Red Shift

by Lois V Vierk

Commissioned by Experimental Intermedia

with support from

The Mary Flagler Cary Charitable Trust

cello
electric guitar
percussion
synthesizer*
sound engineer

*July 28, 2024
I originally created the synthesizer sounds for the Yamaha TX81Z. If you have access to one of these units that's in good working condition, I can email you the MIDI files to load the sounds. Contact me as below.

As of recently, due to the superb work of composer and audio technologist Anastasia Clarke (anastasiaclarke@gmail.com), the synthesizer sounds can also be played using contemporary equipment and resources - a Mac computer plus specific software and files. Contact me as below for more information.

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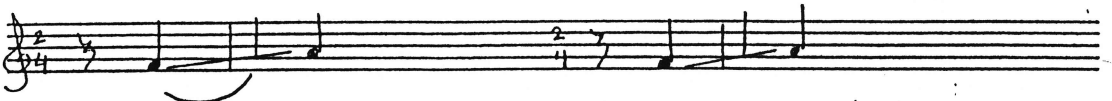
Cello and Guitar

This piece is NON VIBRATO

Accidentals apply only to the note they precede, and to the same pitch following immediately in the same measure

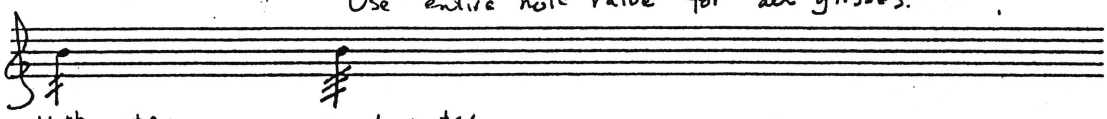
Articulate each 16th note, while glissing



Gliss - do not articulate
EX. 1st beat of second measure

Articulate first beat of second measure, if not slurred.

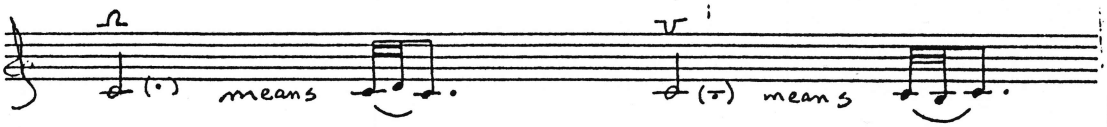
Use entire note value for all glisses.



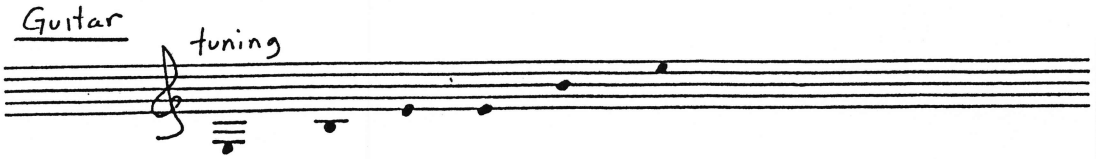
16th notes (measured)

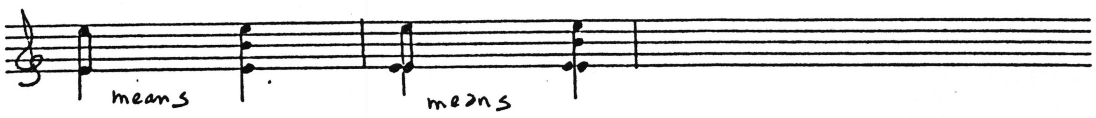
32nd notes (measured)

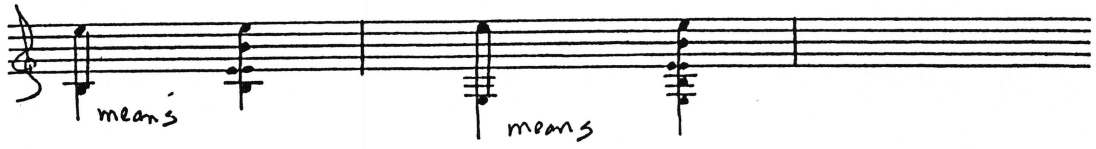
play grace notes as 32nds until m. 199. Then play grace notes as fast as possible,



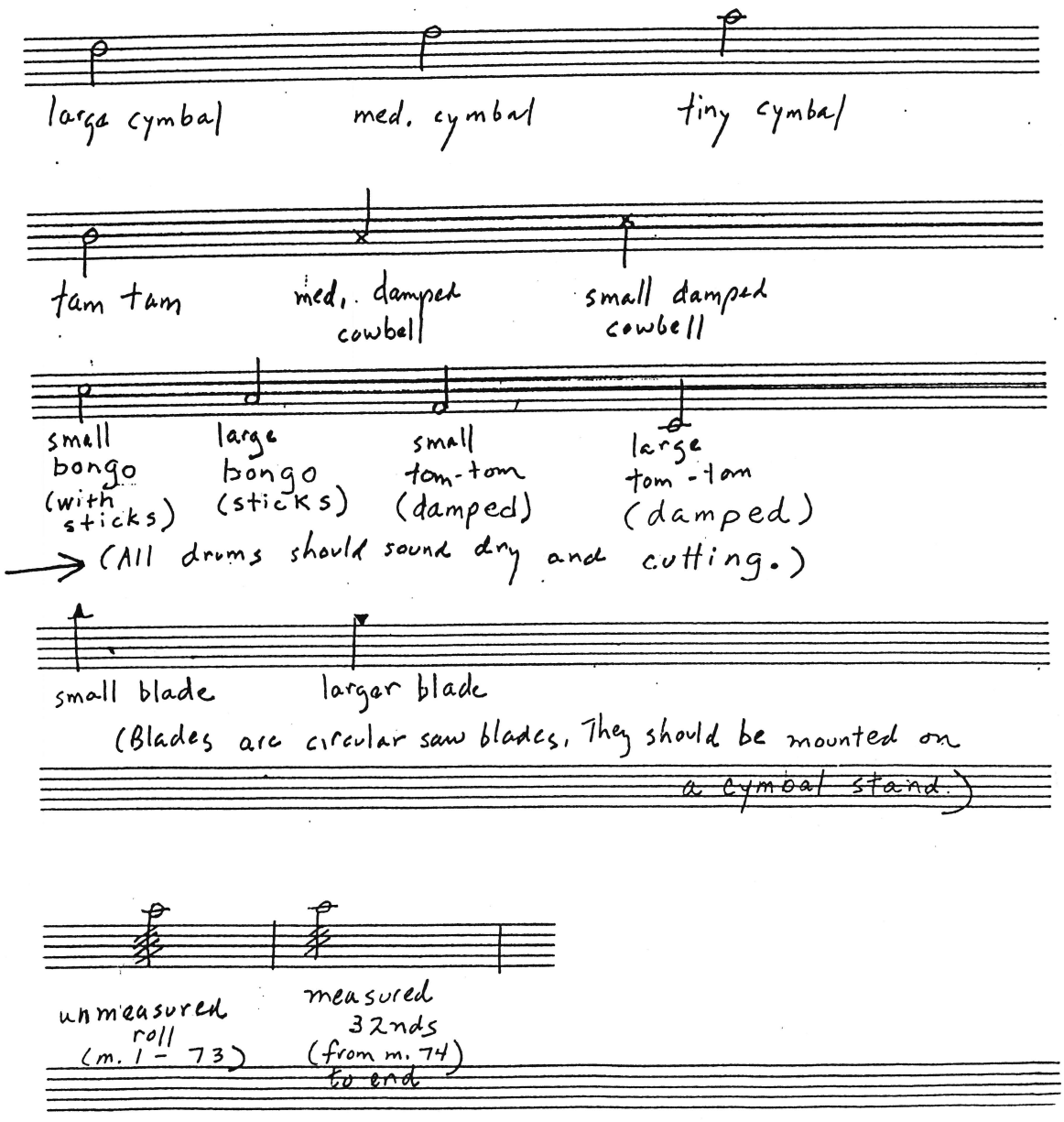
Guitar







Percussion



Let all notes ring unless marked to damp.

Conductor and Sound Engineer

Please note that throughout the piece the electric guitar and cello are heard contrapuntally, and these instruments should be equally prominent, equally loud and clear. This is especially important - and difficult to achieve - at the end of the piece.

Electric Guitar and Cello

Cello must play more articulated and more accented than normal, to blend with electric guitar. Likewise, electric guitar sound and also the guitar pick should be chosen to blend with the cello sound, as much as possible. Try using a bright guitar sound to blend with cello.

Throughout the piece the electric guitar and cello are heard contrapuntally, and these instruments should be equally prominent, equally loud. This is especially important at the end of the piece.

This piece is completely NON VIBRATO - all instruments, entire piece.

Use entire note value for each glissando.

Cello

Cello glissandi are to be played on one string, not crossing strings.

Electric Guitar - must be played through sound system, NOT GUITAR AMP. Use a METAL slide. Before slide indication use fingers, but slide may be added, ad lib.

Cello, Electric Guitar, Percussion

All dynamics and swells should be played strongly, and exactly where marked.

Play grace notes before the beat.

Percussion - let all notes ring.

Synthesizer

Synthesizer is Yamaha TX81Z. Composer's sounds must be loaded into the synth. Midi files are available from composer for downloading these sounds into synth. Also, specs for all synth sounds can be found at the end of the regular score (not this keyboard score.) [If a Yamaha TX81Z is not available please contact the composer.]

A keyboard midi controller with TOUCH SENSITIVITY is required.

Make sure the Yamaha TX81Z is in "PERFORM" mode (not "play" mode). Be careful that synth is sounding in the correct octave. Since synth voices are built up of various sounds in different octaves, the correct octave may not be totally obvious at first. Compare your sounds to the CD recording. Tzadik Records CD is suggested for this.

Keyboardist can conduct ensemble while playing keyboard.

Note: Yamaha TX81Z output is mono.

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Mixing *Red Shift* -- VERY IMPORTANT!!!!

This music is very dense. Yet all instruments, both electric and acoustic, must always be heard strongly and cleanly. The sound engineer is an important and indispensable performer.

This piece requires careful mixing and a high quality stereo sound system. Ample time for sound check is required. The sound engineer must rehearse with the ensemble.

To make the piece clear and powerful, all the instruments need to be amplified (except floor tom, and maybe cymbals, depending on acoustics and size of the room). Acoustic instruments must each be close-miked.

All the instruments are to be put through a high quality sound system, not guitar amps. This includes the guitar -- use the sound system for the electric guitar, too. The idea is to blend the instruments and make their timbres sound as much alike as possible.

Careful panning is essential for clarity of sound.

During the performance the sound engineer must be constantly listening and adjusting levels. For example, the cello and electric guitar are meant to blend as much as possible, and balance each other. When the piano enters, it should be heard clearly and strongly. The sound engineer also must regulate the levels of the synthesizer. The synth should always be present, but it should not overpower any other instruments. (An effort was made to program the synthesizer levels to be as even as possible, but when the synth changes from one sound to another the levels also change somewhat, too.)

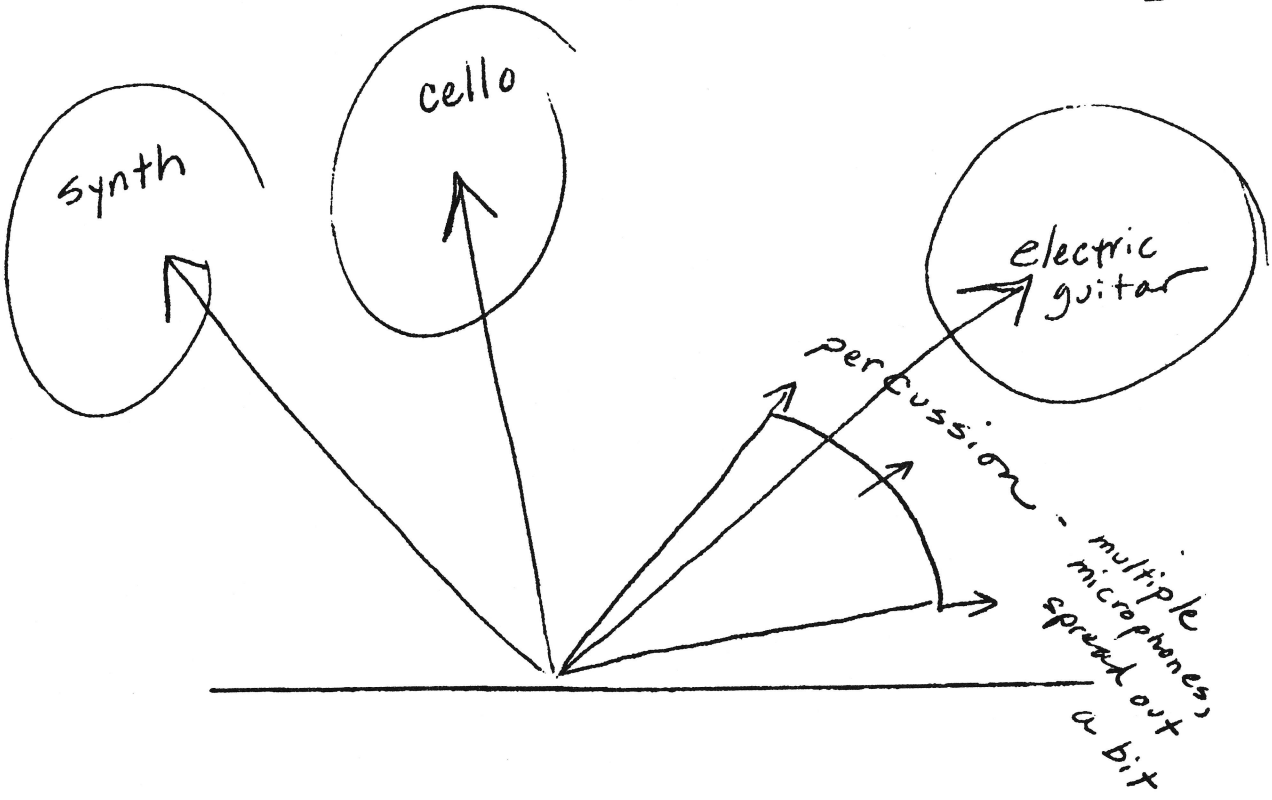
The piece begins softly and then continually gets louder to the end. Boost levels of all instruments slightly at the end (approx. 11:30 into the piece) and then again for the last few measures (approx. 12:00).

In general, all the instruments must be heard all the time.

The composer favors listing the Sound Engineer as one of the performers.

Red Shift

panning (location on mixing board)



(This is one possibility, depending on how you are sitting. The cello should probably be close to center, not on the outside)

***Red Shift* (1989)**
by Lois V Vierk

When I wrote this work, I had the feeling of something of great mass and motion, far away, like a comet. It first seemed to move slowly, then gradually seemed to accelerate toward us on earth, faster and faster, until finally at great speed I felt it sweeping down upon us, through us, and back out into the sky.

The title of this piece refers to the way in which astronomers and physicists measure movement and distances of distant celestial bodies. Briefly, characteristic lines and patterns made by different elements found in the star or other body, as seen through an instrument called a spectrometer, are shifted in one direction or the other, towards the red or towards the blue end of the spectrum, depending on whether the body is moving away from us or towards us. This shift is called the "red shift".

During the 1980s and into the '90s I worked on developing principles of "Exponential Structure", in which elements such as time, harmonic motion, rhythmic and timbral development, sound density, etc. are controlled mathematically by exponential factors. These are not meant to be abstract constructs, but formal ideas based on the emotional thrust of the sounds and of the piece as a whole. The harmonic motion (movement from one pitch center to another), with its ever-decreasing time segments, is the clearest expression of Exponential Structure in this work.

Red Shift was commissioned by the Experimental Intermedia Foundation with support from the Mary Flagler Cary Charitable Trust and is recorded on Tzadik CDs.

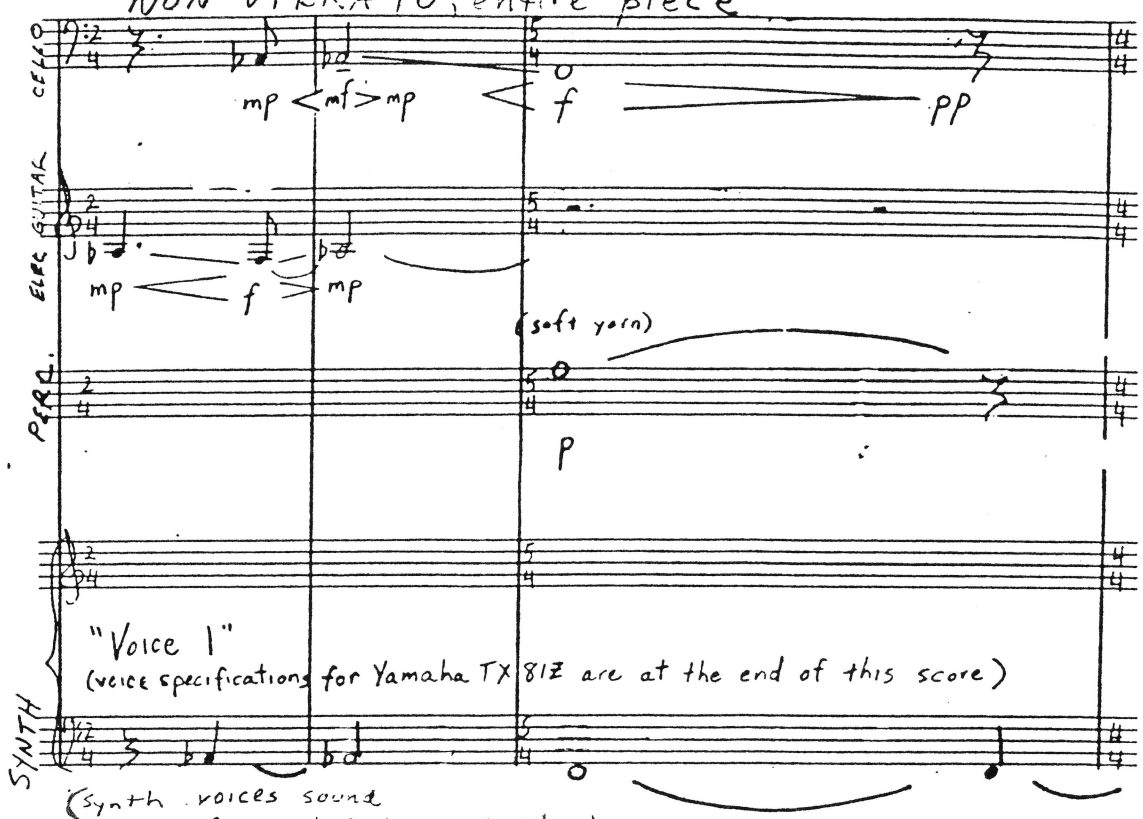
Analytical material on *River Beneath the River* can be found at the very end of this document, following the score.

RED SHIFT

♩=38

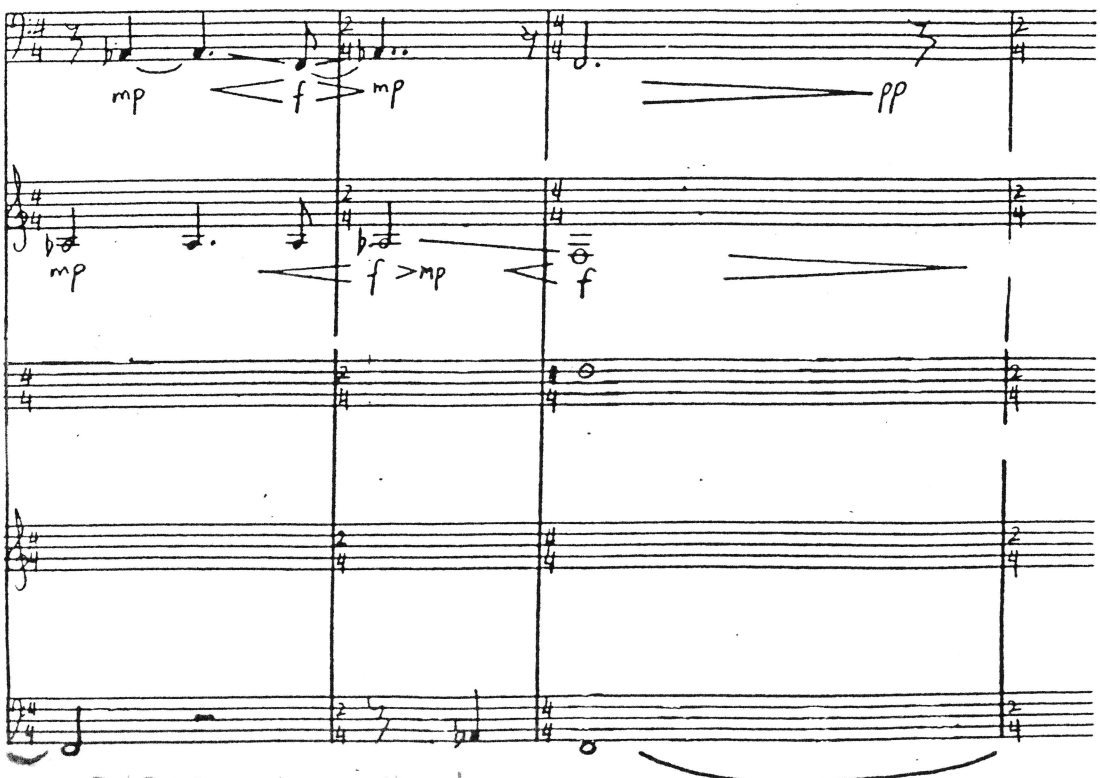
LOIS V VIERK

NON VIBRATO, entire piece



(Synth voices sound different from what they look like.)
Refer to sound file from composer or publisher.

4.



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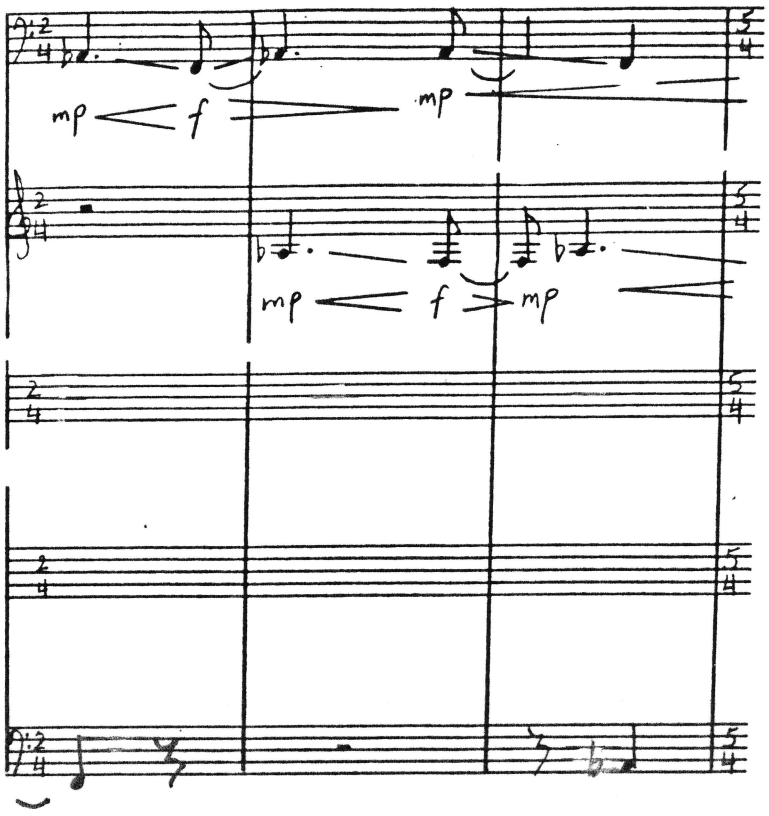

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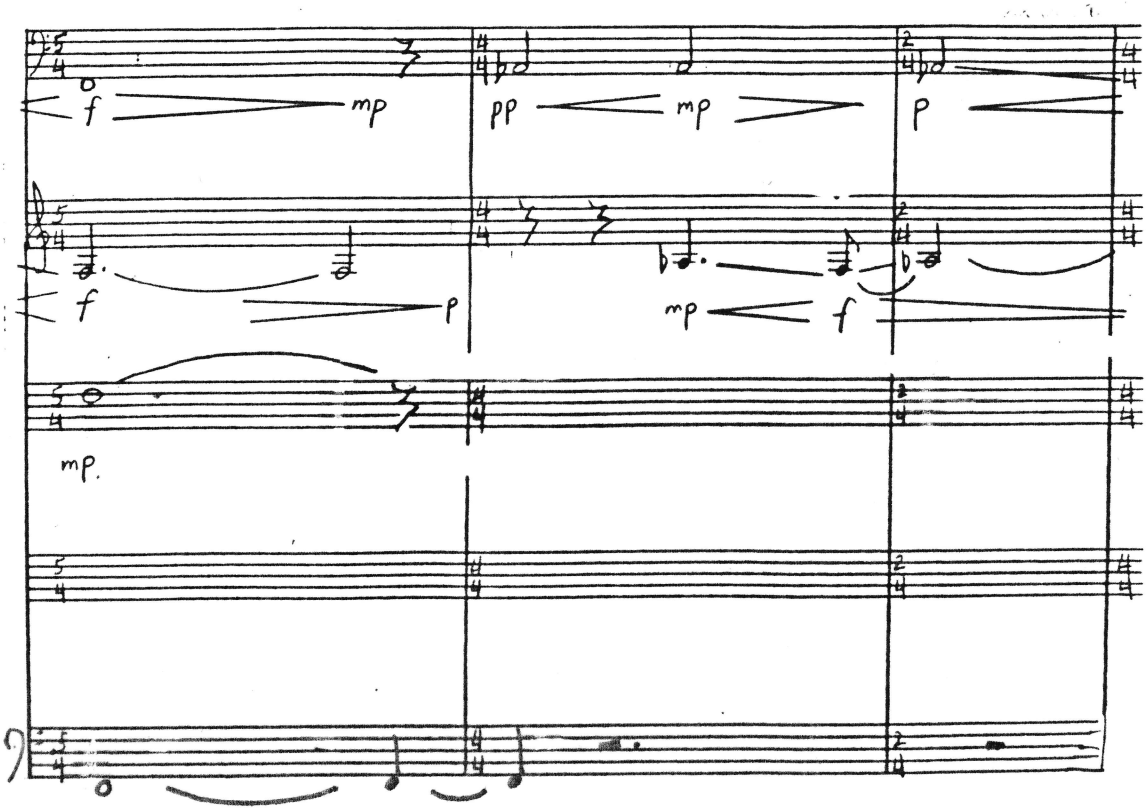

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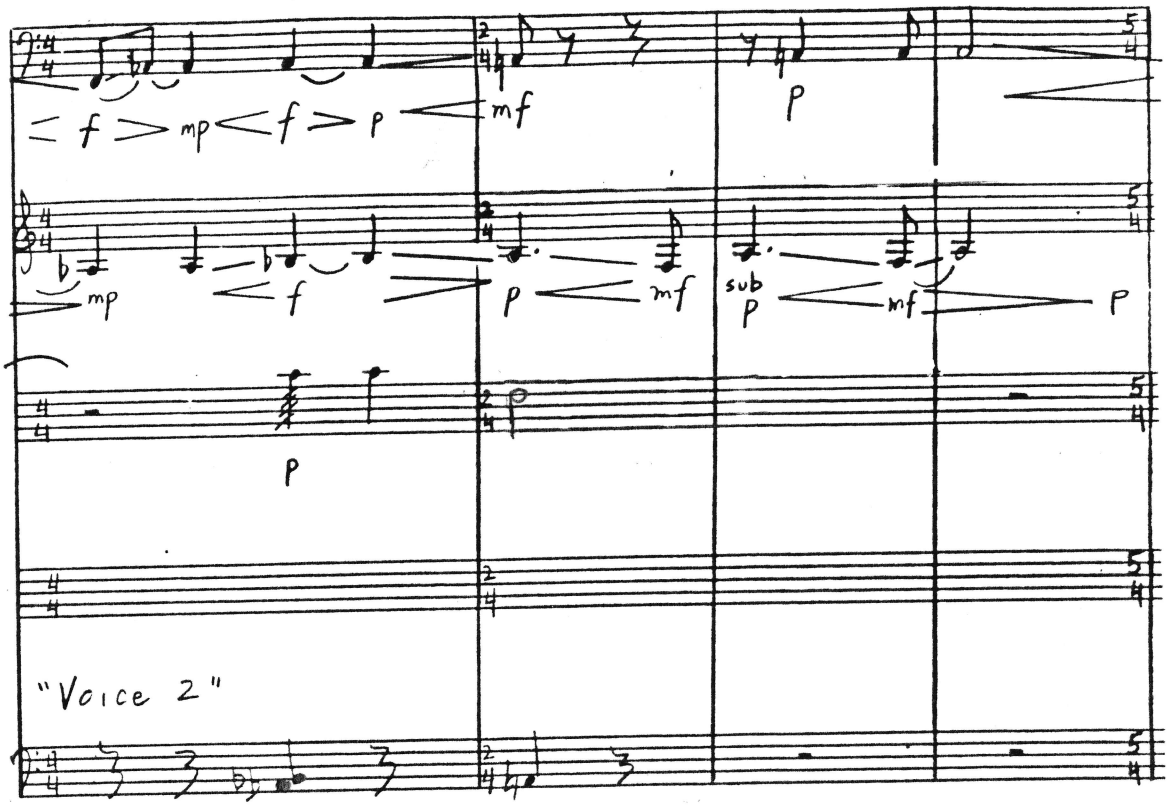

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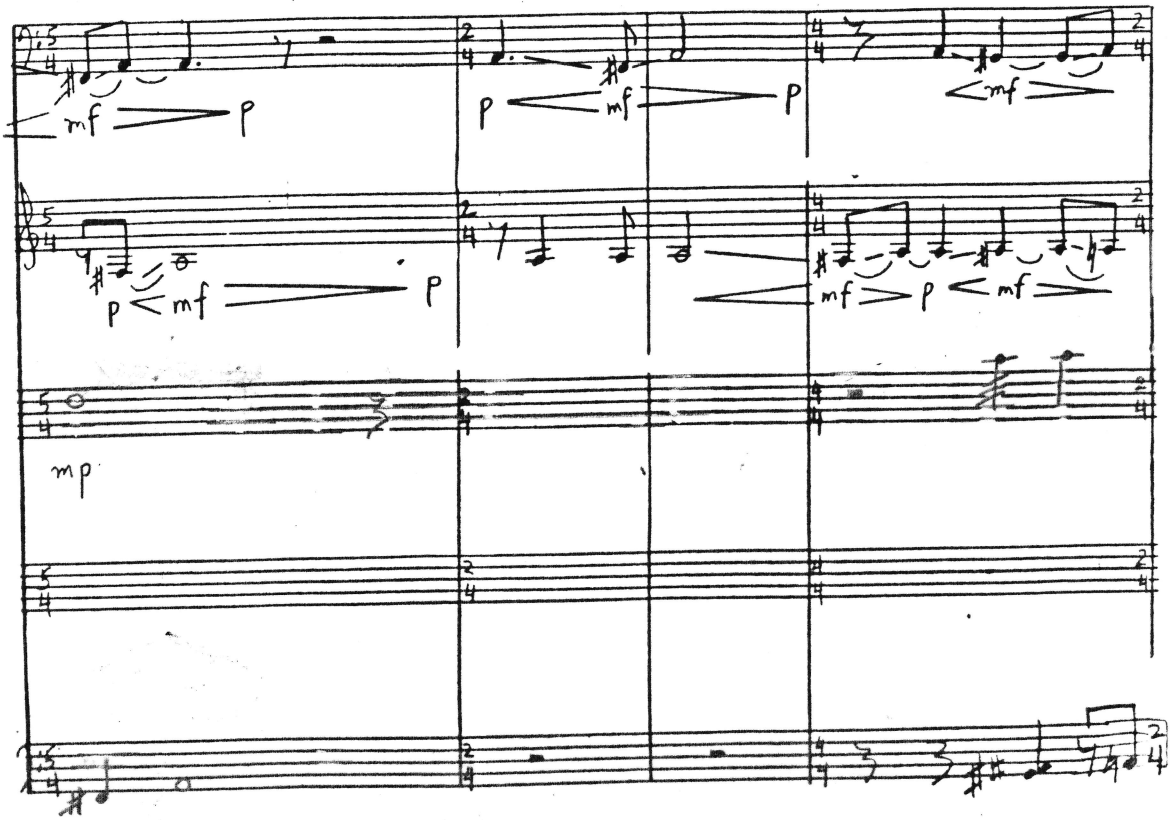

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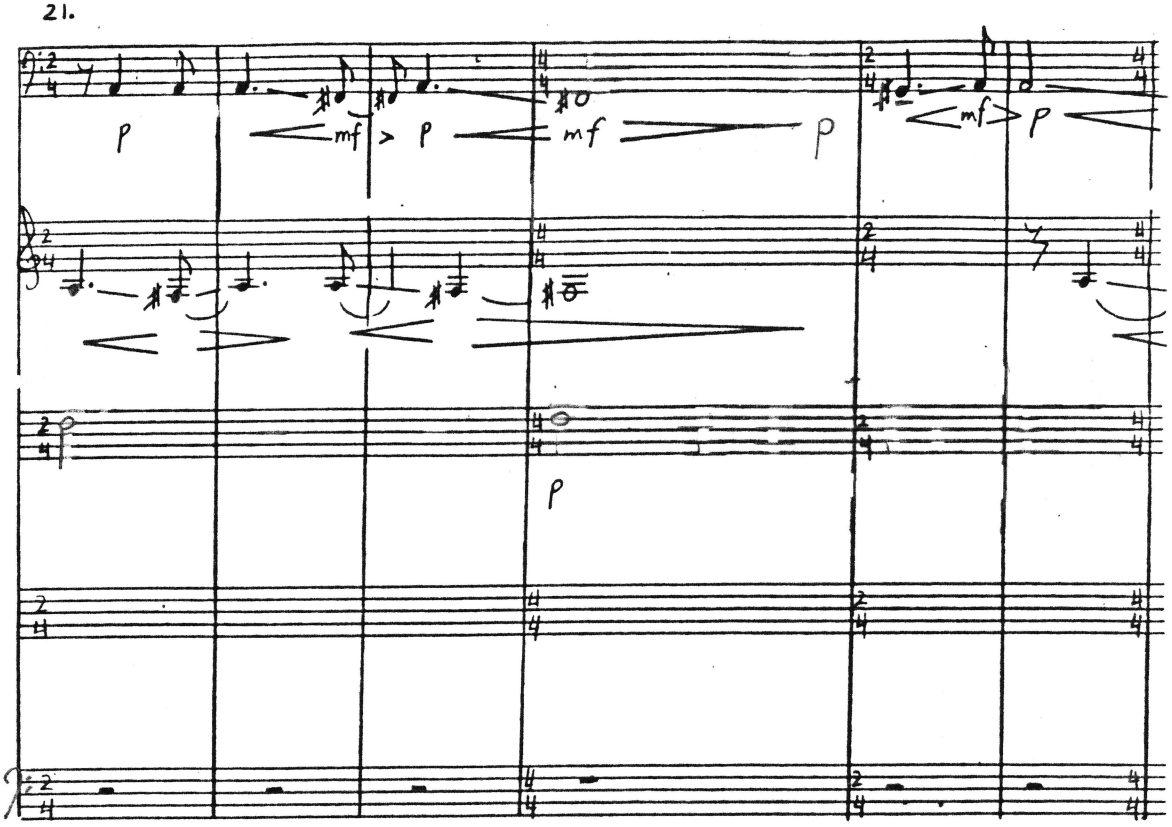

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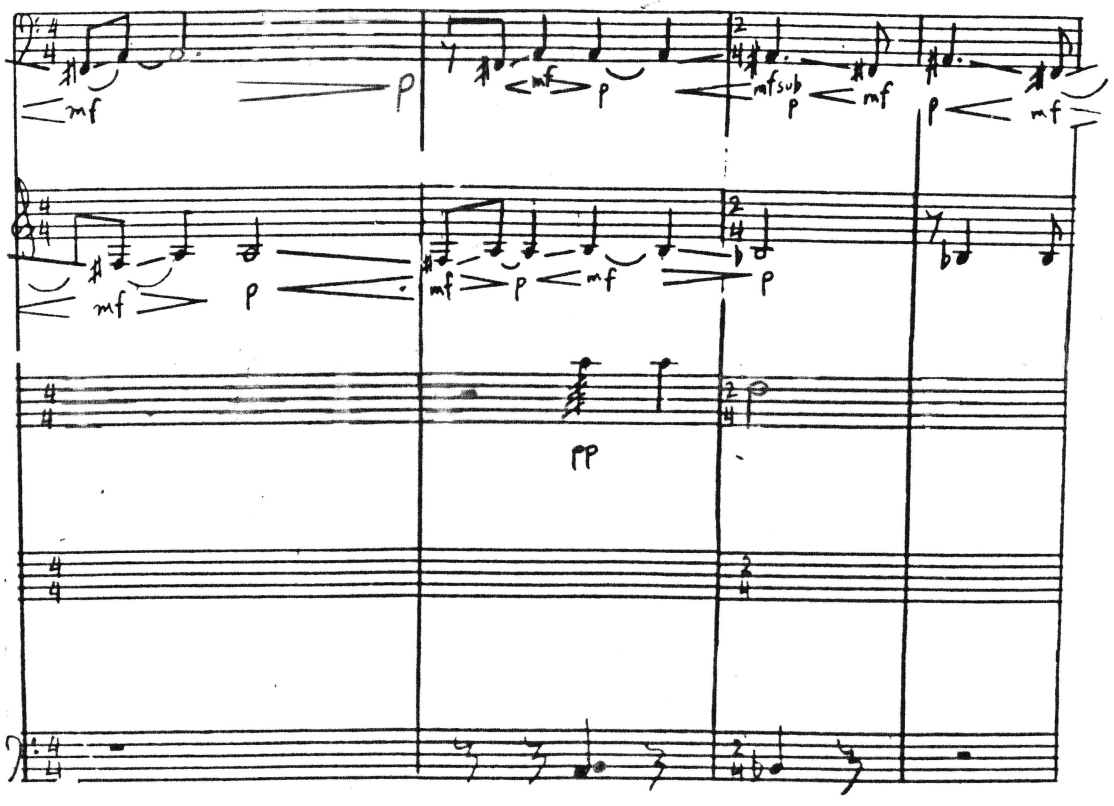

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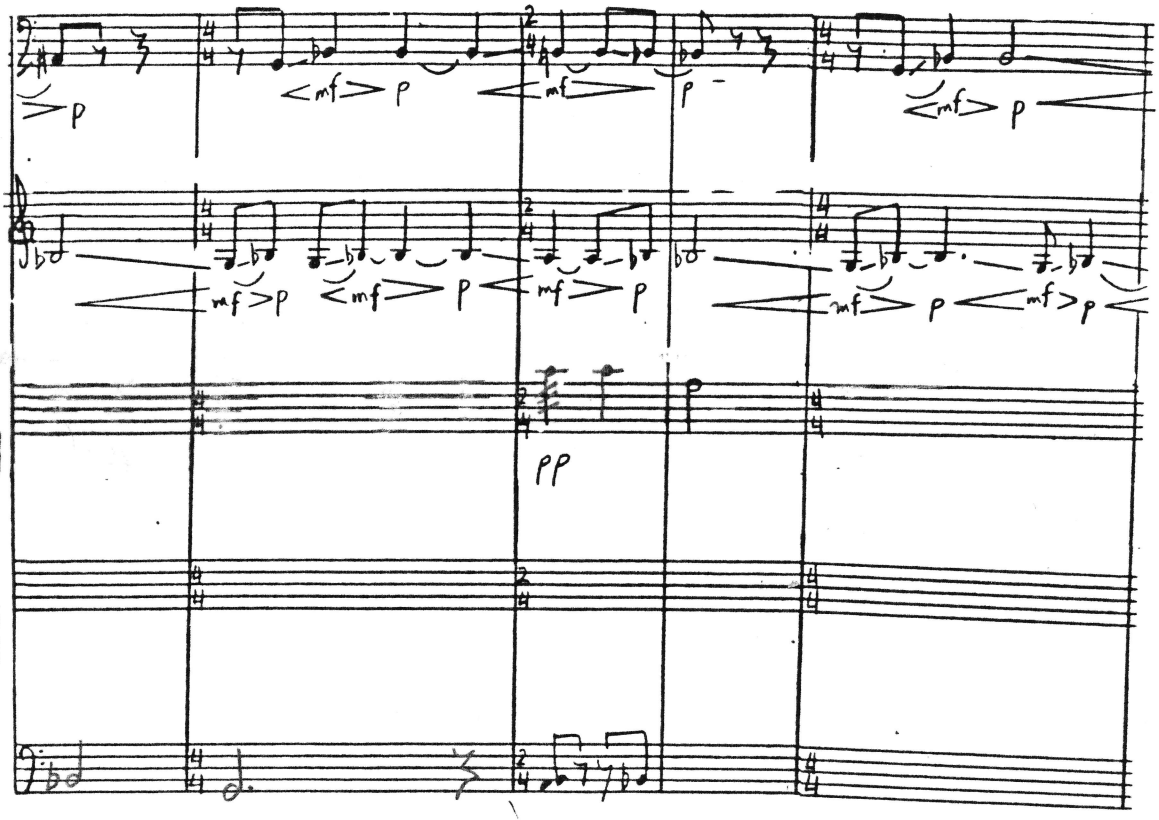

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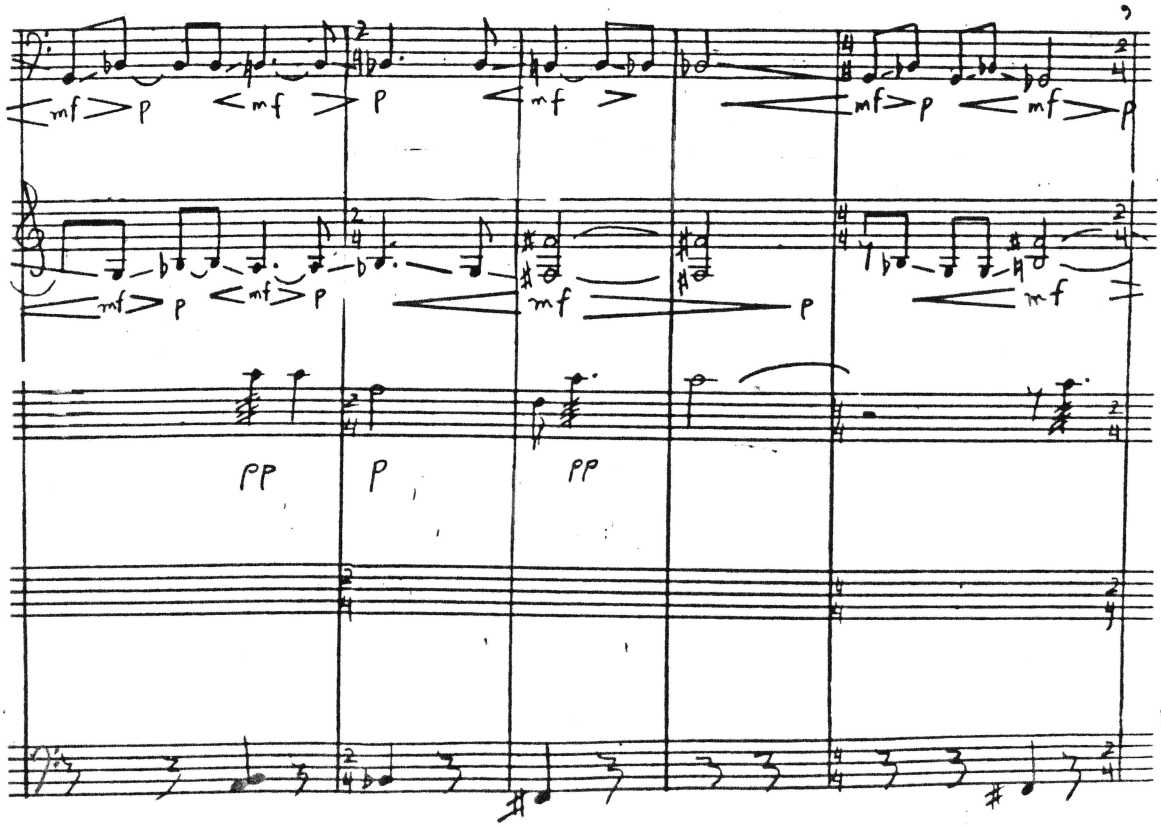
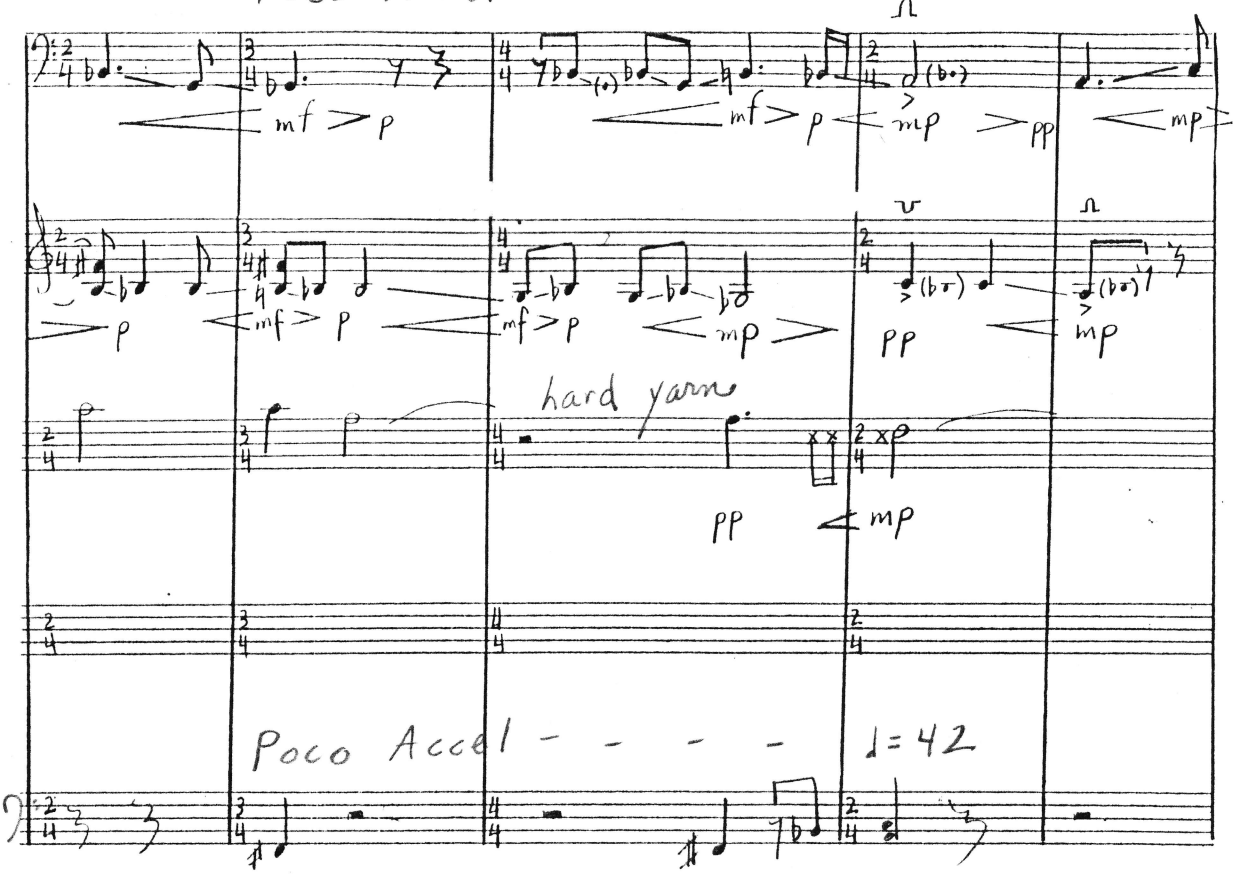


41. Poco Accel - - - - - [A] ♩=42



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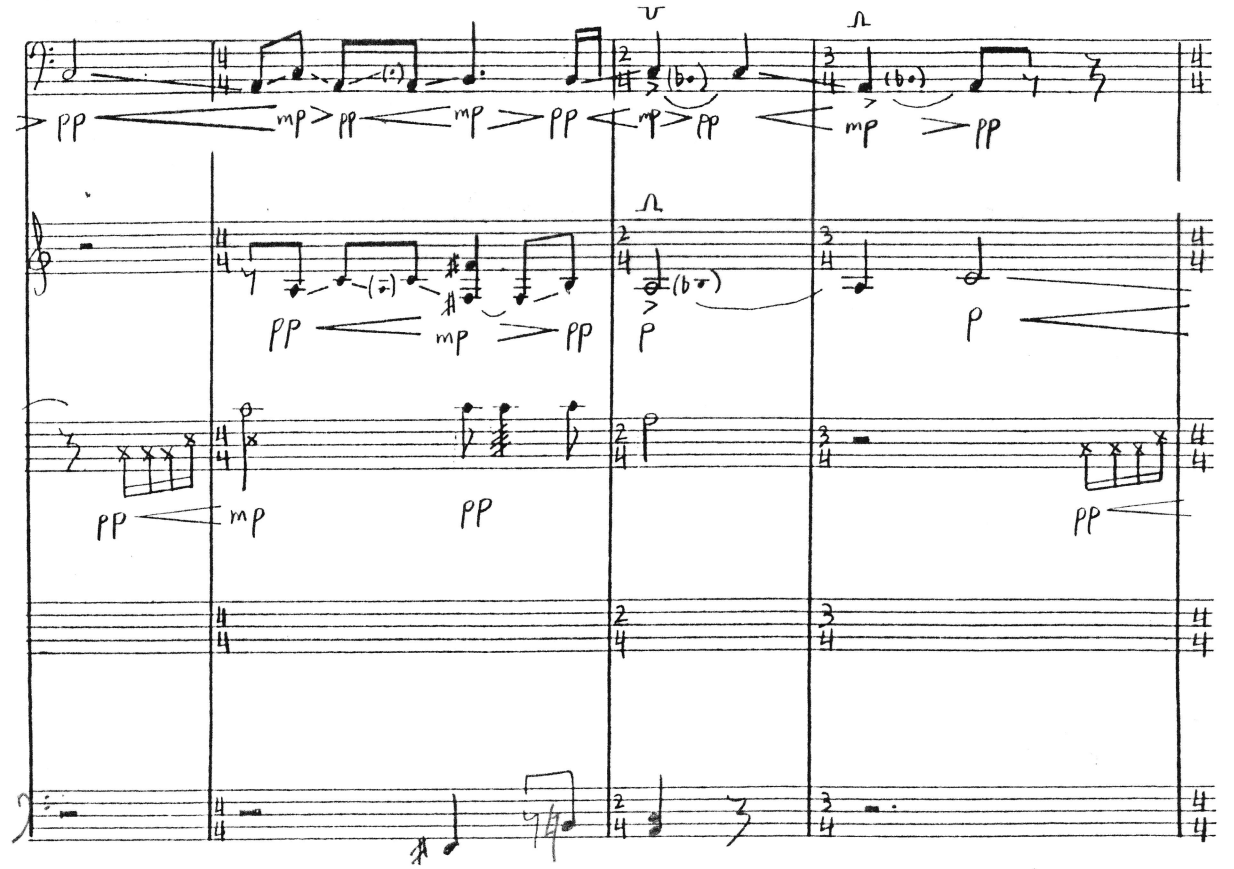

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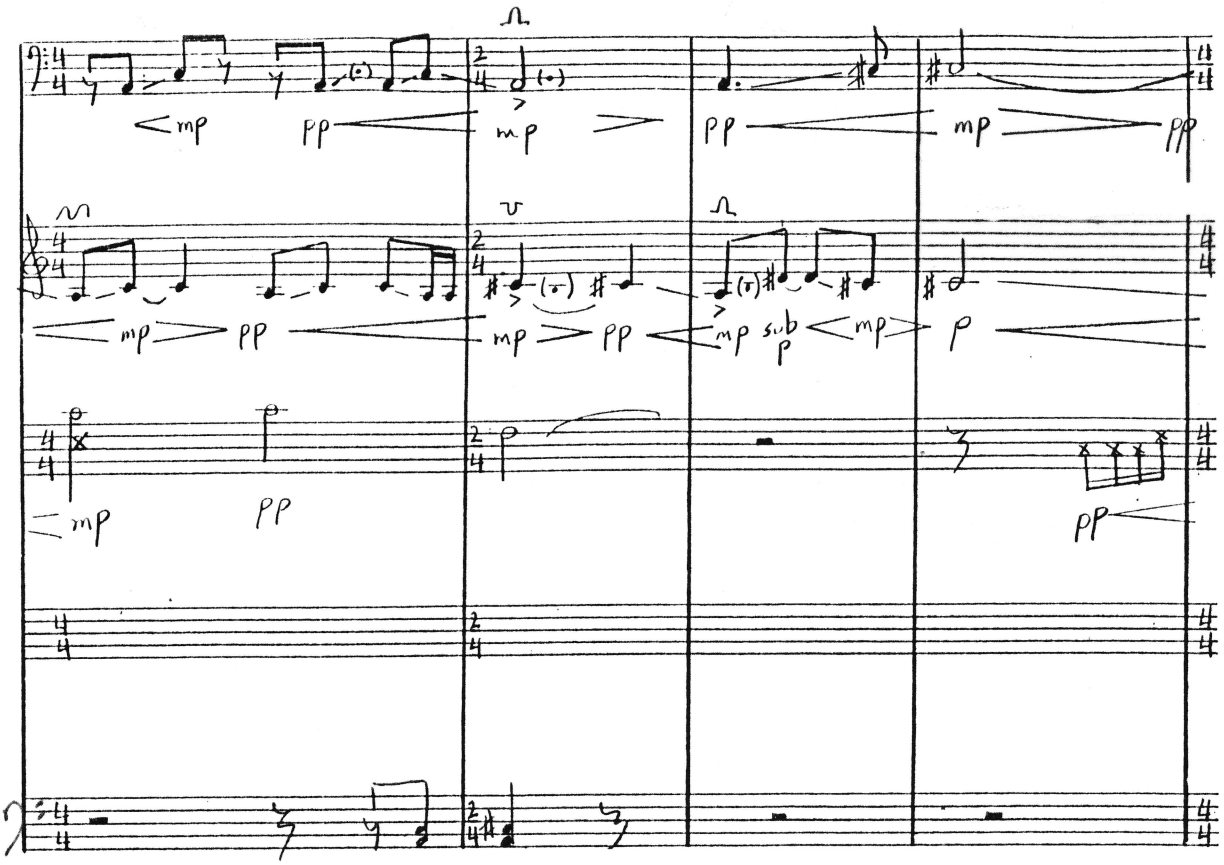
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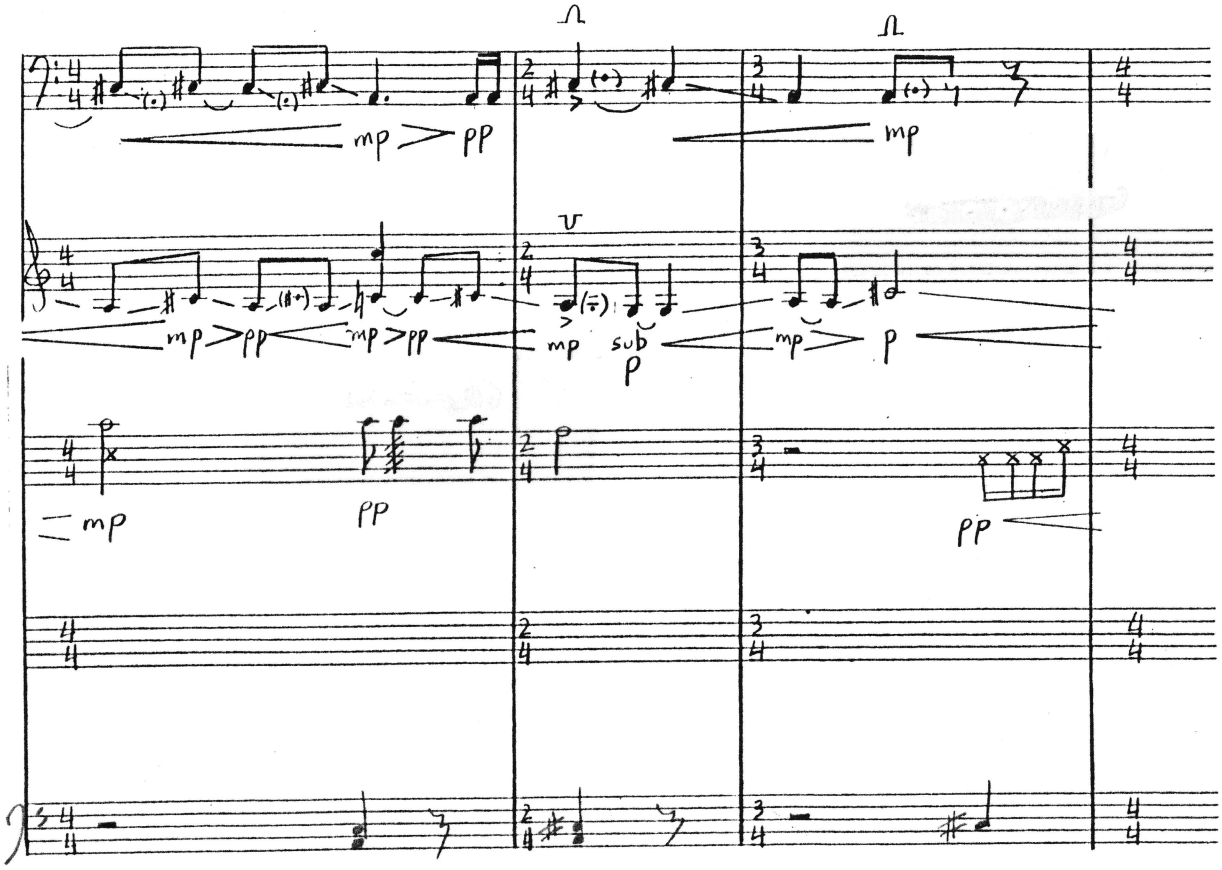
54.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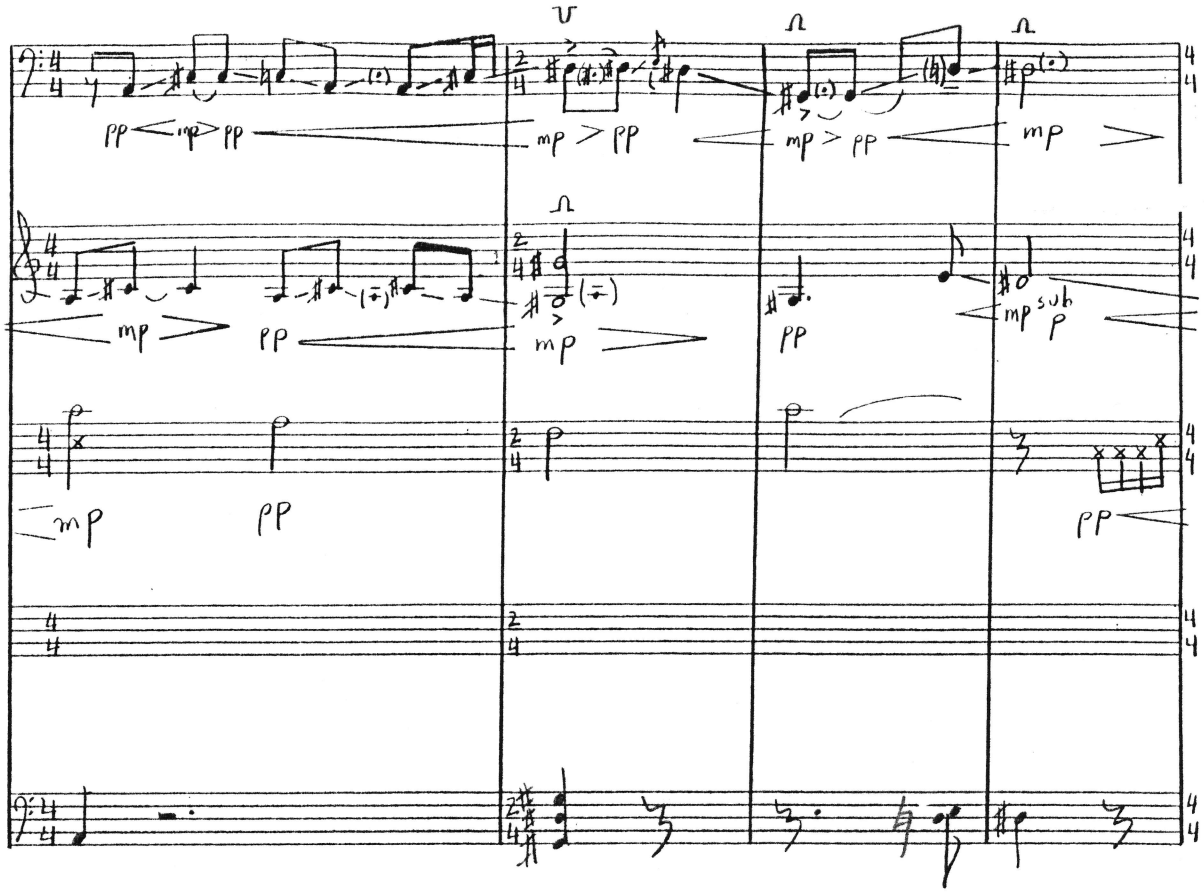

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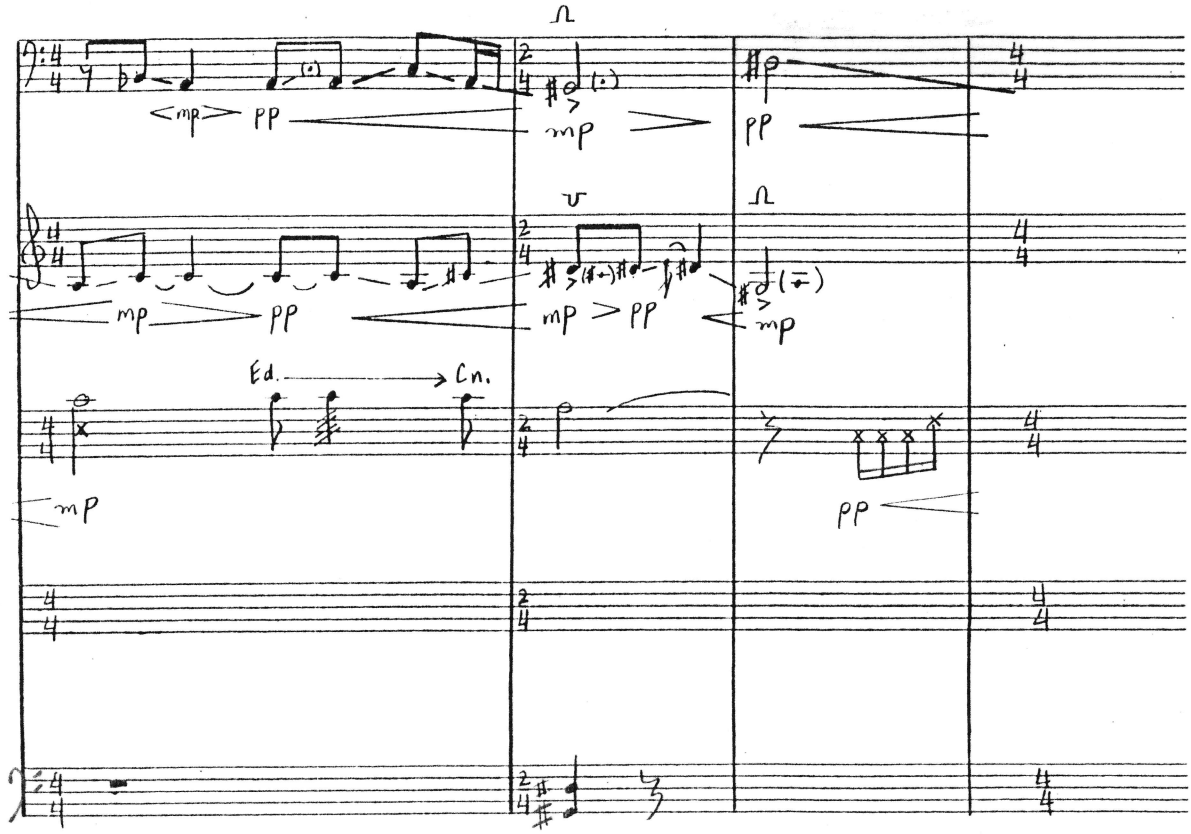

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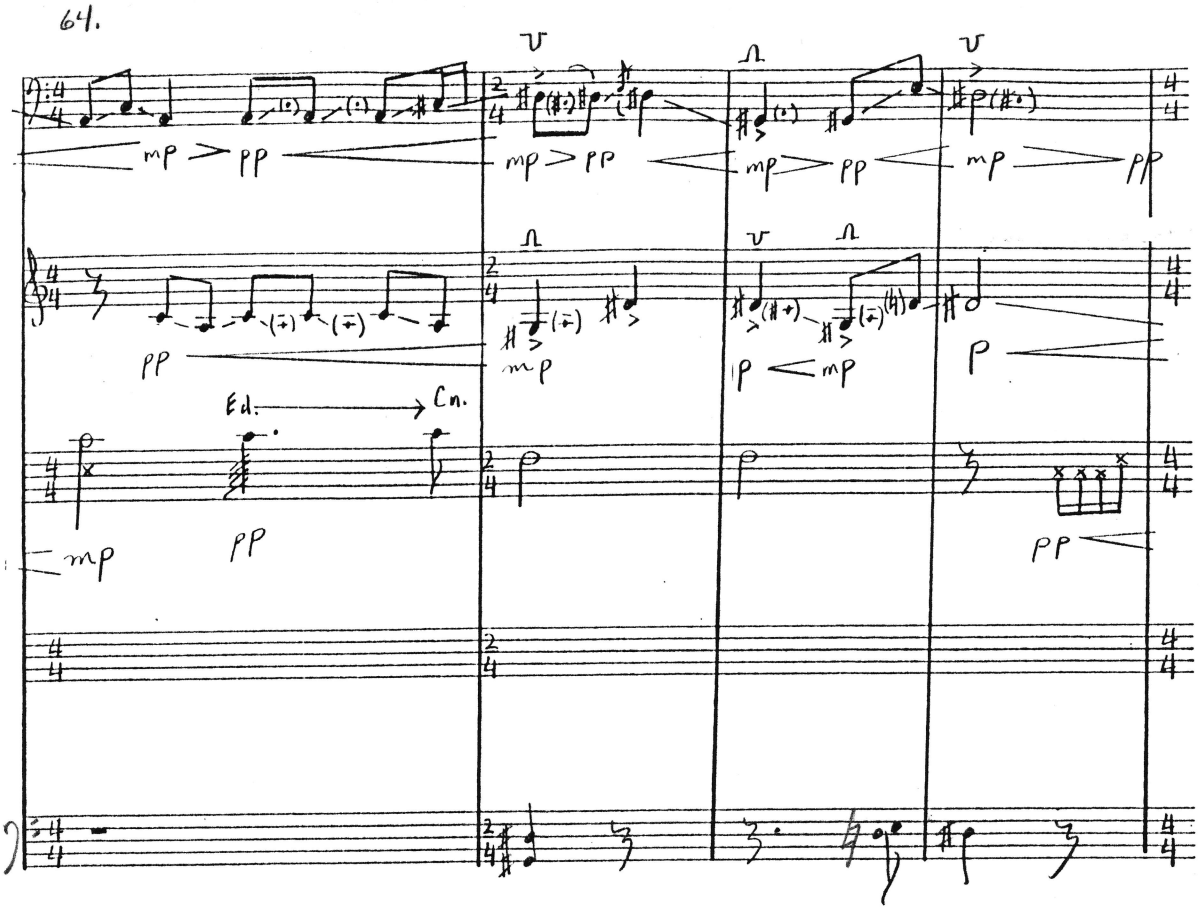
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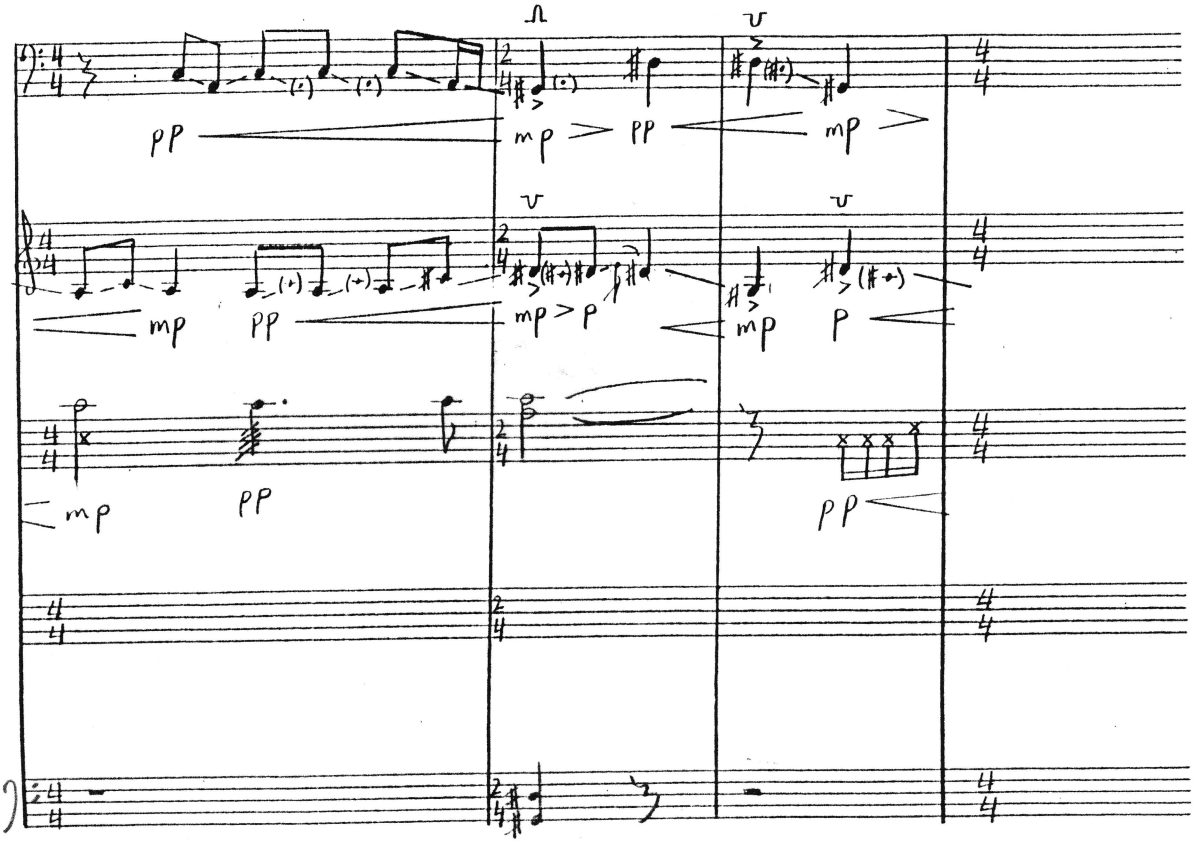
68.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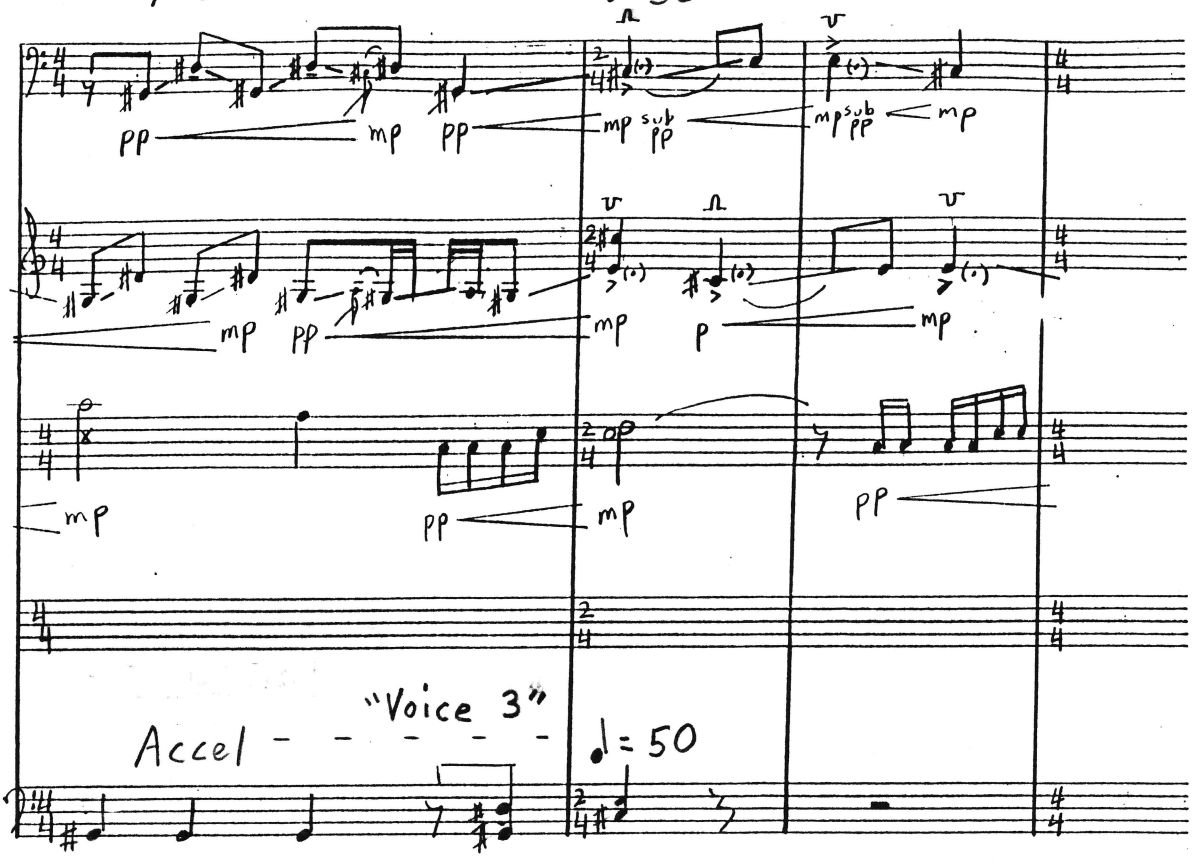
71. Accel - - - - - - - ♩=50



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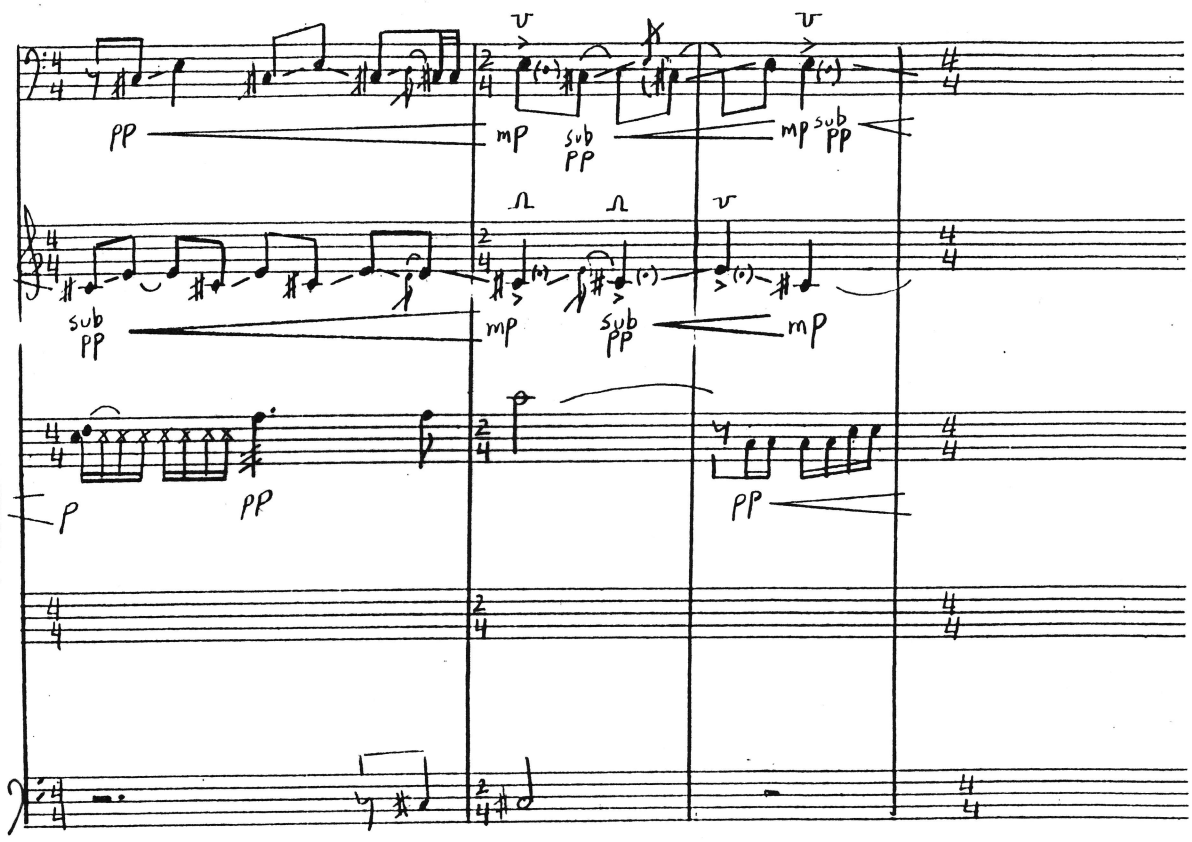

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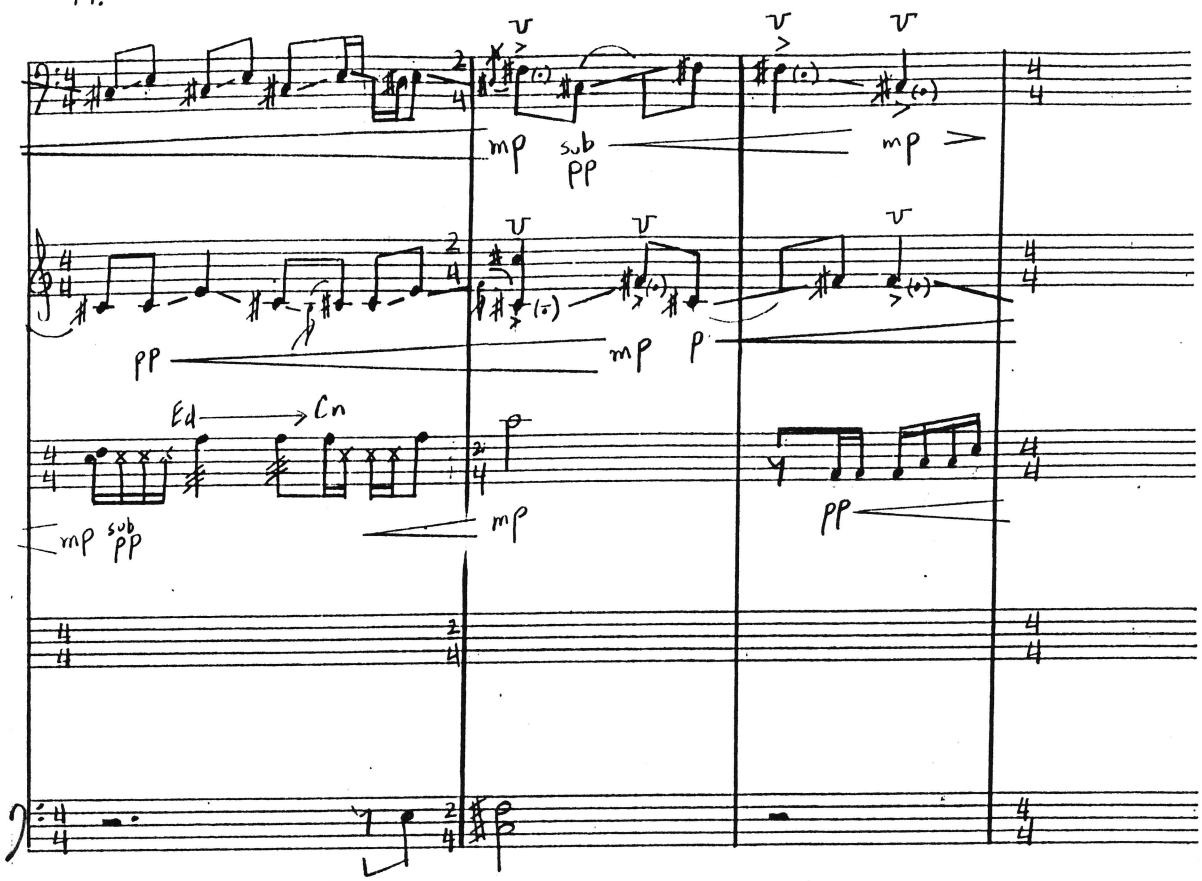
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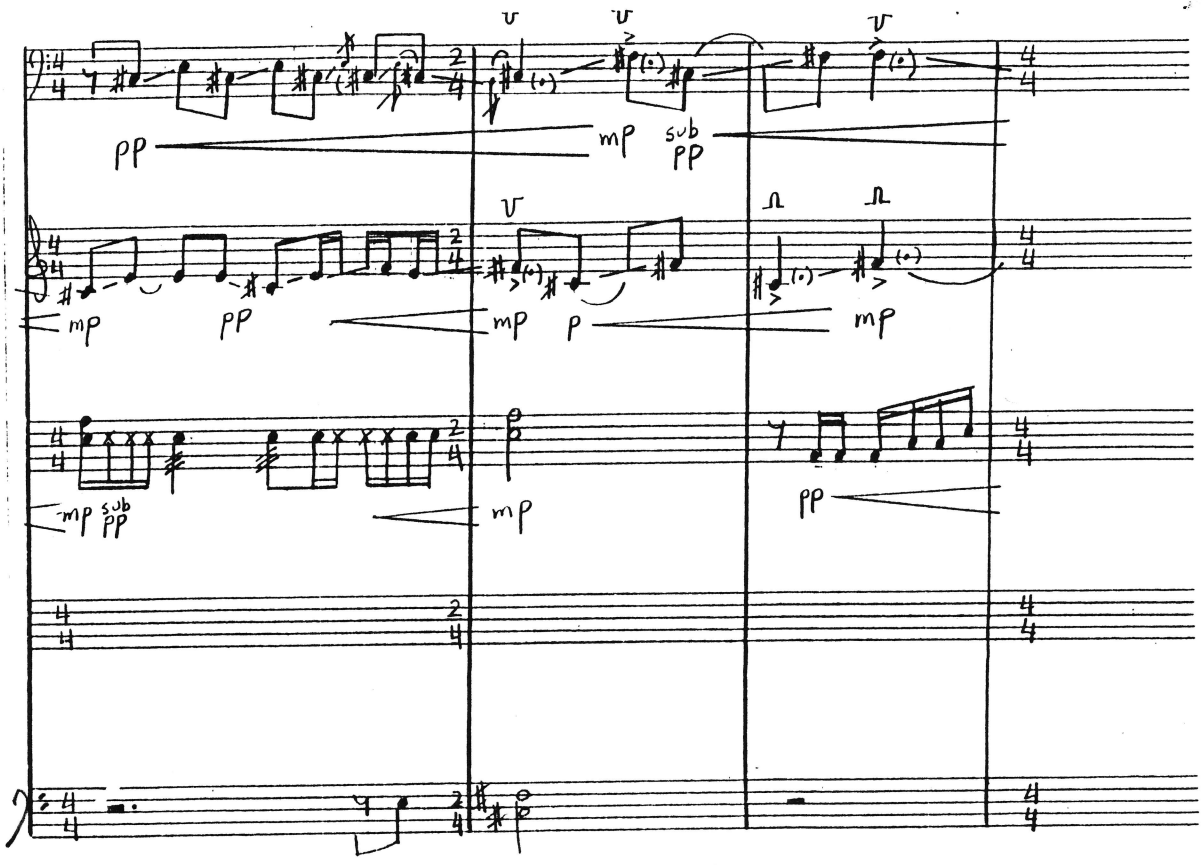
80.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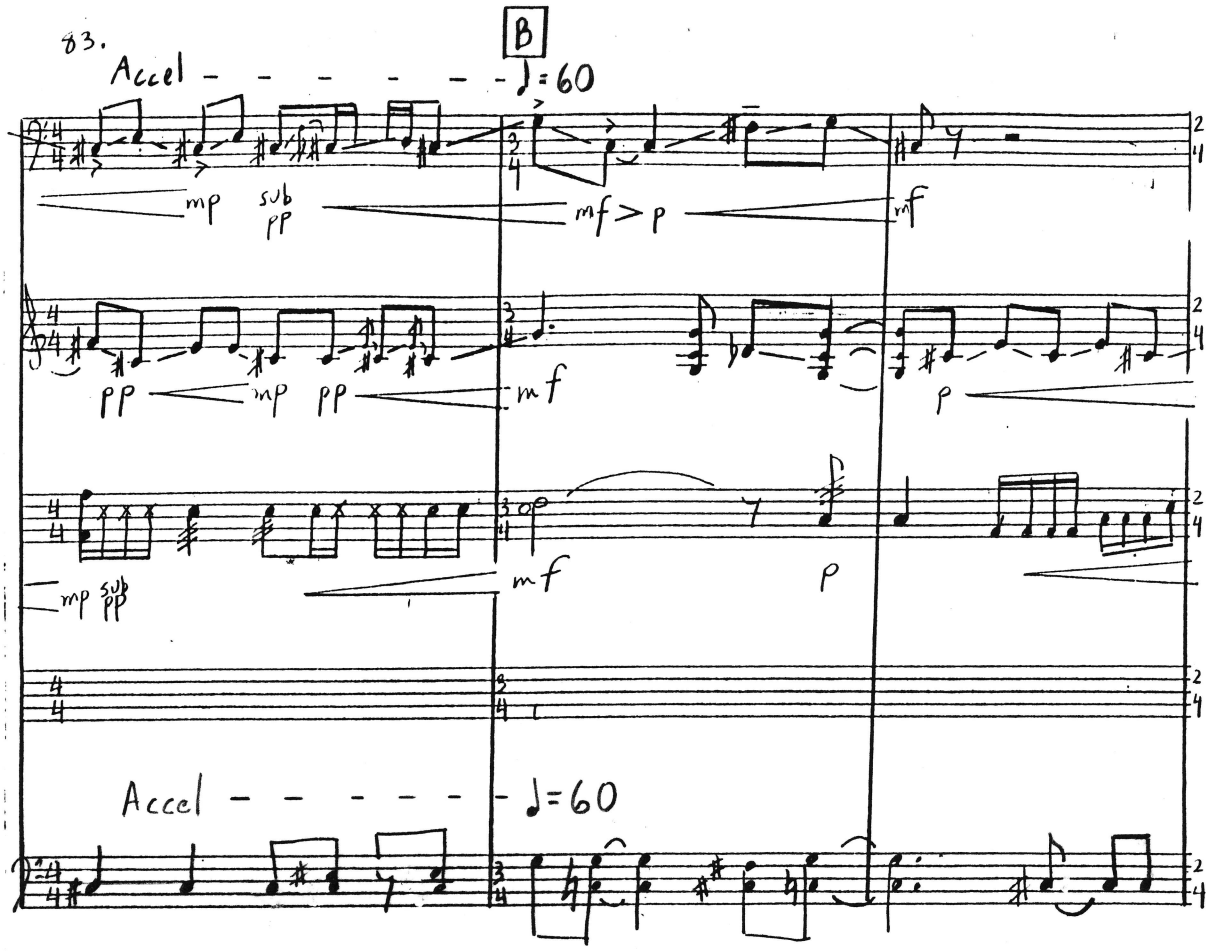
83.
B
Accel - - - - - - ♩=60
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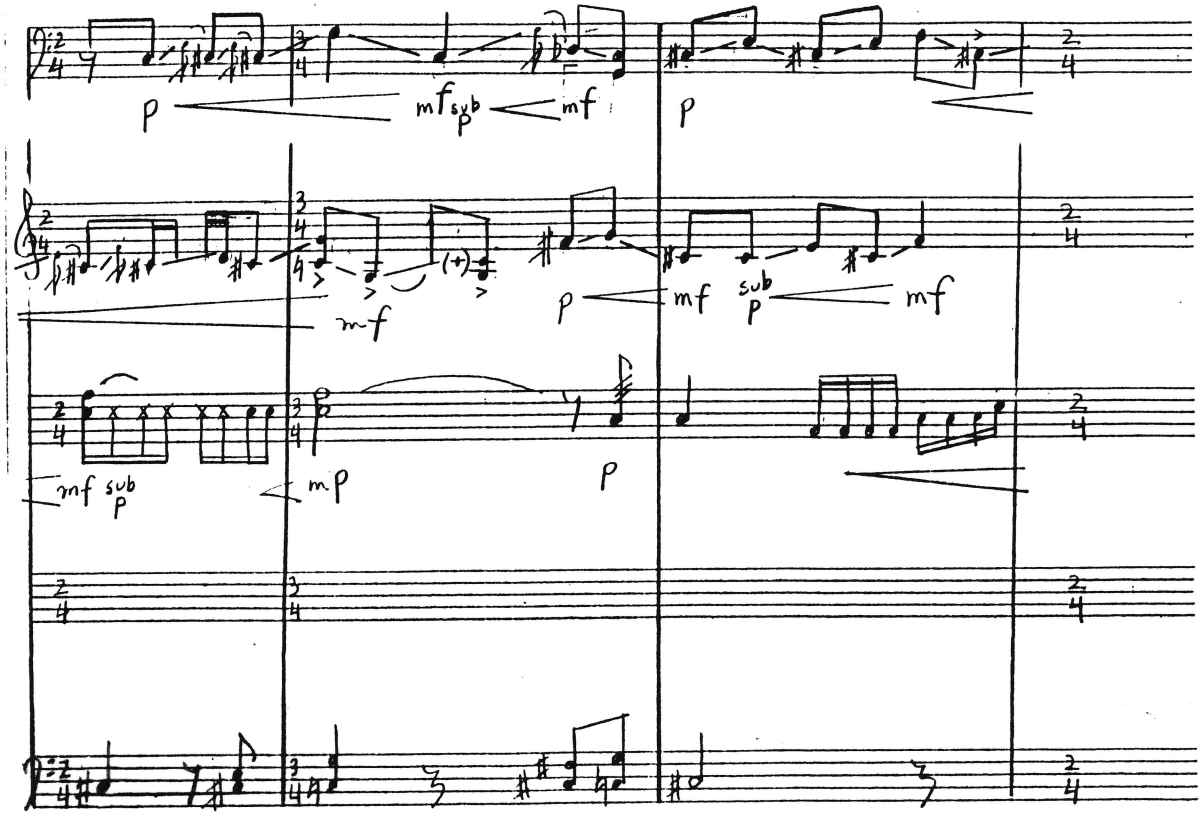
Accel - - - - - - ♩=60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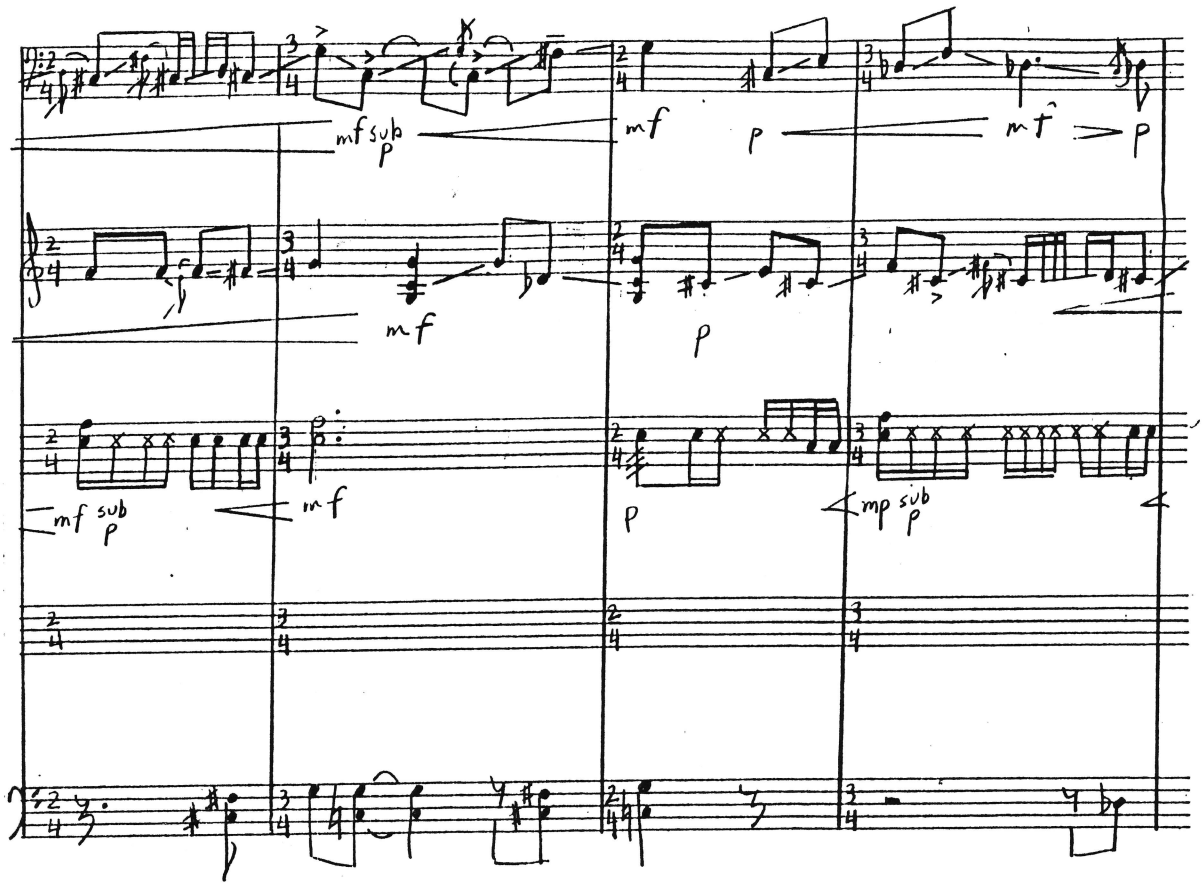
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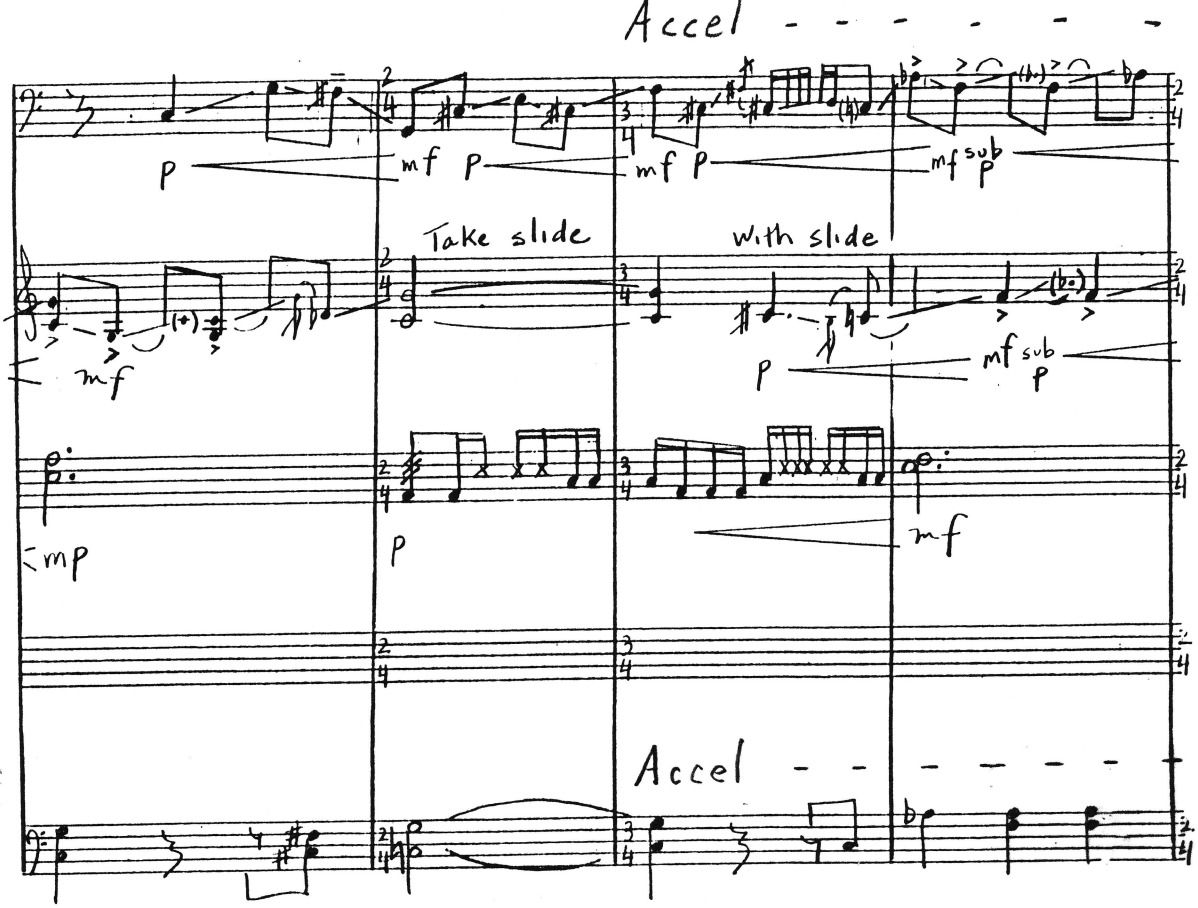
Accel - - - - - -
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mf p
mf sub p
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p
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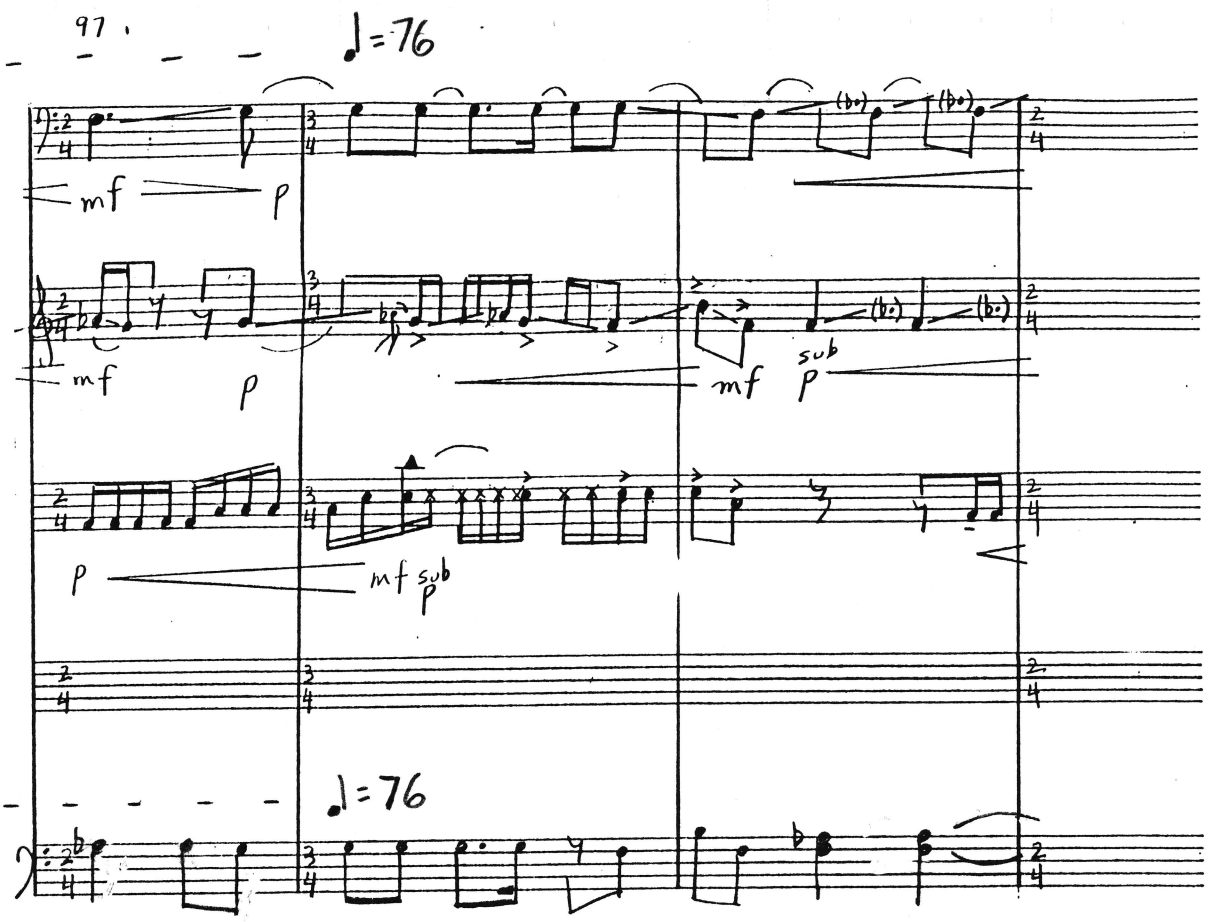
Accel - - - - - -

97.



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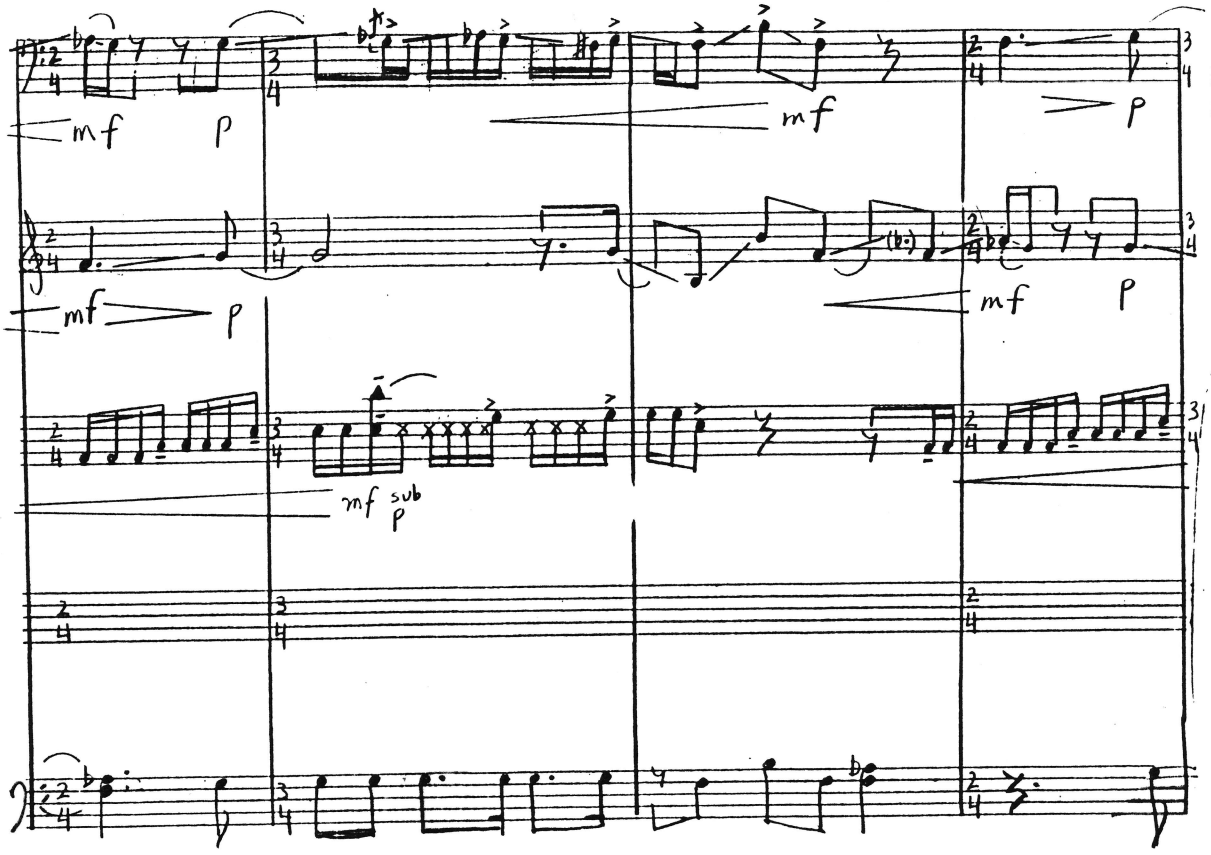

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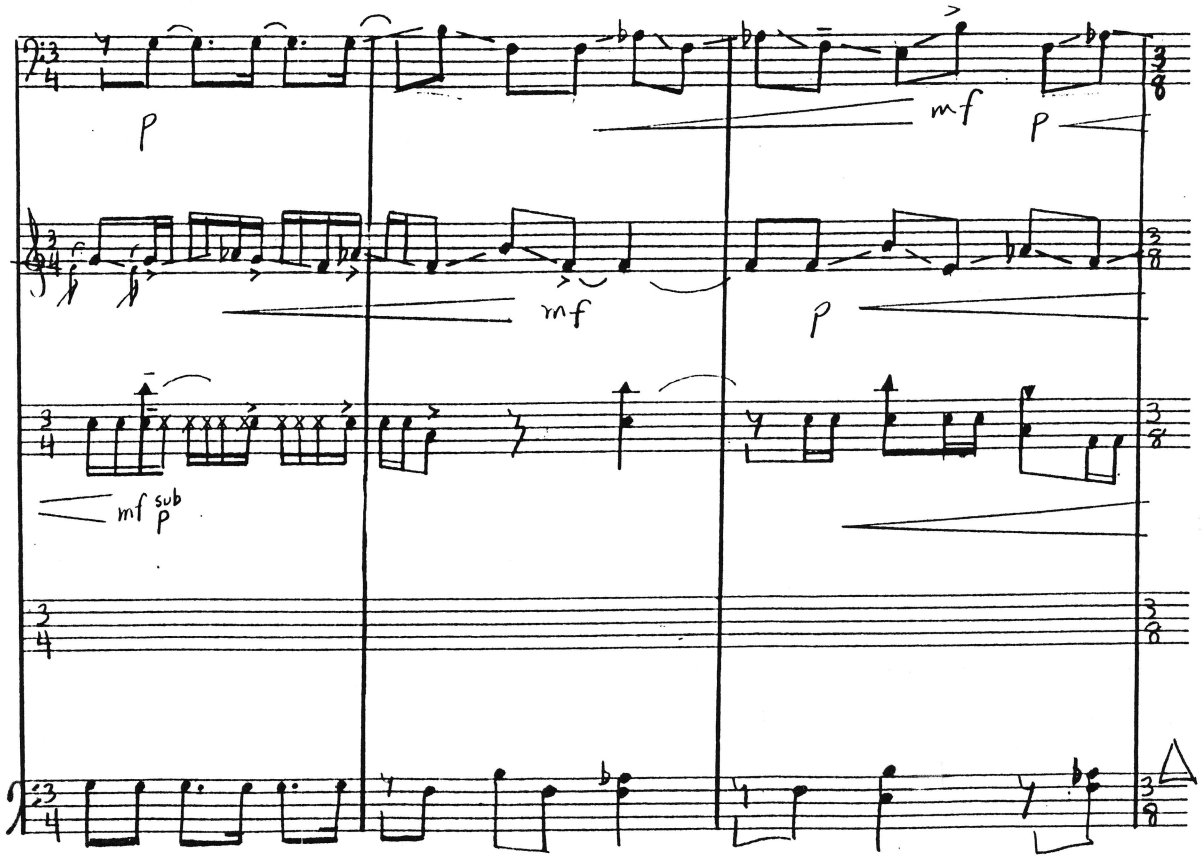
mf
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mf
p
mf sub p
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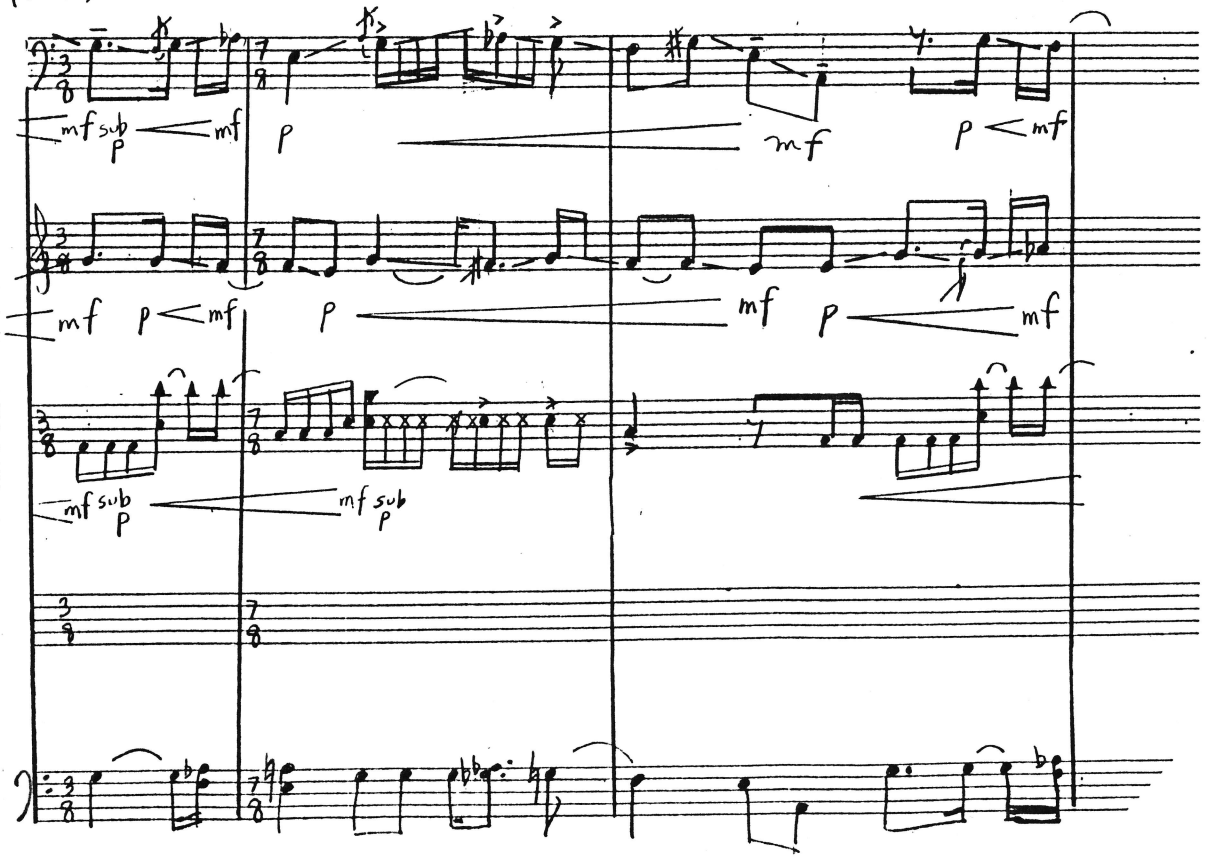
3/8

107

(♪ = ♪)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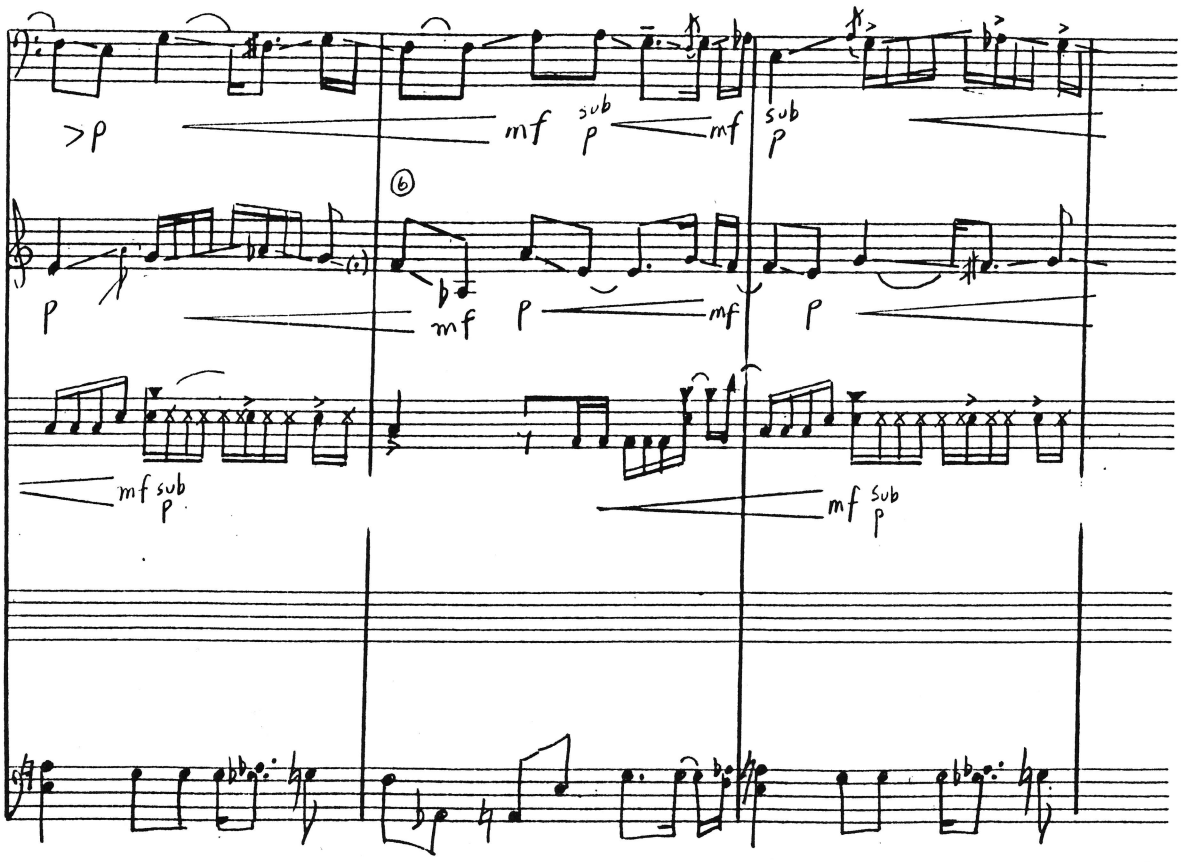
mf sub p
mf sub p
7/8
3/8

110.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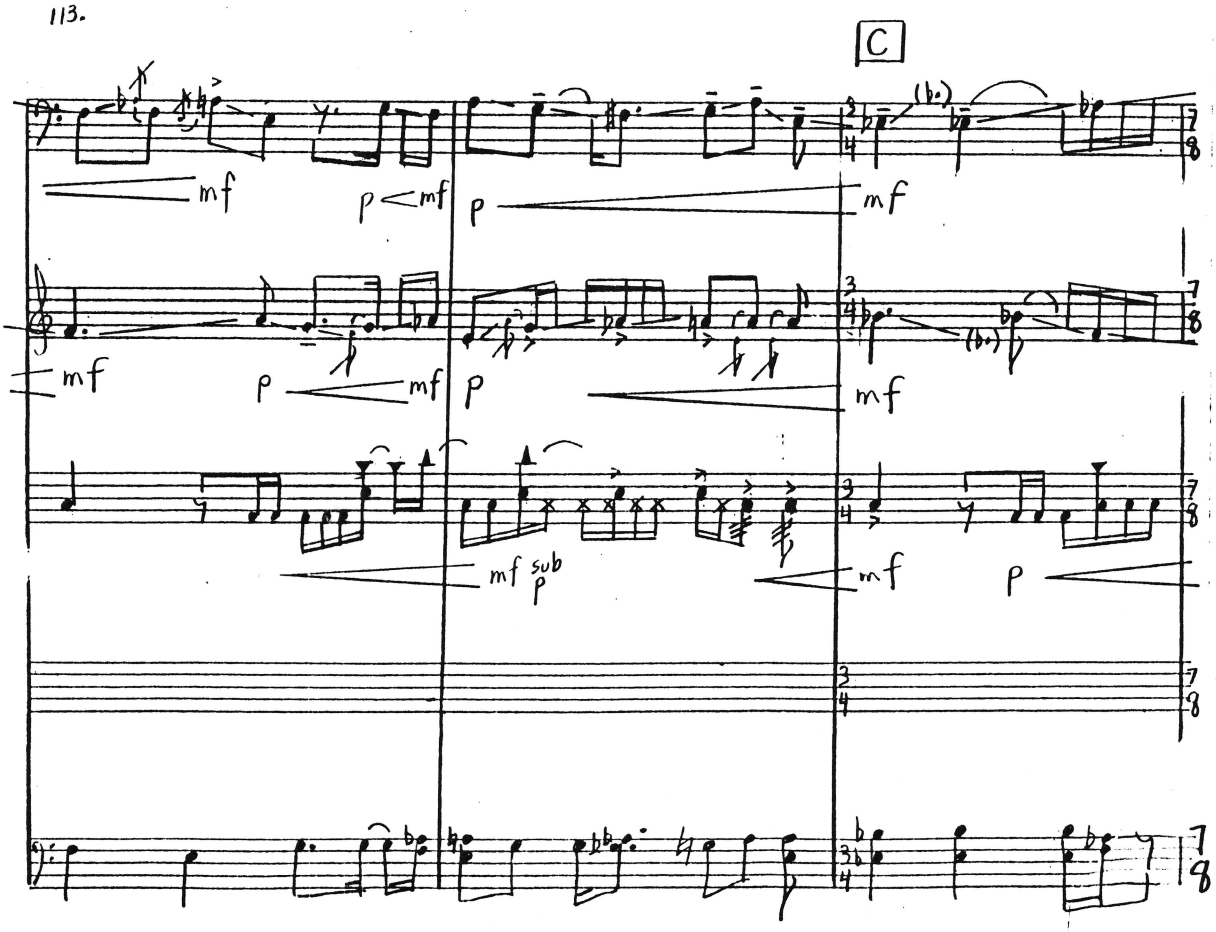
mf sub p
mf sub p

113.


C
mf
p<mf
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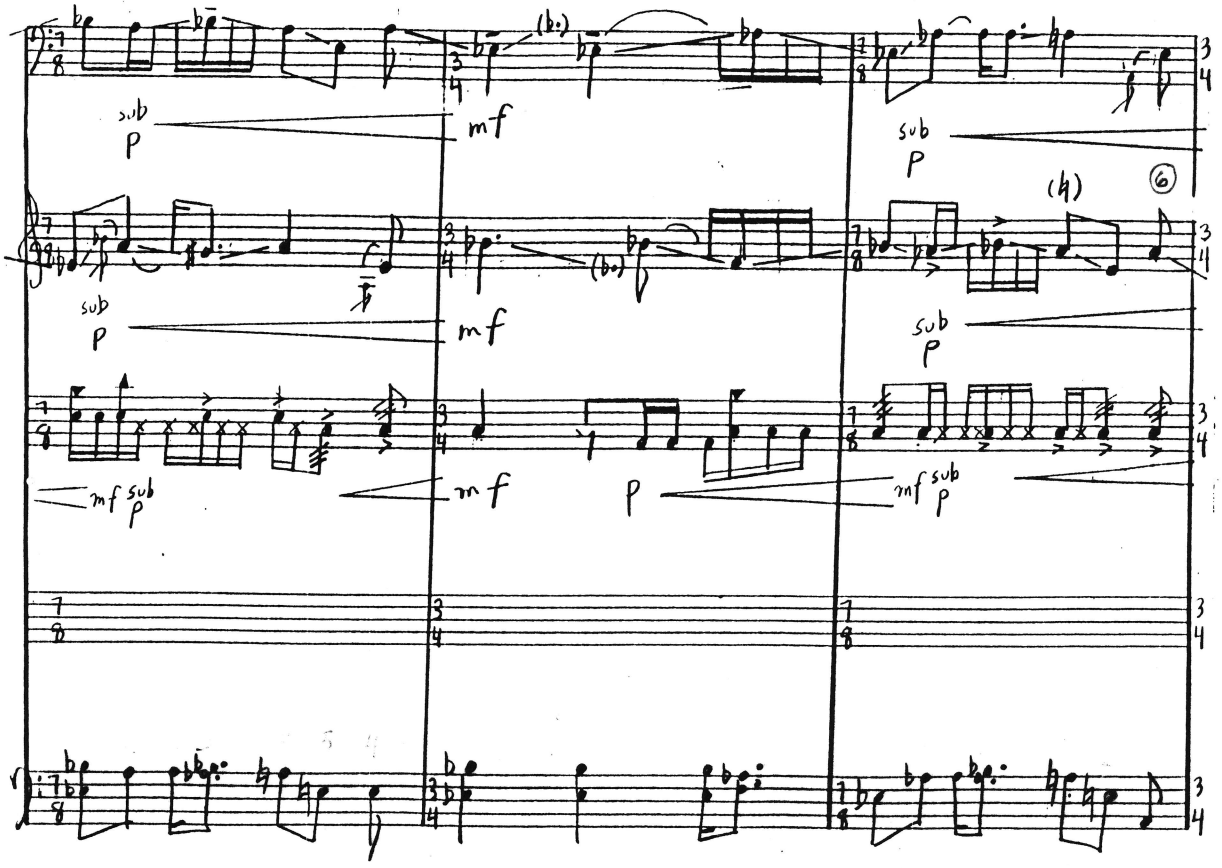
116



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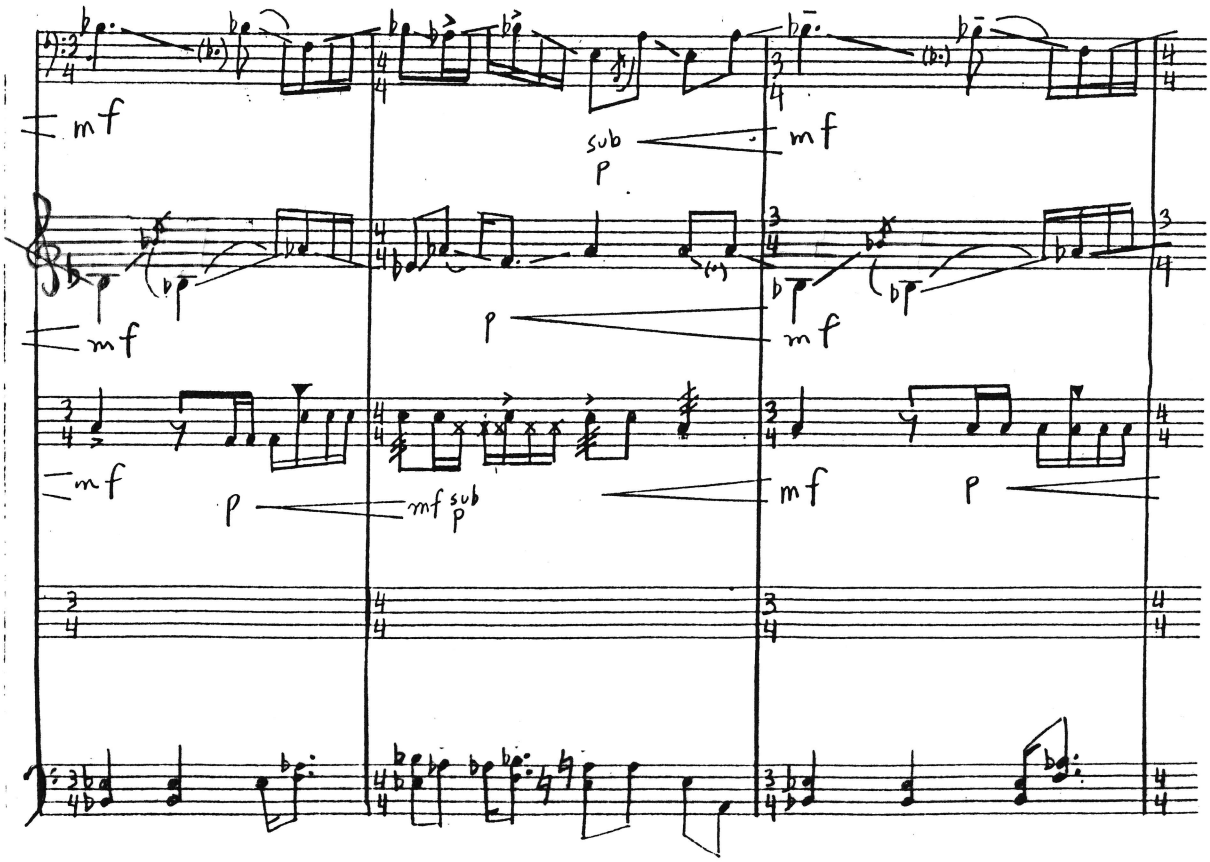
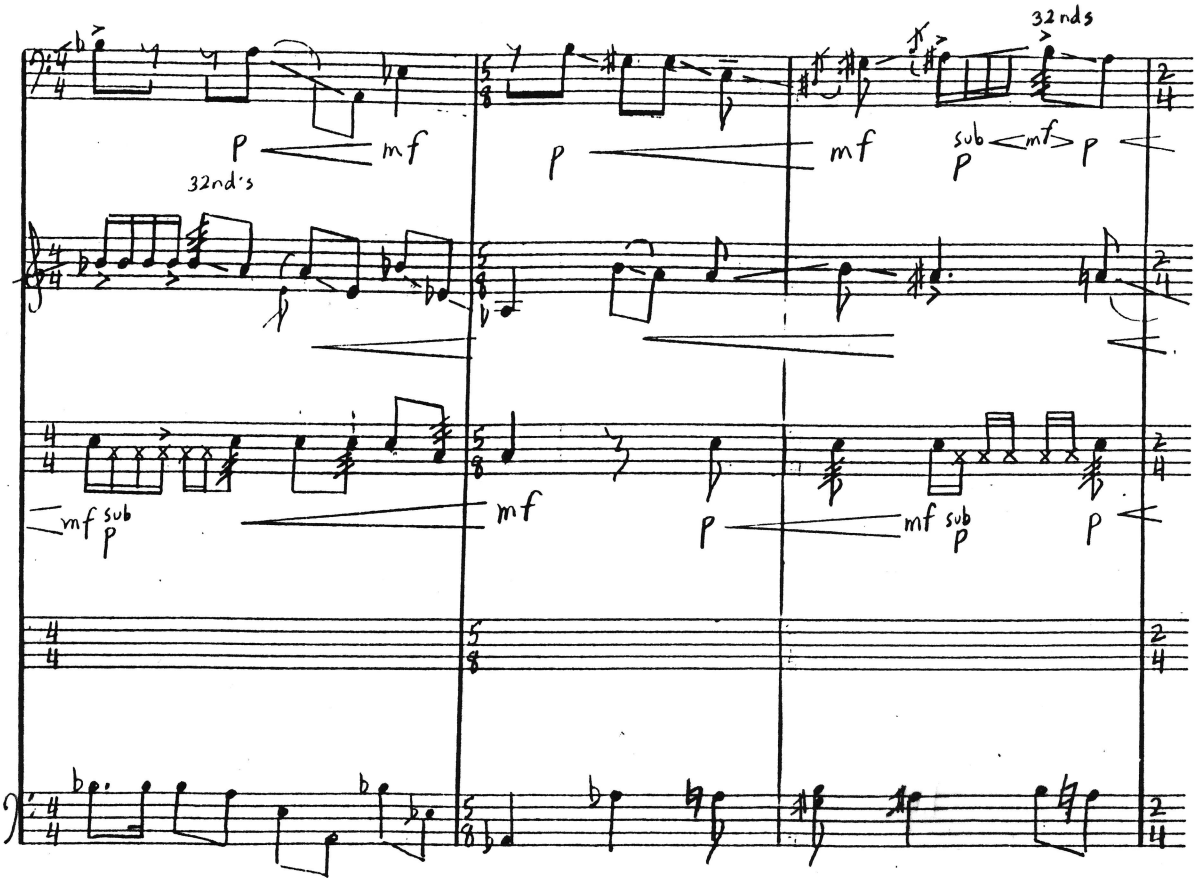
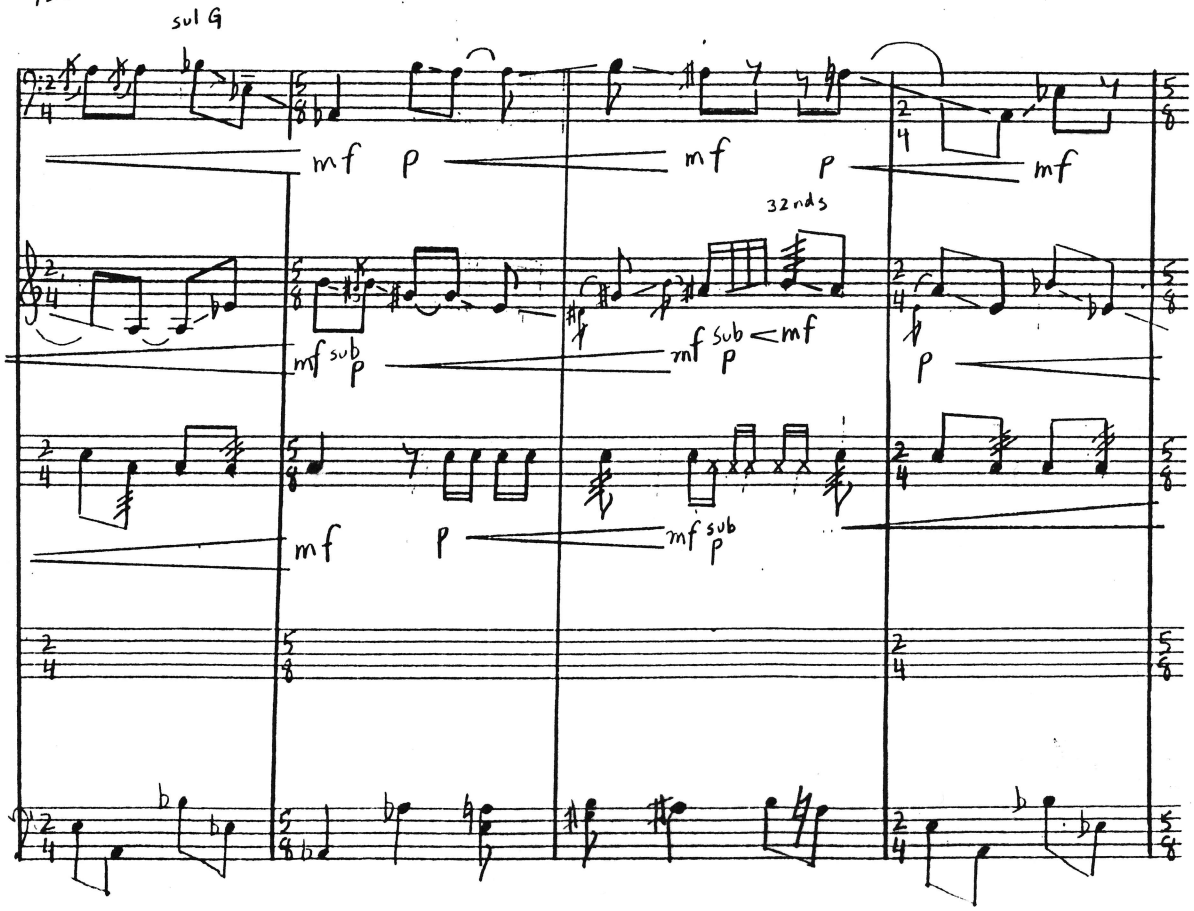
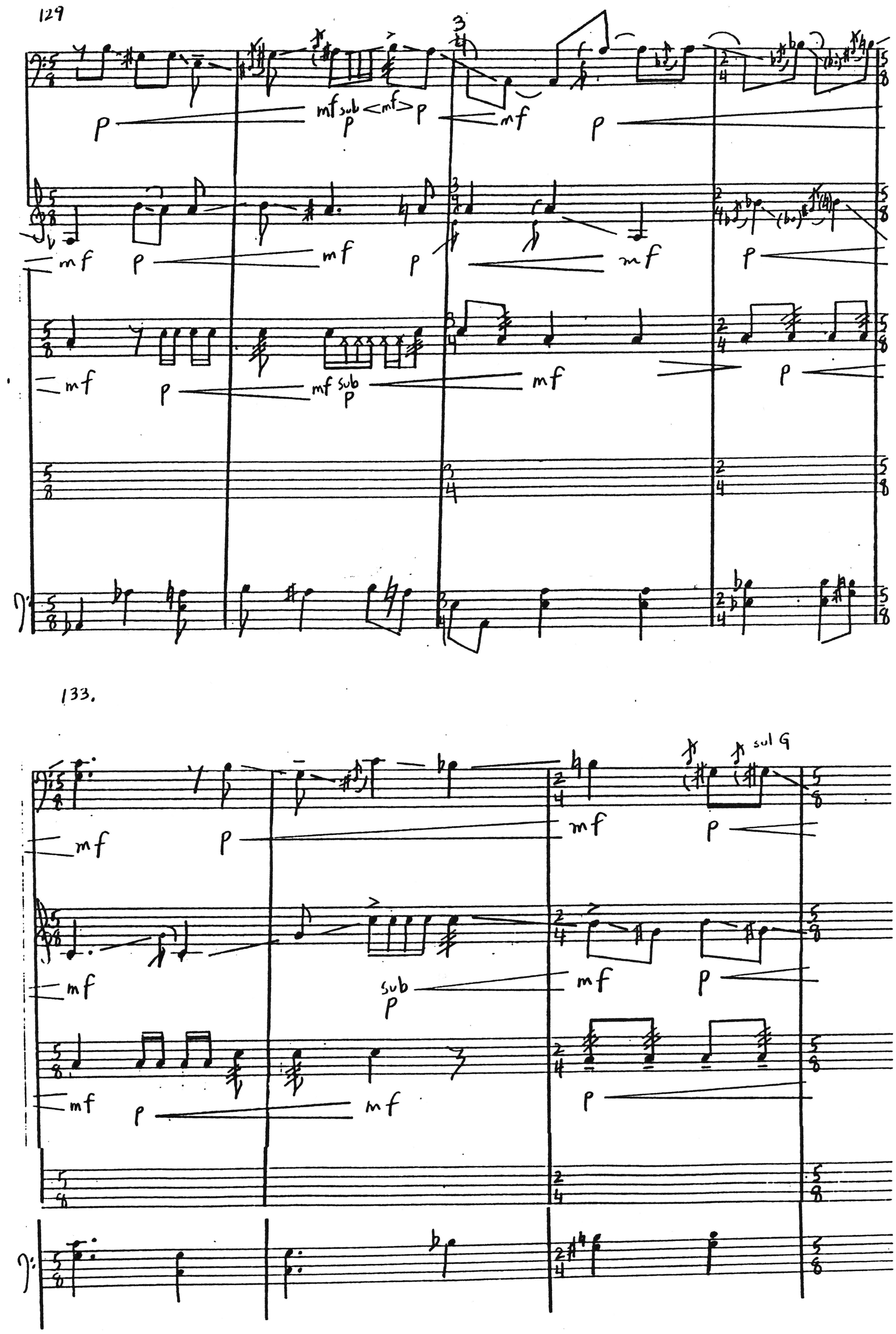


122.

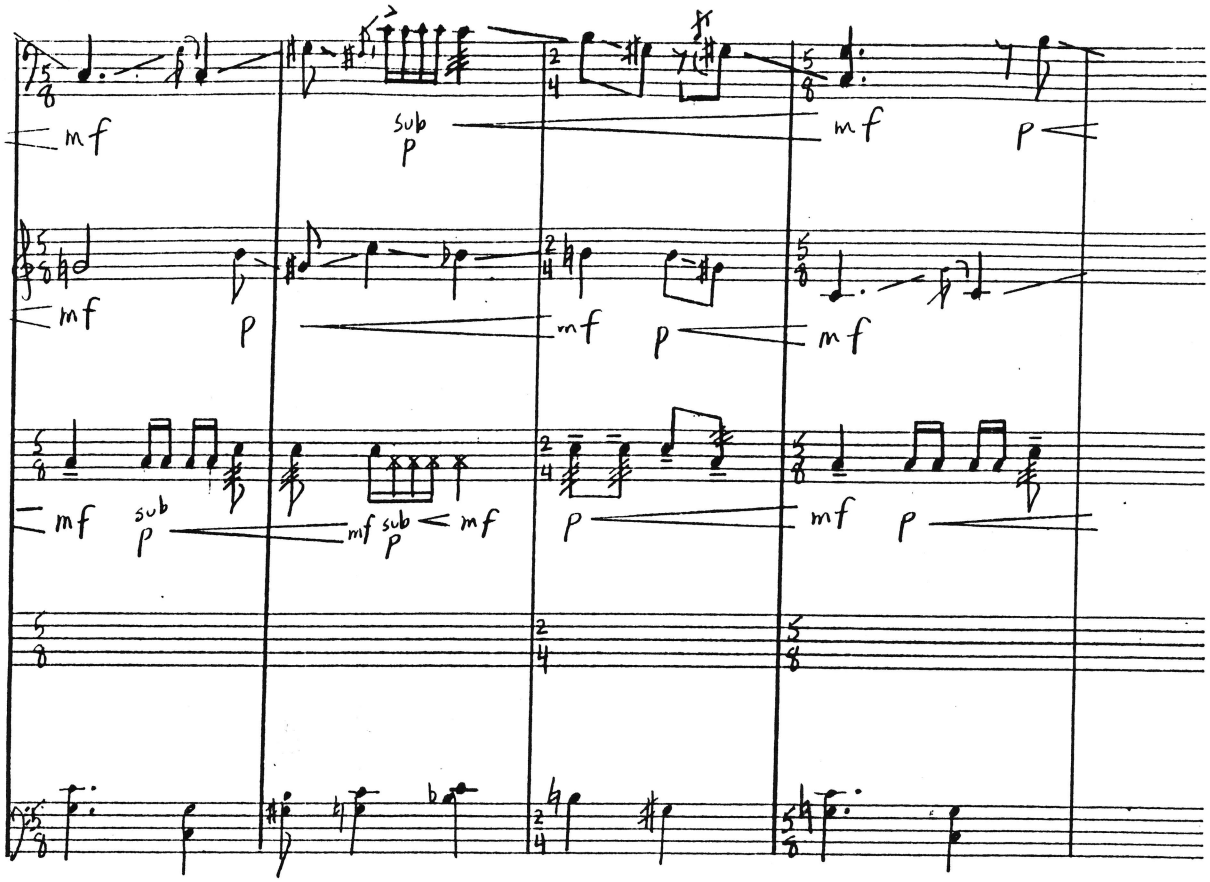


125



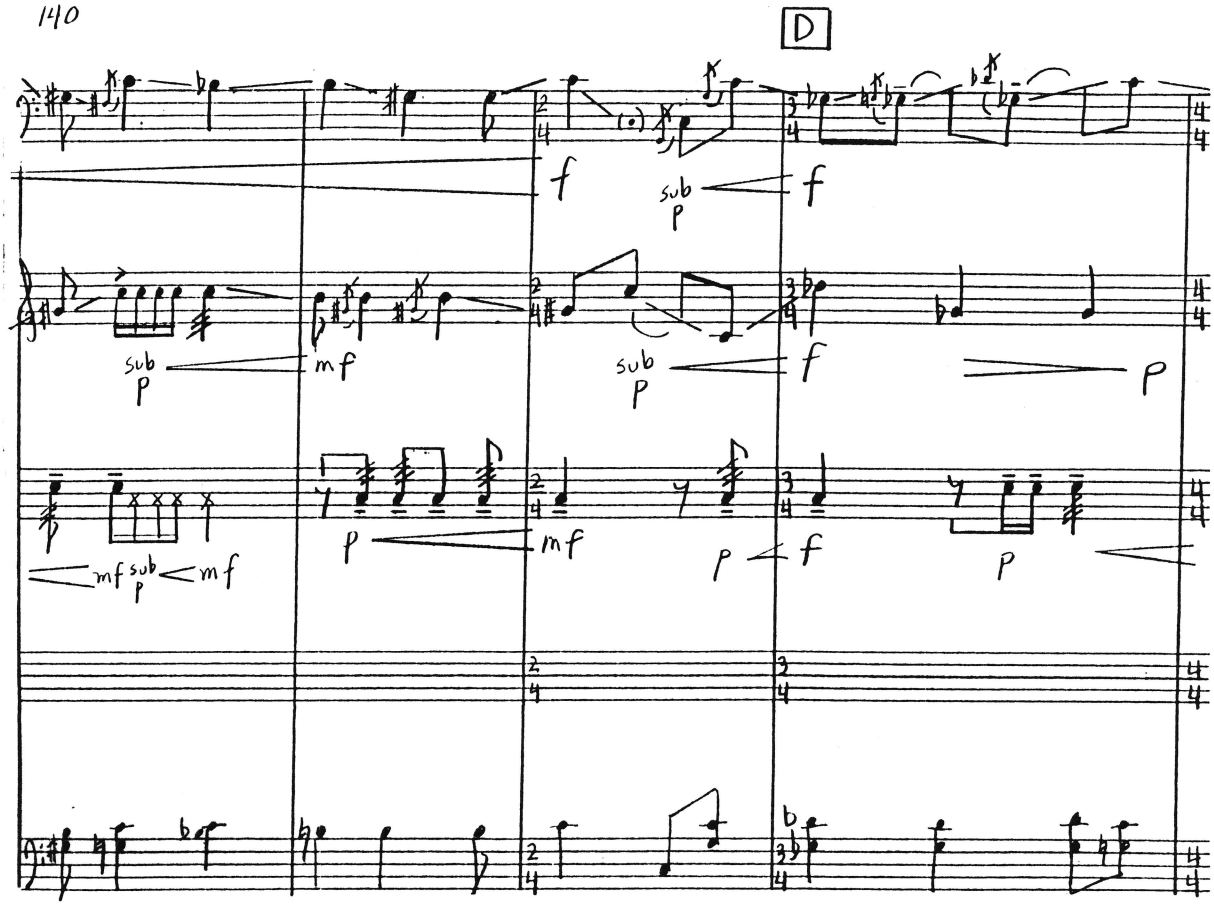

129
p
mf sub
p
mf
mf sub
p
133.
sul G
mf
sub
p

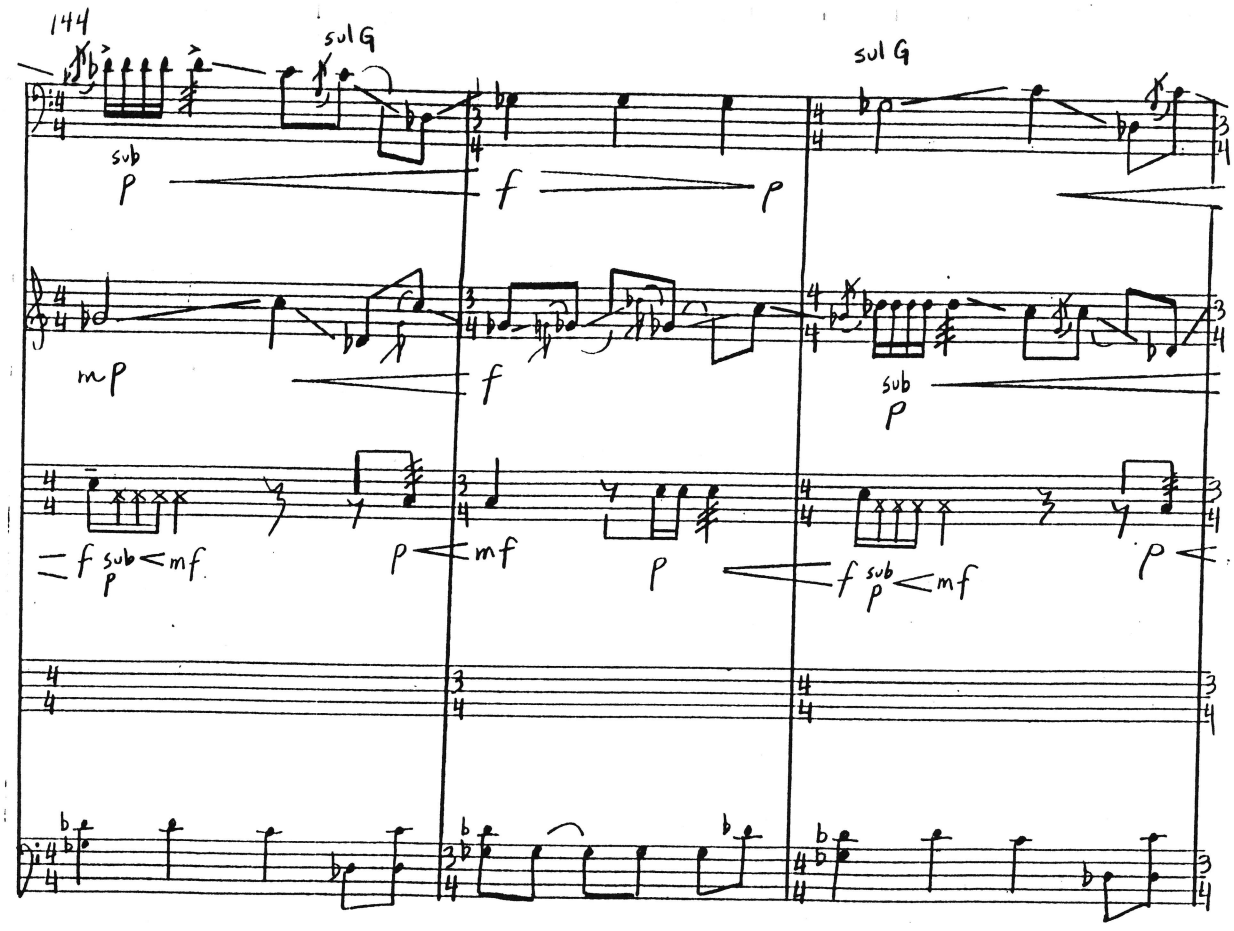
136

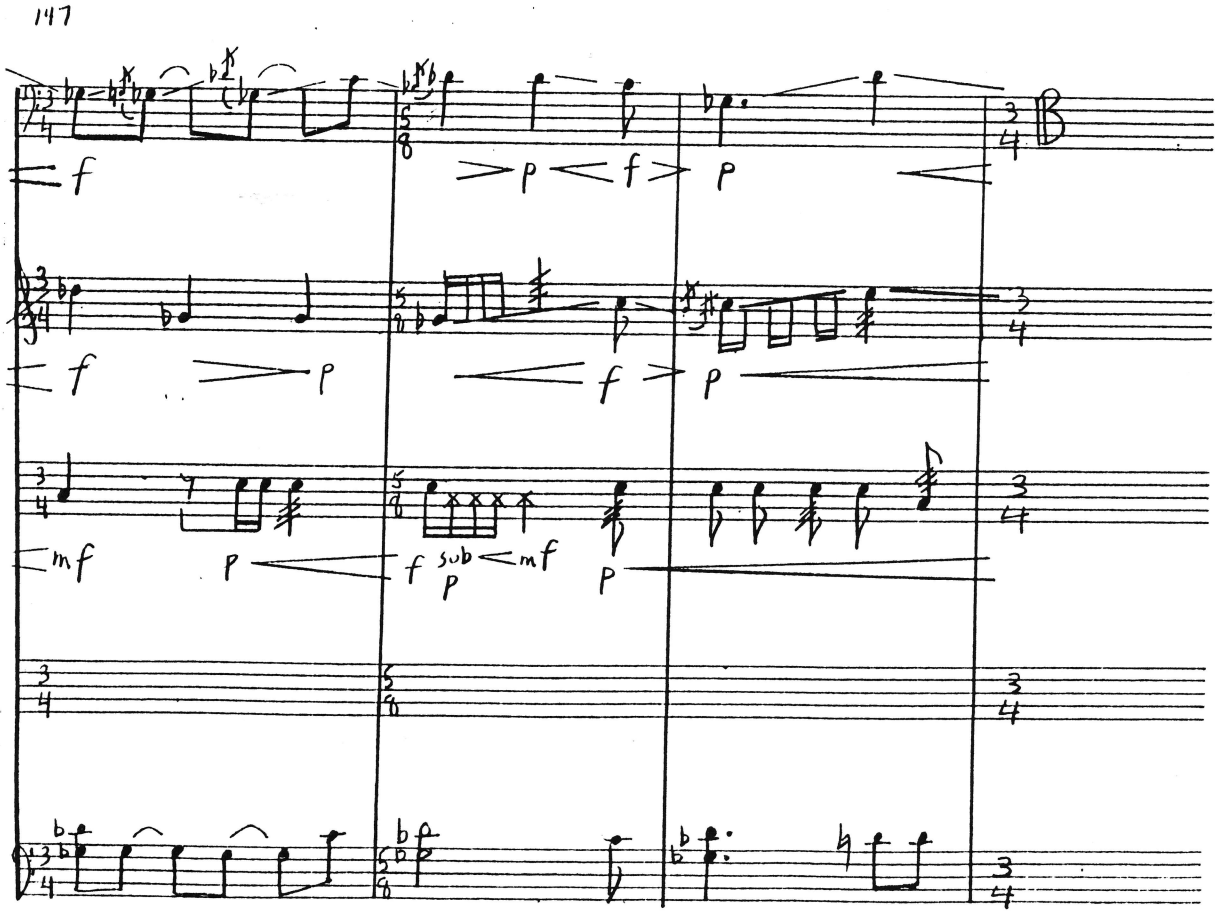

mf
sub p
mf
p
mf
p
mf
p
mf
p
mf
p
mf
sub p
mf
sub p
mf
p
mf
p

140

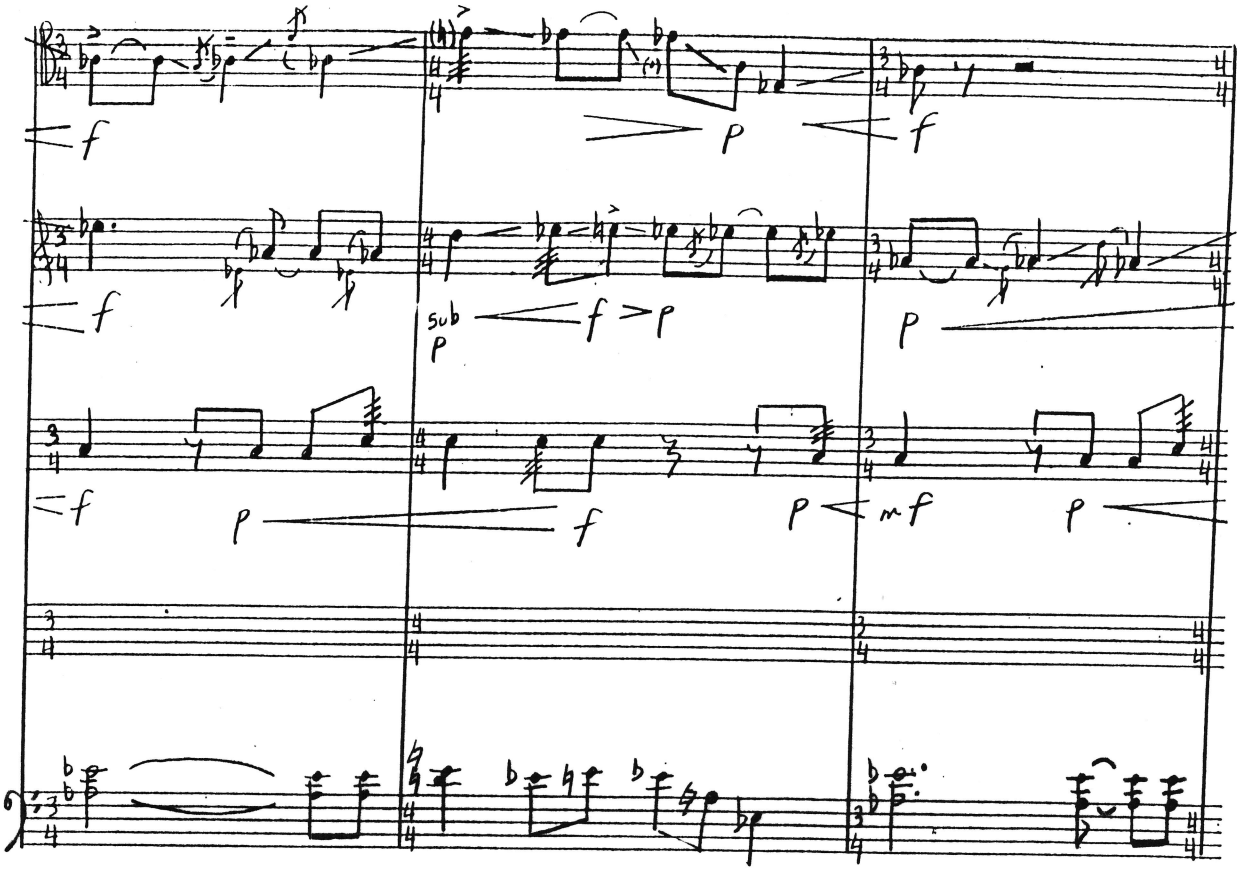
D


f
sub p
f
sub p
mf
sub p
f
p
mf
sub p
mf
p
mf
p
f
p

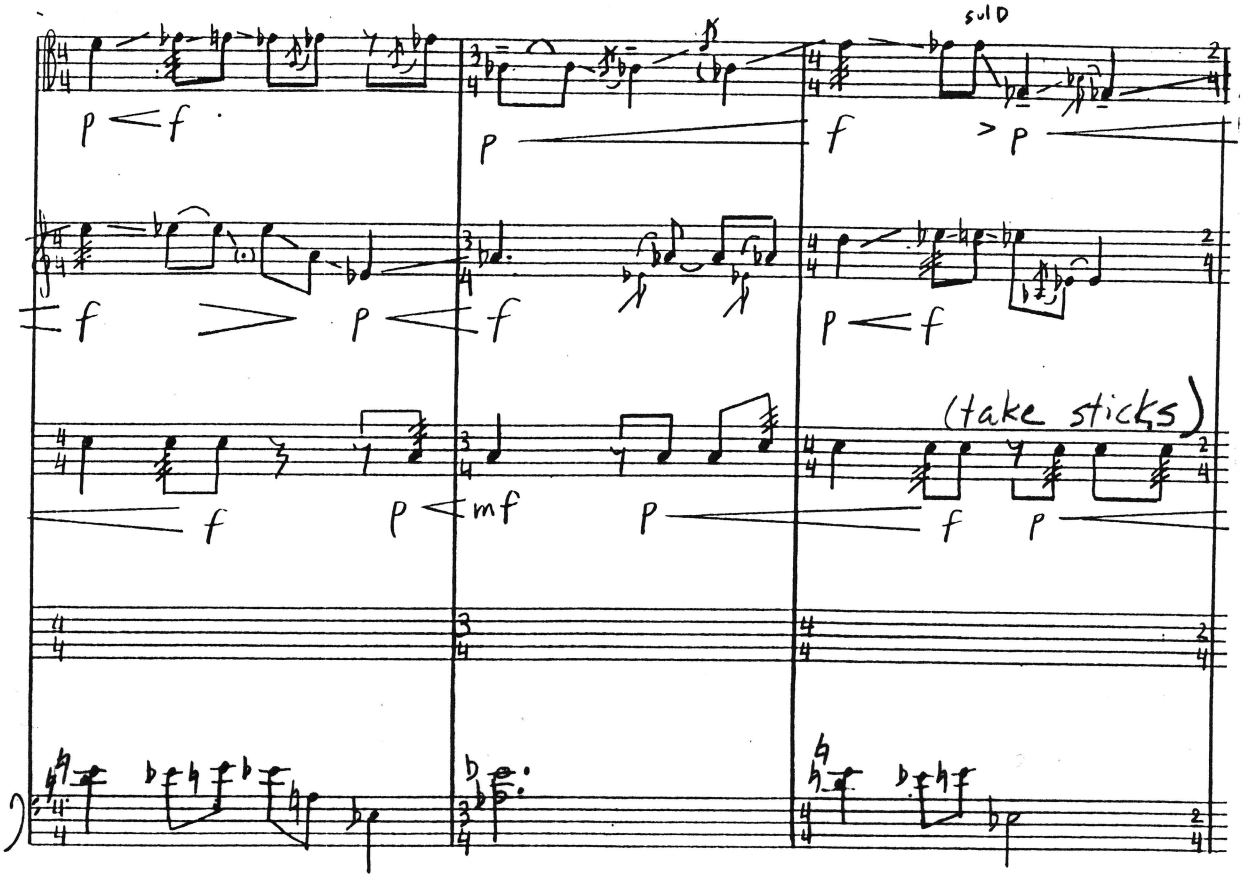

144
sul G
sul G
sub
p
f
p
mp
f
sub
p
f
sub
p
<
mf
p
<
mf
p
f
sub
p
<
mf
p
<

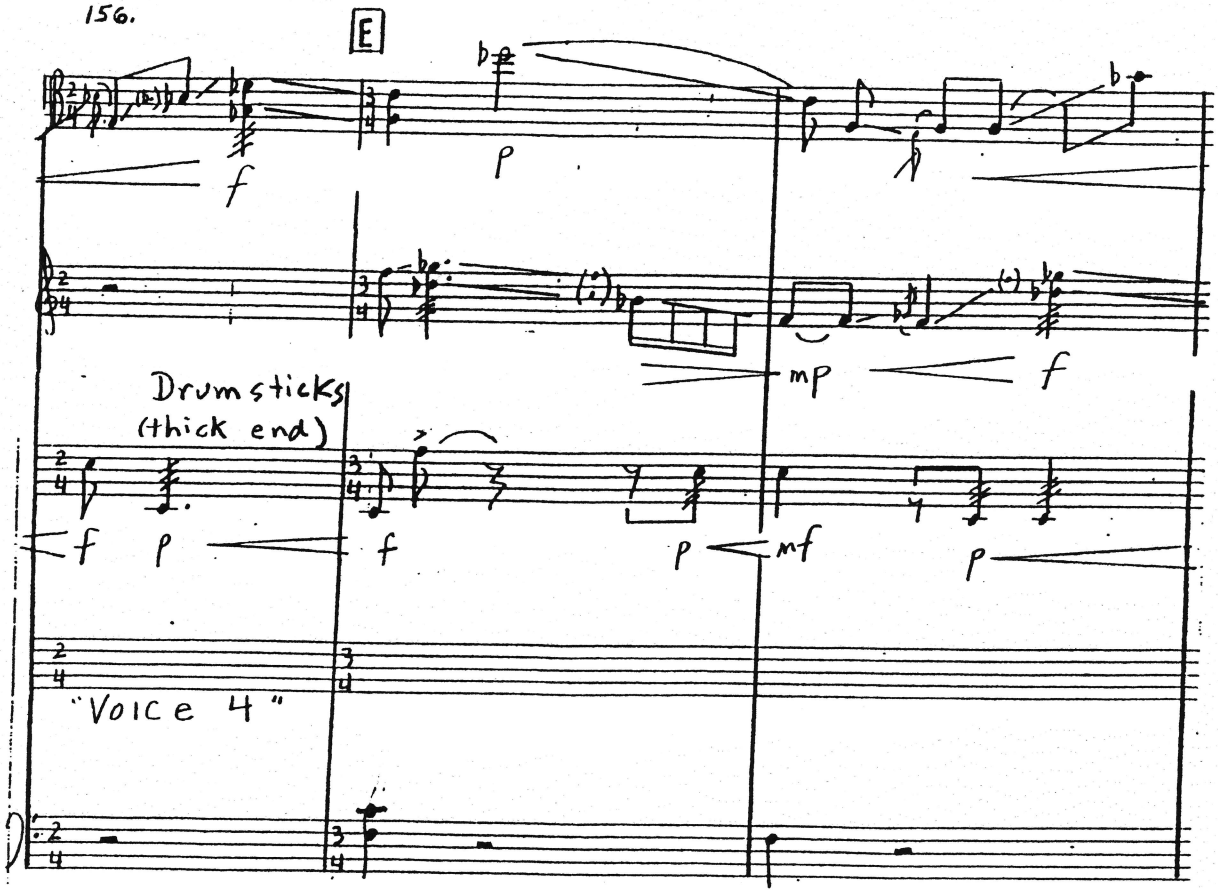

147
f
>
p
<
f
>
p
f
>
p
<
f
>
p
mf
p
<
f
sub
p
<
mf
p

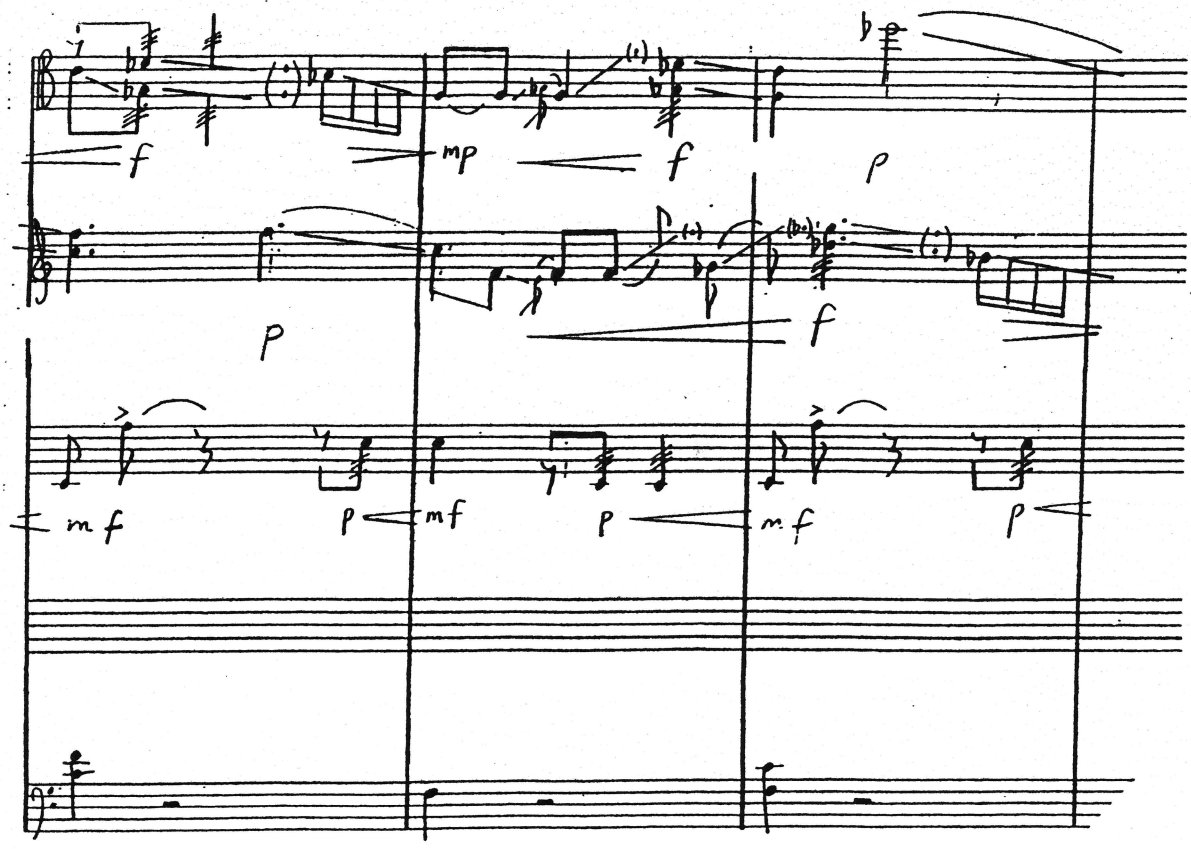
150



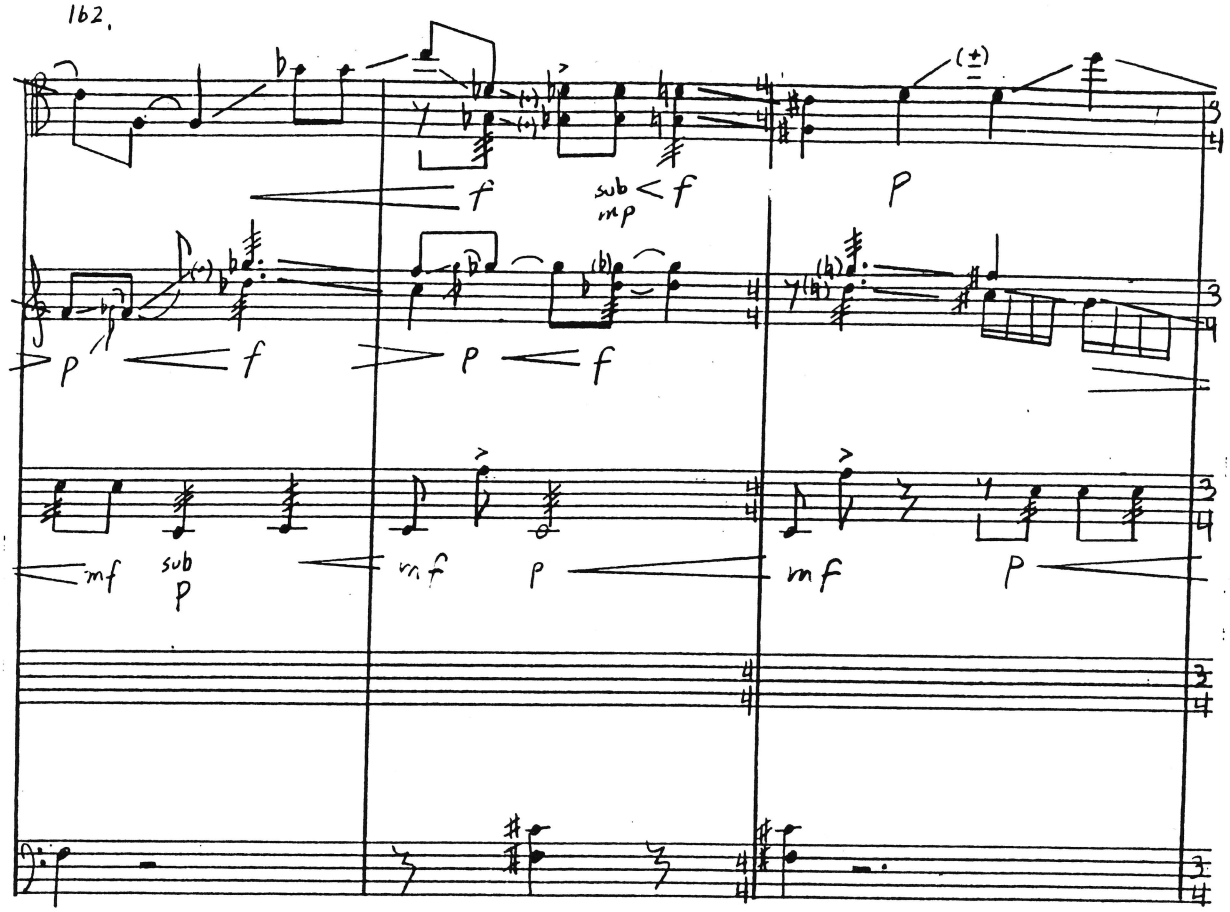
153



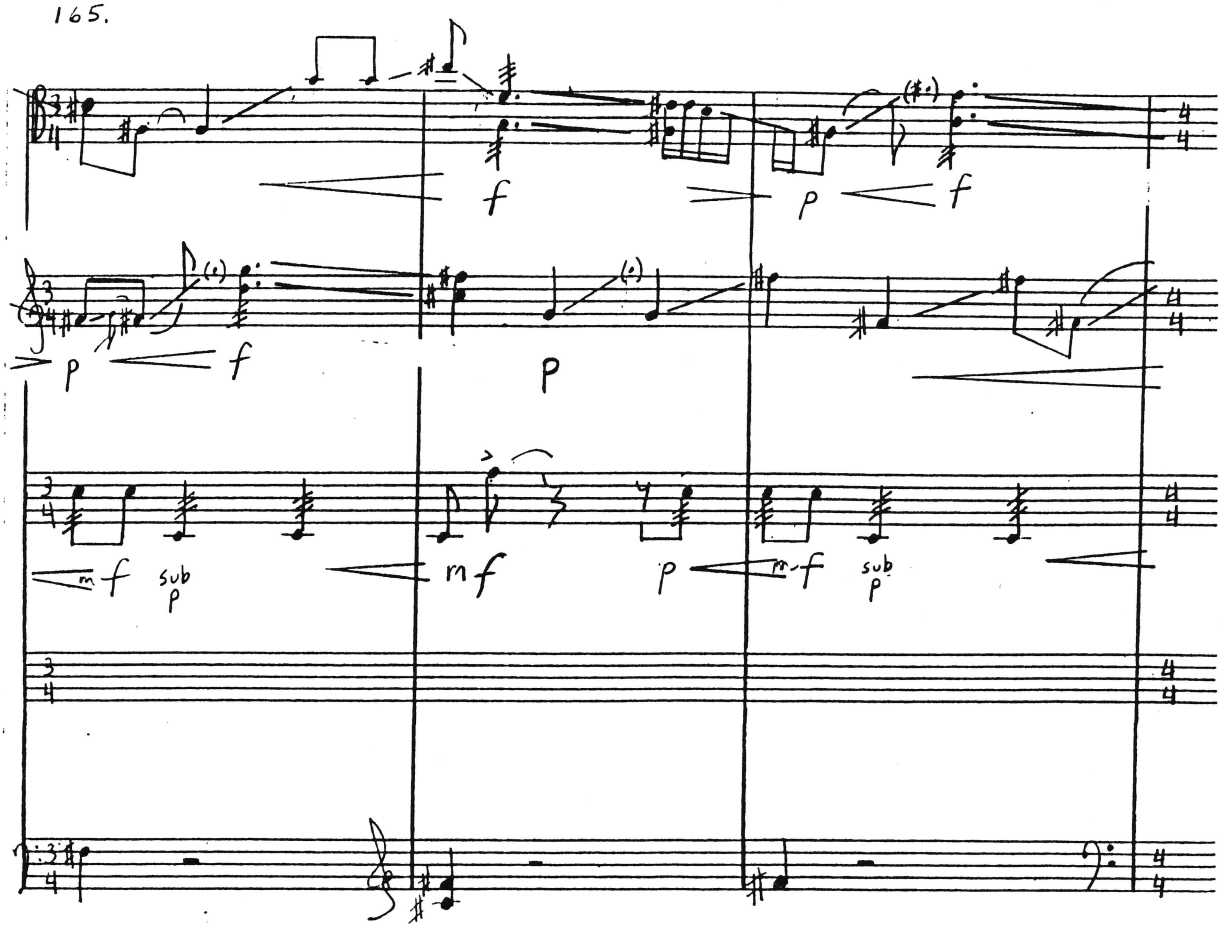

156.
E
Drumsticks
(thick end)
"Voice 4"


159.

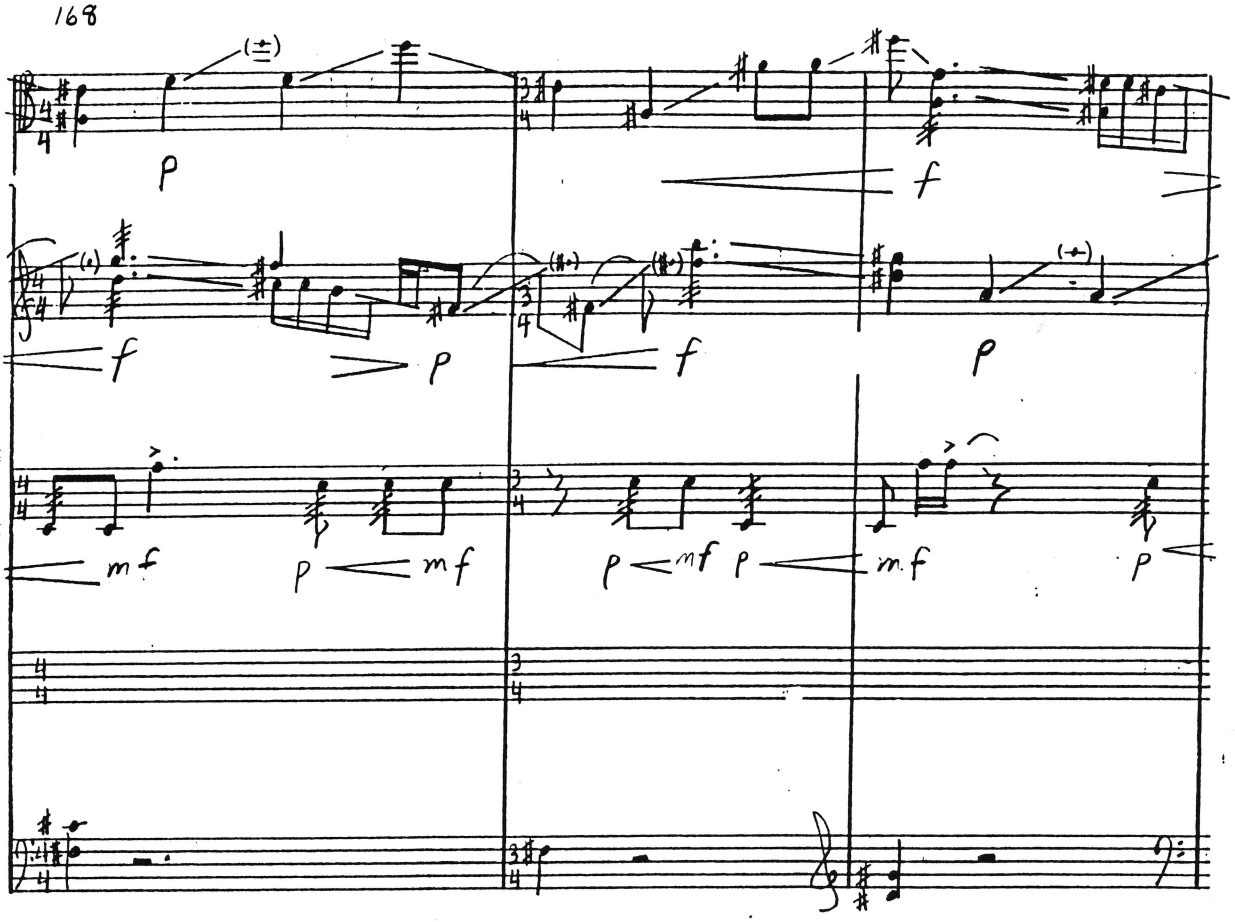
162.



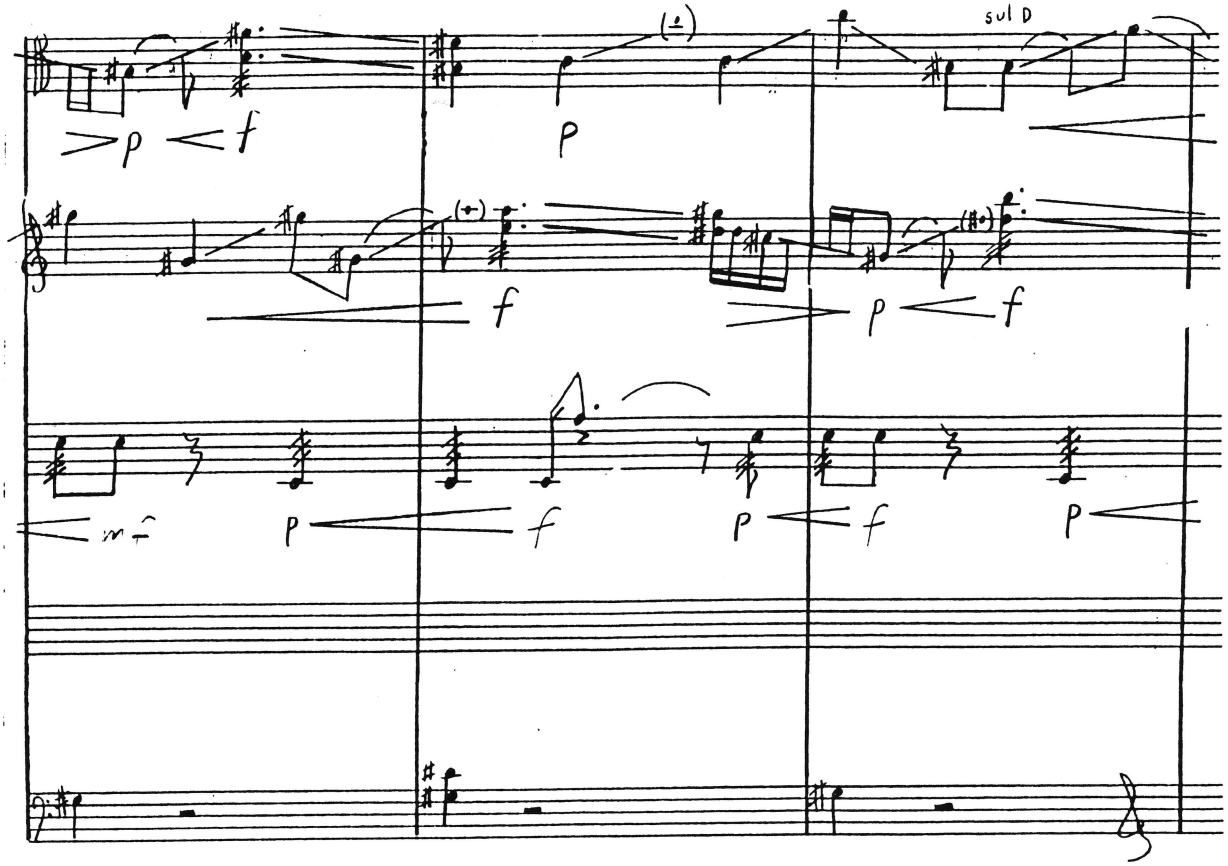
165.



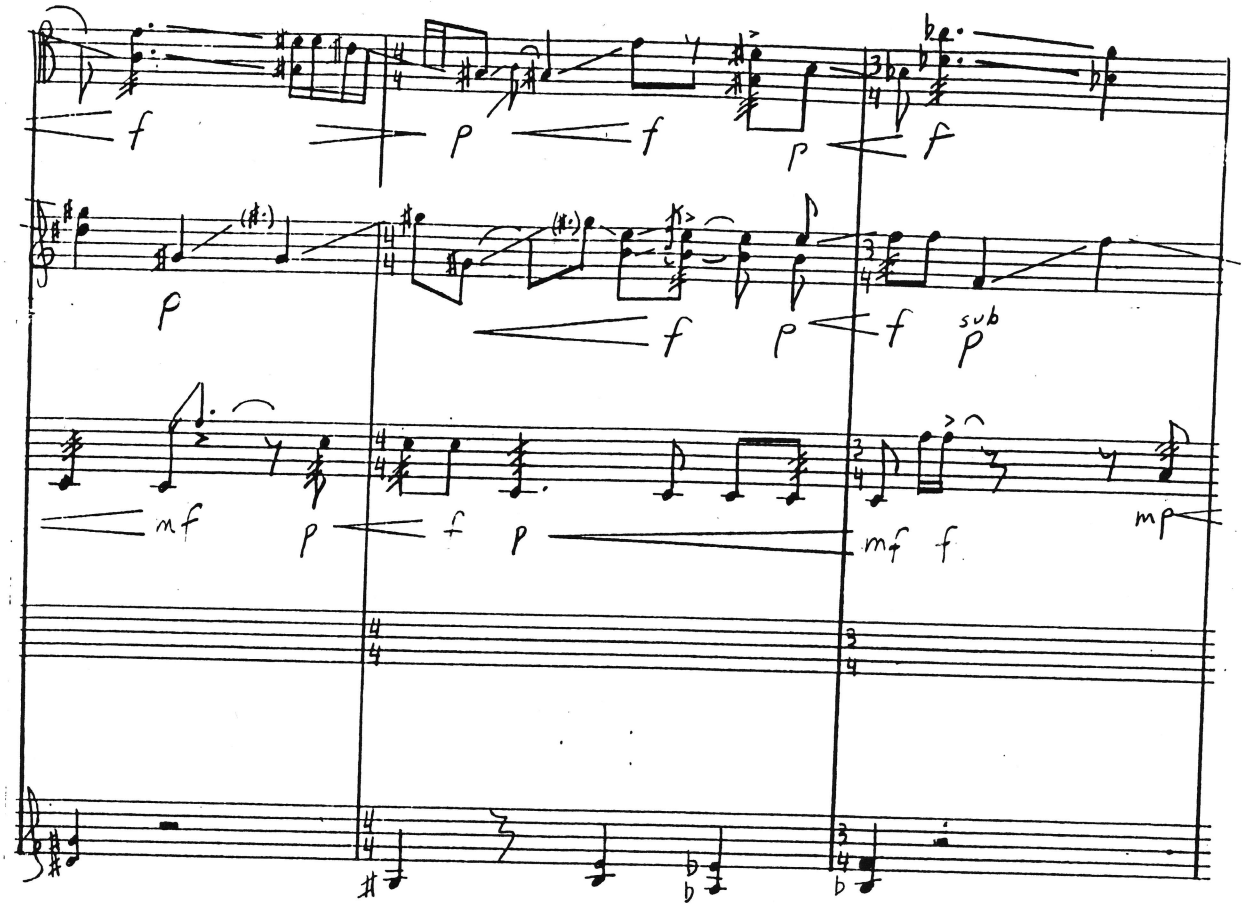
168



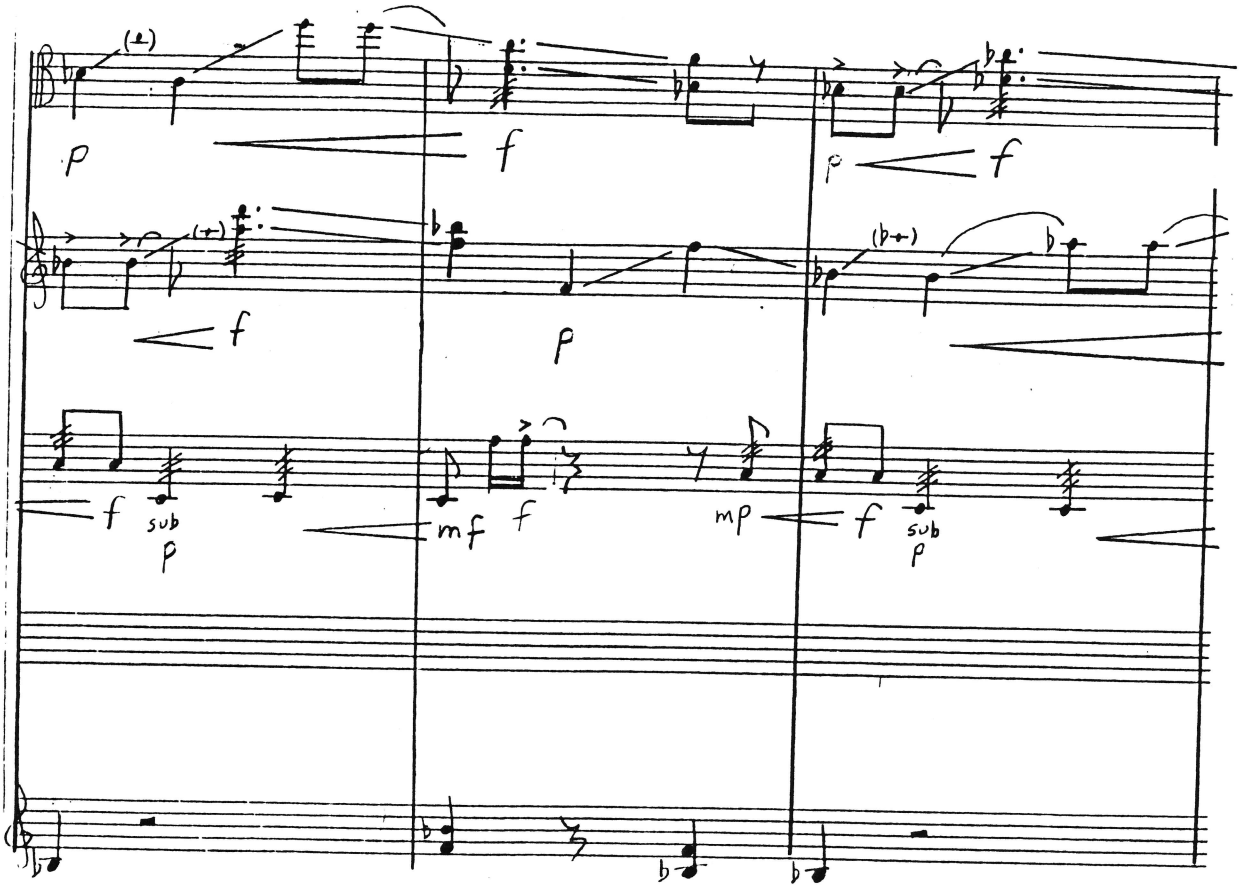
171

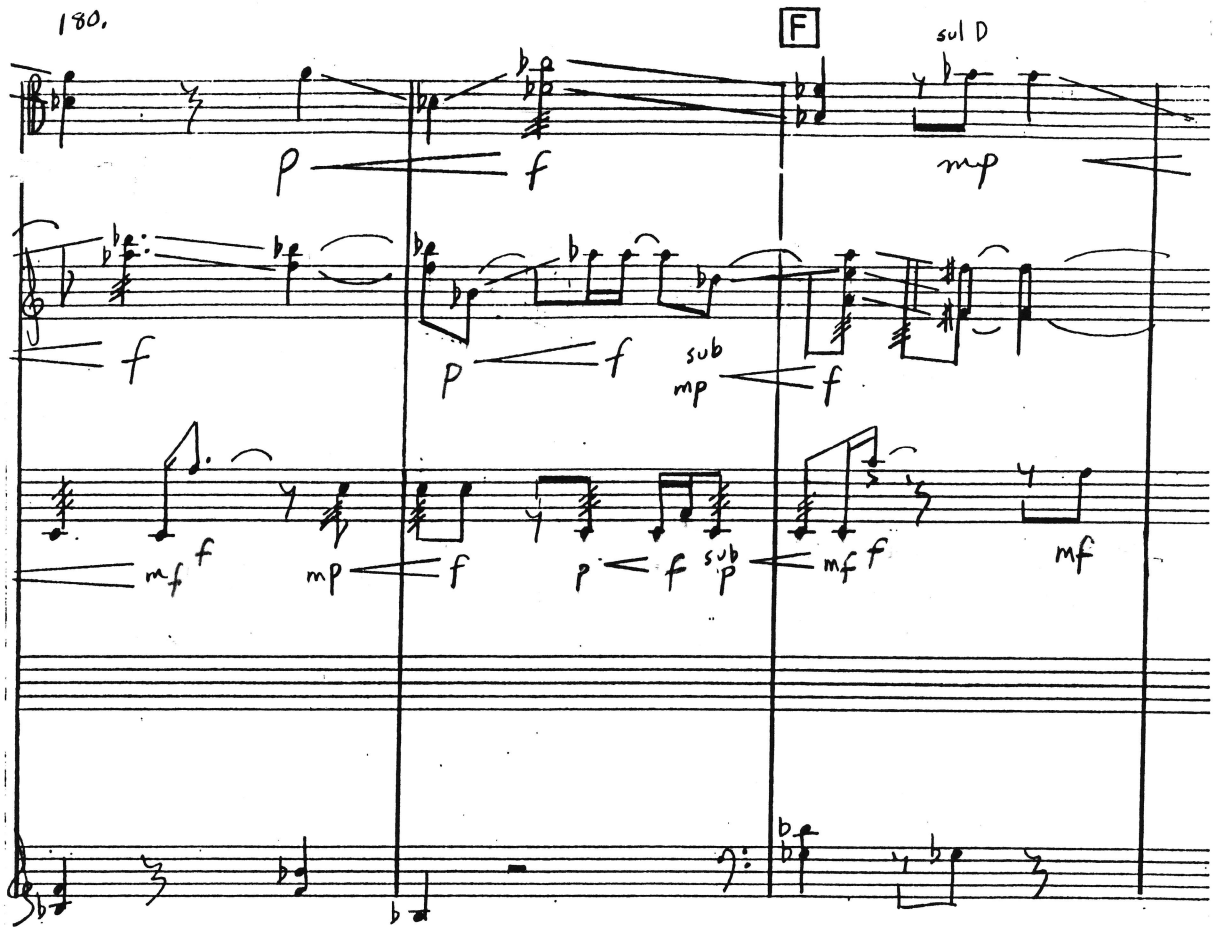


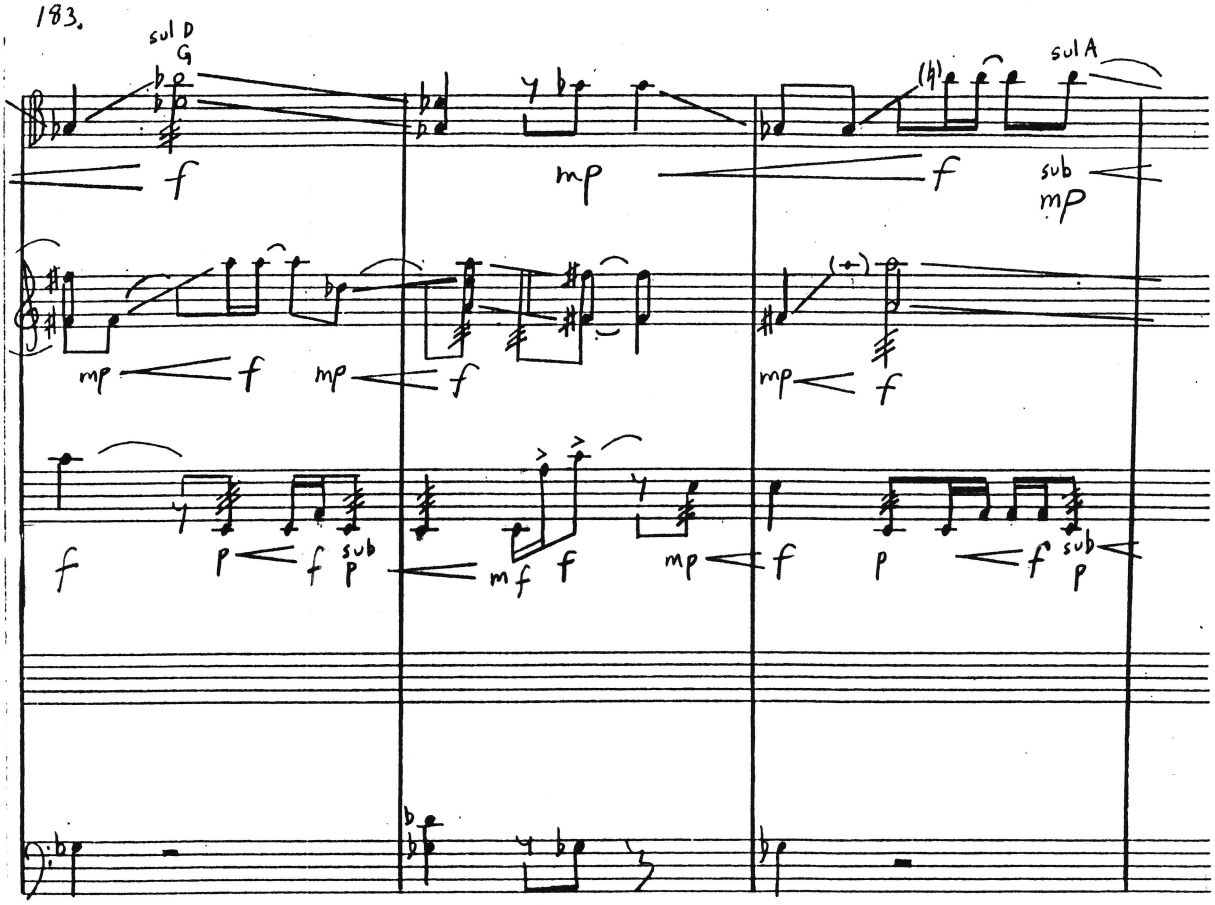
174



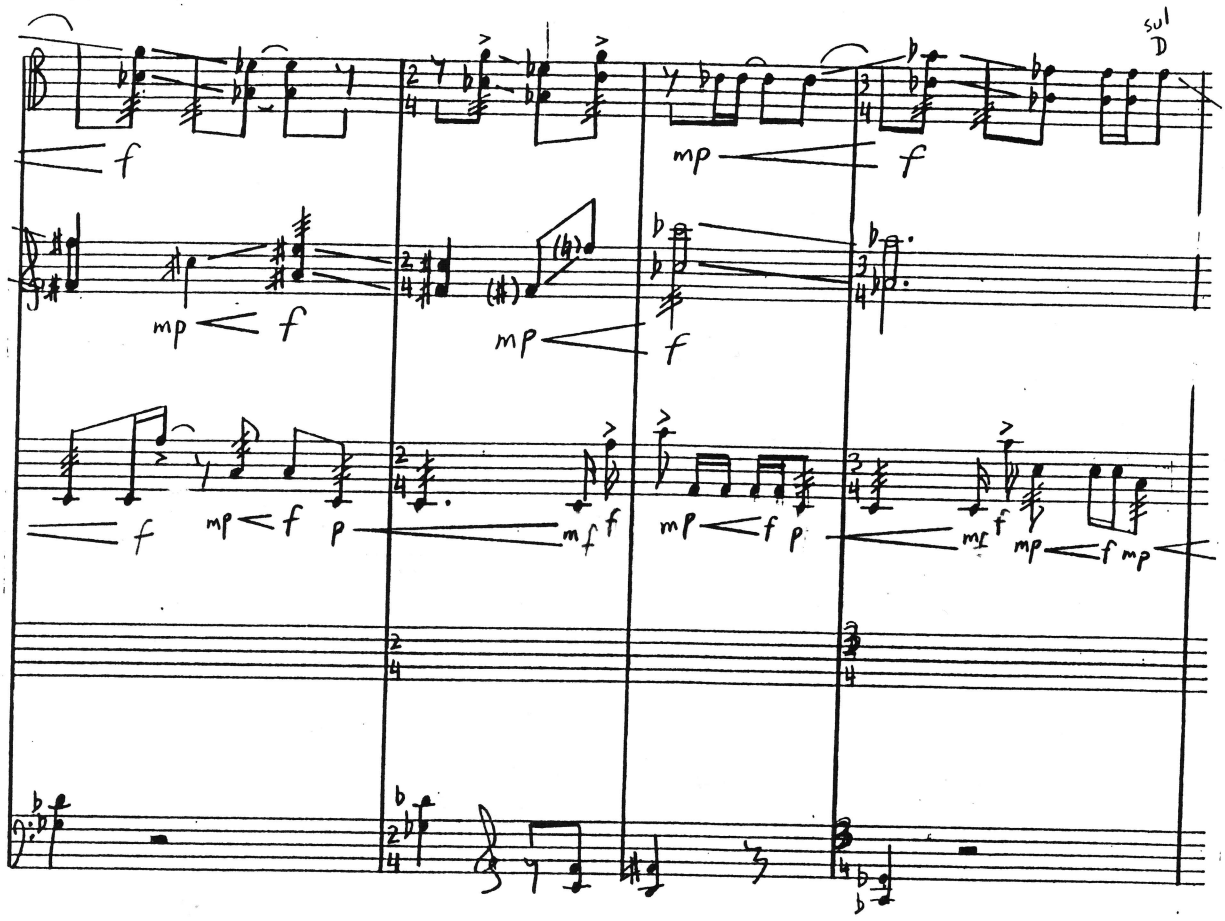
177.



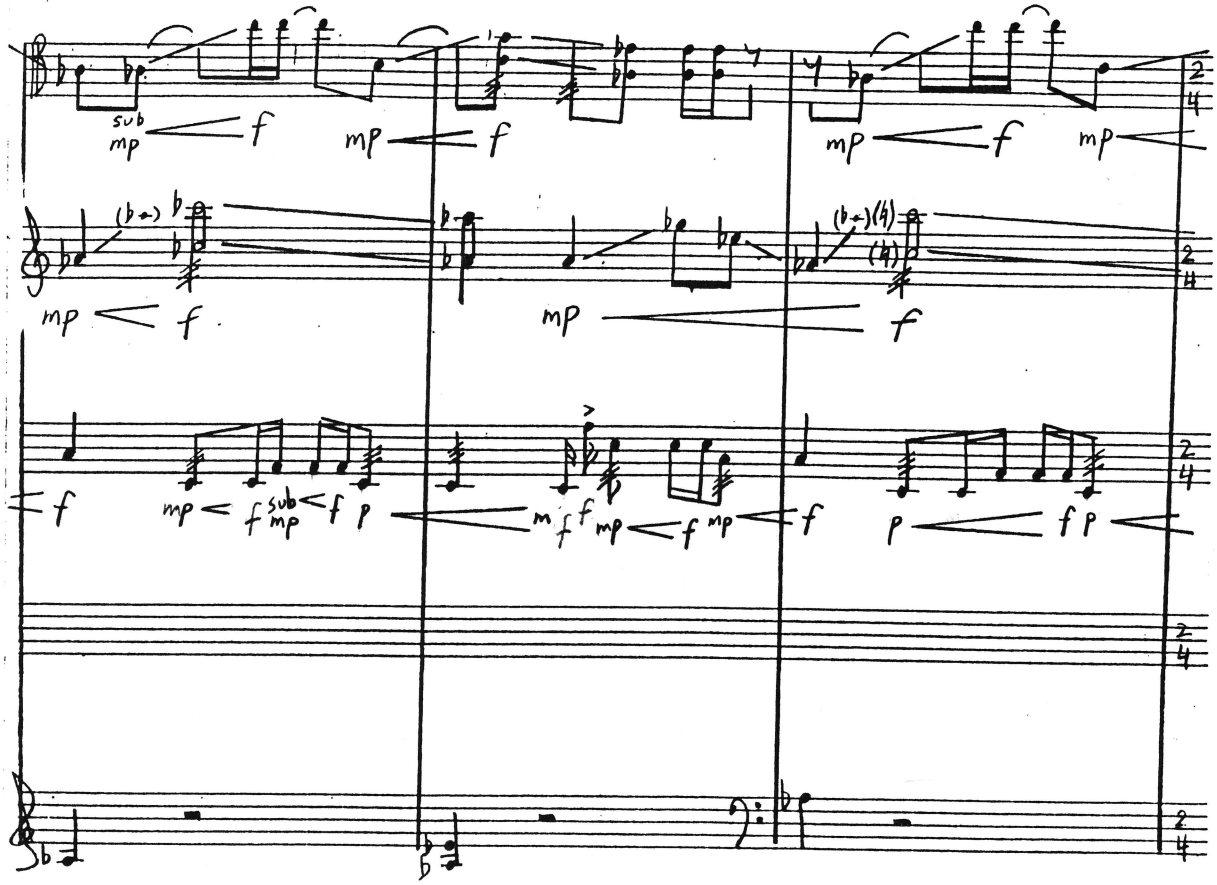

180.
F
sul D
p
f
mp
sub
mf


183.
sul D
G
sul A
f
mp
sub
p

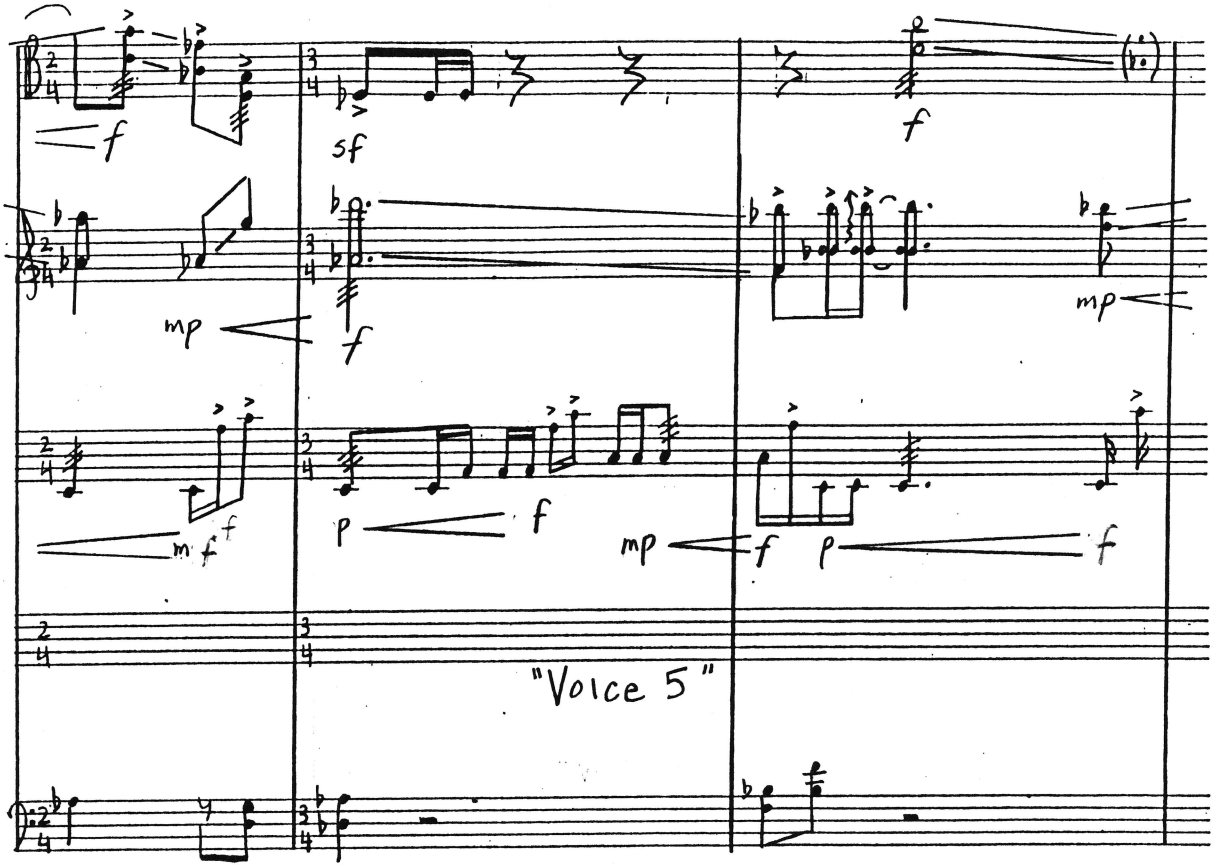
186



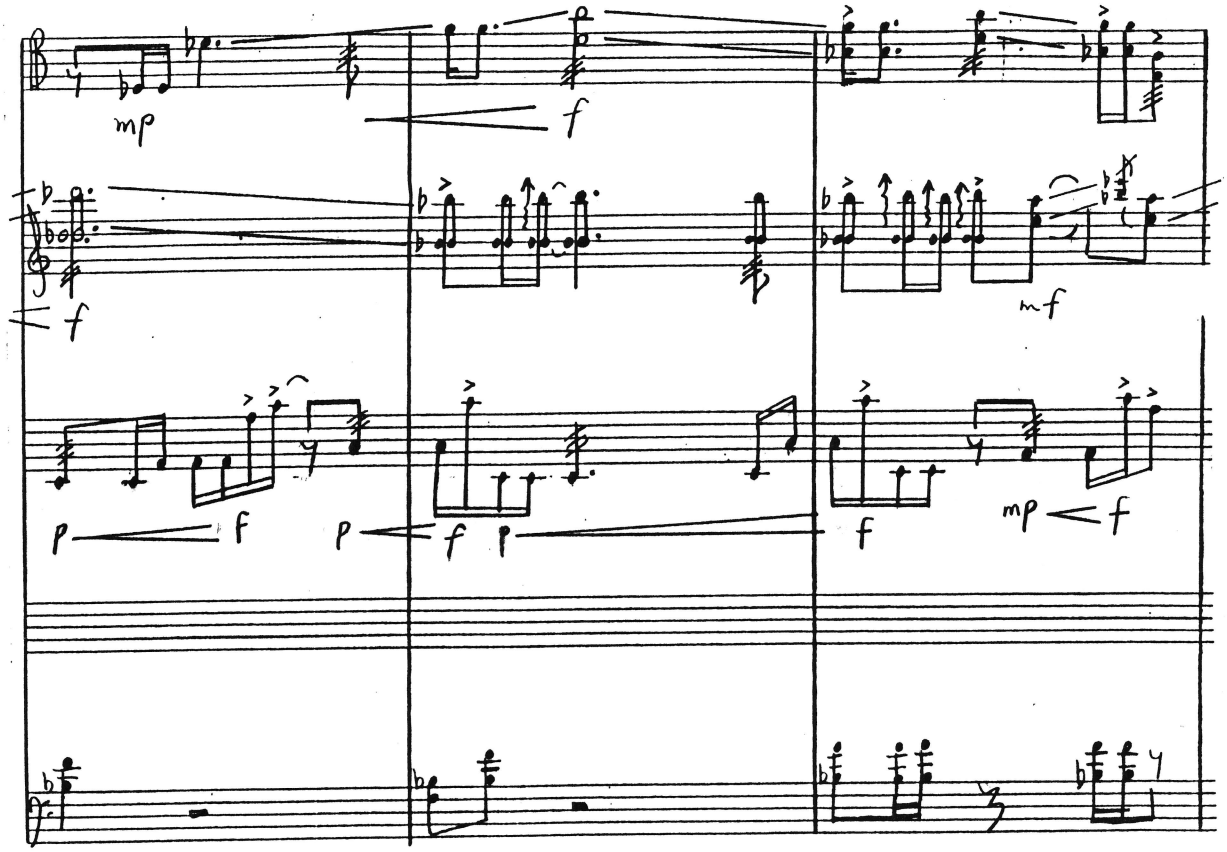
190.

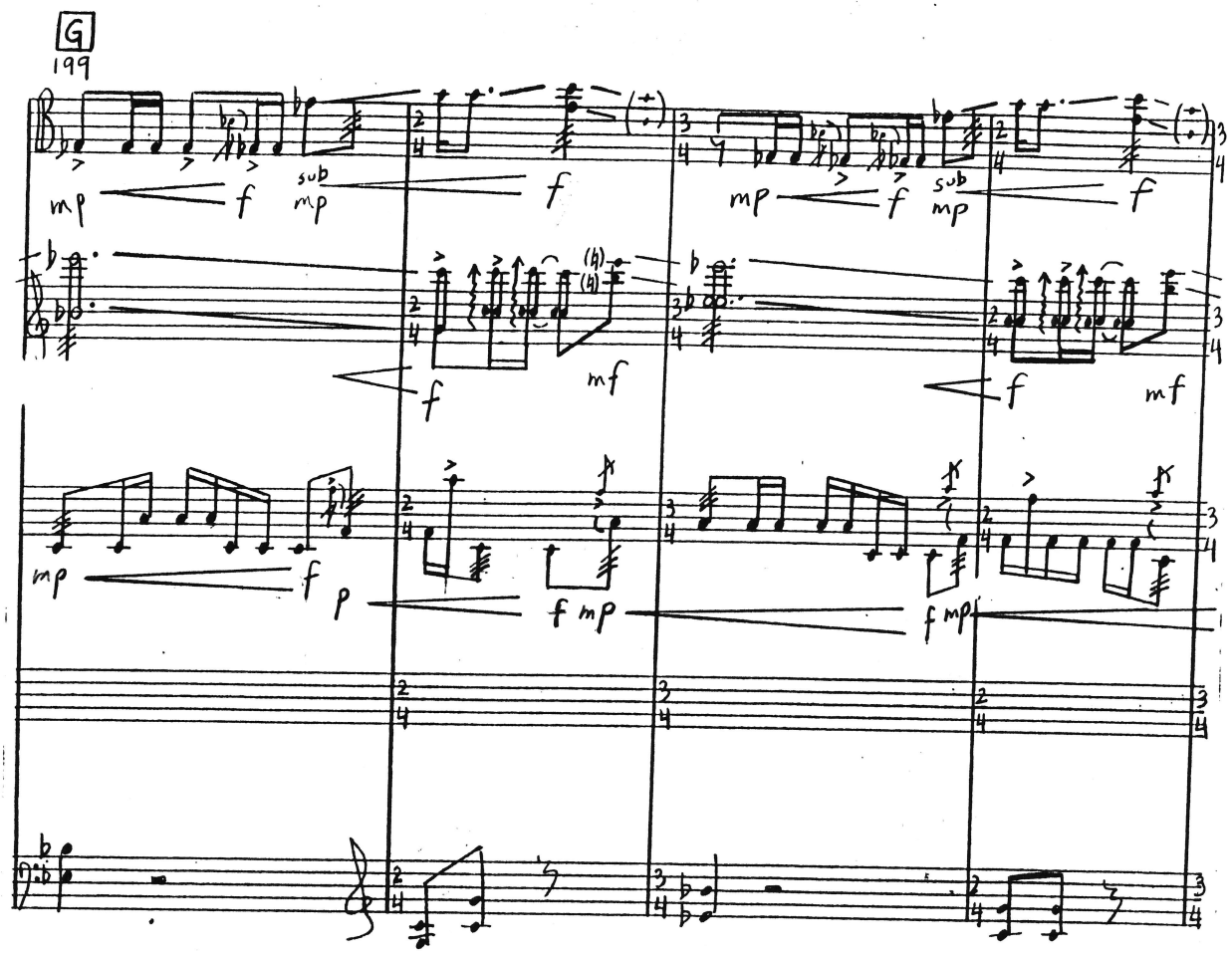


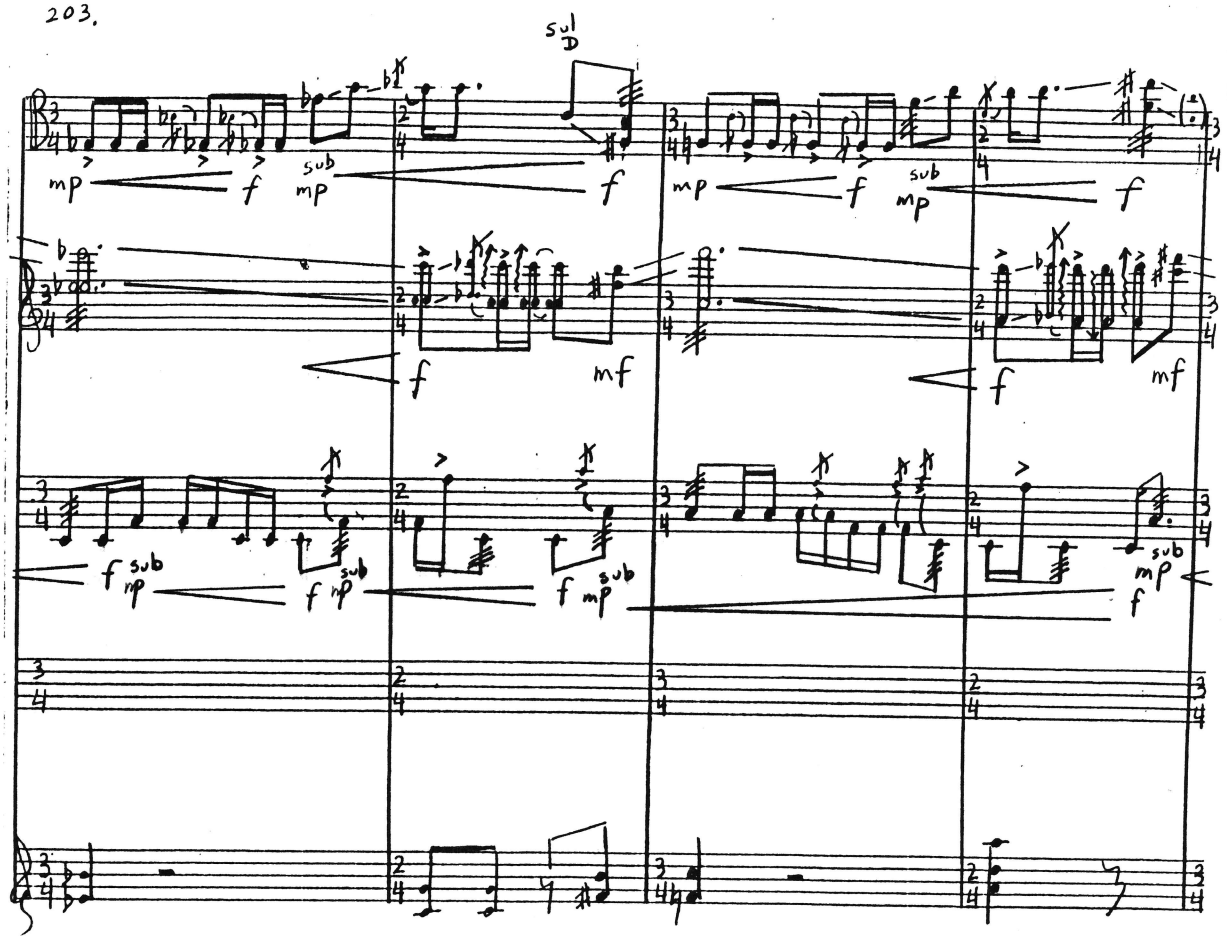
193



196.




G
199
mp
f
sub
mp
f
mf
p
fmp


203.
sul D
mp
f
sub
mp
f
mf
fmp
sub

207

sul D
G

mp f sub mp f

mf

f

sub mp

210.

♪ = ♪

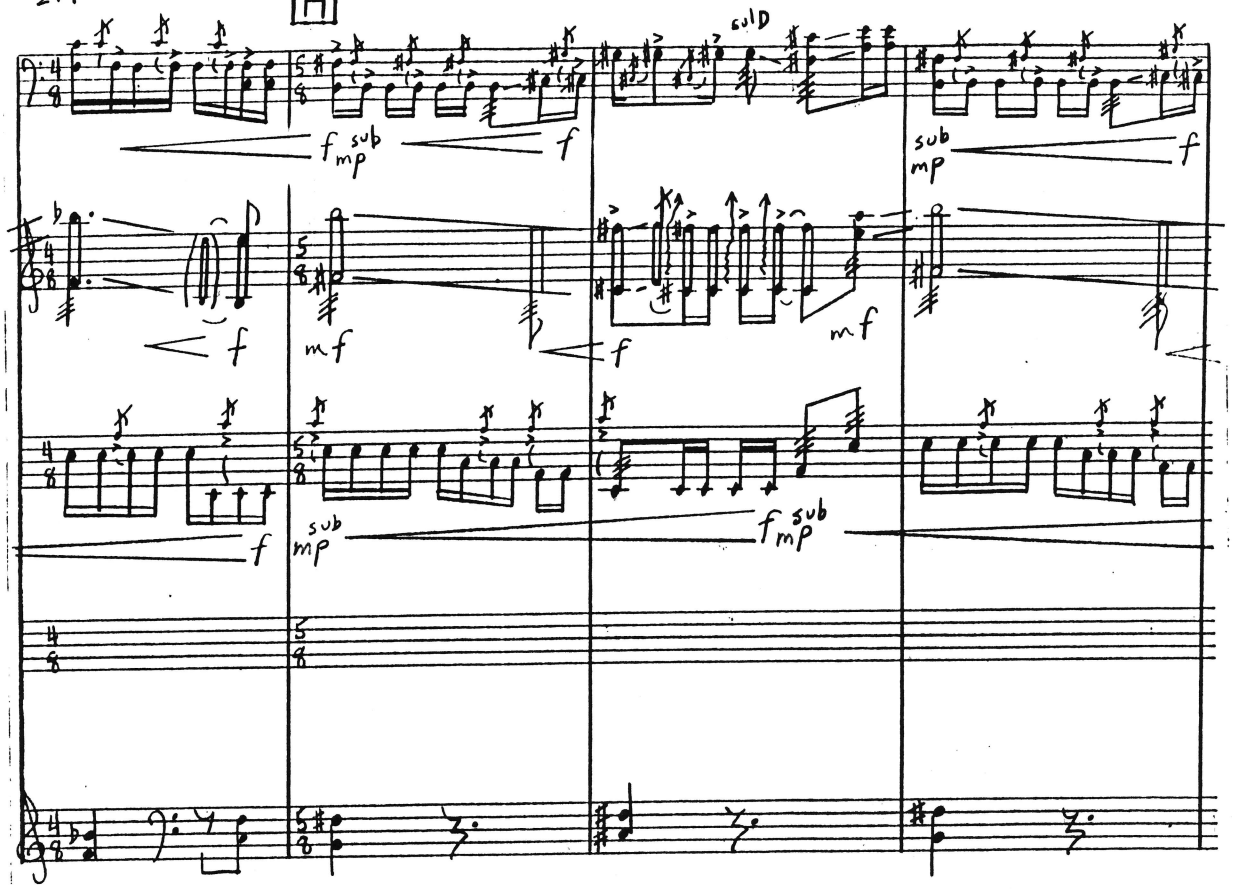
mp f

mf

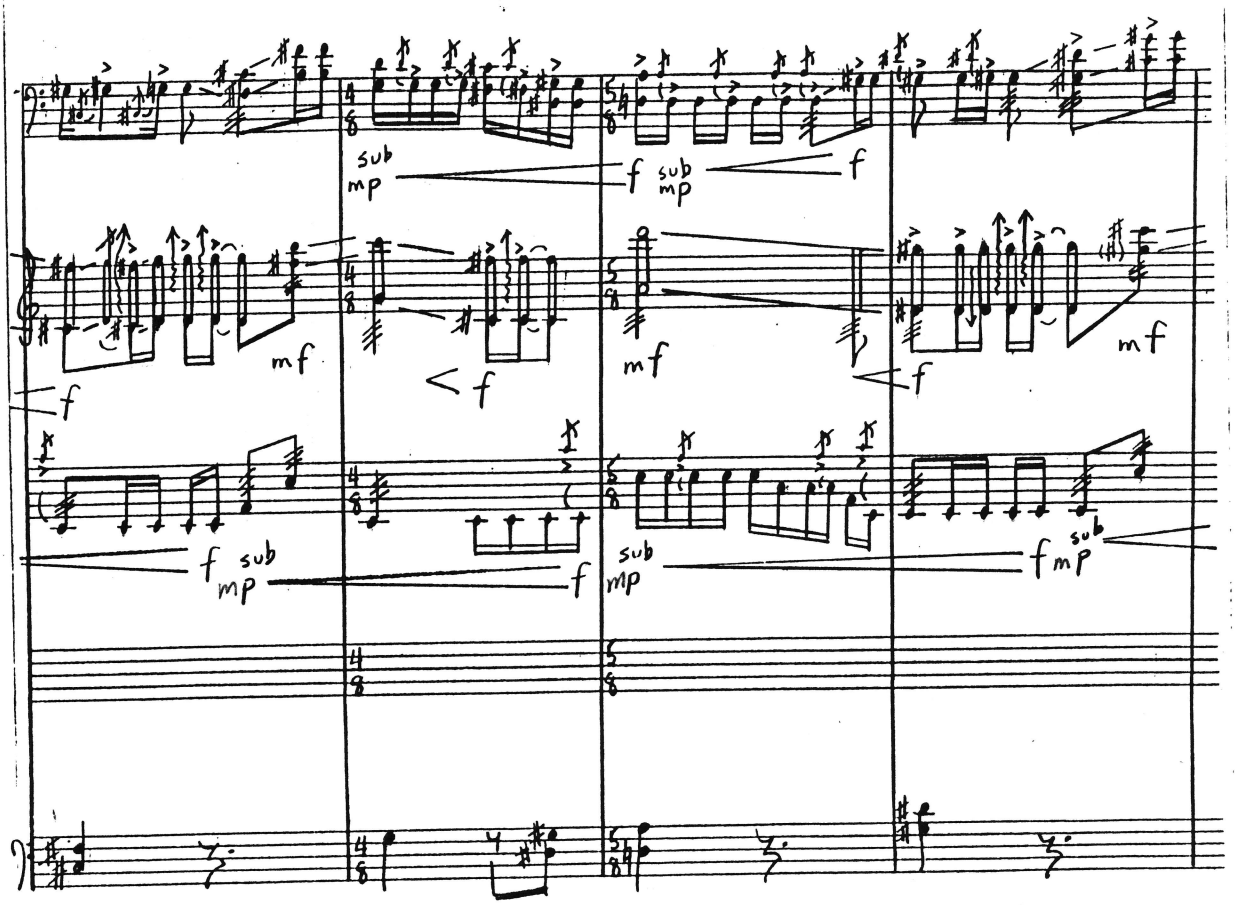
sub mp

214

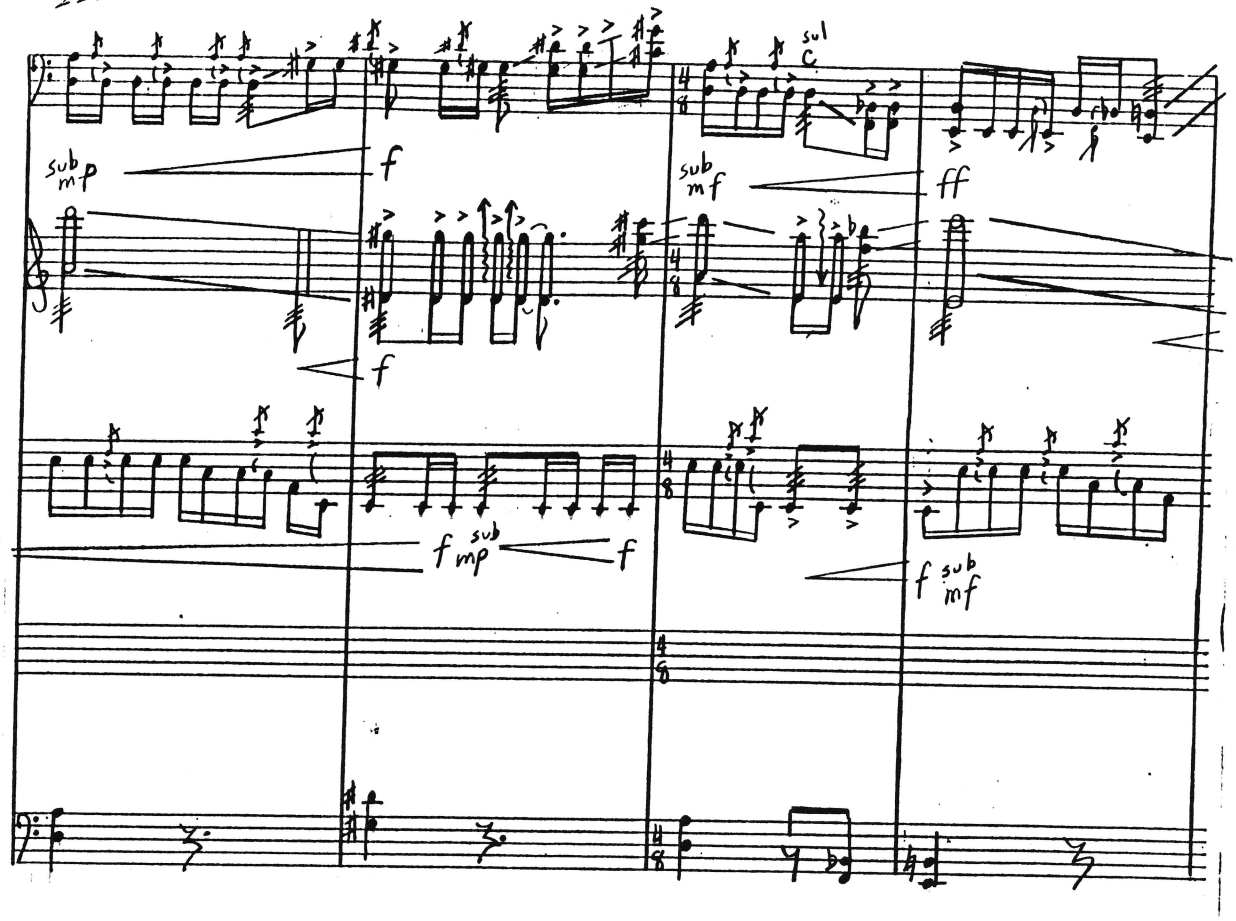
H



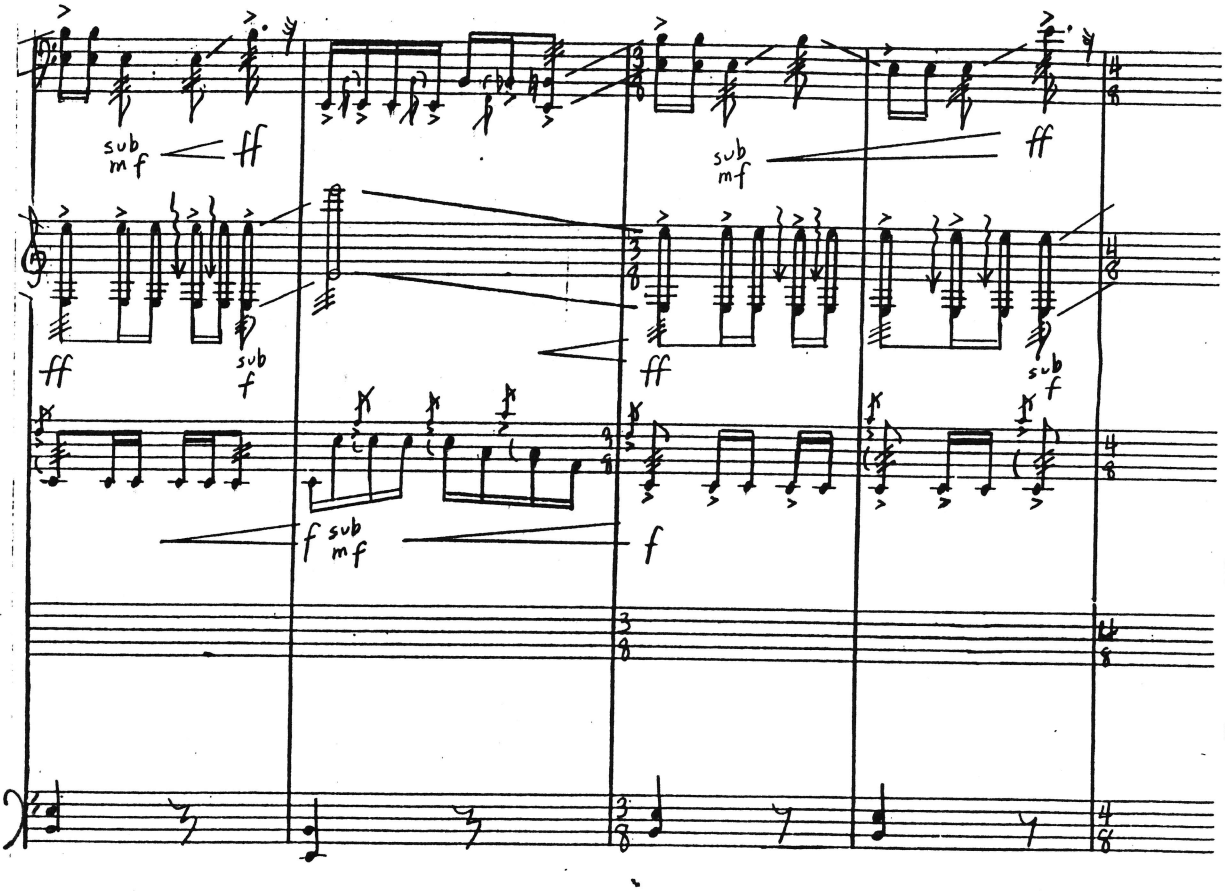
218



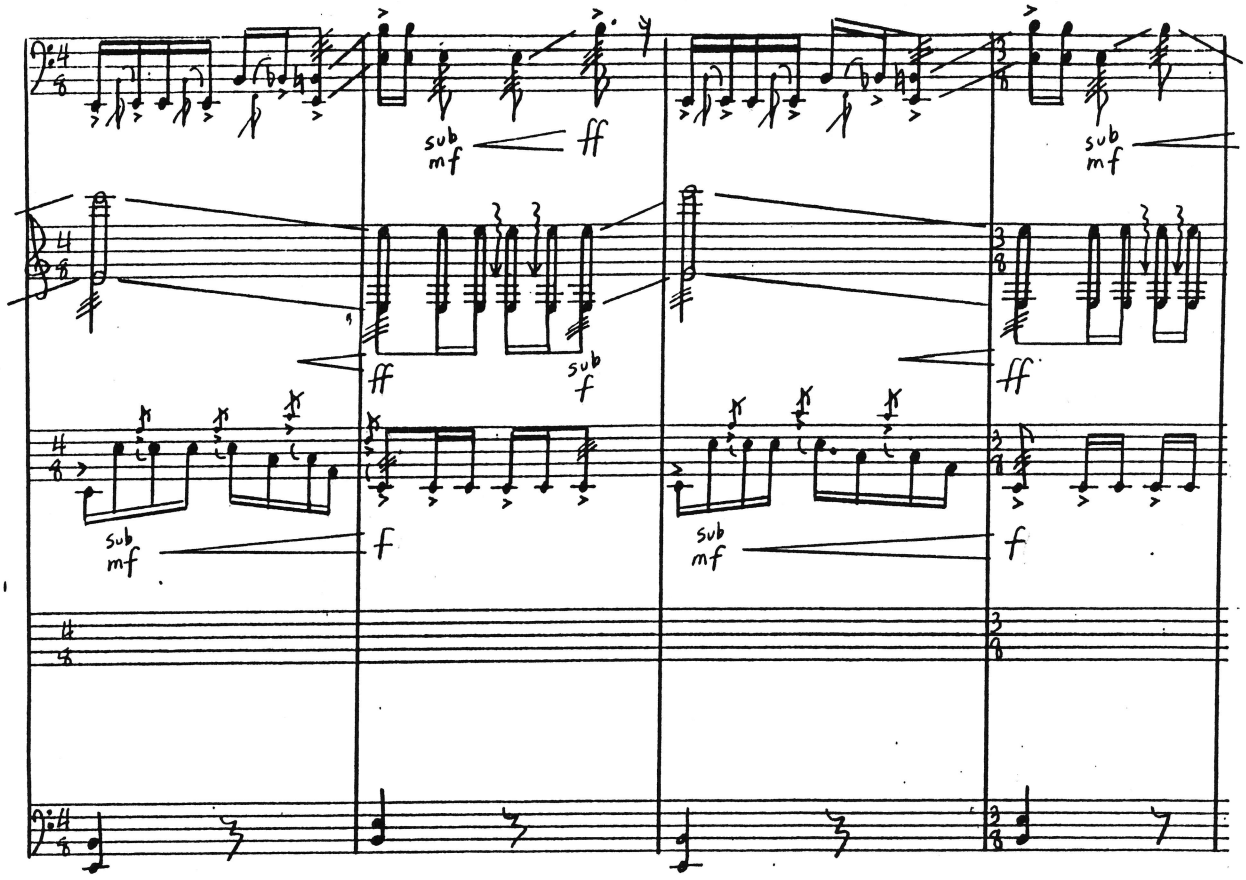
222.


sub mp
f
sul C
sub mf
ff
f
f mp sub f
f sub mf

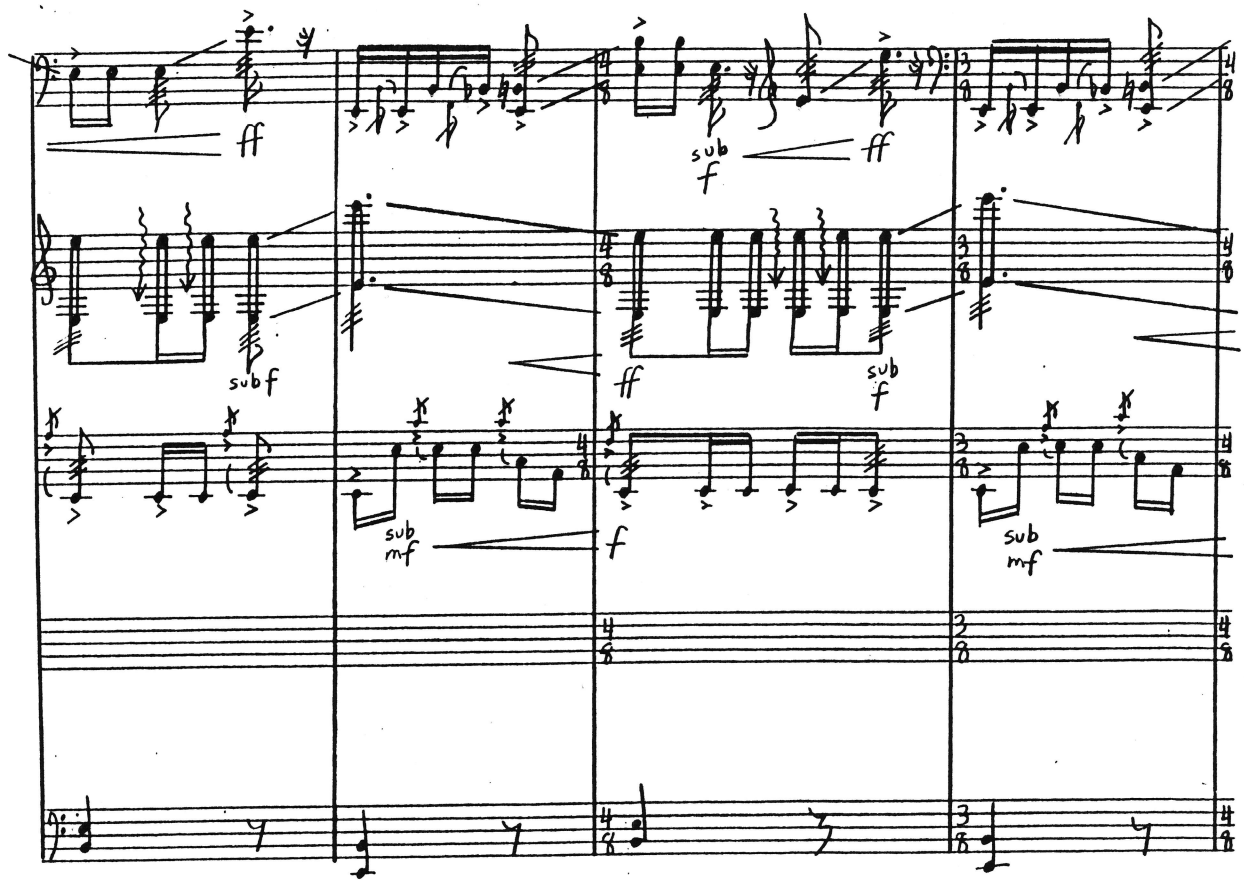
226


sub mf
ff
ff
sub f
f sub mf
f

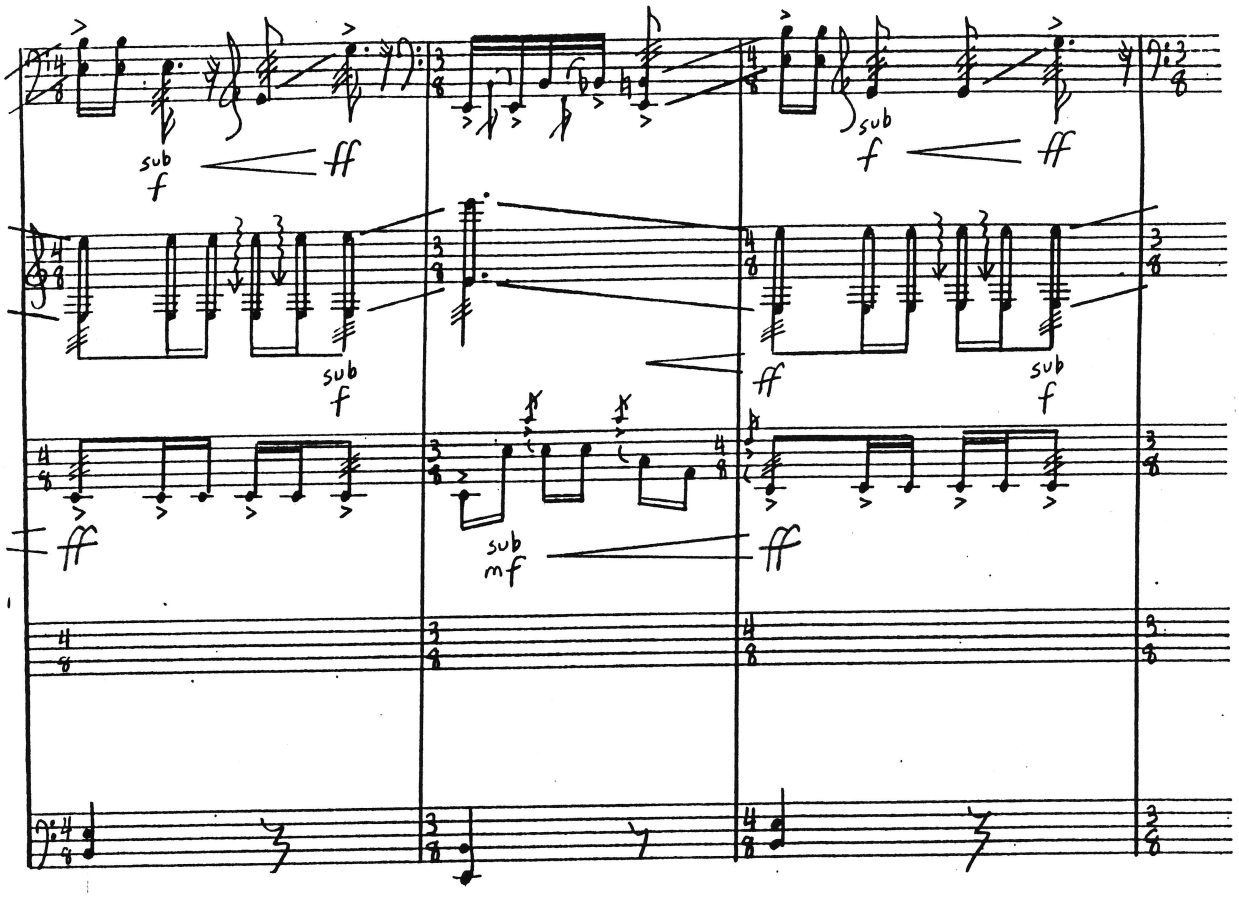
230


sub mf
ff
sub f
ff
sub mf
f
sub mf
f
sub mf
ff
sub f
ff
sub mf
f
sub mf

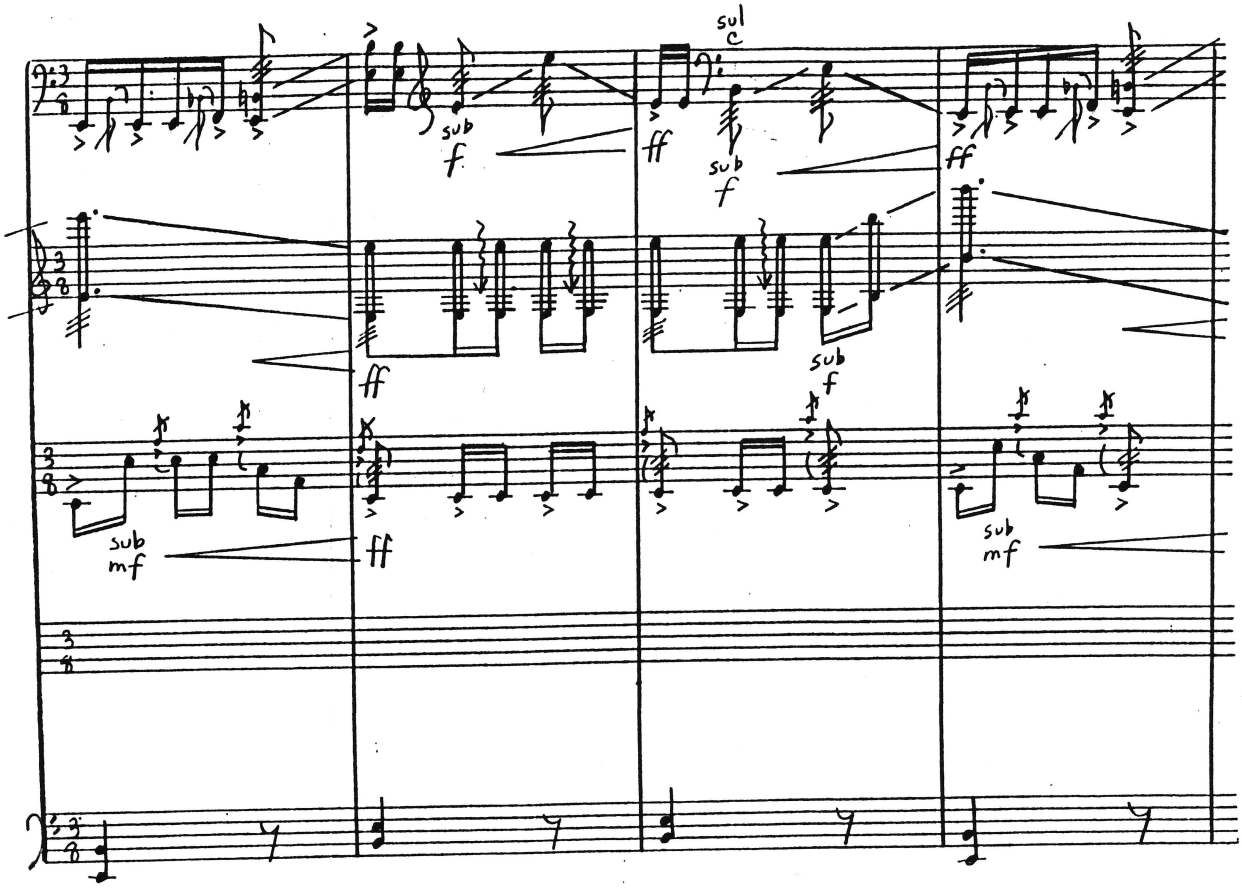
231


ff
sub f
sub f
ff
sub f
ff
sub mf
f
sub mf

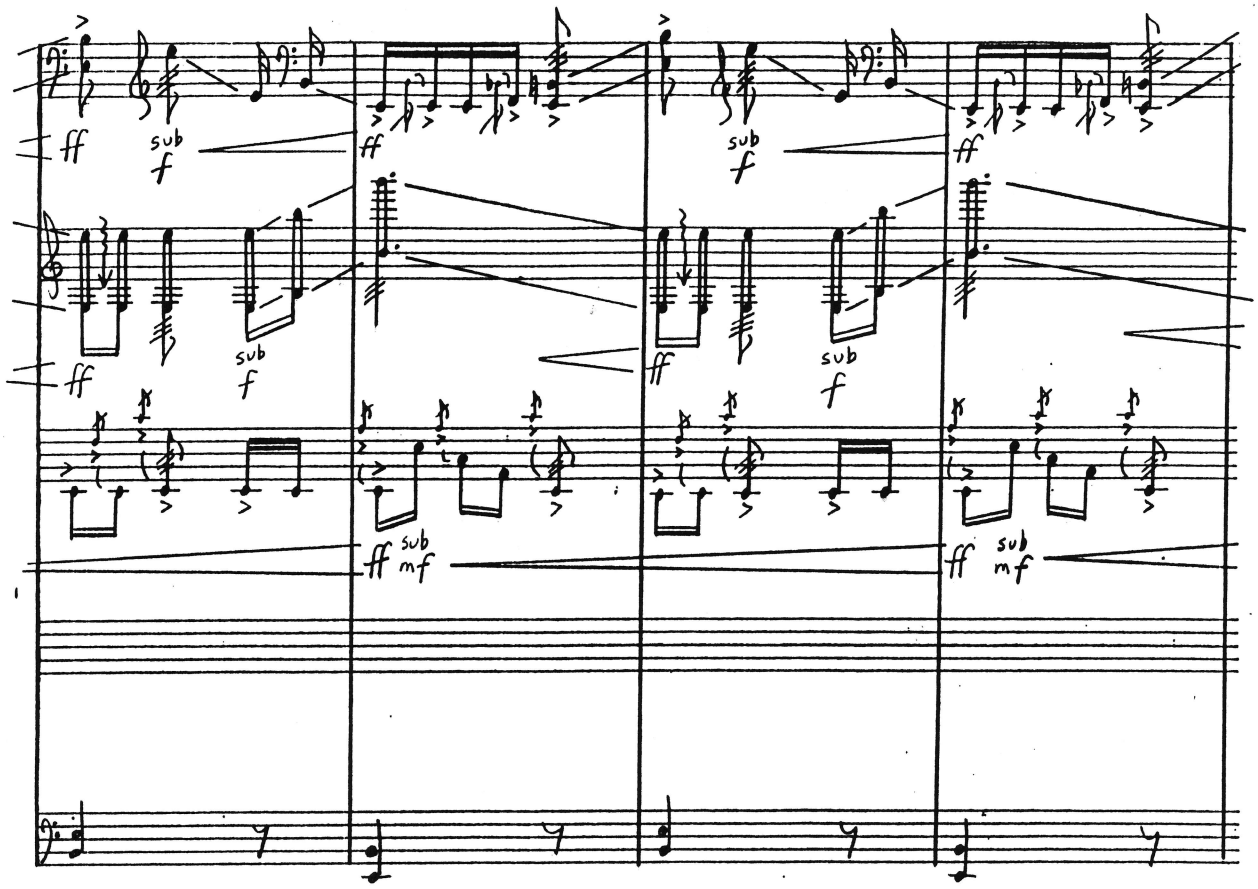
238


sub
f
ff
sub
f
ff
sub
f
ff
sub
f
sub
mf
ff

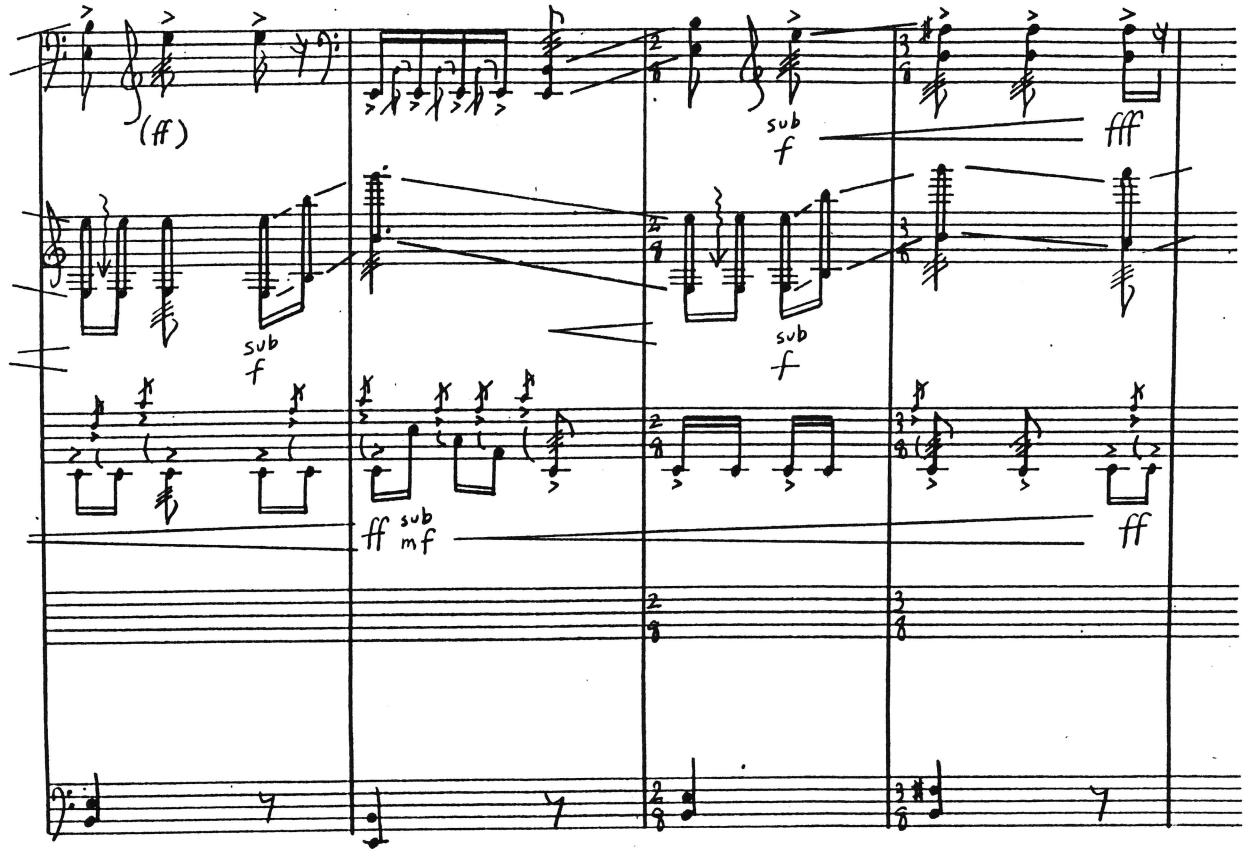
241.


sub
f
ff
sul
C
sub
f
ff
sub
f
sub
mf
ff
sub
mf

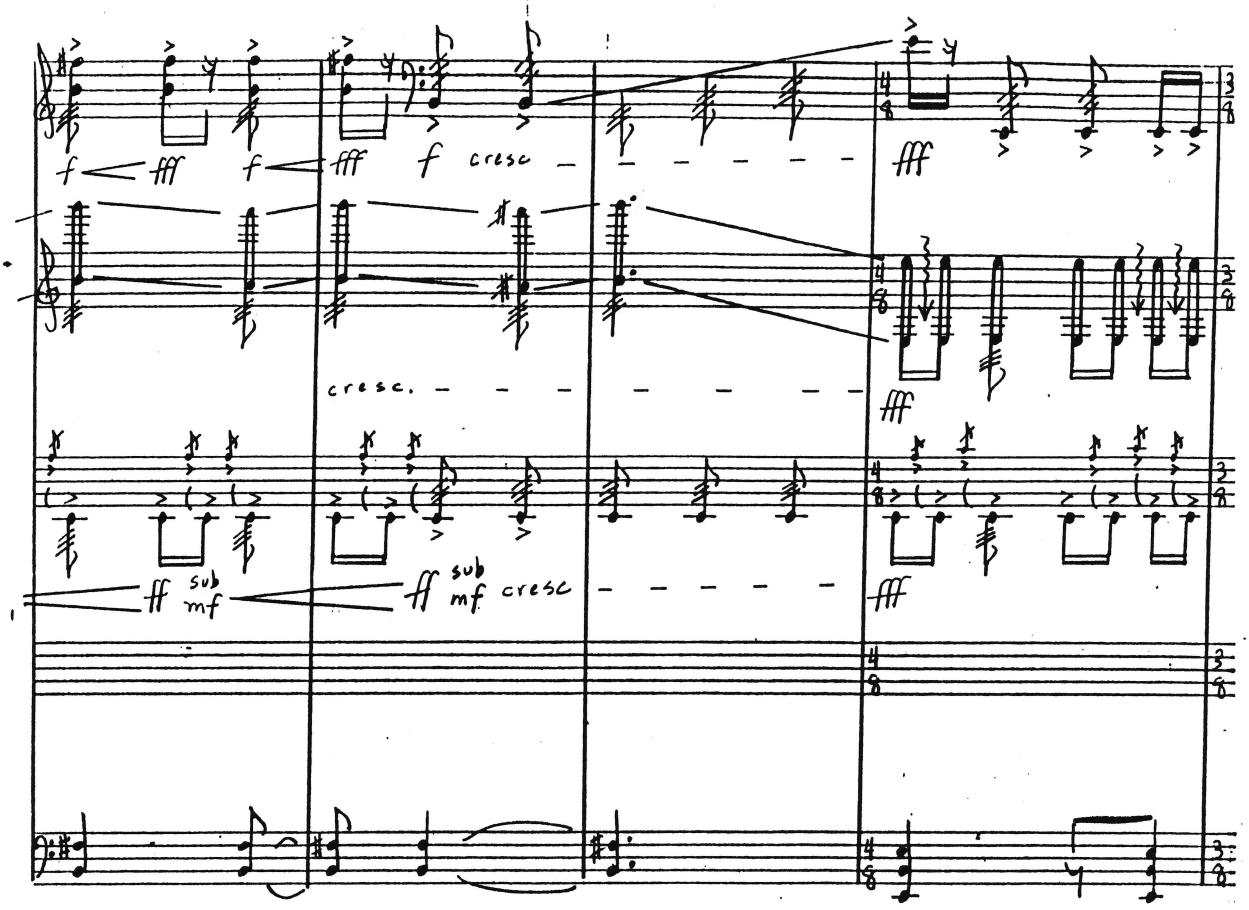
245.


ff
sub
f
ff
sub
f
ff
sub
f
ff
sub
f
ff sub
mf
ff sub
mf

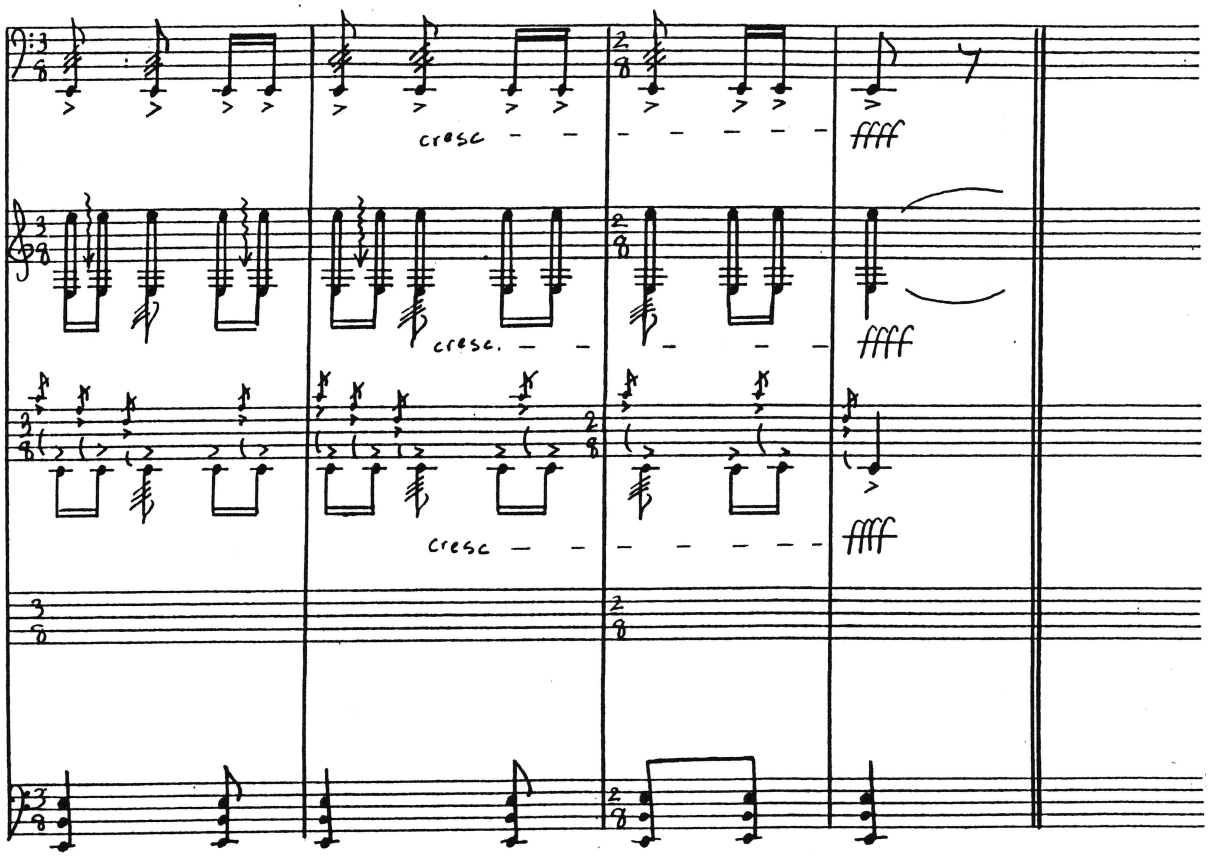
249.


(ff)
sub
f
sub
f
fff
sub
f
ff sub
mf
ff

253


f fff f
fff f cresc
fff
cresc.
fff
ff sub mf
ff sub mf cresc
fff

251


cresc
ffff
cresc.
ffff
cresc
ffff

Yamaha TX81Z

After loading MIDI files from the composer, the readouts in "Perform" mode should look like this:

RED .TXZ
PERFORMANCES

1	1111111111	17	1111111111
2	2222222222	18	2222222222
3	3333333333	19	3333333333
4	4444444444	20	4444444444
5	5555555555	21	5555555555
6	5555555555	22	5555555555
7	5555555555	23	5555555555
8	5555555555	24	5555555555
9	----------	25	----------
10	----------	26	----------
11	----------	27	----------
12	----------	28	----------
13	----------	29	----------
14	----------	30	----------
15	----------	31	----------
16	----------	32	----------

Data for each Red Shift voice (including "play" mode and "perform" mode) follows.

VOICE 1

Yamaha TX81Z

name:#1__POLY4 assign mode:normal

micro tune table:octave key:** effect: off

Instrmnt	1	2	3	4	5	6	7	8
notes	3	4	1	0	0	0	0	0
bank no	I	I	I	I	I	I	I	I
voice no	1	26	6	26	5	6	7	8
channel	3	3	1	3	5	6	7	8
lo limit	C -2	C -2	C -2	C -2	C -2	C -2	C -2	C -2
hi limit	G 8	G 8	G 8	G 8	G 8	G 8	G 8	G 8
detune	+0	+0	+0	+0	+0	+0	+0	+0
shift	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0
volume	99	99	99	99	99	99	99	99
out asgn	II	II	I	I+II	I+II	I+II	I+II	I+II
lfo slct	lfo1	lfo2	vib	vib	vib	vib	vib	vib
microtun	off	off	off	off	off	off	off	off

	INSTRUMENTS
1	1a1a1a1a1a
2	1zzzzzzzzz
3	~~Click 1~~
4	***
5	***
6	***
7	***
8	***

'1a1a1a1a1a' transpose: C 2 reverb:0 alg:3 fdbk:7

	envelope							scale		sens.				tuning			
op	A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	lvl scl	rt scl	vel- cty	eg bi	amp mod	wave form	fix/ rat	rng/ mult	crs	fin	de-tune
4	31	0	15	0	0	off	62	0	0	0	0	off	3	rat	1	1.00	0	-1
3	31	31	15	0	2	off	66	0	0	0	0	off	1	rat	1	1.00	0	+0
2	15	31	15	0	2	off	63	0	0	0	0	off	1	rat	2	2.00	0	+1
1	10	31	15	0	3	off	99	0	0	0	0	off	6	rat	1	1.00	0	+0

LFO		pitch	ampl	sensitivity	bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0 32	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	11	wheel:	50 0	ampl: 2	br egb: 0	porta time:	99
delay:	0	breath:	0 0			bend range:	12
sync:	off	foot:	0 0			foot volum:	99

'1zzzzzzzzz' transpose: C 2 reverb:0 alg:3 fdbk:7

	envelope							scale		sens.				tuning			
op	A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	lvl scl	rt scl	vel- cty	eg bi	amp mod	wave form	fix/ rat	rng/ mult	crs	fin	de-tune
4	31	0	13	1	4	off	69	16	3	0	0	off	1	rat	1	1.00	0	+0
3	11	15	0	0	15	off	79	99	3	3	0	off	1	rat	10	10.00	0	+0
2	11	27	9	26	15	off	49	98	3	2	0	off	1	rat	1	1.00	0	+0
1	31	31	15	2	5	off	99	22	2	0	0	off	1	rat	1	1.00	0	+0

LFO		pitch	ampl	sensitivity	bias mod	keybd mode:	POLY
wave:	SAW UP	direct:	0 0	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	35	wheel:	50 0	ampl: 3	br egb: 0	porta time:	0
delay:	0	breath:	50 0			bend range:	2
sync:	off	foot:	0 0			foot volum:	99

VOICE 2

name:#2-poly4 assign mode:normal

micro tune table:octave key:** effect: off

Instrmnt	1	2	3	4	5	6	7	8
notes	4	3	1	0	0	0	0	0
bank no	I	I	I	I	I	I	I	I
voice no	22	21	6	6	5	6	7	8
channel	2	2	1	4	5	6	7	8
lo limit	C -2	C -2	C -2	C -2	C -2	C -2	C -2	C -2
hi limit	G 8	G 8	G 8	G 8	G 8	G 8	G 8	G 8
detune	+0	+0	+0	+0	+0	+0	+0	+0
shift	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0
volume	99	99	99	99	99	99	99	99
out asgn	II	II	I	I+II	I+II	I+II	I+II	I+II
lfo slct	lfo1	lfo2	vib	vib	vib	vib	vib	vib
microtun	off	off	off	off	off	off	off	off

INSTRUMENTS
1 bass222222
2 2b2b2b2b2b
3 ~~Click 1~~
4 ***
5 ***
6 ***
7 ***
8 ***

'bass222222' transpose: C 2 reverb:0 alg:3 fdbk:7

	envelope							scale		sens.				tuning				
op	A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	lvl scl	rt scl	vel- cty	eg bi	amp mod	wave form	fix/ rat	rng/ mult	crs	fin	de-tune
4	31	1	4	0	8	off	62	0	3	3	0	off	1	rat	3	3.00	0	+3
3	31	9	12	6	8	off	69	27	3	7	0	off	1	rat	9	9.00	0	+3
2	31	1	0	0	8	off	82	0	2	0	0	off	1	rat	0	0.50	0	-3
1	31	9	9	0	9	off	99	0	0	1	0	off	1	rat	1	1.00	0	+0

LFO		pitch	ampl	sensitivity	bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0	0	pitch: 5	br pch:+ 0	porta mode:	FNGR
speed:	28	wheel:	75	0	ampl: 0	br egb: 0	porta time:	0
delay:	0	breath:	0	0			bend range:	4
sync:	off	foot:	0	0			foot volum:	99

'2b2b2b2b2b' transpose: C 2 reverb:4 alg:3 fdbk:7

	envelope							scale		sens.				tuning				
op	A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	lvl scl	rt scl	vel- cty	eg bi	amp mod	wave form	fix/ rat	rng/ mult	crs	fin	de-tune
4	14	16	15	10	4	off	62	0	0	0	0	off	1	rat	1	1.00	0	-1
3	15	19	15	13	2	off	66	0	0	0	0	off	1	rat	1	1.00	0	+0
2	21	31	15	12	2	off	63	0	0	0	0	off	3	rat	2	2.00	0	+1
1	31	31	15	9	3	off	99	0	0	0	0	off	5	rat	1	1.00	0	+0

LFO		pitch	ampl	sensitivity	bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0	32	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	11	wheel:	50	0	ampl: 2	br egb: 0	porta time:	95
delay:	0	breath:	0	0			bend range:	12
sync:	off	foot:	0	0			foot volum:	99

VOICE 3

name:#3-poly4 assign mode:normal

micro tune table:octave key:** effect: off

Instrmnt	1	2	3	4	5	6	7	8
notes	1	2	2	2	1	0	0	0
bank no	I	I	I	I	I	I	I	I
voice no	2	27	18	12	6	1	1	1
channel	2	2	2	2	1	6	7	8
lo limit	C -2	C -2	C -2	C -2	C -2	C -2	C -2	C -2
hi limit	G 8	G 8	G 8	G 8	G 8	G 8	G 8	G 8
detune	+0	+0	+0	+0	+0	+0	+0	+0
shift	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0
volume	99	99	99	99	99	99	99	99
out asgn	II	II	II	II	I	I+II	I+II	I+II
lfo slct	lfo1	lfo2	vib	vib	vib	vib	vib	vib
microtun	off	off	off	off	off	off	off	off

	INSTRUMENTS
1	2a2a2a2a2a
2	Clear Clav
3	4-improved
4	Pizzicato
5	~~Click 1~~
6	***
7	***
8	***

'2a2a2a2a2a' transpose: C 2 reverb:0 alg:1 fdbk:1

op	envelope A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	scale lvl scl	rt scl	sens. vel-cty	eg bi	amp mod	wave form	tuning fix/rat	rng/mult	crs	fin	detune
4	31	22	15	0	0	off	62	0	0	0	0	off	3	rat	1	1.00	0	-1
3	16	31	15	0	2	off	66	0	0	0	0	off	3	rat	1	1.00	0	+0
2	15	31	14	0	2	off	70	0	0	0	0	off	3	rat	2	2.00	0	+1
1	16	31	15	0	3	off	99	0	0	0	0	off	6	rat	1	1.00	0	+0

LFO		pitch_ampl_sensitivity			bias mod	keybd mode:	POLY
wave:	SAW UP	direct:	0	32	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	11	wheel:	50	0	ampl: 3	br egb: 0	porta time:	50
delay:	0	breath:	0	0			bend range:	4
sync:	on	foot:	0	0			foot volum:	99

'Clear Clav' transpose: C 3 reverb:0 alg:3 fdbk:7

op	envelope A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	scale lvl scl	rt scl	sens. vel-cty	eg bi	amp mod	wave form	tuning fix/rat	rng/mult	crs	fin	detune
4	30	28	12	5	0	off	78	32	2	0	0	off	1	rat	0	0.50	0	+2
3	29	1	0	1	0	off	57	50	1	0	0	off	1	rat	6	10.38	0	+1
2	23	26	13	1	0	off	75	9	0	0	0	off	1	rat	0	0.50	0	+1
1	24	27	12	5	7	off	99	2	2	0	0	off	1	rat	2	2.00	0	+0

LFO		pitch_ampl_sensitivity			bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0	0	pitch: 0	br pch:+ 0	porta mode:	FULL
speed:	35	wheel:	50	50	ampl: 0	br egb: 0	porta time:	0
delay:	0	breath:	0	0			bend range:	5
sync:	off	foot:	0	0			foot volum:	99

(more)

VOICE 3 (continued)

'4444444444' transpose: C 1 reverb:0 alg:3 fdbk:7

op	envelope A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	scale lvl scl	rt scl	sens. vel- cty	eg bi	amp mod	wave form	tuning fix/ rat	rng/ mult	crs	fin	de- tune
4	31	0	15	0	0	off	62	0	0	0	0	off	1	rat	1	1.00	0	-1
3	31	31	15	0	2	off	66	0	0	0	0	off	1	rat	1	1.00	0	+0
2	15	31	15	0	2	off	63	0	0	0	0	off	1	rat	2	2.00	0	+1
1	10	31	15	0	3	off	99	0	0	0	0	off	1	rat	1	1.00	0	+0

LFO		pitch_ampl_sensitivity			bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0	32	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	11	wheel:	50	0	ampl: 2	br egb: 0	porta time:	18
delay:	0	breath:	0	0			bend range:	12
sync:	off	foot:	0	0			foot volum:	99

'Pizzicato ' transpose: C 3 reverb:6 alg:2 fdbk:7

op	envelope A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	scale lvl scl	rt scl	sens. vel- cty	eg bi	amp mod	wave form	tuning fix/ rat	rng/ mult	crs	fin	de- tune
4	27	24	10	21	15	off	97	0	0	1	0	off	1	rat	1	1.00	0	+0
3	31	13	0	0	8	off	91	0	0	1	0	off	4	rat	1	1.00	0	+0
2	31	31	12	0	7	off	84	0	0	1	0	off	1	rat	1	1.00	0	+3
1	31	16	0	0	6	off	99	0	0	1	0	off	1	rat	1	1.00	0	+0

LFO		pitch_ampl_sensitivity			bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0	0	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	35	wheel:	50	0	ampl: 0	br egb: 0	porta time:	0
delay:	0	breath:	0	0			bend range:	4
sync:	off	foot:	0	0			foot volum:	99

VOICE 4

name:#4-poly4

assign mode:normal

micro tune table:octave key:** effect: off

Instrmnt	1	2	3	4	5	6	7	8
notes	2	1	2	2	1	0	0	0
bank no	I	I	I	I	I	I	I	I
voice no	28	27	15	25	6	6	7	8
channel	2	2	2	2	1	6	7	8
lo limit	C -2	C -2	C -2	C -2	C -2	C -2	C -2	C -2
hi limit	G 8	G 8	G 8	G 8	G 8	G 8	G 8	G 8
detune	+0	+0	+0	+0	+0	+0	+0	+0
shift	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0
volume	99	99	99	99	99	99	99	99
out asgn	II	II	II	II	I	I+II	I+II	I+II
lfo slct	lfo1	lfo2	vib	vib	vib	vib	vib	vib
microtun	off	off	off	off	off	off	off	off

INSTRUMENTS

1 4444444444
2 Clear Clav
3 4zzzzzzzzz
4 Harpsi Hi
5 ~~Glick 1~~
6 ***
7 ***
8 ***

'4444444444' transpose: C 1 reverb:0 alg:3 fdbk:7

	envelope							scale		sens.				tuning				
op	A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	lvl scl	rt scl	vel- cty	eg bi	amp mod	wave form	fix/ rat	rng/ mult	crs	fin	de-tune
4	31	0	15	0	0	off	62	0	0	0	0	off	1	rat	1	1.00	0	-1
3	31	31	15	0	2	off	66	0	0	0	0	off	1	rat	1	1.00	0	+0
2	15	31	15	0	2	off	63	0	0	0	0	off	1	rat	2	2.00	0	+1
1	10	31	15	0	3	off	99	0	0	0	0	off	1	rat	1	1.00	0	+0

LFO		pitch_ampl_sensitivity			bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0	32	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	11	wheel:	50	0	ampl: 2	br egb: 0	porta time:	18
delay:	0	breath:	0	0			bend range:	12
sync:	off	foot:	0	0			foot volum:	99

'Clear Clav' transpose: C 3 reverb:0 alg:3 fdbk:7

	envelope							scale		sens.				tuning				
op	A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	lvl scl	rt scl	vel- cty	eg bi	amp mod	wave form	fix/ rat	rng/ mult	crs	fin	de-tune
4	30	28	12	5	0	off	78	32	2	0	0	off	1	rat	0	0.50	0	+2
3	29	1	0	1	0	off	57	50	1	0	0	off	1	rat	6	10.38	0	+1
2	23	26	13	1	0	off	75	9	0	0	0	off	1	rat	0	0.50	0	+1
1	24	27	12	5	7	off	99	2	2	0	0	off	1	rat	2	2.00	0	+0

LFO		pitch_ampl_sensitivity			bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0	0	pitch: 0	br pch:+ 0	porta mode:	FULL
speed:	35	wheel:	50	50	ampl: 0	br egb: 0	porta time:	0
delay:	0	breath:	0	0			bend range:	5
sync:	off	foot:	0	0			foot volum:	99

(more)

VOICE 4 (continued)

'4zzzzzzzzz' transpose: C 2 reverb:0 alg:3 fdbk:7

op	envelope A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	scale lvl scl	rt scl	sens. vel- cty	eg bi	amp mod	wave form	tuning fix/ rat	rng/ mult	crs	fin	de-tune
4	31	9	11	9	0	off	62	0	0	1	0	off	1	rat	1	1.00	0	-1
3	31	31	15	10	2	off	66	0	0	1	0	off	6	rat	1	1.00	0	+0
2	15	31	15	0	2	off	63	0	0	0	0	off	2	rat	2	2.00	0	+1
1	24	31	15	2	3	off	99	0	0	0	0	off	7	rat	1	1.00	0	+0

LFO		pitch_ampl_sensitivity			bias mod__	keybd mode:	POLY
wave:	TRIANGL	direct:	0	32	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	11	wheel:	50	0	ampl: 2	br egb: 0	porta time:	46
delay:	0	breath:	0	0			bend range:	12
sync:	on	foot:	0	0			foot volum:	99

'Harpsi Hi ' transpose: C 4 reverb:0 alg:5 fdbk:1

op	envelope A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	scale lvl scl	rt scl	sens. vel- cty	eg bi	amp mod	wave form	tuning fix/ rat	rng/ mult	crs	fin	de-tune
4	29	17	13	0	0	off	91	0	3	0	0	off	1	rat	2	2.00	0	+1
3	23	8	12	6	6	off	87	0	2	0	0	off	1	rat	0	0.50	0	-2
2	29	14	13	0	0	off	91	0	3	0	0	off	1	rat	0	0.50	0	+1
1	23	8	12	6	6	off	89	0	2	0	0	off	1	rat	4	4.00	0	-1

LFO		pitch_ampl_sensitivity			bias mod__	keybd mode:	POLY
wave:	TRIANGL	direct:	0	0	pitch: 0	br pch:+ 0	porta mode:	FULL
speed:	35	wheel:	50	0	ampl: 0	br egb: 0	porta time:	0
delay:	0	breath:	0	0			bend range:	0
sync:	off	foot:	0	0			foot volum:	99

VOICE 5

name:#5-poly4 assign mode:normal

micro tune table:octave key:** effect: off

Instrmnt	1	2	3	4	5	6	7	8
notes	2	2	1	2	1	0	0	0
bank no	I	I	I	I	I	I	I	I
voice no	22	10	23	24	6	6	7	8
channel	2	2	2	2	1	6	7	8
lo limit	C -2	C -2	C -2	C -2	C -2	C -2	C -2	C -2
hi limit	G 8	G 8	G 8	G 8	G 8	G 8	G 8	G 8
detune	+0	+0	+0	+0	+0	+0	+0	+0
shift	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0
volume	99	99	99	99	99	99	99	99
out asgn	II	II	II	II	I	I+II	I+II	I+II
lfo slct	lfo1	lfo2	vib	vib	vib	vib	vib	vib
microtun	off	off	off	off	off	off	off	off

INSTRUMENTS

1 bass222222
2 4xxxxxxxxx
3 4vvvvvvvvv
4 5zzzzzzzzz
~~5 Glick 1~~
6 ***
7 ***
8 ***

'bass222222' transpose: C 2 reverb:0 alg:3 fdbk:7

	envelope							scale		sens.				tuning				
op	A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	lvl scl	rt scl	vel-cty	eg bi	amp mod	wave form	fix/rat	rng/mult	crs	fin	detune
4	31	1	4	0	8	off	62	0	3	3	0	off	1	rat	3	3.00	0	+3
3	31	9	12	6	8	off	69	27	3	7	0	off	1	rat	9	9.00	0	+3
2	31	1	0	0	8	off	82	0	2	0	0	off	1	rat	0	0.50	0	-3
1	31	9	9	0	9	off	99	0	0	1	0	off	1	rat	1	1.00	0	+0

LFO		pitch_ampl_sensitivity			bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0 0	pitch: 5	br pch:+ 0	porta mode:	FNGR
speed:	28	wheel:	75 0	ampl: 0	br egb: 0	porta time:	0
delay:	0	breath:	0 0			bend range:	4
sync:	off	foot:	0 0			foot volum:	99

'4xxxxxxxxx' transpose: C 5 reverb:0 alg:3 fdbk:7

	envelope							scale		sens.				tuning				
op	A R	D1 R	D1 L	D2 R	R R	sh ft	out lev	lvl scl	rt scl	vel-cty	eg bi	amp mod	wave form	fix/rat	rng/mult	crs	fin	detune
4	31	9	11	8	0	off	77	0	0	0	0	off	1	rat	1	1.00	0	-1
3	31	31	15	14	2	off	98	0	0	0	0	off	6	rat	1	1.00	0	+0
2	15	31	15	3	2	off	63	0	0	0	0	off	2	rat	2	2.00	0	+1
1	24	31	15	7	3	off	99	0	0	0	0	off	7	rat	1	1.00	0	+0

LFO		pitch_ampl_sensitivity			bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0 32	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	11	wheel:	50 0	ampl: 2	br egb: 0	porta time:	53
delay:	0	breath:	0 0			bend range:	12
sync:	on	foot:	0 0			foot volum:	99

(more)

(VOICE 5 - continued)

'4vvvvvvvvv' transpose: C 3 reverb:0 alg:3 fdbk:7

	envelope							scale		sens.				tuning				
o	A	D1	D1	D2	R	sh	out	lvl	rt	vel-	eg	amp	wave	fix/	rng/	crs	fin	de-
p	R	R	L	R	R	ft	lev	scl	scl	cty	bi	mod	form	rat	mult			tune
4	31	0	15	0	0	off	62	0	0	0	0	off	1	rat	1	1.00	0	-1
3	31	31	15	0	2	off	66	0	0	0	0	off	1	rat	1	1.00	0	+0
2	31	31	15	0	2	off	63	0	0	0	0	off	6	rat	2	2.00	0	+1
1	31	31	15	0	3	off	99	0	0	0	0	off	3	rat	1	1.00	0	+0

LFO		pitch	ampl	sensitivity	bias mod	keybd mode:	POLY
wave:	TRIANGL	direct:	0	32	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	99	wheel:	50	0	ampl: 2	br egb: 0	porta time:	0
delay:	0	breath:	0	0			bend range:	12
sync:	off	foot:	0	0			foot volum:	99

'5zzzzzzzzz' transpose: C 3 reverb:0 alg:3 fdbk:6

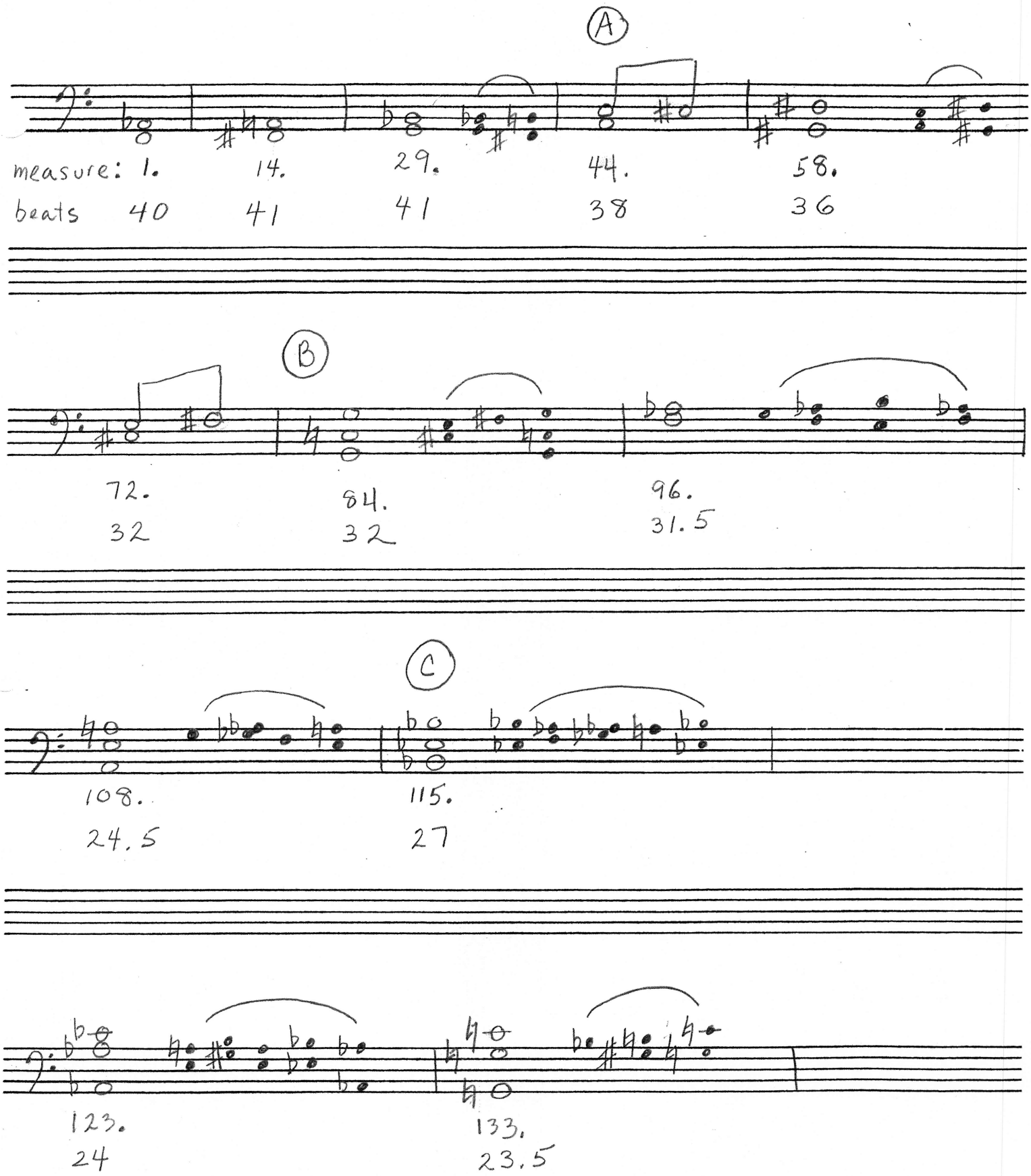
	envelope							scale		sens.				tuning				
o	A	D1	D1	D2	R	sh	out	lvl	rt	vel-	eg	amp	wave	fix/	rng/	crs	fin	de-
p	R	R	L	R	R	ft	lev	scl	scl	cty	bi	mod	form	rat	mult			tune
4	31	0	15	1	0	off	87	41	3	0	0	off	1	rat	0	0.50	0	+0
3	22	0	13	5	0	off	96	0	2	7	0	off	1	rat	8	8.00	0	+0
2	31	1	15	3	0	off	90	43	0	7	0	off	1	rat	1	1.00	0	+0
1	31	2	15	0	2	off	89	0	3	0	0	off	1	rat	4	4.00	0	+0

LFO		pitch	ampl	sensitivity	bias mod	keybd mode:	POLY
wave:	SAW UP	direct:	0	0	pitch: 6	br pch:+ 0	porta mode:	FULL
speed:	35	wheel:	50	0	ampl: 0	br egb: 0	porta time:	0
delay:	0	breath:	0	0			bend range:	0
sync:	off	foot:	0	0			foot volum:	99

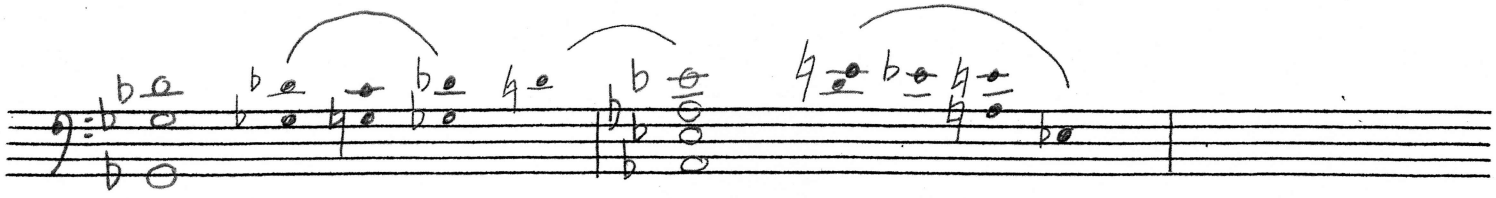
Analytical material on *Red Shift* follows. After the handwritten analysis of pitches and timing there is an explanation of Exponential Structure.

Lois V Vierk : Red Shift

analysis of pitch and timing



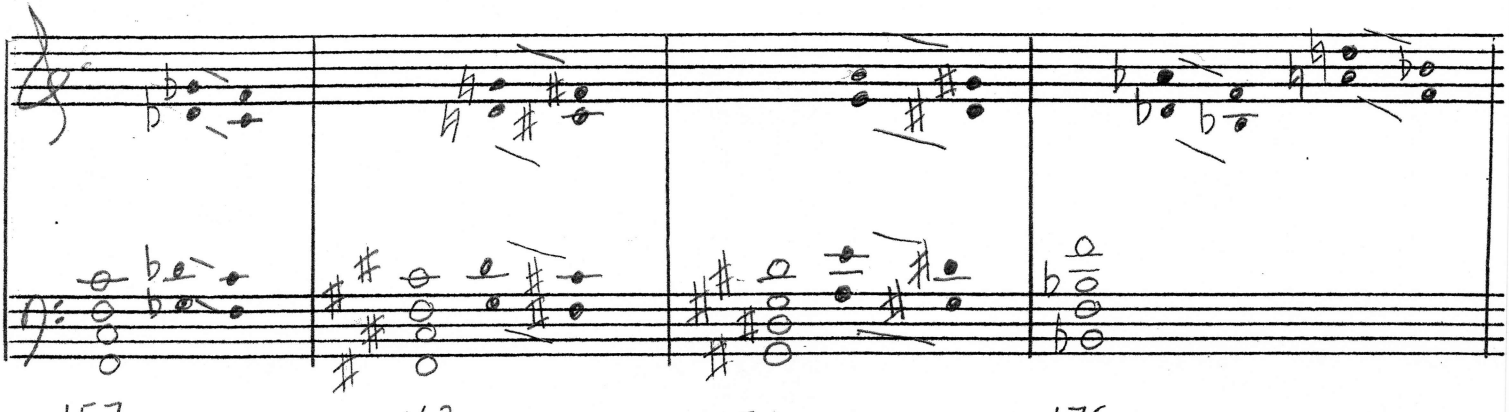
(D)



143.
22

150.
21

(E)



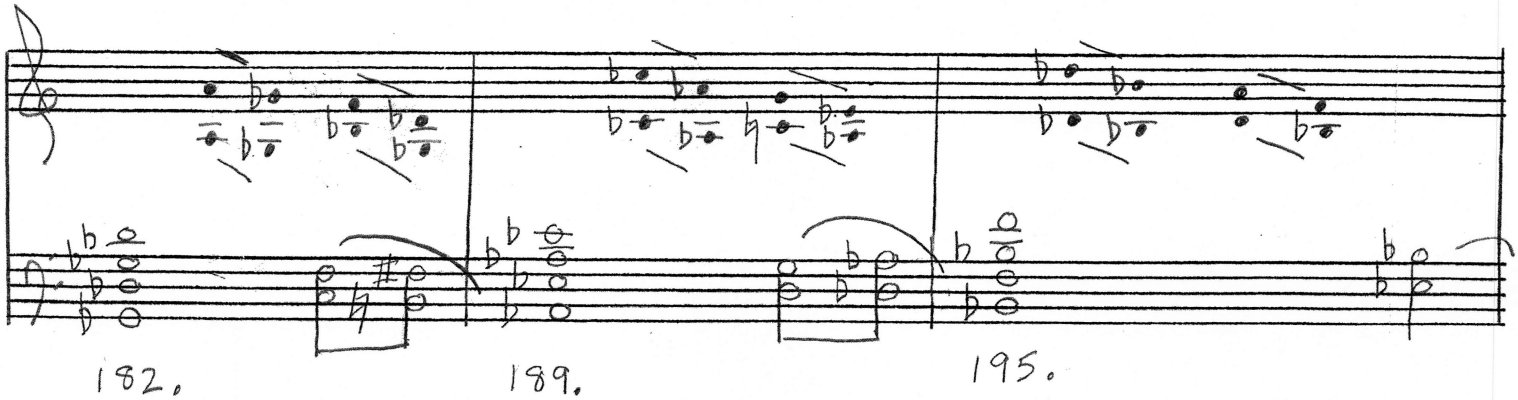
157.
21

163.
20

170.
19

176.
18

(F)

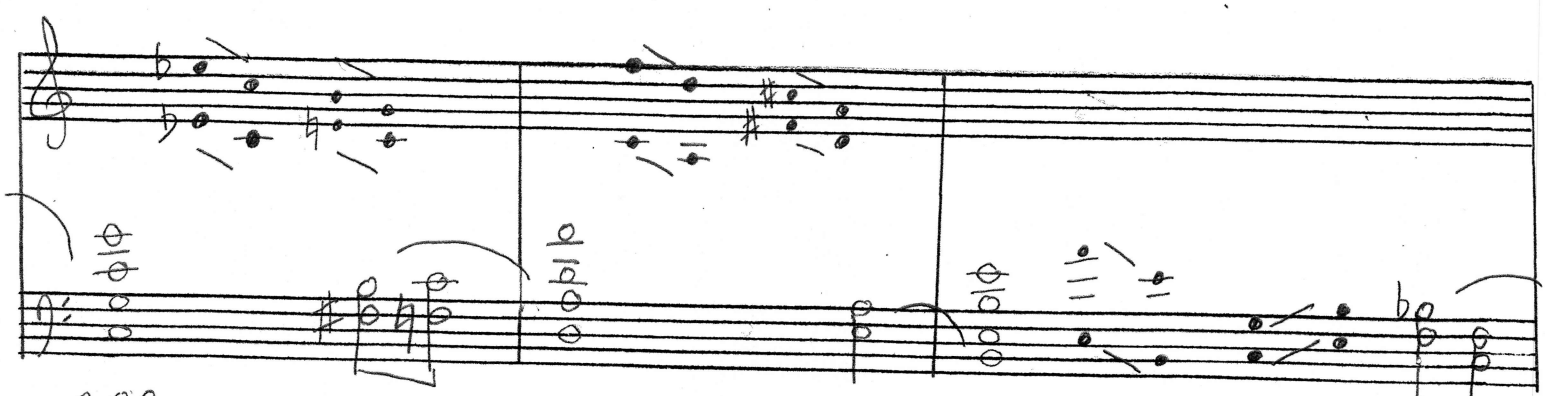


182.
19

189.
17

195.
12

G

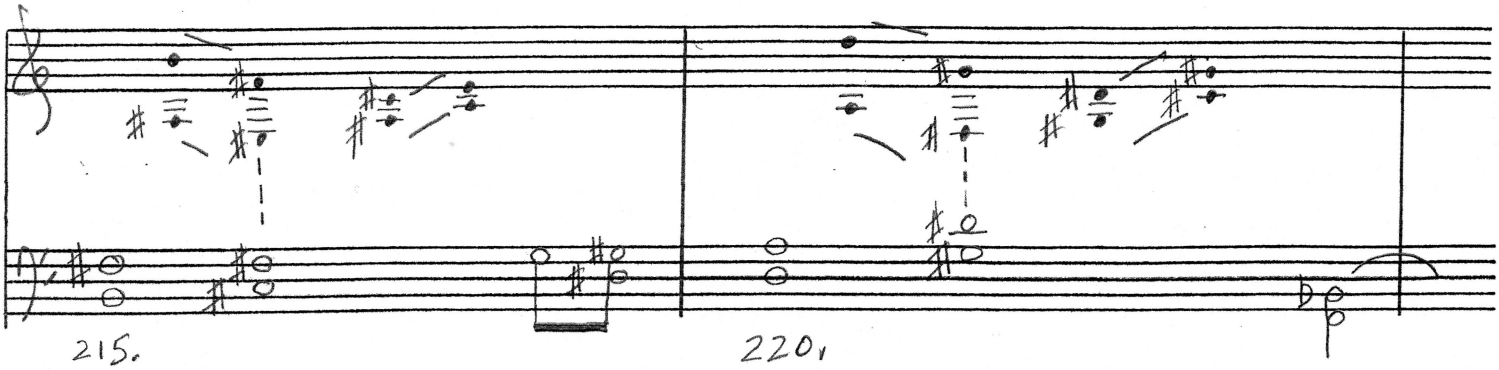


200.
15

206.
14

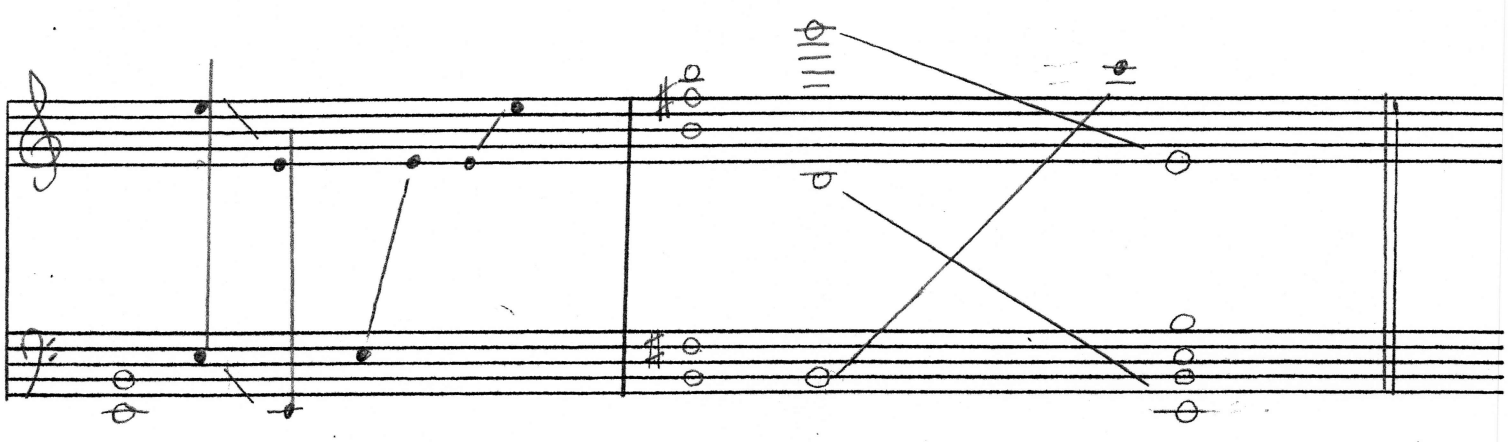
211.
9

H



215.
12

220.
12



225.
44.5

252.
13

260.

This is an explanation of my Exponential Structure, principles of organization of sound and time which I have used in many of my works. Exponential Structure is clearest in some of my pieces which reach high energy climactic conclusions, such as *Timberline*, *Simoom*, *Manhattan Cascade, Red Shift, Words Fail Me (2nd movement)*, and *Cirrus* (this last one reaches a high energy conclusion towards the end, then backs down into a lyrical ending). These pieces use Exponential Structure for the entire work or movement. Other compositions, such as *River Beneath the River*, use Exponential Structure for sections of the piece but not for its entirety. Following is a document for people who want to delve just a little into mathematics. I thank David Sulzer PhD, aka Dave Soldier, for helpful comments as I was writing what's below.

2022Aug4

Exponential Structure:
Organizational Principles in some of my Compositions, using *Timberline* as an Example

by Lois V Vierk

In the 1980s I began crafting principles of sound organization using what I call Exponential Structure. The impetus for this came from my interest in sensory perception. I'd been reading about how the body processes sensory stimuli and I had learned that the amount of stimulation that we take in via our senses is measured and described mathematically in exponential terms rather than in arithmetic terms. The one exception is the length of a line: if someone looks at two lines it can easily be judged that one line is, say, about twice as long as the other. The line is perceived as twice as long and it actually is twice as long. However in other situations it is not so simple, as confirmed by many scientific experiments. For example, sensory stimuli (such as loudness of sound, brightness of light, amount of pain, etc.) that are perceived by a human as "twice as much" or "three times as much" or "four times as much" as the reference stimulus, do not have two, three, or four times the amount of energy as the reference. It might rather be some number squared, cubed, to the 4th power, for example, compared with the reference. Explorations of different sensory stimuli have produced a different exponential equation, a different mathematical curve, for each one.

I thought it would be interesting to apply such exponential ideas to time and to rates of development and change of musical material. I did this is various ways in various pieces. The simplest manifestation of Exponential Structure in my music concerns the amount of time in sections of the work as ever-decreasing by a mathematical factor instead of by subtraction. One of my pieces that demonstrates this Exponential Structure is *Timberline*, as discussed below. The result of using such a structural tool in this case is sustained energy over a period of time, with the energy building up gradually to a climactic conclusion as time segments decrease and musical complexity increases. My music, though, does not seek to present an abstract mathematical concept as art. Exponential Structure is one tool of many that I use in the service of composing music.

Timberline was composed in 1991 for the Relâche Ensemble of Philadelphia (flute, clarinet, bassoon, viola, contrabass, piano/synth, percussion). I began work in my usual way, working with players in order to understand as much as I could of the possible instrumental sounds and playing techniques. I made many pages of sketches of musical materials. Based on sketched materials, I determined that the piece would consist of two parts. In the first part, the materials and methods of developing materials would be gentle and lyrical. It would be close to 6 minutes. The second part would be longer, close to 11 minutes, and would be persistent and unrelenting in the way it would unfold. It would gradually develop from simple phrases to a more complex high energy climax. These decisions informed the equations that I then developed.

Timberline uses two different exponential equations to define the two parts of the piece - beginning through Letter J, and then Letter K to the end. The anticipated tempo for the first part

was quarter note = 50 (though later this was changed to quarter note = 60, because the faster tempo worked better with the sounds and phrases). The first part of the piece was imagined to be a little under 6 minutes, actually 353 seconds, or 294 beats at the anticipated tempo. The number of sections in the first part of the piece was defined to be 11, based on my musical materials.

The equation for first section - beginning through Letter J - is below. The mathematical constant for producing the values by which to multiply the number of beats in the previous segment was set at .97, a number which for these purposes can be considered somewhat close to "1". (Setting the constant to "1" itself would produce no change in time of the segments. A number close to "1" would yield a small change.) Solving for "x" in the equation below gives the value 31, the number of beats in the opening section. The time in the rest of the sections, which sections are denoted by Letters and defined by changes of pitch center, are gently decreasing until the end of the first part of the piece.

$$x + .97x + .97^2x + .97^3x + .974^x + .97^5x + .97^6x + .97^7x + .97^8x + .97^9x + .97^{10}x = 294$$
$$x + .97x + .94x + .91x + .89x + .86x + .83x + .80x + .78x + .76x + .73x = 294$$
$$x \approx 31$$

So the sequence of numbers for beats in each section is approximately:

31, 30, 29, 28, 27, 27, 26, 25, 24, 24, 23

As noted before, the actual tempo was set later to quarter note = 60, but the above equation was basically followed. The length of the first part of the piece at this tempo is about 5 minutes.

The second part of the piece was desired to be close to 11 minutes long. Based on the musical materials, the tempo was set at quarter note = 66. The second part was defined to be 708 beats. The number of sections was defined to be 10. A much smaller multiplier was chosen for this second equation (.85 as opposed to .97) with the result being that the ongoing decrease of the time in the sections (again denoted by Letters and defined by pitch center) is more drastic. The musical changes are propelled at a faster rate as the piece rushes to its conclusion. Again, the numbers serve the music, not vice versa. For example, the equation's numbers are followed fairly closely until letter R, when the piece is nearing its arrival point, at Letter T. From letter R to the end the timing of sections is intuitive.

The equation for the second section, Letter K to Letter T, is below.

$$x + .85x + .85^2x + .85^3x + .85^4x + .85^5x + .85^6x + .85^7x + .85^8x + .85^9x = 708$$
$$x + .85x + .72x + .61x + .52x + .44x + .38x + .32x + .27x + .23x = 708$$
$$5.34x = 708$$
$$x \approx 132$$

So the sequence of numbers for beats in each section is approximately:

132, 112, 95, 81, 70, 59, 50, 42, 36, 31

The above equation was basically followed for much of the second part of the piece, with notable exceptions as explained on the next and last page.

equation number of beats	actual number	comments
beginning - 31 beats	33	From the beginning through Letter J, differences in timing are mainly due to carrying out lengths of phrases.
Letter A - 30 beats	30	
Letter B - 29	29	
Letter C - 28	28	
Letter D - 27	27	
Letter E - 27	28	
Letter F - 26	24	
Letter G - 25	25	
Letter H - 24	22.5	
Letter I - 24	21	
Letter J - 23	18	

(So far this is a very gentle decrease in beats from section to section, perhaps not even picked up as ever-decreasing time segments by the human ear/brain. This is in contrast to the second and final part, with time segments decreasing at a faster pace.)

Letter K - 132	159	Musically, Letter K, beginning of 2nd part of the piece, needed to be longer than in equation.
Letter L - 112	114	
Letter M - 95	99	
Letter N - 81	79	
Letter O - 70	70	
Letter P - 59	60	
Letter Q - 50	47	
Letter R - 42	28	The musical arrival, climax of the piece, is reached at Letter T. In preparation, the timings of sections Letter R and Letter S are intuitive and not controlled by the equation. Note that the equation itself ends with Letter T. More time was added at the end in order to carry out the development of musical materials and the piece as a whole.
Letter S -36	40.5	
Letter T - 31	18	
Letter U - not in equation	29	
Letter V - not in equation	22.5	

Score is available from Frog Peak Music

http://frogpeak.org/

For performance questions please contact the composer

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