deal on the setting of controls in other sections, so we'll talk about them later.

1-1-11 Review of the VOLTAGE CONTROLLED OSCILLATOR

1. The VCO generates sound whose pitch depends on a control voltage (1-1-0).
2. The VCO produces four different types of waves to be used in synthesizing sounds:
   - triangular wave (1-1-5)
   - sawtooth wave (1-1-6)
   - square wave (1-1-7)
   - pulse wave (1-1-8)
3. To produce a sine wave, use the VOLTAGE CONTROLLED FILTER (Patch 45).

Fig. 1-9 Pulse wave

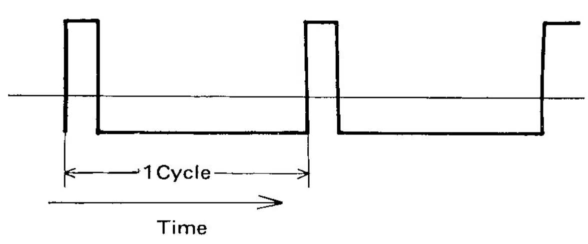


Fig. 1-10 Pulse wave

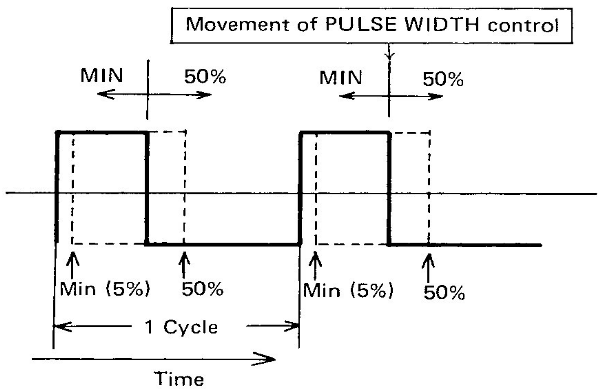
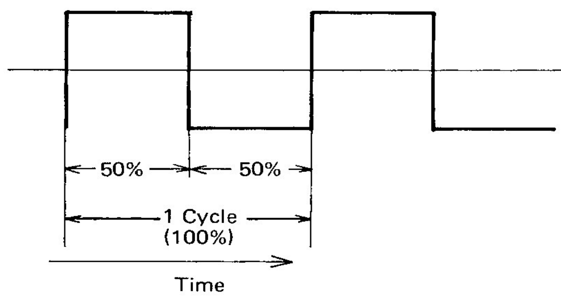


Fig. 1-11 Pulse wave at 50% pulse width



1-2-0 The KEYBOARD CONTROLLER

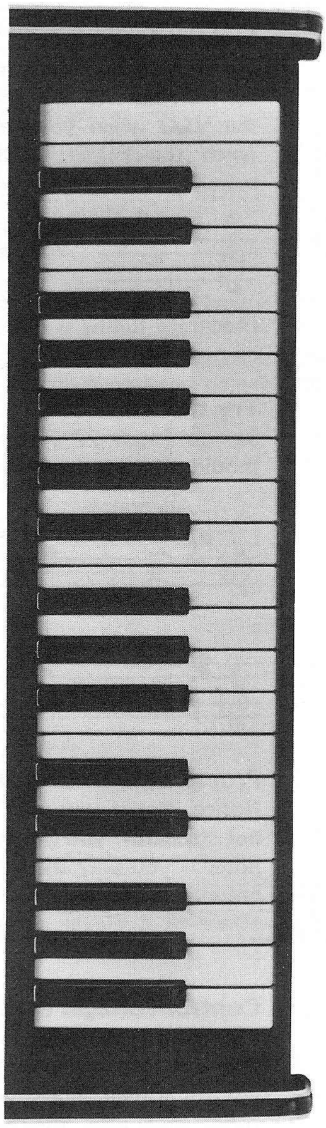
The keyboard or keyboard controller provides two control outputs for the synthesizer circuits.

One is the gate pulse which we'll talk about in the ENVELOPE GENERATOR section (page 24).

The other output is a DC control voltage most often used for controlling the frequency output of the VCO.

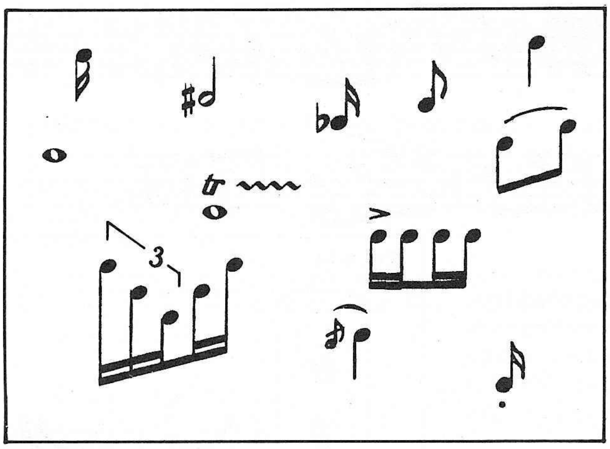
In fig. 1-13, you can see that the VCO is controlled by three separate control voltages. The VCO averages out these voltages to produce one output frequency or pitch.

Fig. 1-12



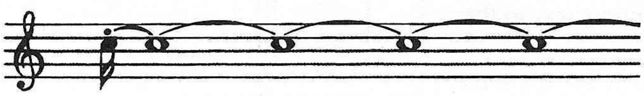
1-2-1 Try it . . . . .

If you haven't already done so, try tapping on a few keys to see what effect the keyboard's control voltage has on the VCO output.



1-2-2 The memory . . . . .

Pressing a key sends the proper control voltage to the VCO for producing the pitch related to that key. Note that the VCO "remembers" which key you touched and continues to produce that pitch even after you release the key.



1-2-3 Priority . . . . .

One VCO is like one trumpet; it can produce only one note at a time. If you press more than one key, only the lower pitch will sound.

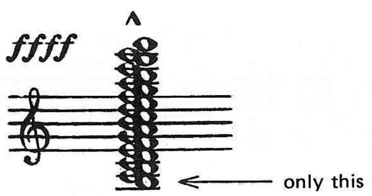
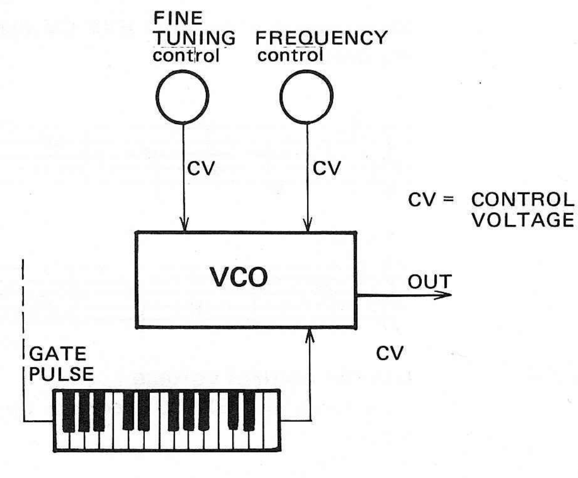
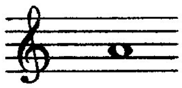


Fig. 1-13 Control voltages acting on VCO

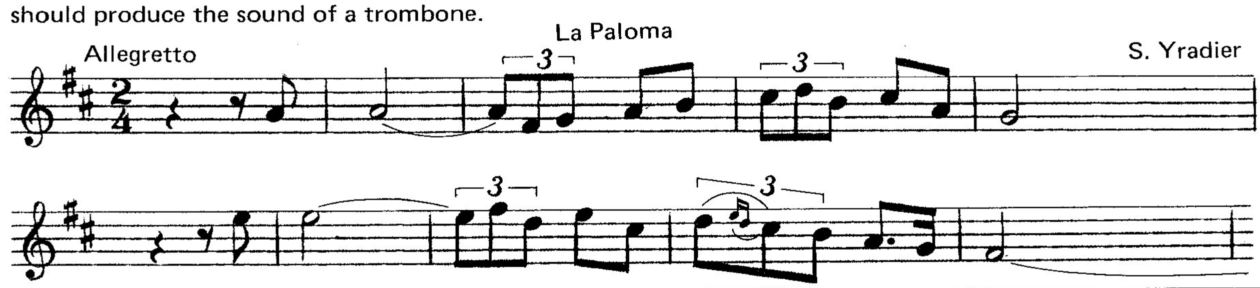


1-2-4 **Middle A . . . . .**
The frequency indications on the VCO FREQUENCY control indicate the approximate frequency output of the VCO when you strike middle A on the keyboard (with the FINE TUNING control. at "0"). In this manual, this middle A will be indicated as:



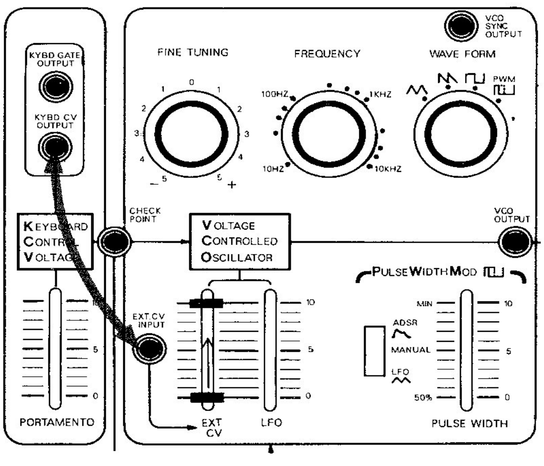
(Accurate tuning is discussed in Section 10 which begins on page 52).

1-2-5 **Try the trombone . . . . .**
Set up Patch 27 (Trombone). Pressing the keys now should produce the sound of a trombone.



1-2-6 **Proper breath control . . . . .**
Notice that if you play the keys slightly detached (but not staccato), you get the effect of a player puffing each note. If you play the keys legato (pressing the next key before the release of the first one), then you get the effect of a player slurring more than one note in the same breath.

Fig. 1-14



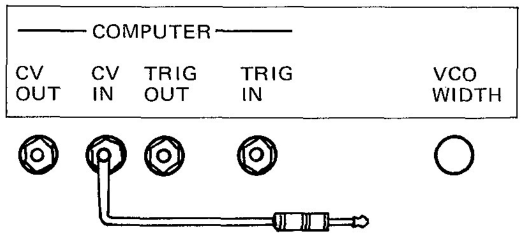
1-2-7 **Control voltages again . . . . .**
Find one of the patch cords supplied with your synthesizer and plug one end into the EXT CV INPUT (external control voltage input) jack in the VCO section. Plug the other end into the KYBD CV OUTPUT (keyboard control voltage output) jack which you'll find in the KEYBOARD CONTROL VOLTAGE section next to the VCO (See fig. 1-14).

Make sure that the VCO EXT CV slider is at "0", then try this:

1-2-8 **Double control voltage . . . . .**
Now move the EXT CV control up to "10" and try again.

What happens here is that the internal circuits are feeding the keyboard control voltage to the VCO and you are also feeding the keyboard control voltage to the VCO again through the external patch cord; therefore, when you play an octave, the VCO receives two octaves (double) worth of control voltage.

Fig. 1-15 Back panel of 101



Note: These jacks are normally used for making connections to computer type sequencers.

1-2-9 Find the octave . . . . .

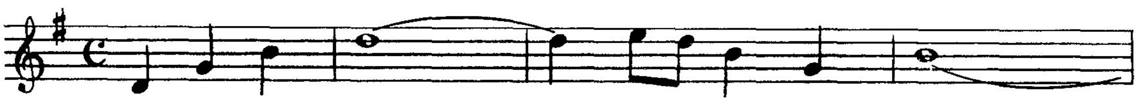
Play the low C, then try to find which key produces the octave above. It should be the key which exactly divides the octave: F#.

1-2-10 Try a chromatic scale . . . . .

1-2-11 Cutting off the internal CV connection . . . . .

Check the back of the 101 synthesizer and you'll find four jacks. Find another patch cord and plug one end into the CV IN jack. Leave the other end hanging free (See fig. 1-15).

Putting a plug into this CV IN jack cuts off the normal internal control voltage connection from the keyboard to the VCO.



The VCO is now receiving its control voltage only through the external connection, and it is the normal amount.

1-2-12 Less than normal CV . . . . .

Try moving the VCO EXT CV control down to about "5".

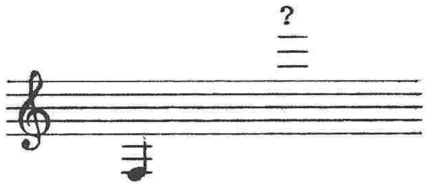
With the EXT CV control at less than "10", you are cutting off some of the control voltage from the keyboard, so when you play an octave, the control voltage received by the VCO is not enough to produce an octave shift in frequency.

Try a chromatic scale.

1-2-13 The big octave . . . . .

With the EXT CV at "5", you have to jump up more than two octaves, possibly more than three octaves, to produce a voltage large enough to force the VCO up one octave.

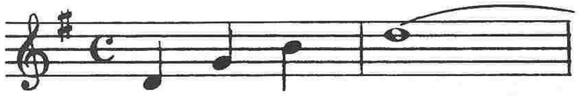
Play the lowest F, then try to find the key which produces the sound of the octave above.



If the octave seems to be higher than your highest F, raise the EXT CV control to "6" or "7".

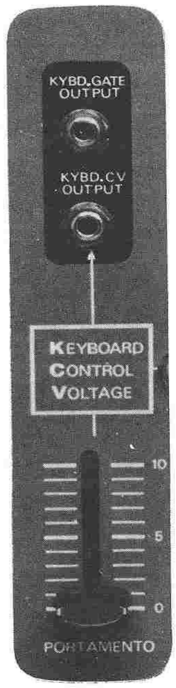
1-2-14 **One more time . . . . .**

Move the EXT CV control to "0" and try "Oh Bury Me Not" one last time.



Now, of course, the VCO is receiving no control voltage from the keyboard, so no matter what interval you play, all you get is one pitch.

Fig. 1-16



1-2-15 **What does all this mean . . . . . ?**

It means that your synthesizer can produce all conventional pitches plus any pitches in between. Not only is this good for certain special effects, but it allows you to play Hindu music, for example, which often contains quarter tones.

1-2-16 **To continue . . . . .**

Remove the two patch cords and check to make sure that Patch 27 (Trombone) is still correctly set up.

1-2-17 **The KEYBOARD CONTROL VOLTAGE section . . . . .**

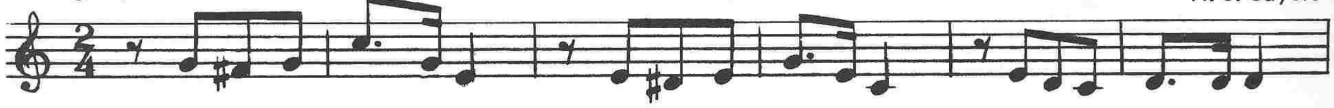
With the PORTAMENTO control at "0" position, the control voltage from the keyboard is normal. Move this control up and the keyboard control voltage will slide from one value (pitch) to the next when you change your fingers from one key to another. The nearer to "10" you get, the longer the slide takes.

Try the following with the PORTAMENTO set at about "3" or "4", depending on how fast you play the example.

Ta-Ra-Ra Boom-Der-E

Brightly

H. J. Sayers

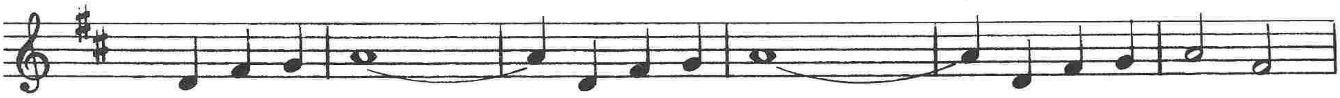


1-2-18 **Just a little portamento . . . . .**

Just a hair above "0" and the portamento effect is hardly noticeable. This may be a good place to leave the PORTAMENTO control when playing the trombone without the slide effect.

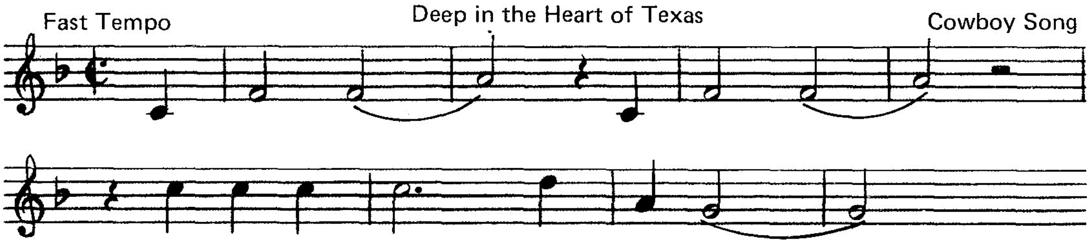
When the Saints Go Marching in

Spiritual



1-2-19 **Try varying the portamento . . . . .**

Put the PORTAMENTO control at just a hair above "0" and try the following.



Try performing the two slurs as follows: After you strike the F, move the PORTAMENTO up to about "5" or "6"; then, after striking the A (hold it down) and after the pitch has finished sliding up to the A, move the PORTAMENTO back down to the hair above "0".

This all should be done without distorting the rhythm. To do this, strike the A early so that the pitch starts to slide up and arrives at the A pitch on the beat. You'll find that this won't take much practice to get it right.

1-2-20 **The memory again . . . . .**

Notice that if the slide was not complete at the instant you release the key, the VCO will "remember" the point on the slide curve where you lifted your finger.

1-2-21 **To illustrate . . . . .**

Try this. With the PORTAMENTO control at "0", strike the low F. Now raise the PORTAMENTO to "10" and try tapping (not holding down) the high F key a few times.

1-2-22 **And last . . . . .**

The KYBD GATE OUTPUT jack is used with the 102 expander Unit. (See 1-1-0, MODEL 102 EXPANDER UNIT INSTRUCTION MANUAL).

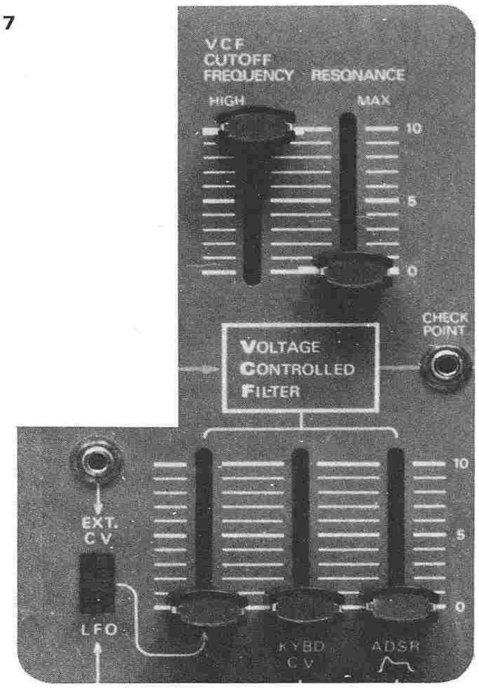
1-2-23 Review of the KEYBOARD CONTROLLER

1. The keyboard controller has two outputs:
   gate pulse (1-5-7)
   control voltage (1-2-0)
2. The keyboard control voltage works together with the VCO FREQUENCY and FINE TUNING controls to produce the correct relation of output pitches (1-2-0).
3. The control voltage can be altered so that the output pitches are not related to our usual musical scale (1-2-7 to 1-2-15).
4. By means of the PORTAMENTO control, the control voltage can be made to "slide" from one value to another (1-2-17 to 1-2-21).

1-3-0 The VCF or VOLTAGE CONTROLLED FILTER

A filter is an electronic circuit for filtering out unwanted frequencies and passing through wanted frequencies. And like the VCO, the VCF depends on a DC control voltage for its operation.

Fig. 1-17

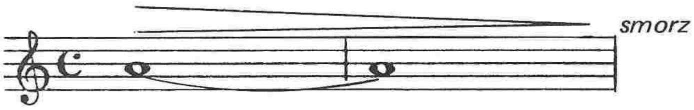


1-3-1 No filtering action . . . . .

With the controls set as shown in fig. 1-17, the VCF passes all frequencies and blocks none.

1-3-2 The tuning fork . . . . .

Set up Patch 29 (Tuning Fork). Now strike the A in the middle of the keyboard.



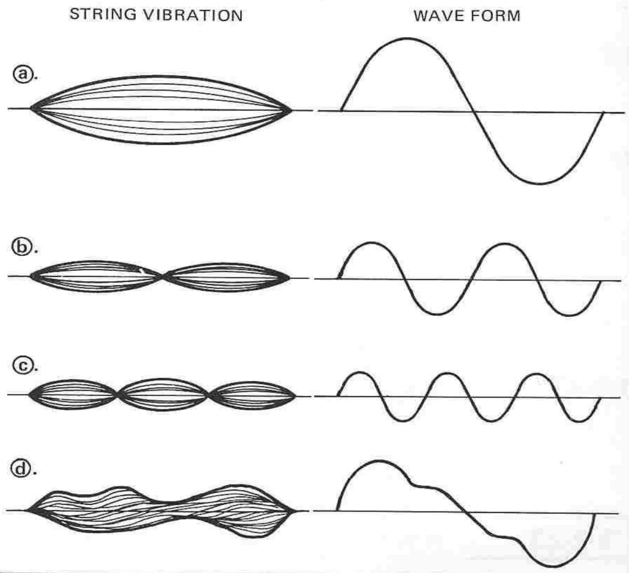
The sound of the tuning fork is the sound of a sine wave, the purest sound in all nature. Most vibrations which produce sound are much more complex than this sound.

1-3-3 The guitar . . . . .

When you pluck a guitar string, it is not only vibrating as a whole (fig. 1-18a), but also it is simultaneously vibrating in halves (fig. 1-18b), thirds (fig. 1-18c), fourths, etc., so that the total might look like fig. 1-18d.

The wave forms for these vibrations can also be seen in fig. 1-18.

Fig. 1-18 Vibration of a string



1-3-4 Tone color . . . . .

These fractional vibrations are called overtones or upper partials, and they produce their own separate pitches. These separate pitches are not easily distinguished from each other, but it is their presence or absence and varying degrees of intensity which gives the guitar its particular tone coloring and helps us distinguish its sound from other sounds.

1-3-5 The natural harmonic series . . . . .

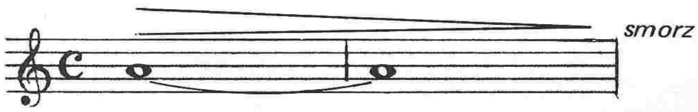
The frequency produced by the string vibrating as a whole is called the fundamental.

The fundamental with its series of overtones is called the natural harmonic series.

The fundamental is the first harmonic; the pitch produced by the string vibrating in halves is the second harmonic; vibrations in thirds, the third harmonic; etc., upwards theoretically to infinity.

The natural harmonic series, then, for the A in the bottom space bass clef would be as shown in Fig. 1-19.

1-3-6 The pure tuning fork . . . . .



You should now be able to see why the sound of the tuning fork is so pure: It produces no overtones; it produces the fundamental only.

Fig. 1-19 Natural Harmonic Series for A_2

NAME OF NOTE	A_2	A_3	E_4	A_4	$C\#_5$	E_5	G_5	A_5	B_5	$C\#_6$	$D\#_6$	E_6	$F\#_6$	G_6	$G\#_6$	A_6
NUMBER OF HARMONIC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FREQUENCY OF TRUE HARMONIC	110	220	330	440	550	660	770	880	990	1100	1210	1320	1430	1540	1650	1760
ACTUAL FREQUENCY OF NOTE WRITTEN	110.00	220.00	329.63	440.00	554.37	659.26	783.99	880.00	987.77	1108.70	1244.50	1318.50	1480.00	1568.00	1661.20	1760.00

Notice that the frequencies of the harmonics actually produced by A_2 are in some cases slightly different from the notes in our musical scale system. The quarter notes indicate harmonics whose pitches would sound slightly but distinctly flat.

2. Note that to find the frequency of any given harmonic, all you have to do is multiply the frequency of the fundamental times the number of the harmonic.

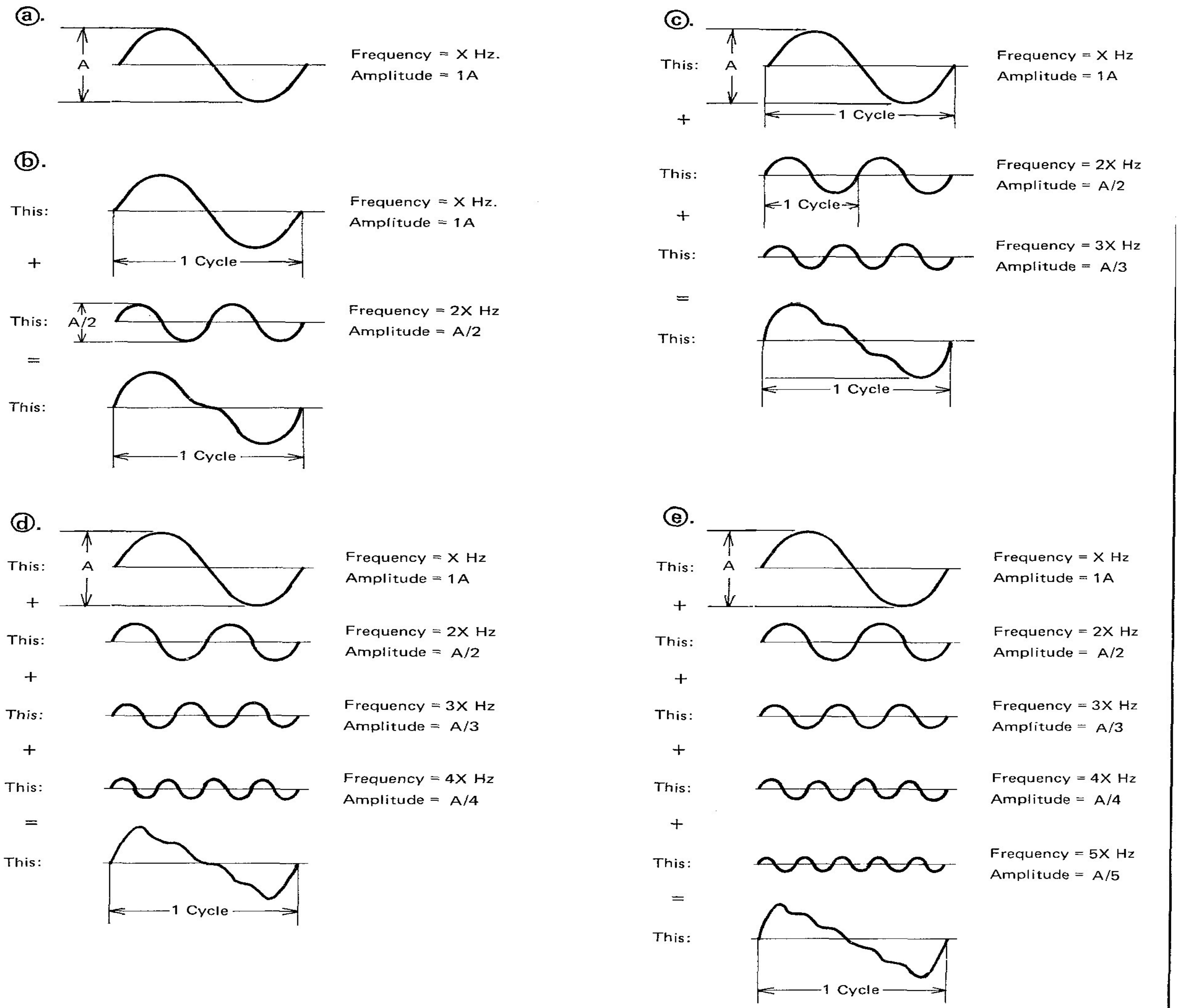
1-3-7 Not so pure sound . . . . .

Fig. 1-20 shows that if we start adding harmonics to a given fundamental, we immediately get a sawtooth-like wave.

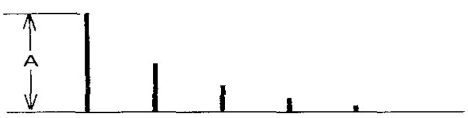
The more harmonics we add, the more perfect the sawtooth shape becomes.

Fig. 1-21 shows the harmonic spectrum (diagram of the harmonic content) of a perfect sawtooth wave.

Fig. 1-20 Adding harmonics to a sine wave

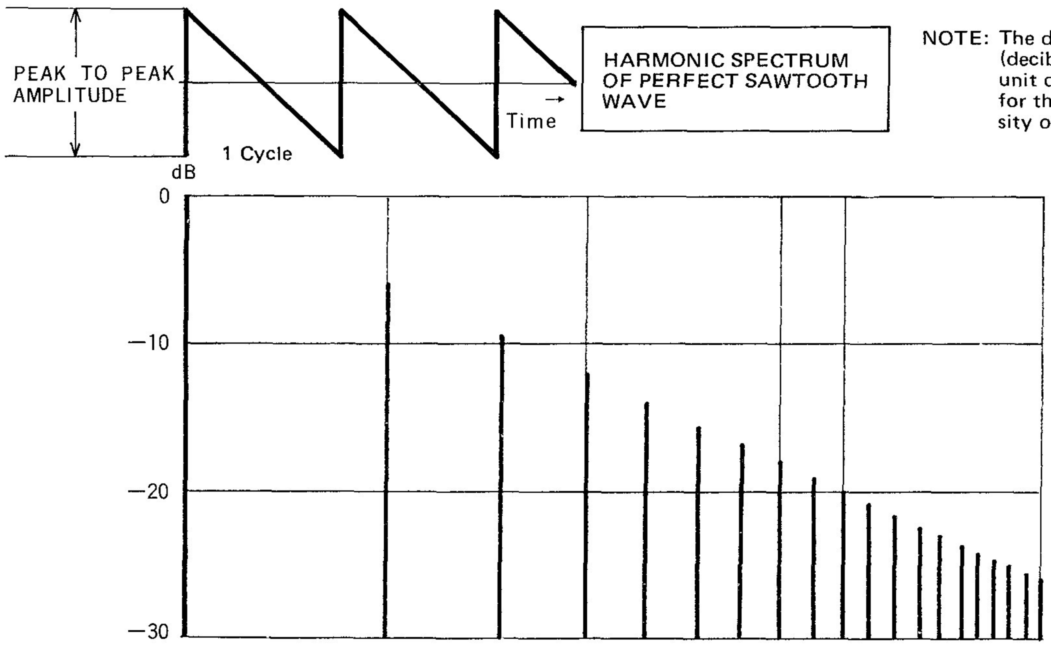


f. Graph showing harmonic spectrum or harmonic content of final wave form in (e) above. The height of each line represents the relative amount of each harmonic.



HARMONIC NO.	1	2	3	4	5	6
FREQUENCY	X	2X	3X	4X	5X	6X
AMPLITUDE	A	A/2	A/3	A/4	A/5	0

Fig. 1-21 Perfect sawtooth wave



NOTE: The dB (decibel) is a unit of measure for the intensity of sound.

HARMONIC NUMBER	1	2	3	4	5	6	7	8	9	10	... ...→N
FREQUENCY	X	2 X	3 X	4 X	5 X	6 X	7 X	8 X	9X	10X	... ...→NX
AMPLITUDE	A	A/2	A/3	A/4	A/5	A/6	A/7	A/8	A/9	A/10	... ...→A/N
dB	0	−6	−9.5	−12	−14	−15.5	−17	−18	−19	−20	... ...→

1-3-8 **Odd harmonics . . . . .**

Fig. 1-22 shows that if we add only the odd numbered harmonics, we get a square wave.

Fig. 1-23 shows the harmonic content of a perfect square wave.

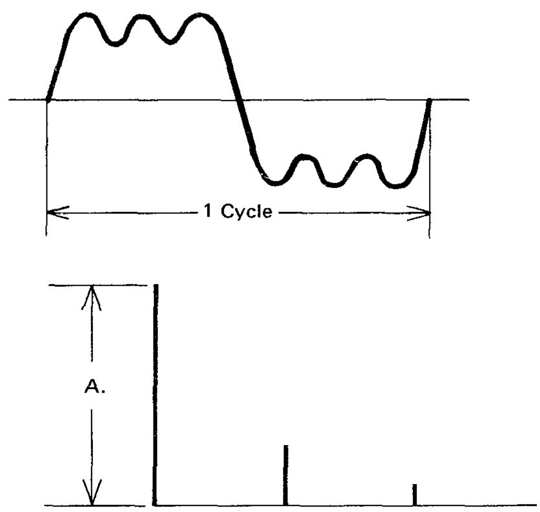
1-3-9 **An important point . . . . .**

Remember that it is the presence and absence *and* the varying degree of intensity of these harmonics that give us specific tone colorings.

Fig. 1-24 shows that the perfect triangular wave is made up of the same harmonics as the square wave but the amplitude or intensity of these harmonics is different.

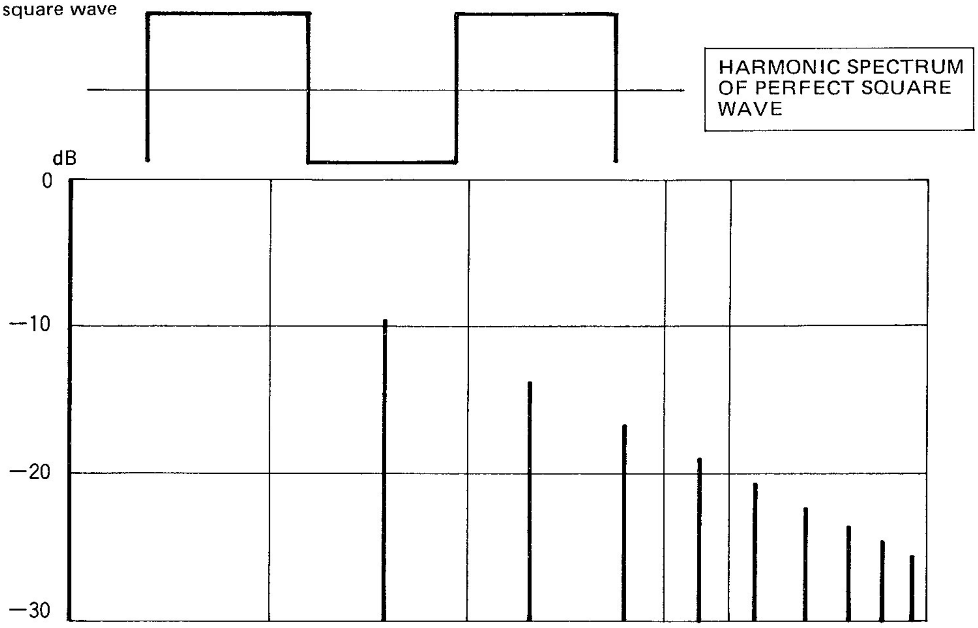
Compare fig. 1-23 with fig. 1-24.

Fig. 1-22 Adding 3rd and 5th harmonic to fundamental



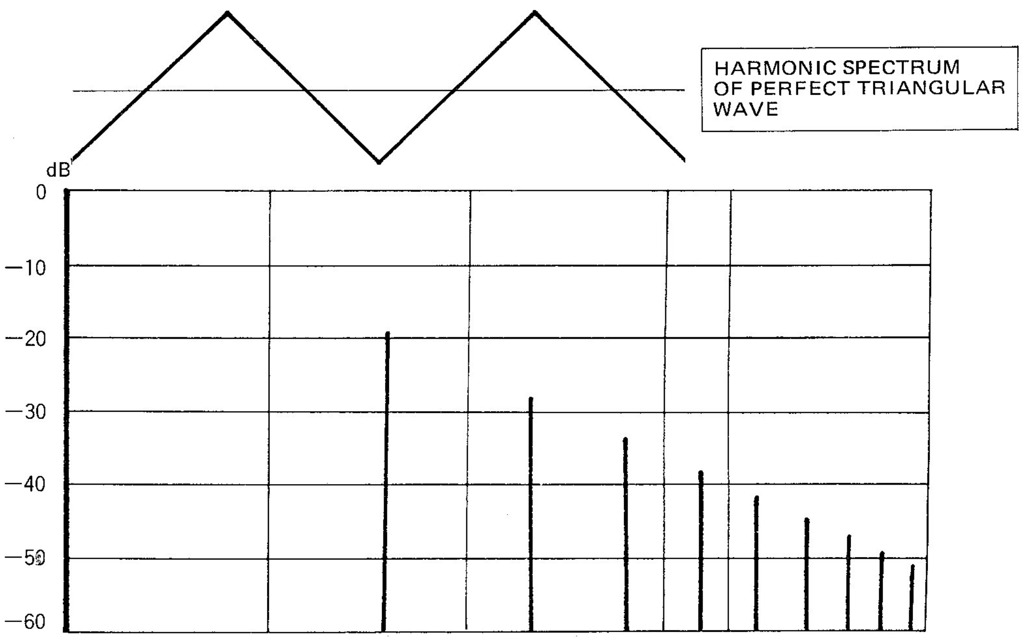
HARMONIC	1	2	3	4	5	6
FREQUENCY	X	–	3X	–	5X	–
AMPLITUDE	A	0	A/3	0	A/5	0

Fig. 1-23 Perfect square wave



HARMONIC	1	3	5	7	9	11	13	15	17	19
FREQUENCY	X	3 X	5 X	7 X	9 X	11 X	...	...	...	19 X
AMPLITUDE	A	A/3	A/5	A/7	A/9	A/11	...	...	...	A/19
dB	0	-9.5	—14	—17	—19	—21	...	...	...	-25.5

Fig. 1-24 Perfect triangular wave



HARMONIC	1	3	5	7	9	11	13	15	17	19
FREQUENCY	X	3 X	5 X	7 X	9 X	11 X	13 X	15 X	17 X	19 X
AMPLITUDE	A	A/9	A/25	A/49	A/81	A/121	A/169	A/225	A/289	A/361
dB	0	—19	—28	—34	—38	—42	—45	—47	—49	—51

Note that the denominators of the fractions above are the squares of the harmonic number.

1-3-10 **Removing harmonics . . . . .**

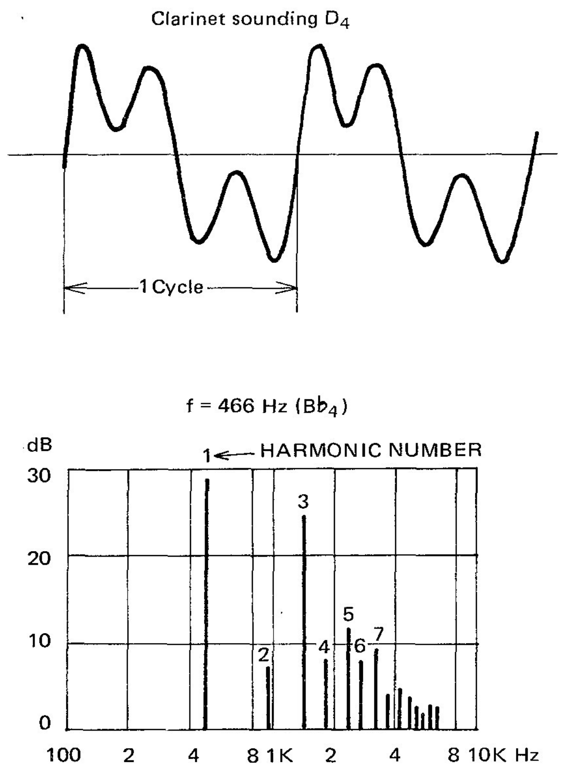
Set Patch 8 (Clarinet), but start with the VCF CUTOFF FREQUENCY control set at "10". In this position, the VCF passes all frequencies. Now, while holding down a key, try moving the CUTOFF FREQUENCY control slowly downwards and notice the change in the tone quality.

What happens is that as the CUTOFF control leaves its upper position and starts down, it begins to shave off the upper harmonics of the square wave from the VCO one by one, until finally when you reach the bottom you are filtering out everything including the fundamental.

If you turn up the volume on your external amplifier, you can probably still hear some sound because electronic filters are not perfect and some of the fundamental is still slipping past the VCF.

Notice, too, that as you shave off the harmonics the output volume of sound also decreases.

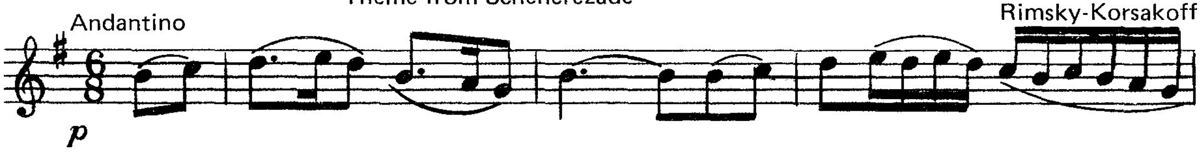
Fig. 1-25 Wave form and spectrum for clarinet



1-3-11 **The clarinet . . . . .**

Move the VCF CUTOFF FREQUENCY control back up to "10" and while playing different keys on the keyboard, bring the CUTOFF slowly down and stop at the point which sounds the most like a clarinet to you. This will probably be somewhere near "7".

Theme from Scheherezade



1-3-12 **The square clarinet . . . . .**

Fig. 1-25 shows the wave form produced by the vibrating column of air in a clarinet. From this you can easily see why a clarinet patch is started with the square wave from the VCO.

Below the wave in fig. 1-25 is the harmonic spectrum for the clarinet and you'll notice that all the odd numbered harmonics are much stronger than the even numbered ones. This is why the clarinet wave form looks rather square.

Note, too, that there's nothing above the tenth harmonic and that is why we use the VCF CUTOFF FREQUENCY control to shave off the upper harmonics.

1-3-13 **Shaving . . . . .**

Let's take a closer look at this shaving action so that we can more fully understand and use the VCF.

Fig. 1-26 shows a diagram of the frequencies which are passed by the VCF when the CUTOFF control is at about "5". Checking this diagram, you can see that 100 Hz. passes through the filter without trouble; 10 kHz. (kiloHertz; 1 kHz. = 1,000 Hz.) is completely blocked; and 500 Hz. would be only partly blocked.

The cutoff point shown in fig. 1-26 is the point you change when you move the CUTOFF FREQUENCY control. Fig. 1-27 shows the frequencies passed with the CUTOFF control in two other positions.

1-3-14 Solid . . . . .

The frequencies shown along the bottom of these diagrams are absolute; they don't move or change. Let's see what that means when we try playing something.

1-3-15 To begin with . . . . .

Set Patch 47 (VCF Test) and set the VCO FREQUENCY control at about 50 Hz.

Check the frequencies shown in fig. 1-28 for a fundamental of 50 Hz. Compare these with the frequencies passed by the VCF with the CUTOFF control at "5".

You can see that the top four harmonics are held back slightly, whereas all other frequencies pass through the filter.

Press middle A on the keyboard, then try sliding the CUTOFF control back up to "10" and you can hear the change in sound as the four top harmonics return to full strength.

1-3-16 Another fundamental . . . . .

Put the CUTOFF control back at "5" and change the VCO FREQUENCY control to 300 Hz. and try middle A again.

What you hear now is almost a pure sine wave. Fig. 1-28 shows that only the fundamental passes through the filter freely. Try moving the VCF CUTOFF back to "10" while holding down middle A and listen to the change in sound.

1-3-17 Cutoff . . . . .

Move the CUTOFF control back to "5" and change the VCO FREQUENCY to 1 KHZ. (=1,000 Hz.) and try middle A again.

What you hear now is silence, or perhaps a little of the fundamental leaking past the foot of the cliff in fig. 1-26.

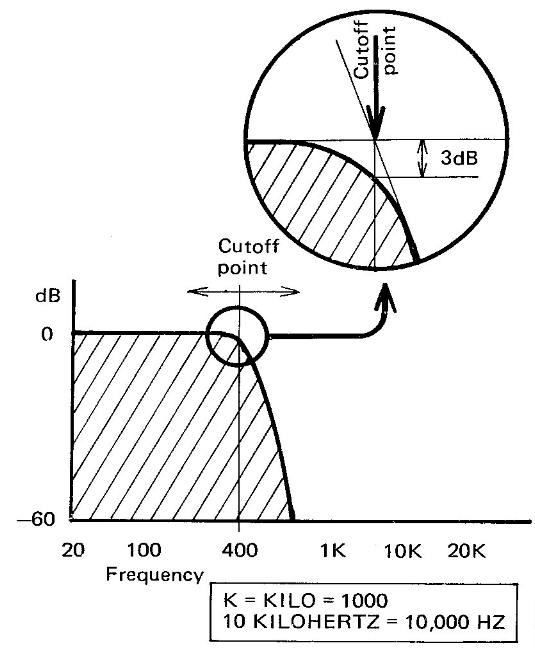
1-3-18 What does all this mean . . . . .?

It means that you could set the VCO FREQUENCY at some point, then strike a key and try to synthesize some sound. But then, if you strike any other key, (thus changing the frequency output of the VCO), you won't quite have the sound you first synthesized because the harmonic content has changed.

1-3-19 Prove it . . . . .

With Patch 47 (VCF Test) set, and the VCO FREQUENCY set at 1 KHZ., try a slow glissando starting with the lowest key and sliding your fingers all the way up to the top of the keyboard.

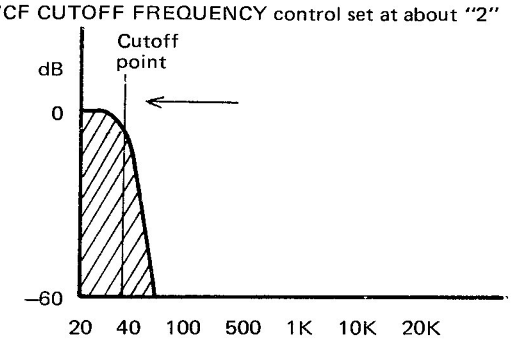
Fig. 1-26 Frequencies passed by VCF with VCF CUTOFF FREQUENCY control set at about "5"



NOTE: The dB (decibel) is a unit of measure for the intensity of sound.

Fig. 1-27 Frequencies passed by VCF

VCF CUTOFF FREQUENCY control set at about "2"



VCF CUTOFF FREQUENCY control set at about "8"

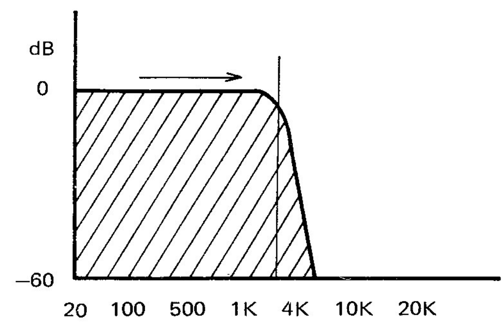
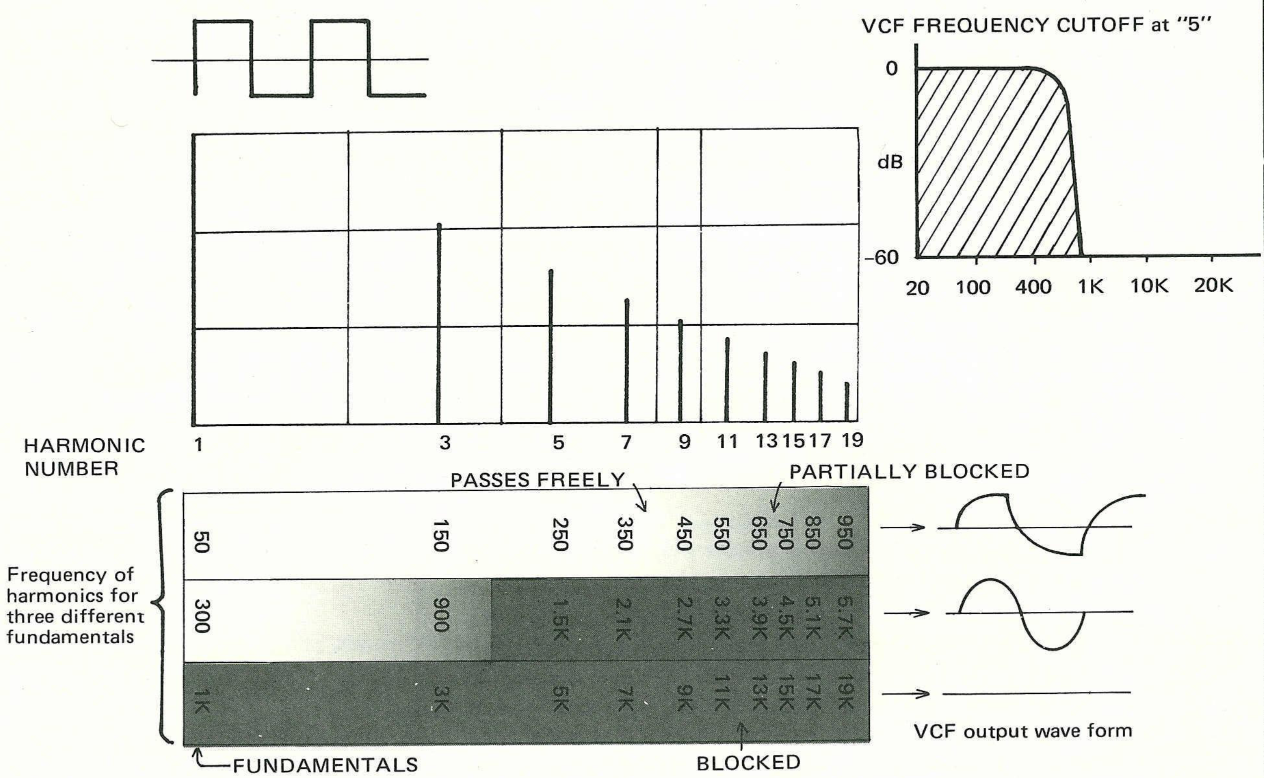


Fig. 1-28 Frequencies passed by the VCF for different fundamentals



1-3-20 **What to do . . . . .?**

If you could get the VCF CUTOFF point to move up and down with the keys as you play, that would solve the problem. You could set the cutoff point at, for example, two octaves above the fundamental of the key you press, and the cutoff point would follow you wherever you went on the keyboard, but at a two octave distance.

1-3-21 **The keyboard control voltage . . . . .**

Remember that the control voltage from the keyboard is directly related to the pitches of the notes played since it is of course being used to control the pitch of the VCO. This control voltage can be used to control the cutoff point of the filter.

In the bottom half of the VCF section you'll see a slider marked KYBD CV (keyboard control voltage). Move this control all the way up to "10" and try the experiments in 1-3-19 again and you'll find that the harmonic content will now remain stable.

1-3-22 **Lost harmonics . . . . .**

Of course, there are instruments whose harmonic content decreases as you play up the scale. One of these is the French horn. In patches like these, the VCF KYBD CV control is set lower than "10". Try Patch 19 (Horn).

Try a scale passage from the bottom to the top of the keyboard. Notice how the quality of the sound changes as you get higher.

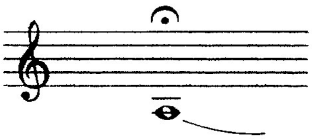
1-3-23 **Resonance . . . . .**

The RESONANCE control affects the VCF as shown by the diagrams in fig. 1-29.

As you move the RESONANCE control up, the frequencies at the cutoff point remain about the same, but the frequencies lower than this decline slightly in amplitude. The total effect is that of accenting the frequencies at the cutoff point. (Notice that the cliff on the cutoff side of the diagram gets slightly steeper as the RESONANCE control moves up).

1-3-24 **Try this . . . . .**

Set up Patch 8 (Clarinet) again. Put the VCF EXT CV/LFO slider at "0" and while holding down the lowest key, try moving the RESONANCE control slowly upwards and you can hear the effect.



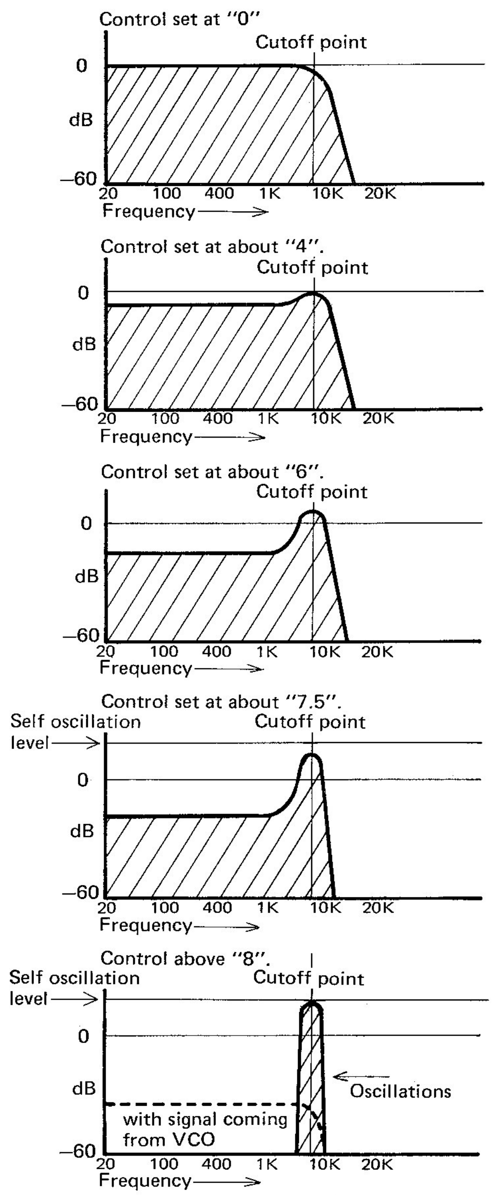
When you get somewhere near "8", the VCF starts to oscillate or generate its own wave all by itself. Your ear will tell you that it is a sine wave. The frequency of this sine wave is determined by the cutoff point of the VCF, so in the examples in fig. 1-29, the frequency is about 400 Hz.

1-3-25 **And try this . . . . .**

Set up Patch 44 (Resonance Test) and try playing this:

As you can see, the keyboard has no effect on the pitch of the sound you hear.

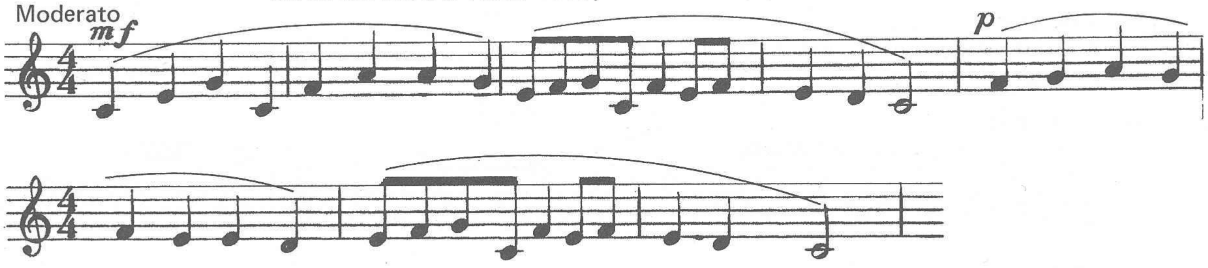
Fig. 1-29 VCF RESONANCE control



While holding down a key, try moving the VCF CUTOFF FREQUENCY control slowly up and down. When you do this, you change the cutoff point of the VCF, therefore you also change the frequency of the self-oscillations.

1-3-26 **Keyboard control . . . . .**

Move the VCF CUTOFF FREQUENCY control back to "5", then try moving the KYBD CV up to "10".



Now you are using the VCF exactly like a VCO except, of course, you are limited to the pure sine wave.

1-3-27 **Less control voltage . . . . .**

Try changing the KYBD CV to about "5".

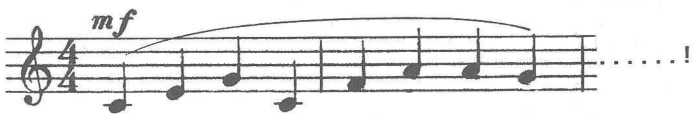
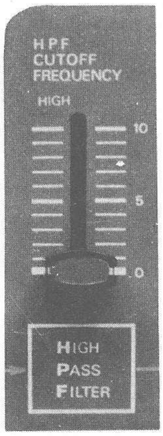


Fig. 1-30



1-3-28 **The point . . . . .**

The whole point of this exercise is that when the RESONANCE control is beyond about "8", the VCF begins to oscillate. The frequency of these oscillations is determined by the VCF CUTOFF FREQUENCY control.

Many interesting effects can be made with an oscillating VCF. (See Patches 5 (Bell), 25 (Thunder), and 16 (Gunshots)).

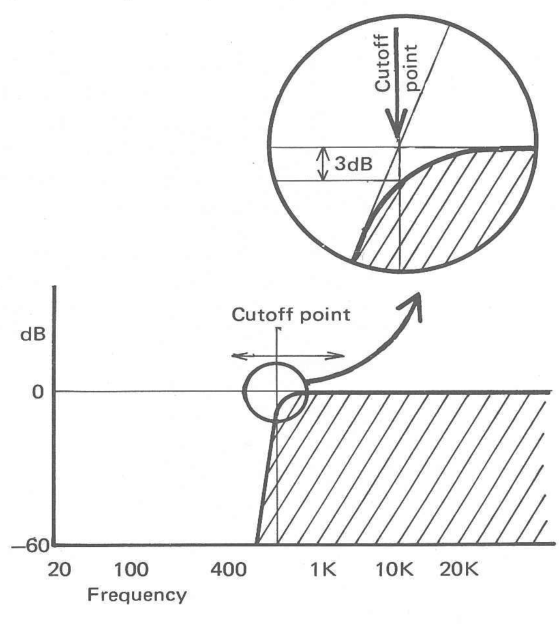
1-3-29 **The HIGH PASS FILTER . . . . .**

The VCF is a low pass filter (LPF) because it passes low frequencies and blocks higher frequencies.

Although it is shown in the same grey area of the panel, the HIGH PASS FILTER is actually a completely separate filter and is controlled only by the HPF (high pass filter) CUTOFF FREQUENCY control.

The effect of this filter is much the same as the VCF except that it operates upside down. Fig. 1-31 shows this.

Fig. 1-31 Frequencies passed by HIGH PASS filter



1-3-30 **Cutoff again . . . . .**

The normal position of the HPF CUTOFF FREQUENCY control is "0", which means that the filter passes all frequencies. As you move the slider up, it shaves off harmonics from the bottom until you reach the top where you are cutting off all but the highest frequencies.

You can hear this effect by setting up Patch 48c (Wave Forms) again and trying the HPF CUTOFF FREQUENCY control.

1-3-31 **The violin . . . . .**

A good example of a patch using this high pass filter is the high violin sound of Patch 34.

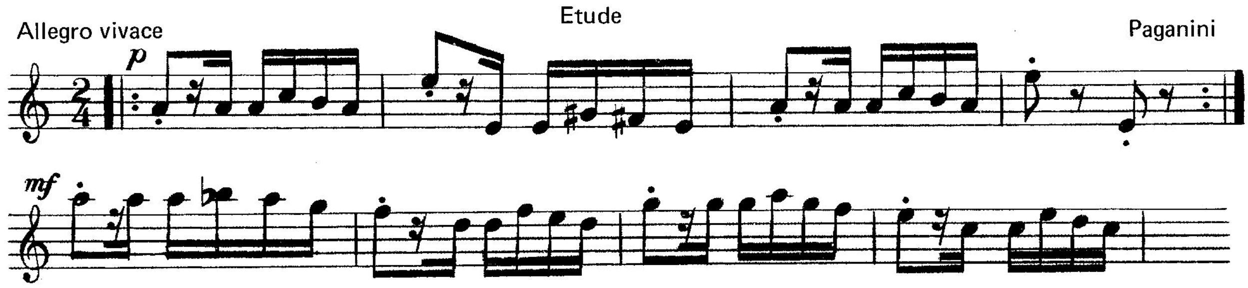
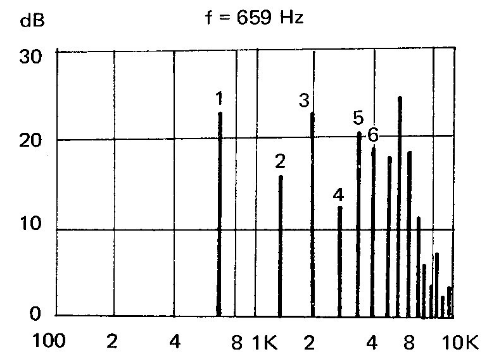


Fig. 1-32 shows the harmonic content of the open E string (the highest string) of the violin. Notice that the higher harmonics are stronger than the lower ones.

Fig. 1-32 Harmonics of violin (open E string)



1-3-32 **A better violin sound . . . . .**

Now that you know how the VCF works, you might try to improve the violin sound by trying to slightly shave off the 9th and 10th harmonics with the VCF CUTOFF FREQUENCY control.

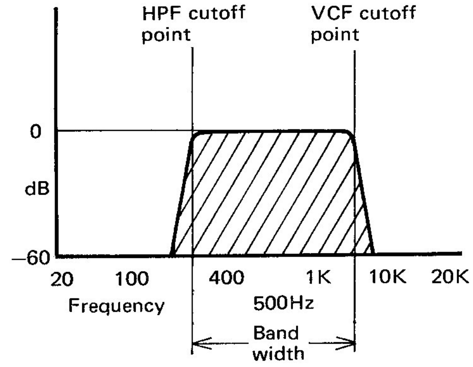
With the Model 102 Expander Unit, you can try accenting the fundamental for an even better violin sound. (See 1-2-13 MODEL 102 EXPANDER UNIT INSTRUCTION MANUAL for methods of accenting the fundamental).

1-3-33 **The band pass filter . . . . .**

When you use both the VCF CUTOFF FREQUENCY and HPF CUTOFF FREQUENCY controls at the same time, you are using the VCF as a band pass filter. A band pass filter passes a group or band of frequencies, eliminating those frequencies above and below the band.

With two band pass filters (using the Model 102 Expander Unit), you can get your synthesizer to pronounce vowel sounds in imitation of the human voice. (See 1-3-1, MODEL 102 EXPANDER UNIT INSTRUCTION MANUAL).

Fig. 1-33 Band pass filtering



Width of band depends on setting of HPF CUTOFF FREQUENCY and CUTOFF FREQUENCY controls.

1-3-34 Review of the FILTERS

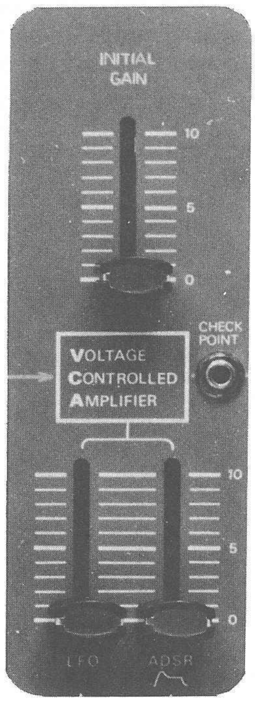
1. The presence and absence and the varying degree of intensity of the harmonics determines the quality of sound (1-3-4; 1-3-9).
2. The VCF CUTOFF FREQUENCY slider controls the cutoff point of the VCF, which decides how many of the upper harmonics are to be shaved off from the top (1-3-10; figs. 1-26, 1-27).
3. The VCF KYBD CV control allows the cutoff point of the VCF to follow the pitches of the notes played (1-3-21).
4. The VCF RESONANCE control de-emphasizes the frequencies below the cutoff point of the VCF thus acting to accent the frequencies at the cutoff point (1-3-23; fig. 1-29).
5. Near the top of its range, the VCF RESONANCE control causes the VCF to oscillate; the frequency of these oscillations is controlled by the cutoff point of the VCF (1-3-26).
6. The HPF CUTOFF FREQUENCY control shaves harmonics off from the bottom (1-3-29; fig. 1-31).
7. The VCF CUTOFF FREQUENCY and HPF CUTOFF FREQUENCY controls used together produces band pass filtering (1-3-33; fig. 1-33).

1-4-0 The VCA or VOLTAGE CONTROLLED AMPLIFIER

The VCA or VOLTAGE CONTROLLED AMPLIFIER amplifies signals coming from the VCF and the VCA INITIAL GAIN slider controls the amount of amplification.

The main function of the VCA, however, is to give the output sound its final shape by means of the ADSR control.

Fig. 1-34



1-5-0 The ADSR or ENVELOPE GENERATOR

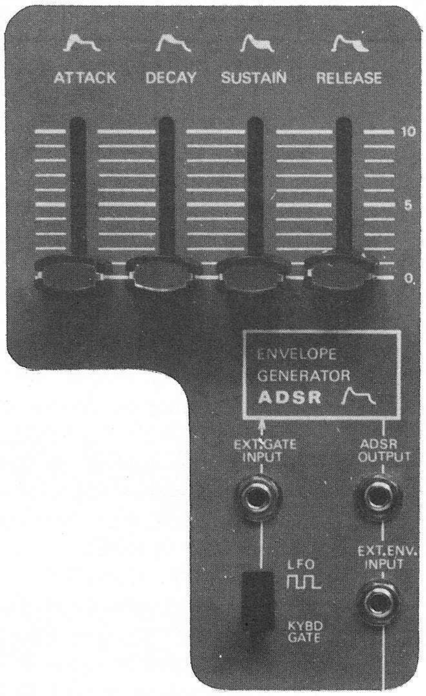
There are two major factors (besides pitch) which allow us to distinguish one sound from another.

The first is tone color (1-3-4).

The second is the loudness pattern of sound which is called the envelope.

The main function of the ENVELOPE GENERATOR (more often called the ADSR) is to generate the envelope.

Fig. 1-35



1-5-1 To explain envelopes . . . . .

When you pluck a guitar string, as soon as your finger releases the string, you hear a tone which immediately begins to decay (decrease) in loudness. The curve for this is shown in fig. 1-36. This curve represents the loudness pattern or envelope of a plucked guitar string.

1-5-2 The piano . . . . .

Set up Patch 21a (Piano) and strike a key.

The envelope for the piano is shown in fig. 1-37a.

When the hammer strikes the string, there is about 0.01 second delay before the string starts to vibrate at full loudness. This delay is called attack time.

At the end of attack time, when the tone is as loud as it's going to get, the sound begins to decay. This is called decay time.

Once you release the piano key, there is about 0.2 second delay while the vibrations of the dampened string die away. This part of the envelope is called release time.

These parts of the envelope are shown in fig. 1-37b.

Fig. 1-36 Envelope for plucked guitar string

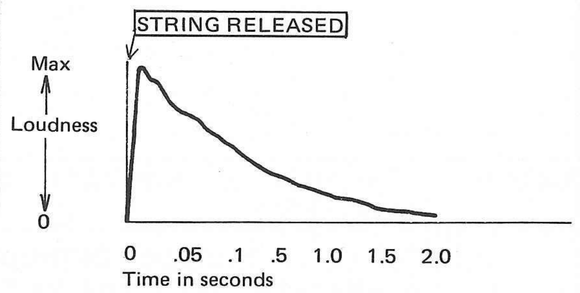
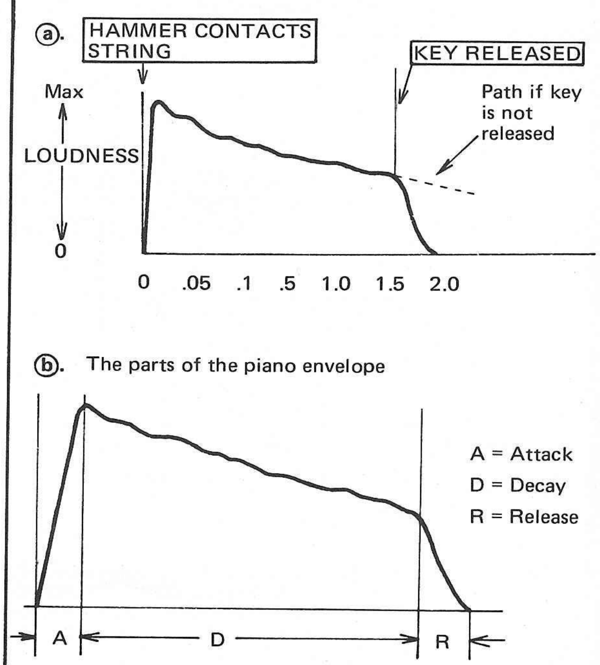


Fig. 1-37 ENVELOPE FOR PIANO

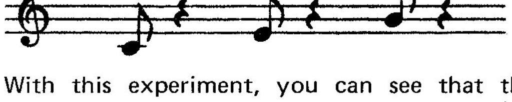


1-5-3 How to make an envelope . . . . .

The keyboard controller has two outputs (1-2-0).

One output is the DC control voltage for controlling the frequency of the VCO.

With Patch 21a (Piano) set, move the VCA ADSR control to "0" and move the VCA INITIAL GAIN control up. (If you can't hear any sound, move the VCF CUTOFF FREQUENCY control up towards "5"). Try tapping a few keys.



With this experiment, you can see that the control voltage controls pitch only. The block diagram in fig. 1-38 shows this.

Fig. 1-38 Block diagram of piano with no envelope

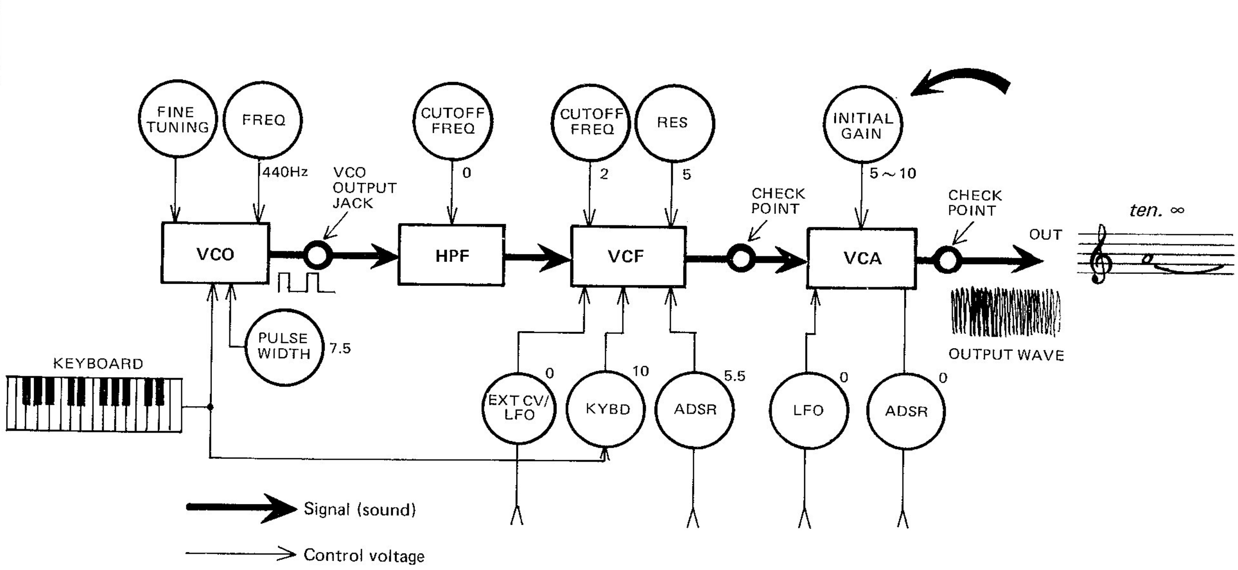
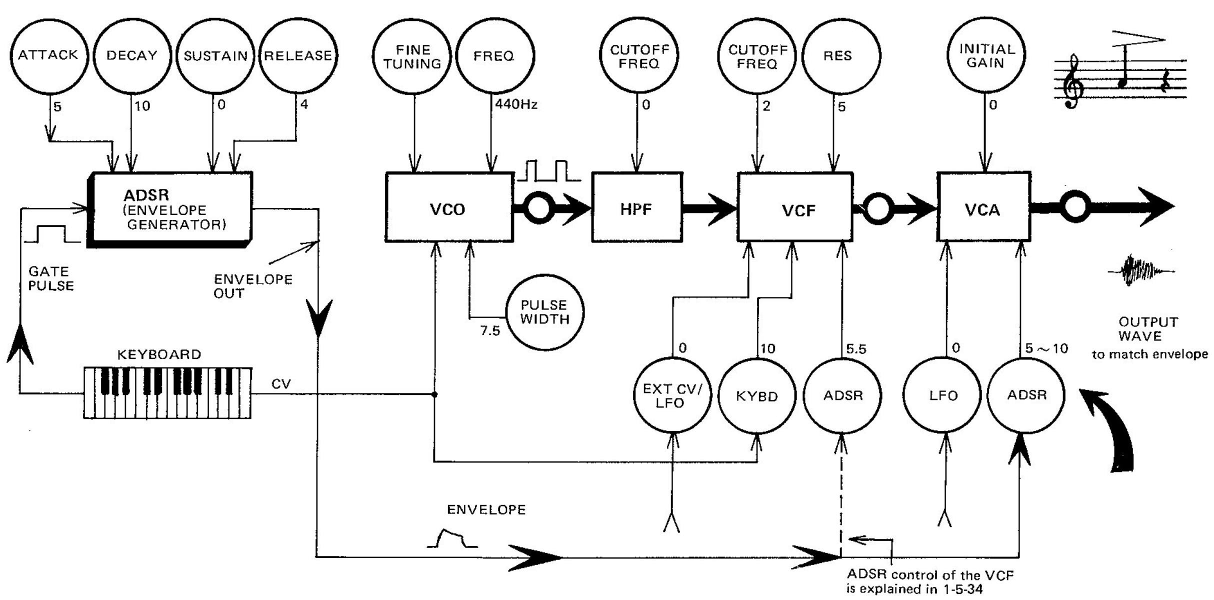


Fig. 1-39 Block diagram of piano



In fig. 1-38 the pulse wave from the VCO travels from left to right.

The HPF CUTOFF FREQUENCY control is at "0", so nothing happens here.

The VCF changes the pulse wave so that it contains the harmonics needed to sound like a piano.

The VCA controls the output loudness by means of the VCA INITIAL GAIN control.

1-5-4 The second keyboard controller output . . . . .

Put the VCA INITIAL GAIN control back down to "0" and move the VCA ADSR control back up again. Now try tapping a few keys.

As shown in *fig. 1-39, with the* VCA ADSR *control* raised, you are now controlling the output level of the VCA with the signal from the ADSR.

Fig. 1-39 shows that when you tap a key, a gate pulse from the keyboard triggers the ADSR into action.

The output of the ADSR is a loudness pattern in the form of a control voltage. This control voltage controls the output level of the VCA, thus producing the loudness pattern or envelope in the final sound.

1-5-5 Varying the ADSR control of the VCA . . . . .

Move the VCA ADSR control up and the ADSR has more control over the VCA; move it down and the ADSR *has less control. The* envelope changes only in amplitude, not timing.

In other words, the VCA ADSR control acts the same as an output volume control.

1-5-6 Try them both . . . . .

With the VCA ADSR control where you had it before, try moving the VCA INITIAL GAIN control up until *you can hear sound.* Tap a key. What you're doing is adding the output of the ADSR control to the GAIN control. See fig. 1-40.

1-5-7 The gate pulse . . . . .

The keyboard gate pulse is shown in fig. 1-41 and its main purpose is to trigger the ADSR.

Notice that the length of the pulse depends on how long you hold the key down.

1-5-8 How does the gate pulse control the ADSR . . . ?

The leading vertical edge of the gate pulse kicks off the ADSR attack time. See fig. 1-42.

When the attack curve reaches its maximum height, that starts off the ADSR decay time.

The trailing edge of the gate pulse will start off the ADSR release time *(even if it comes before the attack* time has reached maximum).

Fig. 1-40 VCA INITIAL GAIN and VCA ADSR controls

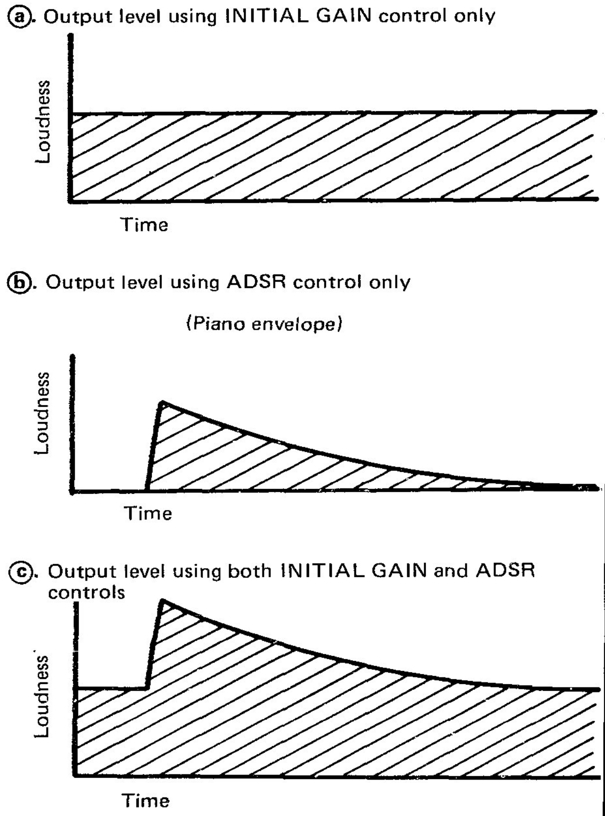


Fig. 1-41 Shape of keyboard gate pulse

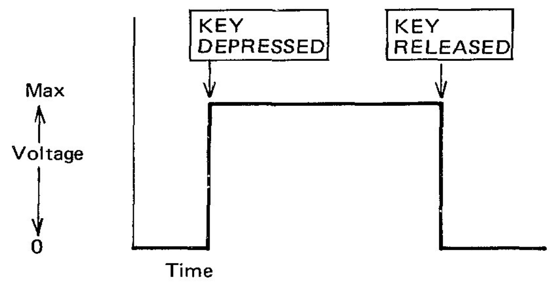
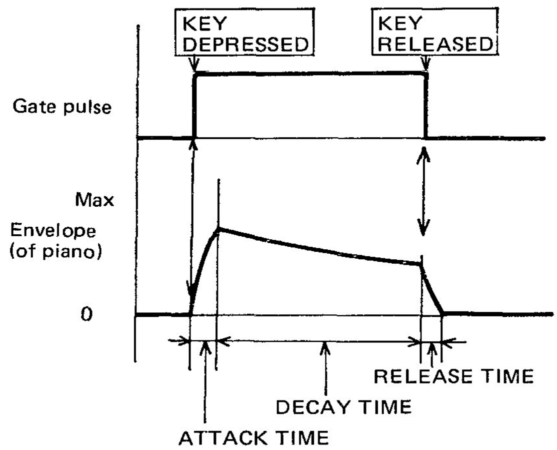


Fig. 1-42 Gate pulse and envelope (Piano patch)



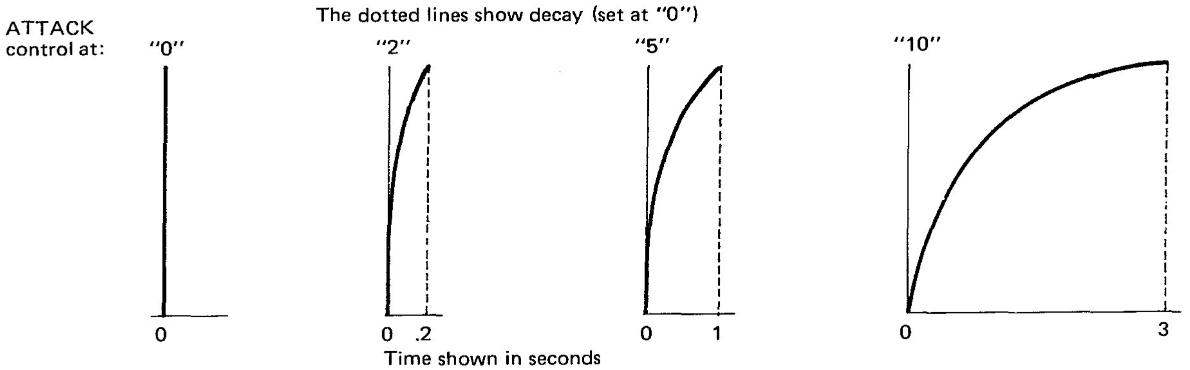
1-5-9 Controlling the shape of the envelope . . . . .

The positions of the four sliders in the ADSR section determine the steepness of the curves of the different parts of the envelope. (The first letters of each control name are also the origin of the abbreviation ADSR).

Fig. 1-43 shows the effect of the ATTACK control on the attack time. Putting the control at "0" creates the shortest attack time which, with this synthesizer, is about 0.0004 second.

At "10" the attack time is about 3 seconds.

Fig. 1-43 Attack time



1-5-10 Try the ATTACK . . . . .

With Patch 21 (Piano) set, move all the ADSR sliders down to "0", then try moving the ATTACK slider slowly up as you tap repeatedly on a key.

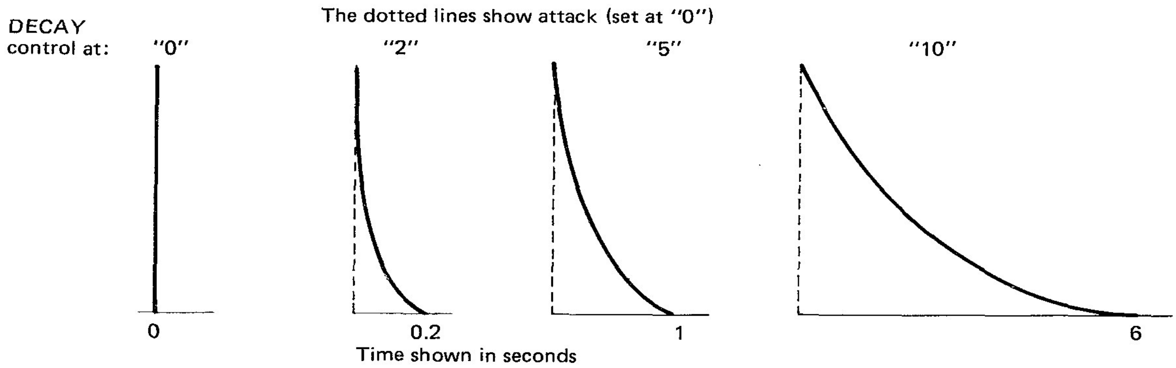
As the ATTACK control gets higher, you'll have to hold the key longer in order to hear all of the attack curve. You'll notice right away that as soon as the attack curve reaches maximum, the loudness of the sound drops almost instantly to zero. That's because the DECAY control is still at "0", therefore the decay is almost instantaneous (0.0008 second).

1-5-11 Try the DECAY . . . . .

Put the ATTACK control back to "0" and try slowly raising the DECAY control while tapping a key. Be sure to hold the key down long enough to hear all of the decay curve when you start getting higher up with the control.

Fig. 1-44 shows some decay curves.

Fig. 1-44 Decay time



1-5-12 **No sound . . . . .**

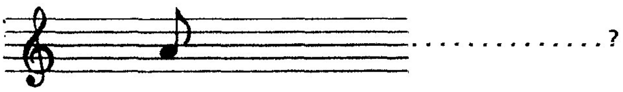
Move the ADSR controls back down to "0" and tap on some keys. If you're using high output volume, you can hear some clicks. What's happening is that the attack time and decay time are so short that you hear them only as a click when you depress a key.

1-5-13 **Try both ATTACK and DECAY . . . . .**

Tap on some keys while trying different positions of the ATTACK and DECAY controls. Fig. 1-45 shows a few combinations.

1-5-14 **Now try RELEASE . . . . .**

Put the ADSR controls back down to "0" and move the RELEASE control up to "10". Try tapping a key.



1-5-15 **What happened . . . . .?**

Reset the ADSR for the normal piano envelope (Patch 21a). Now press a key and hold it down until the piano sound has completely died away.

Now release the key and see what happens.

Once the piano tone has died away, there is no sound left to release. Fig. 1-46 shows this.

Fig. 1-45 Attack plus Decay

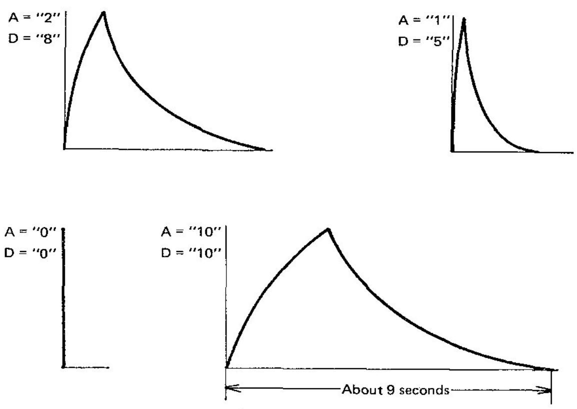
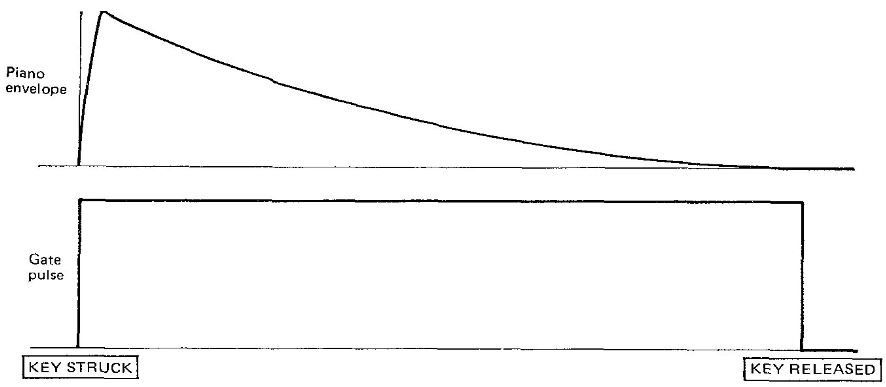


Fig. 1-46 Key release after end of Decay



The same is true when the ATTACK and DECAY controls are at "0". The attack and decay times are so fast that it would be rather difficult to release the key quickly enough to catch them.

1-5-16 Try the RELEASE again . . . . .

Start with the ADSR controls at "0" again. Move the RELEASE up to "10", and while tapping a key, try moving the ATTACK control slowly up.

If you wait until the attack time is finished before releasing the key, the results will be the same as before. But, if you can release the key before attack time ends, you get the release curve. This is, of course, easier to do with longer attacks.

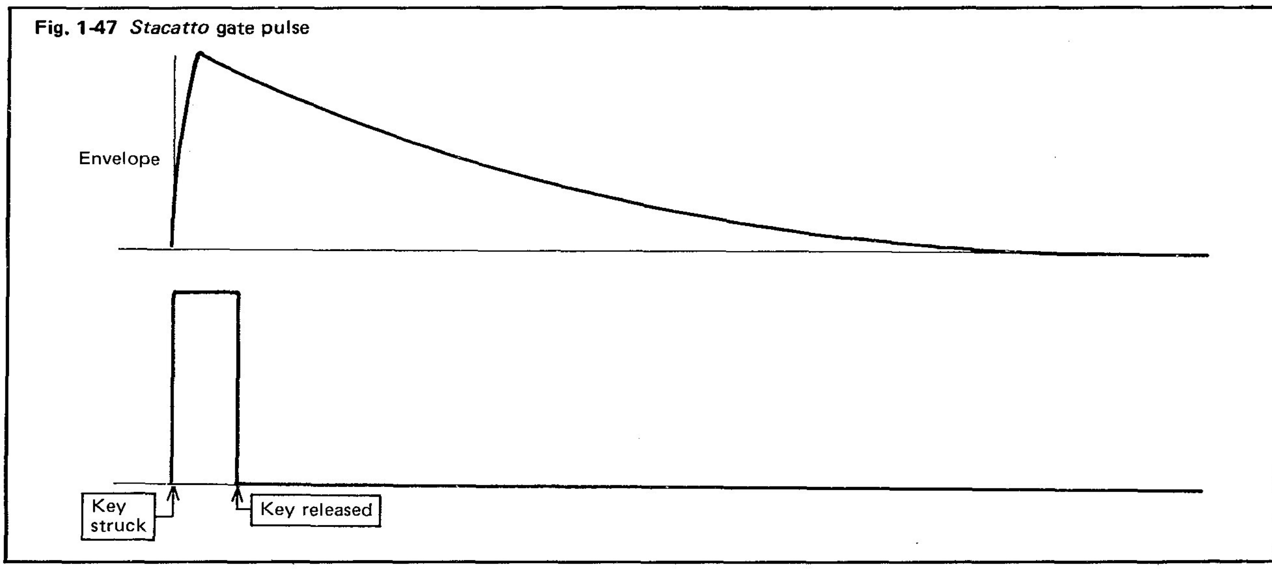
1-5-17 RELEASE one more time . . . . .

This time put ATTACK at "1" and DECAY at "10". Now, starting with the RELEASE at "0", play staccato on the keys while slowly moving the RELEASE up.

. . . . . *etc.*

As the RELEASE control gets higher, wait until the release has completely died away before tapping the key again. Playing this way, the gate pulses and the envelopes look much like the one shown in fig. 1-47.

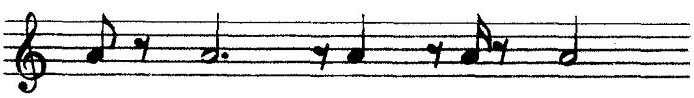
Fig. 1-47 *Stacatto* gate pulse



1-5-18 DECAY and RELEASE . . . . .

With both DECAY and RELEASE at "10", the envelope will remain the same no matter when you release the key. Try it. First strike and hold a key, then strike a staccato note.

Also, try playing notes of different time values.



. . . . . *etc.*

1-5-19 **Why does this happen . . . . .?**
With both DECAY and RELEASE at "10", both the decay curve and the release curve are the same. When you release the key in the middle of the decay curve, the release curve takes over where the decay left off.

1-5-20 **Try playing the piano . . . . .**
Reset Patch 21a (Piano) and try this scale passage lagatissimo:

More than likely, if you're used to playing a real piano or organ, you had trouble getting the notes to sound clearly.

1-5-21 **Why . . . . . ?**
In legato playing on the organ or piano you usually cling to the keys as long as possible in order to get the transition from one note to the next as smooth as possible.

The keys on a synthesizer each produce a gate pulse as shown in fig. 1-48. If you cling to the keys of a synthesizer, the gate pulses overlap and the total is only one gate pulse for the scale passage, as shown at the bottom of fig. 1-48a. One gate pulse produces one envelope.

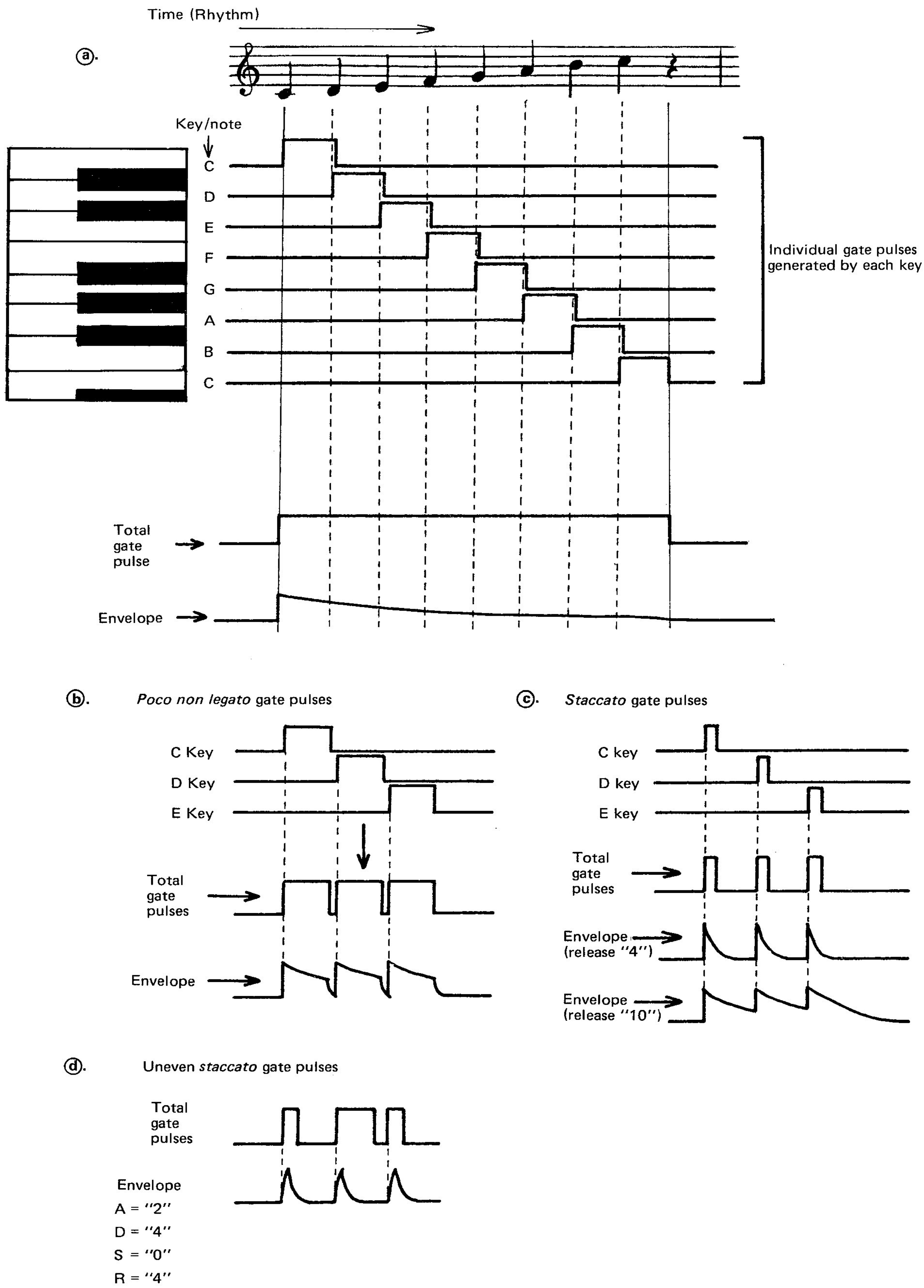
1-5-22 **Lift . . . . .**
If you lift your finger off each key just before you press the next one, this produces gate pulses which do not overlap and as you can see in fig. 1-48b, each gate pulse then produces its own separate envelope.

1-5-23 **Patch 21a (Piano) . . . . .**
The ADSR setting in Patch 21a is ideal for passages which contain both staccato notes and sustained notes.

1-5-24 **Easy legato . . . . .**
If you move the RELEASE control up to "10" and play staccato, the result is legatissimo sounding. Fig. 1-48c compares the envelopes produced by the two positions of RELEASE control when playing staccato.

1-5-25 **Try playing legatissimo . . . . .**
With Patch 21b (Piano) set, try some Chopin, Remember to strike the keys staccato.

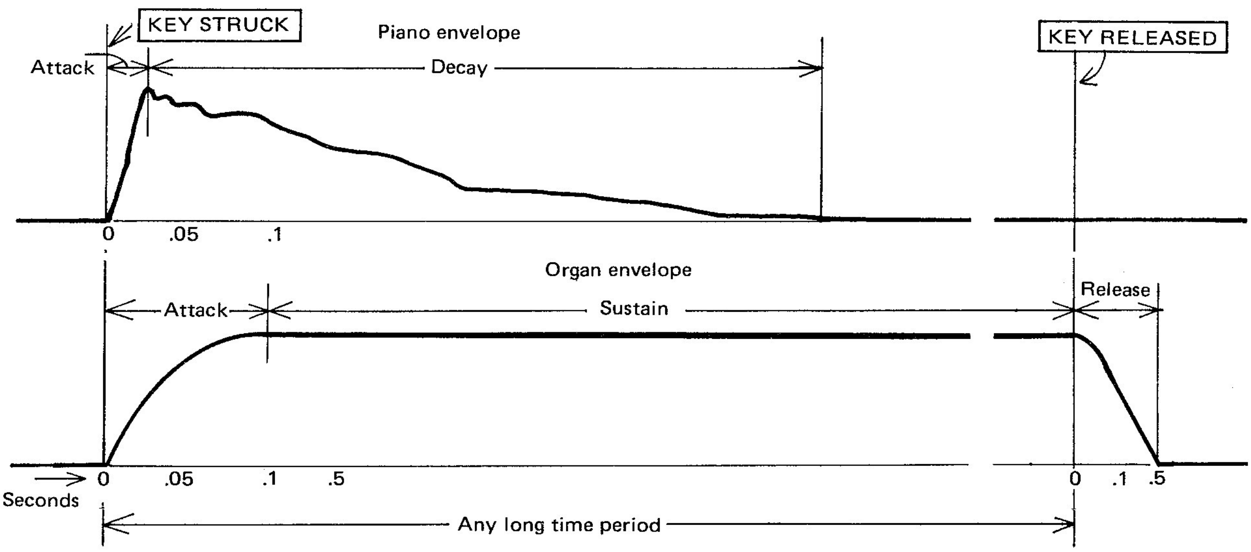
Fig. 1-48 *Legato* gate pulses



1-5-26 **Staccato again . . . . .**
Fig. 1-48d shows what happens if you use both a short decay time and a short release time. You can play notes of any time value and as long as you keep each note slightly detached, the result will always be staccato notes with the exact same time duration.

1-5-27 **Sustain level . . . . .**
Fig. 1-49 compares the envelopes produced by the piano and the organ.

Fig. 1-49 Comparison of piano and organ envelopes



At the end of attack time, the piano sound begins to decay, but the organ sound remains at one level of loudness, called <u>sustain level</u>, until you release the key.

1-5-28 **The tuba . . . . .**
Try Patch 28 (Tuba).

If you play the notes just slightly detached, you get the "huffing" and "puffing" effect.

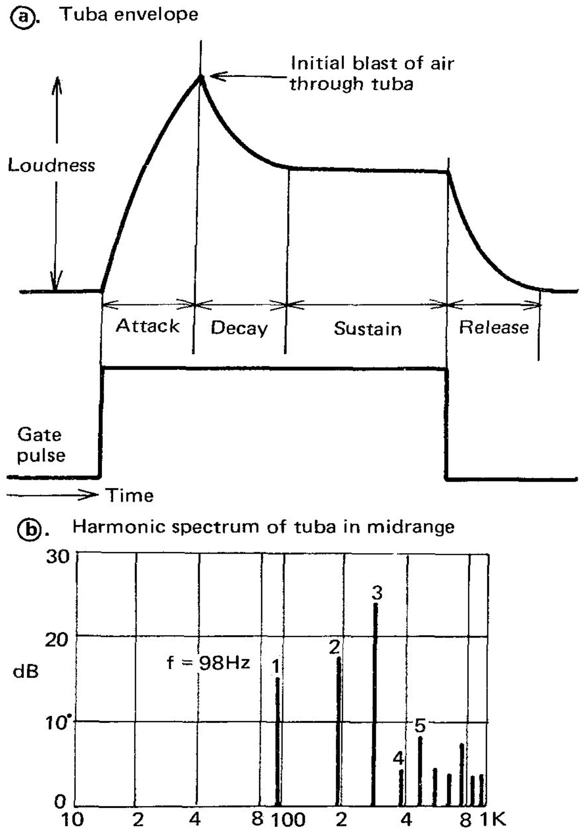
1-5-29 **Puffing . . . . .**

When you blow air into a real tuba, it takes a short space of time to get all the air inside moving. Once the initial blast has left the bell, the flow of air through the tuba settles down to a steady rate which produces a steady loudness of sound.

When you stop blowing, the air remaining in the tuba takes a short amount of time to release.

All of this together produces an envelope shaped as shown in fig. 1-50. Notice that the sustain level is a little lower than the level that the attack curve reaches, and this peak represents the initial blast of air.

Fig. 1-50



1-5-30 Triggering the tuba envelope . . . . .

As before, the vertical leading edge of the gate pulse from the keyboard kicks off the attack time (see fig. 1-50).

When attack time reaches full loudness, this starts off the decay time.

The SUSTAIN control decides how much the loudness will have fallen at the end of decay time. Fig. 1-51 shows some envelopes which are exactly the same except for the setting of the SUSTAIN control.

And last, the trailing vertical edge of the gate pulse triggers the release time.

1-5-31 Try the SUSTAIN . . . . .

Try the tuba sound with the different settings of the SUSTAIN level shown in fig. 1-51.

As an example, Patch 28 (Tuba) with a SUSTAIN level setting of about "5" could very effectively be used in a passage such as the following:

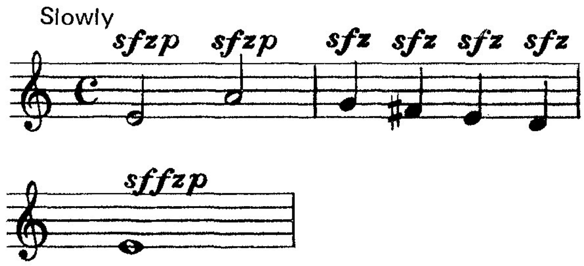
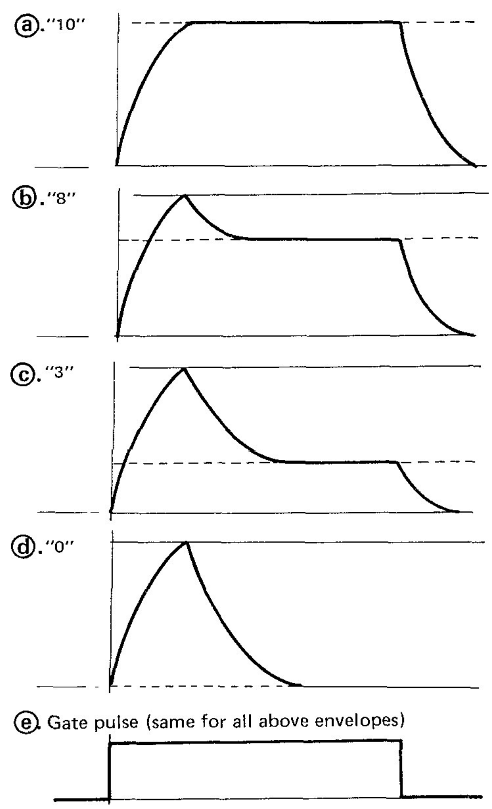


Fig. 1-51 Tuba envelope with different settings of the SUSTAIN level control



1-5-32 An important difference . . . . .

Remember that ATTACK, DECAY, and RELEASE all control time, but SUSTAIN controls how far down the loudness will fall after the decay time is over. In other words, it controls the sustain level.

1-5-33 The tuba again . . . . .

As mentioned earlier (1-5-29), it requires a short space of time to get all the air contained in a tuba moving. One side effect of this is that there is a short delay in the entry of the harmonics.

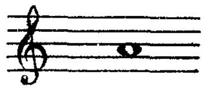
The harmonics enter more or less one at a time starting with the lower ones first until you finally reach the full and rich tone produced at the end of attack time.

Then, as the air pressure settles down to the sustain level, you lose a few harmonics. (Fig. 1-50b shows the harmonic spectrum of a sustained note).

Then finally, when you stop blowing, you lose the harmonics one at a time as the air releases, starting with the higher harmonics and ending with the fundamental.

1-5-34 Controlling the VCF with the ADSR . . . . .

With Patch 28 (Tuba) set, tap the lower F key, move the VCA ADSR control to "0" and the VCA INITIAL GAIN control up until you can hear sound. This is the sound of the sawtooth wave from the VCO after it has been processed by the VCF. Now move the VCF ADSR control down to "4" or "5" and press a key.



When you press the key you can hear the effect that the ADSR control voltage has on the VCF. It moves the VCF cutoff point up, then down, following the ADSR control voltage curve. (The change in loudness is natural (1-3-10)). Move the ATTACK, DECAY, and RELEASE controls up to "10" and the effect is easier to hear.

(Patch 36 (Wah Sound) uses this effect)

1-5-35 Controlling the VCO with the ADSR . . . . .

As you learned earlier (1-1-0), the VCO is a voltage controlled device. Let's try using the ADSR control voltage to control the frequency of the VCO and see what happens.

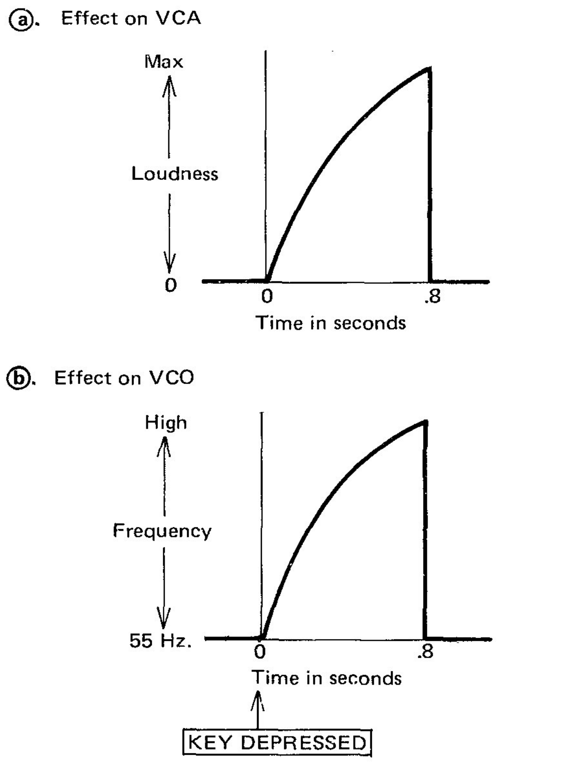
1-5-36 The "Hey, you!" whistle . . . . .

Set Patch 31 (VCO Whistle). Start with the DECAY at "0" and play a note or two.

The ADSR generates the control voltage shown in fig. 1-52a which shapes the envelope of the output by means of the VCA ADSR control.

Also, by means of the patch cord and the VCO EXT CV (VCO external control voltage) slider, the ADSR control voltage controls the frequency output of the VCO. See fig. 1-52b.

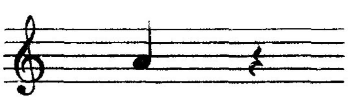
Fig. 1-52 ADSR control of VCO



1-5-37 Frequency only . . . . .

Try Patch 31 (VCO Whistle) with the VCA ADSR control at "0" and the VCA INITIAL GAIN control at the point where you can hear the tone produced by the VCO.

If you press middle A, you can hear the frequency sweep up, then at the end of attack time, drop immediately back to 55 Hz.

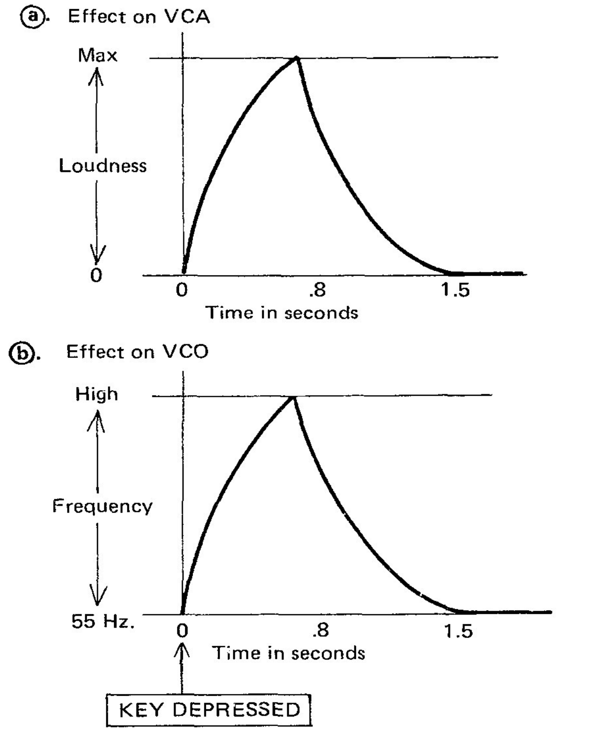


Try moving the ATTACK control up and the VCO EXT CV control down and this frequency change is easier to hear. When you move the VCO EXT CV control down, the VCO frequency doesn't sweep so far up, and with the longer attack time, the frequency change is slower.

1-5-38 **Up and down . . . . .**
Reset Patch 31 (VCO Whistle) and this time put the decay control at "5". Press middle A.

The envelope and VCO frequency pattern are shown in fig. 1-53.

Fig. 1-53 ADSR control of VCO



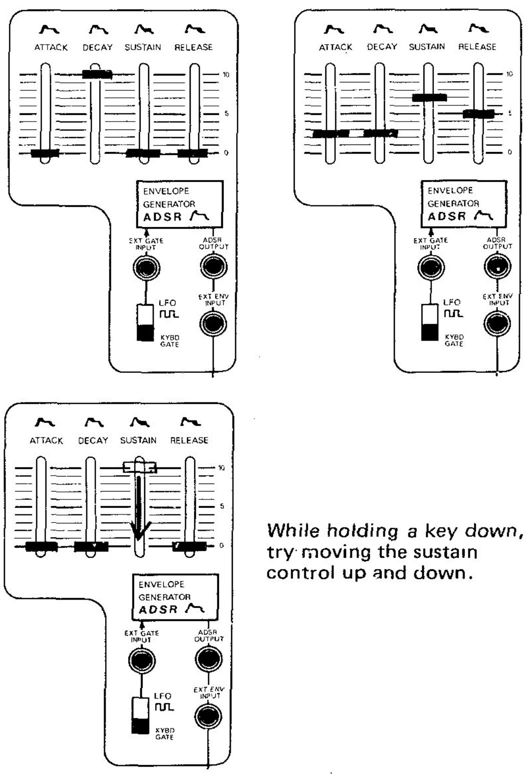
1-5-39 **The wolf whistle . . . . .**
Try this: With Patch 31 (VCO Whistle) set and DECAY at "0", press a key. As soon as the sound disappears, quickly move the DECAY up to "5" or so and press the same key again.

1-5-40 **More whistling . . . . .**
Patch 30 (VCF Whistle) shows how to create these same effects using the VCF as a sound source instead of the VCO.

In this case the ADSR is used to control the cutoff point of the VCF which, with the RESONANCE control at "10", controls the output frequency.

1-5-41 **Different ADSR settings . . . . .**
Try both Patches 31 (VCO Whistle) and 30 (VCF Whistle) with the ADSR settings shown in fig. 1-54. Also, try these while tapping different keys.

Fig. 1-54 Variations for ADSR settings for Patches 30 and 31



While holding a key down, try moving the sustain control up and down.

1-5-42 **Another use for the ADSR control voltage . . . . .**
Set up Patch 41 (ADSR/Pulse Width Test), but for the moment, put the ADSR/MANUAL/LFO switch in the MANUAL position and listen to the effect of moving the PUSLE WIDTH slider.

Next, change the ADSR/MANUAL/LFO switch to the ADSR position. Try the PULSE WIDTH slider and you'll find that it now has no control over the width of the pulses in the pulse wave. Move the VCO WAVE FORM selector back and forth between ⊓⊔ and ⊓⊔ and you'll hear that there is no change, which means that you are listening to a square wave (or a pulse wave at 50%).

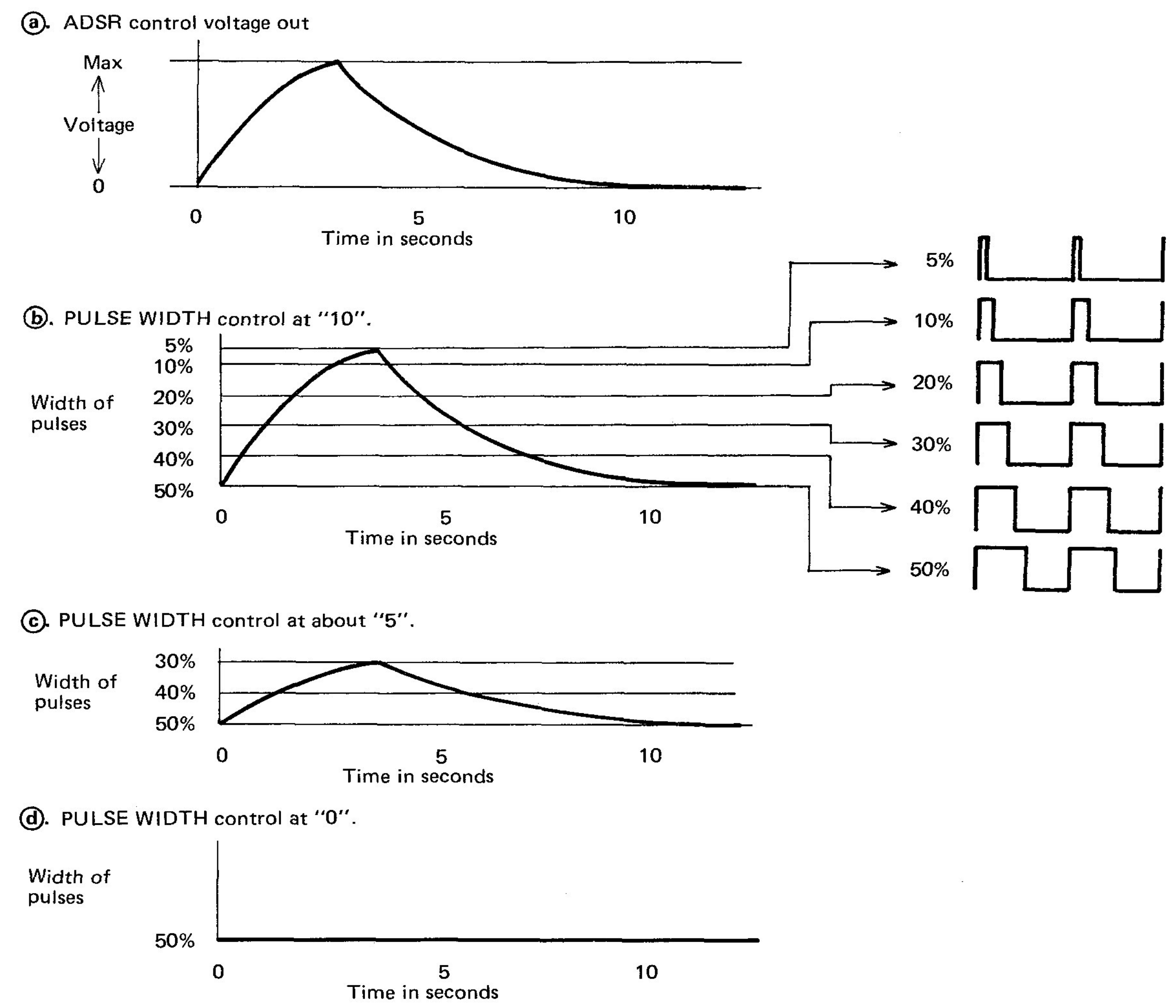
Now, with the PULSE WIDTH control at MIN, press a key and hold it until the action stops.

The control voltage output of the ADSR is shown in fig. 1-55a, and fig. 1-55b shows what happens to the width of the pulses in the pulse wave.

Figs. 1-55c and 1-55d show what happens when you lower the VCO PULSE WIDTH control.

1-5-43 **Fuzz . . . . .**
Reset Patch 21b (Piano) and play a note or two.

Fig. 1-55 ADSR control of PULSE WIDTH



Now change the ADSR/MANUAL/LFO switch to ADSR and move the PULSE WIDTH control up to MIN so that the pulse width changes over the whole range from 50% to 10%. Tap a few keys.

You can hear a little change in the pulse width as the sound dies away.

To make the effect easier to hear, move the VCF CUT-OFF FREQUENCY control up to "10" so that you can hear all of the harmonics.

What you have now is almost the sound of the fuzz guitar. Move the HPF CUTOFF FREQUENCY control up to about "9" and change the VCO FREQUENCY control to 110 Hz. Now you have Patch 14 (Fuzz Guitar I).

Dark Eyes

Russian Folk Song

1-5-44 **More fuzz . . . . .**

Try Patch 15 (Fuzz Guitar II), too.

Back Water Blues

Traditional

1-5-45 **The ADSR jacks . . . . .**

The jacks in the ADSR section are for making external connections. They are used mostly with the Model 102 Expander Unit and the Model 104 Sequencer Unit. (See 1-1-0, MODEL 102 EXPANDER UNIT INSTRUCTION MANUAL).

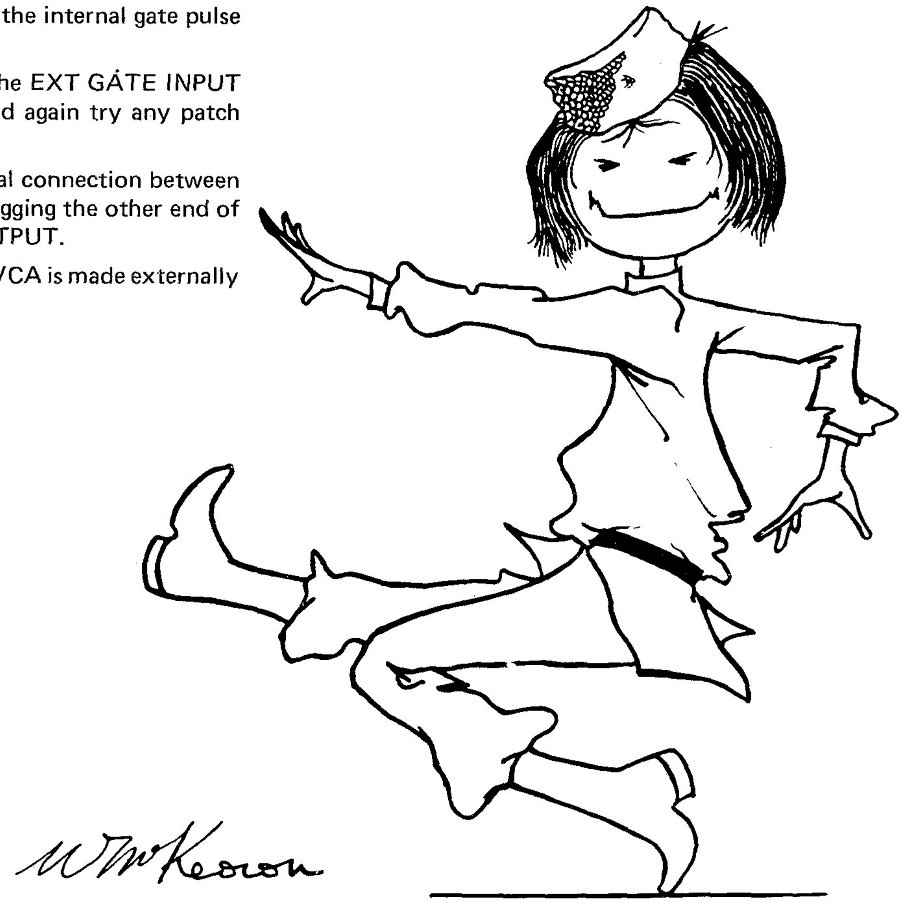
1-5-46 **Experimenting with the ADSR jacks . . . . .**

Try putting one end of a patch cord into the EXT GATE INPUT jack and try any of the patches which use the ADSR. A plug in this jack cuts off the internal gate pulse connection from the keyboard.

Change the patch cord end from the EXT GATE INPUT jack to the EXT ENV INPUT and again try any patch which uses the ADSR.

With a plug in this jack, the internal connection between the ADSR and VCA is cut. Try plugging the other end of the patch cord into the ADSR OUTPUT.

Now the ADSR connection to the VCA is made externally through the patch cord.



1-5-47 Review of the ENVELOPE GENERATOR

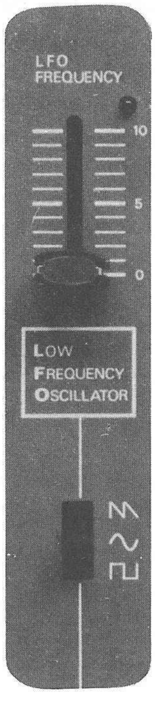
1. The two main characteristics of sound are:
   - harmonic content (1-3-4)
   - envelope (1-5-0)
2. The parts of the envelope are:
   - attack time (1-5-2; figs. 1-37, 1-50)
   - decay time (1-5-2; figs. 1-37, 1-50)
   - sustain level (1-5-27; fig. 1-50)
   - release time (1-5-2; figs. 1-37, 1-50)
3. The ADSR generates a control voltage which controls the amplitude of the VCA output, thus forming the envelope (1-5-4; fig. 1-39).
4. The ADSR is triggered by means of the keyboard gate pulse (1-5-7; fig. 1-41).
5. In envelopes with no sustain element, the keys must be played semi-detached, even in legato passages (1-5-21).
6. In enevelopes with sustain element, the keys can be played legato for slurred passages and detached for "breathing" places (1-5-22; fig. 1-48).
7. The ADSR control voltage output can be used to control:
   - the VCA to form the envelope (1-5-4)
   - the VCF cutoff point (1-5-34)
   - the VCO frequency output (1-5-35; figs. 1-52, 1-53)
   - the width of the pulse wave pulses (1-5-42)

1-6-0 The LFO or LOW FREQUENCY OSCILLATOR

Low frequency, in this case, means from 0.15 Hz. to 25 Hz.

The output of the LFO is used as a control voltage to control different functions.

Fig. 1-56



1-6-1 Vibrato . . . . .

Vibrato is the slight wavering of the frequency (pitch) of a sound. This is called frequency modulation (FM).

The most common examples of vibrato can be found in the sounds of the human voice (Patch 20) and the violin (Patch 34).

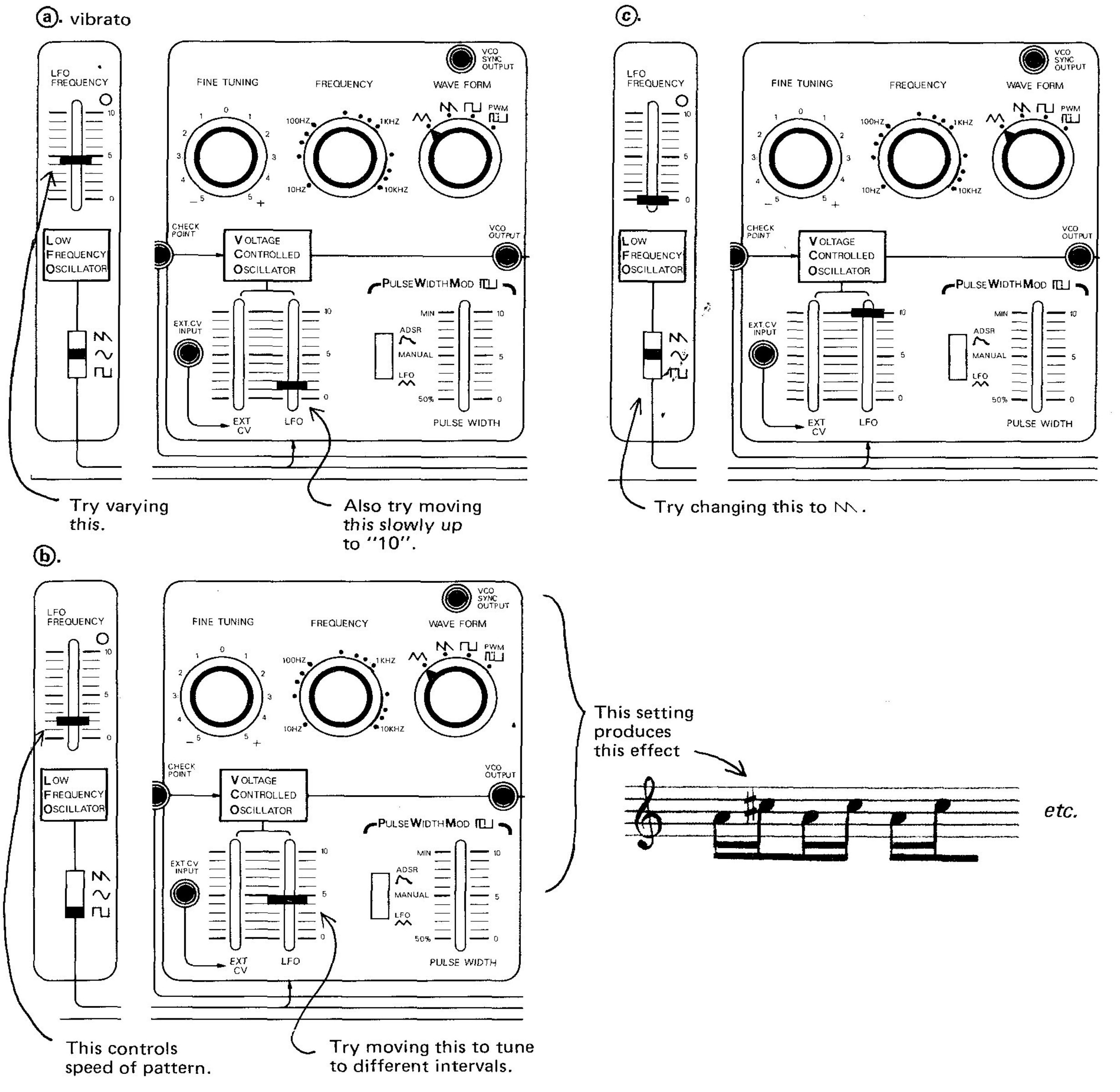
Average vibrato rates vary from about 2 Hz. to about 7 Hz., but about 7 Hz. seems to produce the most pleasing effect.

1-6-2 Controlling the VCO with the LFO . . . . .

Set up Patch 42 (LFO Test) and try the experiments in fig. 1-57.

Fig. 1-57 Controlling the VCO with the LFO

(Sections and settings not shown should be set as in Patch 42)



(Tuning is discussed in detail in Section 1-10)

1-6-3 Pulse width modulation with the LFO . . . . .

Fig. 1-58 shows how to use the LFO to modulate the width of the pulses in the pulse wave.

Try Patch 12 (Frogman).

Slowly — Song of the Volga Boatmen — Russian Folk Song

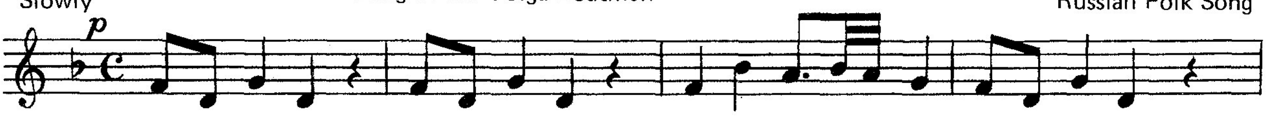
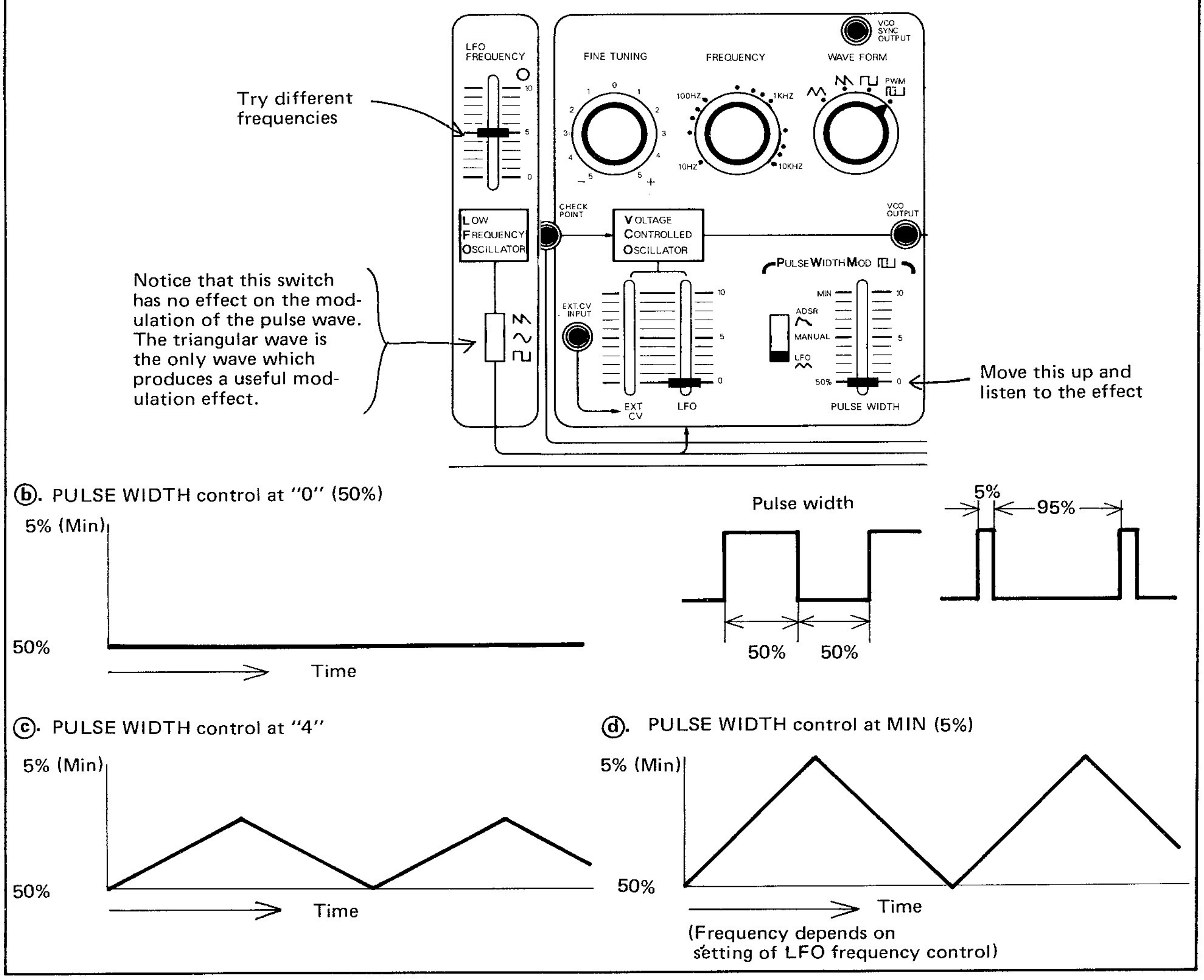


Fig. 1-58 LFO modulation of PULSE WIDTH

ⓐ. PULSE WIDTH modulation by LFO
(Sections and settings not shown should be set as in Patch 12)



Next, put the ADSR/MANUAL/LFO switch in the LFO position. Use an LFO FREQUENCY setting of about "3".

Cassock Lullabye

Slowly

Another Russian Folk Song

What you have now is a group of frogmen or, in other words, a "chorus" effect.

Try different settings of the LFO FREQUENCY control.

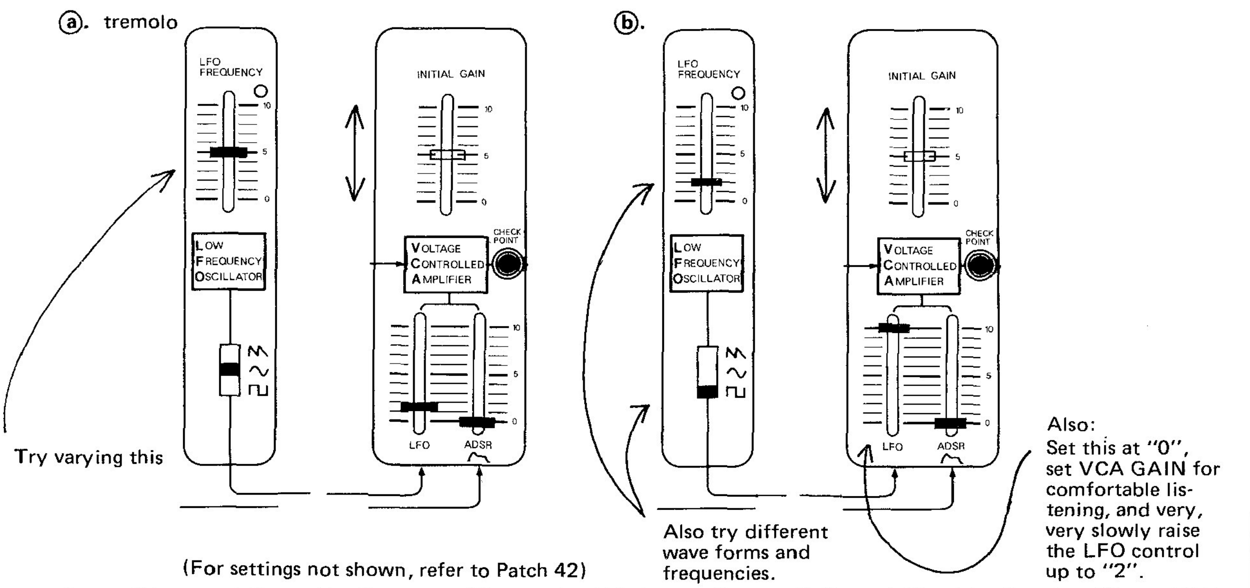
1-6-4 Tremolo . . . . .

Tremolo is the slight wavering of the loudness of a tone. This is called amplitude modulation (AM).

1-6-5 Controlling the VCA with the LFO . . . . .

Set Patch 42 (LFO Test) again and try the experiments in fig. 1-59.

Fig. 1-59 Controlling the VCA with the LFO

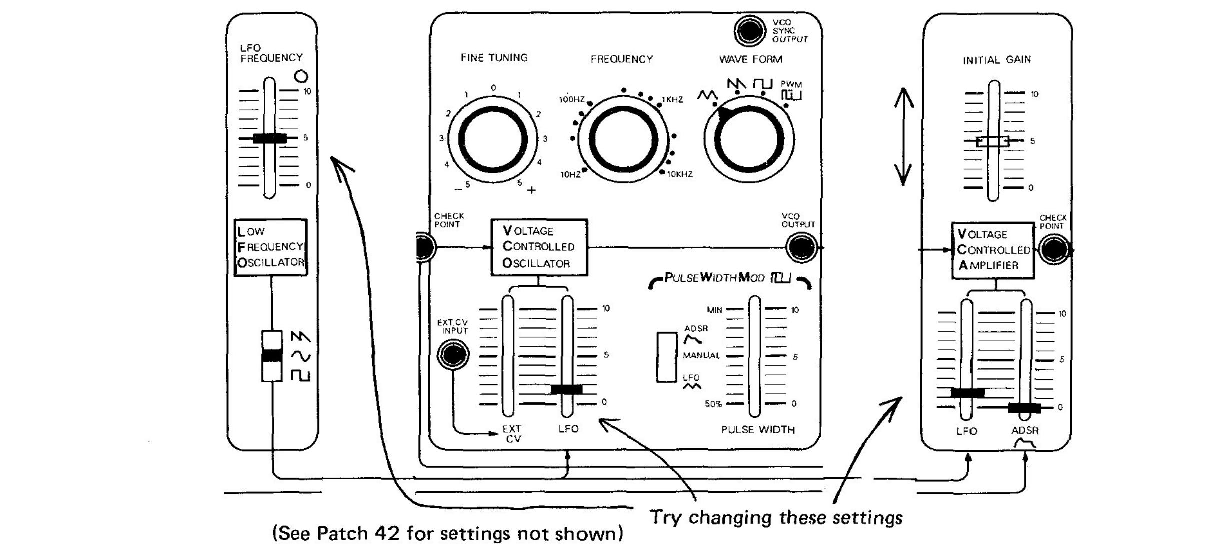


1-6-6 Hand in hand . . . . .

Tremolo and vibrato are very often present at the same time in a musical tone. Indeed, tremolo is sometimes considered to be a special form of vibrato.

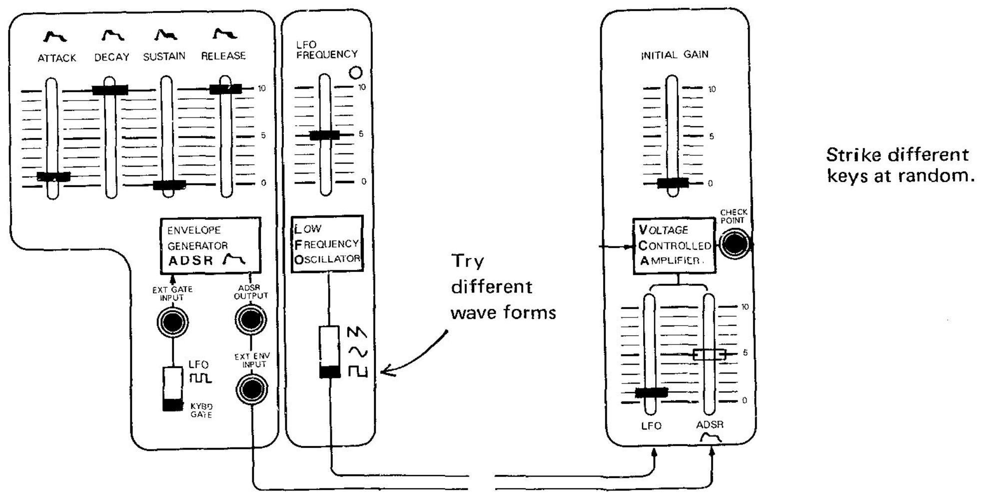
Set Patch 42 (LFO Test) and try the variations shown in fig. 1-60.

Fig. 1-60 Tremolo and vibrato



Also try Patch 10 (European Police). Fig. 1-61 shows some variations of this patch you can try.

Fig. 1-61 Variations on Patch 10.



1-6-7 **Controlling the VCF cutoff point . . . . .**

Not only do vibrato and tremolo often occur together, but in some musical instruments (especially winds), the harmonic content changes slightly at the same rate as the vibrato/tremolo rate. This change in harmonics is called growl.

Try Patch 23 (Saxophone).

Try moving the EXT/CV slider slowly up to "10".

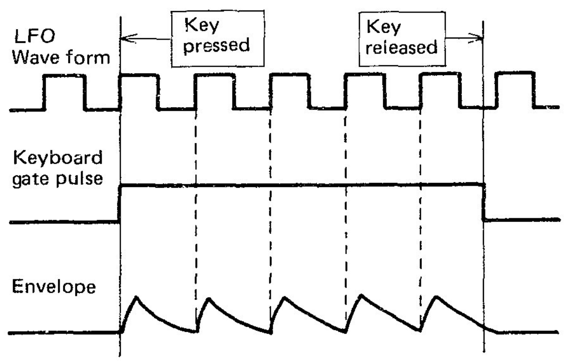
Also try moving the LFO FREQUENCY control up to "10".

With both of these controls at "10", the growl effect is very strong.

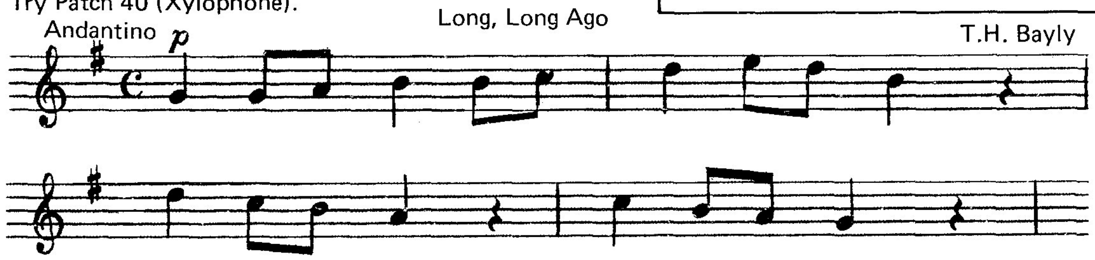
1-6-8 **Triggering the ADSR . . . . .**

A square wave from the LFO can be used as a repeating gate pulse for triggering the ADSR. The keyboard gate pulse then acts as a master gate. In other words, pressing a key allows the square wave from the LFO to repeatedly trigger the ADSR. Releasing the key cuts off the LFO square wave. See fig. 1-62.

Fig. 1-62 Triggering the ADSR with the LFO



Try Patch 40 (Xylophone).

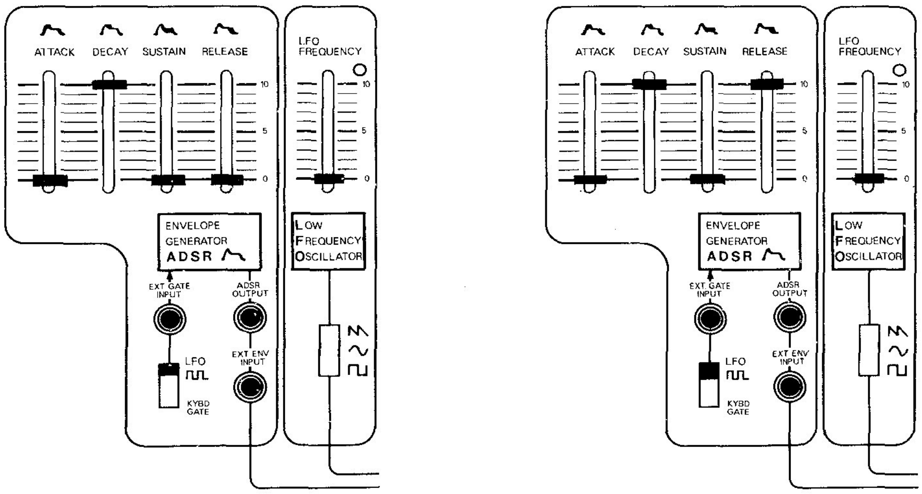


With higher settings of the LFO FREQUENCY control, *this effect works best with short staccato-like* release times. Try the variations shown in fig. 1-63.

Fig. 1-63 LFO triggering of ADSR

(All other settings as in Patch 40)

ⓐ. no release   ⓑ. long release



In both of the above, while holding down a key, try slowly moving the LFO FREQUENCY control up to "10".

1-6-9 Note . . . . .

The VCA LFO control has no effect when the VCA INITIAL GAIN and VCA ADSR controls are at "0".

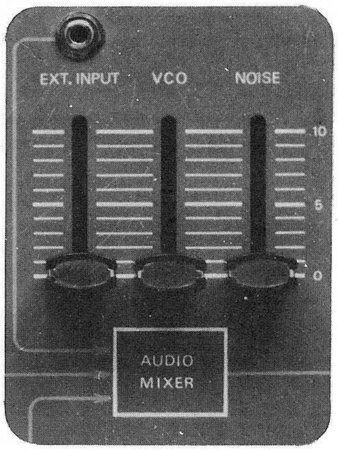
1-6-10 Review of the LOW FREQUENCY OSCILLATOR

1. The LFO produces low frequencies for creating:
   vibrato (1-6-1)
   tremolo (1-6-4)
2. The LFO can be used to control tone color in the VCF (1-6-7).
3. The LFO can be used for triggering the ADSR (1-6-8).

1-7-0 The AUDIO MIXER

The AUDIO MIXER allows the mixing of the three sound sources: Noise (Section 1-8, page 48), VCO, and an external source.

Fig. 64



1-7-1 External inputs . . . . .

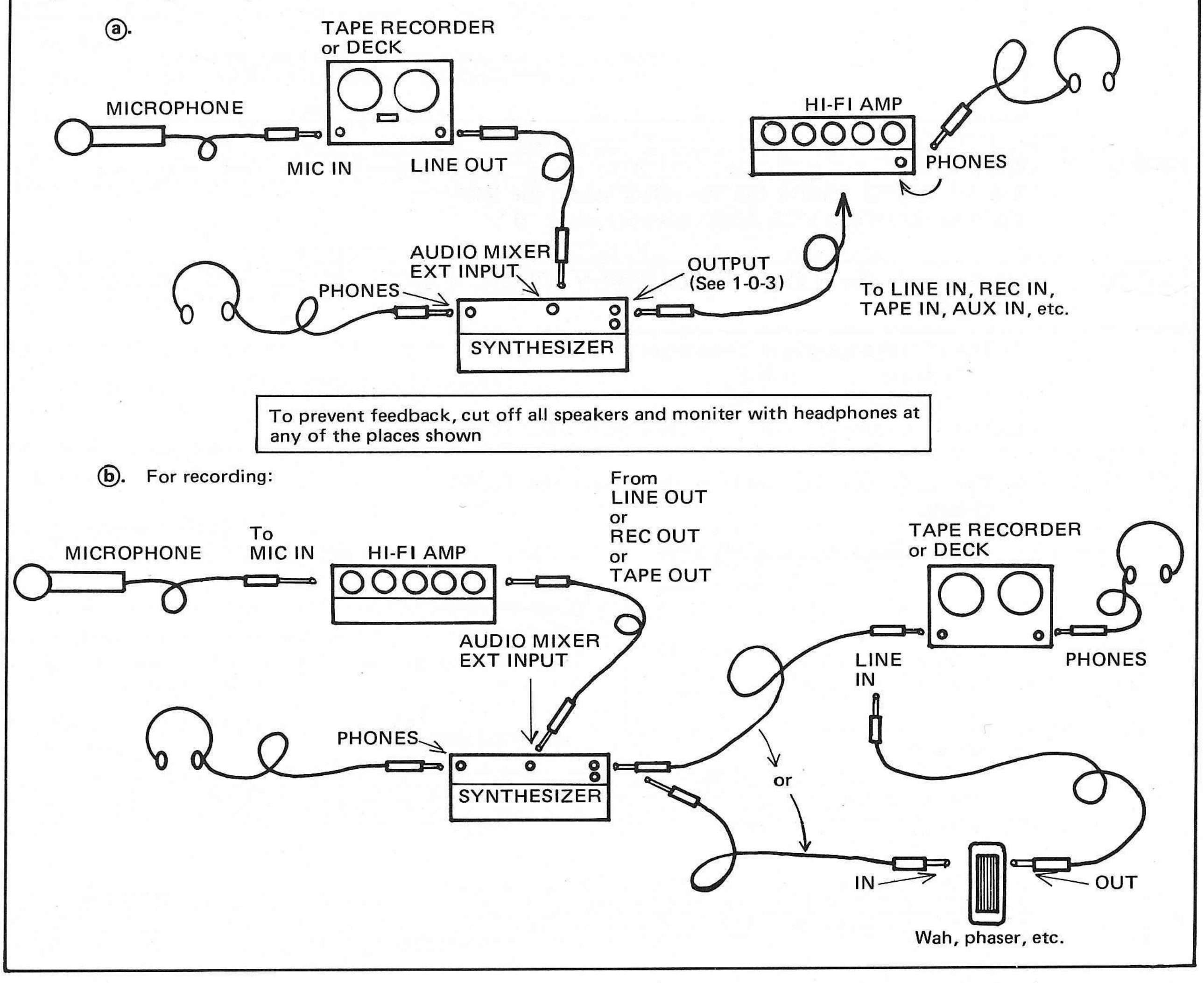
The EXT INPUT jack was designed to be used with other elements of the SYSTEM 100.

For optimum performance, the EXT INPUT jack requires a 10 V. p-p signal. It is possible, however, to use the same kinds of inputs that the LINE IN jacks on tape decks and hi-fi amplifiers take. This means that any sound source you can connect to your hi-fi system, you can also connect to your synthesizer for mixing and/or processing in the HPF, VCF, and VCA.

1-7-2 Using a microphone or electric guitar . . . . .

To use a microphone or electric guitar with the EXT INPUT jack requires some kind of a preamplifier. It is possible to use either a tape deck or your hi-fi amplifier as a preamp, although these will not deliver the optimum 10 V. p-p. signal. Fig. 1-65 shows how.

Fig. 1-65 Using a microphone



Try speaking or singing into the microphone or playing the guitar while experimenting with the filter controls.

Also, try using the LFO and ADSR. For the ADSR, you'll need to create a gate pulse manually using the keyboard.

Try using the LFO as a repeating gate pulse at different frequencies.

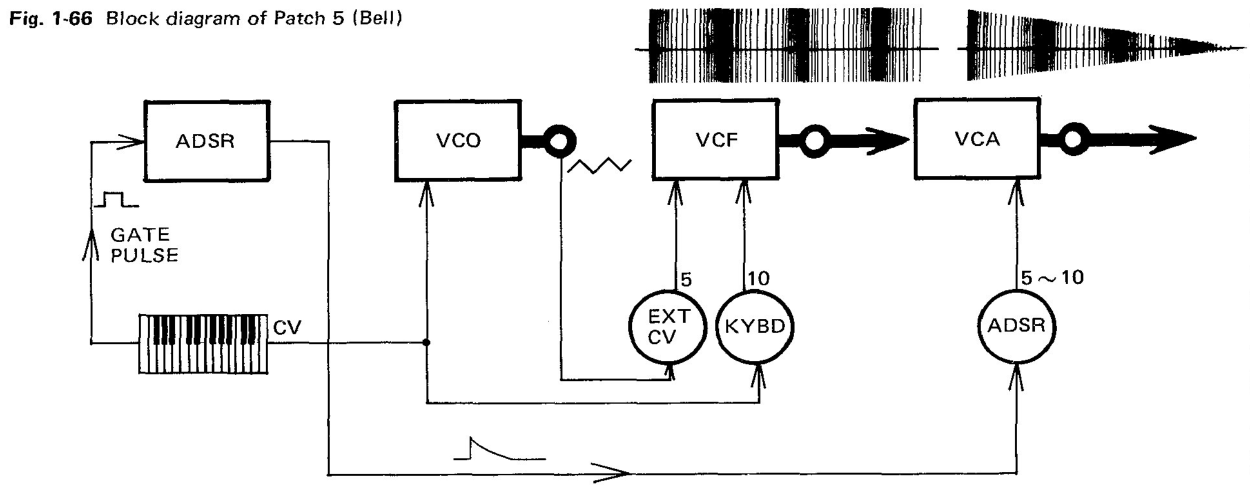
1-7-3 Making bells . . . . .

Set Patch 5 (Bell) and strike a key.

Try moving the VCO FREQUENCY control very slowly one way or the other to find a good bell sound. Use the FINE TUNING to bring it right on.

1-7-4 How does it work . . . . .?

Fig. 1-66 *Block diagram of Patch 5 (Bell)*



All the AUDIO MIXER controls are at "0".

The VCF RESONANCE control is at "10", so the VCF is oscillating.

The VCF CUTOFF FREQUENCY control is at "5", so the cutoff point of the filter centers around 400 Hz.

The output of the VCO is plugged into the VCF EXT CV input, and the EXT CV/LFO slider is at "5". This means that the VCO is being used to change (or modulate) the frequency being generated by the VCF. The distance away from the 400 Hz. center point that the VCF cutoff swings depends on where the EXT CV/LFO slider is.

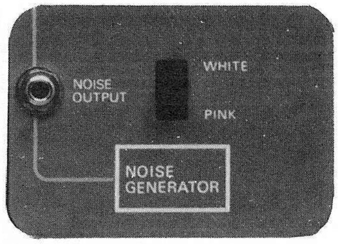
This is roughly how the RING MODULATOR in the Model 102 Expander Unit works in order to produce bell-like sounds. (See Section 2-1, MODEL 102 EXPANDER UNIT INSTRUCTION MANUAL).

And last, the KYBD CV is at "10", which allows the VCF cutoff point to follow the keyboard so you can play melodies.

1-8-0 The NOISE GENERATOR

Electronically, noise is a combination of all frequencies at random amplitudes. Fig. 1-68, shows a noise wave form.

Fig. 1-67



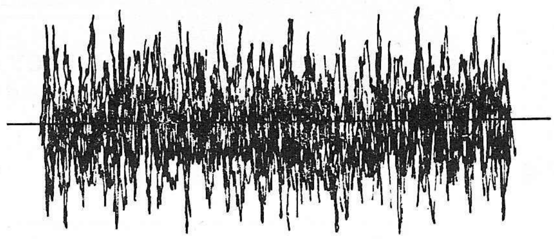
1-8-1 White noise . . . . .

White noise is the random combination of all different frequencies contained in the audio spectrum. (The audio spectrum is 20 Hz. to 20 kHz.). Tune a radio to some place between stations and what comes out of the speaker is white noise.

Patch 43 (Noise Test) generates white noise.

Although white noise contains equal amounts of all frequencies, to our imperfect human ears the higher frequencies seem to be stronger, so we here mostly the higher hissing frequencies and very little of the lower frequencies.

Fig. 1-68 White Noise wave form.



1-8-2 Pink noise . . . . .

With Patch 43 (Noise Test) set, try shaving off some of the higher frequencies by moving the VCF CUTOFF FREQUENCY control slowly down. When you get near "6" or "7", you will get noise which, to our human ears, sounds more like it contains equal amounts of all frequencies. This is called pink noise.

Move the VCF CUTOFF FREQUENCY control back up to "10" and change the NOISE GENERATOR WHITE/PINK switch to PINK to get pink noise. (This pink noise is slightly different in quality from the pink noise obtained by using the VCF.)

1-8-3 Making a storm . . . . .

Set Patch 26 (Thunder) and strike a key.

This patch works much like Patch 5 (Bell) (see 1-7-4) except that, instead of using the VCO output to modulate the VCF, you are using the purely random patterns produced by the PINK output of the NOISE GENERATOR.

1-8-4 Improving the storm . . . . .

If you have the Model 102 Expander Unit, you can use the second ADSR and VCF to give you a better thunder sound. (See 1-3-8, MODEL 102 EXPANDER UNIT INSTRUCTION MANUAL). If not, then you can control it manually.

With Patch 26 (Thunder) set, put the VCF CUTOFF FREQUENCY control at about "6", press a key, move the VCF CUTOFF downwards, then release the key.

This effect sounds even better with a reverberation unit and/or an echo unit.

1-8-5 The gun fight . . . . .

Try Patch 16 (Gun shots). Try tapping on different keys to get the effect of different guns shooting.

Notice that the VCF RESONANCE control is between "8" and "9" which means that the VCF is oscillating. With the VCF ADSR control at "10", the decay/release curve from the ADSR causes the oscillations to sweep downwards, giving the effect of a ricochet.

Try other positions of the RESONANCE control.

1-8-6 Wind . . . . .

Set Patch 39 (Wind) and try running you fingers up and down the keyboard.

1-8-7 Waves . . . . .

If you use pink noise instead of white noise with the wind patch, you get the lower frequencies which sounds much like the surf pounding on the beach.

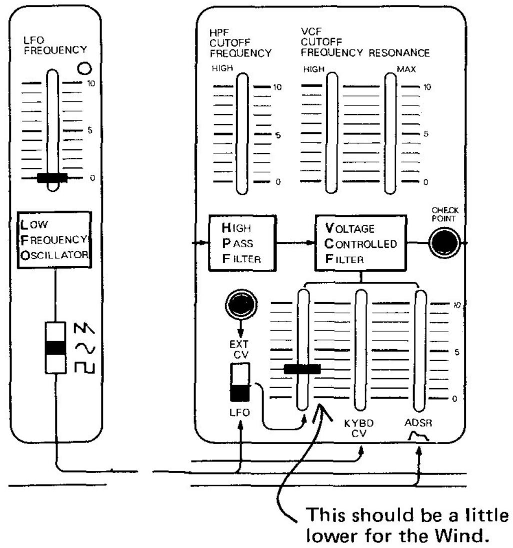
Try Patch 25 (Surf). Run your fingers slowly up and down the keyboard.

1-8-8 Using the LFO for wind and waves . . . . .

In both Patches 39 (Wind) and 25 (Surf) you can use the LFO to control the action. Fig. 1-69 shows how.

You will note, however, that using the LFO in this manner produces patterns which are a little too regular, especially for the wind, so that the result is rather artificial sounding. The SAMPLE & HOLD section of the Model 102 Expander Unit can be used to produce more random patterns for a more natural effect. (See 2-2-5, MODEL 102 EXPANDER UNIT INSTRUCTION MANUAL).

Fig. 1-69 LFO control of Wind and Waves.



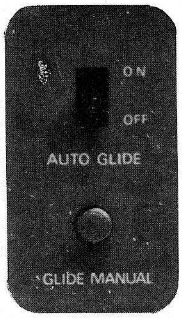
(Sections and settings not shown should be set as in Patch 25 or 39)

1-8-9 Review of the AUDIO MIXER and the NOISE GENERATOR

1. The AUDIO MIXER mixes sound sources together before they pass through the VCF (1-7-0).
2. The NOISE GENERATOR generates two kinds of noise:
   - white noise (1-8-1)
   - pink noise (1-8-2)

1-9-0 The GLIDE section

Fig. 1-70



1-9-1 The AUTO GLIDE switch . . . . .

With the AUTO GLIDE switch ON, all notes you play will be preceeded by a grace note which starts one half step lower than the principal, and slides up to the principal.

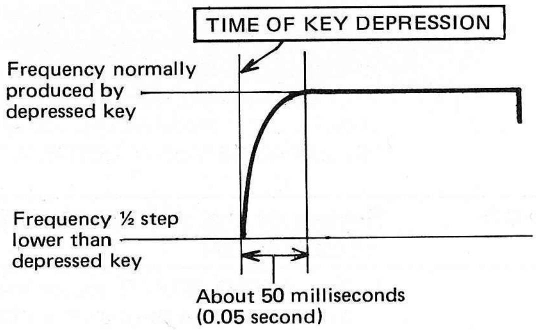
Play:

Result:

Fig. 1-71 shows what happens to the VCO control voltage when using the AUTO GLIDE.

As you can see, since depressing the key initiates the process, if you strike the key on the beat, the grace note will fall on the beat, much like an appoggitura, with the principal falling just after the beat by 50 milliseconds (0.05 second).

Fig. 1-71 VCO control voltage when using AUTO GLIDE.



1-9-2 Whistling . . . . .

Try Patch 37 (Whistler I).

1-9-3 Another whistler . . . . .

Patch 38 (Whistler II) shows how to use the oscillations from the VCF to produce whistling.

As I Walked Out in the Streets of Laredo — Cowboy Song

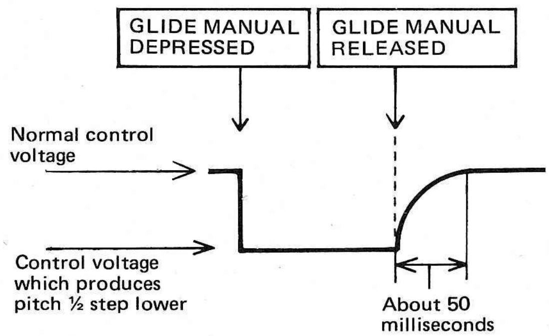
1-9-4 The GLIDE MANUAL . . . . .

Depressing the GLIDE MANUAL button (while holding down a key) will lower the pitch of that note by a half step. Releasing the GLIDE MANUAL will slide the note back up to its original pitch.

Fig. 1-72 shows what happens to the VCO control voltage when using the GLIDE MANUAL.

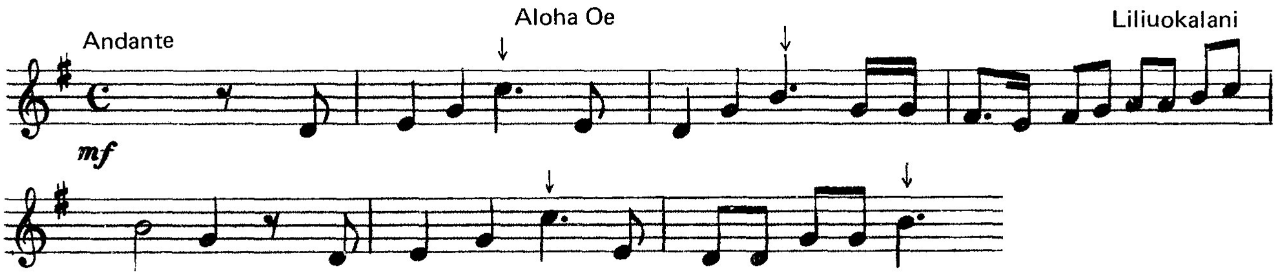
(In 2-2-3, you'll find a method for obtaining a foot pedal controlled pitch bend).

Fig. 1-72 Effect of GLIDE MANUAL button on VCO control voltage.



1-9-5 A taste of Hawaii . . . . .

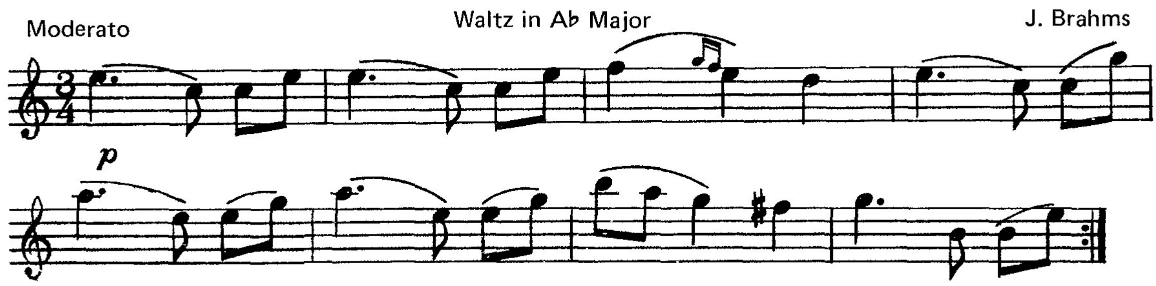
Set Patch 18 (Hawaiian Guitar) and try the following.



Push the GLIDE MANUAL button at the exact time you strike the keys whose notes are marked with arrows, then immediately release the GLIDE MANUAL.

1-9-6 The singer . . . . .

Before leaving the discussion of the GLIDE section, try one more patch; Patch 20 (Human Voice).



1-9-7 Review of the GLIDE section

1. With the AUTO GLIDE switch on, all notes are preceeded by a grace note one half step lower than the principal (1-9-1).
2. Pressing the GLIDE MANUAL lowers notes by half a step (1-9-4)

1-10-0	Tuning your synthesizer

Tuning is accomplished by comparing the output pitch of the synthesizer with the pitch of the STANDARD OSCILLATOR.

Fig. 1-73

1-10-1 The test signal . . . . .

To activate the test oscillator, simply turn the STANDARD test OSCILLATOR LEVEL control clockwise until you reach a comfortable listening level.

The test signal is a 440 Hz. sine wave (the pitch of A above middle C).

1-10-2 Unison tuning . . . . .

The easiest interval to tune is unison.

Set Patch 46 (Tuning Practice). Set the VCA INITIAL GAIN and the STANDARD OSCILLATOR LEVEL control for a comfortable balance between the two sounds.

Tuning is easier if you are comparing two wave forms which are the same or similar. That's why the VCO WAVE FORM switch is in the ∧∧ position for this patch.

Set the VCO FINE TUNING at "0", and start with the VCO FREQUENCY at around 300 Hz. Strike the middle A in order to establish the middle A control voltage to the VCO.

To tune, very slowly turn the VCO FREQUENCY control clockwise until the pitch of the VCO very nearly matches the test pitch. Use the FINE TUNING to bring it right on.

1-10-3 The beat frequency . . . . .

As you near unison with the VCO FREQUENCY control, you should be able to hear a rolling "beat" between the two pitches. This beat frequency is probably clearest when the two frequencies are about a minor second apart.

As you slowly approach unison (using the FINE TUNING control), the rolling of the beat will slow down and finally disappear completely when you reach perfect unison. If you pass the unison point, the beat will appear again.

1-10-4 Trouble with tuning . . . . .

Sometimes it helps to listen to each of the two pitches separately.

Set the VCA INITIAL GAIN at "0" and listen to the test pitch. Next, turn the test oscillator LEVEL to OFF and raise the VCA INITIAL GAIN. Now, using the VCO FREQUENCY and FINE TUNING controls, try to match the VCO pitch with the test pitch you heard.

When tuning with other patches, remember that is very difficult to tune when any of the LFO sliders are above "0". This is especially true of the VCO LFO slider.

1-10-5 Tuning to octaves . . . . .

Once you are able to easily tune to unison, try octaves. Octaves, being perfect intervals, also produce a strong beat frequency and are therefore rather easy to tune.

Try tuning one octave above, then one octave below the test pitch.

Also, try tuning at two and three octaves.

1-10-6 Cheating at octave tuning . . . . .

If you tap the A above or below middle A and tune that to unison, then middle A will be one octave away from the test pitch.

For example, if you want to tune middle A to 880 Hz., tap the low A, tune to unison (440 Hz.), and middle A will be 880 Hz.

1-10-7 Transposing . . . . .

You can see from the above that it would be a simple matter to tune any key on the keyboard to the 440 Hz. A pitch. This is very convenient for reading from band and orchestral scores.

1-10-8 Transposing instruments . . . . .

It is beyond the scope of this manual to discuss in any detail the peculiarities of transposing instruments, but one practical example should be enough show you how it's done.

1-10-9 The clarinet . . . . .

The most common clarinet is perhaps the B♭ clarinet (Patch 8). This means that when the player reads and plays C as written in his part, the frequency of the pitch actually produced is the pitch of the B♭ below this C.

Written:  Sound: 

If you want to play the B♭ clarinet part in a score and play the correct (concert) pitches, tune the synthesizer by stiking the B key on the keyboard and tuning this to unison with the test pitch. Which B you strike depends on whether you want a low, medium, or high register.

Now your synthesizer, like the B♭ clarinet, sounds a major second lower than the written part you play.

1-10-10 Tuning to other intervals . . . . .

Although it is much simpler to tune to unison by tapping the correct key (as with the B key in the clarinet example above), it is very valuable ear training to learn to tune to other intervals.

Perfect fourths and fifths produce beats which are slightly weaker than unisons and octaves but they are fairly easy to tune.

Major thirds and sixths produce weak but definite beats, and minor thirds and sixths produce beats which are weaker still.

1-10-11 For practice . . . . .

Tap middle C and tune to unison with the test signal. Next, with the test signal still turned on, tap the G (perfect fifth) above the C and move the FINE TUNING control very slightly one way or the other until your ear can catch the beat frequency, then practice tuning to it.

Try the same thing with the F (perfect fourth) above.

Also, try this with the E (major third) and the A (major sixth) above. The beats created by these intervals are a little more difficult to hear. Listen for the beat "underneath" the pitches you hear.

Next, try inversions (same letter names, but below the C) of the two major intervals. Remember that a major interval, when inverted, becomes minor. The beat produced by minor intervals is often quite difficult to hear, but if you start with a major interval, then invert it, you should find it easier to catch this elusive beat frequency.

1-10-12 More practice . . . . .

When you get to the point where you can easily find all these different beat frequencies, try tuning the VCO directly to these intervals.

For example, the major third: Tap C and tune it to a major third above the test signal. (You may have to listen to each pitch separately as explained in 1-10-4, but for good ear trianing, you should aim at being able to produce the intervals without this separation). When you think you have it right, check yourself by tapping the A♭ which is a major third below the C and check that this produces unison.

If it doesn't, then the C is not a major third above the test signal.

1-10-13 Not perfect . . . . .

From the above exercises, you have probably noticed that the synthesizer scale is not mathematically exactly perfect. If you tune one key to unison with the test signal, then tap another key to form a tuneable interval, you will sometimes hear a very slight beat frequency. You'll find, too, that this discrepancy will change slighty with the temperature and humidity.

Don't let this bother you, though. Even the pitches in ordinary acoustical instruments will change slightly with the weather, but because of the special tone coloring of each instrument, this discrepancy is rarely noticed.

The same with the synthesizer. Once you've added tone coloring with the VCF and especially such things as vibrato and/or tremolo, this discrepancy can't be heard.

1-10-14 Minimizing the discrepancy . . . . .

The best way to minimize the discrepancy mentioned above is to tune the highest possible note on the keyboard.

For example, if you can tune the highest A accurately to the desired pitch, the notes lower than this, being lower in frequency, would cause the discrepancy to be much less noticeable.

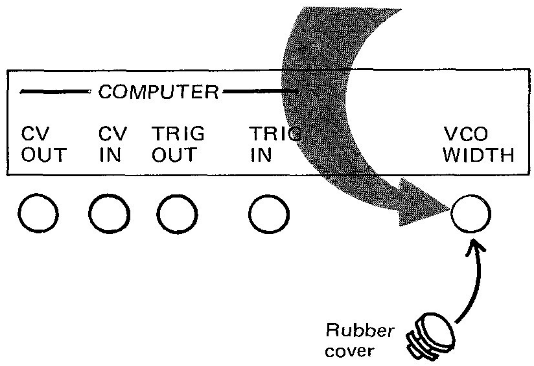
1-10-15 Adjustment . . . . .

If the discrepancy above does become noticeable, then the VCO WIDTH control under the rubber cover on the back of the synthesizer needs adjustment, but **DO NOT TOUCH THIS CONTROL.**

It is virtually impossible to set this control properly without the necessary electronic instruments. Even a tiny change in this control produces a great change in the VCO frequency width and your synthesizer will act as it did in 1-2-8 (p. 8) or 1-2-12 (p. 9).

(If you have the necessary equipment, refer to the service manual for proper adjustment).

Fig. 1-74 Back panel of 101



1-10-16 Review of tuning

1. The STANDARD test OSCILLATOR is used as a comparison for tuning the VCO (1-10-0)
2. Tuning is easiest when tuning to unison and using similar wave forms (1-10-2).
3. Tuning is accomplished by adjusting the VCO FREQUENCY and FINE TUNING controls until the beat frequency disappears (1-10-2).
4. Intervals other than unison create weaker beat frequencies (1-10-10).
5. Tuning can be used to compensate for transposing parts (1-10-8).

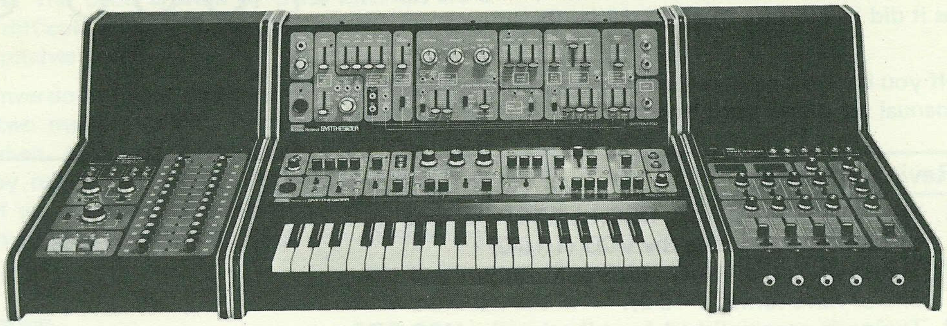
2. ELEMENTS FOR EXPANDING THE SYNTHESIZER

This section of the manual is a brief survey of some of the accessories you can use with your synthesizer to get more out of it.

2-1-0 Elements of the System 100

Fig. 2-1 System 100

MONITOR SPEAKER 109 EXPANDER 102 MONITOR SPEAKER 109



SEQUENCER 104 SYNTHESIZER 101 MIXER 103

2-1-1 The Model 102 Expander Unit . . . . .

The Model 102 Expander Unit doubles the basic synthesizer elements and more than doubles the possibilities for sound synthesis. Some of these possibilities have already been mentioned in the previous section.

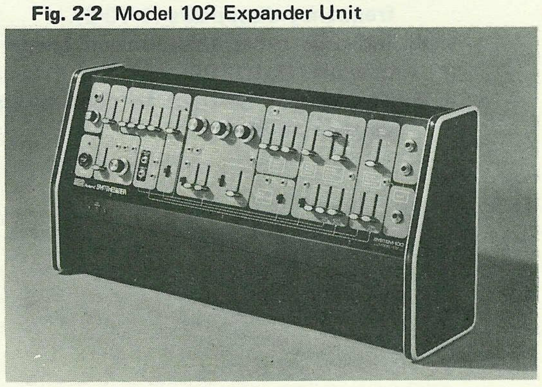
With the additional VCO, VCF, VCA, and ADSR more complicated sounds can be made.

The two VCO's can be tuned to some musical interval for playing melodies in parallel motion.

Two different patches can be set up at the same time for unison or parallel playing.

Besides the basic elements, the 102 Expander also has a RING MODULATOR for producing clear bell-like sounds and a SAMPLE & HOLD section for producing voltage sequences, either in a fixed pattern, or completely at random.

Fig. 2-2 Model 102 Expander Unit



2-1-2 The Model 103 Audio Mixer . . . . .

This is a four channel input, stereo output mixer, ideal for making synthesizer tapes, especially when used in conjunction with a four channel tape deck. (Four channel recording methods are discussed in the MODEL 103 AUDIO MIXER INSTRUCTION MANUAL). It has a built-in reverberation unit and provisions for connection to an external echo chamber, and panning controls for each of the input channels.

Fig. 2-3 Model 103 Audio Mixer

2-1-3 The Model 104 Sequencer . . . . .

This is a 2 channel, 12 step sequencer which can be programmed to run musical sequences of up to 24 notes, or duets of up to 12 notes (with two VCO's). It is especially handy for musical patterns which repeat themselves.

With a pulse shaper, pulses recorded on tape can be used to trigger the sequencer so that 12 and 24 note groups can be recorded one after another in perfect rhythm.

Fig. 2-4 Model 104 Sequencer

Since the sequencer produces nothing more than a sequence of voltages (which are set by the two rows of knobs on the right half of the panel), it can be used in special applications such as in generating odd shaped envelopes which would be impossible with the ADSR circuits.

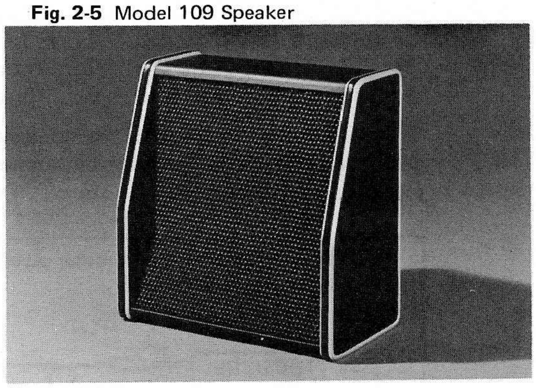


Fig. 2-5 Model 109 Speaker

2-1-4 The Model 109 Speaker Set . . . . .

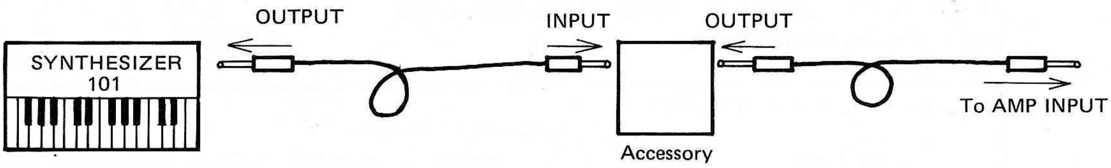
This is a pair of 16 cm speakers enclosed in cases which match the other units in the system.

(The photo at the right shows one of the pair).

2-2-0 Accessories

There are many accessories which can be used with the System 100. In most cases, an accessory would be connected as shown in fig. 2-6.

Fig. 2-6 Connecting accessories



2-2-1 Echo . . . . .

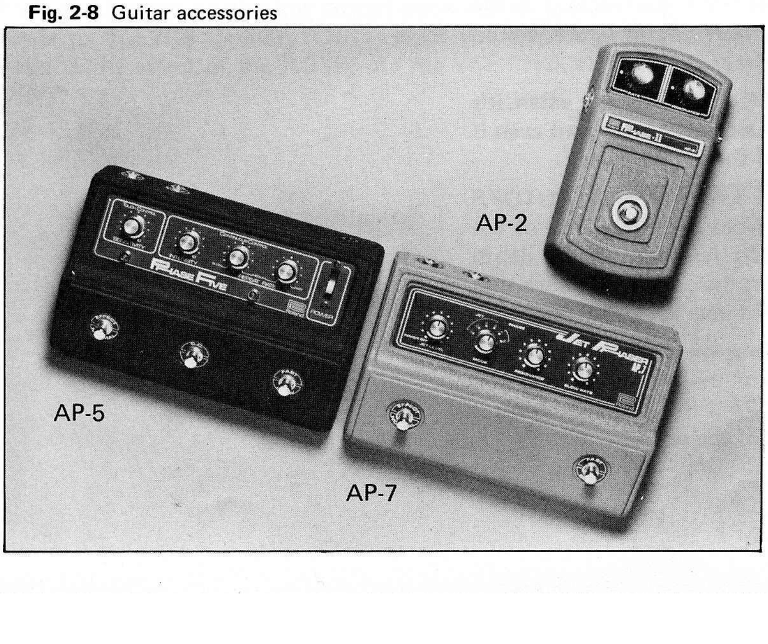
An echo chamber such as the ROLAND RE-201 can add great depth to your sound, especially in arpeggio-like passages.

Fig. 2-7 ROLAND RE-201 Echo Chamber

2-2-2 Guitar accessories . . . . .

Some of the accessories made for electric guitars can be very effectively used with your synthesizer. The best effects are usually produced by fuzz units and phase shifters. A few are shown below.

Fig. 2-8 Guitar accessories



2-2-3 Expression pedal . . . . .

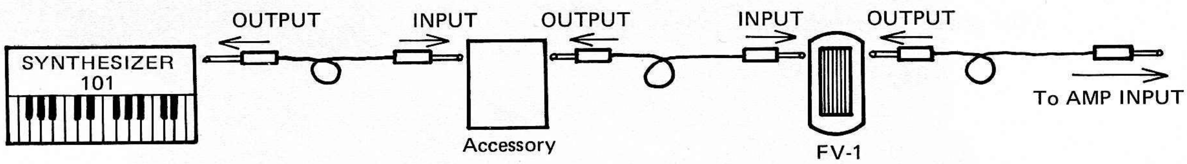
The ROLAND FV-1 Foot Volume control can be used to give dynamic expression to your music.

If you use the foot pedal in conjunction with other accessories, it would usually be connected last in line, just before your amplifier, as shown in fig. 2-10.

Fig. 2-9

FV-1

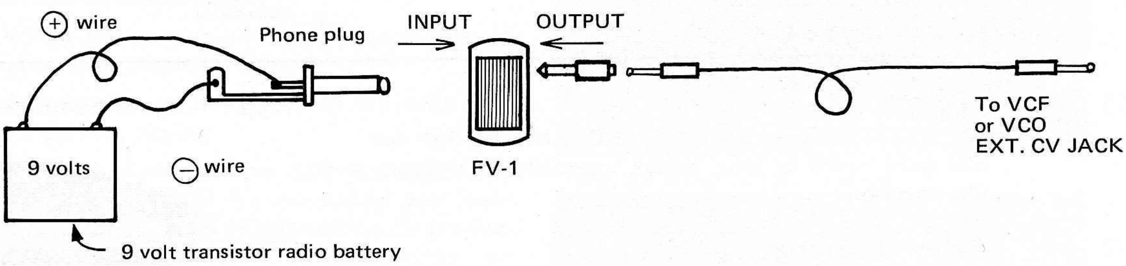
Fig. 2-10 Using the FV-1 with other accessories



When using the FV-1 with an echo chamber, the FV-1 can be connected before or after the echo chamber, depending on the effect you want; or use two FV-1's: one before and one after the echo chamber.

If you connect a 9 volt transistor radio battery to the input (INSTRUMENT) of the FV-1, as shown in fig. 2-11, you can connect the OUTPUT to the EXT CV jack of the VCF to allow foot control of the VCF cutoff point for many varied effects.

Fig. 2-11 Foot control of the VCF and VCO



CAUTION: Be sure that you connect the battery to the input (INSTRUMENT) side of FV-1. Connecting to the OUTPUT side may cause a short circuit which would immediately and completely drain your battery.

Also, don't forget to disconnect the battery when it's not in use. This arrangement uses battery current even if the patch cord is pulled out of the EXT CV jack.

Wired as shown, you should keep the VCF CUTOFF FREQUENCY control away from the HIGH end of the scale. The EXT CV/LFO slider will control the depth of the effect the pedal has on the sound. (Be sure that the EXT CV/LFO switch is in the EXT CV position).

If you change the plus and minus wires around, then you will have an inverted control of the tone color, and you should keep the VCF CUTOFF FREQUENCY control away from the low ("0") end of the scale.

You can also connect the OUTPUT of the FV-1 to the EXT CV INPUT jack of the VCO for foot control of the VCO frequency. Wired as shown in fig. 2-11, keep the VCO FREQUENCY control nearer the low end of the scale. Depressing the pedal raises the frequency. The EXT CV slider controls how far up the frequency will go.

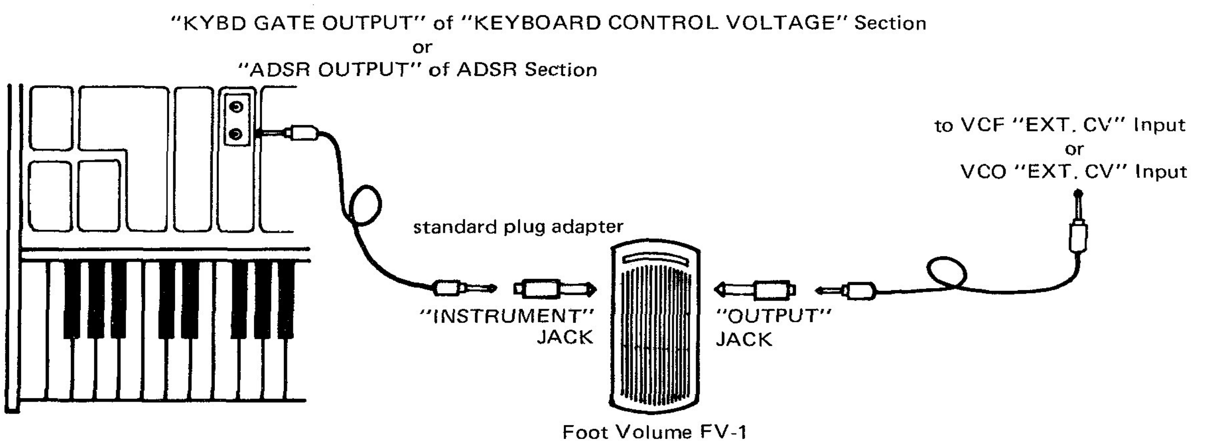
If you change the plus and minus wires around, the effect will be exactly the opposite.

With the controls properly adjusted, this arrangement can be used as a foot operated pitch bender.

One other thing you might try while experimenting:

With the OUTPUT of the FV-1 connected to either the VCO or the VCF, try connecting a patch cord between the FV-1 input (INSTRUMENT) and the KYBD GATE OUTPUT jack in the KEYBOARD CONTROL VOLTAGE section or with the ADSR OUTPUT jack in the ADSR section.

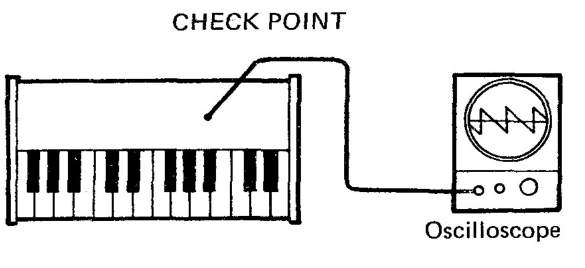
Fig. 2-12



2-2-4 **The oscilloscope . . . . .**

An oscilloscope is an electronic instrument which diplays wave forms on its screen, the screen being much the same as a television picture tube. Using one is an excellent way of monitoring the synthesizer output wave forms. Connect it to the VCA CHECK POINT; or, if you want to minimize the effect of the ADSR, use the VCF CHECK POINT.

Fig. 2-13



3. RECORDING SYNTHESIZER MUSIC

The following is a brief outline of some of the principles and techniques used in recording synthesizer music.

3-1-0 Basic recording priciples

The basic method for recording a synthesizer tape is to record one voice (melody line) on tape, then move the tape back to the starting point and record the second voice while listening to the first. The tape is then moved again back to the starting point for adding the third voice (while listening to the first two), and so on, until all the parts are recorded.

3-1-1 Starting a synthesizer studio . . . . .

If you have a hi-fi system which includes a tape deck (or tape recorder), then you have a very good start at building a synthesizer studio. What you can do with this system will depend pretty much on what kind of tape deck you have.

3-2-0 Tape decks

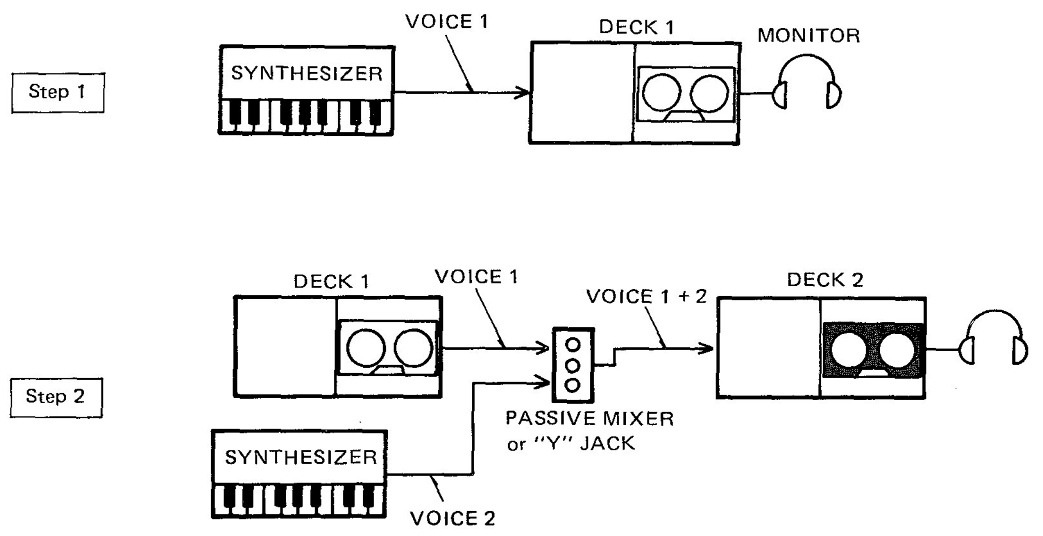
3-2-1 One mono tape deck . . . . .

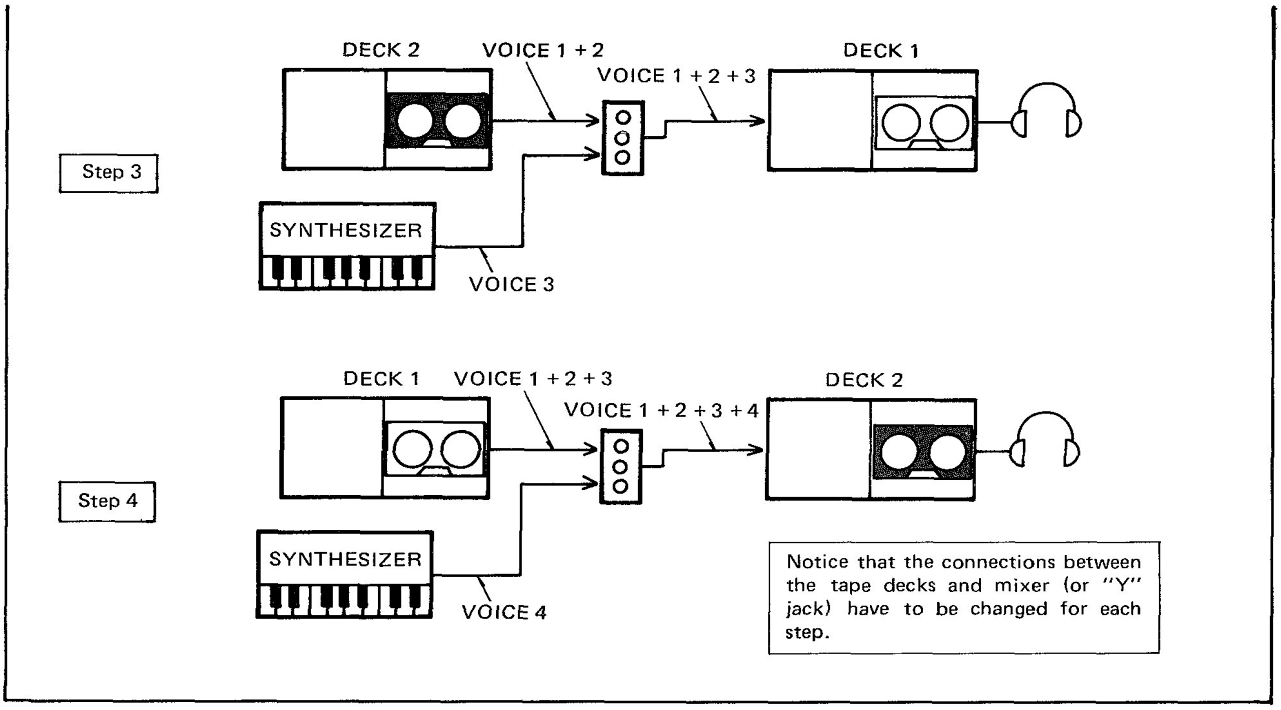
With one mono tape deck you can record one voice on tape; then, while listening to it, play a second voice on the synthesizer.

3-2-2 Two mono tape decks . . . . .

Fig. 3-1 shows how to use two tape decks (cassette or open reel) for recording tapes.

Fig. 3-1 Mono recording with two mono tape recorders (cassette or open reel)





Notice that the connections between the tape decks and mixer (or "Y" jack) have to be changed for each step.

A passive mixer is a mixer which requires no power supply. The output signal level will always be the same or less than the input signal level; it can never be greater.

The opposite of a passive mixer is an active mixer (like the Model 103 Audio Mixer), which requires some power source. Its output signal level can be greater than its input signal.

Passive mixers are usually much less expensive than active mixers.

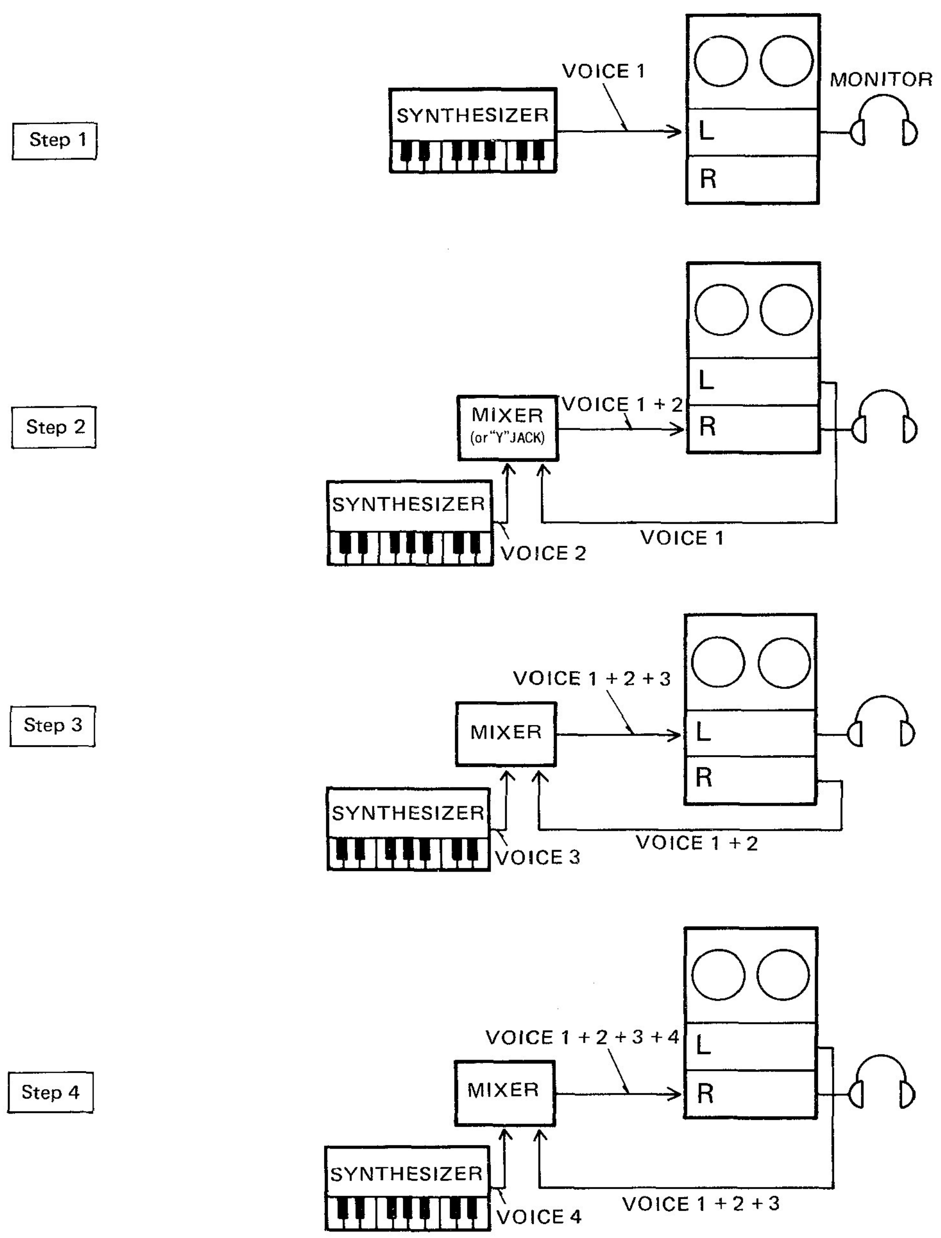
A "Y" plug is a device which allows you to connect two plugs to the same jack. With a "Y" plug, use the play and record level controls on the tape decks to get proper mixing balance.

3-2-3

One stereo tape deck . . . . .

Most modern stereo tape decks are equipped for sound-on-sound or sound-with-sound operation and can be used as shown in fig. 3-2.

Fig. 3-2 Sound-on-sound or sound-with-sound stereo tape recorder

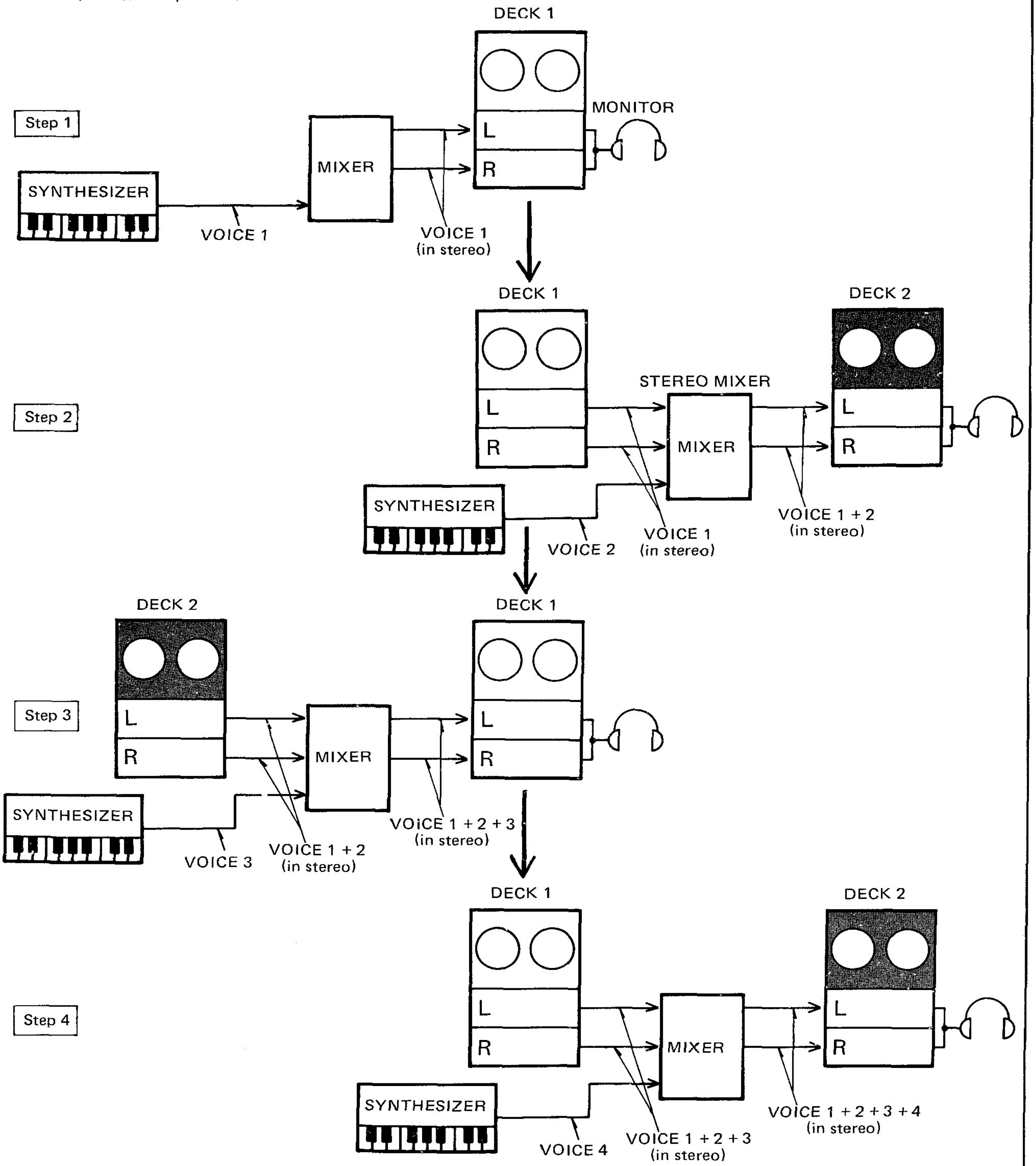


Most three head stereo tape decks can be used in the same way if they have provision for recording on only one channel at a time.

3-2-4 **Two stereo tape decks . . . . .**

Fig. 3-3 shows how to use two stereo tape decks (cassette or open reel) for making stereo tapes.

Fig. 3-3 Stereo recording with two stereo tape recorders (cassette of open reel)



3-2-5 **One four channel tape deck . . . . .**

A four channel tape deck can be used in the same way as two stereo decks (fig. 3-3) by thinking of the front channels as DECK 1 and the rear channels as DECK 2, and bouncing the signal back and forth between them.

3-2-6 **One four channel tape deck with a second deck . . . . .**

If the four channel tape deck is equipped for synchro-track, you can record voices separately on each track, then play the tape back through a mixer to the second deck. The result can be mono or stereo, depending on the second deck.

(The MODEL 103 AUDIO MIXER INSTRUCTION MANUAL contains notes on recording with a four channel deck).

4. STEP-BY-STEP RECORDING EXAMPLES

In this section we present two step-by-step recording experiments. You'll find the musical examples on the pages following Patch 48 in the MODEL 101 SYNTHESIZER PATCH BOOK.

The rock example is a typical rock 'n' roll accompaniment figure with two blank melody lines for you to improvise.

The *Haydn Serenade* was chosen for the classical example because it is well known and liked by rock fans as well as classical fans.

Fig. 4-1 Recording Step 1

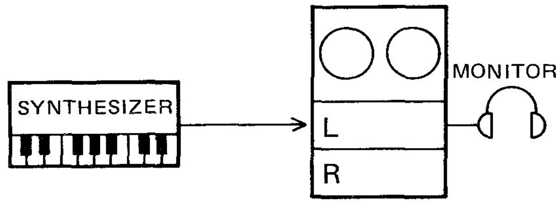
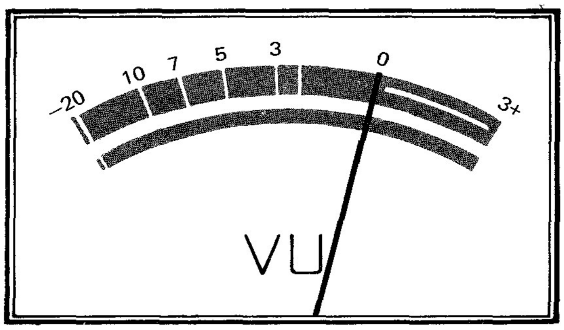


Fig. 4-2



4-1-0 Preliminaries

The recording procedures for both musical examples are pretty much the same, but we will consider the Haydn Serenade first because it has no improvising.

4-1-1 The tape . . . . .

For practice recording sessions any tape will do.

For recordings you want to preserve, use new tape, or use a bulk tape eraser. This will prevent the possibility of previously recorded material from being imperfectly erased and ruining your new recording. (Even a brand new good quality tape deck may not be able to completely erase a strongly recorded signal).

4-1-2 An important point . . . . .

Each time you re-copy a taped voice, you lose some of the original sound volume as well as some of the sound quality. For this reason, use the best tape you can afford to buy and use your deck's highest recording speed.

4-1-3 The tape deck . . . . .

Since they are so common, we will outline the procedures for using a stereo tape deck as shown in fig. 3-2 (p. 62).

4-1-4 The test signal . . . . .

Connect the OUTPUT of the synthesizer to the LEFT channel LINE IN on your tape deck (fig. 4-1).

Set the RECORD LEVEL at about its center point.

Activate the STANDARD test OSCILLATOR and adjust the OSCILLATOR LEVEL so that the LEFT VU meter reads "0" (fig. 4-2).

4-1-5 Recording the test signal . . . . .

Thread the tape and record about fifteen seconds of the test signal at "0" VU meter reading.

The test signal is helpful for setting record and playback levels when dubbing copies. It can also be used as a tuning check, although this is rarely necessary since the test oscillator will remain accurate for long periods of time.

4-2-0 Recording the Serenade

In our example, we will try to retain the feeling of Haydn's string quartet.

4-2-1 Deciding the first voice . . . . .

The best voice for recording first will be the voice with the fewest breaks in rhythm.

Since re-copying of voice lines loses a certain amount of sound volume and sound quality (4-1-2), the melody line should be saved for last, if possible.

The bass line is also often important so, if possible, it should be recorded second to last.

In the Haydn Serenade, both inner voices are perfect for recording first because the rhythm is steady and unbroken, like the ticking of a clock. Since they are both rhythmically the same, and both are more or less of equal importance, the decision can be made freely.

For the test tape we made in our laboratory, we started with the Viola part.

4-2-2 Tuning . . . . .

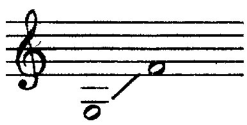
Tune the VCO so that middle A on the keyboard is 440 Hz. and set Patch 32 (Viola, pizzacato).

4-2-3 The recording level . . . . .

Because of the losses when copying voice lines, even though the Viola part is marked *p*, it should be recorded as near "0" VU (*ff*) as possible.

The pizzacato envelope is too short to give accurate VU readings, so raise the ADSR SUSTAIN level control to "10". The idea is to set the recording level so that playing any note within the range of the Viola part will produce "0" or less on the VU meter.

Transposed to the treble clef, the range of the Viola part is:



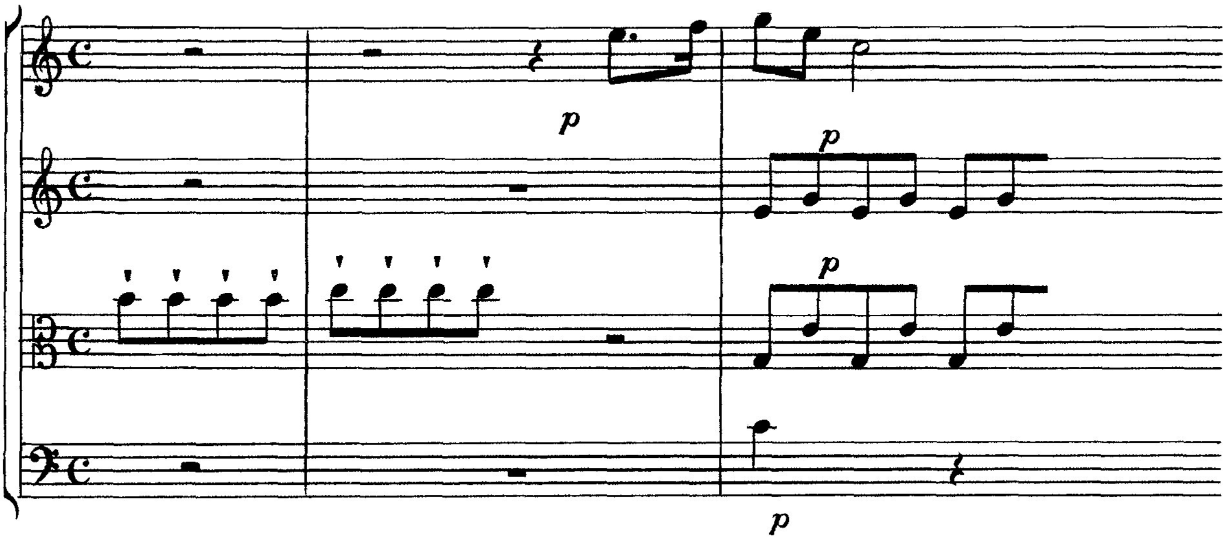
While holding down the F key (and with the tape deck RECORD LEVEL at about mid point), adjust the VCA ADSR control for "0" VU. Now try the G key below and the keys in between, and if necessary, readjust the VCA ADSR control so that the VU meter doesn't go over "0".
Move the ADSR SUSTAIN level back down to "0".

4-2-4 Determine the VU reading . . . . .

Play the first few notes of the Viola part and make a note of how far up the VU meter needle jumps. This reading is needed later.

4-2-5 The time "tic" . . . . .

In the Serenade, the Violin I part begins before the other parts. To get around this, we will record a rhythmic time "tic" so that the total effect of the finished tape (before final editing) will sound like this:



The "tic" notes should be very short so that the rhythm is very clear and easy to follow. The amount of time between the last "tic" note and the first melody note should be long enough so that when editing the final copy, the "tics" can be omitted. (In this example, the one beat is enough).

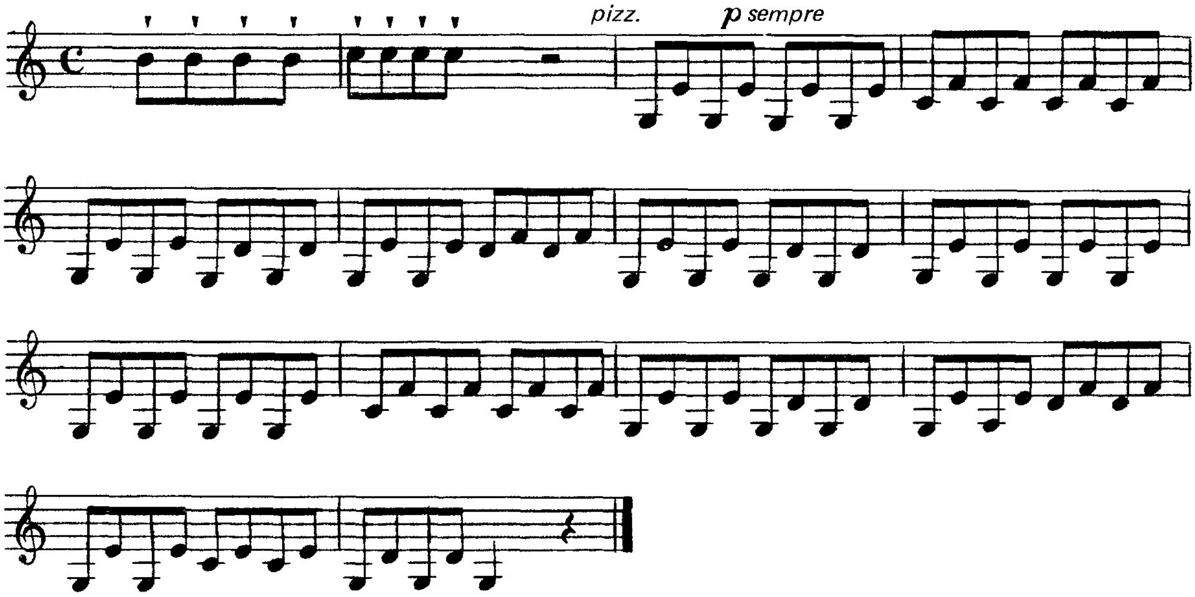
The change in pitch is a handy indication for the first beat in the second measure.

The pizzacato viola sound is excellent for recording time "tics", so they can be recorded in the same operation with the Viola part itself. (See 4-4-2 for non-pizzacato envelopes).

4-2-6 **Practice . . . . .**

Run through the Viola part several times for practice and concentrate especially on keeping the rhythm as even as possible.

The Viola part is reproduced below (with the time "tics"), transposed to the treble clef.



4-2-7 **Recording the first voice . . . . .**

Record the Viola part, including the time "tic". Start the recording a few seconds after the 440 Hz. test signal (recorded in 4-1-5). Keep the rhythm as steady as possible because all the following parts depend on it.

4-2-8 **The result . . . . .**

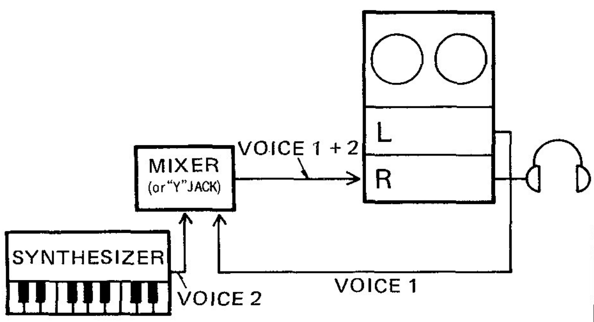
Play back the result and listen very critically. If there is even the slightest hesitation in the rhythm, this will throw all the other parts off. Be especially critical of the timing in the half measure of rest.

It may be necessary to record the part five or six times or more before it is perfect.

The amount of criticism you apply now will determine the quality of the finished tape. (It goes without saying that it would be rather wasteful of time and effort to be too critical of a tape which is being used only for testing some effect or for experimentation).

If you are satisfied with the result or your recording, reconnect the system for the next step (fig. 4-3).

Fig. 4-3 Recording Step 2



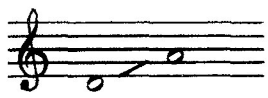
4-2-9 **The second voice . . . . .**

Play the tape and adjust the LEFT channel OUTPUT LEVEL so that the LEFT VU meter reads near the value previously noted in 4-2-4. (When using non-pizzacato type envelopes, adjust so the VU meter reaches "0", but rarely goes over).

Check to make sure that the VCO is still tuned so that middle A is 440 Hz. and set Patch 35 (Violin, pizzacato) for recording of the Violin II part.

4-2-10 **Balancing the parts . . . . .**

The range of the Violin II part is:



Play some notes within the range of the Violin II part while at the same time listening to the Viola part on the tape. The idea is to adjust the VCA ADSR control and the RIGHT channel RECORD LEVEL so as to produce the proper dynamic balance between the two parts and at the same time reach a setting which makes the RIGHT channel VU meter deflect to the value noted in 4-2-4 when both viola and violin notes are struck together. (When using non-pizzacato envelopes, adjust for "0" VU).

In the Haydn Serenade, both the Viola and Violin II parts are marked *p*, so the controls can be adjusted so that both sound more or less equal in loudness.

4-2-11 **Practice . . . . .**

Play through the Violin II part a few times; then play the tape, including the time "tics", and practice playing the Violin II part with the Viola part.

It is particulary important to get the two parts to start at exactly the same time. It may help to replay the "tics" on the synthesizer while you listen to the recorded "tics".

4-2-12 **Record the Violin II part . . . . .**

When you are satisfied with your practice runs, try recording. Be sure to start the tape so that all the time "tics" are copied onto the new track. Don't play along with the "tics" when recording as this may cause the "tics" on the new track to become confused. (It's not necessary to re-record the test signal).

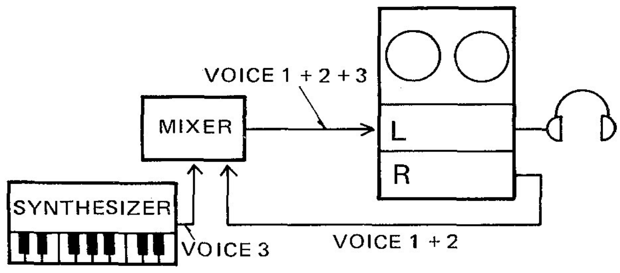
4-2-13 **The result . . . . .**

Listen very critically to the result. Again, it may take quite a few tries to get it exactly right.

If you are satisfied with the result, reconnect the system for the next step (fig. 4-4).

As the tape now stands, the LEFT channel contains the Viola part and the RIGHT channel contains the Viola part + the Violin II part. The next step will be to record the Viola + Violin II parts mixed with the bass part on the LEFT channel.

Fig. 4-4 Recording Step 3



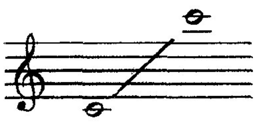
4-2-14 **The third voice . . . . .**

Play the tape and adjust the RIGHT channel OUTPUT LEVEL so that the RIGHT channel VU meter reads the value noted in 4-2-4 (or "0" VU for non-pizzacato envelopes).

Tune middle A to 110 Hz. (or tune the high A to one octave below the 440 Hz. test signal) and set Patch 7 ('Cello, pizzacato).

The range of the bass part is:

Transposed to the treble clef (with middle A = 110 Hz.), this becomes:



4-2-15 **Balancing the parts . . . . .**

Play some notes within the range of the bass part while listening to the recorded parts. Try to reach a setting of the controls which will give you the dynamic balance you want without going over the previously noted VU meter reading (4-2-4) (or "0" VU with non-pizzacato envelopes).

4-2-16 **Practice . . . . .**

Make a few practice runs with the bass part. The bass part is reproduced below transposed to the treble cleff (with middle A = 110 Hz.).

4-2-17 Record the bass part . . . . .
When you are satisfied with your practice runs, record the bass part.

Reconnect the system for the next step (fig. 4-5).

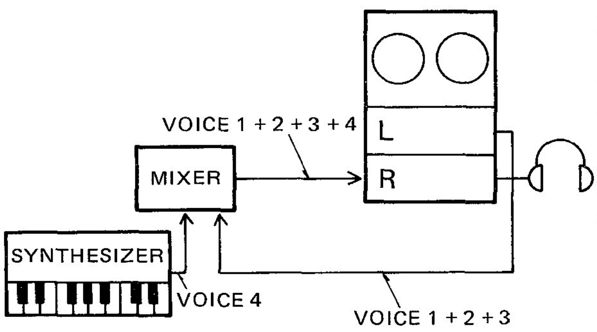


Fig. 4-5 Recording Step 4

4-2-18 The melody . . . . .
Play the tape and adjust the LEFT channel OUTPUT LEVEL so that the LEFT VU meter reads the value noted in 4-2-4 (or "0" VU, as before).

Tune middle A to 440 Hz. and set Patch 34 (Violin). The range of the Violin part is:

4-2-19 Balancing the parts . . . . .
Adjust the controls so that the parts are balanced to your liking. Although the Violin I part is marked to be played *p*, you may want to play·it slightly louder in relation to the other parts so that the melody stands out more clearly.

If this tape is to be a master tape from which copies will be made, then adjust so that the RIGH VU meter jumps up to the value noted in 4-2-4.

If this tape is to be the finished product itself, then you should record the last step at less than the 4-2-4 value to give the proper relationship to the dynamics. First, set the controls so the RIGHT VU meter produces the 4-2-4 reading, play the tape (and the Violin I part on the synthesizer), and adjust your amplifier volume control so that the music sounds loud (*f* or *ff*). Now, without changing the amplifier volume control, reset the controls for proper balance between the parts and so that the total sounds *p* or *mp* in relation to the *f* sample you just heard.

4-2-20 Practice and record . . . . .
Make a few practice runs and record the melody.

If you are satisfied with the result, your tape is ready for editing.

4-2-21 Editing . . . . .
If this is to be the master tape, editing means making a copy with the time "tics" and test signal omitted and at a reduced recording level to get the relative *p* or *mp* feeling.

If this is the finished tape, editing means taking scissors and cutting out the time "tics" and the test signal.

4-3-0 The rock music

The recording of the rock music is the same as the Haydn Serenade except for a few differences pointed out below.

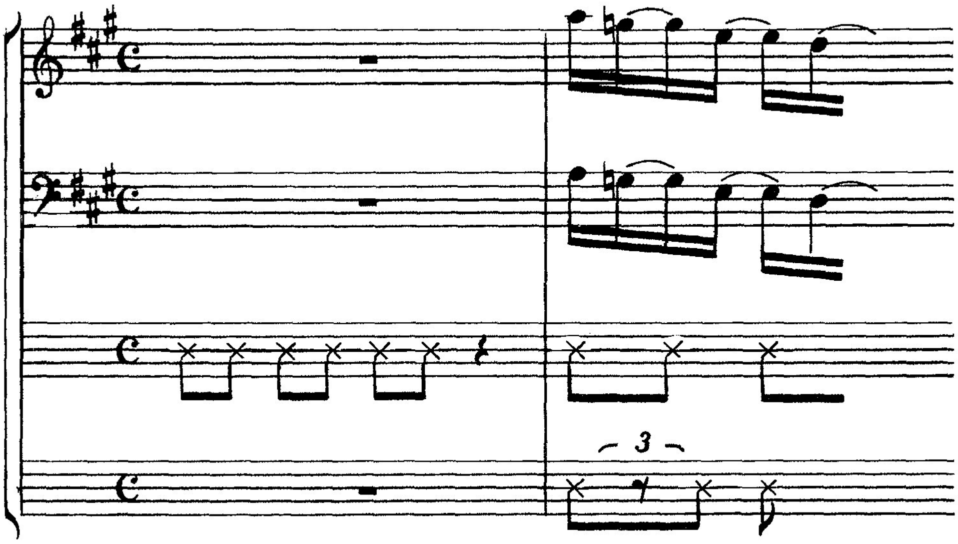
4-3-1 The first voice . . . . .

The Cow Bell part (Patch 9) is perfect for the first voice because the rhythm is steady and unbroken.

4-3-2 The time "tic" . . . . .

Since the Cow Bell patch has a short attack time (ATTACK control at "0"), it will produce a "tic" which is rhythmically easy to follow.

The total effect of the finished tape (before editing) will be like this:



4-3-3 Recording level . . . . .

The decay/release times are long enough that you can use "0" VU or slightly less.

4-3-4 The other parts . . . . .

The Bass Drum part (Patch 2) would probably be good for the next step because the other two parts involve improvising.

You may find it easier to improvise the counter melody of the Bass Guitar II part (Patch 4) after the Wah Sound melody (Patch 36) has been recorded.

4-4-0 General comments

The following are some additional points related to recording.

4-4-1 Dynamic balance . . . . .

Fig. 4-6 shows the dynamic marks for a hypothetical four part composition.

If Part C is recorded first, it should be recorded at or near "0" VU even though it is marked *p*.

The remaining parts should be combined with Part C so that each part sounds at the correct dynamic level in relation to the other parts, while still recording at "0" VU.

For example, if Part D is next, the controls should be adjusted so that Part C sounds *p* in relation to the *mf* of Part D, but with the recording VU meter at or near "0".

If Part B is next, it should be mixed in so as to sound *mp* in relation to the other two parts with "0" VU.

The last voice, Part A, should then be combined so as to sound *f* in relation to the other parts, and the recording VU meter reading will depend on whether this is to be a master tape or the finished product. (See 4-2-19).

4-4-2 The time "tic" . . . . .

If the first voice you record is not suited for the time "tic", then it should be recorded separately as step 1.

The first voice then would be recorded as step 2.

4-4-3 Half speed recording . . . . .

Half speed recording can make difficult passages easier for you to play at the tempo you want.

It works like this:

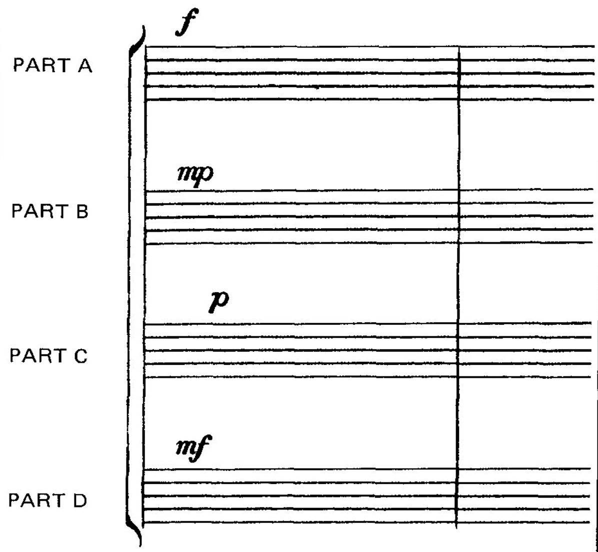
Set the tape deck speed at half speed (3-3/4 IPS, if normal speed is 7-1/2 IPS). Tune the VCO one octave lower than normal (or play one octave lower), and play at half the correct tempo.

When the tape is played back at normal speed, the pitches and tempo will be correct.

You will probably have to make compensations for the speed change. For example, recording at half speed, then playing back at normal speed doubles the recorded frequencies. This means that you will probably have to set the VCF CUTOFF FREQUENCY control a little lower than normal. Also, the LFO FREQUENCY will have to be lowered for a normal sounding vibrato rate. And the attack, decay, and release times will have to be doubled.

All of this can be done with a little experimenting by recording short samples of sound at half speed and listening to the result at normal speed, then resetting the controls.

Fig. 4-6 Hypothetical composition



4-4-4 Recording more than four parts . . . . .

As mentioned before (4-1-2), with each copying of a voice, some of the sound quality and sound volume is lost. This would seem to limit the number of times you can dub a tape before these losses become undesirable. Even with good equipment, five or six times seems to be the limit, depending on how critical you are.

One way of getting around this is to connect a low pass filter to the output of your tape deck. This will cut down on tape noise and, if your voice lines don't contain too many high frequencies, allow you to record as many as fifteen times or more with little loss in sound quality.

5. IN CASE OF DIFFICULTY

5-1-0 Troubles

Most troubles with the synthesizer can be traced to mistakes in control settings. When you strike a key and get no sound, check the following points.

5-1-1 **The test oscillator . . . . .**

Turn the STANDARD test OSCILLATOR LEVEL control up.

If you hear sound, the trouble is with the synthesizer.

If you don't hear sound, the trouble is with your amplifier/speaker system and/or its connections, or your synthesizer may not be getting power.

5-1-2 **The external amplifier . . . . .**

Is the amplifier plugged in and the power switch turned on?

Is the volume control turned up?

Is the cord between the synthesizer and amplifier in good condition? Try wiggling it at each end where it enters the body of the plugs to see if there is a broken connection inside. Check the speaker connections, too.

5-1-3 **Headphones . . . . .**

Is the LEVEL control below the PHONES jack turned up? Is the headphone cord in good condition (no broken connections inside)?

5-1-4 **The synthesizer . . . . .**

Is the power cord plugged in and the POWER switch turned ON?

Is the pilot light lit? (In a very brightly lit room it may be hard to see; use an electrical appliance that you know is working to make sure power is available at the wall socket). If not, the fuse inside may be blown. Your local radio or television repair shop can easily replace it. (Use a fuse rated at 1 A., 250 V or more).

5-1-5 **The VOLTAGE CONTROLLED AMPLIFIER . .**

Is the VCA INITIAL GAIN or VCA ADSR control raised?

5-1-6 **The VOLTAGE CONTROLLED FILTER . . . . .**

Check the VCF CUTOFF FREQUENCY control. At or near "0", you will get little or no sound unless the VCF KYBD CV or VCF ADSR controls are above "0".

5-1-7 **The AUDIO MIXER . . . . .**

Check to make sure that the proper sliders are raised.

If they are all at "0", there will be no sound.

5-1-8 **The ENVELOPE GENERATOR . . . . .**

Check that the ADSR controls are not all at "0".

Remember that patch cords plugged into the EXT GATE INPUT or EXT CV INPUT jacks will cut off the internal circuit connections to the ADSR. (See 1-5-46).

5-1-9 **The VOLTAGE CONTROLLED OSCILLATOR . . . . .**

If the VCO FREQUENCY control is set at or near 10 HZ., and a low key on the keyboard struck, the frequency of the sound produced may be too low to hear.

Also, with the VCO FREQUENCY control at 10 KHZ., striking a high key may produce a sound too high to hear.

5-1-10 **Patch troubles . . . . .**

If you have trouble obtaining sounds with the patch diagrams, check and double check that all settings are as shown on the diagram.

It may help to set Patch 1 (Basic Patch) and start from there.

5-2-0 Cautions

The test oscillator and the VCO are very stable and should go quite a long time before needing the attention of the repair man. The following cautions will help maintain this stability.

5-2-1 **Avoid temperature extremes . . . . .**

Keep the synthesizer away from heaters and coolers.

Changes in temperature will cause the test oscillator and the VCO to drift off frequency slightly, causing inconveniences during recording sessions.

5-2-2 **Keep dust away . . . . .**

Use a cloth or plastic sheet for a cover when the system is not in use.

5-2-3 **Cleaning . . . . .**

Dust the panel and keyboard with a soft clean cloth.

A damp (but not wet!) cloth and a mild detergent can be used for tough dirt and grease stains. **UNPLUG THE SYNTHESIZER FIRST!** Keep moisture out ot the inner parts.

5-2-4 **Waxing . . . . .**

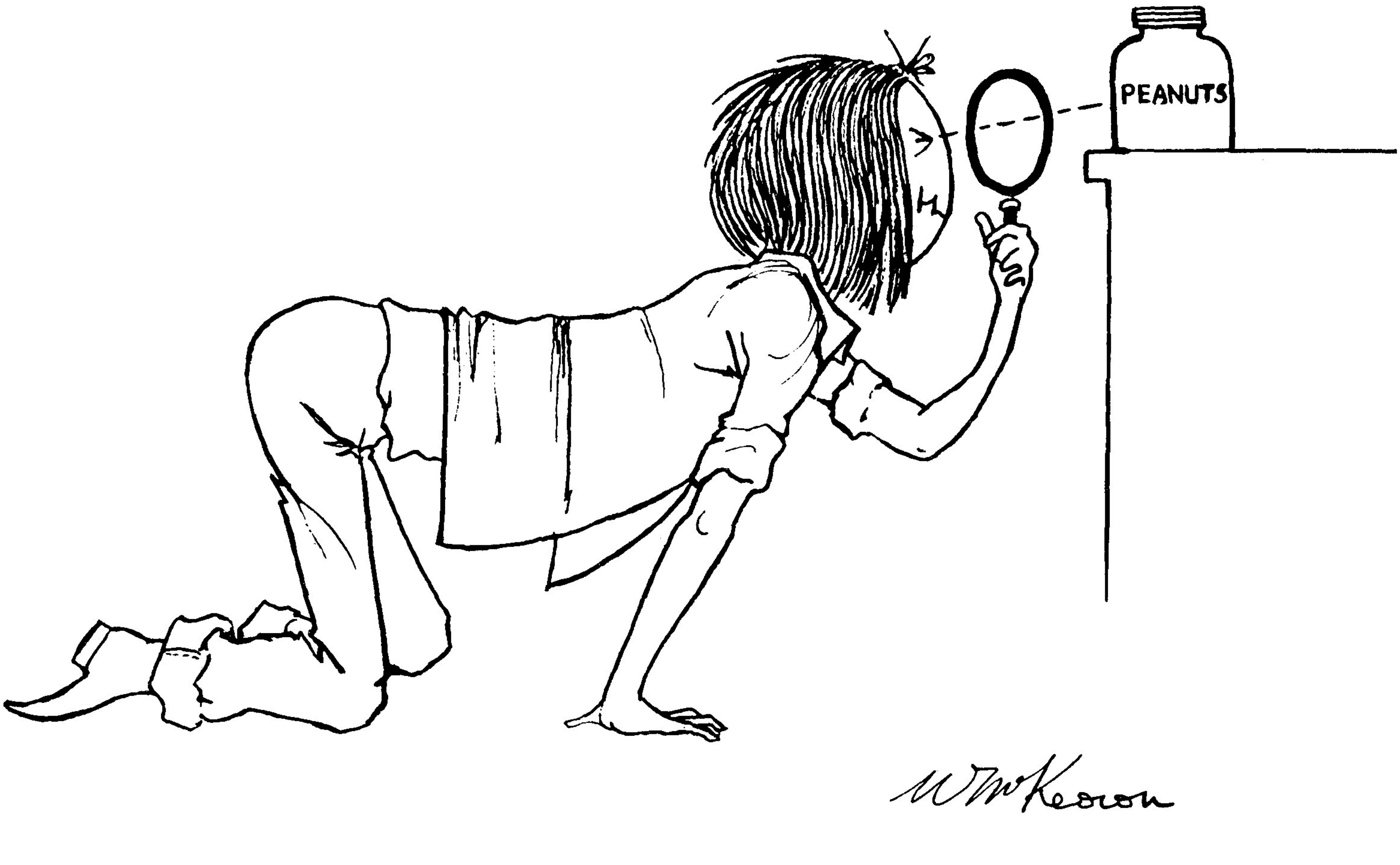
If you want to wax the front panel, be careful to keep the wax out of the jacks, and switch and slider slots. Waxing the panel can improve the appearance and make the finish last longer.

5-2-5 **Idle periods . . . . .**

When your synthesizer will not be in use for a long period of time, unplug the power cord.

5-2-6 **Don't eat peanuts . . . . !**

While working with your synthesizer, don't nibble at salty snacks such as pop corn or peanuts. Salt is a good conductor of electricity and will cause trouble with your patches.



THE LAST WORD.....

A lot of time and effort has gone into the design and preparation of the System 100 Synthesizer, its accompanying instruction manuals and patch books. If you have any suggestions, ideas, questions, problems, complaints, praise, etc., please feel free to write directly to:

Synthesizer Project Manager
Roland Corporation
3-2-26, Shinkitajima
Suminoe-ku
Osaka, JAPAN

It may not be possible to reply to all letters, but all letters will be read and given due consideration by all staff members of the synthesizer division.

SPECIFICATIONS

MODEL-101 SYNTHESIZER

1. VCO (Voltage Controlled Oscillator)
   - Frequency Range : 3Hz-40KHz
   - VCO Output : 10Vp-p
   - VCO Sync. Output : Square Wave

   CONTROLS
   - WAVE FORM : Triangular, Sawtooth, Square, Pulse Wave (Pulse Width Controlled)
   - FREQUENCY : 10Hz-10KHz (at A2 key) continuously variable
   - FINE TUNING : 1 oct.
   - PULSE WIDTH : 5%-50% (MANUAL, ADSR, LFO)
   - EXT. CV/LFO : 1V/oct.

2. NOISE GENERATOR
   - Pink or White
   - Noise Output : 10Vp-p

3. AUDIO MIXER
   - Ext. Input Impedance : more than 50KΩ

   CONTROLS
   - VCO, NOISE, EXT. INPUT

4. HIGH PASS FILTER
   - HPF Cutoff Frequency : 10Hz-10KHz

5. VCF (Voltage Controlled Filter)
   - Cutoff Frequency Range : 20Hz-100KHz

   CONTROLS
   - VCF CUTOFF FREQUENCY : 20Hz-20KHz
   - RESONANCE : O- self oscillation
   - LFO/EXT. CV : 1V/oct.
   - KYBD.CV
   - ADSR

6. VCA (Voltage Controlled Amplifier)

   CONTROLS
   - INITIAL GAIN
   - LFO
   - ADSR

7. ENVELOPE GENERATOR (ADSR)
   - ADSR Output : +6V (contour peak)
   - Ext. Env. Input : same as above
   - Ext. Gate Input : + 14V
   - ADSR Trig. : KYBD Gate or LFO

   CONTROLS
   - ATTACK Time : 0.4msec.-3sec.
   - DECAY Time : 0.8msec.-6sec.
   - SUSTAIN Level : 0-100% (contour peak)
   - RELEASE Time : 0.8msec.-6sec.

8. LFO (Low Frequency Oscillator)
   - Wave Form : Sawtooth, Sine Wave, Square Wave

   CONTROL
   - LFO FREQUENCY : 0.15-25Hz

9. GLIDE
   - AUTO GLIDE (Key Trig. ON/OFF) : Semitone
   - GLIDE MANUAL :

10. KEYBOARD CONTROL VOLTAGE
    - KYBD CV Output : 1V/oct.
    - KYBD Gate Output : +14V

    CONTROL
    - PORTAMENTO : 0-2.5sec.

11. STANDARD OSCILLATOR
    - A-440Hz Sine Wave

12. AUDIO SIGNAL OUTPUT
    - High Output : 3Vp-p with 1KΩ output impedance.
    - Low Output : 0.3Vp-p with 1KΩ output impedance.

13. HEAD PHONE OUTPUT
    - 0.3V max into standard 8Ω stereo headphones.

14. KEYBOARD
    - 37-key

15. FOR COMPUTER (rear panel)
    - CV INPUT : 1V/oct.
    - CV OUTPUT : Keyboard Control Voltage 1V/oct.
    - TRIG. INPUT : +14V
    - TRIG. OUTPUT : +14V

16. DIMENSIONS AND WEIGHT
    - Overall Size : 610mm (24") wide, 355mm (14") deep, 145mm (5-3/4") high.
    - Net Weight : 9Kg. (19.8 lbs.)

17. POWER REQUIREMENTS
    - 100-120V 50-60Hz / 220-250V 50-60Hz : 10W max.

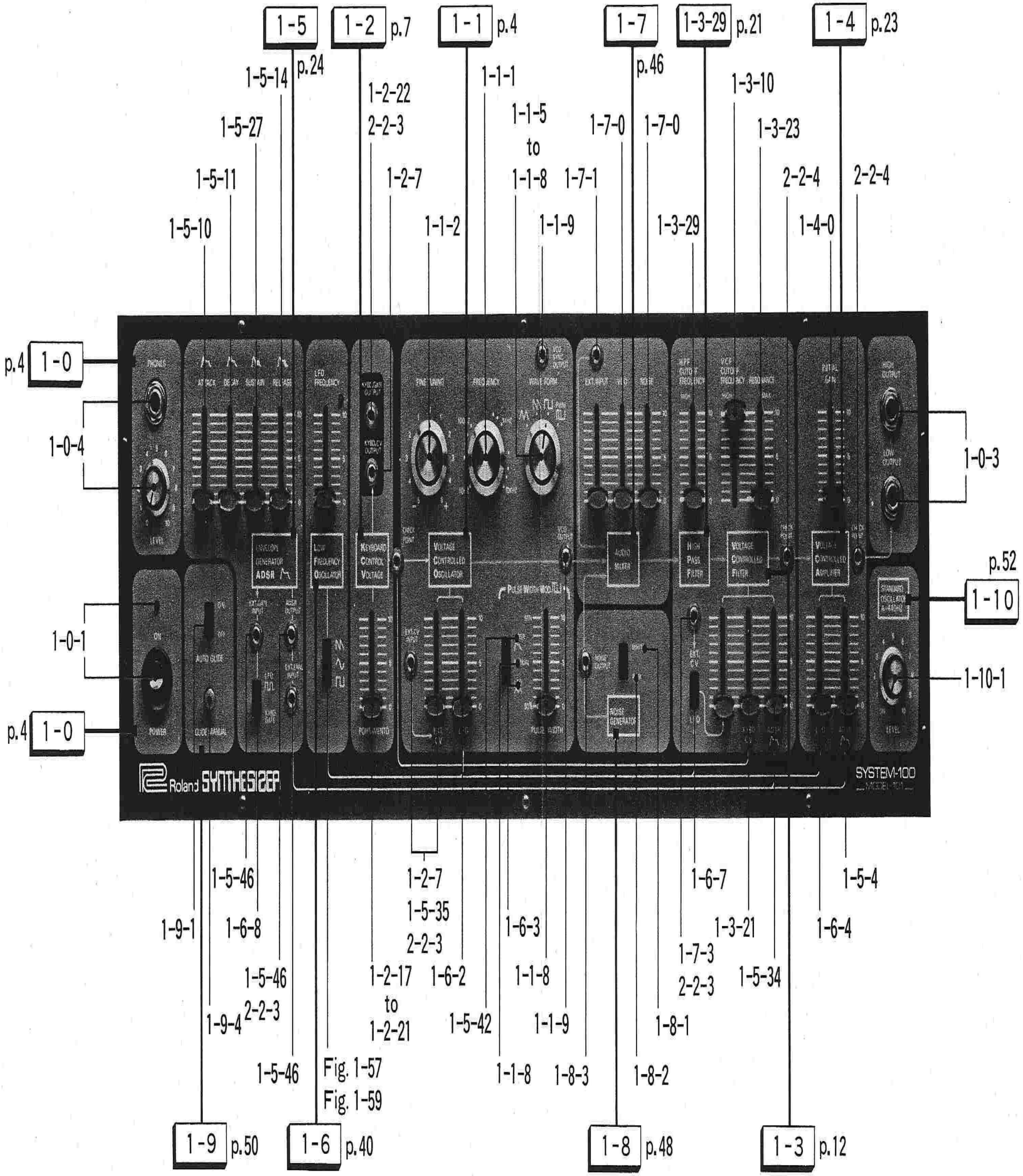
Specifications are subject to change without notice.

INDEX TO TERMS

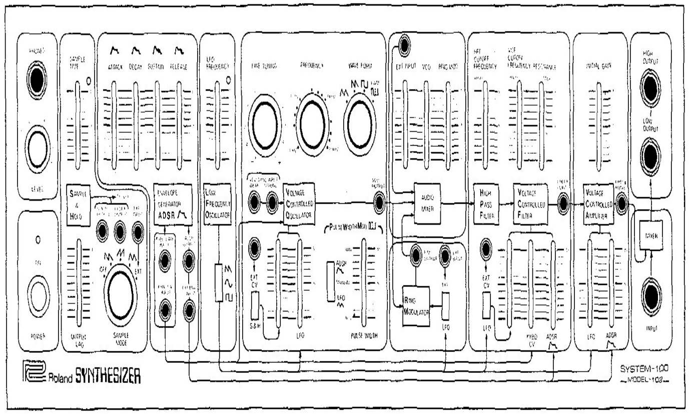
The first figure after each word indicates the page number.
The second figure indicates the paragraph number.
The words are underlined in the text to make them easier to finnd.

Roland Corporation
Printed in Japan Nov. '76 A-3

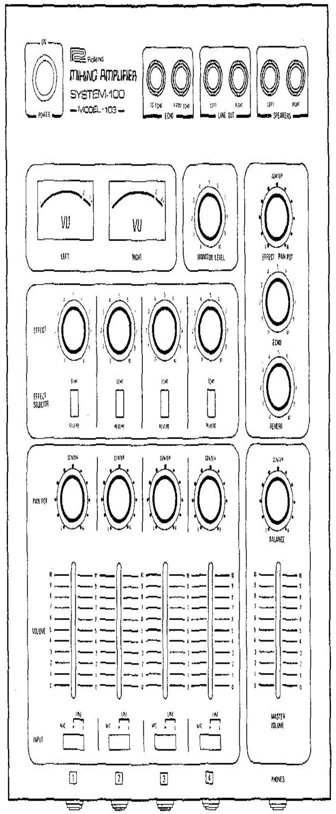
INSTANT INDEX



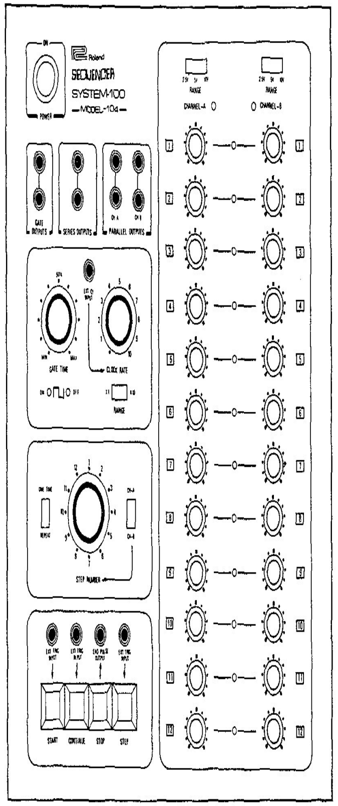
Model 102 Expander Unit control panel



Model 103 Mixer control panel



Model 104 Sequencer control panel



Frequency ranges of voices and instruments.